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

EXPLODER™ 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
  - 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 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
  - 5265 cu in + fuel
  - 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
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
Introduction

Power Technologies

Deployment Examples

Links

Events

Supporting Technologies

Wiki

Search Function

Soliciting input

Website updates

Outreach

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 NFRP’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:

- **Engine** - Internal combustion engines are a proven technology used worldwide. A wide selection of fuels is available, depending on the application.
- **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 at this infancy, but commercial products are becoming available.
- **Hydroelectric** - Small-scale turbines can provide a source of electricity at sites where water can be found in a region for at least part of the year.
- **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 power requirements.
- **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.
- **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.

TECHNOLOGY DEPLOYMENT EXAMPLES

This section provides brief descriptions of systems that have been deployed in the polar regions and some basic information on topics of the specific technologies discussed. Links to accessible agency/docs are often provided to facilitate further reading.
Working Examples - Battery

- Effects of Cold Temperatures on Battery Capacity - UNAVCO

Charge/Discharge Capacity at Cold Temperatures

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Pre-Test Soak Time (hours)</th>
<th>GEL Capacity</th>
<th>AGM Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>n/a</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>-20</td>
<td>24</td>
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<td>23%</td>
</tr>
<tr>
<td>-30</td>
<td>12</td>
<td>10%</td>
<td>13%</td>
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<tr>
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<td>12</td>
<td>3%</td>
<td>4%</td>
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<td>1%</td>
<td>2%</td>
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<tr>
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<td>12</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>-50</td>
<td>12</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>25</td>
<td>48</td>
<td>108%</td>
<td>98%</td>
</tr>
</tbody>
</table>

Recovery After Cold Exposure

<table>
<thead>
<tr>
<th>Test Description</th>
<th>GEL Capacity</th>
<th>AGM Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soak fully-charged battery at -70°C for 48 hours; test after 48 hour soak at 25°C</td>
<td>101%</td>
<td>92%</td>
</tr>
<tr>
<td>Soak discharged battery at -70°C for 48 hours; test after 48 hour soak at 25°C</td>
<td>97%</td>
<td>88%</td>
</tr>
</tbody>
</table>

Battery Cold Temperature Performance

- UNAVCO Gel
- UNAVCO AGM
- Deka Datasheet