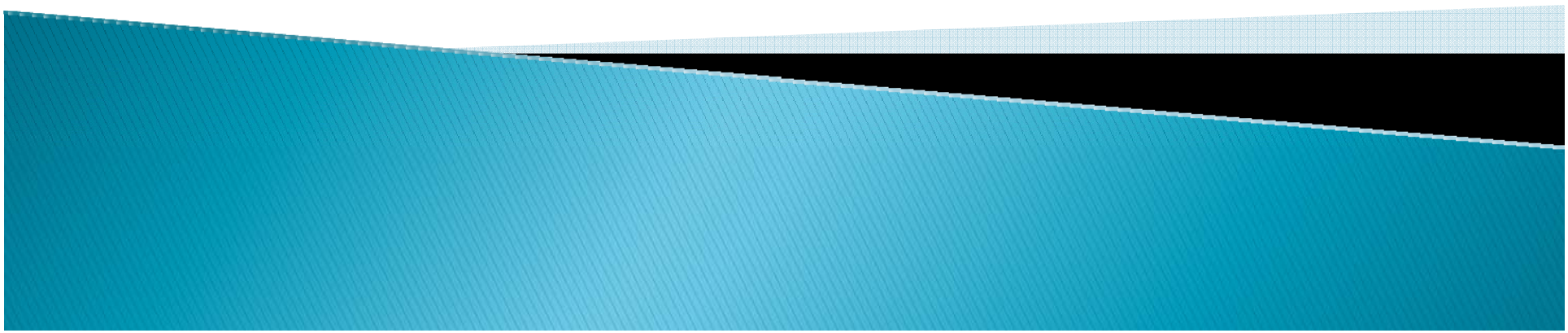
Summit Station Wind Power Pilot Project

Lessons learned in a high polar application.



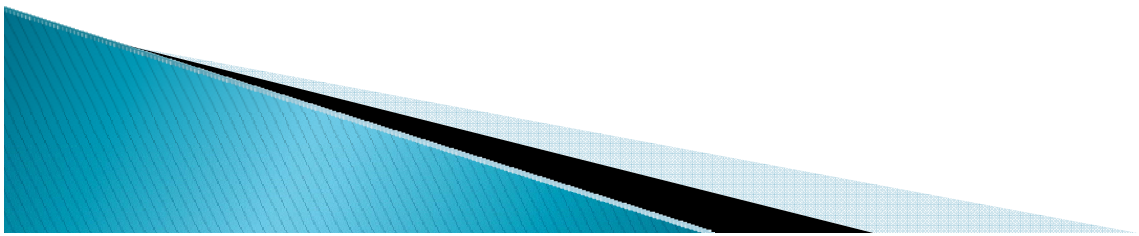

6kW Proven on 15m Mast
50m Swiss Tower

Why Summit Station?

