



## ENERGIZING LIVELIHOODS THROUGH DECENTRALIZED SOLAR POWERED REFRIGERATION SOLUTIONS

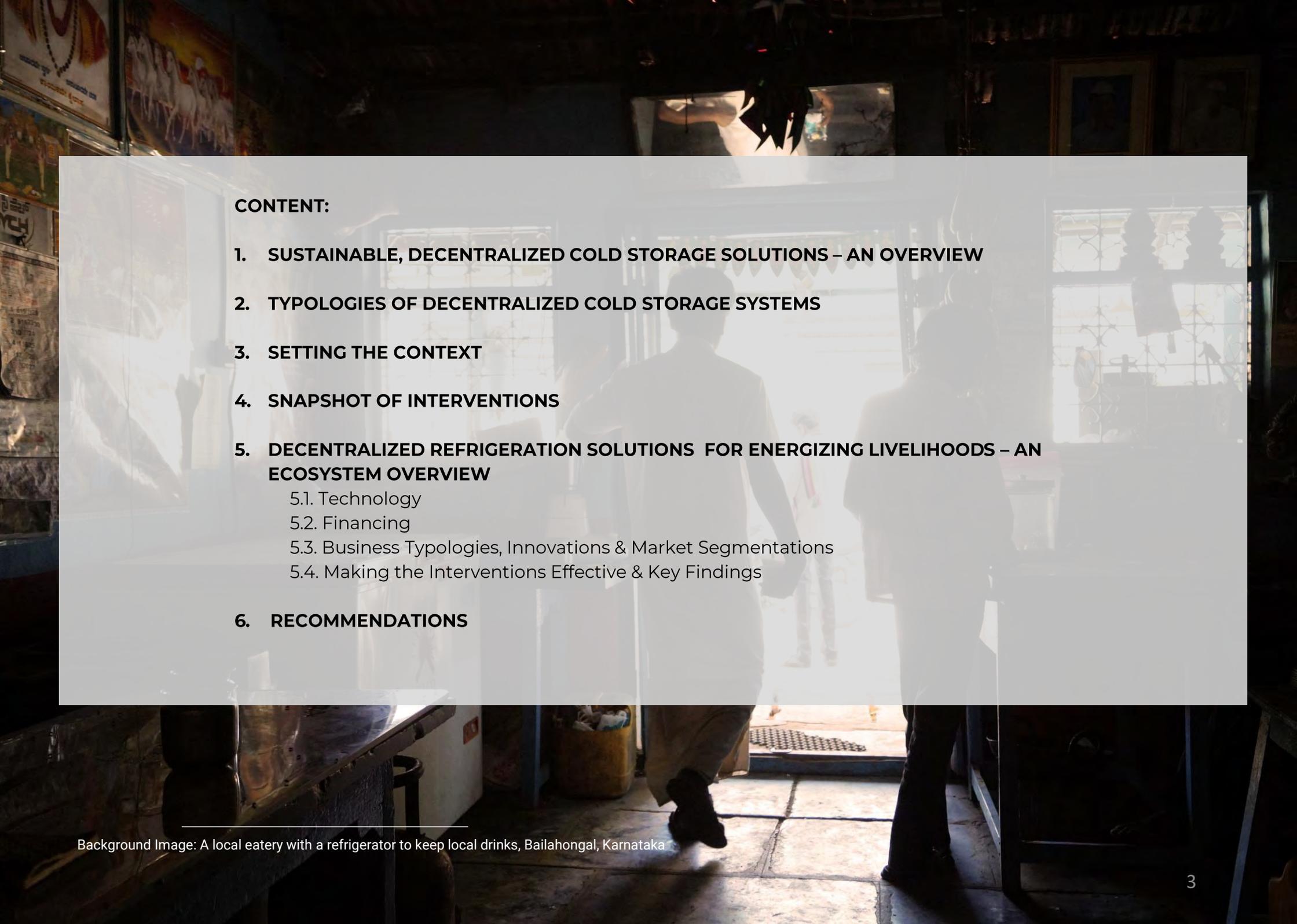
A brief overview of the ecosystem from the inputs provided by the pilot interventions across different typologies of technology, financing and business models

An entrepreneur using the decentralized solar refrigerator system to keep Sugarcane Juice along with other locally procured products cold, which brings the entrepreneur an additional source of income.

Location: Kundapur, Coastal Karnataka



Image: A combination of lighting and a solar powered refrigerator for a small store.  
Location: Kundapur, Karnataka.

The background image shows the interior of a local eatery. A white refrigerator is visible on the left side. In the center, a person is walking through a doorway, silhouetted against the bright light outside. To the right, another person is standing near a counter. The walls are decorated with various posters and notices. The floor is made of light-colored tiles.

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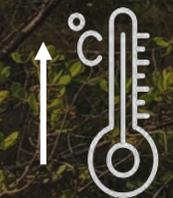
# 1. SUSTAINABLE DECENTRALIZED COLD STORAGE SOLUTIONS – AN OVERVIEW

Sustainable, decentralized cold storage solutions are critical in providing efficient and reliable storage to reduce **post harvest crop wastage** at different stages of food value chain, last mile cold-storage solutions for **dairy and meat value chain** at the local delivery points, **keeping medicines effective** at healthcare facilities that are remote or at places with no reliable electricity access, households to have clean refrigeration solutions to save food wastage as well as reducing commute to buy fresh perishables and thousands of small establishments across rural and semi urban India to have as an income generating additional livelihood source. Understanding that the effective scaling up of the solution goes beyond technology and is a combination of different ecosystems fitting in together becomes paramount while deploying the solutions. The pilot interventions done by SELCO across different typologies have resulted in the creation of a broader framework from the need to the set of holistic solutions.

## OPPORTUNITY

## SOLUTION

### THE NEED



Increasing average temperature



Lack of sustainable, reliable cold storage facilities that address the increasing demand for cold products in the rural and urban regions of the country.



