Solarflux

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Introduction

Problem: Solarflux's solar thermal concentrator (FOCUS) which tracks the sun and provides thermal heating for commercial applications currently runs on costly grid power. In order to mobilize the FOCUS product and increase cost competitiveness with other thermal heating applications, the current control system that the dish uses to anticipate dish movement and motor that moves the dish needs to be powered by an off-grid system.

Solution: We are tasked with creating and wiring an off-grid PV electrical power system with energy storage and we also need to mount the PV on to the dish in a way that minimizes wind loading on the dish with the added Solar module weight.

Project Roles

Caroline Holm - Project Manager, Electrical design lead
Ryan Nett - Communications manager, Mechanical designer
Dillon Muldoon - Mechanical designer, Hardwiring specialist
Gabriel Goins - Electrical designer
Fares Alkhalidi - Electrical team member

Requirements

1. Convert DC solar power to usable AC power for the dish
2. Supply 115VAC power to motor and control system
3. Securely attach PV cells to existing dish structure
4. Output 3.5 kWh of energy daily to operate solar concentrator and charge the batteries
5. Interface charge controller with existing control system
6. Collect/display power system performance
7. Provide a working system of 10 years with minimal maintenance

Constraints

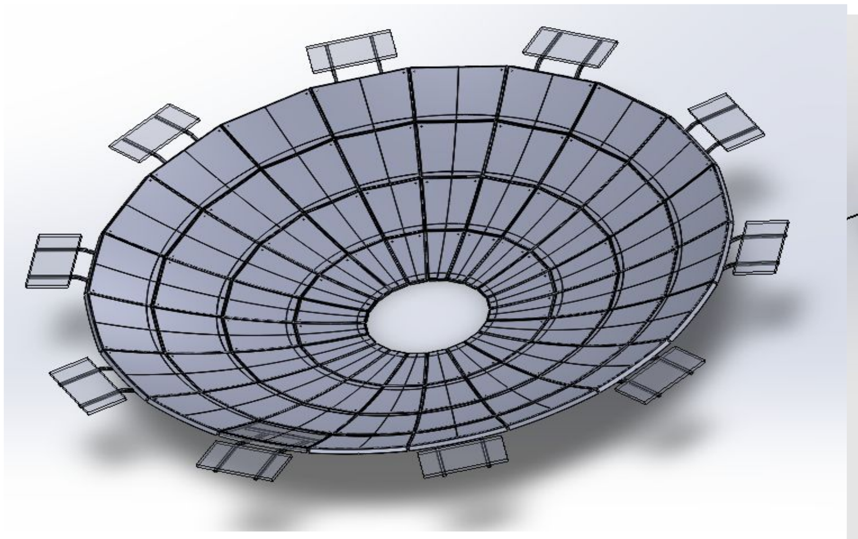
1. Must be able to provide a peak load of 200Wac of power to the solar tracker on the concentrator
2. Must use PV cells - either Silicon PV or Concentrated Triple Junction PV
3. Must withstand weather elements (hail, snowstorm, wind)
4. Must be in compliance with IP 65
5. Must withstand extreme temperatures ranging from -20C to +70C
6. Must be able to have a cyclic cycle of 10 years with weather disintegration. Must have at least 3.5 kWh/day of storage
7. Must be mounted to solar concentrator

