SolarChill – Refrigerators and Vaccine Coolers Powered by the Sun

Introduction

Refrigeration of food and other perishable goods, such as vaccines and medicines, is a big challenge in off-grid areas of southern countries. Today, most off-grid refrigerators run on kerosene or diesel, causing GHG emissions and local air pollution. At the same, solar radiation tends to be high in climates that have great needs for cooling, thus, providing an ideal environment for solar powered cooling appliances.

Key points

The SolarChill refrigerator…

- is a reliable food and vaccine refrigeration solution for regions without grid connection.
- avoids fuel costs and fuel dependency as kerosene / diesel is avoided.
- is a climate-friendly technology as GHG emissions from kerosene / diesel consumption is avoided.
- avoids toxic materials and the need for a charge controller which battery-powered solar refrigerators rely on.
- is a simple technology which allows for manufacturing in factories with non-industrialized standards.
- uses public domain technology which is not patented and free to use.

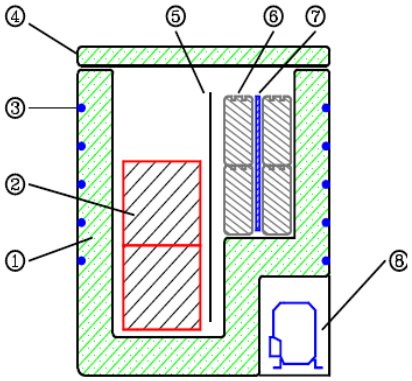
Solar-powered cooling and its advantages

SolarChill technology is relatively simple. The refrigerator is powered by two to three photovoltaic solar panels (total of 100-200W), which run a direct current (DC) compressor. The compressor runs the refrigerant cycle which produces an ice bank that maintains the required temperature in the cabinet. Instead of using a lead battery, which many photovoltaic refrigerators do, the SolarChill system uses a thermal ice storage to cover fluctuation in sunshine and provide cold temperatures at night-time. Simply put, the lead battery is replaced by an ice battery. This avoids the use of relatively costly, maintenance intense and toxic lead batteries.

A thermostat maintains the units at the required temperatures. The required temperature range for vaccines is between 2°C and 8°C and has to be maintained all the time. The optimum temperature range for perishable food storage is around 3°C to 5°C; however, excursions are much less critical here. In low-sun situations, the ice storage together with a reasonable insulation of the cabinet can maintain acceptable temperatures for up to 5 days.

SolarChill design

1- Cabinet with 100 mm PU 2-Vaccine compartment
3- Skin condenser 4-Lid
5- Internal wall, insulated 6-Ice Storage
7- Evaporator, wire on tube 8-Compressor



Status of Development and Market Potential

Two models of SolarChill have been developed: SolarChill A, a unit for vaccine cooling of around 50 litres capacity and SolarChill B, a unit for food refrigeration of around 100 litres. SolarChill A is now commercialized, and SolarChill B is in laboratory testing. While the SolarChill A is primarily for off-grid regions in developing countries, SolarChill B has market potential in off-grid regions throughout the world, e.g. for recreational cottages in industrialized countries.

Possible applications

- Rural health care centres and hospitals
- Small shops in rural areas
- Rural food producing businesses such as fisheries, dairy etc.
- Private households (for food storage)

A reliable cold chain is essential for the safe storage of vaccines. In the fight against the common communicable diseases extensive immunisation programmes are in progress throughout the developing world.

SolarChill enhances the required cold chain. To date, approximately a thousand SolarChill vaccine cooler units have been installed in 15 countries, in South East Asia, Africa and Latin America. SolarChill vaccine coolers are installed in clinics and health centers. They are also in use in refugee camps in Chad and Uganda as well as in earthquake hit zones in Haiti.

SolarChill in Swaziland

In Swaziland, the "The Fridge Factory" plans to produce SolarChill refrigerators especially for the South African market. The Fridge Factory already produces hydrocarbon based refrigerators. The company received technical support for the development of a SolarChill model designed for African conditions, from the German Development Agency, GIZ, financed through the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) within the International Climate Initiative (ICI). While the prototype was optimized in Germany, The Fridge Factory will set up the production line and establish trainings for the technicians. The refrigerator will be sold at a reasonable price and targets rural areas without sufficient access to electricity supply. The experiences gained in this project can be adopted by further refrigeration manufacturers in and outside Africa.

Environmental and Socio-Economic Benefits

- *HEALTH*: SolarChill is a reliable food and vaccine refrigeration solution for regions without grid connection. It can thus contribute to the health situation in rural areas.
- *CLIMATE*: SolarChill is a climate-friendly technology as GHG emissions and local air pollution are avoided compared to fossil-fuel run units which are often used in off-grid areas. On the average, kerosene vaccine coolers consume between 0.8 and 1 litre of kerosene daily, which sums up to 365 litres or ca. 800 kg of CO_2 emissions annually; emissions which are avoided when using the SolarChill technology.
- *WASTE*: On the other hand, compared to conventional solar refrigerators using a lead battery, the toxic waste of the lead battery is avoided in the SolarChill system. Furthermore, refrigerators often use refrigerants such as HFCs which have a high global warming potential (GWP) and thus also cause a certain amount of GHG emissions through leakage and end-of-life discharge. SolarChill uses climate-friendly refrigerants, thus eliminating these emissions.
- *ECONOMIC:* The relatively simple technology allows for manufacturing in factories with non-industrialized standards, making it a suitable product for local production in southern countries. SolarChill technology is not patented and free to use. The utilization of SolarChill B for businesses based on food items such as fisheries or food stores contributes to rural economic development. The SolarChill, direct drive cooling technology, can potentially be adapted to larger, commercial applications.