Possibility to reduce post harvest crop wastage + need for local storage for fish/ meat+ strengthening dairy value chain



Need for the storage of vaccines (humans and animals) in underserved areas and mobile units



Opportunities for entrepreneurs to utilize decentralized cooling solutions to create additional livelihoods in their existing businesses

Appropriate **TECHNOLOGY** design to suit cold storage requirement  
+  
Innovative **FINANCING** to make cold storage system affordable  
+  
Conducive **BUSINESS/ ENTERPRISE/MARKET** environment to deploy the solutions effectively

Background Image: A small store with a refrigerator intervention provides the only source of cold products in the vicinity. Location – Golihole, Karnataka.

## 2. DECENTRALIZED SUSTAINABLE ENERGY POWERED COLD STORAGE SYSTEMS – DIFFERENT TYPOLOGIES

### REFRIGERATION FOR MEDICAL PURPOSE



**Vaccines & certain medicines have to be stored under controlled, cooler temperatures** for them to sustain their effectiveness. Health facilities in rural, semi-urban, and tribal areas with unreliable access to energy find it hard to have these medication ready whenever there's a need. Mobile health-care units staying away from the reliable power for longer durations face the similar issues.

#### **SOLUTION:**

**Compact solar refrigeration & freezer units** with relatively longer autonomy to maintain the temperatures between 2-8 deg.

### POST HARVEST COLD STORAGE SYSTEMS

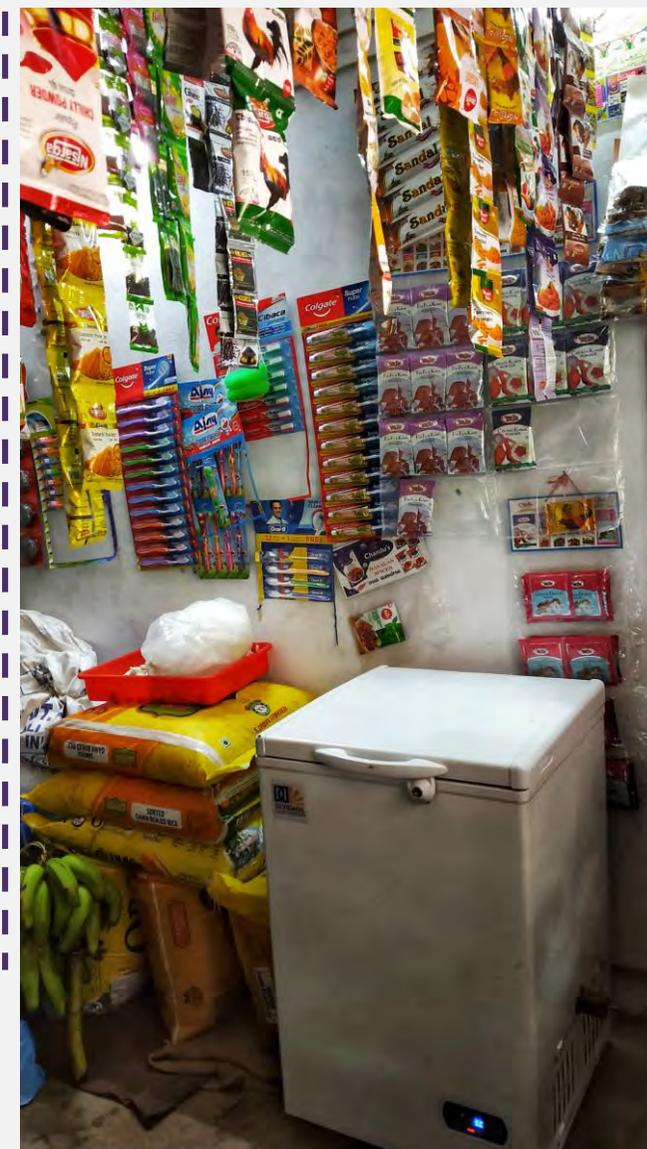
**Huge gap in the post-harvest cold storage facilities** result in almost 20% of fruits & vegetables grown to waste away. The unavailability of cold storages in close proximity to farms for local farmers results in product wastage or farmers selling their perishables for lower prices to the middlemen, thus **losing out on their valuable income.**

#### **SOLUTION:**

**Solar micro cold storage system** consisting of a solar powered cold room enabling both pre-cooling and storage of perishable goods



### REFRIGERATORS AS AN ADD-ON FOR SMALL BUSINESSES



## DECENTRALIZED SOLAR REFRIGERATION SOLUTIONS FOR LIVELIHOODS

**Increase in average temperatures in many parts of India and lack of reliable cooling solutions** have resulted in the increase in relevance of decentralized refrigeration systems, especially in rural and semi-urban scenarios with lack of reliable power. This provides an enhanced livelihood opportunity for end users owning small retail stores, bakeries, canteens, and other smaller establishments present across these rural and semi-urban localities through the consistent demand for dairy value chain products, locally made drinks, chocolates & ice-creams, fresh meat and fish products, drinking water bottles and other cold products.

### SOLUTION:

**Solar powered refrigeration** solution aptly designed with the right **financial and business models** to suit end user's local business needs & the existing supply and market ecosystems.



### IMPACT

AVAILABILITY OF RANGE OF PERISHABLE PRODUCTS IN UNDERSERVED AREAS



INCOME GENERATING OPTIONS FOR MICRO-ENTREPRENEURS



INCREASED MARKET OPPORTUNITIES FOR LOCAL PRODUCTS



Image: Second solar fridge intervention at a small hotel in the coastal region. Location: Gokarna, Coastal Karnataka

### 3. SETTING THE CONTEXT

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The information for the document was obtained from the field from February to April 2019, with an intention to set out the opportunities, challenges and innovations required to scale sustainable cold storage solutions used by micro-entrepreneurs in rural and semi-urban regions to enhance their livelihoods.

The scope of the document is limited to cold storage applications used by microentrepreneurs. The retail livelihood applications were chosen because of their increasing relevance in the sustainable cold storage solutions in the times when the temperatures are rising and end user entrepreneurs of the small businesses have an increasing need of decentralized cold storage systems, and also due to the fact that there was significant supporting in-house data from the past interventions.

