Power Systems

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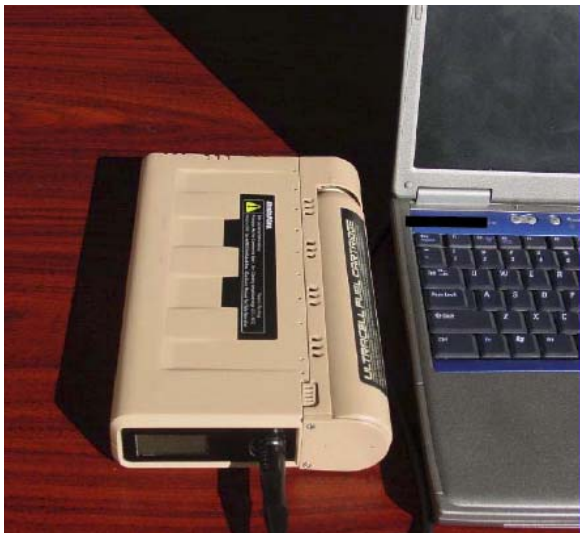
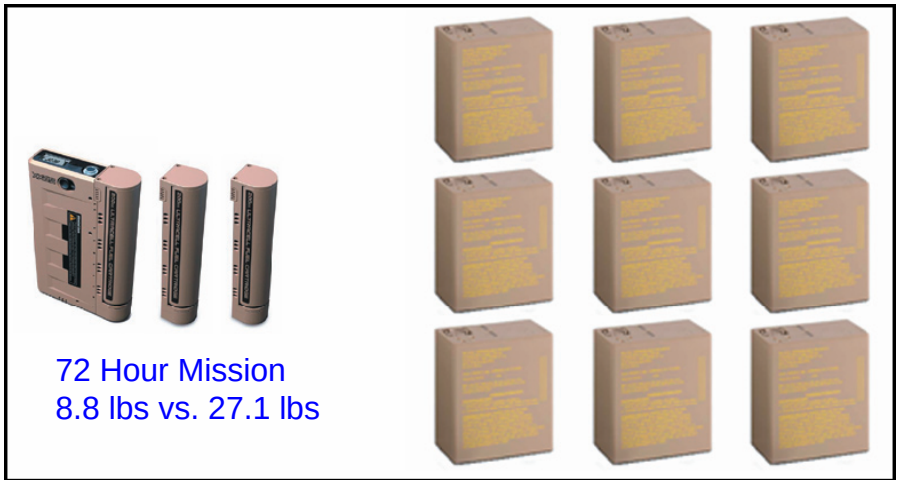
UltraCell XX25 Fuel Cell

- 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**





72 Hour Mission
8.8 lbs vs. 27.1 lbs

EXPLORER™ 700 and UltraCell XX25.

Field Power Systems

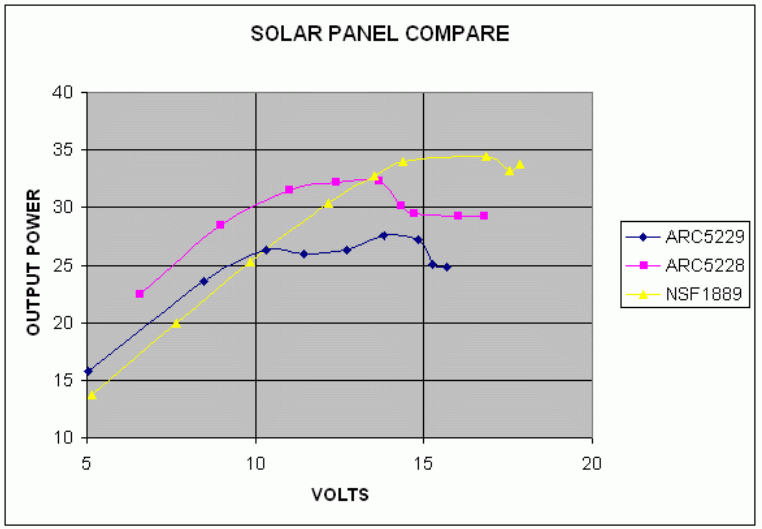
- UltraCell XX25 Methanol Fuel Cell
- 25 W @ 12 V DC Needs storage battery
- 0.37 gal/kWh
- 2.7 lbs + fuel 118 cu in + fuel
- 1 kWh => 5.7 lbs
- Fan noise
- $5,000 + $100 for 1 gallon fuel