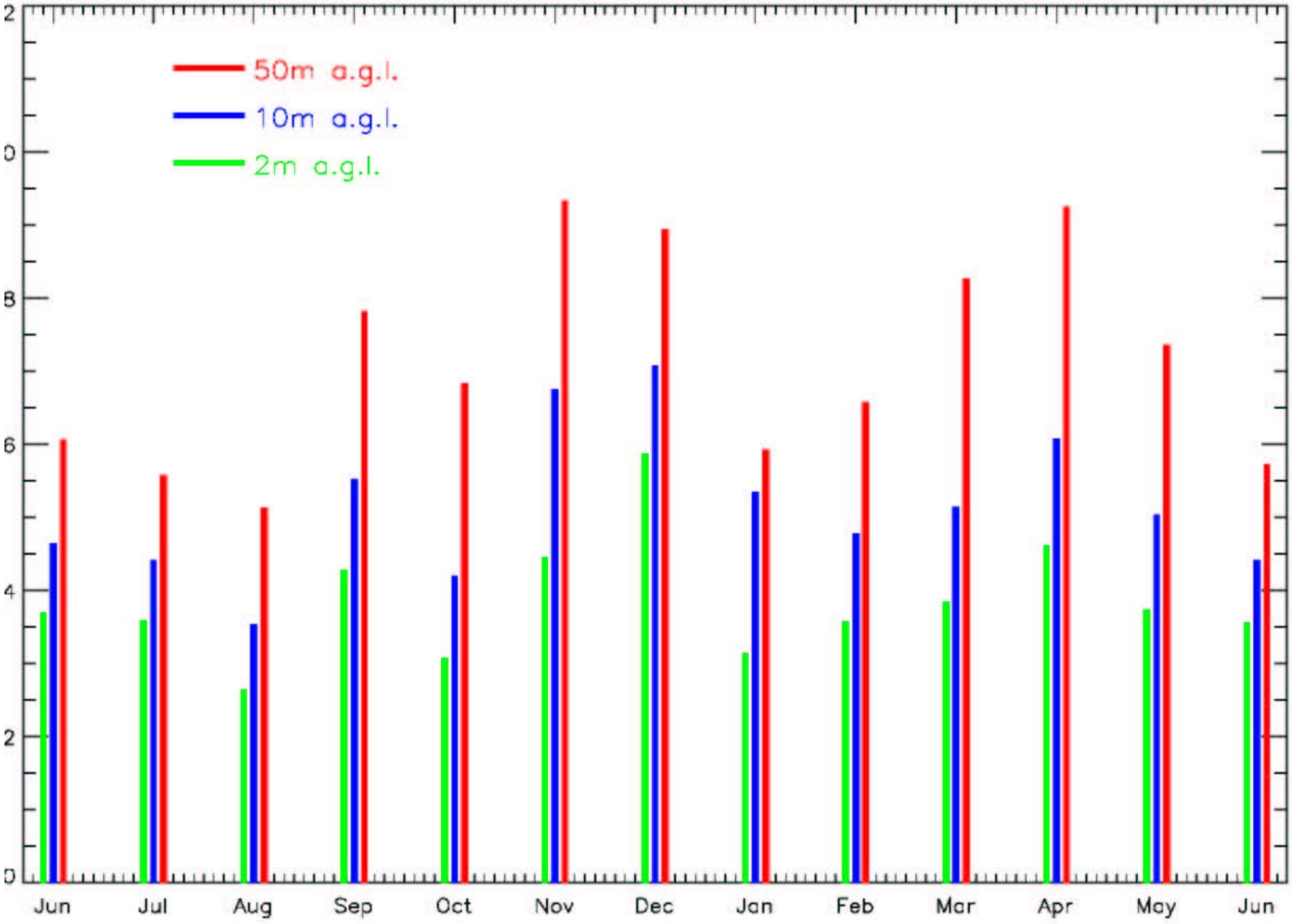
- Only high latitude, high altitude research platform in the northern hemisphere
- Site of GeoSummit long-term environmental observatory
- Site of NOAA environmental observatory
- Numerous atmospheric and near surface snow photochemistry projects
- It is a “dry snow” area at the peak of the cap
- Our own activities tend to compromise the data being collected

Why a pilot project?