Inputs were collated from a spectrum of 45 micro-entrepreneurs in 5 varied geographies using a mix of 5 brands and 8 types of fridges. The inputs were analyzed and complemented with the technical information from manufacturers, and literature available from different studies conducted around reliable sustainable energy

powered refrigeration delivery.

While a total of 45 interventions have been rolled out on the ground, the study specifically targeted 30 number of interventions for a representative sample encompassing varied terrain, end use application, profile of the entrepreneur, type of fridge and end user financing. Information was gathered through in-person interviews with specific sales staff, end users, financiers, R&D teams and manufacturers.

The document shares the learnings that highlights the processes of designing and deploying these solutions via interlinkage of technology, financing and effective business segmentation models. Learnings from the document can complement other existing data while looking at different stakeholders of the decentralized cold storage solution ecosystem (policy makers, financiers, manufacturers, NGOs and small business entrepreneurs) through a holistic lens in order to deploy a more sustainable solution on the ground.

Image: A woman entrepreneur has strengthened her livelihood through the solar refrigerator that helps her with cold drinks for customers in her small hotel and a petty store. Location: Belwadi Cross, Bailahongal Taluk, North Karnataka.

## 4. SNAPSHOT OF INTERVENTIONS

From 45 stand-alone solar refrigeration interventions done across typologies and geographies

### TYOLOGY OF END-USERS



- Petty Shop - 24
- Canteen - 13
- Mobile Canteen - 2
- Institutes - 3
- Homepreneurs - 3

### TECHNOLOGY



- Small : 100-150 ltr - 17
- Medium : 150-240 Ltr - 17
- Large : > 240 Ltr - 11



Karnataka - Geographic spread of interventions

- **47% - North Karnataka**  
Hot, dry – cold beverages, dairy
- **22% - Karnataka - Other**  
Remote – dairy, local products
- **15% - Coastal Region**  
Hot, humid – fish, local drinks
- **16% - Other parts of India**  
Tribal, remote – dairy, cool drinks



**66%**

of entrepreneurs are from rural areas



**85%**

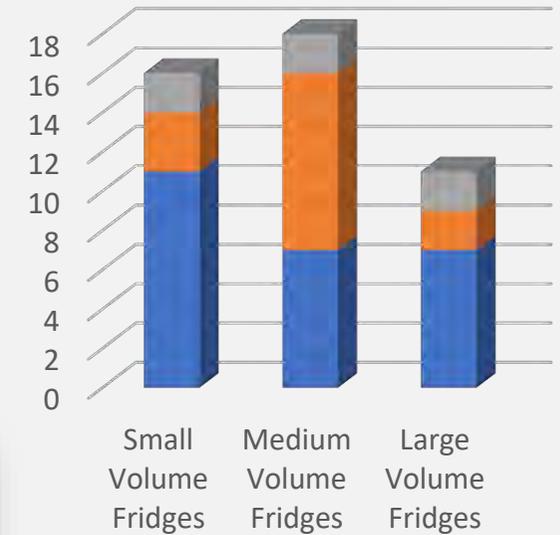
interventions have dairy value chain products in their product range



**Rs. 8,000**

Average profit/ month from the interventions across typologies

### TECHNOLOGY – SMALL BUSINESS END USER TYPOLOGY SPREAD



- Small Stores
- Small Eateries
- Others

Spread of different typology of fridges for major retail applications. (Others include homepreneurs, mobile units & institutes)

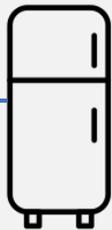
Image: A small shop entrepreneur with a small fridge has set up a sugarcane juice unit as the availability of cold storage has resulted in drawing more customers for his add-on business. Location: Thallur, Kundapur, Karnataka

## 5. SUSTAINABLE DECENTRALIZED REFRIGERATION SOLUTIONS FOR ENERGIZING LIVELIHOODS DEVELOPING SOLUTIONS THROUGH AN ECOSYSTEM APPROACH



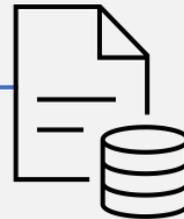
Image: A petty shop entrepreneur at a small town that caters the cold products to thousands of pilgrims who come to the temple that is situated next to the small town, and is the only place in the vicinity to provide the cold beverages before the pilgrims set on to climb the mountain.

### TECHNOLOGY



**Refrigerators of the right size, type, autonomy, cooling capacity and servicing – designed to suit small business entrepreneur's requirement**

### FINANCE



**Appropriate financial product and support to meet the small business owner's need to own the solution, by designing it to suit the entrepreneur's income generation**

