



Power Systems

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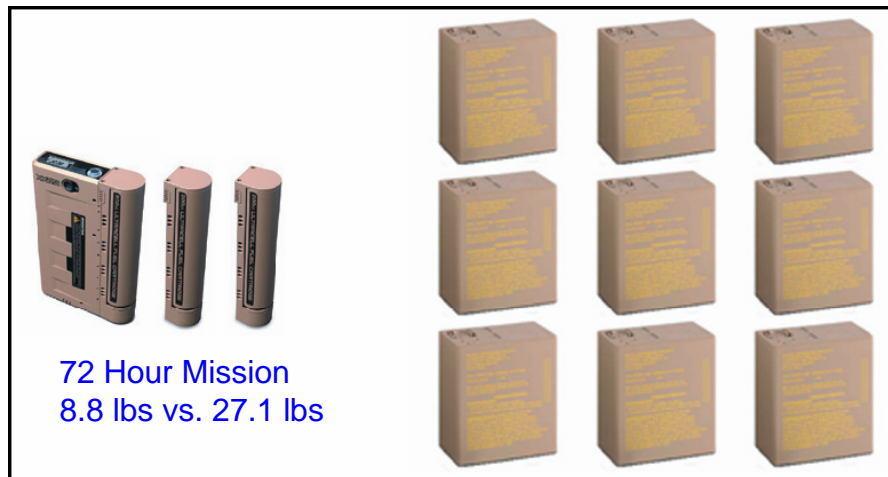
UltraCell XX25 Fuel Cell

- ❑ 25 Watts Output @ 12 – 30 V (factory set)
- ❑ 2.7 lbs + 0.8 lb fuel cartridge
- ❑ 180 Wh per fuel cartridge
- ❑ -20 to +40° C operating temperature range
- ❑ 5.9 x 9.1 x 1.7 inches
- ❑ 2.7 lbs
- ❑ MIL-STD-810F
- ❑ Environmentally friendly



Fuel Cell System

- ❑ Methanol Fuel has high power density
- ❑ Rechargeable fuel cartridges much lighter than Li-Ion batteries for same capacity



EXPLORER™ 700 and UltraCell XX25.

Field Power Systems



- ❑ UltraCell XX25 Methanol Fuel Cell
- ❑ 25 W @ 12 V DC
Needs storage battery
- ❑ 0.37 gal/kWh
- ❑ 2.7 lbs + fuel
118 cu in + fuel
- ❑ 1 kWh => 5.7 lbs
- ❑ Fan noise
- ❑ \$5,000 + \$100 for 1 gallon fuel



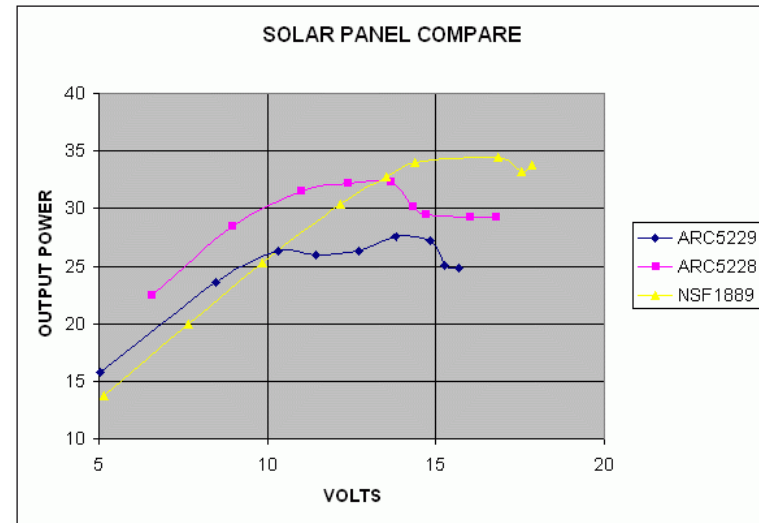
- ❑ Honda EU1000i Generator
- ❑ 12 VDC to 8 A
1000 W @ 115 VAC
- ❑ 0.16 gal/kWh full load
0.3 gal/kWh $\frac{1}{4}$ load
- ❑ 29 lbs + fuel
2565 cu in + fuel
- ❑ 1 kWh => 32 lbs
- ❑ 53–59 dB(A) @ 7 m
- ❑ \$780



