Solar Based Vaccine Refrigerator

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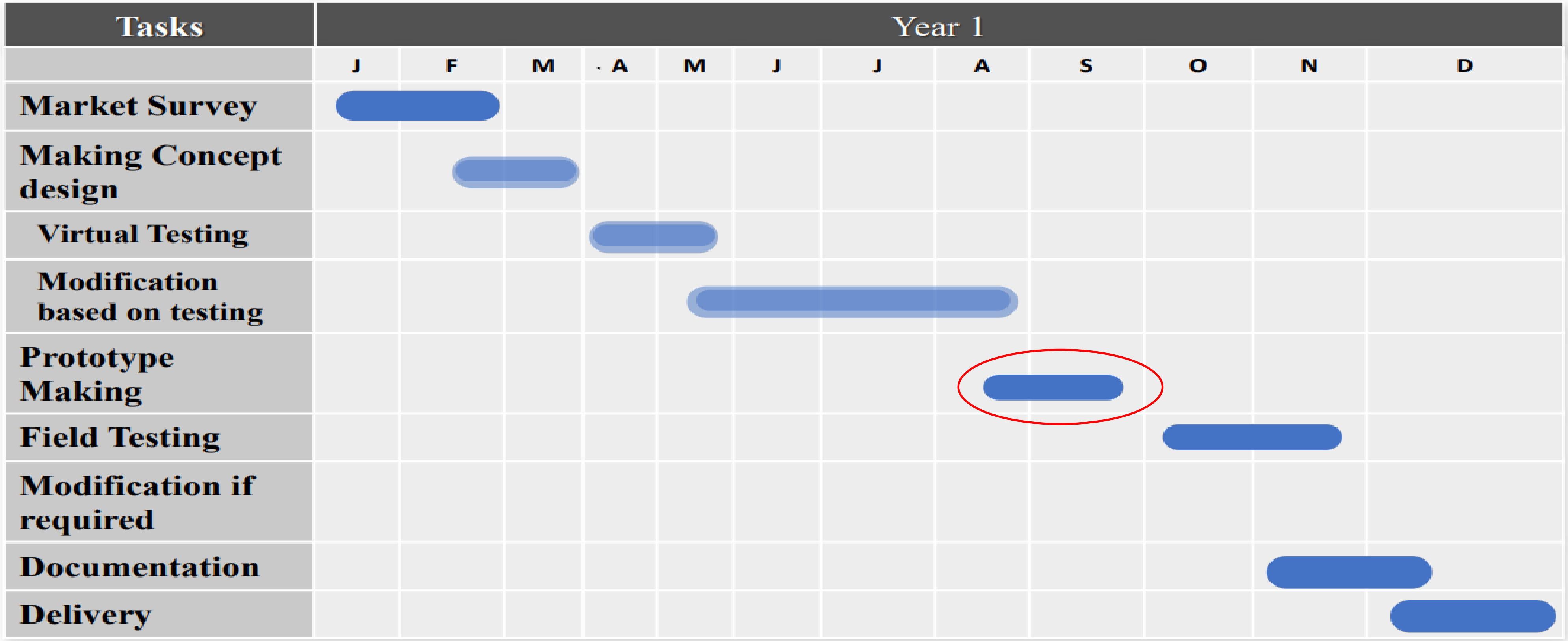
Work Plan & Time * Schedule



*This is an indicative timeline; it can be changed based on the actual work.

As per this plan we are making the prototype for the testing.

Problem Statement

- Transporting vaccines to remote villages where proper cooling facilities are lacking poses a significant challenge. This significant loss underscores the importance of maintaining the vaccines at the correct temperature throughout transportation.
- According to data from the World Health Organization (WHO), approximately half of the vaccines are rendered ineffective during this process, mainly because of the absence of adequate refrigeration during long journeys to distant locations.
- Presently, we rely on traditional methods, such as using iceboxes, which are both cumbersome and inefficient. Firstly, iceboxes are cumbersome and can be challenging to transport to these remote areas, mainly when they are situated in hard-to-reach locations. Secondly, they are often inefficient in maintaining the necessary temperature range for vaccines, leading to a substantial risk of spoilage.
- This problem is mainly concerned with the remote rural areas and the areas where there is either no or less electricity is available in the dispensaries

Objectives

- To maintain the optimal temperature range of 2 to 8° C for vaccine preservation, these regions need reliable long-term refrigeration where electricity is unavailable.

