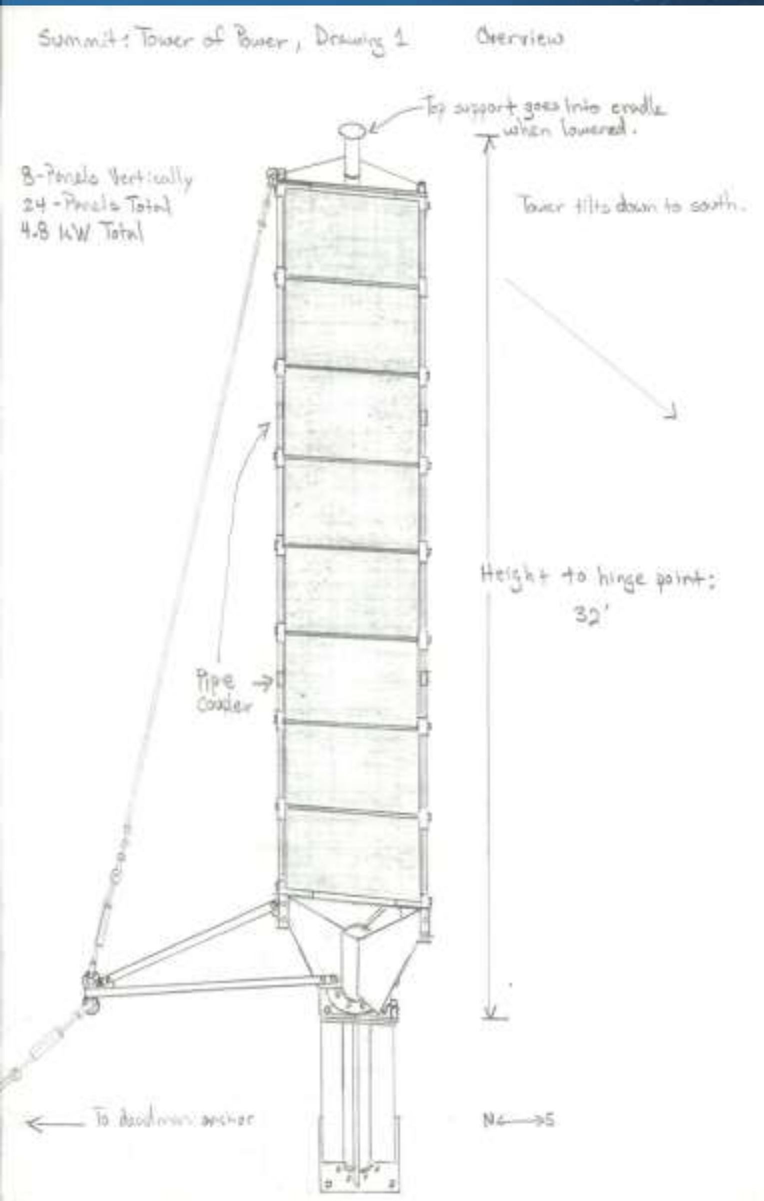
Polar Solar

Considerations and Recent Deployment Examples

Tower of Power: Concept to Implementation

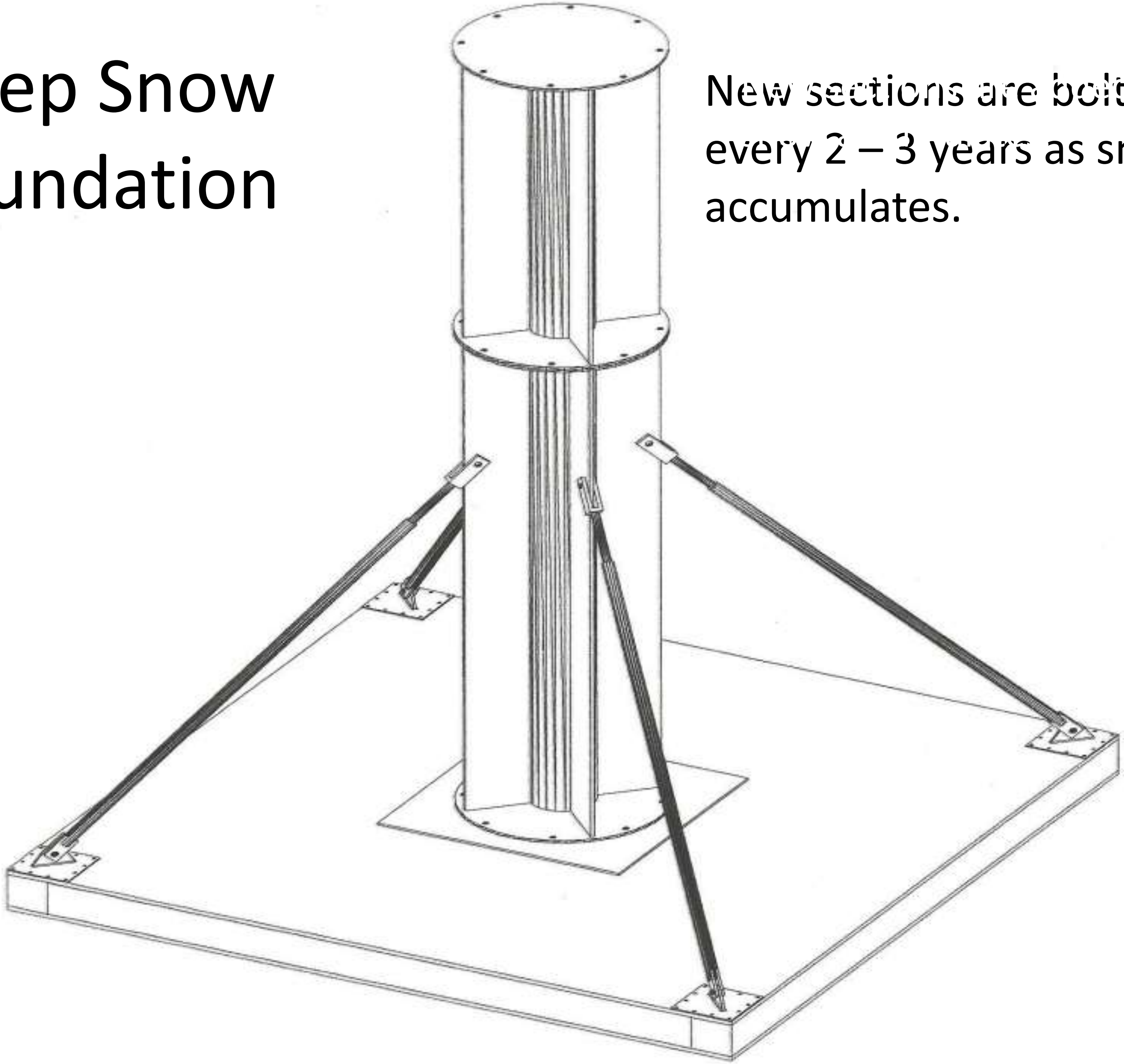


Design Drivers

- Implement significant PV at low cost
- Re-use existing wind tower foundation
- Use the environment to our advantage to maximize power production
- Strong enough to withstand the environment, yet light enough for two people to deploy with hand tools.
- Make a statement

