

Solar Panel Micro Cool Chamber (5 M.T.)

Introduction

A large percentage of population in the country is dependent on agriculture livelihood. Though it is important to increase productivity and produce more from the same acreage of land it is also important to manage the produce well post-harvest. It has been analyzed that 2/3 rd of this wastage happens on the farm level. The wastage is 0.5-4% in food grains and 4%-18% in different horticulture crops, the latter evidently being high value and more perishable.

This calls for a clear step in terms of post-harvest management at the first mile i.e. the farm to arrest the value loss.

There is a clear co-relation between availability of power and the viability of the cold storage facilities. Operation cold storages in regions without at least 18 hrs/day availability of power in unviable. Alternately diesel generators are used as a power source, which are costly and unviable.

Objective: A step towards Micro Cold Revolution in agriculture

To address majority of these challenges, a small scale cold storage system is developed that will operation sustainable power source at the source. Micro Cold storage system/cold Room owned by a farmer will enable him to time the market right. It will de-risk the farmer and give him negotiation leverage as compared to being forced to sell due to fear of perishing commodities thereby leading to lower prices. Act as both pre-cooler as well as cold storage. Having both storage and pre-cooling facilities at source through will also enable excellent produce quality to last for longer durations thus allowing the producers pursue farther markets and boosting exports. It will further add on to reducing the loss of value which happens at the production source.

Be powered by Solar and uses innovative thermal storage technology for 24-30 hours' backup during the non-sunshine hours. The passive thermal design allows for efficiency close to 100% and works on radiant cooling than forced convection alone.

The system is portable and it can shifted from one location to another. The system also has the capability to charge itself completely with just 6-8 hours of grid power. It will automatically detect critical conditions and switch to grid and charge the system in case of poor sunshine days.

Present scenario of Horticulture production in Bihar

Bihar produces about 11.64 Mil MT of horticulture produce accounting for 10 % of horticulture production in the country. Fruit crops were grown in an area of 301.5 (ha- 000) in the State with a production of approx. 4249.2 (MT- 000). Major fruits grown are Mango, Guava, Litchi, Banana etc. Vegetables were grown in an area of 861.8 (ha -000) with production of 16325.7 (MT- 000) Almost all vegetable crops like cucurbits, beans, okra, onion and other root crops are widely grown successfully in the state. The total production flowers in the State is 10.37 Thousand MT. Bihar State is the major producer of the fruits and vegetables in country, but according to estimation as much as 25-40% of fruit and vegetable production is lost on account

of lack of adequate post-harvest infrastructure. Agriculture produce of the farmer don not get remunerative prices due to lack of Cold Storage facility.

Requirement of Cooling System

In Bihar seventy-nine percent populations depends on Agriculture. Upliftment of these farmers can improve the overall status of the State. The farmers cultivate Mango, Guava, Litchi, Lemon, Pineapple, cabbage, cucumber, capsicum, bean, onion, tomato, Brinjal, Chilly etc. Similarly, these commodities have also limited life after harvest. Post-Harvest cooling rapidly removes field heat, reduces respiration activity, reduce internal water, reduce wilting, slows down the growth of microorganism and reduce the production of natural ripening agent i.e. ethylene. Post-Harvest cooling also provides marketing flexibility by allowing the grower to sell produce at the most appropriate time. Unavailability of cooling and storage facilities makes it necessary to market the produce immediately after harvest. This can be an advantage to growers who wait to assemble truck load for transportation to other places. Post-Harvest cooling can be an effective tool to deliver highest quality produce to the consumer. Intervention through Post Harvest cooling will help farmers to store their produces and market them at the opportune time.

Necessity of Cold Room

The concept of cold room is to store vegetables, fruits and flowers for shorter duration and sell it without deterioration of the product, Farmers will also get appropriate value of the product. It will reduce the distress sale. The farmers can establish cold rooms having 5 MT capacity where the storing of surplus quantities may vary from 50 quintals. Since the investment of such cold room is low a farmer can easily establish a cold room to store his surplus products. Bihar has been plagued by substantive losses of fruit and vegetable output effected by lack of adequate cold storage.