Existing technologies and Gaps

- Current transportation and storage methods in remote regions rely on ice packs that last just a few hrs.
- Some of the existing solar-based vaccine refrigerators are costly
- The Frizer part is attached, which made it bulkier and can't be mobilized to some other places.
- Technology is vapor absorption and those working on vapor compression have very little COP (2-3).

Highlights of Project

- Transporting vaccines to remote villages where proper cooling facilities are lacking poses a significant challenge. According to data from the World Health Organization (WHO), approximately half of the vaccines are rendered ineffective during this process, largely because of the absence of adequate refrigeration during long journeys to distant locations.
- Presently, we rely on traditional methods, such as using iceboxes, which are both cumbersome and inefficient.

Beneficiaries of the project

- This problem has its most significant impact on distant rural areas, particularly those characterized by remote locations, where healthcare facilities, such as dispensaries, face the challenge of either not having access to electricity or dealing with unreliable power sources.
- In these underserved regions, the absence of a stable electrical supply greatly compounds the difficulties associated with storing and administering vaccines effectively. It underscores the urgent need for innovative solutions to ensure the safe and efficient delivery of vaccines to these vulnerable communities.

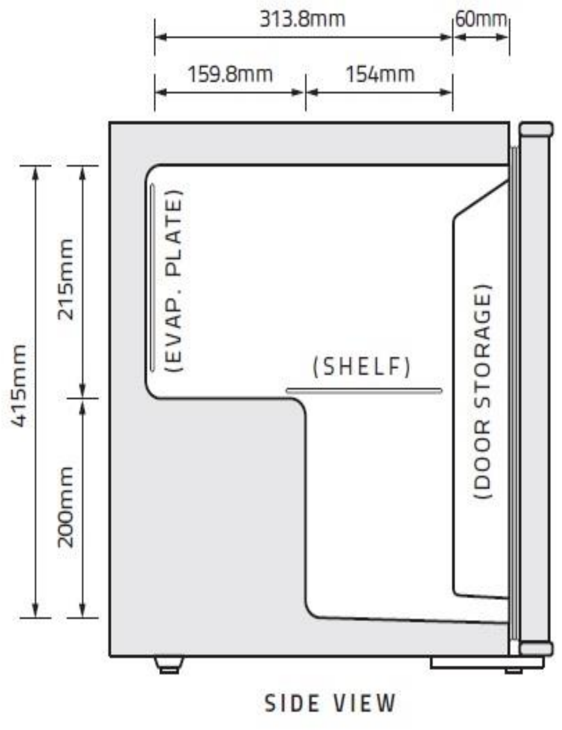
Market survey of existing refrigerator designs.

- We had gone through the existing refrigerator designs and the working principles of the refrigerator.
- In the market, multiple types are available by model type (Top Freezer Refrigerator, Bottom Freezer Refrigerator, Side by Side Refrigerator, and French Door Refrigerator).
- Based on capacity <200 L, 200-499 L, 500-700 L, >700 L.
- State governments offer a capital subsidy, stamp duty exemption, interest subsidy, tax reimbursement, and electrical duty exemption on white goods. These factor is driving the demand for refrigerators. The make in India movement is pushing the supply of refrigerators in the market.
- Freon is a refrigerant gas containing halocarbons used in air conditioning, refrigeration, and dehumidification. Halocarbons that contain chlorine are known as ozone-depleting substances. Increasing refrigeration and air conditioning use are affecting the ozone layer and the absence of repairing facilities in rural areas. These factors are restraining the market growth of refrigerators.