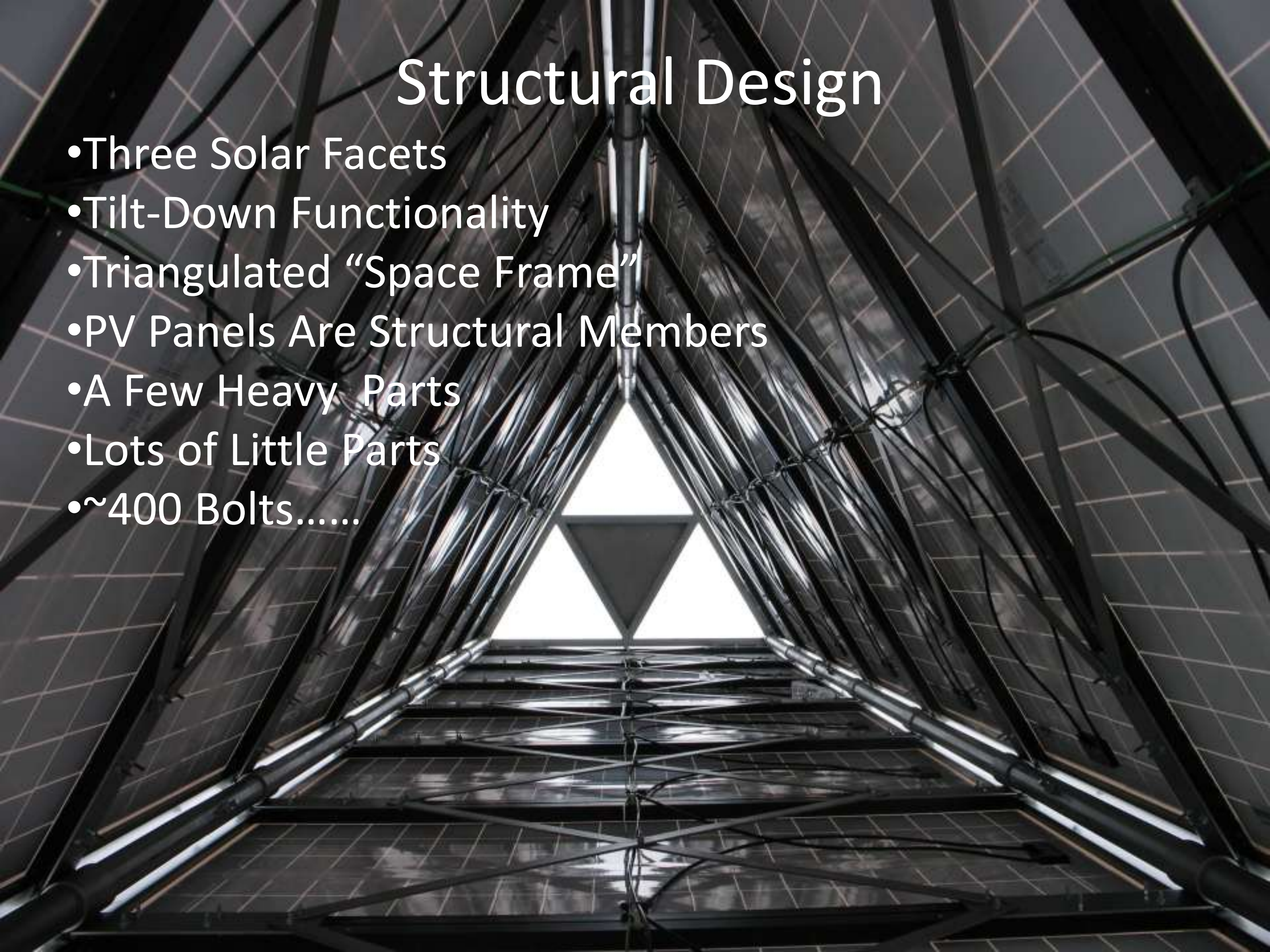
Deep Snow Foundation

New sections are bolted on every 2 – 3 years as snow accumulates.