### BUSINESS



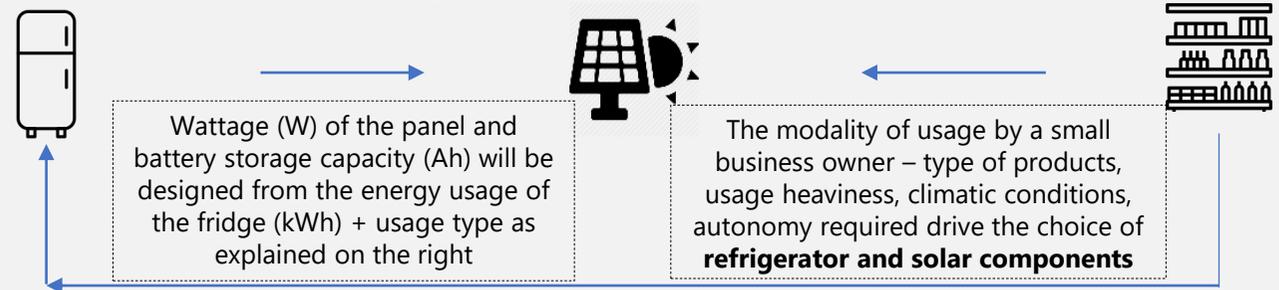
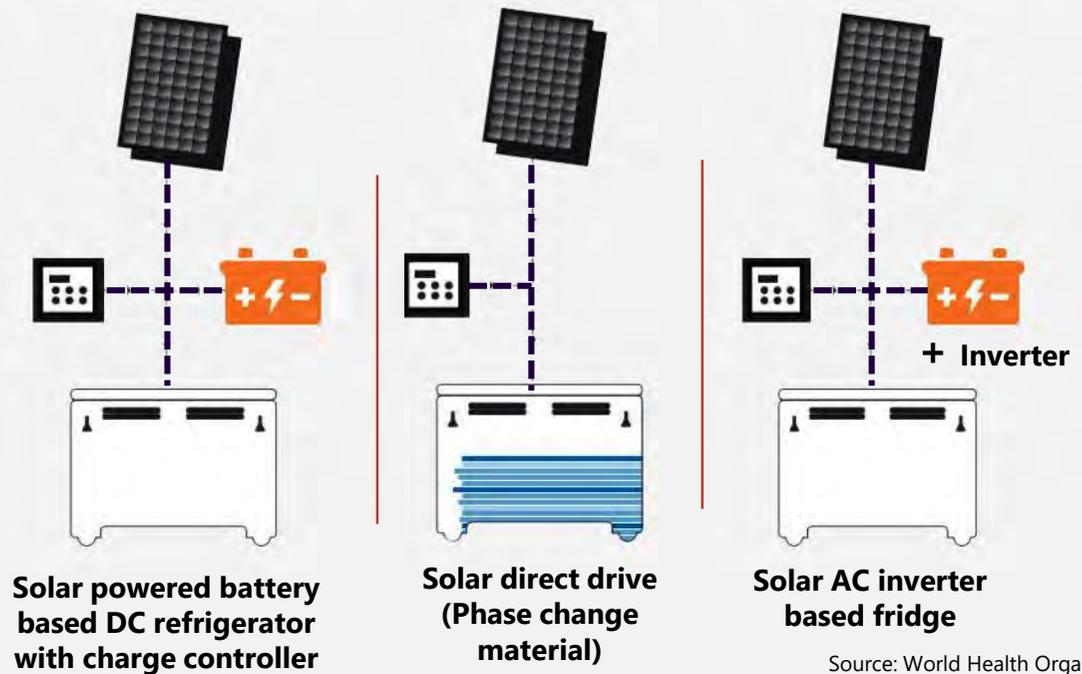
**Right need assessment, diversified product range cooled in the fridge, add-on businesses, catering to the local supply/need, distributorship for dairy value chain**

## 5.1. TECHNOLOGY

The refrigerators should **be compact, affordable and energy-efficient** in order to be viable for decentralized, small business owner's settings. Although the **volume** of the fridge majorly drives the price, size and usability of the system, the **efficiency of the fridge** which is in direct correlation with energy consumption and thus the price is greatly influenced by the **insulation materials and better sealing at the doors**.



Image: Small store with a refrigerator providing space for locally made drinks. Location: Udupi



The main parts of the system design include the refrigerator and an optimum solar component designed to suit the requirement on the field. The units of energy consumed by the fridge (kWh) along with the autonomy (*the number of hours or days the refrigerator can maintain the temperature below a certain level with the combination of refrigerator's insulation property + battery back or phase change material's capacity*) required for the intervention drive the design of the panel (wattage) and batteries (Ah).

## 5.1. TECHNOLOGY

TYOLOGY
<p><b>Small</b> <b>100 L – 150 L</b> Approximate price range (including solar) Rs. 70,000 to Rs. 95,000</p>
<p><b>Medium</b> <b>150 L – 240 L</b> Approximate price range (including solar) Rs. 1,00,000 to Rs. 1,20,000</p>
<p><b>Large</b> <b>240 L and above</b> Approximate price range (including solar) Rs. 1,20,000 to Rs. 1,50,000</p>

**SOLAR DESIGN EXAMPLE**  
(Accurate sizing is decided on assessing local context accurately, this is generalized to provide a broader idea)

**Panels:** 100Wp x 2  
**Battery:** 100Ah,12V  
(For 1 day autonomy))

**Panels:** 100Wp x 2  
**Battery:** 200Ah,12V  
(For 2 day autonomy)

**Panels:** 300Wp  
**Battery:** 80Ah x 2,12V  
(For moderate usage)\*

**Panels:** 250Wp x 2  
**Battery:** 150Ah x 2,12V  
(For heavy usage)

**Panels:** 250Wp x 3  
**Battery:** 200Ah x 2 ,12V  
(For general cooling)

**Panels:** 250Wp x 4  
**Battery:** 120Ah x 4,12V  
(For Ice creams/ freezer)

### SUITABILITY OF TECHNOLOGY

Petty shop/mobile, cold drinks,  
good irradiation, moderate usage

Canteen/ petty shop, dairy  
products + cold drinks, occasional  
cloudy climatic conditions

Petty shop/ canteens, regular  
usage with steady customers  
throughout the day

Canteen/ petty shop, heavier  
usage with more number of door  
openings, dairy products  
distribution & sales, food products

Petty shop/ canteens, regular  
usage with steady customers  
throughout the day

Petty shop, canteens, freezing  
options – Ice creams, fish, and  
other frozen products

### SOLAR DIRECT DRIVE REFRIGERATORS

Greater autonomy due to Phase  
Change Material technology, initial  
cost high but no battery cost,  
potential technology for  
decentralized sustainable solutions.

Vaccine storage for remote, off-grid  
centres with no reliable power  
backup, livelihood interventions with  
difficulty in access for servicing,  
regular retail applications with a well-  
established financial linkage

### AC REFRIGERATORS WITH INVERTER SYSTEMS

Well evolved, efficient refrigerators,  
easily available, evolved service  
ecosystem, solar is an add-on,  
provide both cooling and freezer  
options, solar cost is higher due to  
their high energy consumption

Locations where grid power is  
available as it can be used as hybrid,  
ice-creams, ice cubes, frozen  
products.