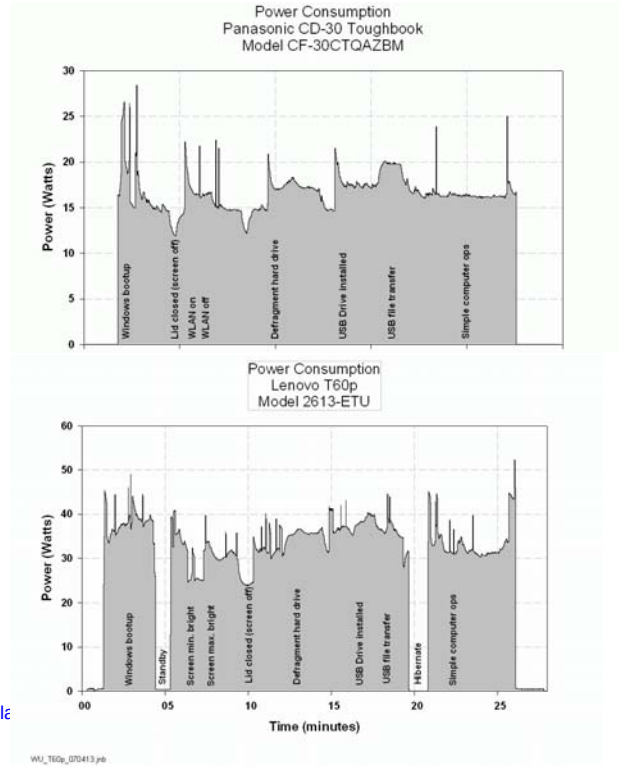
- Honda EU1000*i* Generator
- 12 VDC to 8 A 1000 W @ 115 VAC
- 0.16 gal/kWh full load 0.3 gal/kWh ¼ load
- 29 lbs + fuel 2565 cu in + fuel
- 1 kWh => 32 lbs
- 53–59 dB(A) @ 7 m
- $780

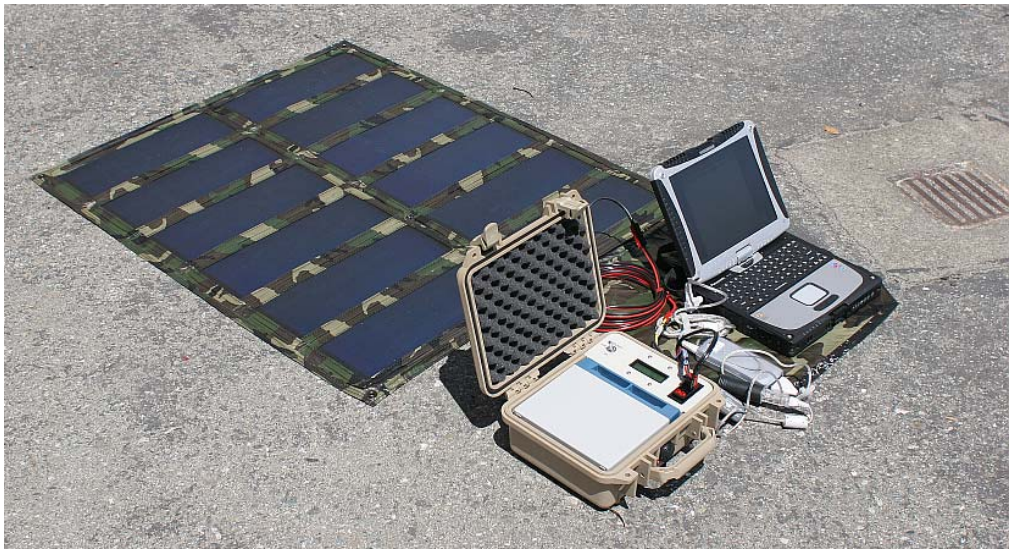
- UniPac 34 Solar Panel & battery
- 12 V DC * 2 A
- 20 Ah battery
- 20.7 lbs 526 cu in
- 1 kWh => 20.7 lbs if clouds < 7 days
- Silent
- $800