Design Specifications

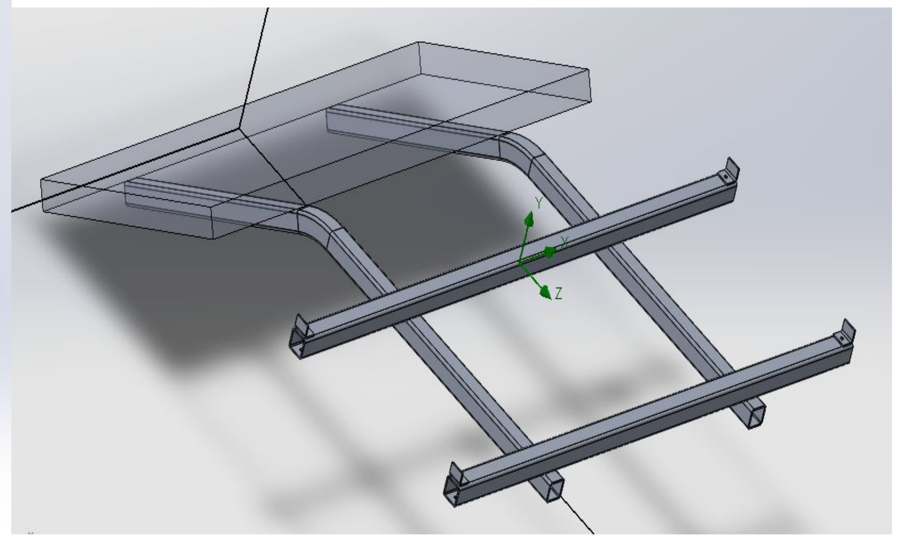
Full-Scale Design Model:

- Ten 12V 100W monocrystalline PV panels
- MPPT 75V 15A charge controller
- Four 12V 100Ah AGM deep cycle batteries
- 500W 24V DC 120VAC inverter
- Custom aluminum mount for each PV panel

