DESIGNING FOR SUSTAINABILITY: BLUEPRINT FOR A LOW CARBON COLD ROOM

JUNE 2025

Efficiency for Access Coalition

CONTEXT

Sub-Saharan Africa faces the highest greenhouse gas (GHG) emissions from food loss globally. Strengthening cold chain management in this region could help reduce these emissions by two thirds.

Fresh produce such as fruit and vegetables typically need temperatures between 0—10°C and 80—95% relative humidity to ensure secure food supply chains. Yet, limited access to reliable grid electricity in many parts of Sub-Saharan Africa means that communities in remote and rural areas lack the cooling infrastructure needed to preserve fresh produce. Locally assembled, solar-powered cold rooms can help mitigate GHG emissions while bolstering food security and strengthening livelihoods.

PROJECT AIMS

While solar-powered systems produce very little greenhouse gas emissions when in use, they can still generate significant emissions during the production process, especially from raw materials and manufacturing. This project built on the findings of *Efficiency for Access' report Life Cycle Greenhouse Gas Emissions: Assessment of Off- and weak-grid refrigeration technologies* to demonstrate that a cold room made from locally available materials could generate minimal GHG emissions. The goal was to create an energy-efficient, high-quality cold room that used solar photovoltaic panels, thermal and battery storage, and natural, environmentally friendly materials for wall insulation. *You can read the full report here.*

THE PROJECT'S KEY INNOVATION

The project's most important innovation was using life cycle assessment as a tool to make decisions in real-time. Gaining rapid insights into the cold room's environmental impact helped the design team to iterate quickly and refine the technology efficiently.

Figure 1. The main phases of the project

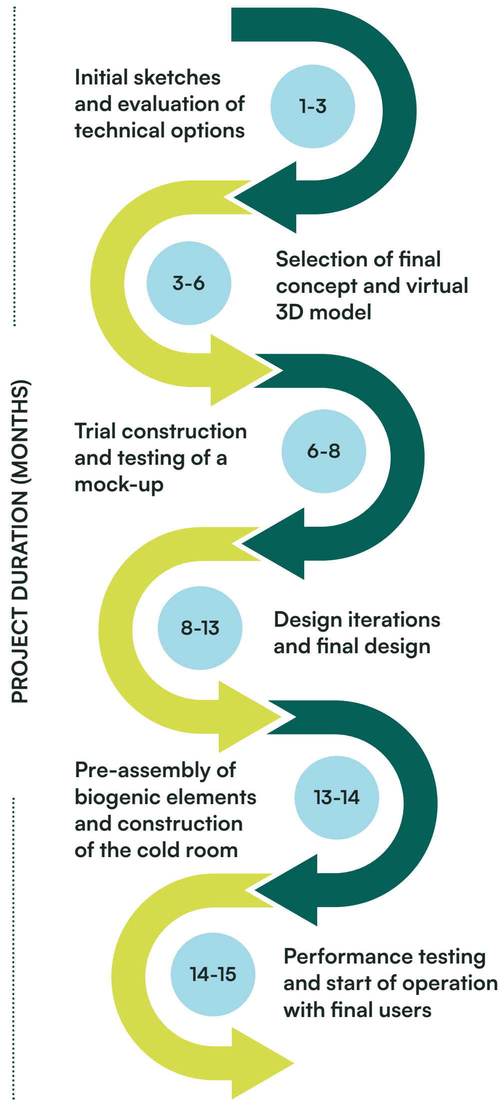
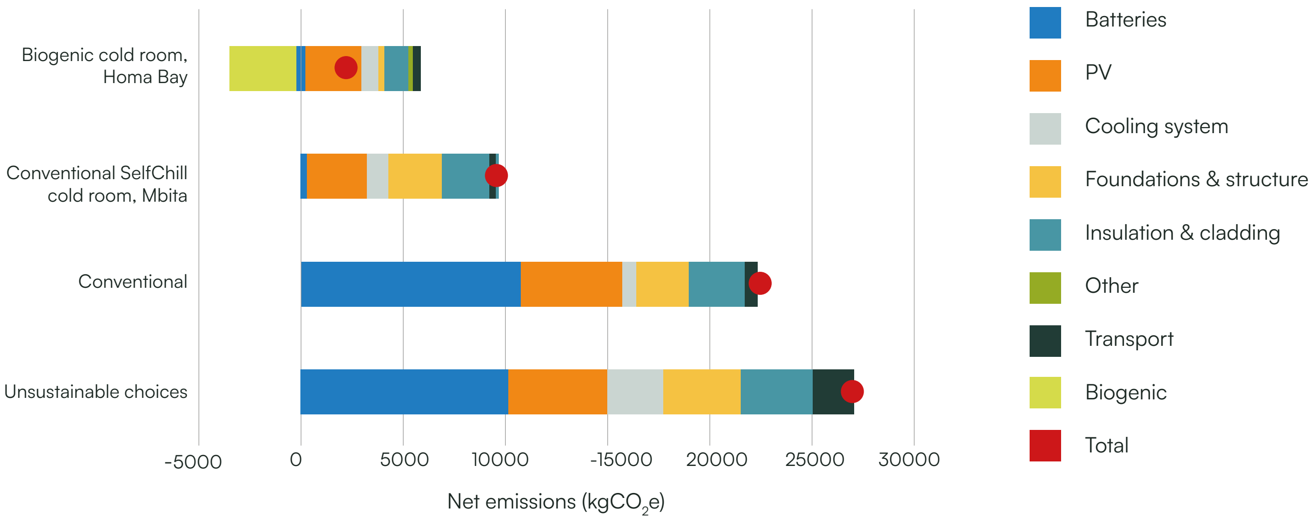