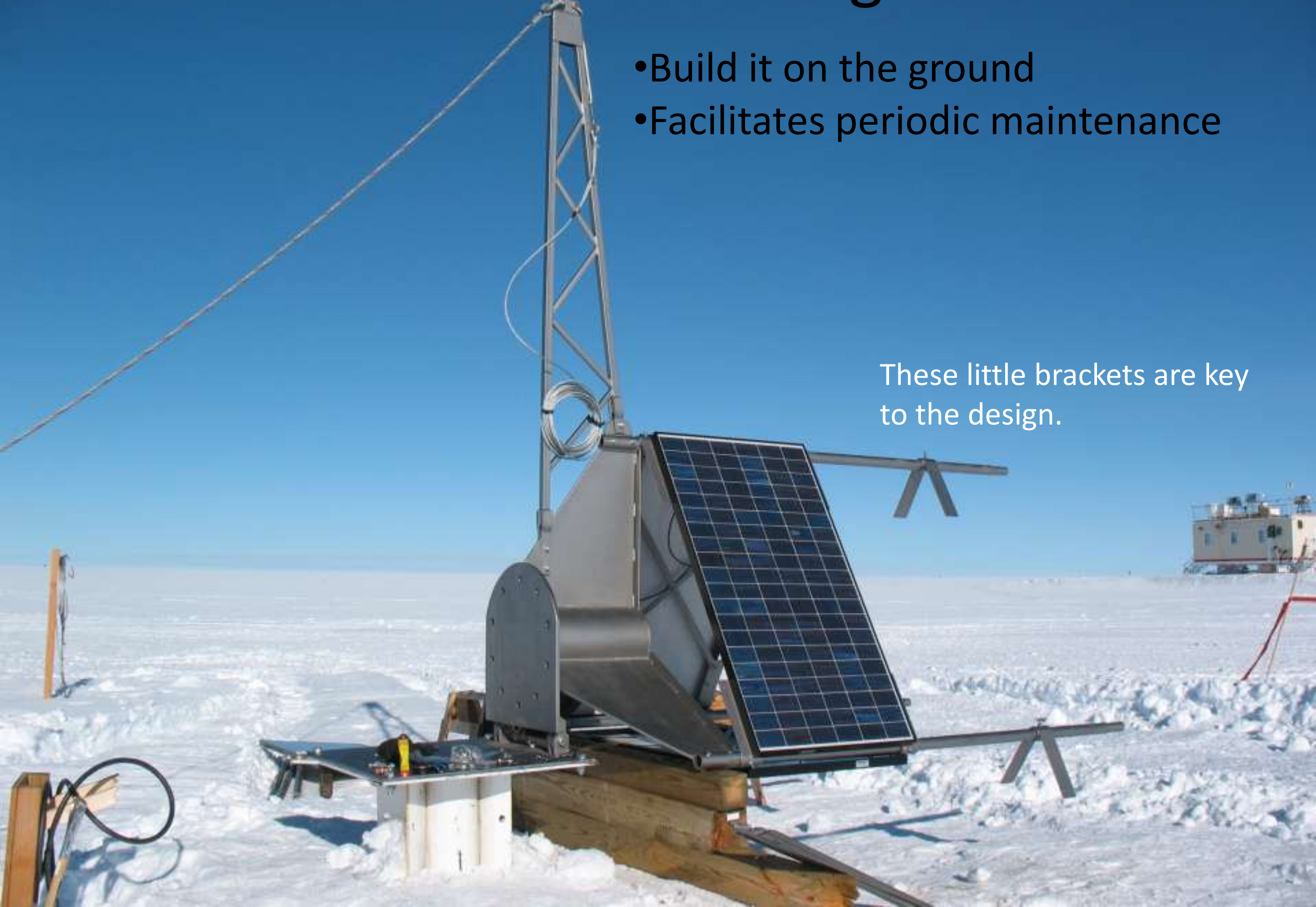
Structural Design

- Three Solar Facets
- Tilt-Down Functionality
- Triangulated “Space Frame”
- PV Panels Are Structural Members
- A Few Heavy Parts
- Lots of Little Parts
- ~400 Bolts……



