WLGA
Energy Anywhere

SOLAR AND LPG HYBRID HEAT PUMP FOR AIR-CONDITIONING AND REFRIGERATION

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POLAR POWER'S INNOVATIVE HYBRID PROJECT

This Solar Hybrid project is founded on our past 40 years of developing cooling and power systems, providing unique solutions to our customers' needs. Our projects have serviced military, government aid programmes, telecom, off-grid applications, etc... Over time we learned from our customers' performance requirements, failures and success through the support of our equipment in the field. Every step of this evolution has led us to our current Solar hybrid systems design.

The concept is a high-level integration of multiple energy sources directly powering the application appliance (HVAC). Incorporating an LPG DC generator and Solar with a brushless DC refrigeration unit (heat pump) along with a master control unit as an integrated package.

Our UN installation trip to Egypt in the 1980s

POLAR POWER'S INNOVATIVE HYBRID PROJECT

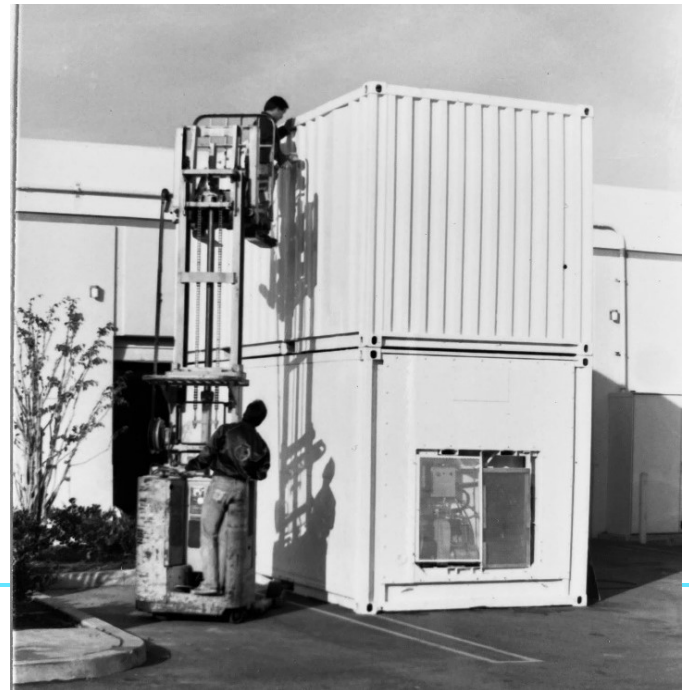
Polar began in 1979 with the launch of a solar-powered vaccine refrigerator, when photovoltaic (PV) costs ranged between $14 and $16 per peak watt. Flooded lead acid batteries were somewhat affordable, and the ones selected by Polar lasted 10 to 15 years. However, Lithium batteries are a more efficient choice, but still expensive.

Our UN installation trip to Egypt in the 1980s The high cost of solar necessitated a secondary energy source, leading us to explore small wind generators.

BACKGROUND AND DEVELOPMENT

In the late 1980s, Polar engineered and prototyped a solar-powered Ice Plant producing up to 14 tons of ice per day to support transporting low-cost farm-raised tilapia to fish markets in Cairo. With solar PV costs between $4 and $6, the system operated without batteries, utilizing a 60 kW AC diesel generator to support refrigeration compressor motors during nighttime.

There were subsidies back then that made diesel fuel nearly free in Egypt and other areas in the Middle East, LPG was not a competitive fuel. Using the AC generator required an AC to DC conversion that was costly and inefficient, highlighting the need for a DC generator to reduce system costs and enhance efficiency.