\* Indicates the number of times the door  
opened: moderate – 20 to 30 times a  
day, heavy – more than 50 times a day

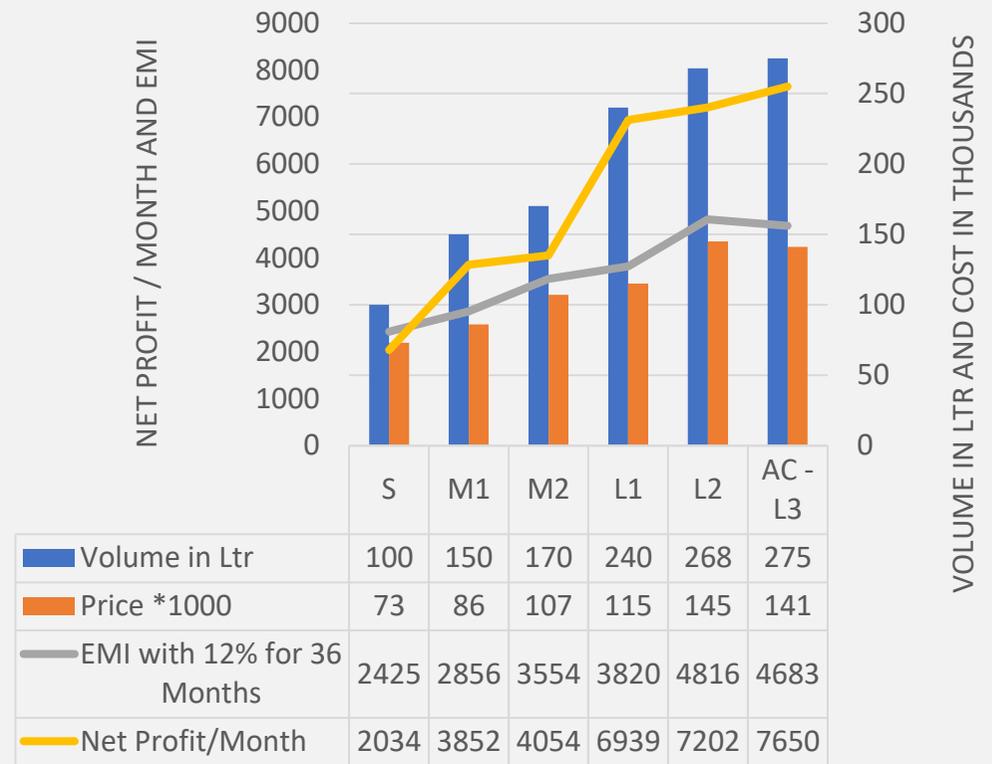
## 5.2. FINANCING

Although there's a high demand for decentralized solar refrigerators, the lack of affordable financing - from awareness of available products in the FIs to push for financial innovation - has been one of the barriers for the solutions not scaling up. Considering the possibility of additional income that the small business micro-entrepreneurs can earn from the productive usage of the cold-storage solution, the pilot projects explored following possibilities in financing the decentralized refrigeration systems to different types of business owners.



Image: The 66-year-old entrepreneur with his first refrigerator significantly increasing his income to his small restaurant business and helping him identifying the demand for local dairy value chain. Today, he has been financed for the second fridge with him shifting to a less operational heavy small store with a capability to cater to more than 50% of market of a local dairy brand

### Business and financial model for different volume and prices of refrigerators

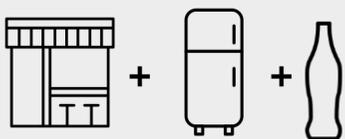


S – SMALL, M – MEDIUM, L - LARGE

The above graph shows a viable financial product (Bank loan at 12% interest with 3 years term) applied to different technological solutions that were considered in the scope of the document. The net profits are calculated after subtracting the EMI from average earned profits. The entire loan amount (cost of solar + refrigerator + interest) was considered for the calculation without any support, however different financial solutions were explored during the interventions as explained in the following page.

## 5.2.1 DIFFERENT FINANCIAL PRODUCTS – MAKING THE SOLUTION AFFORDABLE

### Typology of entrepreneur



**Petty store** with a **small fridge** and **local drinks and dairy products**

**Canteen** with a **medium sized fridge** and **well-established dairy market linkage**

### Financial Product

**Total Cost:** 72,000

**Bank Loan:** Rs. 50,000, @12% interest for 36 months

**EMI:** Rs.1,660

**Capital Support:** Rs.22,000

**Total Cost:** Rs.1,15,000

**Bank Loan:** Rs. 1,15,000 @12% interest for 24 months

**EMI:** Rs. 5,413

**Interest Margin Support:** Rs.15,000

### Financing to make solution viable

The initial assessment of the micro-entrepreneur showed that he had the potential to earn a profit of around Rs.4,000 per month from the refrigeration solution. So a capital support was provided to match his income and the EMI.

The entrepreneur's initial evaluation showed that he had an established dairy product market linkage through his sole presence in the vicinity and the network he had built. Bank loan was paid back in 2 years with a higher EMI as he had the potential to earn more than Rs. 15,000 profit every month.

**LIST OF FINANCIAL PRODUCTS LEVERAGED TO FINANCE SOLUTIONS TO DIFFERENT SMALL BUSINESS ENTREPRENEURS:** Affordable loans from Nationalized banks, regional co-operative banks, MFIs, NABARD, Self Help Group financing from SKDRDP, MYRADA – designed to suit the profit earned by the entrepreneur from the additional income via refrigeration system.