Mechanical Project Design

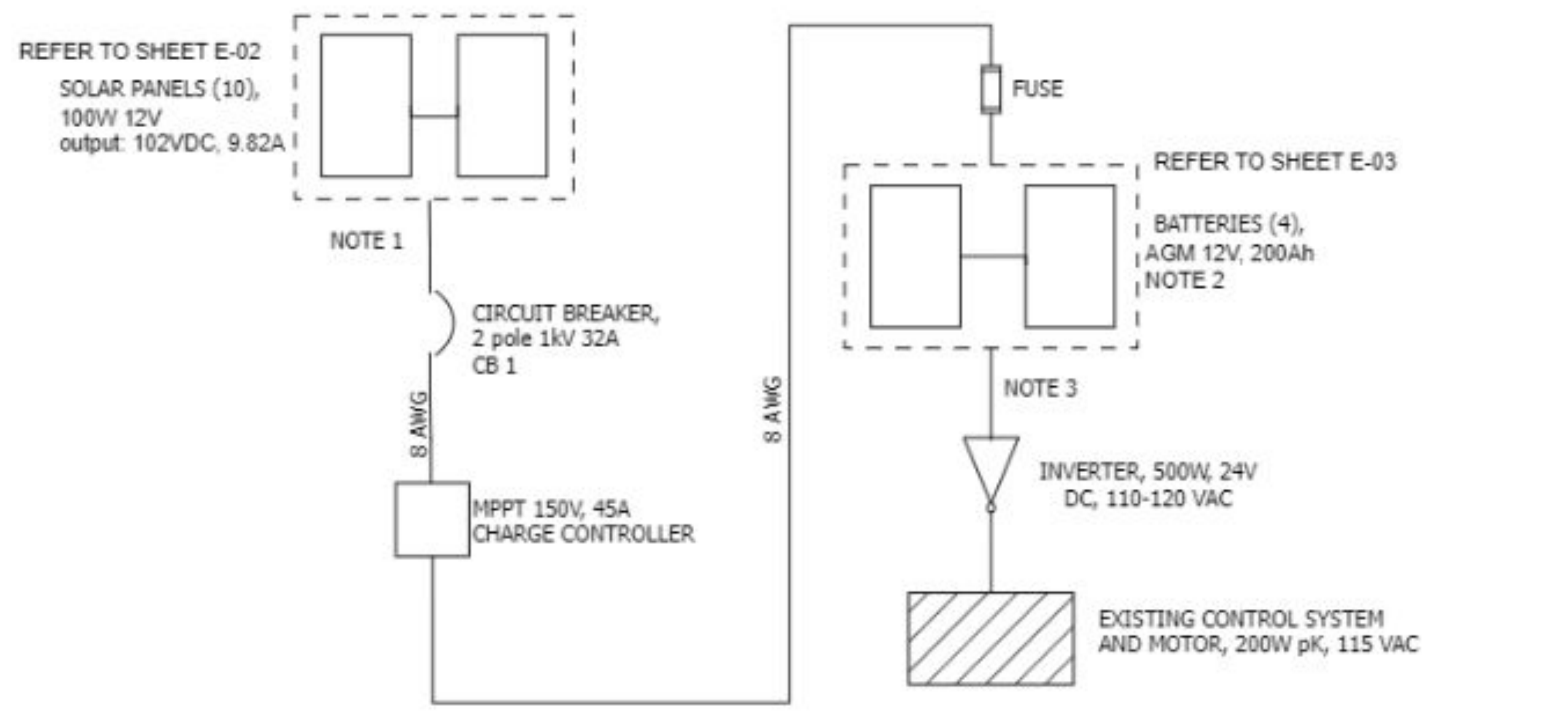


Mounting Prototype Integrated into Concentrator



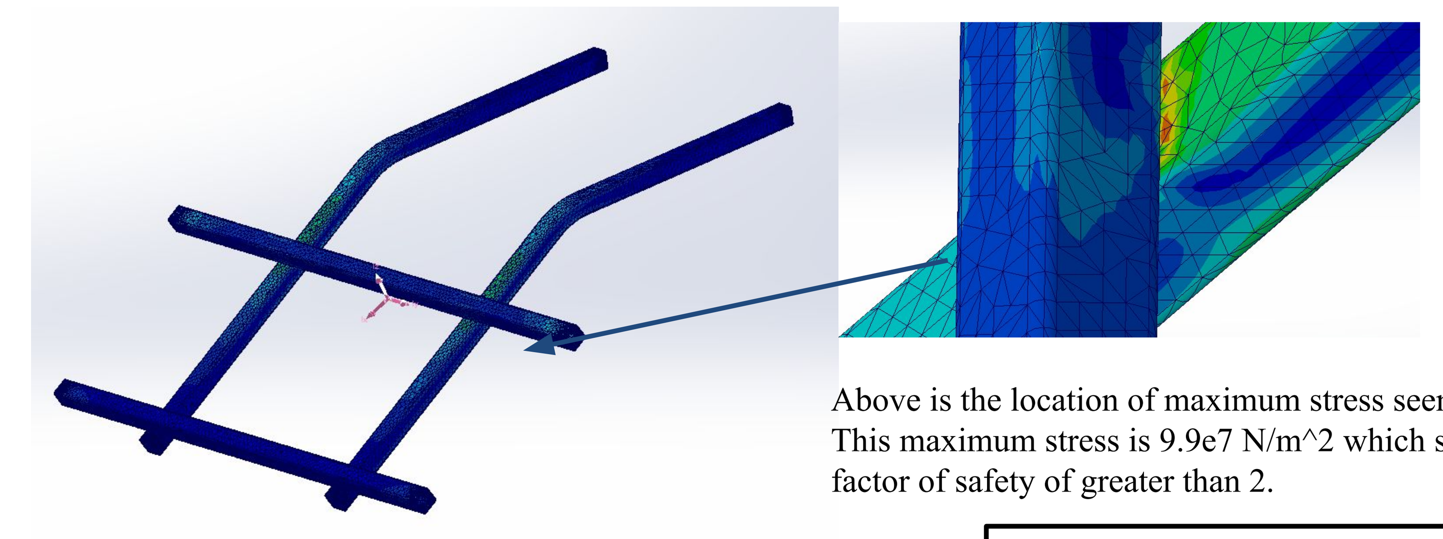
Solidworks Design of PV Mounting Prototype

Electrical Project Design



NOTES:
1. MC4 CONNECTORS WILL BE USED TO CONNECT OUR SOLAR PANELS TO BARE 8 AWG WIRE.
2. A CONNECTOR KIT WILL BE USED TO FEED 8 AWG WIRE TO BATTERIES. BATTERIES WILL BE CONNECTED IN SERIES USING PROVIDED BATTERY CABLES.
3. USE PROVIDED CABLES FROM INVERTER TO CONNECT BATTERIES TO INVERTER.