Statement of the Problem

- The transportation of vaccines to remote villages becomes a formidable challenge when these areas lack the necessary infrastructure for proper cooling and refrigeration. According to data compiled by the World Health Organization (WHO), nearly 50% of vaccines transported to such regions lose their effectiveness due to the absence of adequate refrigeration during the extended journeys to these remote locations. This significant loss underscores the importance of maintaining the vaccines at the correct temperature throughout transportation.
- At present, the prevailing approach to address this issue involves using traditional methods, primarily relying on iceboxes. However, this approach has several drawbacks. Firstly, iceboxes are cumbersome and can be challenging to transport to these remote areas, especially when they are situated in hard-to-reach locations. Secondly, they are often inefficient in maintaining the necessary temperature range for vaccines, leading to a substantial risk of spoilage.
- The inefficiency and limitations of the current reliance on iceboxes highlight the pressing need for innovative and more reliable solutions in the field of vaccine transportation. Developing new technologies and methods that can maintain the cold chain effectively in resource-constrained settings is essential to ensure the successful and widespread vaccination of communities in remote areas. This endeavor is critical in our global efforts to improve healthcare access and reduce the prevalence of vaccine-preventable diseases among underserved populations.

- Market Observation: During our market research, we noticed the availability of mini refrigerators that align with the design principles we have outlined for our project.
- Suitability for Our Design: These mini refrigerators appear to be a viable match for the design specifications we have defined. Their dimensions closely resemble those of our project design.



Reference of Mini refrigerator

Our refrigerator design

A comprehensive survey involving solar panels near Kamkole village, located in the Sadashivpet region. This survey aims to gather valuable information regarding the current state and usage of solar panels in this area.

These pictures will serve as essential visual documentation, helping us assess the extent of solar energy adoption and infrastructure in the community.

- **Here are the key points:**

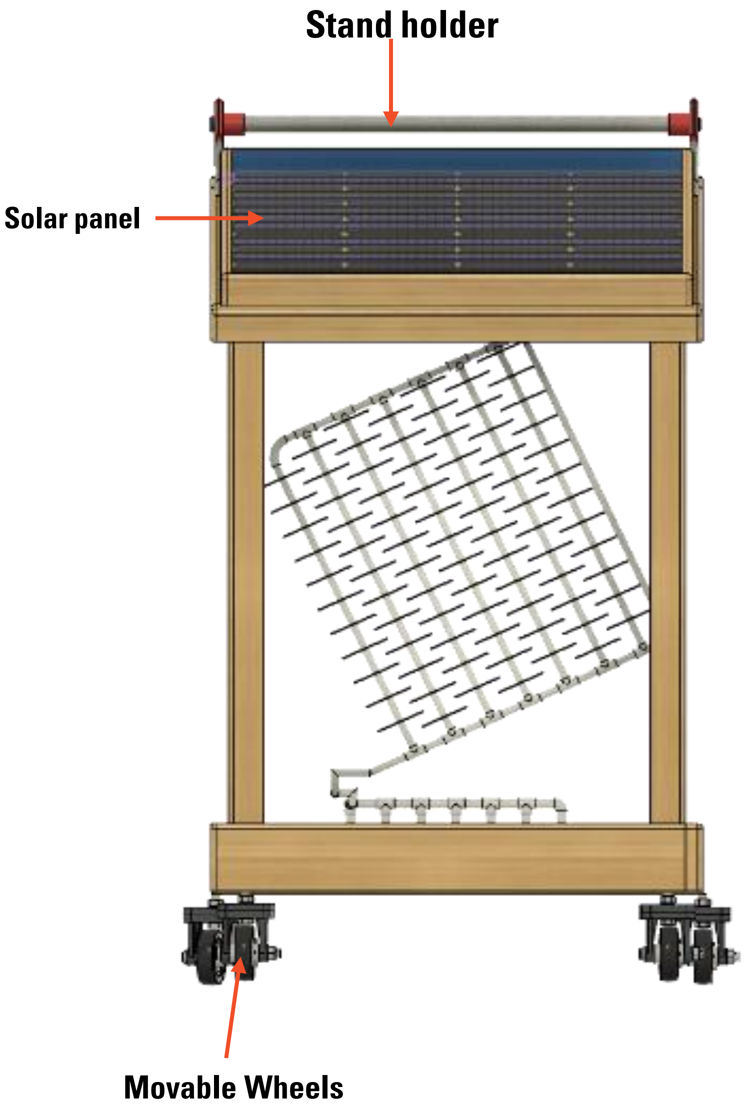
  Incorporation of Stand Holder and Wheels: We have added a stand holder and wheels to the base of the vaccine transportation system to facilitate easier carrying and enable pushing and pulling, especially in challenging terrain.