BACKGROUND AND DEVELOPMENT

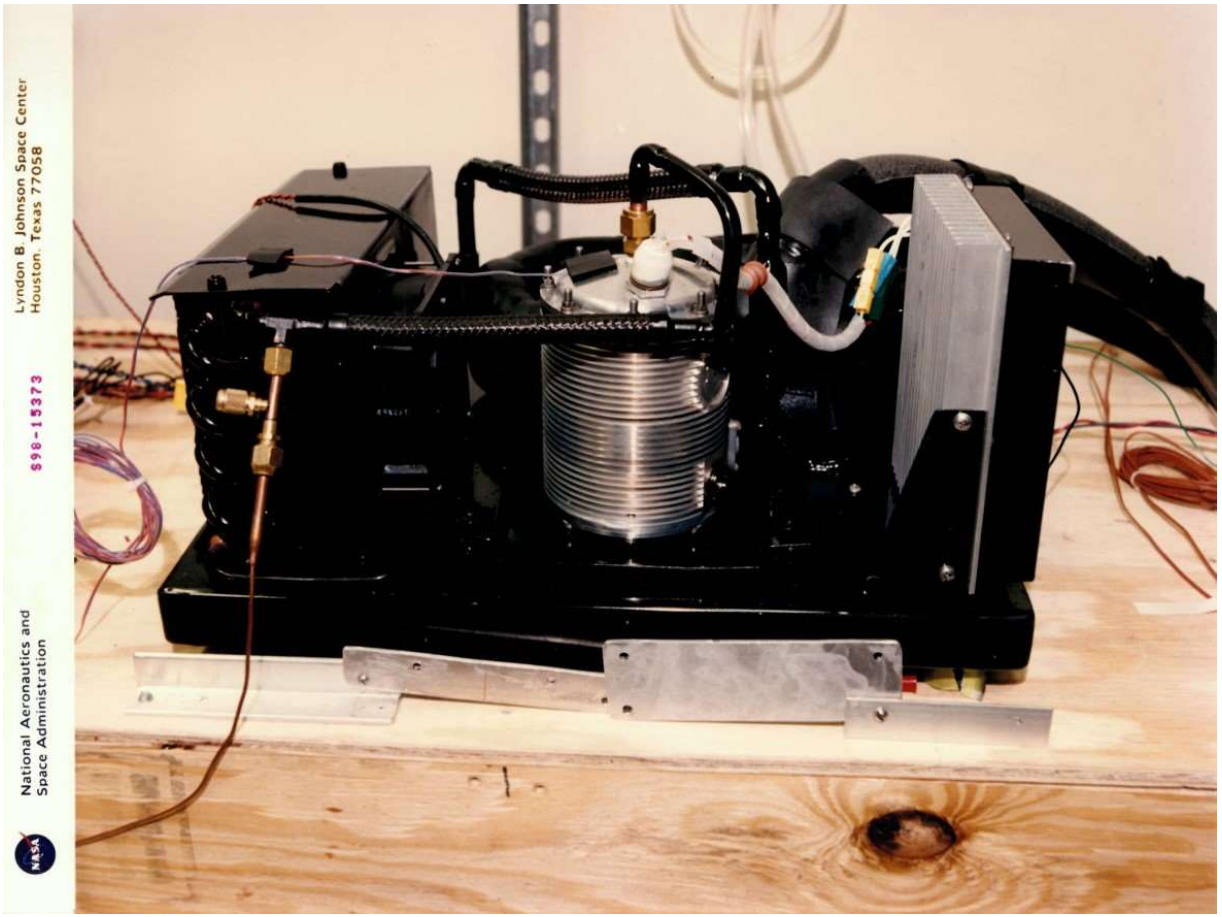
Another Polar project: a mobile solar-powered walk-in refrigerator Polar created for the US Department of Agriculture. Like the ice plant project, this system functioned without batteries, employing cold plates to maintain refrigeration when solar energy was unavailable. The cold plates would freeze when the solar energy was available, then provide the cooling effect similar to 300 kg of ice placed within a very large ice chest.

For larger containers (20 and 40 foot) and storing food, this technology would not work due to the wide fluctuation of temperature and the cost, weight, and volume required for significantly larger cold plates. These experiences led to our Solar Hybrid system solution consisting of: Solar PV, DC generator, DC refrigeration compressors, no batteries, no inverters, LPG as the fuel.

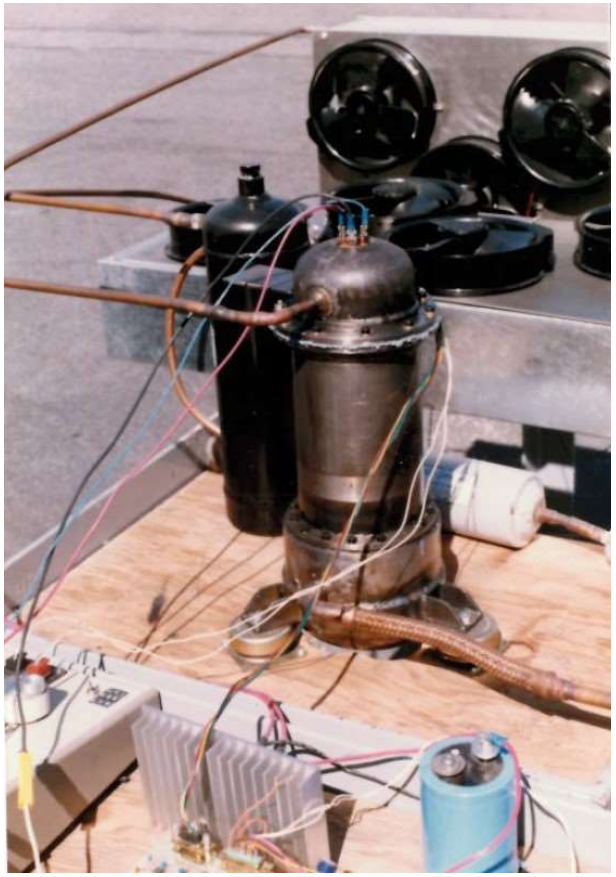
INNOVATION AND EFFICIENCY

Our earlier projects (Solar Ice plant and mobile solar powered walk-in refrigerator) employed brush-type DC motors driving compressors (with shaft seals to retain refrigerant gas). To further improve efficiency, we pioneered the use of brushless PM motors hermetically sealed with the compressor inside a metal can, similar to AC hermetic compressors.