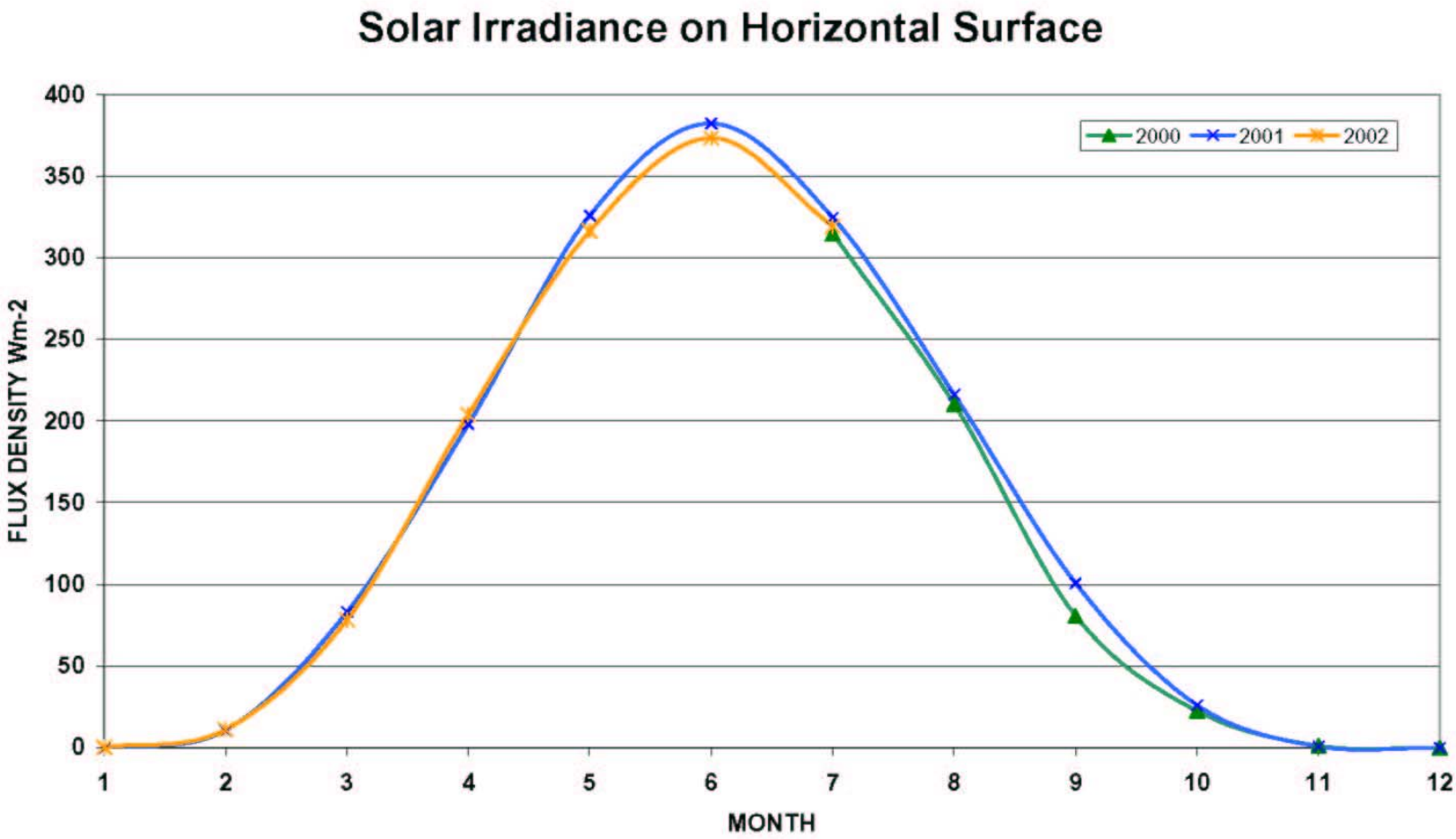
- Develop a better understanding of the potential for large scale wind power.
- Create solutions for implementing wind power in a high polar environment.
- Identify the problems on a small scale to reduce costs and facilitate later installations through lessons learned.