- **Utilization of Standard Refrigeration Components:** The system uses familiar materials like a 12 V condenser and compressor, similar to regular refrigerators. This choice ensures reliability and compatibility with existing refrigeration technology, simplifying maintenance and servicing.

- **Integration of Solar Panel:** A 75Wp mono-perc solar panel has been embedded in the system to harness solar energy, reducing dependency on external power sources and allowing the system to function in areas with limited access to electricity.

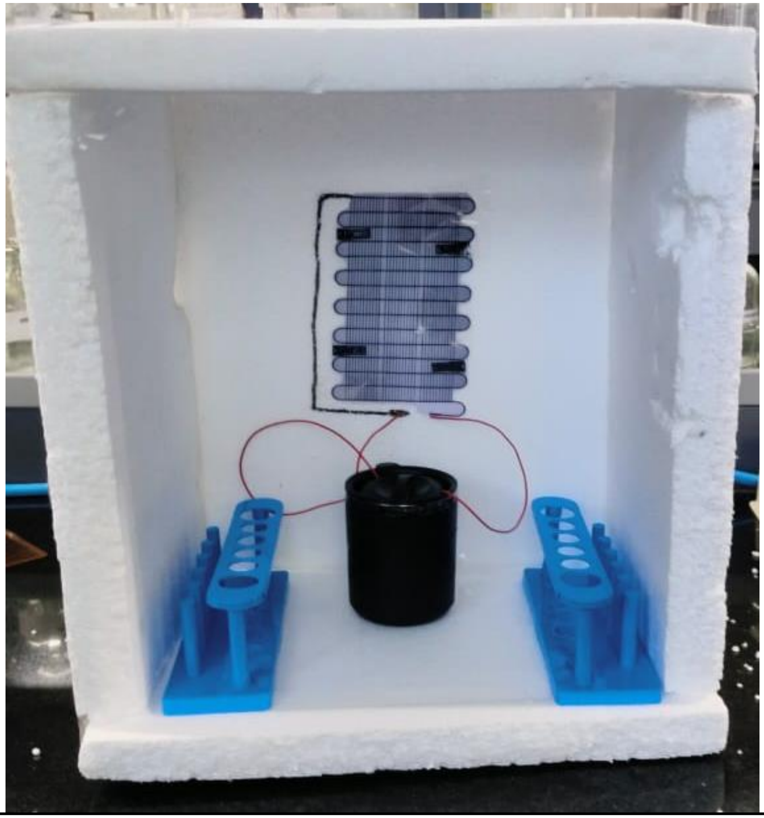
- **High-Capacity Lithium-ion Battery:** The system incorporates a robust high-capacity rechargeable Lithium-ion battery with a 40Ah capacity at 24V. This battery serves as a backup power source, ensuring continuous and reliable vaccine cooling during transportation, even on cloudy days or when solar power is limited.

- These features collectively enhance the effectiveness, sustainability, and self-sufficiency of the vaccine transportation system, making it a valuable tool in reaching remote and underserved communities with crucial vaccinations.



The technological solution(s) developing and implementing.

- **Prototype Development for Testing:** To carry out testing and experimentation, we have meticulously designed a prototype based on the original concept. This prototype serves as a scaled-down model, allowing us to assess and refine the design before full-scale implementation.