Low Power Systems

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

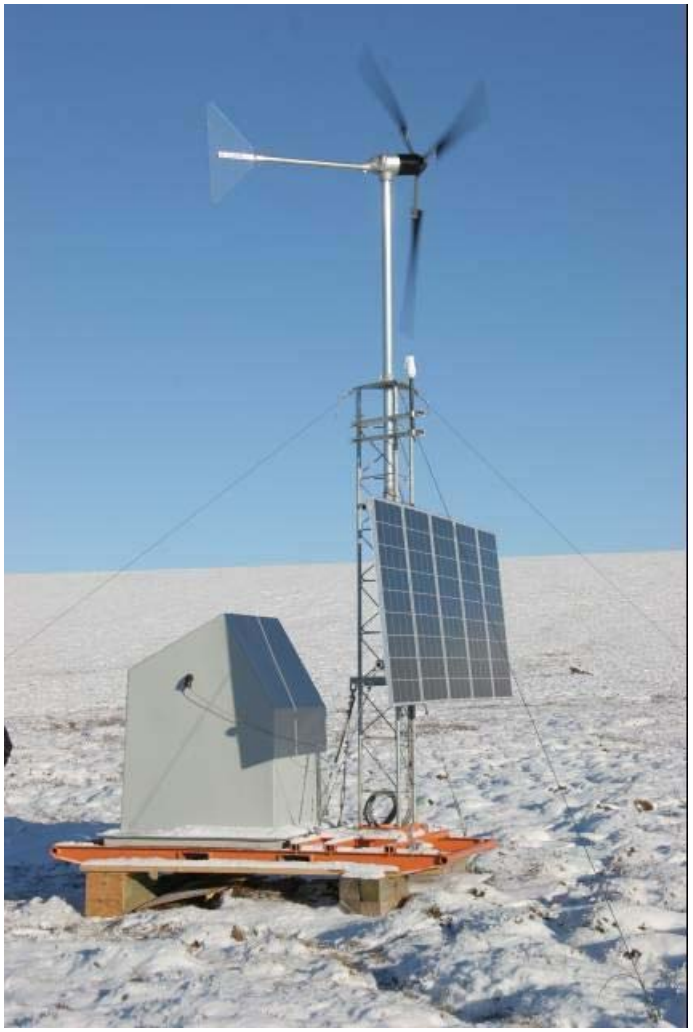






Imnavait Creek, Alaska

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

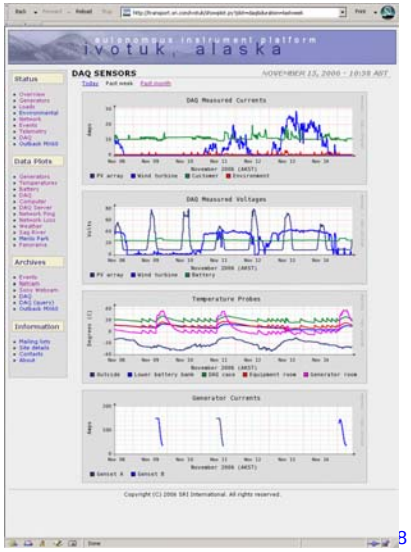


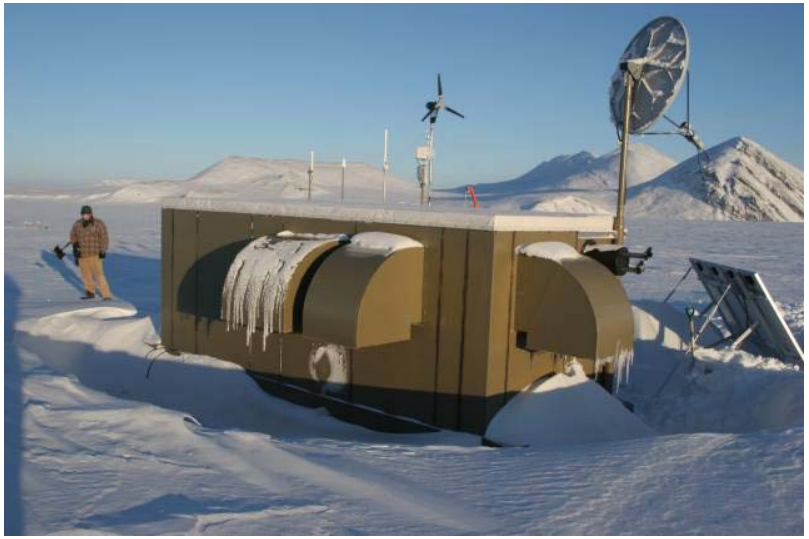
Summit Station, Greenland

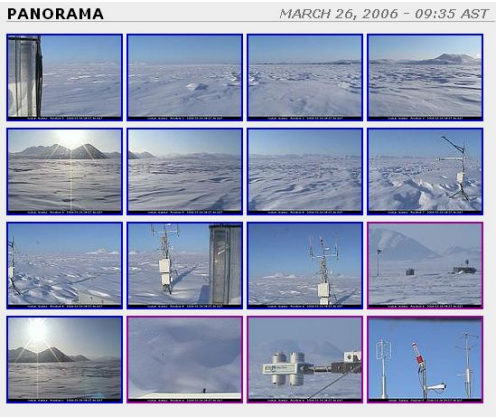
- **Proven WT6000 (6 kW) turbine**
  Supplements diesel gensets
- **10,000 ft ice foundation**
  Plywood ice anchors
- **No derrick for erection**
- **-60° C temperature**
- **Hoar frost destroys blade aerodynamics**

