

An Autonomous Renewable Energy Platform for Scientific Applications in Remote Alaska



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Presented by

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ALASKA

POPULATED PLACES

- 100,000 – 499,999 • Anchorage
- 25,000 – 99,999 • Fairbanks
- 24,999 and less • King Salmon
- State capital ★ Juneau

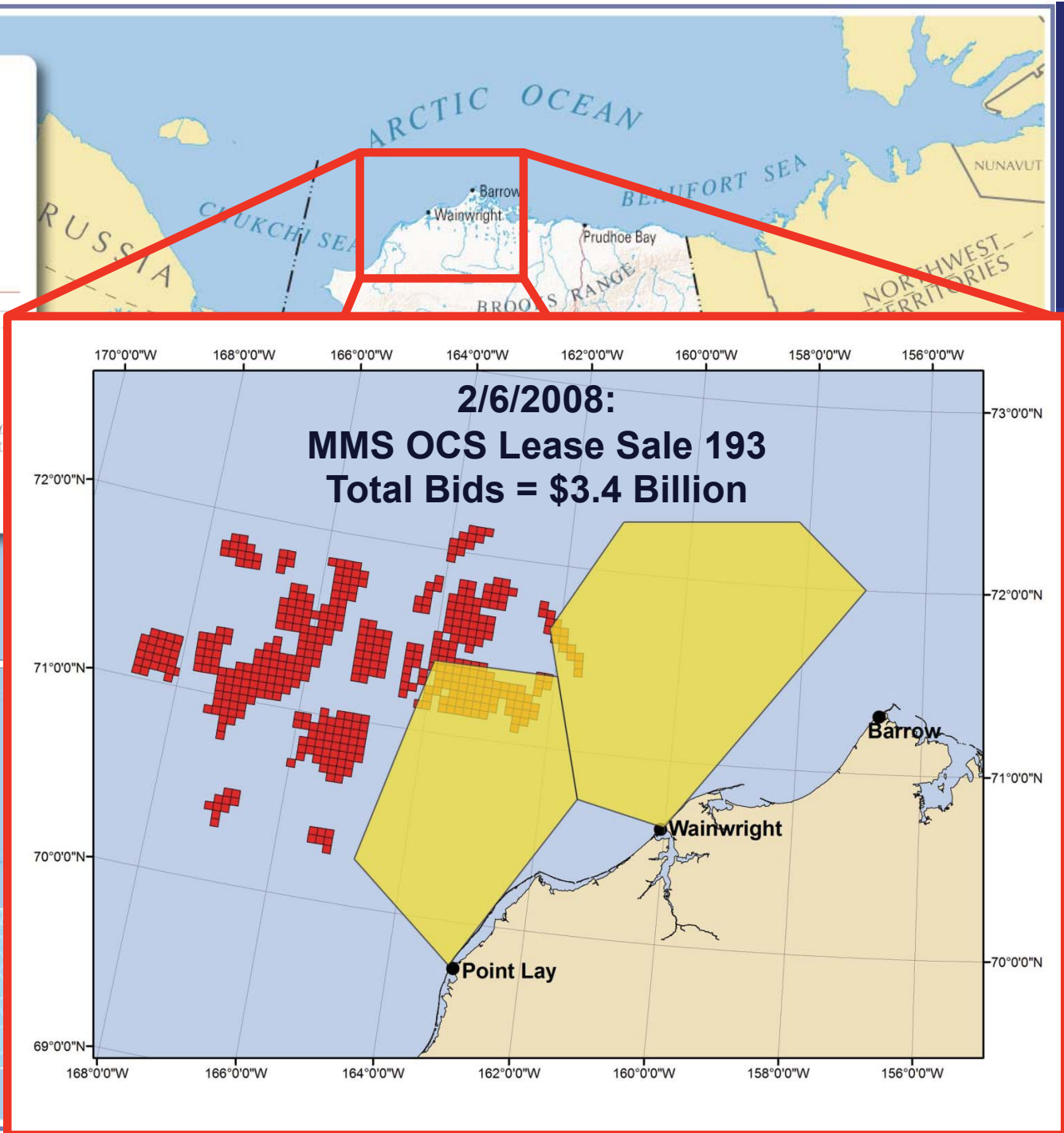
TRANSPORTATION

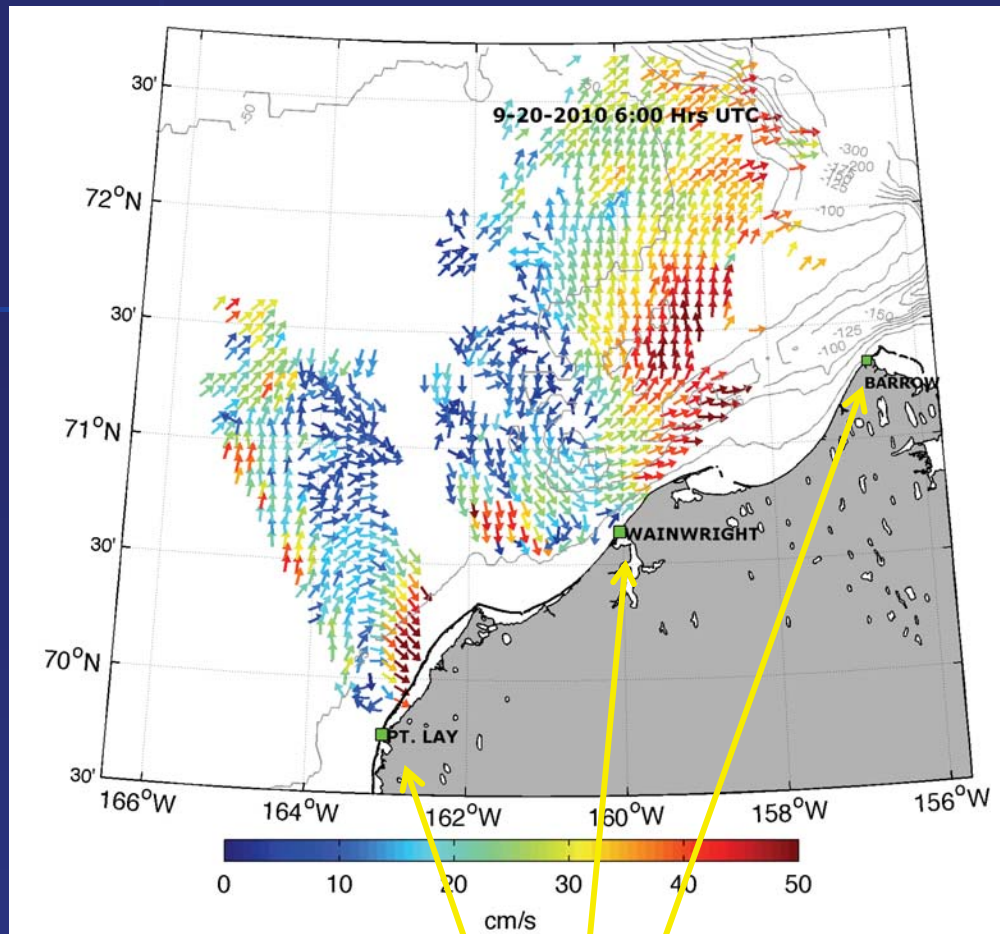
- Principal highway ———
- Railroad ———
- Ferry - - - - -

PHYSICAL FEATURES

- Streams ———
- Lakes ○
- Highest elevation in state (feet) +20,320
- Other elevations (feet) +15,300
- The lowest elevation in Alaska is sea level (Pacific Ocean).