Summit's Wind Resources

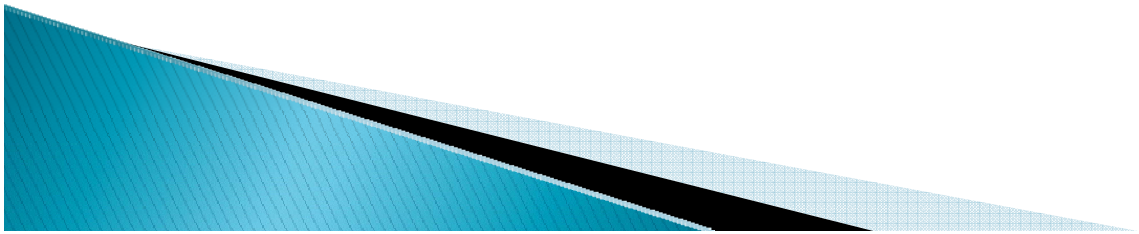


Summit's Solar Resources

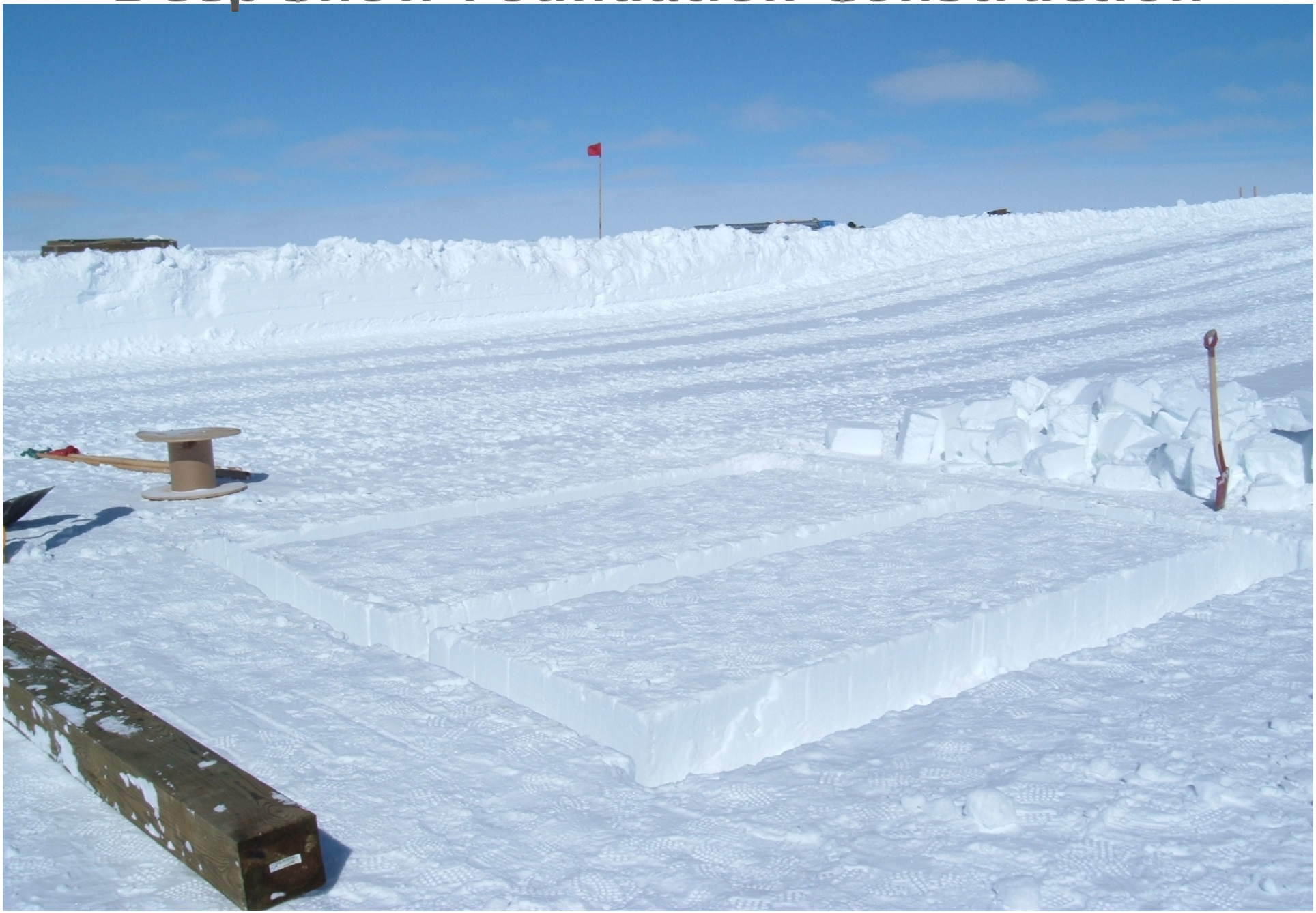


Project Challenges

- Deep snow foundation construction
- Connection to 3-phase diesel generator grid
- Deep cold of winter (-70C)
- Periodic high wind events (>40m/s)
- Potential for high voltage static discharge
- Frost/ice deposition on blades
- Limited equipment
- Constant snow accumulation



