Opportunities and Challenges for Solar Cold Storage in Cambodia

November 2021
Author: Sevea

This document is produced as part of the SWITCH to Solar Project, funded by the European Union and the Czech Development Agency, and implemented by three partner agencies: People in Need, EnergyLab and Sevea. The goal of this document is to present the results of the study led by Sevea on the opportunities and challenges for solar cold storage in Cambodia. The author of this summary and all graphs is Sevea.



In recent years, Cambodia's electricity sector has been through outstanding improvements fuelled by the government's success in rapidly expanding access to grid electricity up to 81% of households at the end of 2020. Nonetheless, in light of the relatively high electricity costs, remoteness of farmers and overall low mechanisation of the agriculture sector, solar technologies for productive use have the potential to improve agri-fishery MSMEs competitiveness on the market while reducing their operational costs. This summary provides a short overview of the opportunities and challenges for the adoption of solar cold storage in Cambodia.

Starting by looking at the need for cold storage…

Cold storage is a term that encompasses all commercial facility or devices used to store perishable products under controlled temperature conditions. It regroups a wide variety of technologies of different sizes and features. It can be used for the storage of all kinds of products, from vegetables and fruits to meat and fish.

If the technology is still at a very early stage of development in Cambodia, there are many benefits that can positively influence its uptake:

- **Reduce post-harvest losses:** In some value chains, post-harvest losses are significant – up to 30-40% in the vegetables value chain. There are most often due to the heat and poor storage conditions. Cold storage could be an effective way to reduce such losses.
- **Improve quality & shelf life:** By reducing spoilage, introducing the cold storage of products helps improving their quality and lengthening their shelf life, quite drastically for some products, and especially if coupled with proper cleaning practices (e.g.Hot Water Treatment in the case of fruits).
- **Improving hygiene:** In the case of meat and fish, introducing cold storage and a proper cold chain is paramount to guaranteeing the hygiene of products and reducing the prevalence of zoonotic diseases in Cambodia.
- **Accessing premium markets:** For all the above reasons, introducing cold storage in value chains can help access premium markets, since they usually have stronger quality and hygiene standards. This is especially the case for stakeholders wishing to target formal export markets.

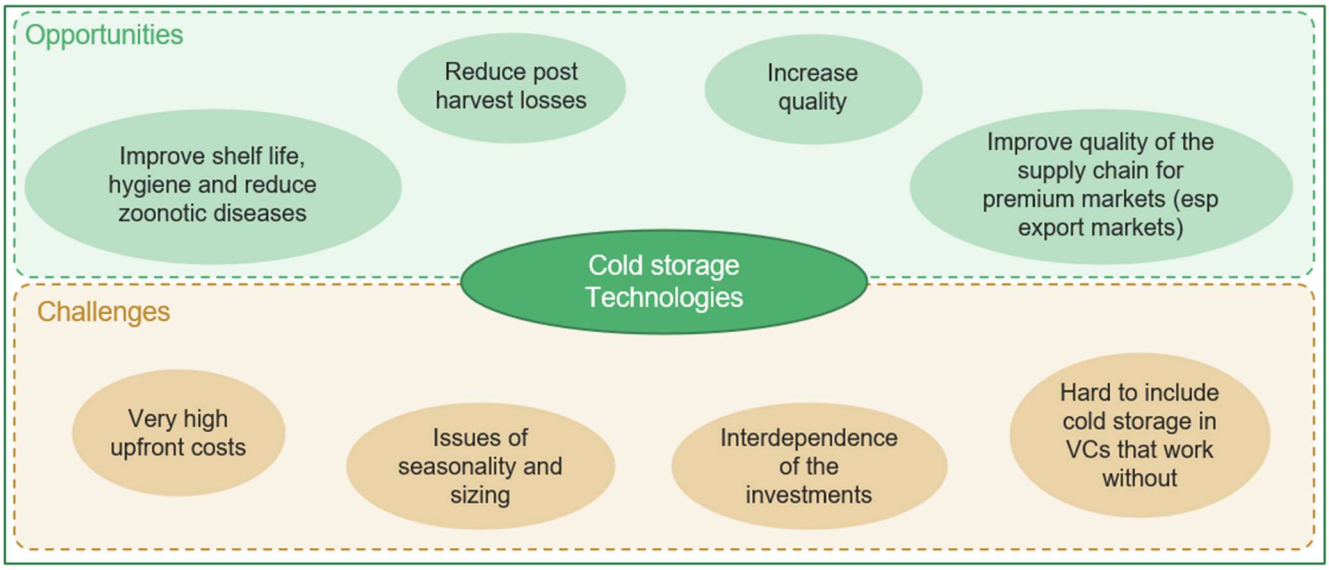
Yet, as the market is at a very early stage in Cambodia, there are many challenges that need to be considered as they might constrain the adoption of the technology in Cambodia:

