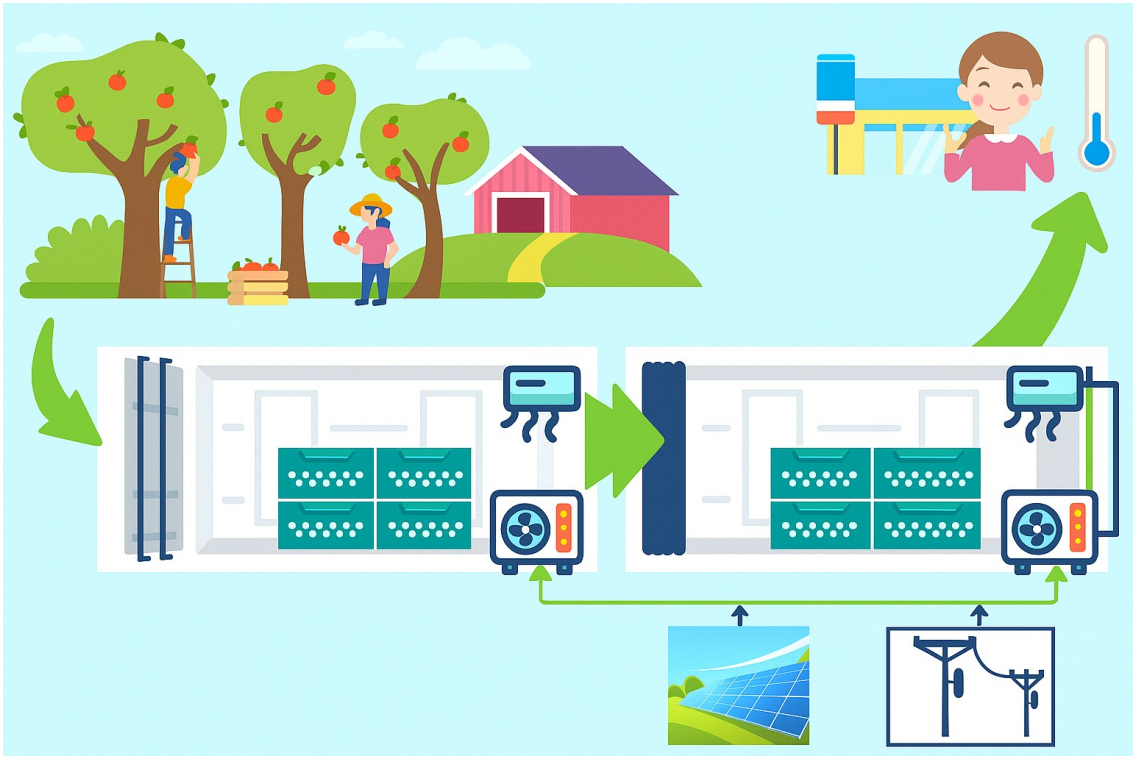
Feasibility research of Solar Electric-Based Cold Warehouse equipped with Low-temperature Latent Heat Material for Fruit Storage in Bangladesh Climate Conditions



Deliverable 1.1 Project initiation and kick-off

April, 2025 |

1. Online Kick-off Meeting

An online kick-off meeting was held in relation to the CTCN project. The meeting was attended by KITECH, Pacific Solar, Bangladesh NDE, and CTCN.

The aim of the CTCN project is to build a cold storage system in Bangladesh that combines solar power and thermal energy storage (TES), and to evaluate the applicability and effectiveness of this technology by providing a demonstration.

Agriculture accounts for a large share of Bangladesh's economy and food security, but significant losses occur due to a lack of post-harvest storage infrastructure. Cold storage facilities are particularly scarce in rural and remote areas, resulting in large quantities of produce being wasted before it can be consumed. Solar-powered refrigeration systems have been proposed as an alternative and are gaining traction as a sustainable, environmentally friendly technology. However, as solar power does not generate electricity at night or on cloudy days, so energy storage technology is essential to fill this gap. Therefore, this project aims to install a cold storage system combining a solar system and thermal energy storage technology.