Costs

The running costs of SolarChill are very low as there is no fuel consumption. SolarChill requires little routine maintenance or repairs. Current manufacturing and purchase costs are expected to reduce with economy of scale as more units are produced. At the same time, prices for photovoltaic panels are coming down, which further reduces costs.

But even today, lifetime costs of SolarChill refrigerators normally break even with those of kerosene units after 5-10 years, depending on varying prices for equipment and fuel. Still, the higher investment costs are a significant barrier for end-users with low budget, so further cost reductions and/or financial schemes such as small credits are needed to reach a bigger target group.

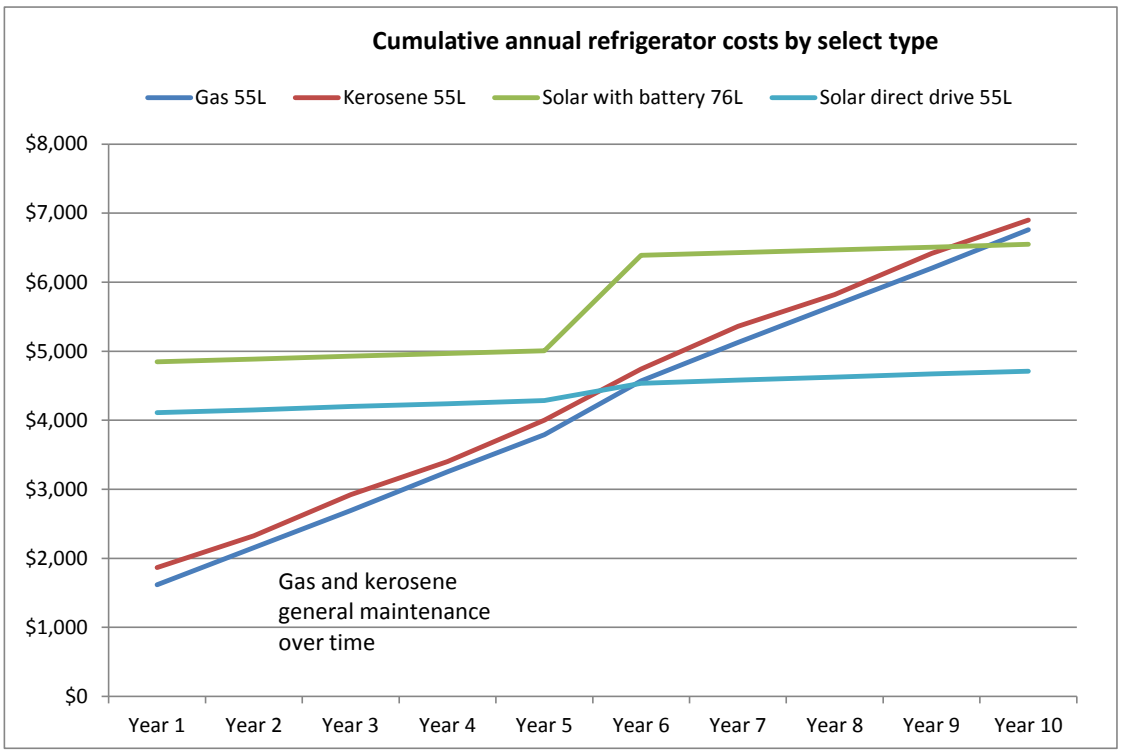


Figure: Cumulative costs of conventional, solar and SolarChill off-grid vaccine coolers. Source: PATH. Notes:

- Prices reflect 2013 WHO PQS price (or pre-2013 inflation adjusted price estimates) for unit, photovoltaic panel (if appropriate), other installation equipment, freight and installation charges.
- Maintenance and repair costs include estimated technician time, travel and repair parts and equipment.
- Assumed LP gas price of $1.83 per kg and kerosene price of $0.85 per liter.

Recommendation for Policy Makers

- Promote utilization of solar vaccine coolers in public hospitals in off-grid areas
- Develop and conduct training programs on solar refrigeration for the servicing and maintenance sector
- Collaborate with refrigerator manufacturers to produce SolarChill models
- Introduce micro-credit schemes for the end-users of SolarChill units
- Support the development and the uptake of SolarChill technology for a variety of commercial applications

Conclusion

Solar powered refrigeration is a practical, cost efficient and simple solution to supply rural areas with necessary cooling power. It can support human health and contribute to food security by enabling users to store perishable goods in off-grid areas. However, there are further efforts needed to make solar powered refrigeration commercially available on a broader basis. There is a need for creating awareness among stakeholders, political decision makers and end-users about the availability and the economic and environmental benefits of the technology.

The Project and its Partners

The name SolarChill stands for an environmental-friendly refrigeration concept developed over the past 13 years by the SolarChill Project, a unique partnership between seven international organization. In 2012 the Global Environment Facility approved a 2.7 million dollar grant to run larges scale SolarChill demonstration and technology transfer projects in Kenya, Swaziland and Colombia.

- Greenpeace International
- United Nations Environment Programme (UNEP)
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH-Proklima
- Danish Technological Institute (DTI)
- United Nations Children's Fund (UNICEF)
- World Health Organization (WHO)
- Programme for Appropriate Technology in Health (PATH)
- Global Environment Facility

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Additional information

http://www.unep.fr/ozonaction/information/mmcfiles/4489-e-SolarChill.pdf

http://www.solarchill.org

www.iorec.org/pdf/4_Session%205.pdf