➤ **Technology Overview**

Background

A large percentage of population in the country is dependent on agriculture for livelihood. Though it is important to increase productivity and produce more varieties and products from the same acreage of land it is also important to manage the produce well postharvest. The wastage is 0.5-4% in food grains and 4%-18% in different horticultural crops, the latter evidently being high value and more perishable.

This calls for a clear step in terms of post-harvest management at the first mile i.e. the farm to arrest the value loss. There is a clear co-relation between availability of power and the viability of the cold room facilities. Operating cold rooms in regions without at least 18 hrs/day availability of power is unviable. Alternately, diesel generators are used as a power source, which are costly and unviable too.

Solar micro cold room, is a small-scale standalone hybrid solar powered cold room meant to store fresh fruits, vegetables, flowers, processed foods and other perishable commodities. It is a pioneering product in the cold chain space that bundles various innovations together.

The unit is a solar powered cold room with thermal storage backup for storage of fresh produce – fruits, vegetables & flowers specifically. The unit has dimensions of 20 ft x 8 ft x 8 ft with solar panels mounted on the rooftop of the unit. maintains a temperature in the range of 4°C to 10°C and can maintain 80-95% relative humidity.

system has battery-less compressor operation. A small battery is provided to operate only the auxiliary loads and the control system.

product enables both pre-cooling and storage of perishables to preserve their freshness and maximize shelf life. It comes with every feature of an ideal cold room and is completely standalone. It can be hybridized with any other source of energy as the need be.

The product fits conveniently at various nodes in the cold chain, offering lucrative value propositions for each customer. Its robust and smart controls enable maintaining temperature, humidity and air quality parameters at just the right levels inside the storage volume. The very intuitive human-machine interface provides a hassle-free and an unparalleled user experience.

The unique battery-less back-up system provides cooling for several non-sunny hours and even on the next day. The thermal storage technology entails minimum maintenance and operational costs.

➤ **Objective : A step towards**

Micro Cold Revolution in Agriculture

To address majority of these challenges, , a small scale (micro) cold room system is developed that will operate on sustainable power source. micro cold room owned by a farmer will enable him to time the market right. It will de-risk the farmer and give him negotiating leverage as compared to being forced to sell due to fear of perishing commodities thereby leading to lower prices. can act as both pre-cooler as well as cold room while controlling the humidity of the produce. Having both storage and pre-cooling facilities at source, will also enable excellent produce quality to last for longer durations thus allowing the producers to pursue fater markets and boosting exports. It will further add on to reducing the loss of value which happens at the production source.

can be powered by Solar and it uses innovative thermal storage technology for 24-30 hours power backup during the non sunshine hours. The passive thermal storage design allows for efficiency close to 100% and works on radiant cooling than forced convection alone.

The system is portable and it can be shifted from one location to another. The system also has the capability to charge itself completely with just 6-8 hours of grid power. It will automatically detect critical conditions and switch to grid and charge the system in case of poor sunshine days.





➤ **Micro Cold Room**

- 21 metric cube storage capacity
- Solar Powered
- Grid & DG hybridization
- 4 to 10 degree Celsius, 80% - 95% RH



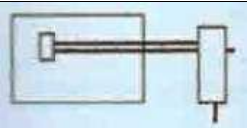



- Pre-Cooling Capable
- Battery Less – Thermal Storage Technology
- Portability
- Remote monitoring & Predictive Diagnostic

Solar Micro Cold Room
(On-Farm pre-cooling and storing facility)

			
Low weight & high strength design	Online monitoring & predictive diagnostics	Room Interior with Thermal Storage	Pre-fabricated & Shipped

➤ Innovation and IP

	NO BATTERY FOR REFRIGERATION	<ul style="list-style-type: none"> • Allows for more effective tapping of solar power, reduces compressor size (patent pending)
	Innovative Thermal Storage Design	<ul style="list-style-type: none"> • Innovative thermal storage design allows for flexibility in cooling levels and includes sensors to determine thermal cooling charge density size (patent pending)
	Unique Control System	<ul style="list-style-type: none"> • Control system enables use of the same cooling solution for different crops with dedicated profiles to maximize crop quality instead of selecting static temperature and humidity values (patent pending)
	Predictive Maintenance	<ul style="list-style-type: none"> • Remote monitoring setup predicts failures, reducing operational & maintenance costs while improving servicing.