In relation to the project, KITECH proposed a refrigerated storage system combining solar power generation and thermal energy storage technology (TES). The system consists of a solar power generation facility, a thermal energy storage cooling system based on LHM (Latent Heat Material), and two 20-ft containers, one for pr-cooling and one for storage. The system will be built in Bangladesh and operated to enable flexible power usage according to local conditions to evaluate the applicability and effectiveness of this technology.

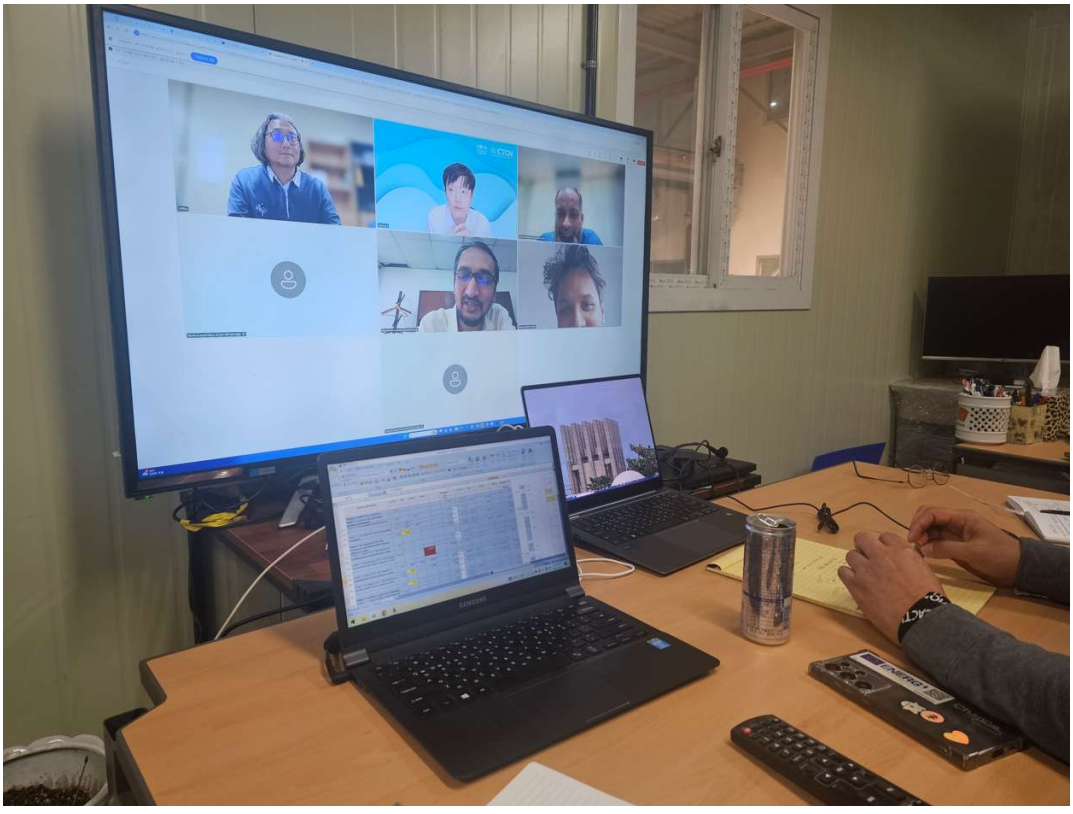
KITECH explained the overall contents of the project and the cold storage warehouse system and thermal energy storage technology combined with solar power generation and thermal energy storage technology to be implemented. The explanation is as follows.