Tilt-Down Design

- Build it on the ground
- Facilitates periodic maintenance



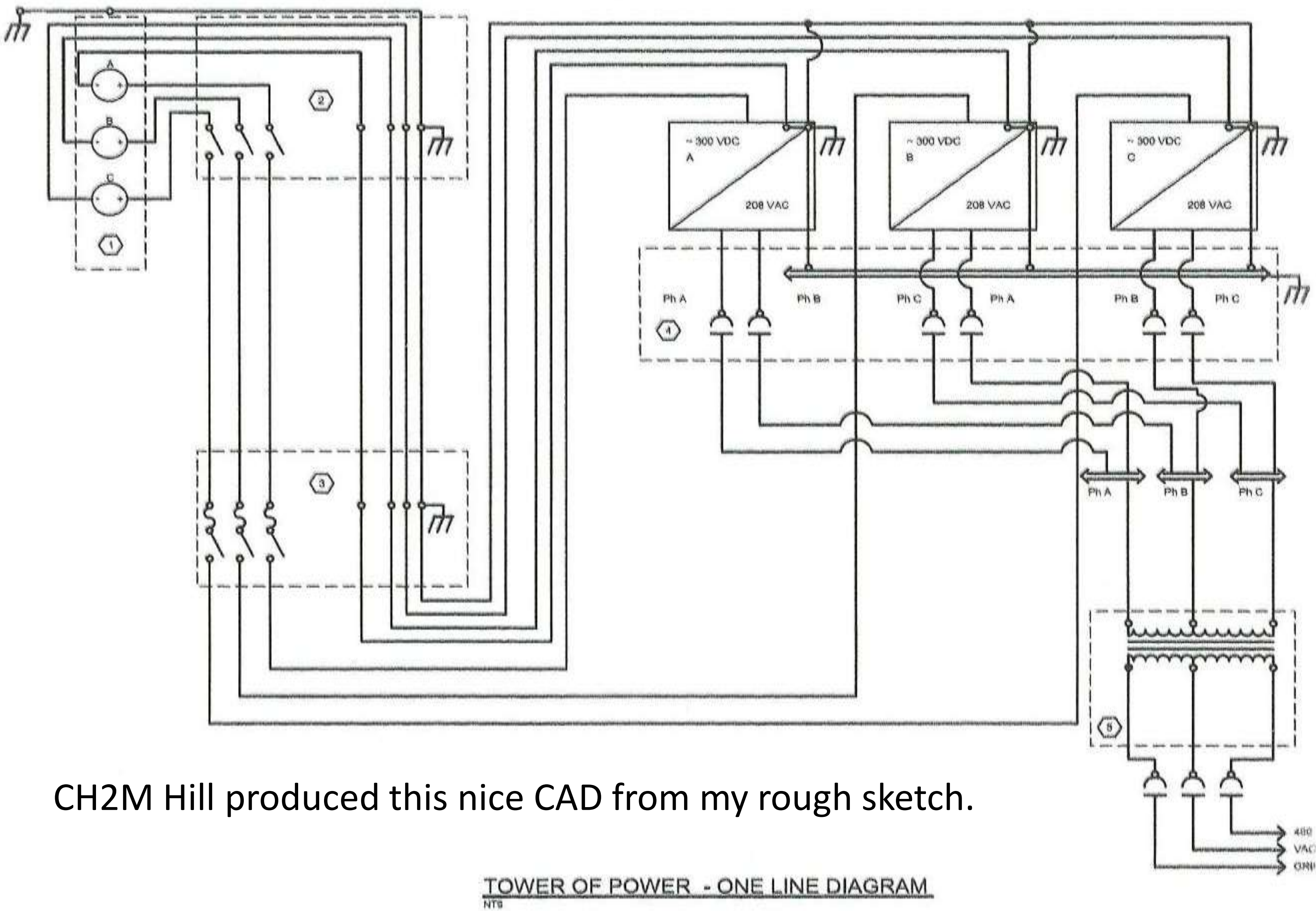
These little brackets are key to the design.

Construction

- Required support until all the pieces were bolted together
- Top fixture will support tower while base is rotated out of the way
- Project was blessed by unreasonably good weather
- Had some nightmares about those 400 bolts, but in the end it was not bad.

Raising the Tower of Power

Electrical Design



CH2M Hill produced this nice CAD from my rough sketch.

