SolarChill Refrigeration - Cooling Vaccines, Food and the Climate

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www.solarchill.org

Overview

- Background:
  - The SolarChill Consortium
  - Situation and issues of off-grid refrigeration
- The SolarChill technology as a solution
- Present barriers for bigger deployment
- Palfridge: An example for knowledge transfer

Background: The SolarChill Partnership

The SolarChill Project brings together organizations working on health, environment and technology development:

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

Background: Off-Grid Refrigeration: Today's Situation

Situation:

- >2,000,000 domestic kerosene and gas fridges worldwide
- Plus app. 100,000 kerosene vaccine coolers worldwide.
  - Av. kerosene consumption per unit: About 300 l / year, Corresponding to 750 kg of CO_2 emissions / year

Drawbacks:

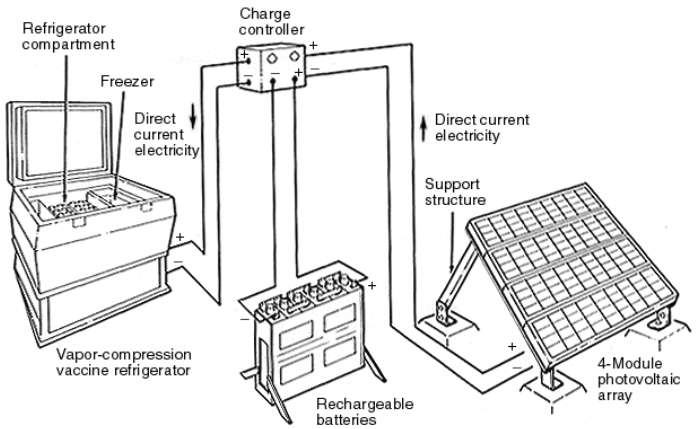
- Total >1 million tCO_2 per year (~5% from vaccine coolers), plus emissions from HFC leakages, amounting to a similar amount
- Local air pollution from kerosene (smell…)
- Dependence on fuel supply

Vaccine Cooler V110KE, Sibir

One Solution: Solar Fridges

Solar Vaccine Coolers as a more environment-friendly solution (PV system using a lead battery):

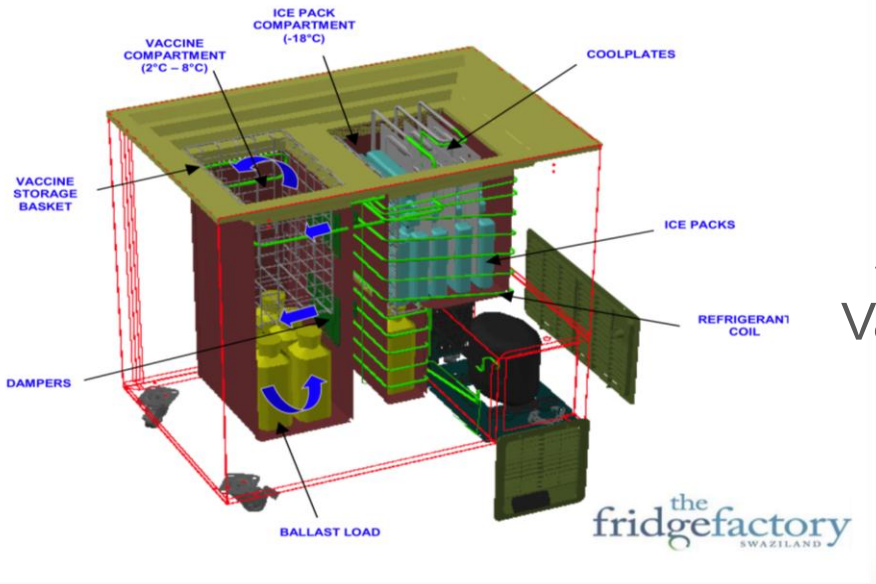
- No kerosene consumption:
  - No CO2 emission, no local pollution
- But:
  - Still climate-intense emissions from HFC (= refrigerant, insulation gas) leakage
  - Recycling and operational issues for lead batteries



Vaccine Refrigerator Powered by a Photovoltaic System

The solution, thought further: The SolarChill Technology

- Electricity from 2 or 3 solar panels drive a direct current compressor.
- Compressor runs refrigeration cycle which in turn produces an ice bank.
- Ice bank provides cooling in storage cabinet; the power of the sun is thus stored in an “ice battery”.
- Thick insulation maintains temperature without adequate light for up to 3 to 5 days.