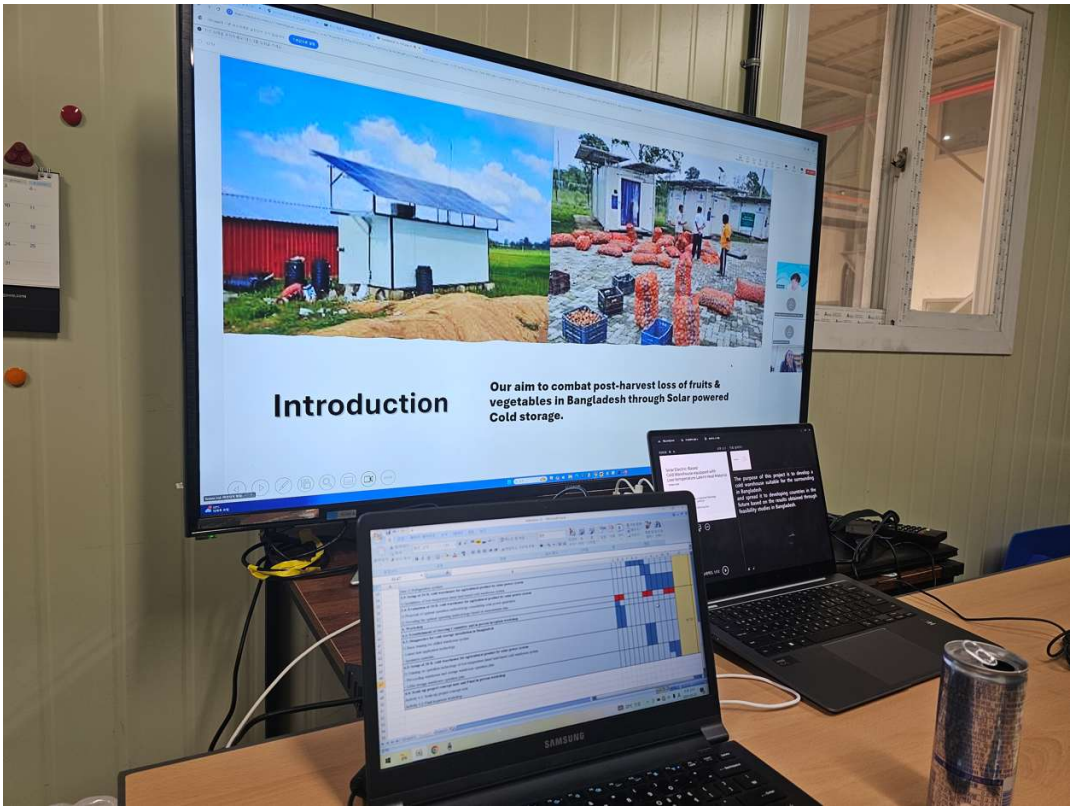
- CTCN project background
    - Bangladesh's agricultural sector, critical to food security and economic stability. However, it is suffering significant post-harvest losses due to a lack of refrigerated storage facilities.
    - There are inadequate refrigerated storage facilities, particularly in rural and marginalized areas.
    - Solar-powered cold storage provides a sustainable solution.
    - However, technology is needed to store thermal energy during periods of time when solar power is not being generated.
    - In this project, we intend to implement a cold storage system for harvested agricultural products in Bangladesh that combines solar power and thermal energy storage technology(TES), with the support of UNEP CTCN, to investigate its feasibility.