- **Dependence of the investments.** Cold storage, especially for meat and fish, cannot come as a single investment. In order to preserve the cold chain, cold storage has to be introduced at all stages following the harvest/slaughtering, including transportation in-between stakeholders. This means that investments are highly inter-dependent.
- **High upfront costs.** Cold storage facilities are very expensive, and even more so when incorporating solar. Plus, as investments are inter-dependent, for a stakeholder like an aggregator who handles the whole supply chain from production all the way to distribution, creating a cold chain for the products, requires the purchase of several technologies. It is only possible for companies with significant investment capacities.
- **The current organisation of value chains doesn't require cold storage.** Most value chains currently operate without any cold storage. Instead, the whole value chain is organised so that there is as little time spent between the moment products are harvested/slaughtered and the moment they are sold to the end-consumer. This means that the need for cold storage is far from being obvious for a lot of stakeholders. This also means that products going through cold storage,

because they will have higher production costs, cannot be sold on the same market as other products, as they wouldn't be competitive. Specific routes to market need to be used or established for products using cold storage, targeted at a market in demand for quality and safe products. Finally, it can be tricky to "insert" a new stage in a value chain that currently works without. This can require some reorganisation of the supply chains and of actors, as well as aspects of behaviour change.

- **Cold storage facilities require a precise sizing and optimal use**. Indeed, to ensure that the cost of the technology can be recovered, it is important that it is used at optimal capacity. This means that the technology can make economical sense only for stakeholders who would be able to use the technology at an optimal capacity (>70%) daily and all year long. This can especially be a problem for products that are highly seasonal.

As such, cold storage is not an easy technology to push the adoption of. Considering these opportunities and constraints and the current state of the market, primary targets for cold storage are stakeholders in the vegetables, fruit, meat and fish value chains that have a rather high investment capacity, need regular storage, manage large and centralised volumes, and ideally that have access to premium markets. Optimal targets would especially be aggregators and agri-businesses, but it is important to note that their number is rather limited.



Technical considerations

A variety of technologies exist under the umbrella of cold storage. Main ones include:

- Cool boxes
- Cold rooms, which can widely vary in size
- Chiller facilities
- Cold transportation

Each of these technologies have their pros and cons, and they are not necessarily suited for the same purpose.

There are noteworthy opportunities to power cold storage by making use of solar energy:

i. Cold storage technologies have a significant energy consumption and could benefit from solar PV to decrease operational costs.
ii. Cold storage requires a constant energy supply. Making use of a solar energy allows installing the technology in non-connected areas or in areas where the network is unstable.
iii. Energy requirements are particularly well aligned with solar production: the higher the sunlight, the higher the temperature and the more energy a photovoltaic system will have available.

Still, using a solar solution comes with several constraints:

i. Cold storage facilities need to be powered 24 hours a day without fail, so the system architecture must include batteries.
ii. Solar solutions have limited flexibility in terms of mobility, making them hard to use in transport solutions.
iii. The limited development of cold storage in Cambodia means that implementing such a solution is already expensive in itself. Making use of solar energy adds an additional significant investment cost whose economic benefit needs to be carefully assessed.

Recommendations – How to increase the adoption of Solar Cold Storage?

Solar Cold Storage holds potential in improving the quality of the vegetables, meat, fish and fruit supply chains in Cambodia. Still, the market is at a particularly early stage, posing significant challenges to the adoption of cold storage, yet alone solar cold storage. The important investment cost of the technology and the fact that supply chains currently operate without cold storage reduces the number of stakeholders that are in the ability to adopt the technology. It is unlikely that such a solar powered solution can be adopted at scale for the time being. Even so, there are many opportunities currently opening for cold storage in Cambodia, such as the development of a National Cooling Action Plan as well as multiple donor programs focused on the development of logistics and cold chains in Cambodia. As such, the market is likely to evolve very quickly; here are a few recommendations to increase the adoption of solar cold storage in Cambodia:

- In the current state of the market, the stakeholders most likely to adopt the technology for the time being are those who have a rather **high investment capacity**, manage **large and centralised volumes** (not in Phnom Penh), have **access to premium markets** (locally or internationally) and who **need to store their products**, to smooth out the supply chain, ease logistics or improve resilience to price fluctuations for example. Recommended targets include aggregators, agri-companies and farmer organisations/agriculture cooperatives.
- Still, it will be important for these end-users to have an **optimal use of the technology**. It is recommended that technology providers size the solution carefully in accordance to the needs of the end-user to ensure that the technology can be used at an optimal capacity most of the time.
- Technology providers also need to offer efficient **after-sales and maintenance services**, to ensure the smooth functioning of the technology and secure its added value.
- Finally, it will be of utmost importance **to introduce end-user financing mechanisms** to mitigate the very high upfront costs of the solutions. It can be done through partnerships with MFIs, simple financing mechanisms by technology providers themselves (payment terms), or more innovative models such as leasing, rent-to-own or Pay as You Go. Putting in place such mechanisms will be key to facilitate the early uptake of solar cold storage.

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Website: www.switchtosolarkh.org
Email: info@switchtosolarkh.org
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