MILES
0 100 200 300 400
Albers equal area projection





Shore-based power available

Coastal Radars map surface currents:

- Hourly maps
- over broad areas (~175 km) at 6 km resolution
- realtime access via web
- easily understandable
- cost effective

To guide:

1. Response to marine spills
2. Search and rescue operations
3. Evaluate spill models
4. Vessel-tracking

To understand:

1. Ocean Dynamics
2. Marine Ecosystems

Problems

- Needs shore-based AC power
- Where available, siting precludes optimal coverage
- Requires ~8kW hours/day
- No off-the-shelf power supplies available
- Permitting (fossil-fuel), Maintenance, Logistics (\$\$\$\$)

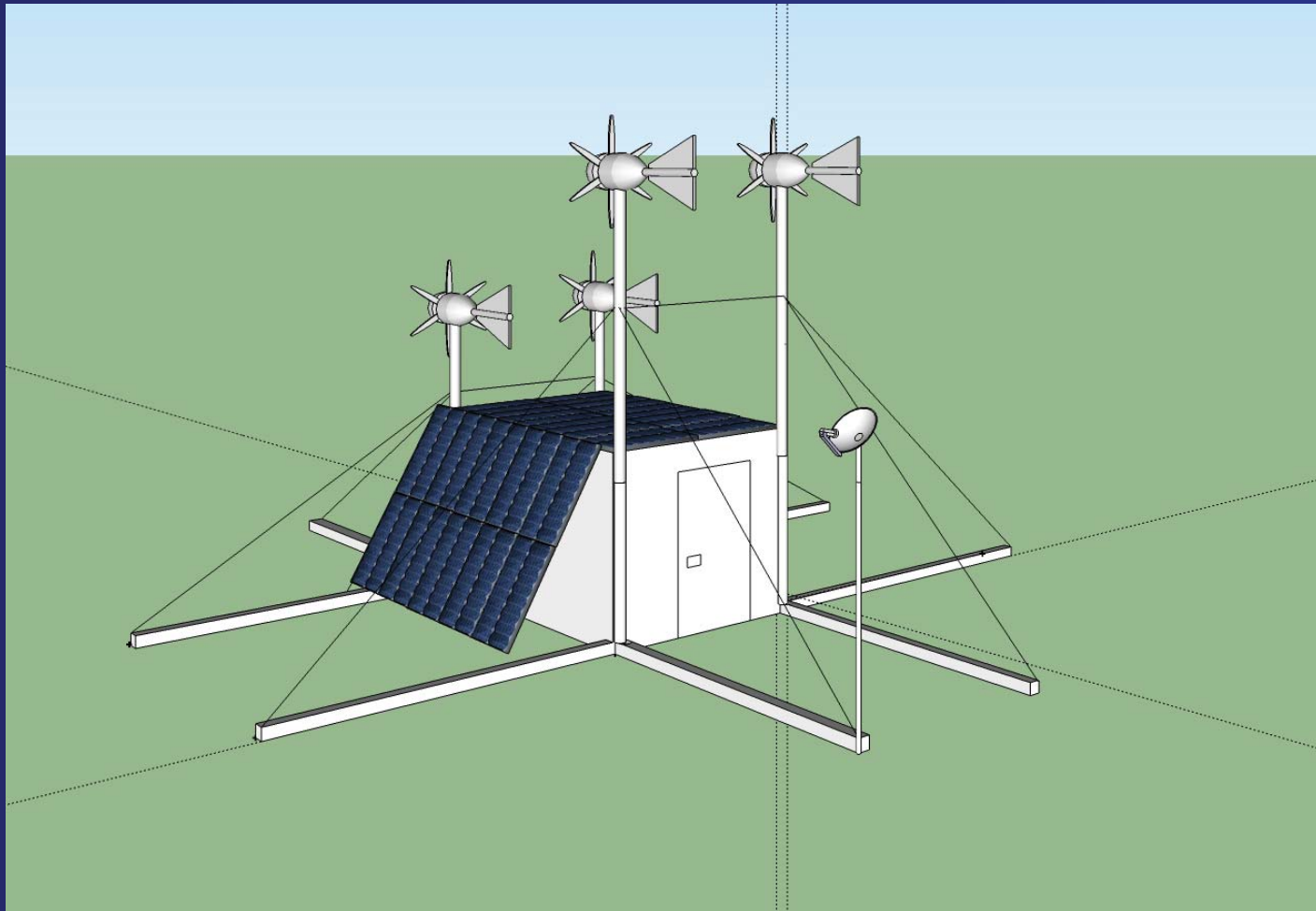
Solution: Develop an autonomous power supply

The Remote Power Module (RPM)