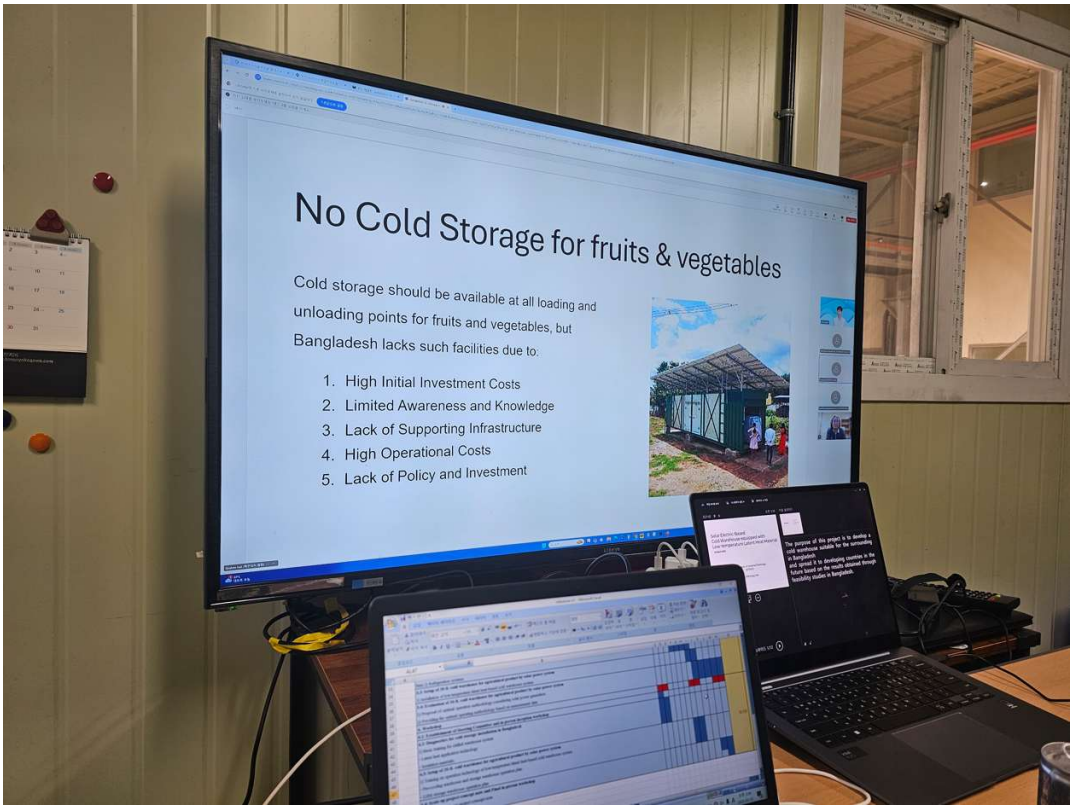
- CTCN project goals
    - Development of a pilot-scale cold warehouse system for stable storage of harvested agricultural products

- CTCN project technical description
    - PV system
        - Calculate the heat load of two containers and an LHM cold storage warehouse to determine the correct capacity of the solar panel capacity.

        - PV systems are manufactured and installed in Bangladesh.
        - Installation of an ESS (2-4 kWh) to support the electrical system
        - LHM thermal chamber design and manufacturing
        - The LHM-based refrigeration system unit installation container will be designed and fully manufactured in Korea.
        - The manufactured containers will be shipped by sea and assembled with cold storage warehouses.
- 20-ft container design and manufacturing
    - 20-ft container consists of two units: one for pre-cooling and one for cold storage.
    - Heat load calculation for 20-ft container.
    - 20-ft containers will be designed and manufactured in South Korea.
    - 20-ft containers will be shipped by sea to Bangladesh for local assembly.
- System operating methodology
    1. Cold storage warehouse operation using location's power.
    2. Cold storage warehouse operation using solar panels.
    3. Cold storage warehouse operation using a combination of the location's power and solar panels.
    4. Cold storage warehouse operation with LHM storage warehouse using location's power.
    5. Cold storage warehouse operation with LHM storage warehouse using solar panels.
    6. Cold storage warehouse operation with LHM storage warehouse using location's power and solar panels.




Introduction
Our aim to combat post-harvest loss of fruits & vegetables in Bangladesh through Solar powered Cold storage.


