Power and Deployment Workshop

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Common Polar Power Technologies

Solar: Abundant power source during summer months, and relatively simple to harness. Can store solar power for winter operation but need large battery banks.

Wind: Highly variable but non-seasonal power source. Year-round success has been demonstrated in ALL polar locations, but systems must be correctly designed.

Fuel Cell: Historically, difficult to operate in cold, but technology is improving.

Generators: Cost, complexity, maintenance considerations, but appropriate for many applications. Many polar examples of hybrid systems with diesel + solar and/or wind.

Rechargeable battery: Lead-acid is still the primary energy storage for most polar systems; AGM and Gel types widely used. Other chemistries find niche uses.

Non-rechargeable battery: Can offer savings in size/weight over lead-acid where these parameters are critical, but typically more expensive.

Others, less common: ultracapacitors, flywheels, nuclear,
Critical Design Factors

What is power demand?
- Overall system scale. For today’s convenience define four regimes:
  Micro: <1 W          Medium: 10-100 W
  Small: 1-10 W        Large: >100 W
- Operating mode. Polar light/dark and “warm”/cold seasonal differences = year-round operation much more difficult than summer-only. Latitude makes a big difference – Antarctic circle vs. S. Pole!
- Is constant operation year-round needed, or are different modes allowable? Specifically a low- or zero-power winter mode: turn off comms, system on only part-time, or entire system asleep?

What are cost/logistical constraints?
- Number of systems.
- Time available / required on-site to build each system.
- Resources available for transportation to site.

Following examples are a small sample of those operated by PTC attendees.
Micro-Power: U. Wisconsin AWS

Scope: ~60 in Antarctica
Power: ~1 Watt
Batteries: 12V PowerSonic AGM
240-480 AH (latitude dep.)
Solar: 1x-2x 10W panels (latitude dep.)
Wind: not necessary

- Multi-year operation unattended
- Standardized kits
- Campbell datalogger based
- ARGOS communications
- Deploy in few hours, on snow or rock
Small-Power: Temporary Station (summer only)
UNAVCO GPS

Scope: Many in Antarctica and Arctic
Power: ~3 Watts
Batteries: 12V PowerSonic AGM, 36 AH
Solar: 1x BP 40W 12V panel
Wind: not necessary

- 6 month+ with small solar+battery
- Campaign GPS and glaciology
- Compact, much pre-assembly
- With or without 900 MHZ comms
- Very quickly deployed (minutes)
Small-Power: Semi-Permanent Station (1-2 yrs)

PASSCAL seismic

Scope:      Dozens in Antarctica, e.g. AGAP and POLENET projects
Power :     <2 Watts
Batteries:  12V Concorde AGM, 100 AH
            18V Tadiran lithium, 1900 AH, non-rechargeable
Solar:      3x Suntech 20W 12V panels
Wind:       not necessary

- Summers on solar + lead acid
- 1-2 winters running on lithium
- Iridium comms (control, SOH)
- Super-insulated enclosures
- Deploy in <2 hours
Small-Power: Permanent Station (3 yrs +) UNAVCO GPS

- Multi-year operation unattended
- Snow or rock surface designs
- Iridium data retrieval + control
- Deploy in 4-5 hours

Scope: ~70 in Antarctica and Greenland
Power: 4-5 Watts
Batteries: 12V Deka Gel, 1000-2200 AH (latitude dep.)
Optional lithium backup, non-rechargeable.
Solar: 2x-4x Sharp 80W 12V panels (site dependent)
Wind: 0-2 Forgen500 “15W” for high wind sites
0-1 Aero4gen “200W” for low-wind sites
Medium-Power: CH2M Polar Imnavaiait Creek

Scope: Two on Alaska North Slope
Power: ~40 Watts
Batteries: 6V Concorde AGM batteries
  48V battery bank, 3500 AH
Solar: 5x Kyocera 130W 12V panels
  60V solar bank
Wind: One “900W” turbine
  Southwest Windpower Whisper 200

- Year-round operation unattended
- Powers separate instrument tower
- Iridium comms
- 60V system DC-DC converters
Large Power: Several Arctic/Antarctic Systems

Scope: Most are located at or near manned research sites
Power: 100’s to 1000’s of Watts
Many successful approaches:
   Solar
   Solar + wind
   Wind + generator
   Solar + generator
   Solar + wind + generator

Antarctic Examples (these operated by Raytheon Polar):
   Several stations in Dry Valleys
   Black Island satellite telecom facility

Arctic Examples (these operated by CH2M Hill Polar):
   Summit Station and Raven Camp, Greenland
   Ivotuk (North Slope) Alaska
More Examples

Many more diverse polar projects within 2010 PTC:
  - Under-ice submersible vehicles
  - Balloon-borne instrument systems
  - Ocean buoys
  - Rock and ice core drilling
  - Glacier instrumentation
  - Expeditioning
Unique challenges but definite commonality.
PTC = wealth of polar technical experience with power and deployment.

Moderated discussion session: some pre-defined topics but also open Q&A

ALSO ONLINE:
http://polartechnologyconference.org: Previous years’ presentations.
http://facility.unavco.org/project_support/polar/remote/engineering.html: Design game for E&O
Specific Topics from Questionnaires

More manufacturer presence at PTC

Solar panels: Latest solar panel technologies
Real annual solar production, e.g. for 2W load in Alaska?

Solar regulators: reliability
low-temp performance
parasitic power draw
MPPT

Batteries: why lead-acid vs. “advanced” batteries
lifetime of polar lead-acid
recommendations to -50C
what lithium types out there?
lifetime of trickle-charged Electrochem lithium?
transport of lithium cells
Specific Topics from Questionnaires

Wind turbines: failure modes
models for high- vs. low-wind environments
suggestions for wind turbine, 200W plateau system

Static (ESD): failure modes
abatement (w/composites?).

Enclosures: heating options
insulation approaches
permafrost environment (melt, mud)
fiberglass enclosure manufacturers

Inexpensive cold test chamber
Polar “loc-tite” for bolts?
Standardization, re-use across projects
Ice anchors