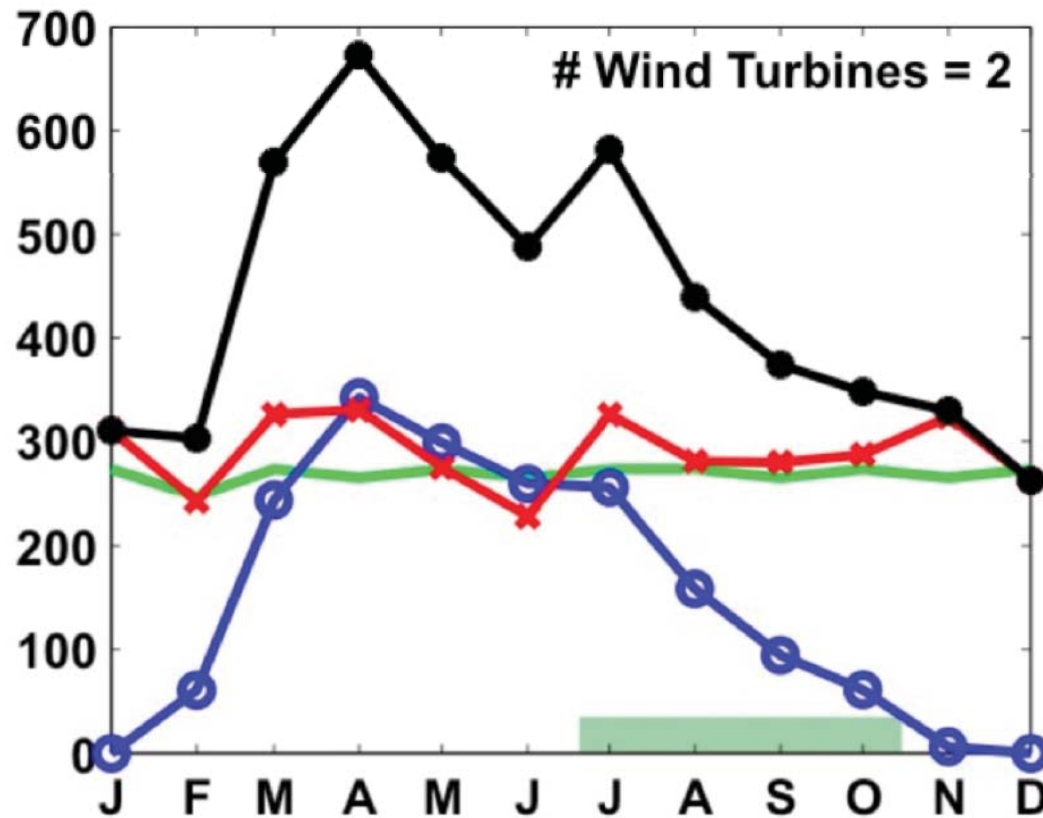
RPM Design Criteria

- Ruggedized for Alaskan conditions
- Modular
- Currently Off the Shelf Components (COTS)
- Portable
 - aircraft, small boat, 4-wheeler, snow machine
- Fits within size and weight restrictions
 - 10' Long, 120 pounds
- Installed by Three Technicians < 1 week
- Low operations and maintenance costs
- Remotely monitored and controlled
- Accommodates a 450 watt load

Original Conceptual Drawing Spring 2008



Barrow (Alaskan Beaufort Coast)



- Approximate months of open water
- Estimated solar power generated
- Estimated wind power generated
- Estimated total power generated
- Estimated total power consumption

Conceptual Model Ver. 2.0:

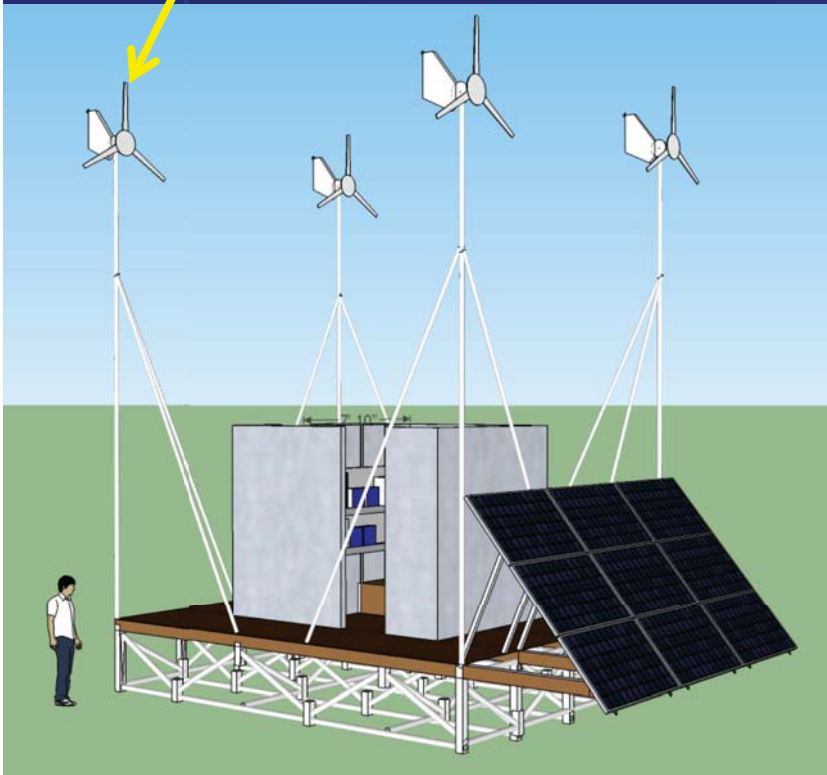
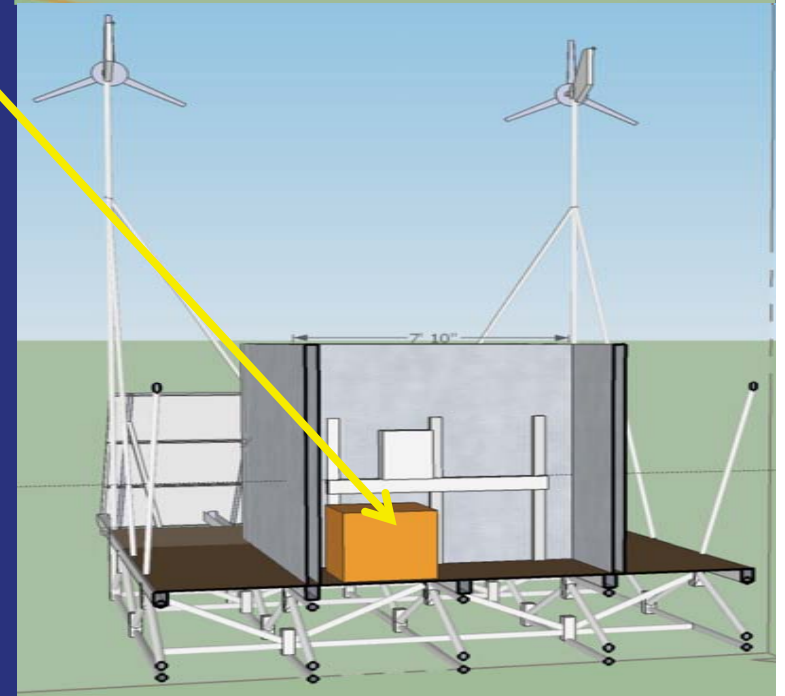
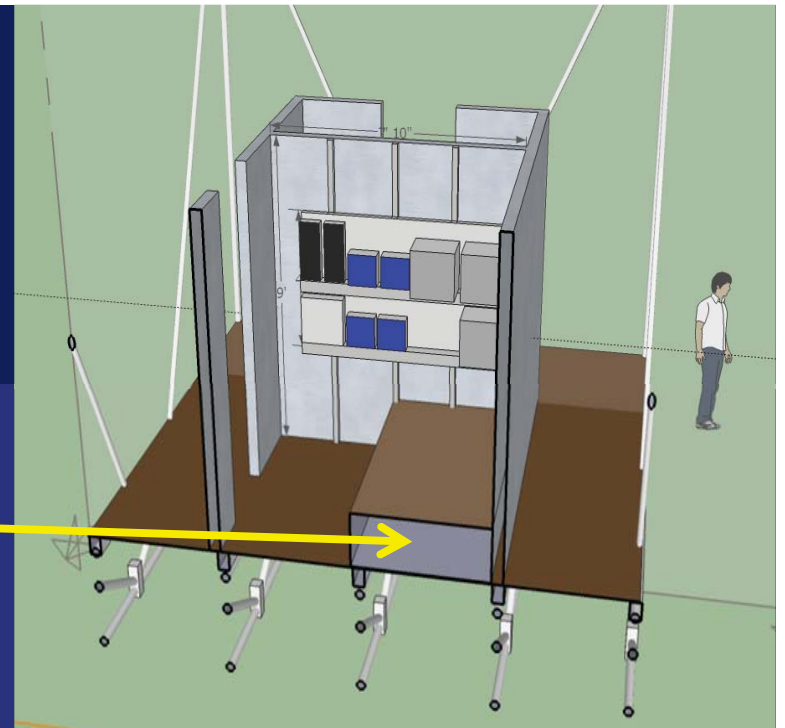
Modular (flexibility), portable;