Deep Snow Foundation Construction

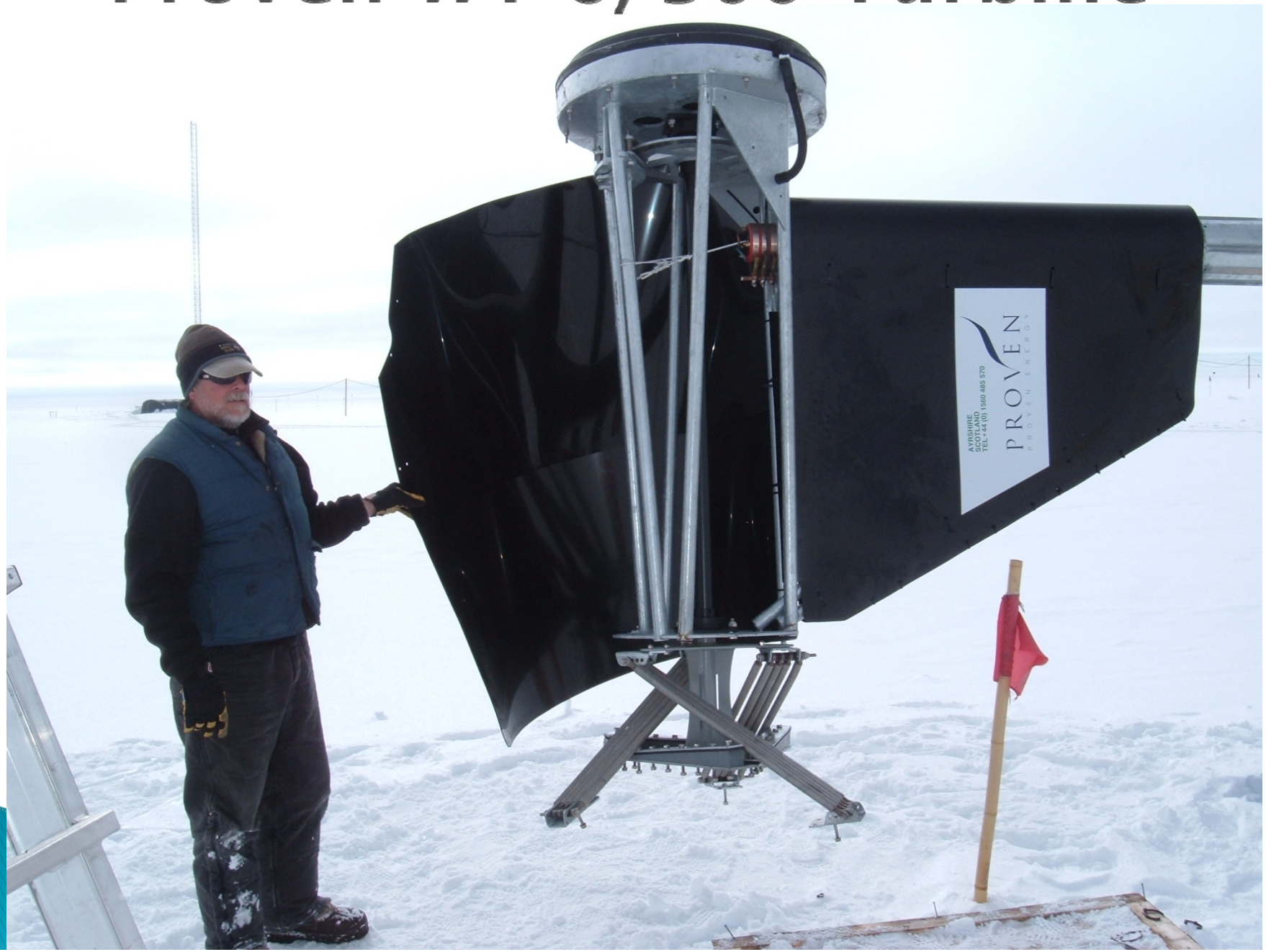


Foundation Platform

Structural Steel

Joe with Deadman Anchors

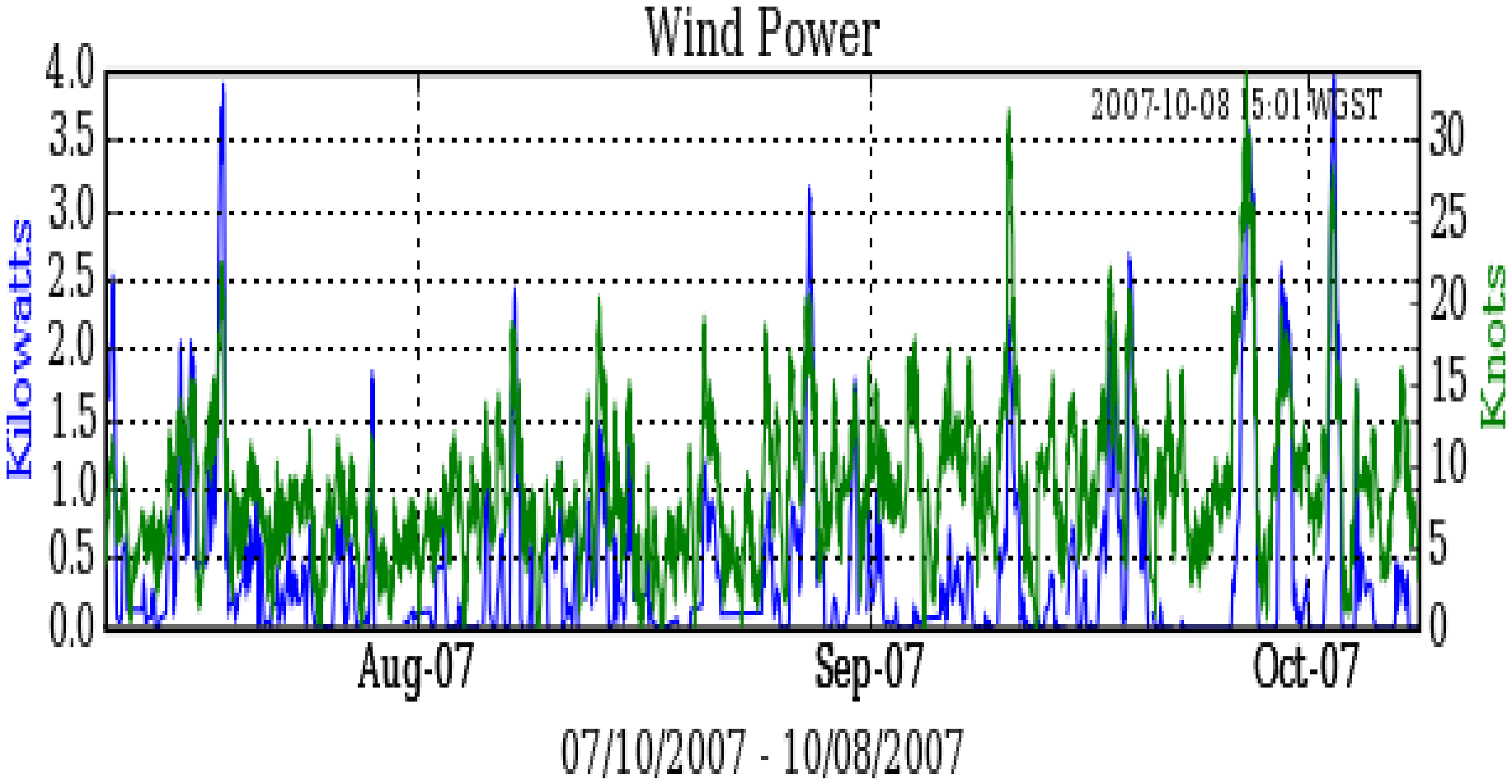
Proven WT 6/300 Turbine