No Cold Storage for fruits & vegetables
Cold storage should be available at all loading and unloading points for fruits and vegetables, but Bangladesh lacks such facilities due to:
1. High Initial Investment Costs
2. Limited Awareness and Knowledge
3. Lack of Supporting Infrastructure
4. High Operational Costs
5. Lack of Policy and Investment

2. Time line

- March, 2025
    1. Project contract
    2. Establishment of Steering Committee and inception workshop
    3. System basic design completed (PV, LHM system, Container)
- APRIL, 2025
    1. On-site investigation through visits to sites where demonstration technology will be applied (KITECH, Dr. KIM)
    2. Visit to PV system manufacturing and installation company
    3. System design modifications and decisions (PV, LHM systems, containers)
    4. Bangladesh PV System Manufacturer Selection Completed
- May - September, 2025
    1. Design of cold warehouse
    2. Operation monitoring & control system design
    3. Manufacturing of cold warehouse
        - Insulation panels for warehouse
        - Refrigeration systems
        - LHM modules
    4. Bangladesh site visit (Final check)
- October, 2025
    1. Setup of cold warehouse
        - Pre-cooling warehouse
        - Cold storage warehouse
        - LHM cold storage warehouse
    2. Training on operation technology of warehouse system
- November, 2025 - January, 2026
    1. Evaluation of cold warehouse
        - Providing the optimal operating methodology
        - Proposal of optimal operation methodology considering power system
    2. Technical feasibility (Commissioning and operational aspects)
    3. Socio-economic and financial analysis
    4. Feasibility report and stakeholder consultations (Communities and government)
- February, 2026
    1. Writing a concept note for a scale-up project
    2. Final workshop

3. Annex

3.1 Workshop material

The online workshop material is attached in a PPT format..

Solar Electric-Based Cold Warehouse equipped with Low-temperature Latent Heat Material

25 March 2025

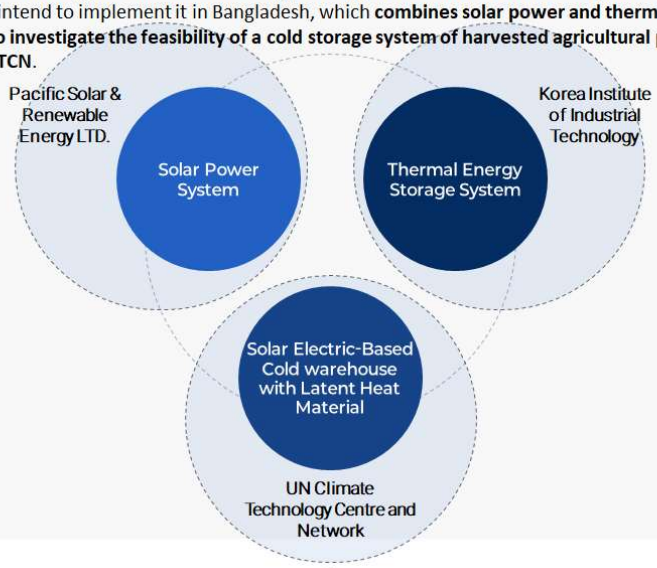
Korea Institute of Industrial Technology
(KITECH)

Dr. KIM Jeong-Yeol

Contents

I Backgrounds

- Bangladesh's agricultural sector, critical to food security and economic stability, is suffering significant post-harvest losses due to lack of refrigerator storage facilities.
- There are no adequate refrigerated storage facilities, especially in rural and marginalized areas.
- Solar-powered cold storage provides a sustainable solution.
- However, we need technology to store thermal energy **during periods of time when solar power is not generated**.
- **In this project**, we intend to implement it in Bangladesh, which **combines solar power and thermal energy storage technology(TES), to investigate the feasibility of a cold storage system of harvested agricultural products with the support of UNEP CTCN**.