Monitor system performance;

resilient/redundant power:

Solar, Wind, battery charge ~5-day

battery bank), bio-diesel genset



Transport: 20' Conex, each crate < 200 lbs (portable), 6000 lbs total
Fairbanks - Prudhoe (truck)
Prudhoe - Barrow (barge)



Triodetic Foundation & Wood Deck



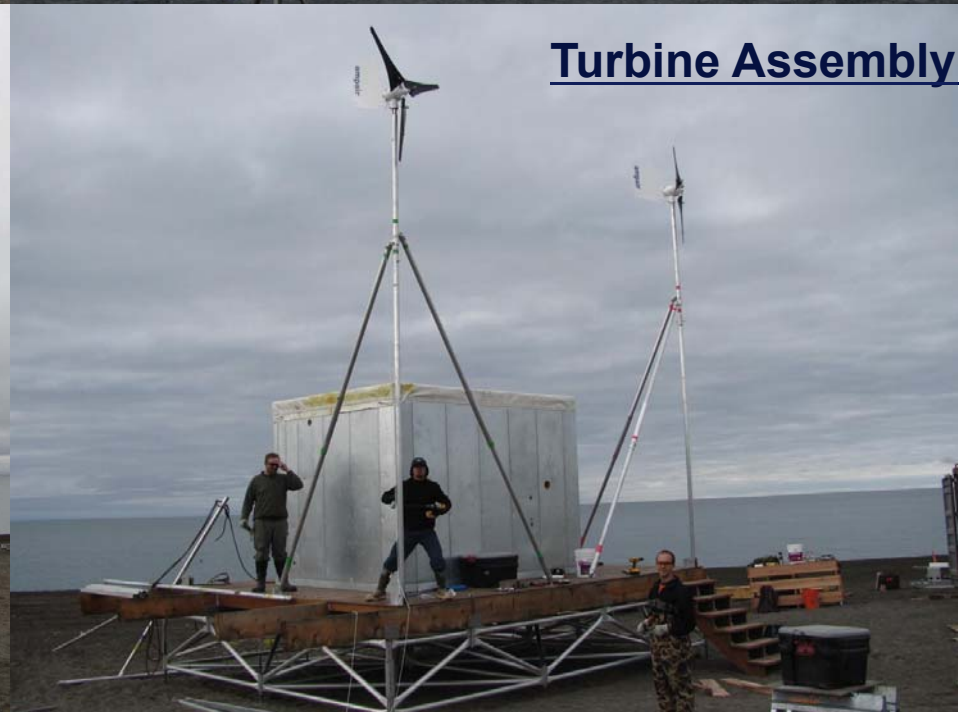
Refrigeration Hut



PV Assembly



Turbine Assembly





