Redesign of Solar Automatic License Plate Reader Trailer

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Kellogg Honors College Capstone Project

Abstract

Throughout the nation, one tool that our law enforcement agencies use is the automatic license plate reader (LPR). These readers are responsible for scanning license plates of vehicles on roadways or traffic stops and running these plates against databases of vehicles with known violations. License plate readers can be statically mounted on infrastructure, mounted on patrol vehicles, or can be relocated with ease on deployable mobile trailers. The goal of this project is to redesign the mobile LPR trailer by replacing a gas-powered generator system with self-sufficient solar power. This project encompassed the procurement of a trailer, design of mounting structures, selection of back-up power, design of a thermal control system, and the generation of plans for construction and assembly of consequential trailers in mass production.

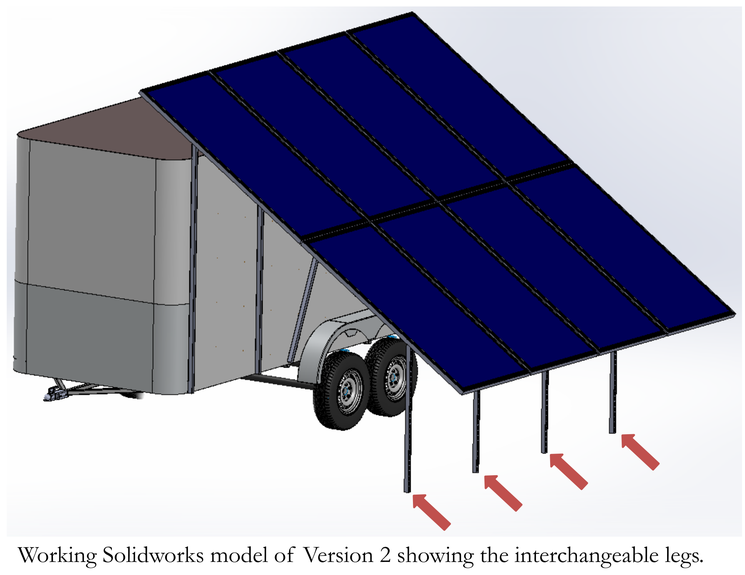
Objectives

- Select a trailer
- Design external structure for solar panels
- Design for seasonal and thermal considerations
- Select back-up generator
- Document for production
- Maintaining mobility for Caltrans

Implementation

- Pace Outback 6' x 12' enclosed trailer
- Secondary flooring framework with insulation
- Separate compartment for electronic component
- Propane back-up generator
- MaxxFan Deluxe 12 V Roof Vents

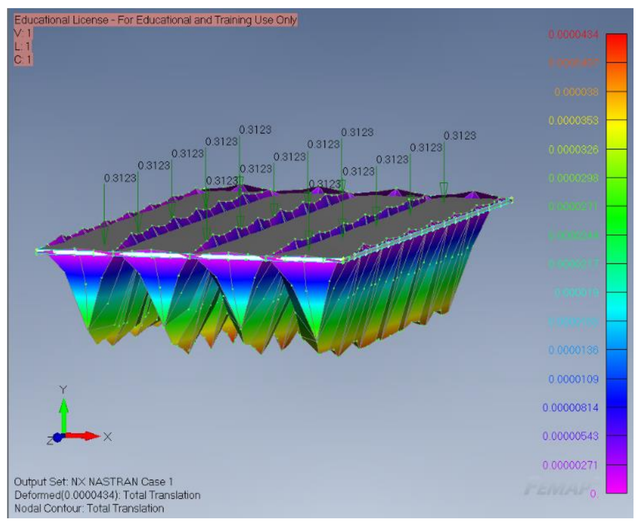
Inside electronic component compartment.



Working Solidworks model of Version 2 showing the interchangeable legs.

Prototype Version 1

- 8-panel solar array
- 32-battery storage system
- Flatbed Trailer



Finite Element Analysis of the secondary plywood floor.

Basic Finite Element Analysis

The secondary floorboard was analyzed using Nastran and FEMAP to confirm the weight of the batteries would not seriously compromise the plywood floor. The weight of the batteries was applied as an evenly distributed force per area. The modulus of elasticity of the plywood was assumed to be

$$E = 2.1325\ x\ 10^6\ psi$$

and the Poisson's ratio was assumed to be

$$\nu = 0.4.$$

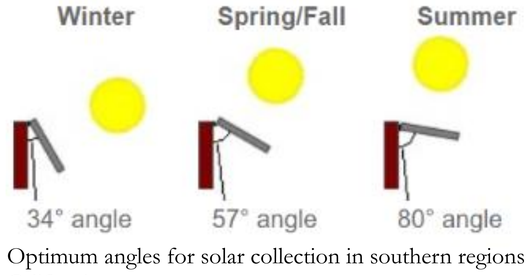
The computed force per area of the batteries was

$$\frac{Force}{Area} = \frac{75\ lbs\ x\ 32\ batteries}{121\ inches\ x\ 65\ inches} = 0.31\ psi.$$

Using the supporting plywood boards as constraints in the simulation, the greatest deformation of the floor was 0.0000434 inches.

Seasons

The rotations of the earth change the path the sun crosses the earth with, which changes the optimum angle solar panels should be set to in order to have maximum efficiency. Although this solar array is non-tracking, the modular steel structures allow for the three optimal angles to be achieved by the trailer with the simple exchange of four supporting legs.

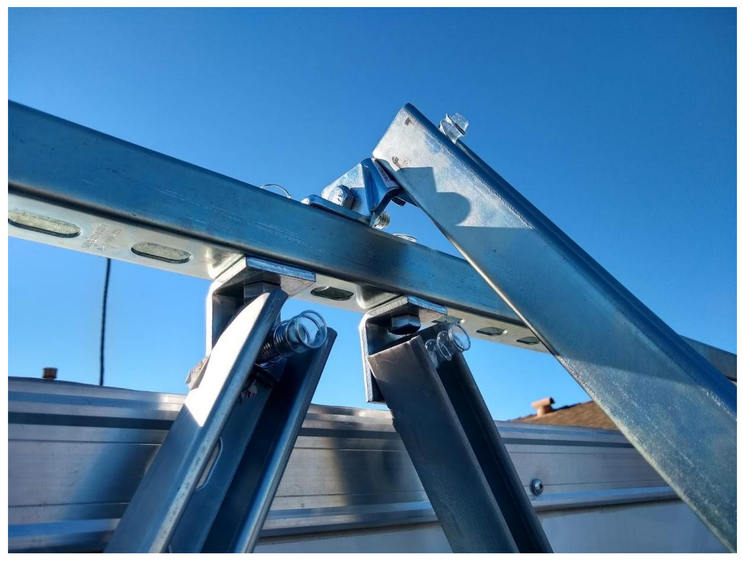


Optimum angles for solar collection in southern regions of California.

Prototype Version 1 deployed in field.

Thermal Considerations

- Electrical Components Compartment
  - Requires 6.3 CFM
  - 1 intake vent
- Battery Compartment
  - Requires 38.5 CFM
  - 3 intake vents
- MaxxFan Deluxe Roof Vents: 12 V
  - Fan Capacity 900 CFM
  - One fan per compartment



Steel structures arranged to support solar panel array.

Discussion and Future Work

The redesigned trailer is now in better condition to withstand all seasons in deployment without concern of overheating or concern of loss of power due to cloud coverage. The new design and corresponding documentation can be taken to trade shows with a proof of concept for companies to assess its capabilities and how it can provide power for their needs.