S.O.L.R - SELF. ORIENTING. LIGHT. REFLECTOR. Group 11: Jose Camacho, Kevin Cochran, Connor Duffy, Matthew Liffrig, Dante Marra, Connor Murray, Alden Zamorano

#### Abstract

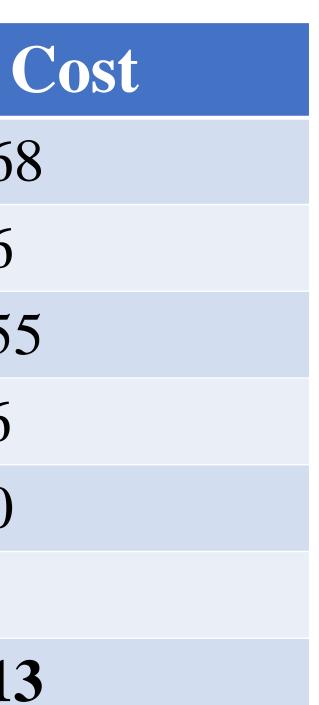
Our modular heliostat was designed around the hedgehog concept of minimizing overall size while maximizing range of motion and using simplistic modular design to limit cost. The design utilizes four subsystems to maximize efficiency and address the customer needs: Mirror, Rotational Device, Modular Support Structure, and Protective Casing. The mirror was constructed from flat plexiglass to enable easy attachment by bolt and cleanability from a flat non-reactive surface. The rotational device uses stepper motors with metal worm gears to maximize torque and lifespan while limiting tracking errors and cost. A support structure, constructed from welded steel for easy assembly, was used to raise the heliostats slightly off the ground for protection. This structure is secured to concrete anchors buried in the ground which limits the assembly time on-site. The protective structure is made from ABS vacuum-molded plastic which seals well from the elements, increasing lifespan at a low cost. This design is unique due to the modularity as well as the safety and protective features. The design features four main components that can be constructed off-site and then assembled with ease on-site: mirror with bracket, elevation tracker, azimuth tracker, and support structure. The modularity allows for quick set up on-site with minimal labor required and easy replacement of broken parts. Finally, the protective casing, and electrical shutoffs combined with high-wind modes ensures longevity and safe use of each module.