Mechanical System Analysis



Above is the location of maximum stress seen during testing. This maximum stress is 9.9e7 N/m^2 which still allows for a factor of safety of greater than 2.

Design considerations:
The strength of the mount was tested against a 100lb load on the outer fork in the location of which the panel would be. This load is meant to represent a high wind hitting the panel while in an angle perpendicular to the wind which would be the maximum load. Testing is focussed on the following:

A. Displacement of the outer forks.
B. Squeezing of the cross sections of square tubing
C. Bending of the tube due to the force on the panel.
D. Tearout strength of the angles against the spines of the dish

Design specs:
- 1.5" Square Aluminum Tubing
  - ⅛" Thickness
- 6063 Aluminum T5
- 1" x 1" x 1.25" L angle
  - 6061 Aluminum
- ¼" Threaded Bolts
- Weight: 18lbs

Electrical Subsystem Analysis

Charging our System from 0% Battery Storage: (fully charged after 6 days)

	Day 0	Night 0	Day 1	Night 1	Day 2	Night 2	Day 3	Night 3	Day 4	Night 4	Day 5
Usage	1200	600	1200	600	1200	600	1200	600	1200	600	1200
Battery Level (quantity)	2300	1700	4000	3400	5700	5100	7400	6800	9100	8500	10800
Battery Level (percentage %)	23.96	17.71	41.67	35.42	59.38	53.13	77.08	70.83	94.79	88.54	112.50
Energy Produced	3500	0	3500	0	3500	0	3500	0	3500	0	3500

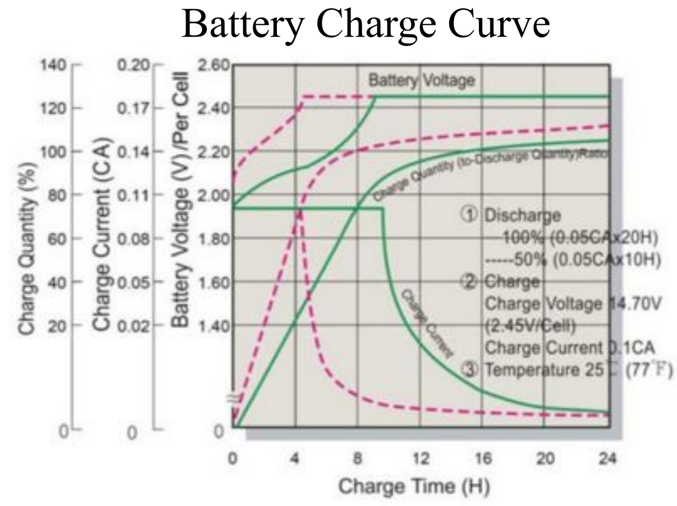
Battery Health After Minimal Sunlight Event: (recharged after 3 days)

4 Batteries 12V, 200Ah			no sun		no sun		no sun		Sun				
	Day 0	Night 0	Day 1	Night 1	Day 2	Night 2	Day 3	Night 3	Day 4	Night 4	Day 5	Night 5	Day 6
Usage	1200	600	1200	600	1200	600	1200	600	1200	600	1200	600	1200
Battery Level (quantity)	9600	9000	8150	7550	6700	6100	5250	4650	6950	6350	8650	8050	10350
Battery Level (percentage %)	100.00	93.75	84.90	78.65	69.79	63.54	54.69	48.44	72.40	66.15	90.10	83.85	107.81
Energy Produced	3500	0	350	0	350	0	350	0	3500	0	3500	0	3500

System Energy Analysis + Panel Sizing

energy input (irradiance)	Panel Efficiency	Battery Efficiency	Charge controller eff.	inverter eff.	area (m^2)	energy output		Area of selected panels (100W)
								0.564

Battery Charge Curve



Terminal Voltage Discharge Curve