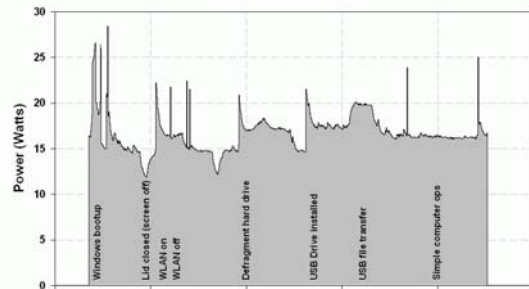
- ❑ UniPac 34 Solar Panel & battery
- ❑ 12 V DC * 2 A
- ❑ 20 Ah battery
- ❑ 20.7 lbs
526 cu in
- ❑ 1 kWh => 20.7 lbs
if clouds < 7 days
- ❑ Silent
- ❑ \$800

Low Power Systems

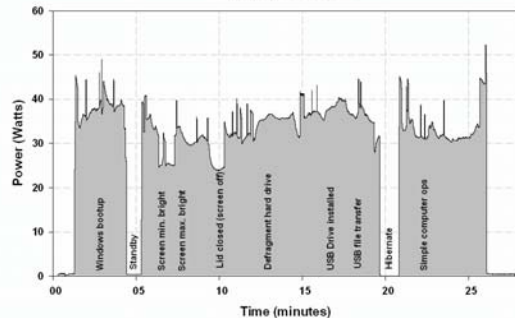
- ❑ Reduce power consumption rather than supply more power
- ❑ GSE P3 48-W panel didn't meet specs



Power Consumption
Panasonic CD-30 Toughbook
Model CF-30CTQAZBM



Power Consumption
Lenovo T60p
Model 2613-ETU



Imnavait Creek, Alaska

- ❑ 40 Watt continuous load
- ❑ 650 Watt solar array
- ❑ 1000 Watt wind turbine
- ❑ 32 6-V 220-Ah batteries
- ❑ Iridium data link



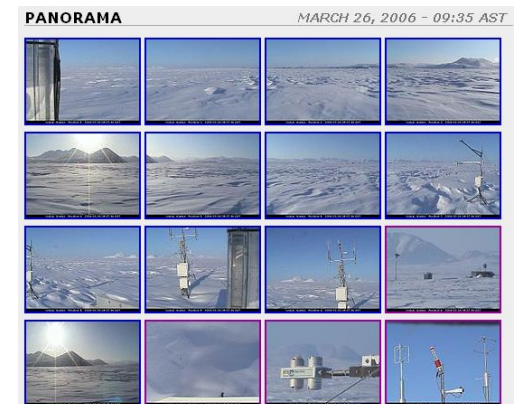
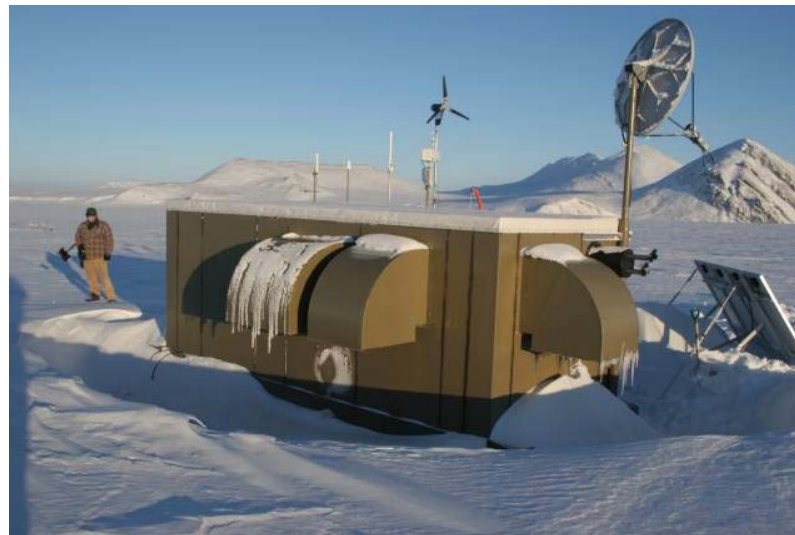
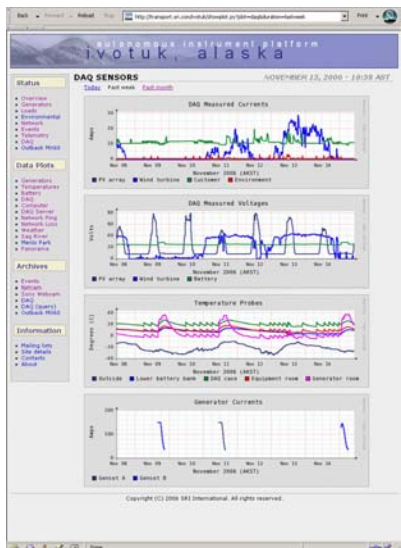
Summit Station, Greenland