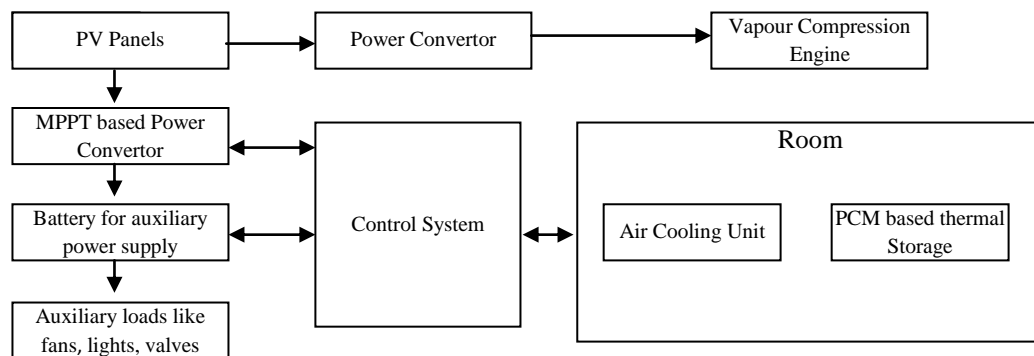
➤ Working Explained

harnesses solar energy from PV panels which is fed directly to the compressor via a drive that works on algorithm developed by us and ensures maximum utilization of solar power generated while accounting for variations in solar insulation, variations in load inside the cold storage





(depending on time of day, amount of produce loaded, location etc.) and user's set points. Cooling is generated due to compressor's operation which is used to cool the room and create back-up in the form of thermal storage system.



The thermal storage system and the room cooling system works in tandem to maintain the set-point at all points of time and ensure that the system has enough back-up to run for the maximum time possible when any power is not available. A part of the solar power generated also charges a small battery which is meant for control system operation and running auxiliary loads.

Below is pictorial representation of the working principle of .



➤ Unique Features

	<p>Thermal Storage Back-up</p> <p>The thermal storage back-up provided by ensures that the system runs for 24-30 hours during non-sunny hours. This is different from a typical thermal storage mechanism where a central back up is created and then disseminated to the room causing inefficiencies.</p>		<p>Remote Monitoring</p> <p>The system is enabled with remote monitoring features that sends minute by minute data on the operational conditions and health of the system.</p>
	<p>Predictive Analytics based maintenance</p> <p>Our technology enables us to do preventive maintenance of the system. This is made possible through our remote monitoring system. The data from this is analyzed to make conclusions on the health of the system even before the downtime is triggered.</p>		<p>Power Electronics</p> <p>The power electronics components which go into the product have been designed for the product which ensure efficient solar utilization, compressor operation and back-up creation.</p>

	<p>Control System</p> <p>The control system is the heart of the product which ensures smooth functioning of the product. Its unique algorithms have been developed in-house to enable the system's operation 24x7.</p>		<p>Battery less compressor operation</p> <p>operates its compressor and maintains temperature of 4-10 degree Celsius without the support of battery. Unique technology innovation helps to work efficiently with a backup of 24-30 hours during non-sunny days without any battery being operated.</p>
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Technical specification of 5 MT solar cold room

The proposed units solar powered cold room with thermal storage backup for storage of fresh produce – fruits, vegetables & flowers specifically. The unit has dimensions of 20ft x 8ft x 8ft with solar panels mounted on the roof top of the unit. The cold room maintains a temperature the range of 4C to 10 degree C. The system has battery less compressor operation. A small battery is provided to operate only the auxiliary loads and the control system.