Schematic view: Vaccine cooler by Palfridge/the fridgefactory, Swaziland

The SolarChill Technolgy - Advantages

1. Substitution of the refrigerant and insulation gas HFC by Hydro-Carbons (C_nH_n):
   - ➢ Further reduction of emissions
2. Substitution of the electric lead battery by a thermal ice “battery”:
   - ➢ Avoidance of lead and potentially reduction of costs
3. Thick or vacuum insulation:
   - ➢ Long autonomy time (e.g. 3 days)

Plus:

- Reduction of costs by integrating production into existing mass produced cabinets.
- Simple installation as no charge controller etc. is needed

SolarChill A: Vaccine Cooler

- For vaccines
- Net volume 50 liters for vaccines plus ice package compartment (WHO specs)
- 72h of autonomy (when lack of sun)

SolarChill B: Food Refrigerator

- For domestic and commercial use
- Prototypes working since 2005
- Net volume 100/160 litres

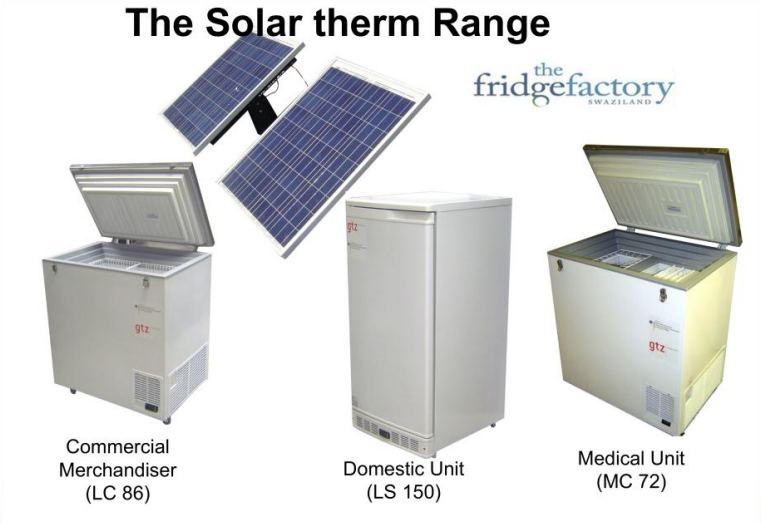
Main Barriers to big scale deployment

- Yet **limited recognition** of the existence and availability of the SolarChill technology as well as acceptance issues created by underperformance models
- **Technical Challenges** to Technology Transfer:
  - requires companies to work with **hydrocarbons**
  - proper safety measures, training and service infrastructure
  - supply of high-grade hydrocarbon refrigerants
- **Price difference** to kerosene models (only on investment costs!)

	Kerosene Vaccine Cooler	SolarChill Vaccine Cooler
Price	~ $1,500	~1,800-2,800
Fuel costs / a	~$270 (300l)	-
Break-even solar vs. kerosene		~1-5 years

An example: Palfridge (Swaziland)

- In 2009/10, GIZ Proklima funded the **conversion** of the commercial production lines of refrigerator manufacturer Palfridge in Swaziland **from CFC to CH**.
- GIZ also supports Palfridge in the **design of a SolarChill model**; with support from a German engineering office, Palfridge makes **innovative modifications** to the original SolarChill design
- Vaccine cooler: Price currently about $1750, **aiming for $1500** incl. 2x 90W solar panels (yet to be tested under WHO specs)



Conclusions SolarChill

- SolarChill is **an innovative design for off-grid, low-emission solar food refrigerators and vaccine coolers**, thus bridging environmental, development and health topics.
- With commercial production, there is a **big scope for low costs, high deployment rates and competitive local manufacturing**. A certain improvement on technology and costs should be the aim.
- **Local partners** such as manufacturers, government agencies or organizations from the health sector are always welcome for collaboration.

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Supplementry Slides

Financial Aspects

- Purchase price for SolarChill units: $1800 to $2800 US
- Kerosene units: Around $1000
- Annual fuel costs: 300 l x 0.9 $ / l (in Ghana): 270$
- Amortization in 4 to 8 years vs. kerosene units
- Will be further improved with future models

SolarChill Vaccine Refrigerators

Current WHO prequalified SolarChill vaccine refrigerators and freezer:

Manufacturer	*Model*	*Product type*	*PQS Zone*	*Vaccine volume*	*Autonomy*	*Freezing capacity/ day*	*PV power (min)*	*Price/unit (USD)***	*Price/panel (USD)*
Vestfrost	MKS044	Vaccine Refrigerator**	Temperate	19.5 litres	147 hours at +32C	1.8 kg/day @ +32C note: freezer not PQS prequalified	160 Watts at 6.0 kWh/m2-day	$1,490	?
True Energy	BLF100DC	Vaccine Refrigerator	Hot	99 litres	>72 hours at +43C	NA	370 Watts at 3.5 kWh/m2-day	$4,115	?
Dometic	TCW3000SDD	Vaccine Refrigerator	Temperate	156 litres	87 hours at +32C	NA	250 Watts at 3.5 kWh/m2-day	$5,918	?
Haier	HTC60	Vaccine Refrigerator**	Temperate	21 litres	135.5 hours at +32C	NA	360 Watts at 6.0 kWh/m2-day	$1,436	?
Manufacturer	***Model***	***Product type***	***PQS Zone***	***Vaccine volume***	***Autonomy***	***Freezer capacity/ day***	***PV power (min)***	***Price/unit (USD)****	***Price/panel (USD)****
Sundanzer	DDF50	Water-pack freezer (WHO prequalification not required)	Temperate	NA	?	3 kg/day @ +32C	320 Watts @ +32C at 3.5 kWh/m2-day	?	?

***Advertised with a water-pack freezer; freezer compartment did not meet WHO prequalification specifications**

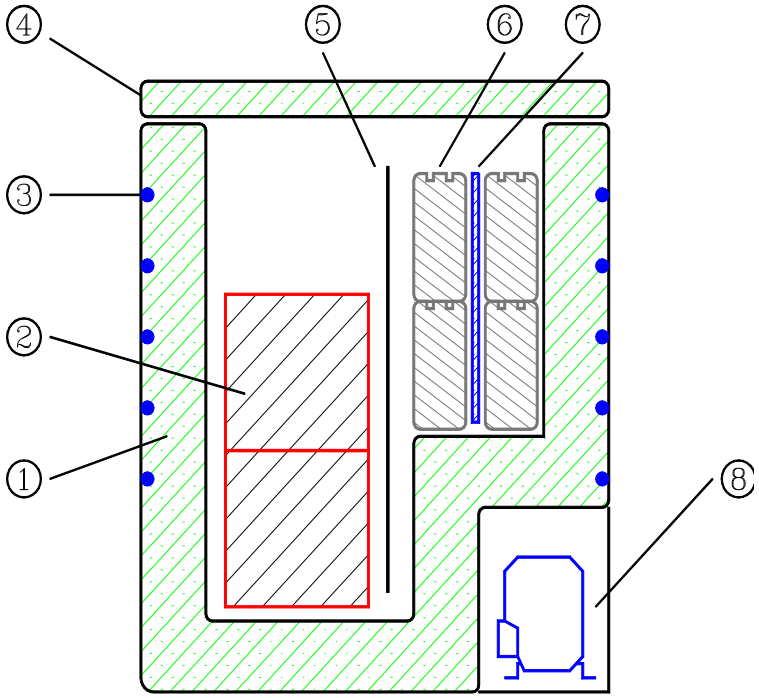
****Price reflects cost of refrigerator or freezer based on the WHO price not including the solar panel. Pre-2012 prices are inflation-adjusted to reflect 2012 price estimate. (www.who.int/immunization_standards/vaccine_quality/e03_prequalified_equip/en/index.html),**

Installation of Vestfrost vaccine cooler in Africa

Cuba, Indonesia

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



Developing SolarChill for Bigger Scale Deployment: The GEF SolarChill Project (Preparatory Phase 2012)

- Conduct large scale demonstration projects and tests of SolarChill vaccine coolers in Kenya, Colombia, Swaziland
- Further develop and field test SolarChill food refrigerator for technical performance and user acceptance and stimulate interest and investment by private manufacturing sector
- Develop market information and technology transfer packages and conduct outreach programs with manufacturing sectors in Africa and Latin America (esp. cooperation with Palfridge, Swaziland)

SolarChill History

- **Founded in 2001** by Greenpeace, UNEP, GIZ, WHO, UNICEF, later PATH (Partners for Appropriate Technology in Health) and DTI (Danish Technology Institute) plus Danfoss and Vestfrost (Danish refrigeration companies) as industry partners
- **SolarChill prototypes** were field tested over 18 months in Senegal, Indonesia and Cuba in 2004-2005.
- Since then, different models by different producers have been **installed in 15 countries** in East Asia, Africa and Latin America
- Also: Deployment in **disaster areas**: Vestfrost SolarChill used by Medicine Sans Frontiers in refugee camps in Chad and Sudan, over 150 units deployed by UNICEF in Haiti.
- Some issues remaining with **reliability** of certain models