This photo shows a DC heat pump Polar developed for a NASA programme to provide refrigeration and air-conditioning in a future lunar habitat.



INNOVATION AND EFFICIENCY



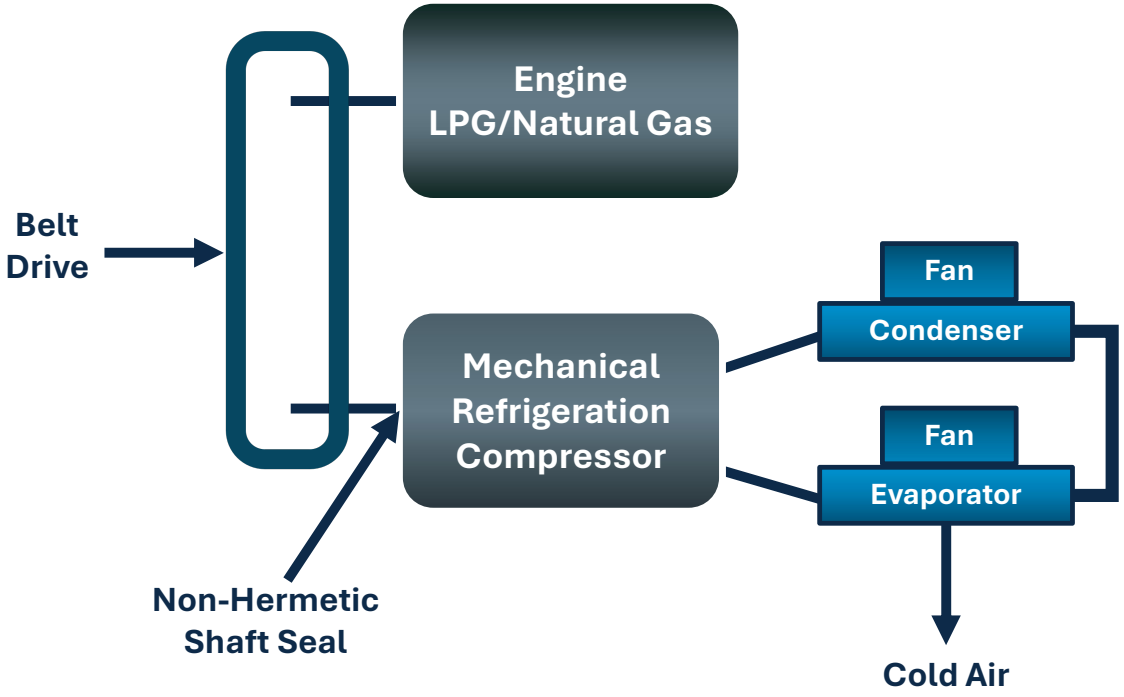
The above photos show the first hermetic compressor produced by Polar for EV air-conditioning on the G-Van.

CURRENT TECHNOLOGY - BELT DRIVEN GAS POWERED HEAT PUMP.

The disadvantages with this LPG or Natural Gas only approach are:

- Drive belts, pulleys, compressor shaft seals require maintenance and produce more noise.
- Power from other sources is not incorporated