**FINANCIAL SUPPORT & INNOVATIONS EXPLORED IN THE PILOT PROJECTS:** **Interest margin support, initial capital support, enterprises collecting the cost in EMIs** (without a loan from FI in cases where there was no bank/FI linkage available), **entrepreneurs paying partial payment upfront** and remaining amount designed for the loan, **variable EMI** collected by the enterprise to **match the seasonality of sales by the entrepreneur**, Entrepreneur Fund provided the full support - **EMI was started after the sales picked up.**

## 5.2. EXPLORING OTHER FINANCIAL MECHANISMS : MAKING THE SOLUTIONS AFFORDABLE

### CHANNELING **DECENTRALIZED SOLAR ENERGY + LIVELIHOOD FINANCING** SCHEMES

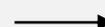
Decentralized solar energy powered refrigeration systems that are used for **income generating activities** come under the financing purview of different financing schemes of government and financial institutions. The cooling solutions bought as a livelihood option by the unorganized sector of small restaurants, local eateries, mobile canteens, fish and meat vendors (within the secondary sector of micro, small and medium enterprises) can be categorized as lending towards MSME as it is essentially a capital investment. The schemes such as Micro Unit Development Refinancing Agency (**MUDRA**), Credit Guarantee Fund Trust for Micro and Small Enterprises (**CGTMSE**), and **Udyogini** (for women entrepreneurs, capital for productive use solution) can be availed for financing as the refrigerators can be considered as new income generating assets for the small establishments. Since the solutions fall under the solar powered products, different schemes specific to banks and state governments can be used for financing. Apart from that, financial linkages could be formed from the non-banking entities such as SKDRDP (MFI), MYRADA (SHG), and other informal capital lending mechanisms as well to support the micro-entrepreneurs. The possibility of converting a commercially available AC fridge to solar powered through an inverter provides an opportunity to utilize the well-established financing landscape for electrical appliances with affordable EMIs, and implementing solar components separately with other possible financial products available specifically for solar.



Image: A small fridge used in a mobile canteen next to a toll booth as an income generating source. Location: Chitradurga, Karnataka



(If the micro-entrepreneur can afford solar component and seeks support for the fridge)



**Small Fridge : Cost < Rs. 50,000**  
**Schemes: MUDRA SHISHU/ CGTMSE/ UDYOGINI (<25,000, collateral free for women entrepreneurs)**  
**Interest rate: As per bank policy**



+



**Medium/ Large Fridge + Solar**  
**Cost >Rs.50,000 up to Rs. 5,00,000**  
**Schemes: MUDRA KISHORE/ CGTMSE**

Livelihood collateral free loans for refrigeration under MUDRA can be obtained under **Cold Storages (Food Products sector)** loan section.



Bought by end-user separately under the existing financial schemes (Both commercially available AC fridges and DC fridges from the vendor directly)

+



Solar component can be installed by the enterprises separately which could be covered under specific schemes for solar energy

### 5.3. BUSINESS TYPOLOGIES

Decentralized solar refrigeration solutions fit in rightly as an **add-on income generating option for existing small businesses**. All the decentralized refrigeration interventions that SELCO has piloted fall into this category. As refrigeration provides a source of income for the entrepreneurs without investing in an additional human resource or extra efforts, the business models can be highly effective if designed and developed well in areas where small businesses are run by an individual and need for cold product value chain exist. The learning from the analysis conducted for the document reveals that the intervention becomes most effective when the solutions are customized for social, geographical and local business environment that the entrepreneurs cater to. This section discusses a range of business typologies where decentralized refrigeration systems have intervened and have impacted to the existing business with more income generation, along with product/ business model innovations that the entrepreneurs have implemented.

#### KEY BUSINESS RELATED ASPECTS RESULTING IN EFFECTIVE INCOME GENERATING SCENARIOS

##### Identifying the need – typology of small business

Demand generated due to geography, remoteness, specific needs, tourists etc

##### Product Range: Local drinks to popular products

Water bottles, cool drinks, ice-creams, dairy products, Both local & global brands

##### Market for local home-made products

Home-based businesses prepare drinks with locally available products get market access

##### Add-on businesses

Sugarcane, fruit juices/ milkshakes, special dairy products



Image: A medium sized refrigerator used in a coastal restaurant to keep fish, cold beverages in the high humidity region.

Location: Gokarna, Coastal Karnataka

## PRODUCT & MARKET SEGMENTATION – UNIQUE TYPOLOGIES FROM THE PILOT INTERVENTIONS

### Site and type Uniqueness

#### Next to a highway/ toll-booth

Year-round demand, extra margin for cold drinks, majorly cold drinks & water bottles

#### Vicinity of a religious/tourist place

Constant demand with peaks in some seasons/ weekends/festivals, extra margin for drinks kept in the fridge

#### Remote, rural, need for decentralized energy

Often only place in the vicinity with a cold storage system – so high demand, available market for a wide range of products

#### Neighbourhood/ inside an institution

High demand for specific products, additional livelihood options (photocopier/ printer) can be combined, petty store + canteen, as demonstration units

#### Physically disabled, old age entrepreneurs

Refrigerator being one of the livelihood solutions which requires no extra efforts to operate, has served as a valuable addition to small stores, eateries run by such entrepreneurs

#### Vicinity of complementary businesses

Solutions to keep fish, meat, vegetables, flowers etc fresh next to their existing businesses around



Image: For a small fridge intervention in a petty store, the PKGB bank finance along with interest margin support was designed to match the entrepreneur's income. Location: Kundapura, Karnataka

### Product Range: Local drinks to popular products



#### Milk & Dairy Products

Main product source, high in quantity, better margin if local dairy



#### Locally sourced products

Procured from home-based local entrepreneurs. High margin, rapidly perishable, seasonal and high demand



#### Carbonated and other beverages

Low margin for bigger brands, extra margin & demand for locally owned brands, water bottles.



#### Sugarcane/ Fruit Juices

Complementary business, seasonal, value addition to fresh products



#### Fish & Meat Products

High demand, higher cooling consistency required, better margins



#### Ice-creams

Higher cooling required, demand is higher in summer, range of products available



#### Flowers & Vegetables

Vicinity of temples, vegetable markets, renting cooling space models

## PRODUCT & MARKET SEGMENTATION – BUSINESS MODEL INNOVATIONS EXPLORED BY ENTREPRENEURS



### Market for local home-made products

Developed supply chain of home-based products through encouraging **local home-based women entrepreneurs to provide them with local products such as grain malts, local drinks, dairy based sweets** etc. Products are fresh, have the touch of nativity and have high demand in summer seasons, and due to their high perishability nature requires cold storage.



### Add on businesses

The access to cold-storage facilities in their small stores/ canteens have encouraged many entrepreneurs to **set up small units to create a set of products** that will have a value addition through cooling. Examples are: Sugarcane juice, fresh juices and milkshakes, ice-creams etc.