Primary Materials Used in the Prototype:

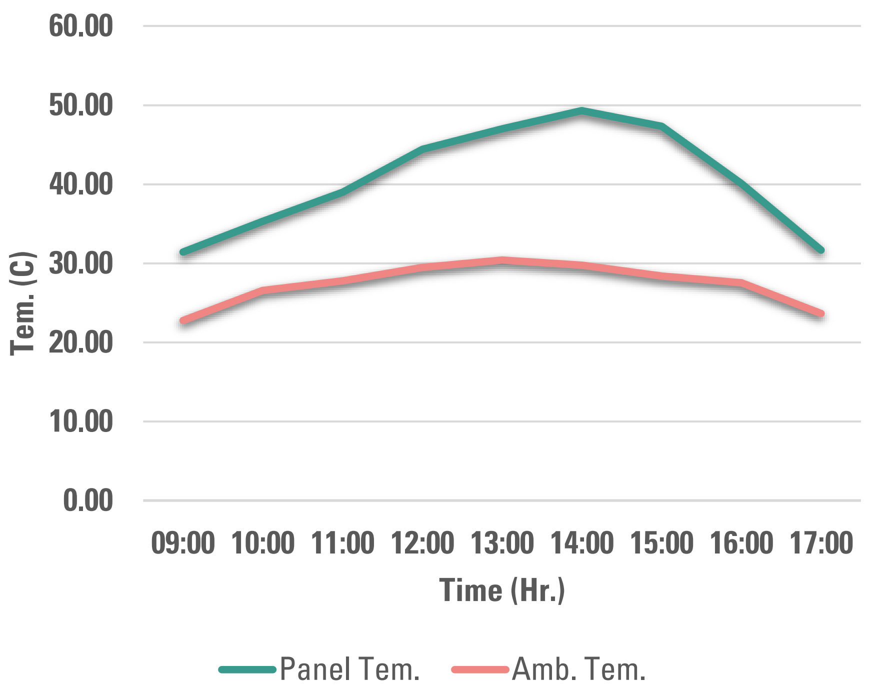
- **Thermocol Sheets**: These sheets have been utilized as a structural material for the prototype's housing, providing insulation and protection for the internal components.
- **Condenser and Compressor**: The prototype incorporates a condenser and compressor, vital elements in the refrigeration system, to demonstrate the cooling capabilities of the design.
- **Lithium-ion Battery**: A high-capacity Lithium-ion battery with a capacity of 40Ah at 24V has been integrated into the prototype. This battery serves as the power source, ensuring the continuous operation of the refrigeration system.
- **Solar Panel**: The prototype includes a solar panel, crucial in harnessing solar energy for sustainable and eco-friendly power generation.
- **Phase Change Material**: Glauber salt is a phase change material that has been explored for use in refrigeration systems due to its high latent heat of fusion and low melting point

