Power System Design for High Lattitudes and Wiring Best Practices

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Tracy Dahl
Polar Field Services
tracy@polarfield.com
What Drives System Design?

- Project Requirements and Constraints:
  - How much power/energy?
  - AC? DC? Both?
  - Autonomous or grid-tied?
  - Summer only or year-round?
  - Portability/set-up time?
  - Data/communications requirements?
  - Logistics considerations
  - Budget/resources
  - Timeline
Environmental Factors/Resources:
- Solar resource?
- Wind resource?
- Fuel generator only?
- RTG – maybe someday….
- Hybrid design?
- Energy storage requirement based on calculations including de-rating factors. Can be many sources, e.g., battery + fuel.
Power/Data/Communications for Seismic Stations in Antarctica.

- Major focus on minimizing energy consumption; 1.6 Watt average load
- Different battery technologies are used for different environmental conditions.
  - For polar plateau sites where weight and reliability in extreme cold are major design drivers, a small, solar rechargeable lead acid battery is used during the summer, then the system switches over to lithium primary cells for the winter months.
  - At other locations, conventional deep cycle lead acid batteries are a more cost effective alternative.
Lead Acid Only System

100Ah Lead Acid Batteries (More Underneath)

Charge Controller
200 Ah Lithium Thionyl Chloride Primary Battery Packs

Lithium Primary System

Charge Controller with LVD and Battery Switching

34Ah Lead Acid Battery (hidden)
Example: UNAVCO

- Power/Data/Communications GPS stations in Antarctica and Greenland
- About a 5 Watt average load year-round; 120 Wh/day, 840 Wh/wk, 43.68 kWh/year.
- Even with a lot of energy storage, active generation becomes more essential.
- Systems are exceptionally well adapted to the project requirements and environmental drivers.
- Variations in design between super windy rock sites and polar plateau sites
Autonomous Power System for Surface Current Mapping Radars

RPM Module: Howard Island, Antarctica
Installed November 2014

www.ims.uaf.edu/artlab
10kWh/day load with very plug and play design
Collaboration between UAF and Remote Power Systems
Autonomous operation of SONAR, computer and peripherals
Summer only in North Slope Alaska
Will be moved 9X per season by R44 helo
Quick set-up/take down essential
Power : $80W > 120W = 100W$ average load
2.4kWh/day energy budget
Modest $ budget
Power system and science data archived locally
No communications or remote telemetry
PV panels create 3D self-supporting structure.
Light, compact, fast set-up.
Seasonally adjustable.
3.2 kWh LiFePO4 Battery
70 lb versus 210 lb
APRS WT 14 Wind Turbine
Tool-less installation
Excellent power/weight
Test the System Before Deployment!!!

Disclaimer: Although every effort has been made to optimize this design to fulfill the project requirements, it has not yet been subjected to the final test - deep field use. Feedback from the researchers will be used to refine subsequent iterations.
Electrical Wiring Best Practices

- Mentoring Program: Be a Mentor or Find a Mentor
  - Save yourself a lot of time and grief and learn what others have done successfully.
  - Institutional knowledge
  - Colleagues, peers, training, workshops
- Understand Ohm’s Law Calculations
- Tap Into Available Resources
  - National Electrical Code (NEC)
  - Online resources
  - Publications; books, magazines
- Never stop learning because you will never know it all and technology doesn’t stand still.
Wiring Best Practices contd.

- Use the Correct Wire for the Job
  - Understand Insulation/Conductor Designations; USE-2, SOOW, XHHW, etc.
  - Voltage rating must exceed anticipated maximum voltage for the circuit.
  - Size conductors for voltage drop as well as ampacity.
- Use the right type and quality of connector and install them with the correct tool
- If making soldered connections, strain relief near connection is critical
- Generally do not tin a conductor that will be used in a mechanical connection
- Use ferrules, particularly with fine-strand wire
- Secure conductors to prevent excessive movement
- Protect wire from mechanical damage
  - Use conductors with outer sheathing when possible
  - Flexible conduit
  - Cable tray
  - Split loom
  - Heat shrink
  - Mining cable (MC) for long outside runs (e.g., Tundra Grid)
Many PV larger panels come with USE-2 cable and MC4, SMK or other connectors. This can be a good option for higher voltage series connections.
Strive for Plug & Play Connections

- Para-Cord Tie Downs
- Wind Power Input
- Three Trolling Motor Connectors for PV Input
- Twist-Lock Connector for 120VAC Out
Careful Component Selection

- Rated for expected temperatures
- Rated for voltage
- High efficiency
- Conformal coated PC boards
- Strive to standardize components to the extent possible
- Unsolicited testimonial for Polar Wire Products
  - Arctic Ultra-Flex Power and Control Wire
  - Vendor for Marinco and Blue Sea marine products
- Anxious to see other folks favorite gizmos
Many additional subjects that could be discussed if time permitted:
- Facility scale power systems
- Bonding and grounding
- Engine generators and fuel cells
- Energy storage systems
  * Battery technologies
  * Hydrogen
  * Fossil fuels

Make your suggestions for PTC 2016!
Let’s go workshop!