II Objectives

A Final Goal

Development of a pilot scale cold warehouse system for stable storage of harvested agricultural products

How to Reduce Energy Costs
How to Maintain the Quality of Products

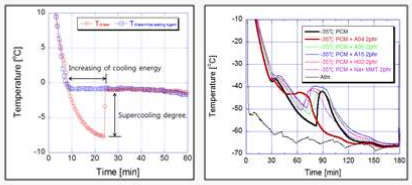
II Objectives

B Key Technologies of KITECH

Latent heat storage technology

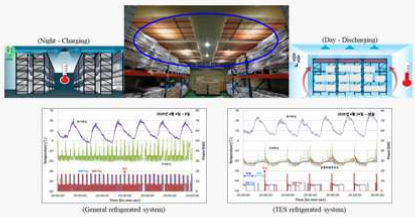
1. Development of LHM

2. Nucleating Technology (Release of super cooled, etc.)



Cold chain system operation know-how

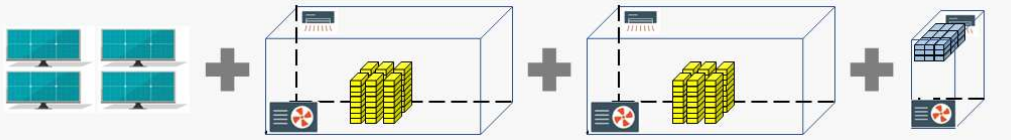
1. Cold Warehouse Energy Saving



2. Holdover Refrigerated Truck System

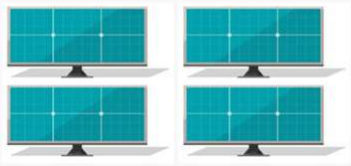
III Technology Solutions

A Pilot Scale Cold Warehouse System



PV System | Pre-cooling warehouse | Cold storage warehouse | LHM cold storage Unit

B PV System



1. Calculate the heat load of two container and LHM cold storage warehouse to determine the correct capacity of the solar panel
2. PV systems are manufactured and installed in Bangladesh
3. Installing and ESS (2~4 kwh) to support electrical system

III Technology Solutions

C LHM Thermal Chamber Design and Manufacturing

LHM Material | Module | Refrigeration System

1. The LHM-based refrigeration system unit installation container will be designed and fully manufactured in Korea.
2. The manufactured containers will be shipped by sea and assembled with cold storage warehouses.

D 20-ft Container Design and Manufacturing

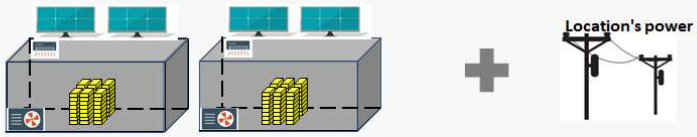
Insulation Panel | Heat Insulated door | Refrigeration System | Measurement System

1. 20-ft container consists of two units: one for pre-cooling and one for cold storage
2. Heat load calculation for 20-ft container
3. 20-ft containers will be designed and manufactured in South Korea
4. 20-ft containers will be shipped by sea to Bangladesh, and it will be assembled locally

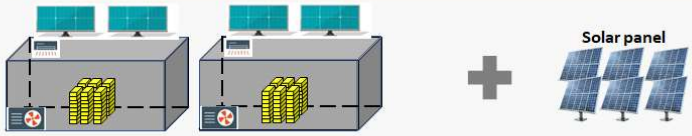
III Technology Solutions

E System Optimization (Operating methodology)

Scenario 1_Cold storage warehouse operation using location's power



Scenario 2_Cold storage warehouse operation using solar panel

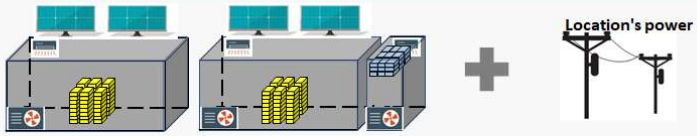


Scenario 3_Cold storage warehouse operation using location's power and solar panel