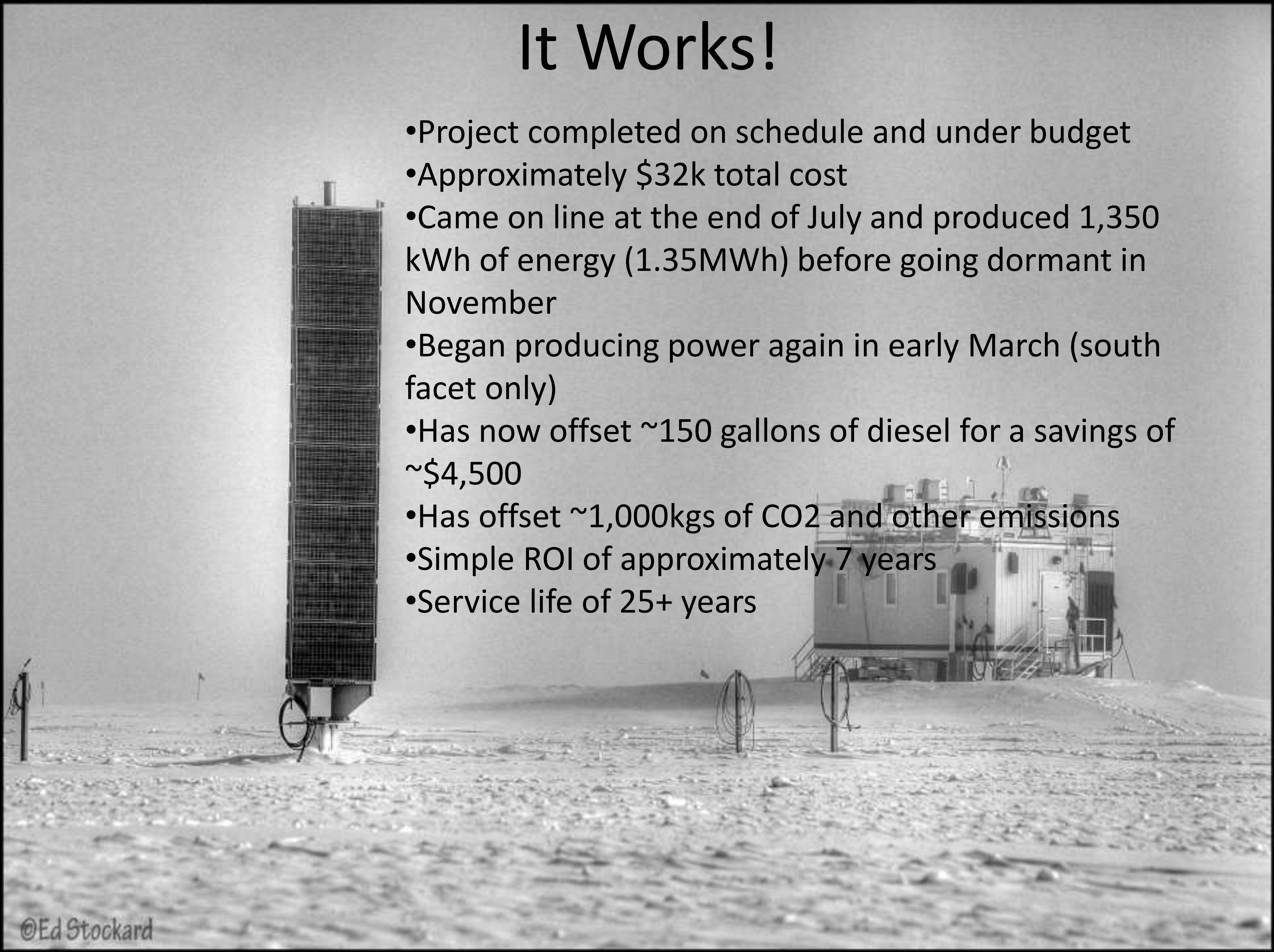
- ~240VDC to 340VDC output
- Facet Outputs Kept Discrete for 200’ Run to D-Shack
- DC/AC Inverters Connect to Grid
- Huge Temperature/Voltage Coefficient (~25% V increase @ -50C)

Nick’s
Immaculate
Workmanship

Three Solectria PVI 1800 inverters tie into the 3-phase grid

It Works!

- Project completed on schedule and under budget
- Approximately $32k total cost
- Came on line at the end of July and produced 1,350 kWh of energy (1.35MWh) before going dormant in November
- Began producing power again in early March (south facet only)
- Has now offset ~150 gallons of diesel for a savings of ~$4,500
- Has offset ~1,000kgs of CO_2 and other emissions
- Simple ROI of approximately 7 years
- Service life of 25+ years



Design Advantages

- Vertical panels are good for polar ice caps:
  - Snow does not collect
  - Takes advantage of "global irradiance"
  - Captures low angle light
  - Captures reflected light
- Three PV facets produce power 24/7 in mid summer, resulting in even power input to grid.
- Closed structural design maximizes strength and minimizes wind load
- The higher the latitude, the better the design works