Technical Specifications

Constructional

Product Dimensions	20ft by 8ft by 8ft
Cold Room insulation	Poly Urethane Foam, 100 mm, 40 +/- 2kg/m ³
Cold Room Body	Pre-painted galvanized iron
Room Door	Insulation : PUF Thickness : 100mm Width : 6ft
Curtains	PVC to reduce Heat infiltration on door openings

Operational Data

Refrigeration TR	(~1.8 TR approx.) @ -5 C Evaporating & 50 C Condensing
Storage Capacity	5 MT depending upon commodity
Temperature range	4-10 Degree C by using set point control as per req.
Humidity Range	80-95% by using set point controlled
Backup Type	Wall Mounted Plate Type Thermal Energy Storage
Backup duration	24-30 hours (non-door opening & 5.5 KW/m ² /day radiation)
Remote Monitoring	Per minute logging, GPRS based, viewable on desktop and Smart phones

Power Source

Auxiliary Battery	24 V 100 Ah
Solar Power Capacity	4 kWp
Alternative Power Source	Grid or DG Hybrid

Commodities fit for Solar Micro Cold Room

1. Fruits					
Sl. No.	Popular Name of Horticulture commodity	Storage Temp. (Degree C)	Storage Humidity (%)	Shelf-life at Room temperature (Days)	Storage-life (Days)
1	Pineapple	10	92.5	2 TO 3	14 TO 21
2	Sugar Apple/Custard Apple	7	87.5	2	3 TO 8
3	Dragon Fruit, Red	10	92.5	4	14 TO 18
2. Vegetable					
Sl. No.	Popular Name	Storage Temp. (Degree C)	Storage Humidity (%)	Shelf-life at Room temperature (Days)	Storage-life (Days)
1	Capsicum Inspiration F1 (Yellow) Bachata F1 (Red)	10	92.5	3 TO 4	14 TO 21
		10	92.5	2.5 TO 3.5	15 TO 21
		10	92.5	2.5 TO 3	15 TO 21
2	Okra	8.9	92.5	3 TO 4	7 TO 14
3	Tomato (Ripe)	9.5	90	3 TO 4	6 TO 8
4	Bean, Snap	5.27	92.5	2 TO 3	7 TO 12
5	Bean, Long	5.27	92.5	2 TO 3	7 TO 10
6	Cucumber	10	92.5	3 TO 5	10 TO 14
7	Green Chilli	4	92.5	3 TO 4	21 TO 35
8	Cabbage	4	92.5	2.5 TO 4	UP TO 14
9	Broccoli	4	92.5	1	2.5 TO 3
10	Ridge guard	10	92.5	2	3 TO 8
3. Flowers					
Sl. No.	Popular Name	Storage Temp. (Degree C)	Storage Humidity (%)	Shelf-life at Room temperature (Days)	Storage-life (Days)
1	Marigold	4	92.5	1 TO 1.5	12 TO 18
2	Rose	4	92.5	3	11 TO 21
3	Carnation	4	92.5	5 TO 7	15 TO 24
4	Tuberose	4	92.5	3 TO 4	9 TO 14
5	Gladiolus	4	92.5	3 TO 4	9 TO 14
6	Gerbera	4	92.5	3 TO 4	9 TO 26
7	Chrysanthemum	4	92.5	3 TO 5	12 TO 18
8	Aster	4	92.5	2.5 TO 4	10 TO 14
9	Dendrobium	5	92.5	3 TO 5	18 TO 26
10	Gomphrena	4	92.5	2.5 TO 3	7 TO 16

Table 1. Recommended Optimum Storage Conditions for Fruit, Vegetable and Flower in the solar Cold Room Benefits of micro Cold Room

Benefits of micro cold room

- Minimizing wastage of fruits, vegetable due to improper storage
- Help farmers realize better pricing for their produce by storing and selling at the right time
- The product is battery-less as innovative thermal storage technique has used, so bringing down the maintenance cost of the product

Quotation for solar Micro Cold Room

We are pleased to release the quotation to you to execute the following. The price, Terms & Conditions and warranty are as mentioned below :