### Renting cold-storage space for neighbouring businesses/ needs

Keeping flowers next to the temple vicinity, vegetables and other perishable products from neighbouring vendors with rent for space



Images: Different product typologies: Fish, cold beverages, local dairy products, and sugarcane



## 5.4. MAKING THE INTERVENTIONS EFFECTIVE: KEY FINDINGS

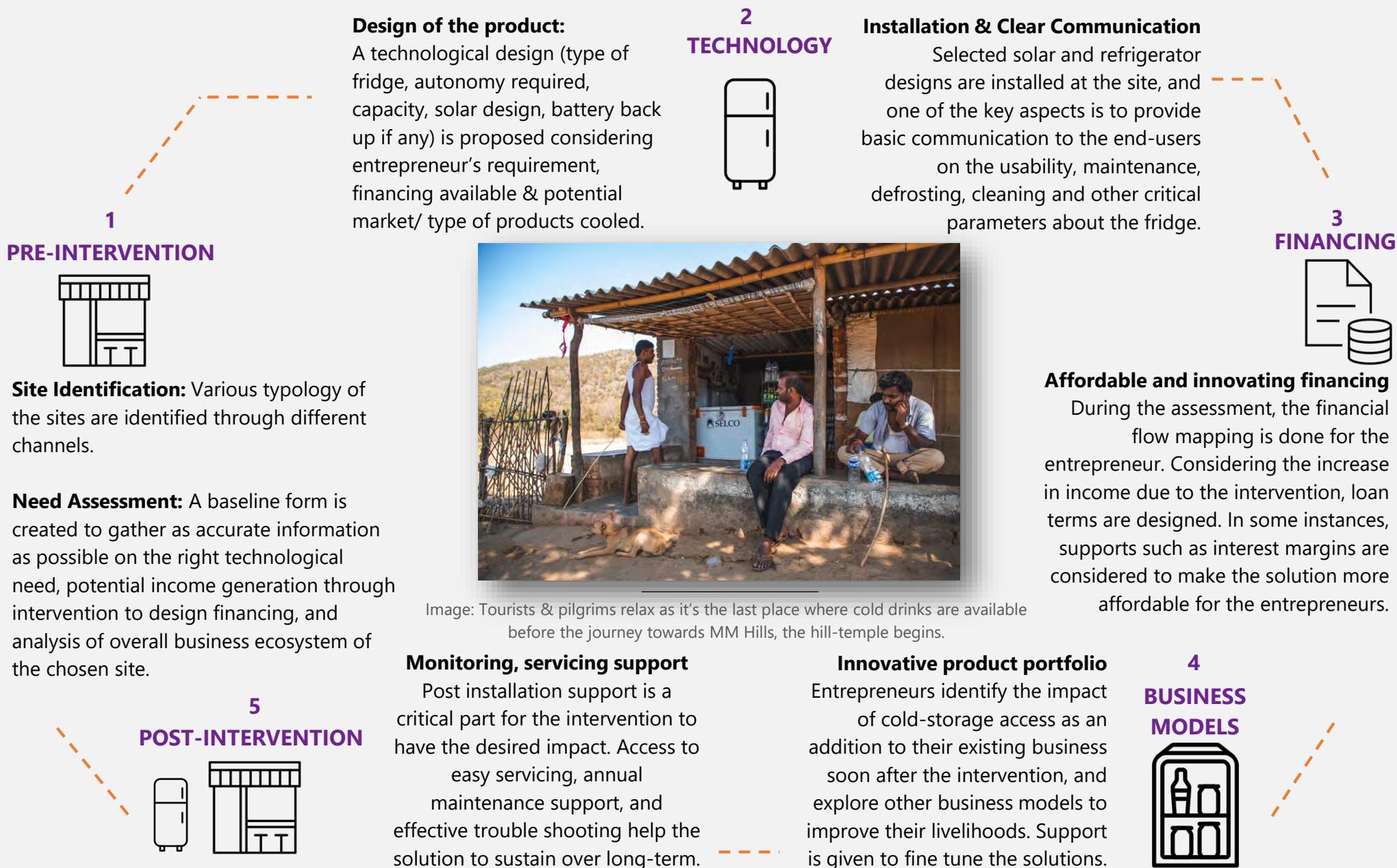
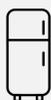


Image: Tourists & pilgrims relax as it's the last place where cold drinks are available before the journey towards MM Hills, the hill-temple begins.

## 5.4. POINTS TO TAKE FORWARD FOR DISCUSSION

1. There exists a **potential business case** for solar refrigerators and thus visible socio-economic impact as more than **70%** of entrepreneurs who were part of the study have seen a profit of more than Rs.4000 per month.
2. One of the main challenges identified from the field are in terms of **servicing and reliability**. Since the technology providers still don't have an evolved servicing ecosystem, **training the local enterprises, NGOs, other service technicians, and end users by the solar enterprises/ tech providers** become very critical. Reliability in terms of door sealing, mechanical parts are to be addressed apart from striving for improved efficiencies.
3. Although majority of the entrepreneurs were aware of solar technologies, solar powered refrigeration systems were quite unfamiliar to them. This often results in issues with the refrigeration systems. Hence, the **communication towards the usage of the system** (product documents are not in vernacular language) seems to be a critical gap that could be addressed with effective methodology while installation.
4. **Different products were piloted from SELCO Foundation** to understand the on-field performance, end user's experience, income generation through intervention, financial linkage and adoptability of the product to the market.
  - The study revealed the on-field energy consumption in a couple of refrigerators to be **more than twice from the value in the product specs**. This is due to the constant opening and closing of the fridge, replacement of the cold drinks with warmer ones among others operational aspects.
  - From the pilot projects that have been done, it is found that in the cases where the bank financing was done, the entrepreneurs paid back the loan much before the loan terms through higher EMLs through product diversification and innovative business models. In a very few cases (2-3) where the pilots were done without any loans and the products were given for testing, the average income generation has been less as there was a lack of participation from the entrepreneur's side.
  - Although the cost of solar + refrigerators varied from Rs. 70,000 to Rs. 1,45,000 for different typology of decentralized refrigeration solution, the entrepreneurs were comfortable in getting a loan (for fridges costing more than Rs.1,00,000) for an average of Rs. 90,000. Around 50% of the cases, the entrepreneurs paid the remaining amount up front in cash and in other carefully considered cases, interest margin subsidies were provided to meet the cost. **Hence the optimum spot that technology, financing and business models meet was found to be around Rs. 90,000 for 200-240 L fridges**. The scaling up of technology to meet this price point will be one of the key aspects to consider.

