Metallic Mirror:
A Parabolic Solar Trough

Nick Petro - Alyssa Brown - Kieran Bell - Delaney Dobracki - Yash Kothari

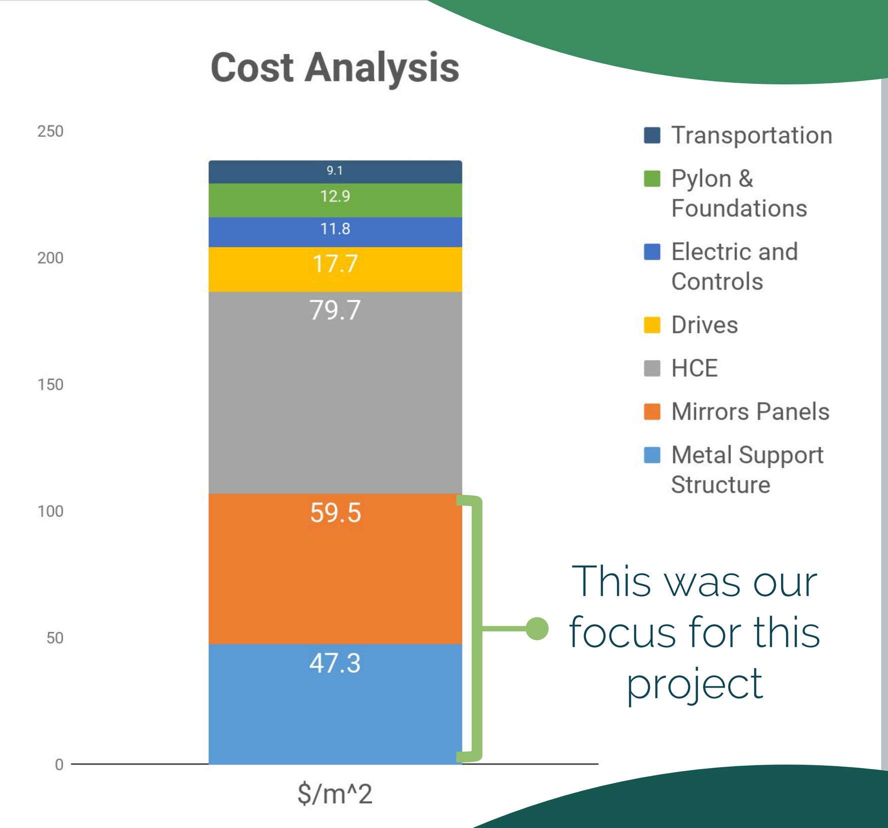
Background

Parabolic solar reflectors capture solar energy in the form of heat.

Current parabolic solar consist of silver-backed glass mirrors supported by an intricate substructure that provides the support for all of the components, and keeps the mirrors in correct orientation after assembly.

Countless parts go into attaching and aligning the mirrors so that they are buffered from the torsion the trough experiences, yet stay focused on the heat collection element.

The trough also is setup to track the sun throughout the day for optimum power output.



Problem

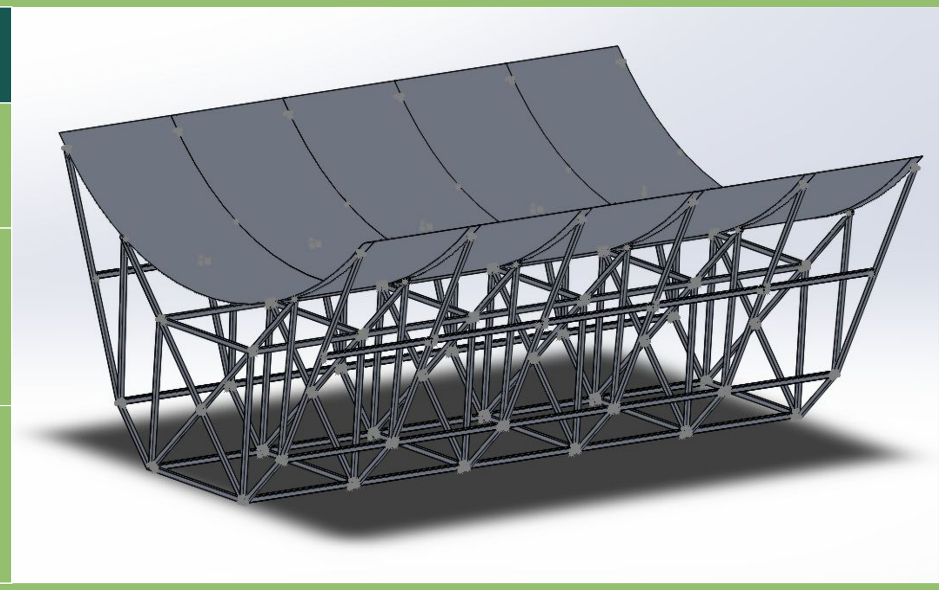
The current glass-mirror parabolic trough technology is dead-weight on the structure, expensive to manufacture, complex to assemble, and sensitive to cracking during calibration.