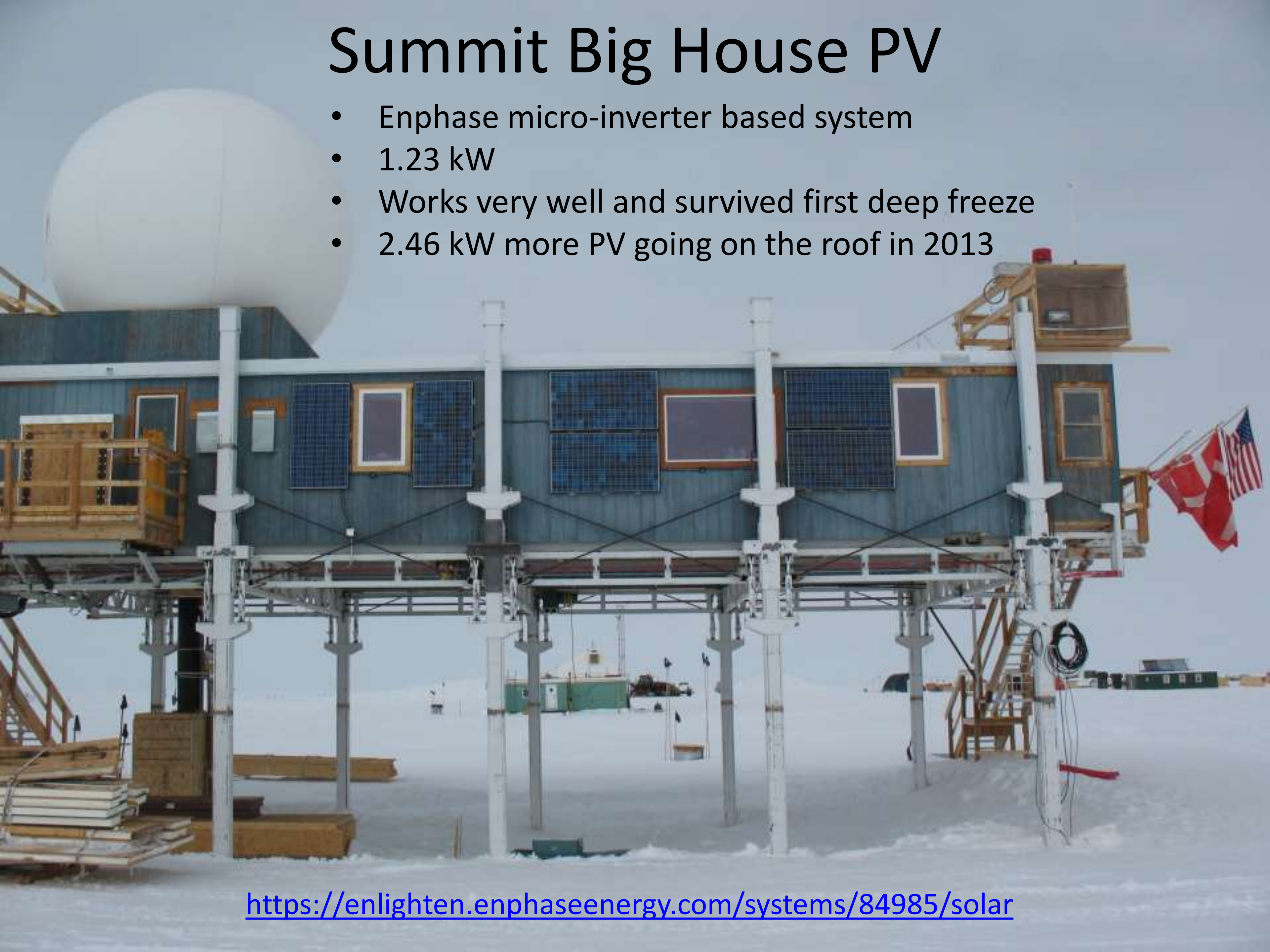
Design Disadvantages

- It is where it is and cannot be easily relocated
- Due to permanent snow accumulation, it will need to have the base extended periodically.
- It is structurally very strong, but raising/lowering must be done with premeditated care.


A New Summit Icon?
Photo: Nick Salava

Summit Big House PV

- Enphase micro-inverter based system
- 1.23 kW
- Works very well and survived first deep freeze
- 2.46 kW more PV going on the roof in 2013



https://enlighten.enphaseenergy.com/systems/84985/solar

Summit Solar Thermal

Evacuated tubes looked the best on paper, but……….

Conclusions

- Although somewhat attenuated by atmosphere the solar resource in high polar environments is actually quite good.
- Recent advances like maximum power point tracking (MPPT) allow us to take better advantage of the environmental conditions.
- PV is a particularly good technology as it usually coincides with the peak power usage during the summer.
- Solar thermal is also useful, but is out of phase with peak heat requirements.
- Integrating solar technologies with building envelopes is a very cost effective strategy, but requires forethought and planning for maximum efficiency.
- You don’t just have to point em’ south (or north in Antarctica). There are distinct advantages to utilizing multi-azimuth orientations.

Questions?

Carpe Diem!