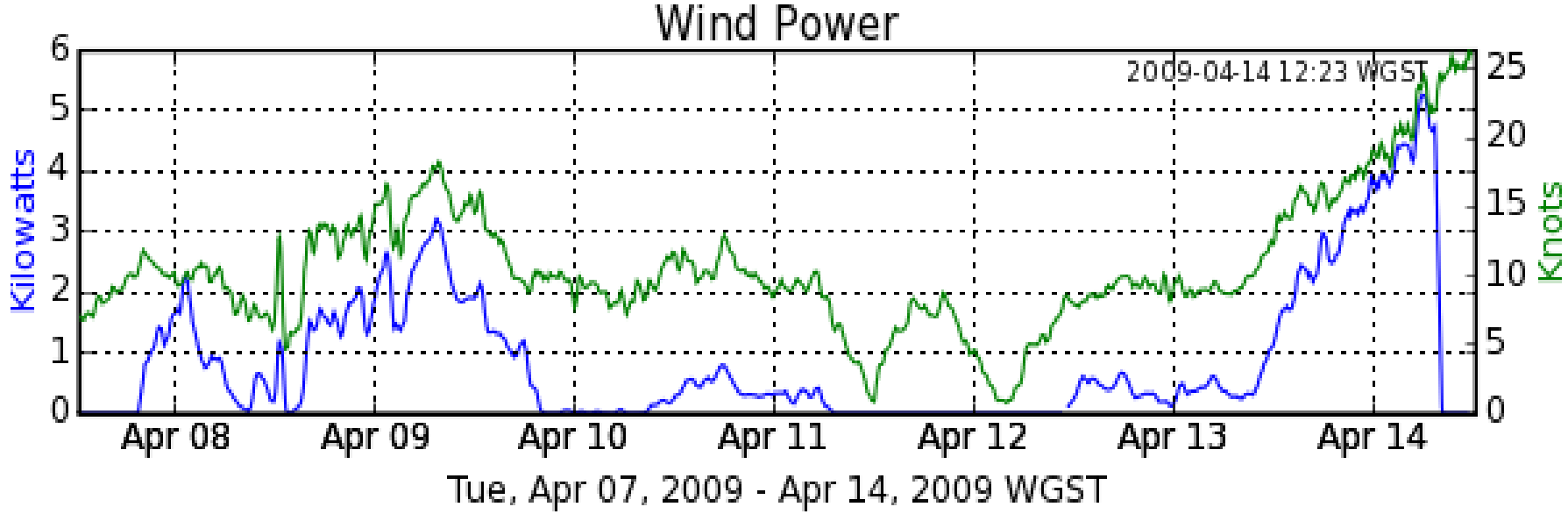
Electronics Installation

Raising the Tower

Performance Monitoring



Remote Diagnostics

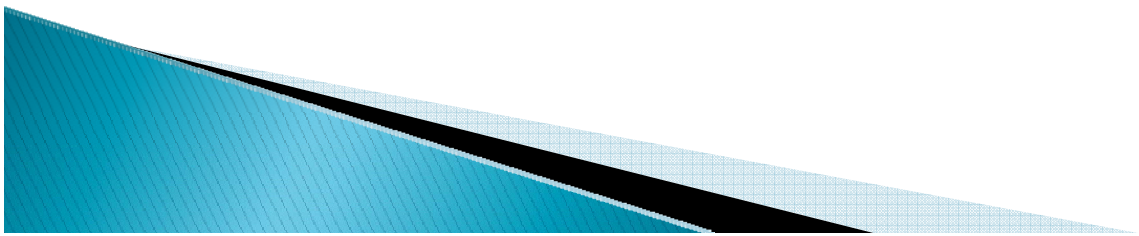


Note that at 22 knots and 5.5kW output (approx. 14% instantaneous penetration level), the power suddenly drops out. We believe this is due to the poor heat transfer characteristics of low density air. A circulation fan will be installed this year to address the problem.

