The Cold Silence: Lessons from Solar Cold Storage in Madhya Pradesh

The sun in Betul, Madhya Pradesh, has a particular way of making its presence felt—a heavy, dry heat that reminds you exactly why cold storage isn't just a technical specification for a farmer, but a survival tool. Standing in front of a 5-metric tonne (MT) Solar Cold Storage (SCS) unit in the local mandi, I expected to hear the steady hum of a refrigeration unit and see the bustling activity of farmers loading crates of perishables. Instead, there was a profound silence. The solar panels were gleaming, the technology was sound, and the battery storage was charged, yet the unit sat empty.

Figure 1 Solar Cold Storage at APMC Mandi Betul

As a manager with En-genuity, working on a project supported by UNDP India, my mission was to look beyond the steel and silicon to evaluate the real-world impact of 36 such systems deployed across Bihar and Madhya Pradesh. While the project spanned two states, my journey was a deep-dive into the 12 sites located in Madhya Pradesh, from the grain-heavy markets of Sehore to the vibrant Farmer Producer Organizations (FPOs) of Bhopal and Sagar. We weren't

just checking if the lights were on; we were conducting a comprehensive Impact Evaluation and Social Return on Investment (SROI) study.

High Hopes and Clean Tech

The project, on paper, was a masterstroke of climate-resilient agriculture. Funded by the Japan Supplementary Budget 2022, the initiative aimed to support India's Nationally Determined Contributions (NDCs) toward a net-zero future. By deploying these 5 MT units, the goal was simple yet profound: enable smallholder farmers to defer distress sales, improve their bargaining power, and drastically reduce post-harvest losses using clean energy.

We used a quasi-experimental design, comparing "treatment" groups (farmers with access to the units) against "control" groups (those without). We were looking for the "Social Return"—a way to quantify value that doesn't always show up on a traditional balance sheet, like carbon emissions avoided, time saved for women farmers, and the growth of social capital within an FPO.

But as I moved through the 12 sites in MP, I realized that the story of development is rarely a straight line from "input" to "impact". It is found in the friction between a brilliant idea and the grit of ground reality.

Why "Functional" Isn't "Operational"

In policy reports, we often use the word "functional" to mean the machine works. In the field, however, that definition is dangerously narrow. At sites like APMC Mandi Betul and APMC Mandi Ichhawar, the units were technically perfect, yet they were lying idle.

The issue at the mandis was a fundamental mismatch between technology and market behaviour. Farmers in Betul, for instance, are part of a high-frequency trading ecosystem. They arrive with the intention of immediate sale. Traders procure the produce and dispatch it to nearby cities on the same day, resulting in a "rapid turnover" model that leaves no organic demand for on-site storage.

Then there was the commodity mismatch. Ichhawar is predominantly a grain and oilseed mandi—wheat, soybean, and garlic. These crops need dry warehouse storage, not short-term cooling. It was a humbling reminder that without deep, local consultative planning, even the most advanced climate-smart solution can feel like an imposition rather than an asset.

The FPO Contrast: Ownership vs. Inertia

The narrative shifted significantly when I visited the FPOs. At Evraj Seeds Producer Company in Namdarpura (Bhopal) and Varidal Kissan Producer Company in Badarkha (Sehore), the silence was replaced by a sense of ownership. These units were functional and in regular use, with some reaching 60-70% utilization.

Figure 2 Solar Cold Storage at FPO Varidal Kissan Producer Company

Unlike the mandis, where the units felt like orphaned government assets, the FPOs treated them as commercial tools. However, this ownership came with its own set of challenges. At Jai Balaram FPC in Bedakhedi, the unit had been down for months. They had raised complaints, but no trained electrician was available in the vicinity to fix it.

This highlighted an uncomfortable truth: we can deploy all the "hardware" (solar panels and cooling units) we want, but without the "software" (maintenance networks, clear SOPs, and technical support), the impact will always be fragile.

Finding the Missing Middle

The turning point in my reflection came during a conversation at the Sehore mandi with officials like Jagdish Maurya. While the unit there was idle—waiting for bureaucratic clarity on tariff fixation—we began to see a different kind of potential impact.

We realized that while the 5 MT capacity was too small for big traders and the logic of immediate sale too strong for large farmers, there was a "missing middle":

1. The "Failed Sale" Farmer: The smallholder who fails to secure a favourable price today. Currently, they face a choice: a distress sale or the cost of transporting the produce back home. A 24-48 hour buffer storage would allow them to wait for the next day's price discovery without the produce rotting.
2. The Micro-Vendor (Thelawala): The hawkers who buy 10 kg to 200 kg of produce daily to

sell in urban areas. They currently store unsold stock in their homes, leading to massive overnight spoilage. Providing them with crate-based storage could save their slim margins and reduce food waste at the very end of the value chain.

Impact evaluation isn't just about measuring what happened; it's about discovering what *could* happen if we pivot the strategy toward those the system currently ignores.

SROI: Measuring the Value of a Rupee

One of the most complex parts of my job is explaining SROI (Social Return on Investment). In simple terms, it's about asking: *"For every rupee we spent, how much total value did we create for society?"*.

Using our framework, we look at three critical pathways:

1. Economic: Direct income increases for farmers and the financial viability of FPOs.
2. Environmental: GHG emissions avoided and energy cost savings.
3. Social: Reduced drudgery for women and increased community trust through the FPO model.

In our initial assessments, we calculated a conservative SROI ratio of 1.72. This means every ₹1 invested in a solar cold storage unit generates ₹1.72 in combined social, economic, and environmental value over a 10-year horizon. This includes the valuation of intangible benefits, like the ₹1.84 lakh in social value generated through gender empowerment proxies. However, achieving this ratio depends entirely on moving these units from "functional" to "consistently utilized".

Reflections on the Policy-Implementation Gap

The units in the mandis I visited were non-functional largely because of a "Bureaucratic Freeze". Mandi officials were hesitant to initiate usage without written orders on tariff fixation and operational procedures. They were risk-averse, rightly worried about audits and administrative accountability.

This project taught me that technology is only 20% of the solution. The other 80% is the ecosystem. It's the policy clarity that empowers a mandi official to say "yes" to a local vendor. It's the training that allows an FPO member in Kopra to fix a minor technical glitch without waiting weeks for a specialist.

Professionally, this journey reinforced the importance of Systems Thinking. We cannot drop a cooling unit into a mandi and expect the market to spontaneously reorganize itself. We have to understand the flow of the truck, the logic of the trader, and the specific needs of the local micro-entrepreneur.

Way Forward

As we move toward the final synthesis of our report, I am hopeful but realistic. We are recommending a strategic repositioning of these units. Instead of competing with massive commercial cold storages, these solar units should become "Micro-Buffer Hubs" for small vendors and farmers needing short-duration cooling.

We need clear policy interventions that empower local officials to set flexible, slab-based pricing. We need to strengthen the maintenance network so that a unit in Jai Balaram FPC doesn't sit idle just for want of a trained electrician.

The sun in Madhya Pradesh is still hot, and the solar panels at the 12 sites are still there, waiting. The technology is ready. Now, it’s up to us to ensure that the policy and the people are ready too. Development isn't a destination; it's a constant, reflective recalibration. And sometimes, the best way to move forward is to stop and listen to the silence of an idle machine—it’s usually trying to tell you exactly what’s missing.