Sl. No.	Item	Rate	Nos.	Total
1	Solar Micro Cold Room 5 MT Capacity Refrigeration System - Includes condensing unit, expansion valve, compartment air distribution system	INR 13,00,000/-	1	INR 13,00,000
2	Power System and Control System - 4kWp Solar PV Polycrystalline - Panel Mounting - Drive Control - Power Convertors - Battery			
3	Thermal Storage backup - 24 hours backup			
4	Cold Store Room - 20 ft x 8 ft x 8 ft - PUF Panels - Thickness- 100 mm - PPGI lined - Heavy duty door			
TOTAL				INR 13,00,000

Terms & Conditions

- GST 5% extra or as applicable at the time of dispatch
- Inclusive of DG Set.
- Delivery duration- 30 days from the date of technically clear purchase order
- Transportation and Installation expenses – Rs 1.0 lacs.
- Client scope of work-
 - o Providing shadow free, water logging free cemented area of 300 sq ft.
 - o Ensuring the safety of the product on the site
 - o Product unloading at the site

Warranty Conditions

- Solar Panel-Output wattage, will not be less than 90% at the end of 10 years and 80% at the end of 25 years
- 1 year warranty on the control system battery.
- Onsite warranty support against manufacturing defects for five years is available at an extra cost of 1.5 lacs.

Financial Analysis:

Financial Analysis

Project Cost

Cost of Solar Cold Room (without DG set)	15,10,000
Insurance charges @ 1% p.a.	15,100
Misc. Charges p.a.	10,000
Depreciation @ 10% per year for ten years	1,50,100

Storage Condition & Duration

Crops	Shelf Life at Room Temperature	Storage Conditions Temperature & Relative Humidity	Storage Duration
Capsicum	3-4 days	9.5 Degree Celsius & >92.5% RH	14 – 21 day

Storage Utilization Plan

Storage Utilization of Color Capsicum													
Crops	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Batch Size in Kg	2500	2500	2500	2500	2500	2500	2500	2500					20000
Storage duration in days	15	15	15	15	15	15	15	15					
Number of cycle in Month	2	2	2	2	2	2	2	2					
Total Commodity passing	5000	5000	5000	5000	5000	5000	5000	5000					40000

Revenue Analysis

Crops	Stored quantity (Kg) one acre	Current selling price (INR/Kg)	Peak selling price with (INR/Kg)	Average selling price (INR/Kg)	Cumulative returns based on average price (INR)	Cumulative returns based on prices (INR)	Increase in income due to use (INR)	Cost of cultivation for 1 acre (INR)
Capsicum	40,000	35	80	55	2200000	140000	800000	2,50,000

Farmer Income Analysis (all figures in INR)

Gross farmer Revenue	2200000
Cost of cultivation	2,50,000
Operation expenses (solar cold room) per year	10,000
Risk mitigation factors/insurance @1% p.a.	15,100
Depreciation of @ 10% p.a.	1,50,100
Gross annual expenses excl. capital costs	4,25,200
Net disposable income per year	17,74,800

Project Profit & Loss Analysis (all figures in INR)

Increased income due to use	8,00,000
Operating expense	10,000
Insurance Charges @ 1% p.a.	15,100
Depreciation @ 10% p.a.	1,50,100
Annual Profit due to use	6,24,800

Note/Disclaimer :

The above calculations are based on Ideal conditions however, field conditions may vary depending upon the local area and usage pattern by farmers but, On an average, farmers gets additional income of Rs. 3 to 3.50 lakhs per year

Financing Analysis (all figures in INR)

Project Cost for financing if external financing is required	15,10,000
Bank Loan	7,55,000
Loan Tenure	5
Interest Rate	12
Monthly EMI payable	16,833
Net disposable income per annum as calculated above	17,74,800
Yearly EMI outgo	2,01,996

Financial ratios

Debt service ratio	5.75
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Conclusion

- 1) Project substantially improves quality of the produce reaching end consumers
- 2) Project increases income of the farmer by 36%.