Insulating material

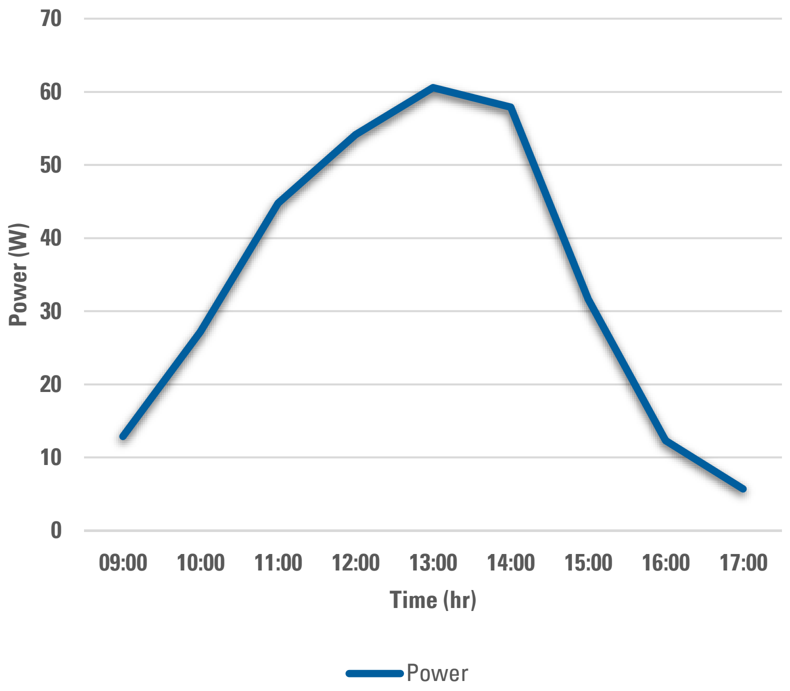
- Light in weight (density: 150 to 300 N/m3). The foam is very light because it contains over 98% (by volume) air. Compressive strength = 0.07 to 0.1 MN/m2; cross-breaking strength = 0.14 to 0. 18 MN/m2.
- Very low value of thermal conductivity.
- Highly resistant to moisture.
- Odourless, chemically stable, and resistant to fungus attack.
- Fully resistant to water, salt, soaps, bleaching agents and HCl (35%), HNO_3 (upto 50%), H_2SO_4 (upto 95%), caustic soda, caustic potash, strong ammonia, alcohols, and silicon oil.
- Very good shock-protecting properties.
- The ability to be molded into well-fitting, contoured cases.
- Thermocole (with an operational range of – 200°C to 80°C) is an excellent material for cold insulation in refrigerators, cold storages, air-conditioning, chilled pipelines, and chemical processes.
- It is used for industrial insulation and insulation for buildings against climate extremes.

Prototype models Connected to the solar panel: 3 different size

Results:



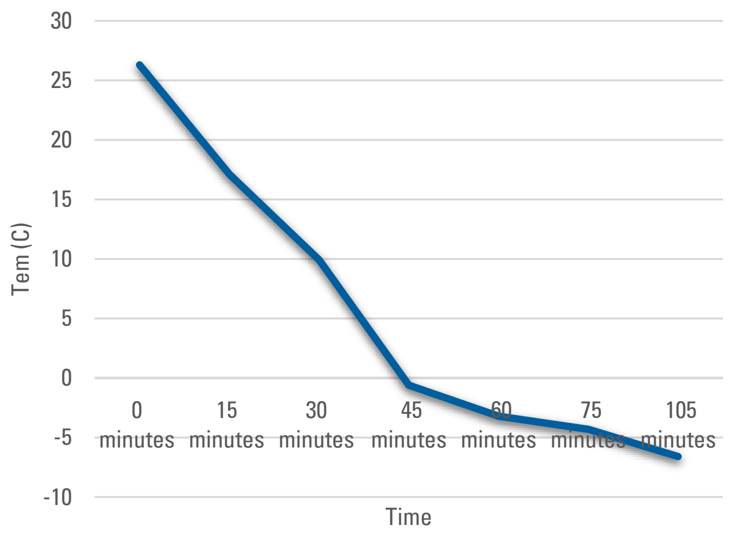
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Tem. (C)
09:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00
Time (Hr.)
Panel Tem.
Amb. Tem.



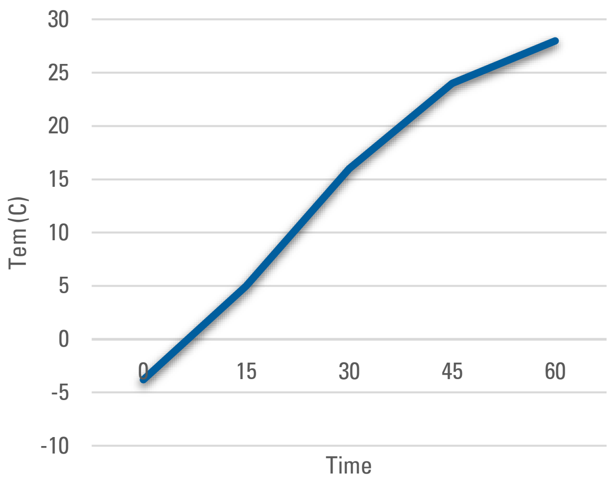
70
60
50
40
30
20
10
0
Power (W)
09:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00
Time (hr)
Power