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

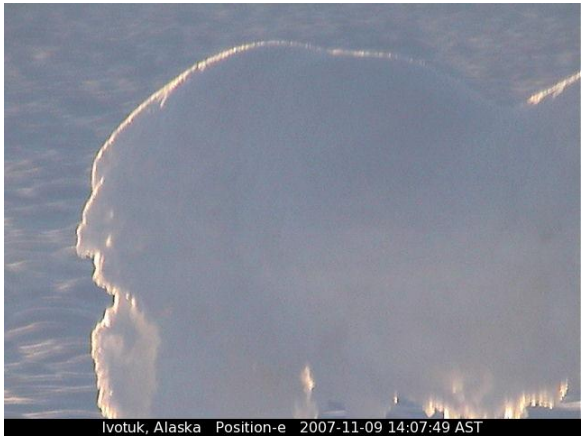






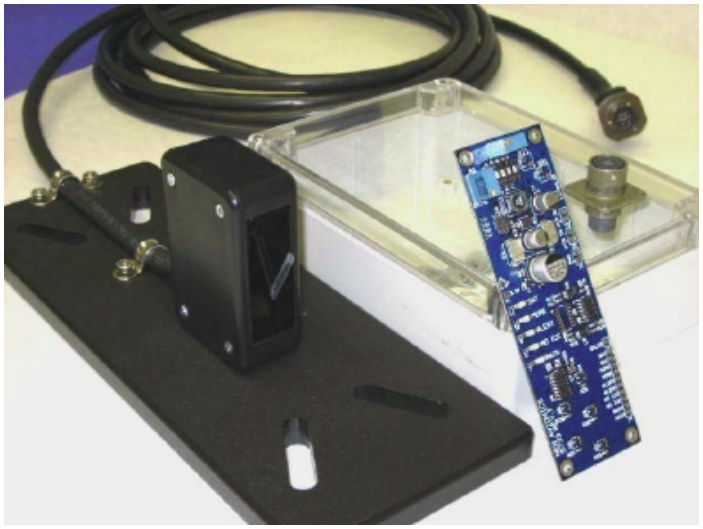
Icing at Ivotuk

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



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

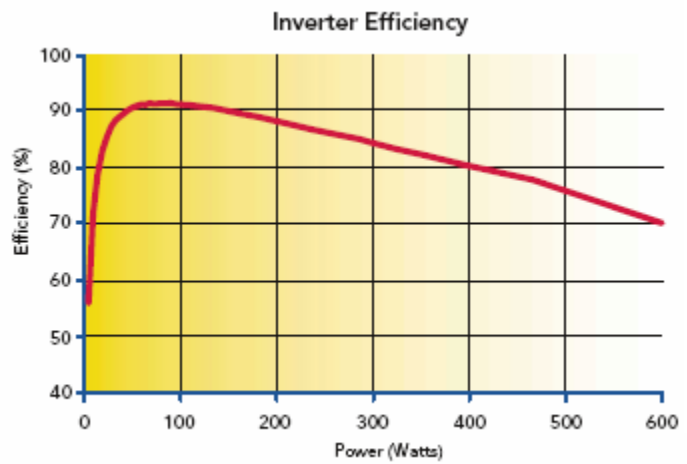
Kick off

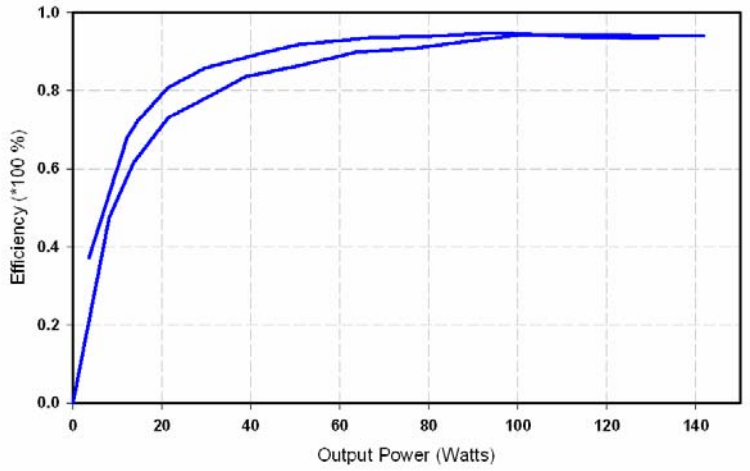
McGill Univ.

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

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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 dicharged battery at -70C for 48 hours; test after 48 hour soak at 25C	97%	88%