Figure 2. Comparison of total net emissions over 20-year lifetime for the biogenic cold room and three alternative designs.

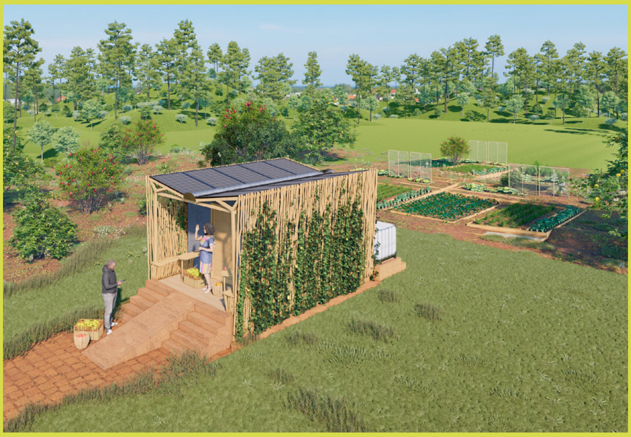


RESULTS

POSITIVE ENVIRONMENTAL AND ECONOMIC IMPACT

The final design reduced embedded GHG emissions by **63% and cost by 20% compared to the best-in-class cold room**, which is insulated with regulated polyurethane sandwich panels. Using an optimised combination of solar panels, thermal storage, batteries, and evaporative cooling proved to be the most effective way to preserve selected fresh produce.

By using straw, timber, and eco-boards for insulation, the design maximised local materials and minimised environmental impact. This solar-powered system would save 3.8 times more GHG emissions over its 20-year lifespan compared to grid-connected alternatives, even in countries like Kenya where 90% of electricity comes from renewable sources.



DESIGNING A COMMERCIALLY VIABLE AND SCALABLE SOLUTION

Creating a completely 'net zero' cold room where the technology components' emissions would be equal to the emissions stored in the straw bale and timber used for insulation would have affected commercial viability and scalability. It would have required expensive and potentially impractical decisions, such as significantly increasing the biogenic wall insulation. The project carefully balanced financial cost, scalability potential and environmental impact while ensuring a high-performing cooling technology.

KEY RECOMMENDATIONS AND CALLS TO ACTION

1. LEVERAGE MULTIDISCIPLINARY EXPERTISE

Assemble a diverse team of experts and local stakeholders early in the project to ensure specialised knowledge and regional insights.

2. ENSURE HIGH LOCAL INVOLVEMENT

Work with local suppliers and professionals from the start to ensure that the design meets local needs.

3. OPTIMISE RELEVANT TOOLS AND TECHNIQUES

Prioritise simple but effective design solutions such as biogenic sandwich panels with moisture control and use optimisation tools to help achieve the best outcomes.

4. USE LIFE CYCLE ASSESSMENT AS A DECISION-MAKING TOOL

Use LCA tools from the beginning to enable swift and informed design decisions that reduce environmental impact and lower costs.

5. BUILD A MOCK-UP TO TEST THE DESIGN AND PERFORMANCE

Develop and evaluate mock-ups of key construction elements to check performance and address potential issues prior to construction.

6. CONSIDER STORAGE NEEDS

Ensure that selected design features can store the targeted types of produce and follow relevant food safety compliance and regulations.

7. MANAGE HUMIDITY DURING CONSTRUCTION AND OPERATION

Select an insulation material that can withstand the levels of humidity recommended for relevant produce. This project used straw insulation with eco-boards to store fruit and vegetables.

8. IDENTIFY AND REDUCE CARBON FOOTPRINT HOTSPOTS

Choose hybrid energy storage solutions that combine thermal storage with lithium-ion batteries to reduce solar PV needed, improve performance and reliability, minimise embedded GHG emissions and cut costs.

9. ADOPT GREEN BUILDING TECHNIQUES

Implement green building techniques to reduce thermal losses through eco-friendly materials, avoid direct solar radiation to the walls to enable passive cooling, and improve aesthetics.

10. MAXIMISE COOLING EFFICIENCY:

Use evaporative cooling and thermal storage to boost energy efficiency and reduce the carbon footprint while balancing storage space.

YOU CAN READ THE FULL REPORT HERE.