National Aeronautics and Space Administration

technology opportunity

# Solar-Powered Refrigeration System

*A proven, environmentally friendly solution that eliminates the need for batteries*

*Innovator Michael Ewert (pictured above) is the inventor of the solar-powered refrigeration system.*

Innovators at NASA's Johnson Space Center have patented a proven, solar-powered refrigeration system that eliminates reliance on an electric grid, requires no batteries, and stores thermal energy for efficient use when sunlight is absent. The innovation uses a variable speed, direct current (DC) vapor compression cooling system, connected to a solar photovoltaic (PV) panel via novel electronic controls. This environmentally friendly system is ideal for use in commercial or household refrigerators, freezers, vaccine coolers, or solar ice-makers. It is particularly ideal for off-grid applications.

## Benefits

- **Environmentally friendly**: Harnesses the energy of the sun to reduce dependence on fossil fuels and eliminates the need for batteries that can be damaging to the Earth upon disposal
- **Longevity**: Operates continuously for years as proven by prototype units tested at various locations around the world
- **Scalable**: Suits applications in a wide range of sizes, from portable 50-liter coolers to building-size air-cooling systems

## Applications

- Refrigerators
- Freezers
- Ice-makers
- Coolers
- Building air-cooling systems

## Technology Details

### *How It Works*

Johnson Space Center's solar-powered refrigeration system employs a PV panel, vapor compressor, thermal storage and reservoir, and electronic controls. The process that makes the refrigeration possible is the conversion of sunlight into DC electrical power, achieved by the PV panel. The DC electrical power drives the compressor to circulate refrigerant through a vapor compression refrigeration loop that extracts heat from an insulated enclosure. This enclosure includes the thermal reservoir and a phase change material. This material freezes as heat is extracted from the enclosure. This process effectively creates an "ice pack," enabling temperature maintenance inside the enclosure in the absence of sunlight.

Proper sizing of the highly insulated cabinet, phase change thermal storage, variable speed compressor, and solar PV panel allow the refrigerator to stay cold all year long. To optimize the conversion of solar power into stored thermal energy, a compressor control method fully exploits the available energy. Other power optimization measures include:

- Smoothing the power voltage via a capacitor, providing additional current during compressor start-up
- Monitoring the rate of change of the smoothed power voltage using a controller to determine if the compressor is operating below or above the available power maximum, enabling adjustment of the compressor speed if necessary
- Replacing the capillary tube in the refrigerator system with an expansion valve, improving energy efficiency in certain operating conditions

These adjustments to the compressor operation contribute to the conversion of the majority of the available solar power into stored thermal energy. Applications may include a cold side water loop or incorporation of the evaporator into the thermal storage. Electronic controls also can be added to provide backup power from an alternative power source such as an electric grid.

### *Why It Is Better*

The standard use of AC electricity supplied by the electric utility to power a single-speed vapor compression cooling system in a moderately insulated cabinet ties refrigerators to an electric grid and limits where they can be used. This prohibits their use in off-grid applications and maintains a dependence on fossil fuels for power. For these reasons, the demand for solar appliances of all kinds is increasing. However, other existing solar refrigerators use batteries, presenting a number of disadvantages. Batteries add expense, and their use and disposal cause undesirable maintenance and environmental consequences. Heat-driven cooling systems, such as absorption cycle, can also be solar powered, but their thermodynamic efficiency is not as good as vapor compression, they require more complex solar collectors, and they do not scale down in size as well.

In contrast, the solar-powered refrigeration system developed at Johnson Space Center is environmentally friendly because it eliminates the need for an electric grid or batteries and provides enough reserve thermal storage for cooling in the absence of continual sunlight.

### *Patents*

NASA's Johnson Space Center has received patent protection for this technology: U.S. Patent No. 6,253,563. This technology is also closely related to U.S. Patent Nos. 6,469,487 and 6,453,693.

## Licensing and Partnering Opportunities

This technology is part of NASA's Innovative Partnerships Program, which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to inquire about the licensing possibilities for the Solar-Powered Refrigeration Technology (MSC-22970-1) for commercial applications.

## For More Information

If you would like more information about this technology, please contact:

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For information about other technology licensing opportunities, please visit:

**Innovation Partnerships Office**
**NASA's Johnson Space Center**
**http://technology.jsc.nasa.gov**

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