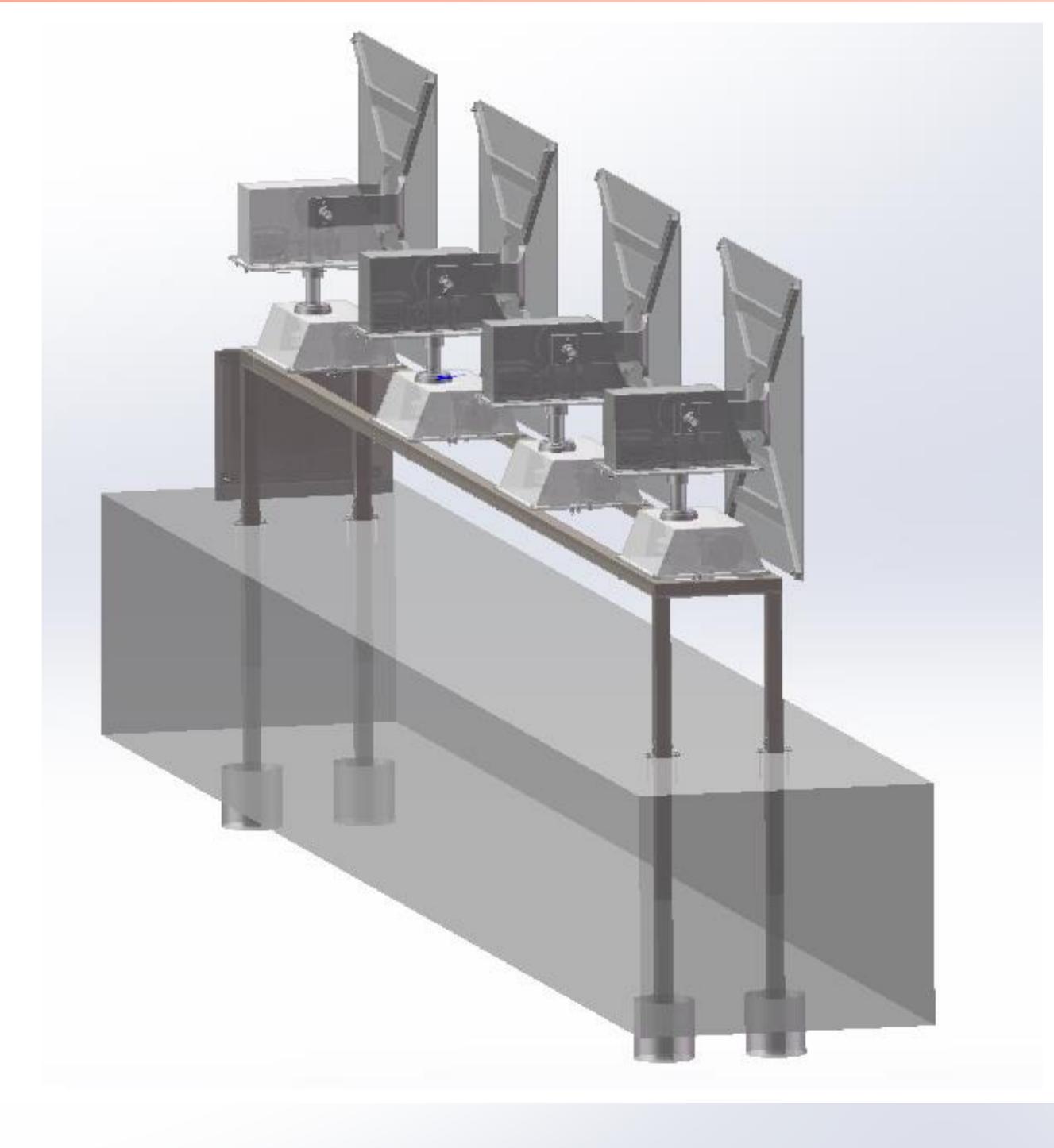
# **Product Functionality**

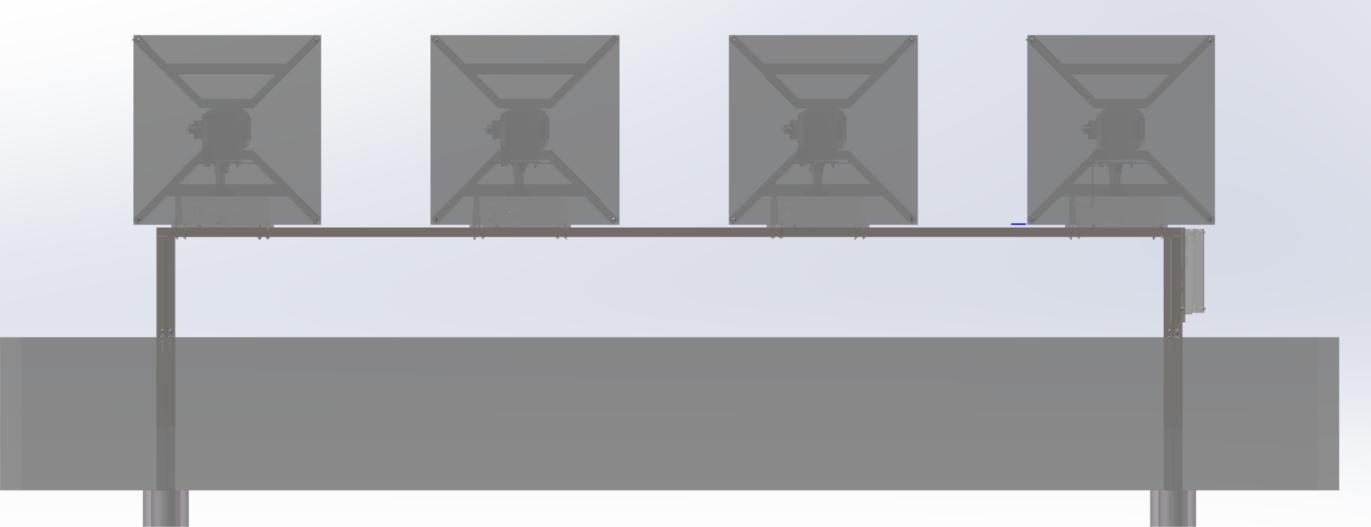
SOLR is a state-of-the-art small-scale heliostat module that is comprised of 4 identical individual heliostats mounted in-line on a rectangular steel support structure. There is one centralized raspberry pi computer that will receive an input command via WiFi and distribute it to each rotational device on each heliostat in order to move the mirror to the optimal position. SOLR is not only inexpensive to implement, but also inexpensive to maintain due to its modularity, accessibility of components, safety features for high winds combined with the emergency electrical shut-off switches.