**Assembling
Controllers
(with quick
connects)**

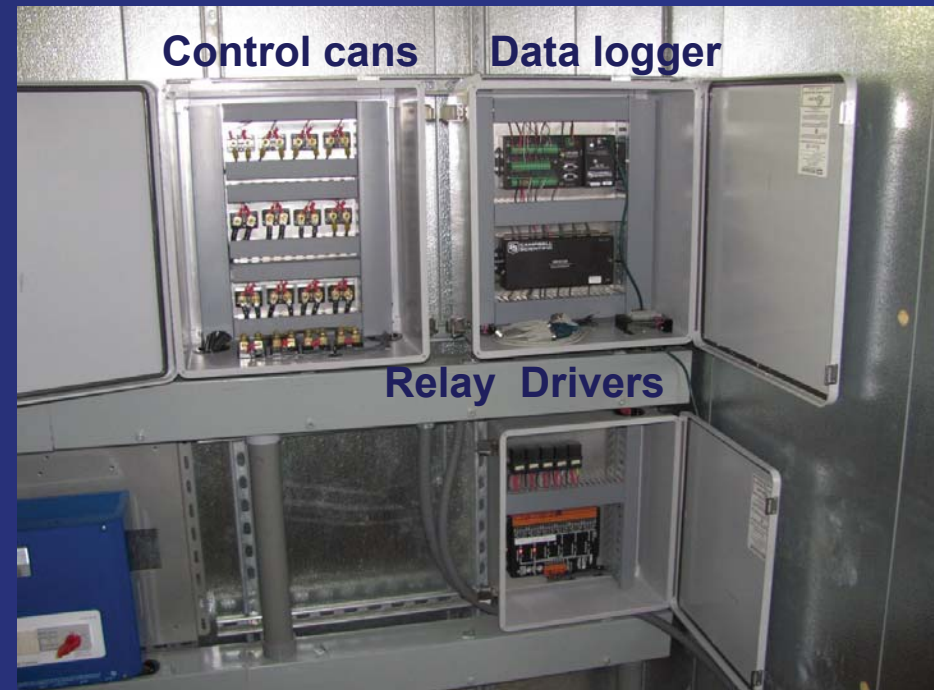


Battery Bank



PV wind controllers

fuses



Control cans Data logger

Relay Drivers

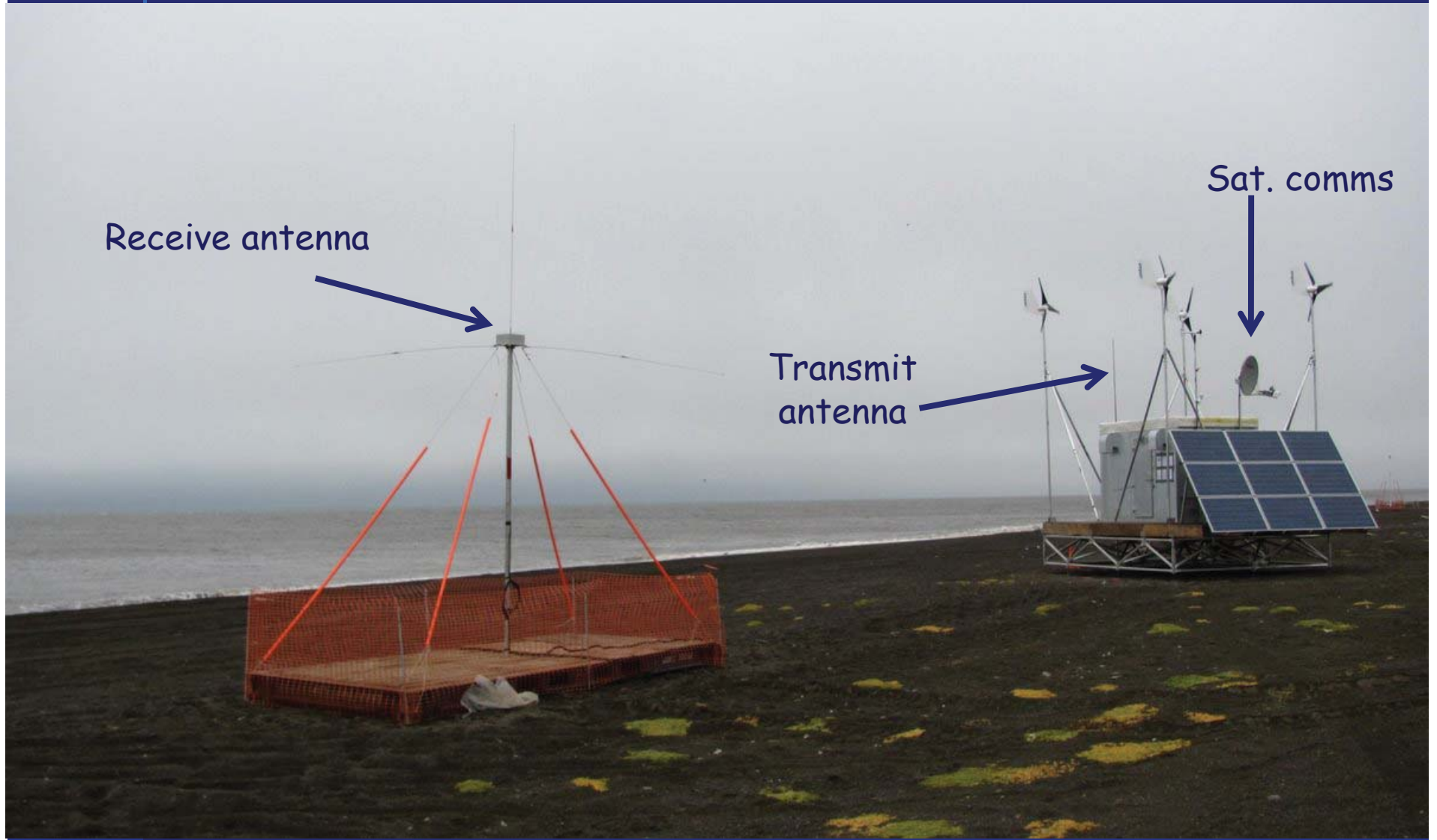


Generator + 15 gals. Fuel
(60 hours run time)
Startup: Battery bank 50% SOC
Shutdown: 80% SOC

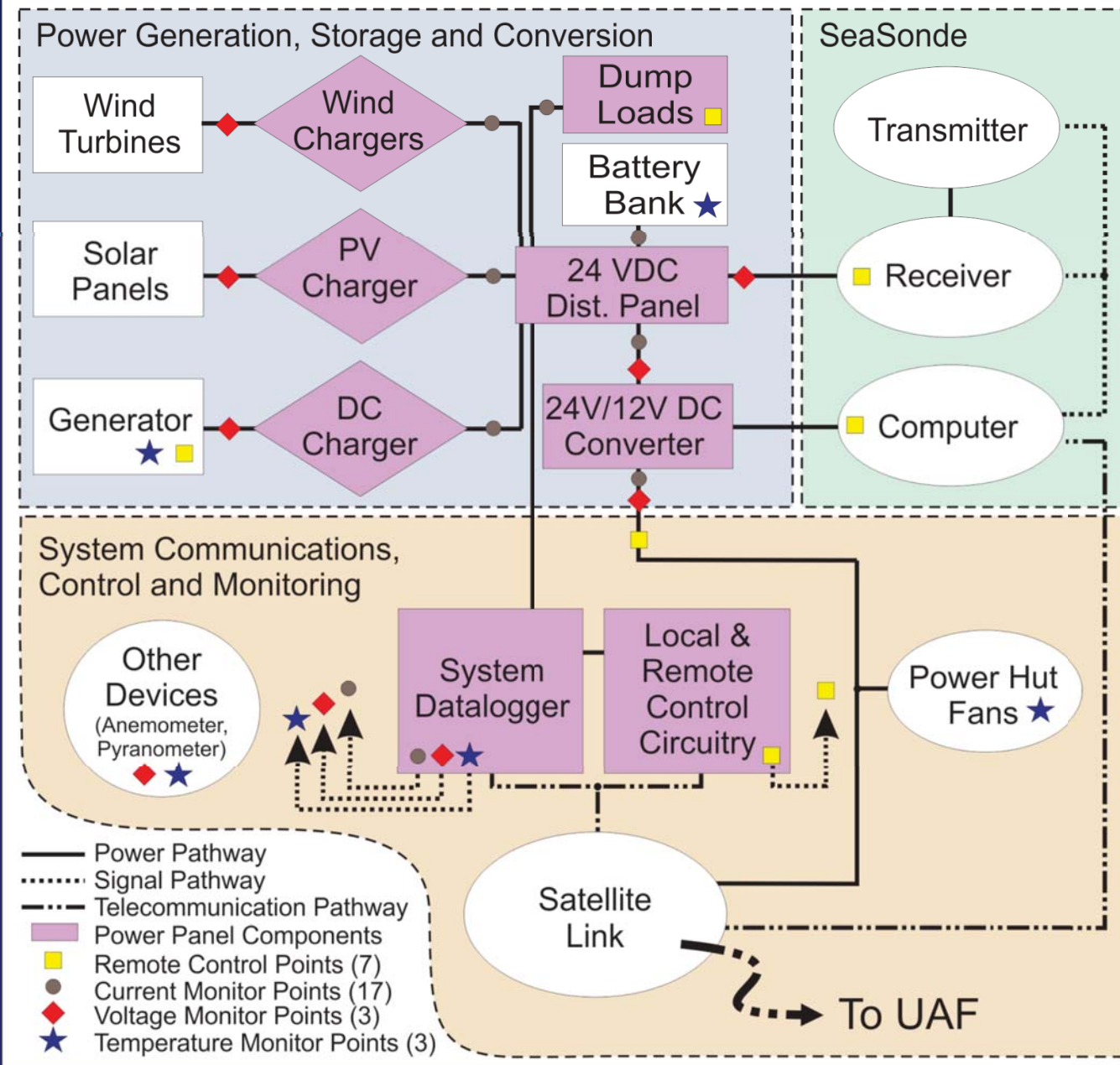
Met. Tower
(Wind, solar, Air Temp.)