Load Calculation:

- 6 liters of water inside the freezer; in 75 minutes, it reaches -4.3 C (**Without PCM**)

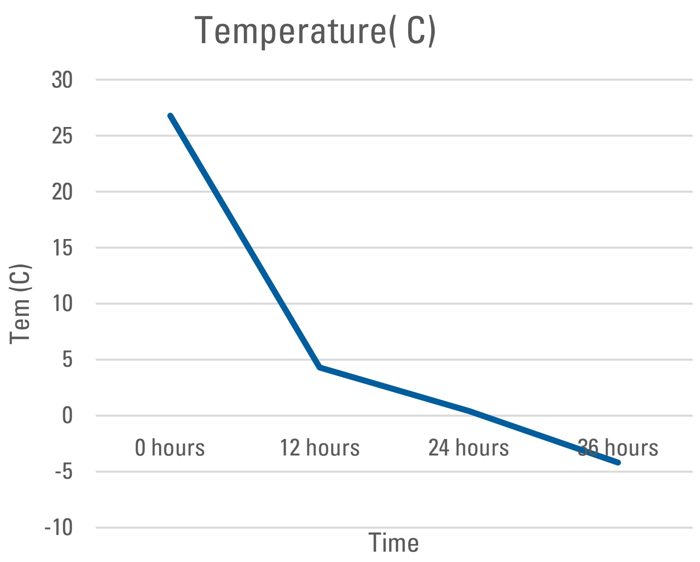


- Warm-Up Time for Load **(Without PCM)**

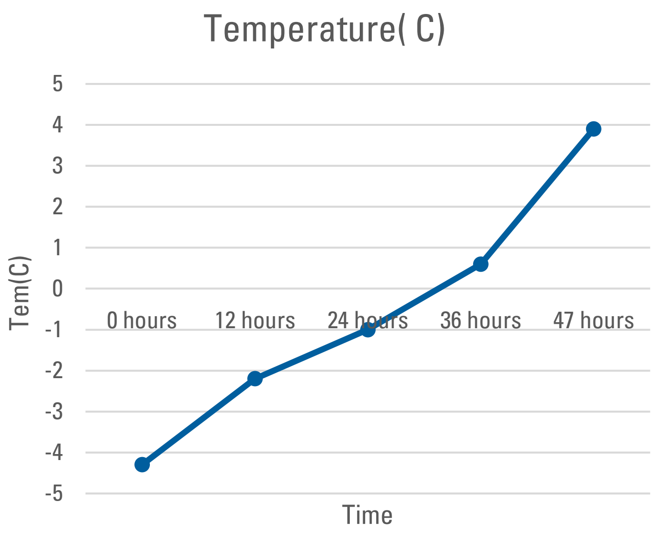


With PCM (10 kgs) Cool Down Time

- The time required to cool the 2 liters of water with 10kg's PCM is nearly 36 hours from the ambient temperature of 27 C to -4.2 C