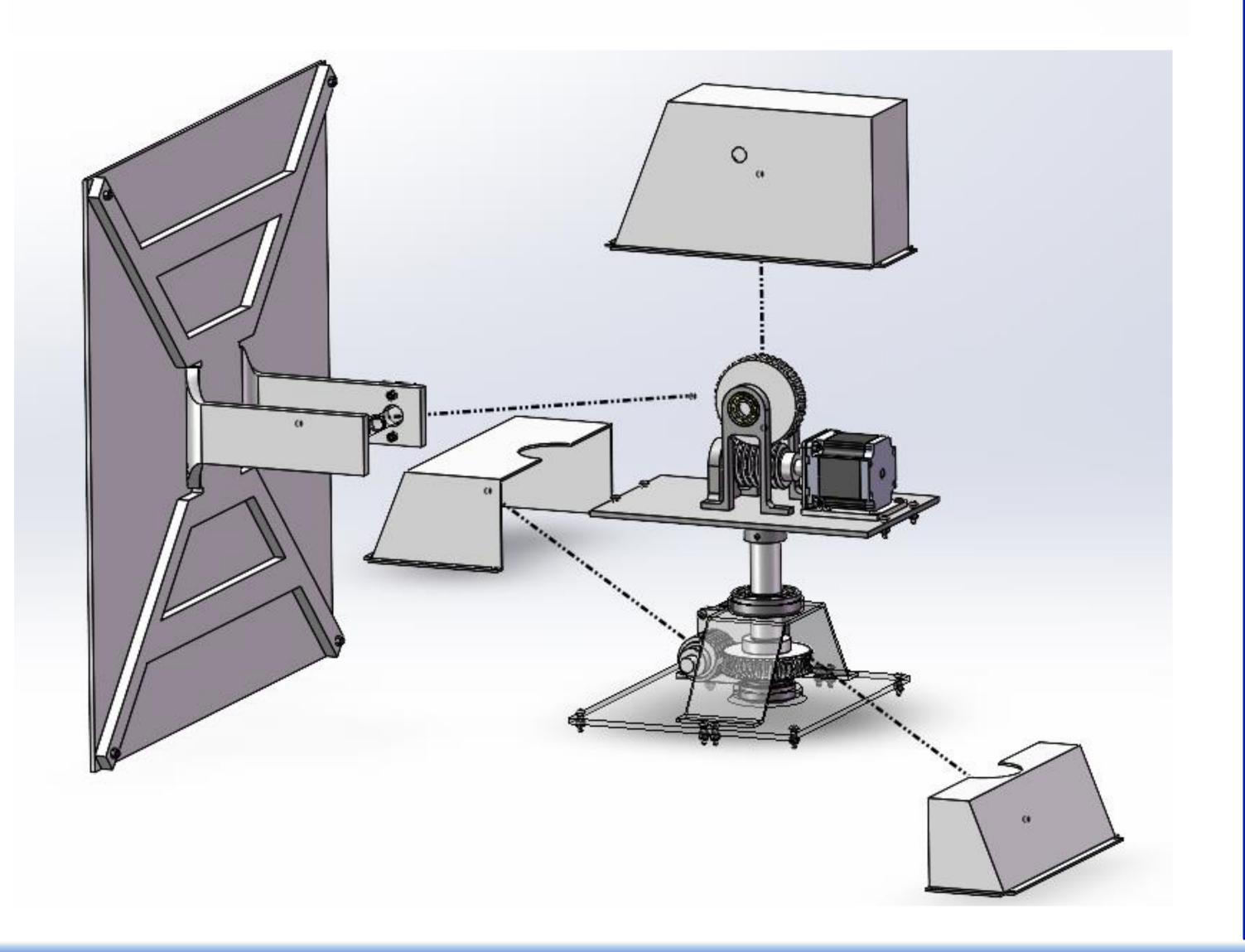
Subsystem	
OTS Parts	\$234.6
Modified OTS Parts	\$59.36
Raw Materials	\$160.5
Manufacturing Labor	\$11.36
Assembly Labor	\$34.50
Energy Consumption	\$1.68
TOTAL	\$502.1