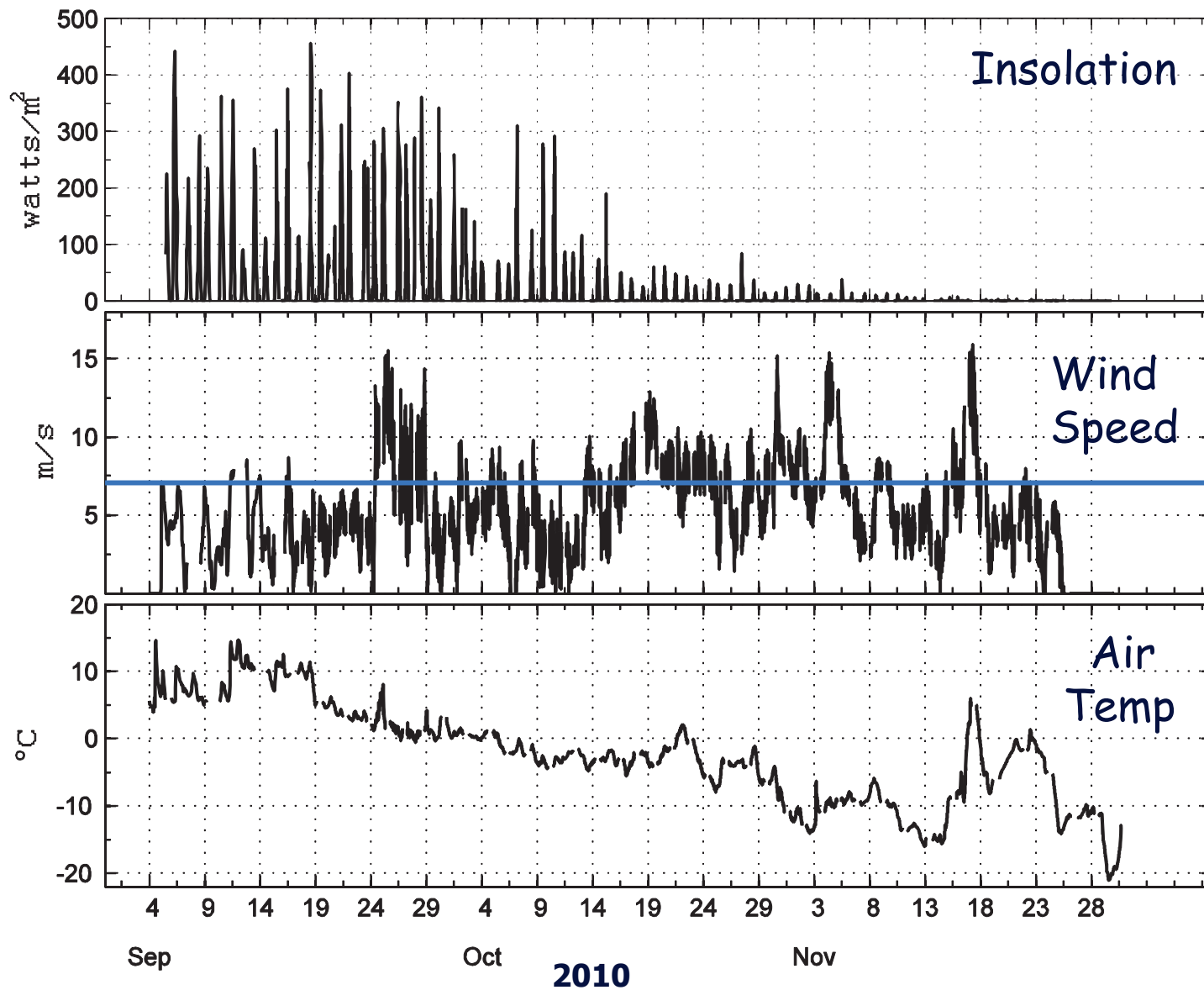


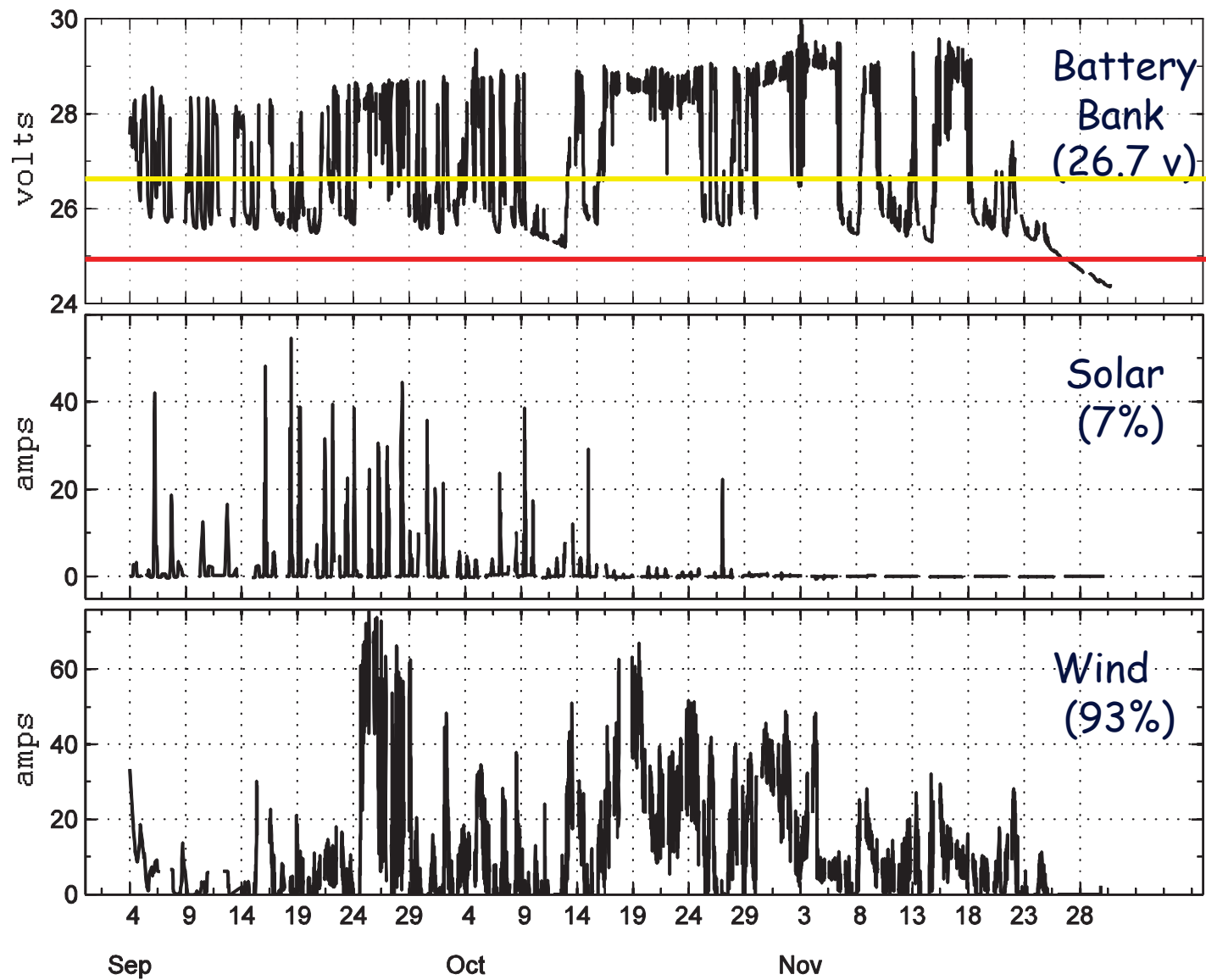
RPM Test: Barrow, Fall 2010



Autonomous Power & Communication System

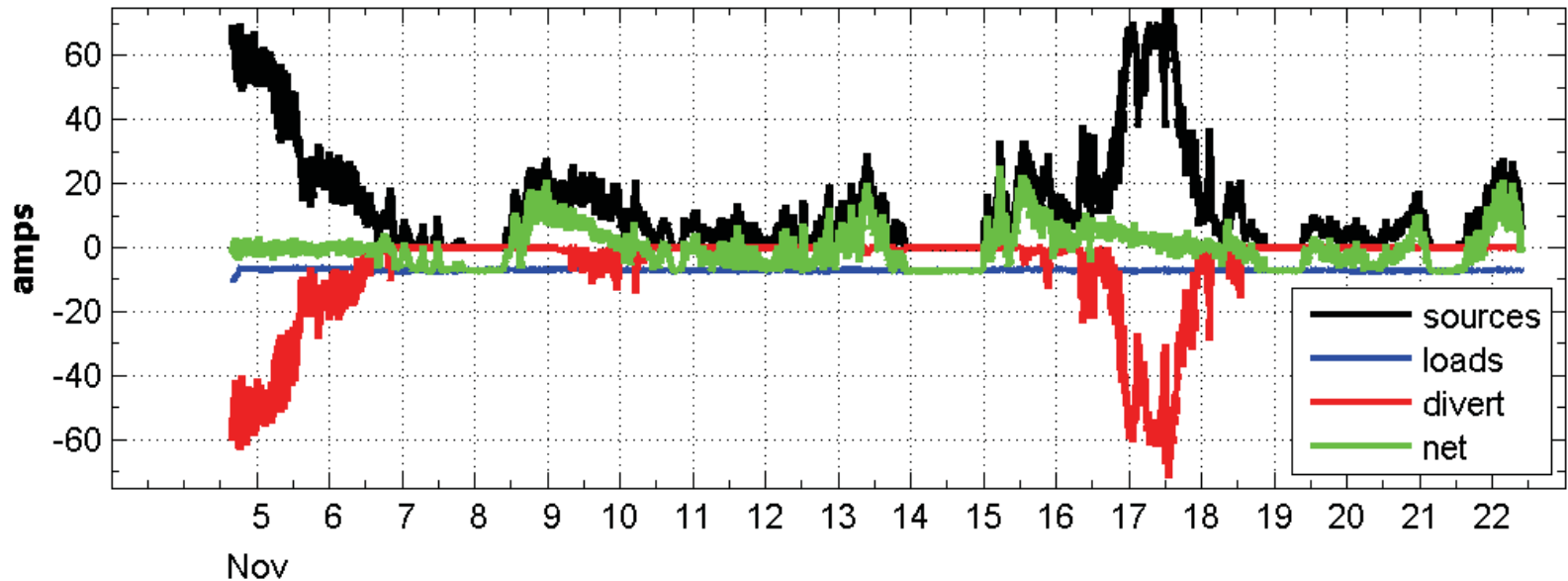




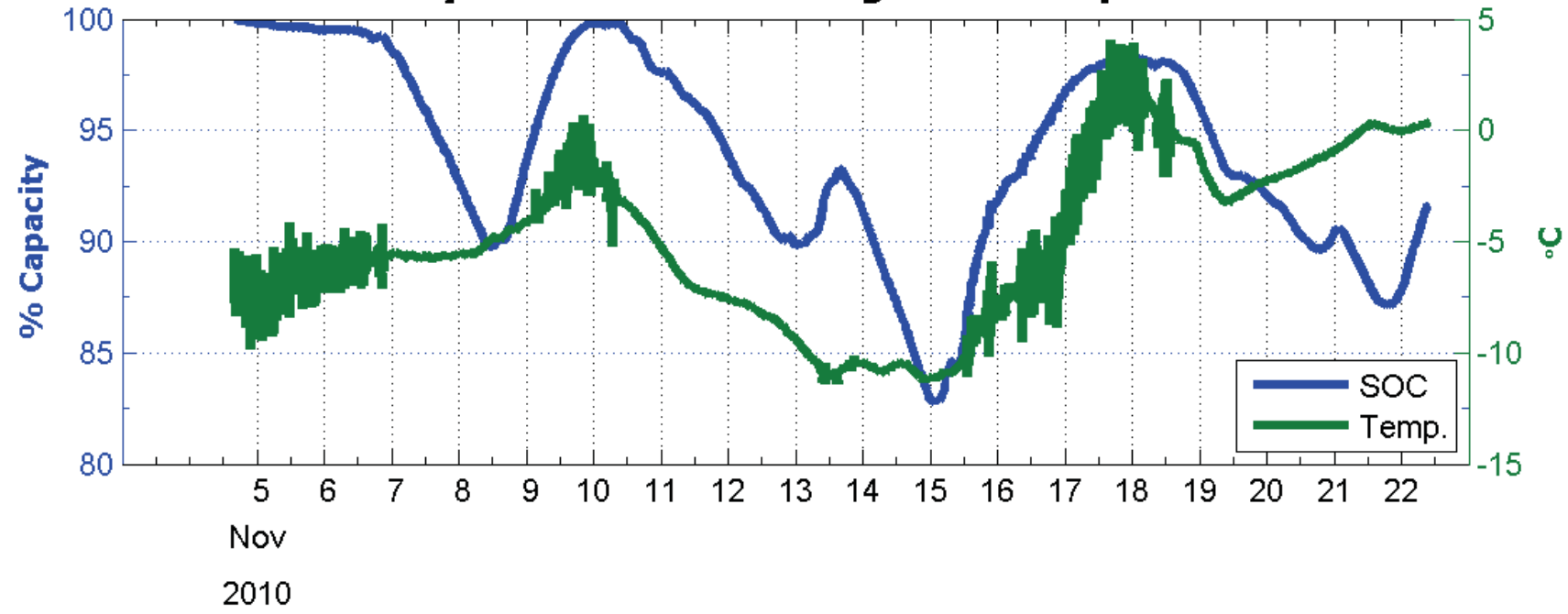


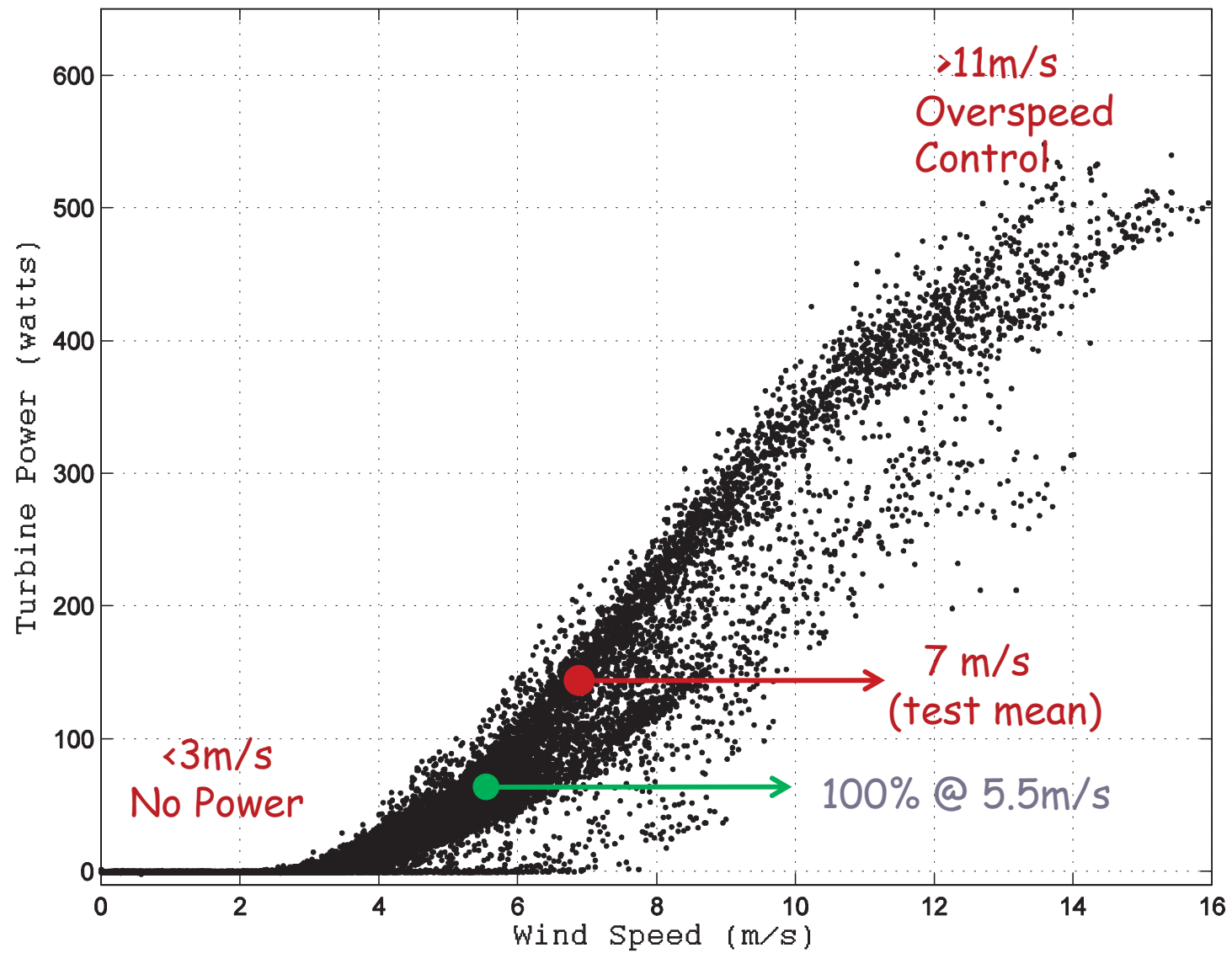
2010

RPM-450 Barrow Data: Power Production



2010 Battery Bank State of Charge and Temperature





Problems Encountered

- O-ring failure on turbine housing after 3 months