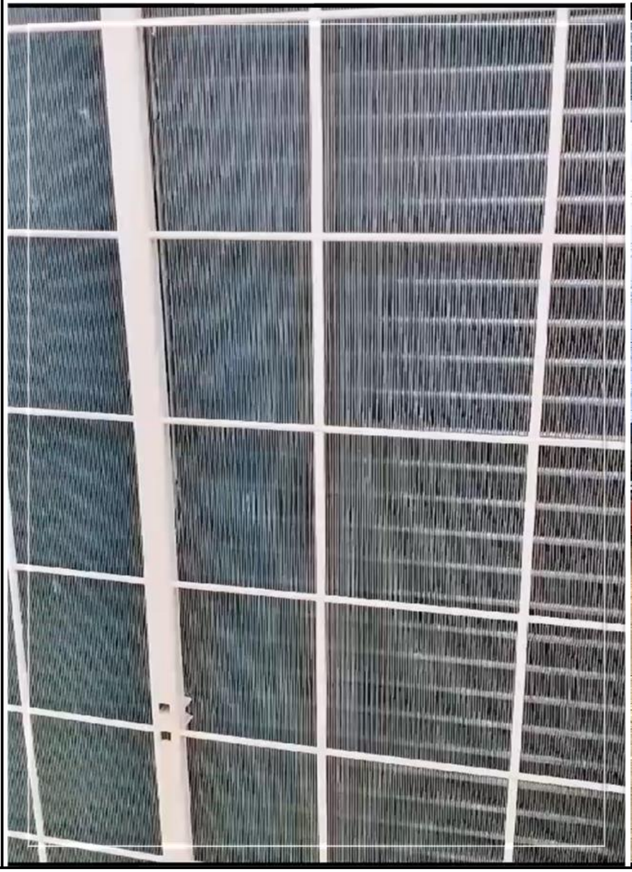


Heat up of water with PCM -maintained temperature below 4 C up to 48 hrs (2-days)



- **Prototype Concept Development:** Our prototype concept design is now in its advanced stages, having been meticulously crafted based on scientific assumptions and fundamental laws. This design represents the culmination of our theoretical and practical knowledge, serving as the foundation for our project.
- **Virtual Testing Phase:** The next phase of our project involves the virtual testing of the electrical, electronic, and mechanical circuits. Through the utilization of various software tools, we will simulate the operation of these circuits and conduct a comprehensive analysis. This analysis will rely on practical data inputs, allowing us to evaluate the prototype's performance in a simulated environment.
- **Analysis through Software:** Multiple software applications will be employed to assess different aspects of our design. These software tools will provide us with valuable insights into how our prototype functions under various conditions, helping us identify potential strengths and weaknesses.
- **Modification and Improvement:** Based on the outputs generated by the virtual analysis, we will proceed with the necessary modifications to refine our existing prototype model. These adjustments will be informed by the data and insights gathered during the virtual testing phase. Our goal is to enhance the prototype's efficiency and effectiveness.
- By systematically progressing through these stages, we aim to ensure that our final design is not only grounded in sound scientific principles but also optimized through rigorous virtual testing and continuous improvement. This iterative approach will contribute to the development of a robust and reliable solution for our project.

- Here are some operational video demonstrations featuring the prototype.



Budget Spent on Proto-type design & Testing– Rs. 1,05,953/- (1,201.51 Euro)

Technical Specifications				
S.No	Parts	Specifications	Price (In INR)	Remarks
1	Solar Panel Monocrystalline 12V	2 x 100 watts with 12v output connected in series	12,000.00	2 panels
2	DC Compressor	BD80F	6,053.00	ACO 007 140l/m 130W Hailea DC Air Compressor - 12V
3	Evaporator	Coil length = 40 feet, diameter = 5/16 inch	26,000.00	
4	Capilalary Tube	Diameter = 1.5-1.6 mm	5,000.00	
5	Condenser	Length = 30 cm, Diameter= 12mm	350.00	
6	Battery	Lead Acid Batteries, Capacity: 150Ah, 12 V	22,400.00	
7	Charge Controller	RSE12v/24v10amp	6,530.00	
8	Insulation	100mm thickness PUF and themocol	3,700.00	1 Square meter
9	Refrigerant	R134a (Eco friendly)	520.00	per kg
10	Consultncy fee		10,000.00	
11	Transportation		9,400.00	
12	Miscelleneous		4,000.00	
		Total Amount (in Rs.)	1,05,953.00	

We have successfully collaborated with the Akshaya Patra Foundation & ISKON-AP & TS to test this proto-type and for the distribution support.

Thank You