- ❑ **Proven WT6000 (6 kW) turbine
Supplements diesel gensets**
- ❑ **10,000 ft ice foundation
Plywood ice anchors**
- ❑ **No derrick for erection**
- ❑ **-60° C temperature**
- ❑ **Hoar frost destroys
blade aerodynamics**



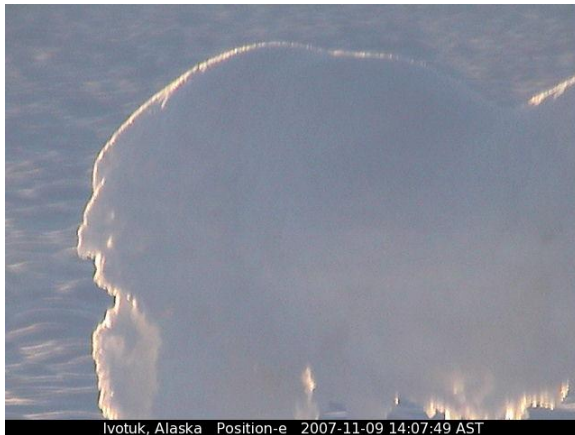
Ivotuk, Alaska, Power Platform

- ❑ 250 Watt continuous load
- ❑ Two 6.5-kW diesel gensets
- ❑ 440-W solar array
- ❑ 600-W wind turbine
- ❑ AGM battery bank in external enclosure
- ❑ StarBand satellite link



Icing at Ivotuk

- ❑ Hoar frost affects instrumentation
- ❑ Limited power for deicing
- ❑ Remote sensing of icing



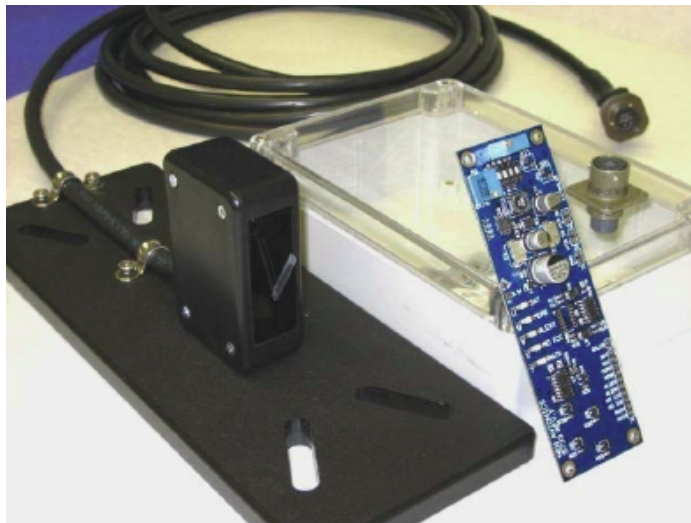
Ivotuk, Alaska Position-e 2007-11-09 14:07:49 AST



Ivotuk, Alaska Position-f 2007-11-09 14:07:49 AST

Deicing Testing

- ❑ Icing Detectors
 - Goodrich - vibration
 - New Avionics – laser refraction



2008 Clean Snowmobile Challenge

- ❑ 15 University teams
- ❑ McGill University winner of Zero Emissions category (4 entries)
Li-Ion technology, lightweight (499 lbs)
- ❑ Two sleds to be “test driven” at Summit Station, Greenland



Kick off



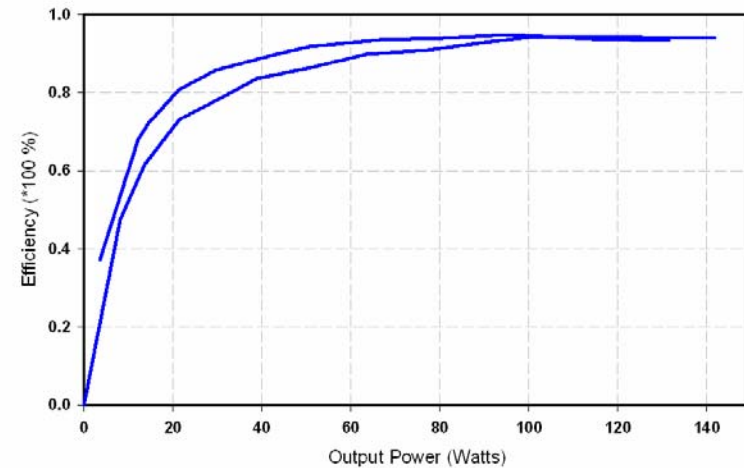
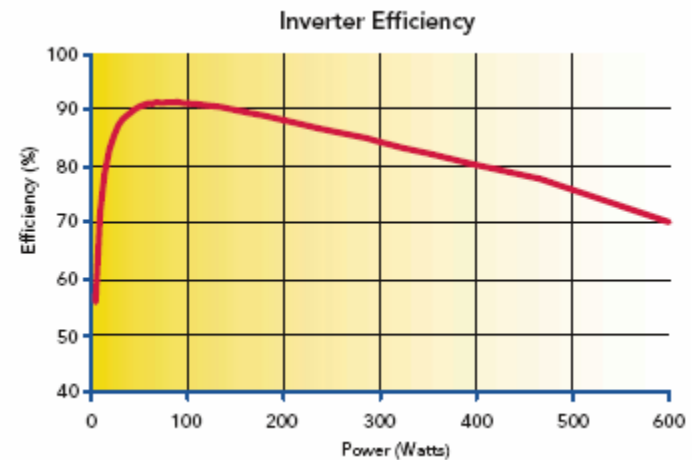
McGill Univ.