- Hughes Net Modem failure
- Inadequate settling time on current shunts
- Hughes Net / Logger Net Latency issue
- Single turbine failure due to rubbing on face plate
- Melted wires to resistive dump loads



Future Directions

- Partner with DHS to co-locate additional instrumentation
 - VHF Transciever
 - AIS Ship Tracking
 - Sea-Ice Radar (x-band)
- Setup site earlier in season
- Modifications
 - Waste Heat Recovery
 - Engine starter battery
 - Aluminum decking
 - Iridium SBD Backdoor

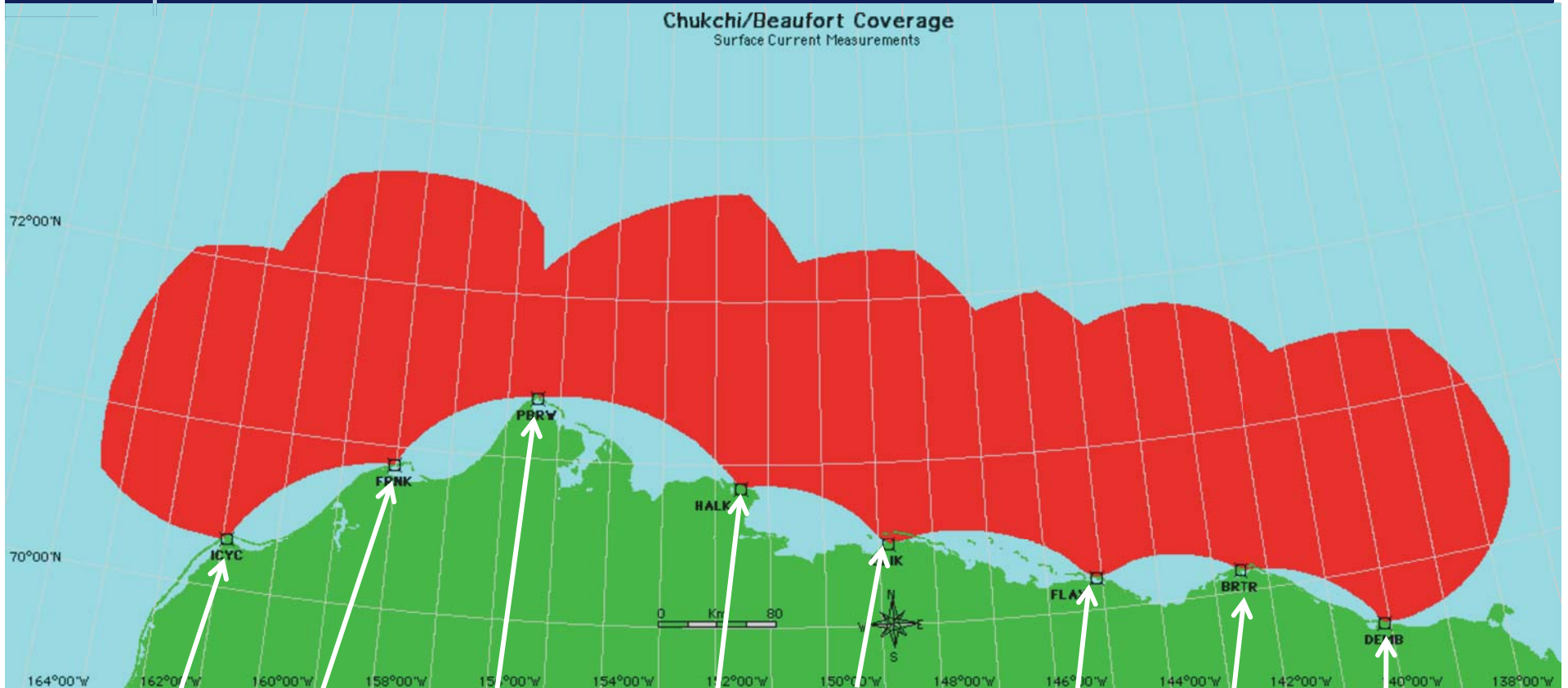
Winterized RPM March 15, 2011



Example Radar Mask: 8 Long-Range HF-RPM systems

Coverage: 800 km (425 n. mi.) \times 175km = 1.4×10^6 km² (~40,000 n.mi.²)

Chukchi/Beaufort Coverage
Surface Current Measurements



Icy
Cape

Pt.
Franklin

Pt.
Barrow

Cape
Halkett

Oliktok
Pt.

Flaxman
Is.

Barter
Is.

Demarcation
Bay

Questions?



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