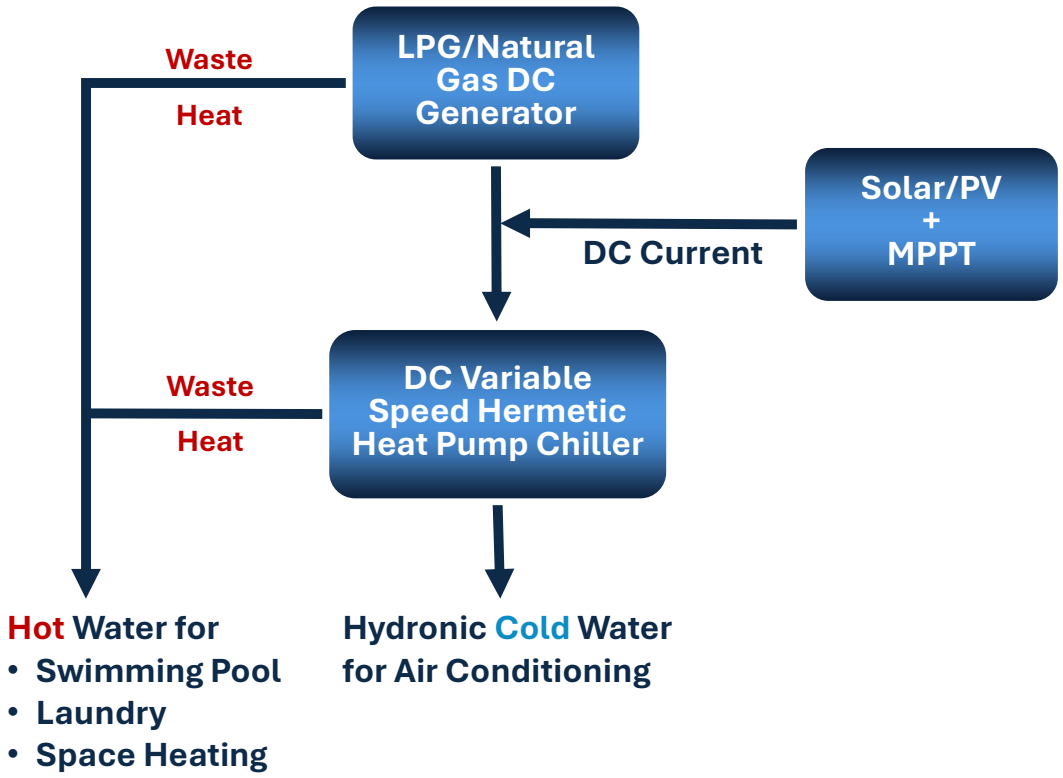
Aisin GHP



PROPANE/SOLAR HYBRID HVAC - ELECTRIC DRIVE

The concept is a high-level integration of 2 energy sources: Solar and LPG with the HVAC or refrigeration appliance. Also capturing the waste heat from the engine and the refrigeration cycle.

The solar power is consumed first and if additional refrigeration is required the LPG DC generator provides the additional power. At night, the DC generator continues to provide the energy needs. The combined solar power and DC power generated by the LPG fuel, powers the variable speed DC hermetic compressor. Digital controls regulate the amount of LPG used to meet the end users' refrigeration needs.



COMMERCIAL, OPERATIONAL, AND ENVIRONMENTAL IMPACT

The current market conditions are ideal for our Solar and LPG Hybrid Heat Pump for Air-conditioning and Refrigeration due to several factors:

1. **Cost Efficiency**: Solar costs have dropped to $0.30 to $0.50 per peak watt, making Solar PV implementation very cost-effective, especially when batteries and inverters are excluded.
2. **Rising Diesel Costs**: Diesel prices are escalating, compounded by issues of: theft, poor fuel quality in rural areas, and stringent emission regulations.
3. **Grid Reliability**: Declining grid quality, with more frequent and prolonged blackouts.
4. **Rising Food Costs**: Increasing food costs necessitate programmes to reduce spoilage by using lower cost means of refrigeration.
5. **Climate Change**: Rising global temperatures drive demand for increasing the use of air-conditioning, and this is placing greater demands on the grid for increased power production. Air-conditioner using Solar and clean fuel would be exempt from utilities demands to shut down during grid overloads.
6. **Education**: Is far more effective with air-conditioned classrooms.

MARKET POTENTIAL AND BARRIERS

Our technology has potential applications in water pumping and refrigeration for transportation of cold goods, where these current systems rely on diesel engines. LPG could emerge as a preferred fuel in many urban areas.

The primary market barrier is the need for widespread education on technology and the availability of LPG.

A large barrier to adoption of LPG as a source of electric power generation under 50 kW are consumers' negative experiences with the low-cost backup generators from major brands. Applications should not use backup generators when the application requires fuel efficiency, low maintenance and long life.

In summary, our Solar Hybrid project is a product of decades of innovation, designed to meet modern energy and environmental challenges. It offers a sustainable, cost-effective, and efficient solution for air-conditioning and refrigeration needs.

OBJECTIVES AND EXPECTATIONS

Our long-term objective is to manufacture and distribute these systems in large volume. Before we can proceed with production and sales, we need minimum support on:

1. **Customer Education** on: the availability of LPG and other clean fuels, how the fuels are stored on site, any regulations that may affect their use.
2. A **Supply Chain** that will assure customers that they have a reliable source of fuel delivered to their site at a competitive cost with other sources of energy.
3. **Market Education** on the availability of products. Ideally this function should be a team effort between the fuel suppliers and equipment manufacturers.
4. Create new and separate **Sales and Marketing Groups** to pursue new LPG sales opportunities

Thank you!

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