Michigan Tech

Morningstar SureSine Inverter

- ❑ Pure sine wave inverter
- ❑ 300-Watt continuous output
600-Watt peak rating
- ❑ 115- or 220-VAC, 50 or 60 Hz
- ❑ 90% efficiency at 50- 150 W
- ❑ -40 to +45° C



PolarPower.Org Home Page

- ❑ Introduction
- ❑ Power Technologies
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PolarPower.org Remote power systems for polar environments.

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OBJECTIVE

PolarPower.org is funded by the [National Science Foundation](#) with the goal of providing a useful working resource for researchers in choosing, designing, implementing, and maintaining remote power systems in polar environments. This site allows the polar research community to establish a foundation of knowledge, share experiences, and stay current on technological developments.

TECHNOLOGIES FOR REMOTE POWER APPLICATIONS

This section offers basic information regarding the various technologies available for remote power systems and their applicability for both small and large implementations, as well as practical information regarding choosing, designing, and implementing them.

The content draws on the design and field experiences of both VPR's team of experts and the polar research community. This information is presented as white papers, product reviews, and (in the future) engineering calculators.

The basic technology sections are:

Icon	Definition
	Engine - Internal combustion engines are a proven technology used worldwide. A wide selection of fuels is available, depending on the application. link
	Fuel Cell - A fuel cell is an electrochemical device that combines hydrogen and oxygen to produce electricity. The process is clean, quiet, and efficient. A byproduct of the process is water, however, which can be a problem for deployments in a polar environment. The technology is still in its infancy, but commercial products are becoming available. link
	Hydroelectric - Small scale turbines can provide a source of electricity at sites where water can be found in a liquid state for at least part of the year. link
	Solar Electric (Photovoltaic) - Cells made up from two or more layers of semiconductor material can produce electric power when excited by photons. The sun is a major source for such photons, but the process also works for other sources of light. Cells may be stacked into arrays to meet different voltage and power requirements. link
	Storage - Primary and rechargeable batteries are often used as a site's sole source of power or in conjunction with one or more of the available power generation technologies to provide a reservoir of continuous power to the load. Flywheels and ultracapacitors are new technologies that are finding their way as a replacement for rechargeable batteries. link
	Wind - Wind-powered turbines are a clean source of power. Special problems arise with a moving mechanical device in polar regions prone to ice formation and high wind velocities. Mounting structures also provide challenges for systems that may be located on ice fields well above solid ground. link

TECHNOLOGY DEPLOYMENT EXAMPLES

This section provides brief descriptions of systems that have been deployed in the polar regions and some basic information of the specifics of the technology deployed. Links to responsible agency sites are often provided to facilitate a deeper

Done

Working Examples - Battery



Effects of Cold Temperatures on Battery Capacity - UNAVCO

Charge/Discharge Capacity at Cold Temperatures

Temperature (C)	Pre-Test Soak Time (hours)	GEL Capacity	AGM Capacity
25	n/a	100%	100%
-20	24	24%	23%
-30	12	10%	13%
-35	12	3%	4%
-40	12	1%	2%
-45	12	0%	1%
-50	12	0%	0%
25	48	108%	96%

Recovery After Cold Exposure

Test Description	GEL Capacity	AGM Capacity
Soak fully-charged battery at -70C for 48 hours; test after 48 hour soak at 25C	101%	92%
Soak discharged battery at -70C for 48 hours; test after 48 hour soak at 25C	97%	88%

Battery Cold Temperature Performance