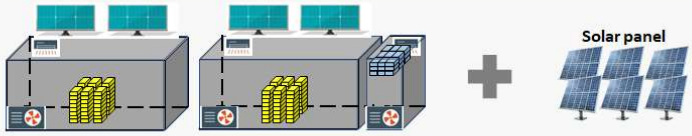
III Technology Solutions

E System Optimization (Operating methodology)

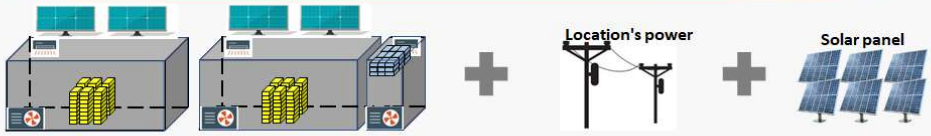
Scenario 4_Cold storage warehouse operation with LHM storage warehouse using location's power



Scenario 5_Cold storage warehouse operation with LHM storage warehouse using solar panel



Scenario 6_Cold storage warehouse operation with LHM storage warehouse using location's power and solar panel



III Technology Solutions

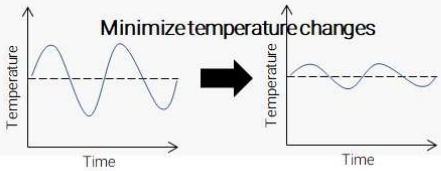
F System Operation from Harvest to Storage

Mango farm
Atmospheric temperature : 35℃

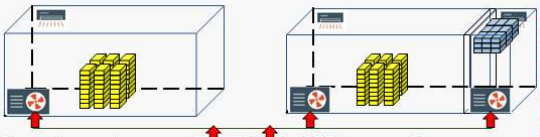
Put harvested mangoes (fruits) into boxes of a constant size

Electricity energy cost ↓

Maintain good quality ↑



Day time

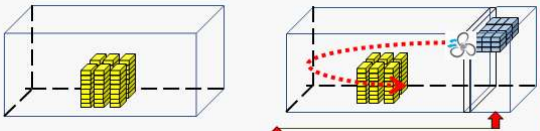


Pre-cooling warehouse
Indoor temperature : 20~25℃
- Day time : Using chiller

Cold storage warehouse
Indoor temperature : Below 15℃
- Day time : Using chiller

LHM cold storage warehouse
- Day time : Freezing LHM module using chiller

Night time



Pre-cooling warehouse
- Night time : Not used chiller

Cold storage warehouse
Indoor temperature : Below 15℃
Night time : Not used chiller
Using LHM module

LHM cold storage warehouse
- Night time : Not used chiller

IV Time Line

A March, 2025

1. Project contract
2. Establishment of Steering Committee and inception workshop
3. System basic design completed (PV, LHM system, Container)

B APRIL, 2025

1. On-site investigation through visits to sites where demonstration technology will be applied (KITECH, Dr. KIM)
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D October, 2025

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4. Feasibility report and stakeholder consultations (Communities and government)

F February, 2026

1. Writing a concept note for a scale-up project
2. Final workshop

Thank you for your attention

3.2 List of attendees

Attached is the list of attendees for the online workshop.

	Name	Organization	Positions	E-mail
1	Jeong-Yeol Kim	KITECH	Principal Researcher	esperant@kitech.re.kr
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4	Hoyoung Jo	CTCN	Climate Technology Specialist	hoyoung.jo@un.org
5	Ibrahim Lodi	Pacific Solar & Renewable Energy LTD.	Managing Director	pacific.xpo@gmail.com
6	Mirza Shawkat Ali	Department of Environment	Director	mirzasa1@yahoo.com
7	Md Mirza Asadul kibriya	Department of Environment	Inspector	mirza.doe@gmail.com
8	Md Harun Or Rashid	Department of Environment	Deputy Director	harun.rs83@yahoo.com