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

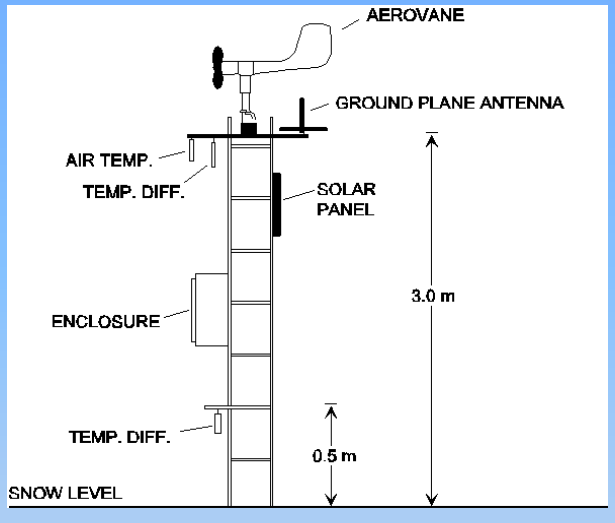
Power : ~1Watt

Batteries: 12V PowerSonic AGM

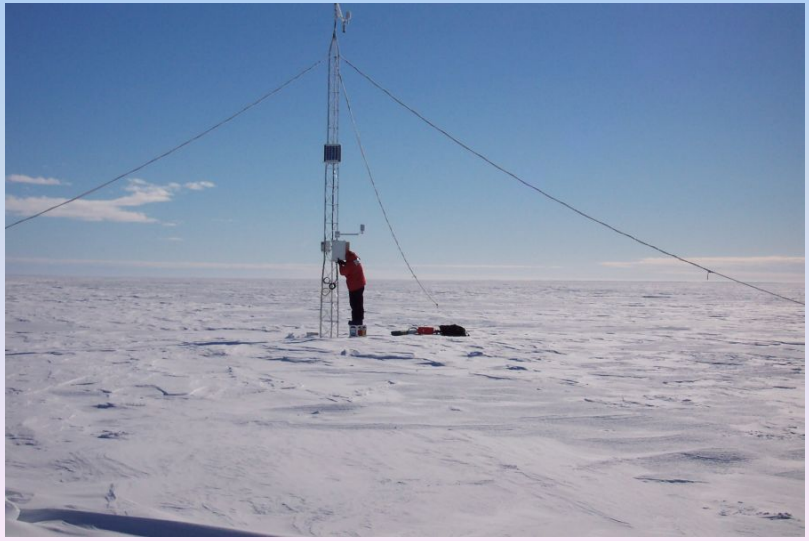
240-480 AH (latitude dep.)

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

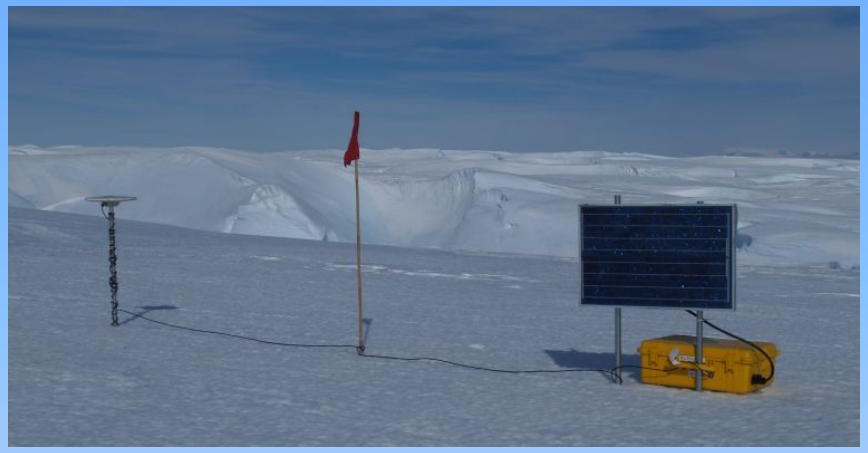
Scope: Many in Antarctica and Arctic

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

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

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

Medium-Power: CH2M Polar Imnavait Creek

Scope: Two on Alasaka 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://polarpower.org: NSF-OPP sponsored technology site. Many examples and links.

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