We aim to find a new metallic-mirror parabolic trough design that could alleviate all of these issues and do more, specifically:

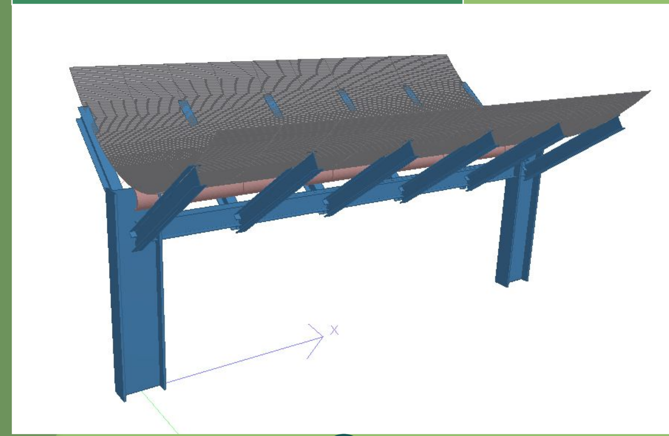
Less Deflection
Greater Precision
Larger Surface Area
25-50% Cost Reduction

Our Solution

	Prototype
Trough Thickness (inches)	0.075
Substructure Al Square Tube Size (inches)	1.5 x 1.5
FEA - Max Deflection (inches)	0.69



Trough Thickness (inches)	0.75
FEA - Max Deflection (inches)	0.51



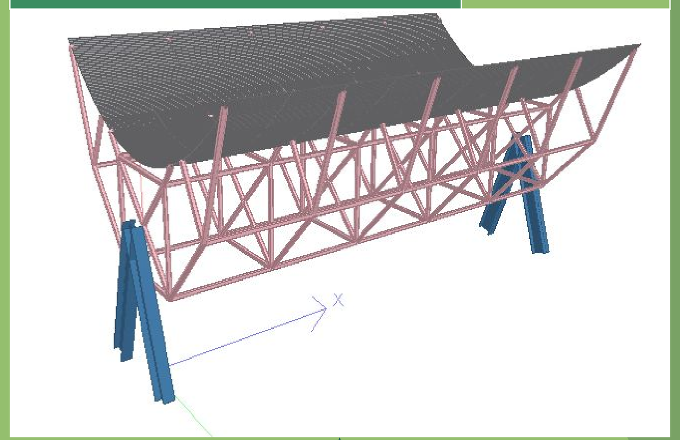
Final Assembly:

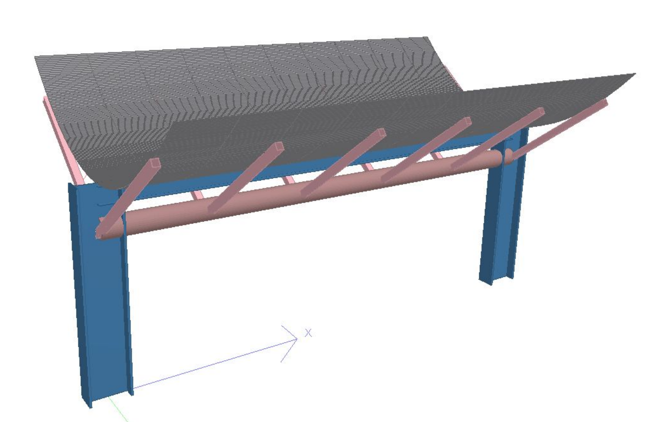
The five mirror sections will be joined by formed strips of 6" x 0.25" aluminium with an adhesive, effectively restoring the structural integrity of a single sheet, while also using the added stiffness to enforce the desired parabola.

The strips will then be mounted to the truss structure with slip-fit joints secured with a bolt and nylock nut.

The remainder of the truss structure will be welded with slip-fit joints (secured by bolt and nylock nut) for the horizontal linkages to achieve the final structure (shown below).

Trough Thickness (inches)	0.10
FEA - Max Deflection (inches)	0.68





Trough Thickness (inches)	0.375
FEA - Max Deflection (inches)	0.45

Results

	Our Design	Technical Requirements
Precision Error (mrad)	8.0-	< 8.00
Intercept Factor	0.96+	> 0.96
Surface Area (m^2)	45.92	> 45.0
Deflection (inches)	0.69	< 2.00
Cost ($\$/m^2$)	238.40	< 265*

* This target was set as being 25% less than the cost of the current model ($\$360/m^2$)

Conclusion

In conclusion, we were able to create, model, and test a design that met all of our requirements.

It has improved effectiveness over current solution with

Less Deflection by ~1.3 in
Greater Precision
Larger Surface Area by ~1 m^2
Reduced Cost of ~34% per m^2

Looking forward, more research should be done to investigate alloys, films, or layered aluminium for the mirror to increase the efficiency of the reflectivity.

Additionally, a more comprehensive cost analysis should be conducted, looking at more than just the mirror and substructure.

PITT | SWANSON ENGINEERING
ARCONIC

We would like to thank our sponsor Matt Kiley and professor Dr. Winter for their support through the completion of this project.