Web enabled monitoring in near real-time

SMA Webbox -> WLAN -> broadband satellite - > SRI server

- http://polar.sri.com/summitcamp/status/power/



Lessons Learned

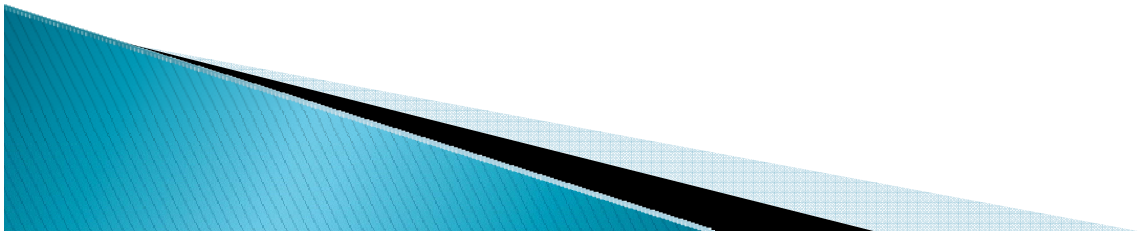
Minor blade icing = reduced performance

Severe Icing in Winter

Lessons Learned: Contd.

- Lower air density at altitude led to a cascade of problems to resolve:
- *Reduced power output from the turbine*
- *Poor inverter cooling leading to overheating and drop-outs*

- Power quality issues at higher penetration levels
- Difficulties with manufacturer
- Other issues: stator potting, frost intrusion

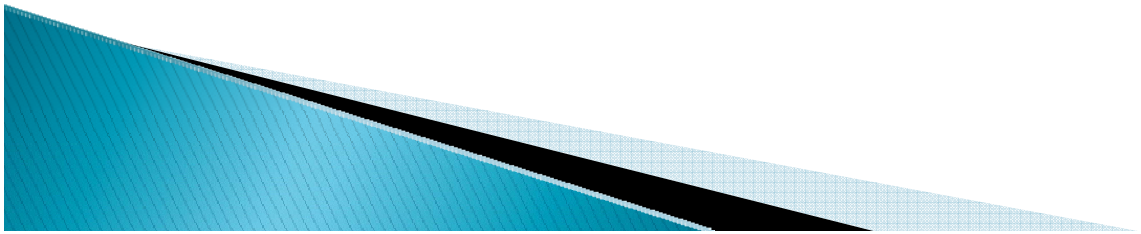


Frost Filters

Economic Feasibility

- Average monthly power production averaged over 20 months: 25,933 kWh/month
- Cost of generated power at Summit: $.75/kWh
- Annual fuel cost offset: $19,450

- Capital cost of project: $66,690
- Shipping, labor: $46,000
- Total installed cost: $112,690
- Project ROI = 5.8 years
- Design life of turbine = 20 years
- Economy of scale with larger machines!
- Reduced emissions = enhanced research platform. Difficult to quantify.



Moving Forward

- Wind power is a viable strategy for Summit Station
- Most problems have been identified
- Solutions must be developed
- Solar (thermal and PV) will begin to be implemented
- Renewable energy will play a key role in the re-development of Summit Station as a sustainable research platform.
- Wind power was done first because it is the more difficult nut to crack. Solar offers similar paybacks and coincides with summer research season/maximum loads.

Many Project Partners:

- NREL
- Proven
- SMA-America
- Solar Wind Works
- CH2M Hill Polar Services:
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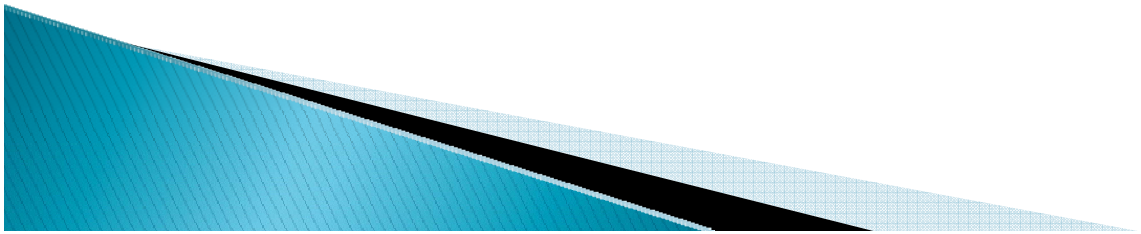
  - SRI-International
  - Polar Field Services

Special thanks to Larry Levin and Joe Yarkin!



Questions?