## 6. RECOMMENDATIONS



### TECHNOLOGY & SERVICING

The technology ecosystem of solar refrigerators is evolving and its maturity is directly related to the scale at which the market uptake occurs. Following recommendations are drawn from the pilot interventions which would facilitate an effective adoption of solutions by entrepreneurs.

- **System level testing protocols** are to be designed based on the **inputs to the designers, manufacturers coming from the field**, as the conditions where decentralized refrigeration systems are deployed offer challenging scenarios for the cooling technology, hence those aspects have to be factored in during research & development.
- The entrepreneurs mentioned the need of more reliable solutions for the **preparation of ice-cubes and to keep ice-creams along with the regular refrigeration solutions**. Although some technology providers do provide an option of using it either as a general cooling solution or a freezer, but the solutions aren't still very reliable yet, and it is generally not providing both the solutions together.
- The feedback from the pilot projects showed that the **lack of established product service network** (resulting in even minor issues taking longer time to resolve hence affecting the overall perception of reliability of technology among the end user entrepreneurs) is one of the biggest hurdles for solar refrigerators to scale up. Although a servicing ecosystem needs a well-established market to serve, measures such as **manufacturers providing service training to local solar enterprise technicians, other on-grid refrigerator service providers, having an additional servicing team serving last mile intervention areas during the pilot implementations** would certainly help setting up a strong initial market for solar fridges in rural and semi-urban areas.



Image: A good communication is necessary to the end users to make sure the fridges are maintained well, like in this petty store example at Kundapur, Karnataka

### FINANCING AND POLICY



Current high up front cost of the solar refrigerators is a result of combination of factors from technology to unexplored market ecosystem. So to make the solutions affordable and available for rural entrepreneurs, conducive financing schemes and policies have to be created.

- Creation of **long term financing support through conducive loan terms and interest rates**, such as ones that are available for other small scale entities for rural micro-entrepreneurs to afford cold-storage solutions as a livelihood option .
- Conducive policies to be created to **integrate training programs** for decentralized sustainable energy powered refrigeration systems with the other technician skilling programs.

## 6. RECOMMENDATIONS



## OPERATION & COMMUNICATION

The study showed that some of the issues occurring at the site of interventions could be prevented by **clear communication of information on technology, operation and maintenance** from enterprises to the end users:

- Clear instructions on panel maintenance, cleaning, defrosting and basic measures towards keeping the fridge operational to be given from the technicians during the installation.
- There have been instances of product losses when products were kept inside the fridge that were incompatible with that particular solution (ice creams kept in a fridge with not enough solar component designed for it), hence hampering the perception of the solar fridge. So, end users need to be instructed clearly on the right set of products and temperature settings.
- The energy efficiency of the refrigerator is in direct correlation with the operational processes such as number of times the fridge is opened (cold air will be replaced by warm air outside – hence needs more cooling), the occupied volume inside the fridge by products, and ventilation around the system. So the entrepreneurs have to be communicated clearly on these critical factors to improve the effectiveness of the system.



Image: Entrepreneurs have created their own niche by encouraging local home-based product makers to provide them with fresh drinks, food items, such as here in a petty store at Udupi.

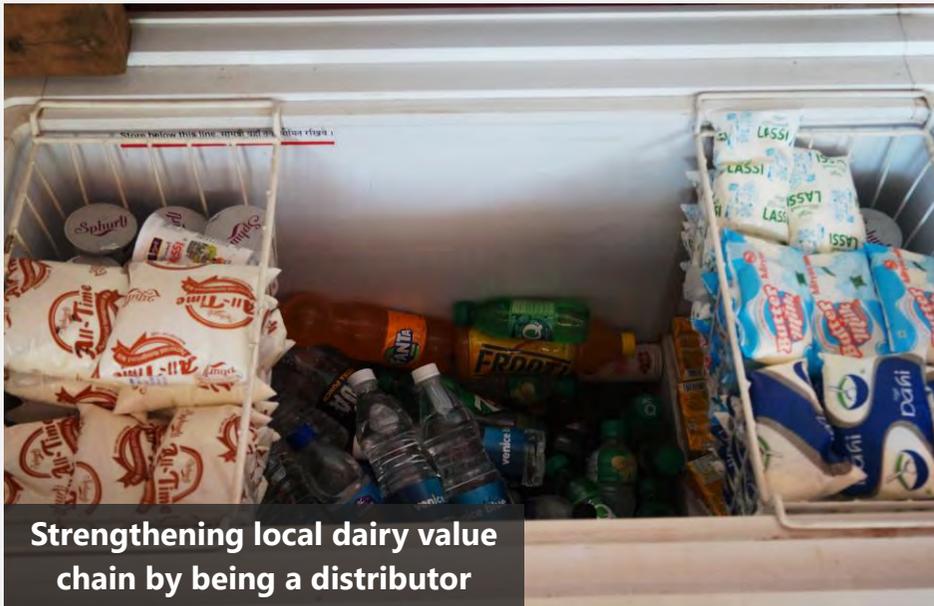
**Creating a value chain for locally made home-based drinks**



**Keeping fish cool and saving money on ice cubes**



**Strengthening local dairy value chain by being a distributor**



**Alcoholic beverages, cheese and cold-drinks**





Image: One of the examples of add-on businesses with the access to reliable last mile refrigeration solution – entrepreneur installing sugarcane unit next to his petty store next to a highway providing cold sugarcane juice and improving his livelihood. Location: Thallur, Kundapura.





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