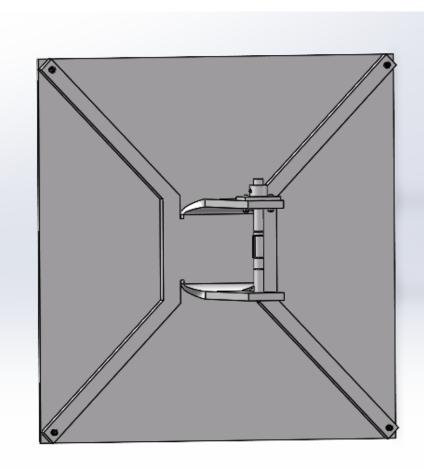
# **Cost Overview**

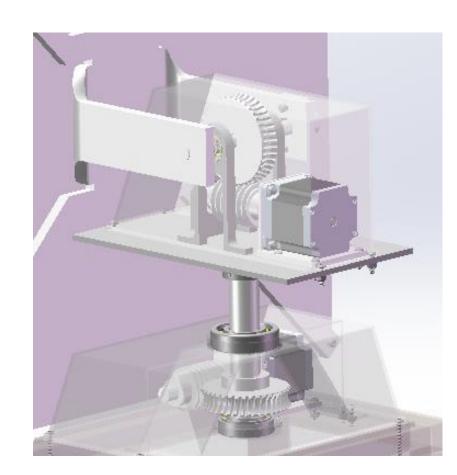


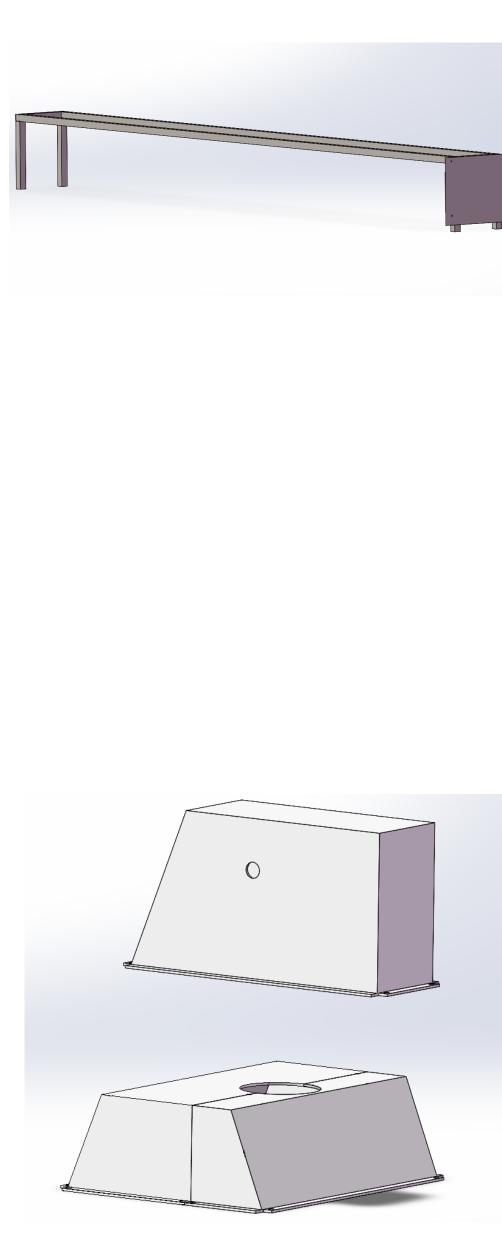












### Subsystems

#### Mirror

- 0.25 m<sup>2</sup> square mirror
- Made of lightweight plexiglass with a reflective solar film which is very cost effective
- "X" shaped bracket on the back of the mirror made of ABS plastic for strong support and easy mounting with screws, washers, and a PVC mount

#### **Rotational Device**

- Motors, gears, shafts, bearings, snap rings, etc. made of durable metal allows for a long lifetime
- E-series NEMA 23 Bipolar Stepper Motors used to allow for 360° of rotation about the vertical axis.
- Safety mode for high winds to limit excessive stress on the motor, shafts, mirror, bracket, support structure, etc.

#### **Modular Support Structure**

- Welded steel rectangular frame with a corrosion resistant coating
- Four heliostat systems mounted in line limit interference
- Raises heliostats and electronics off the ground to limit damages
- Simplifies assembly with easy mounting of heliostats to the structure and the structure to the ground
- Central electrical box minimizes costs and protects the electrical components

#### **Protective Casing**

- Made from vacuum formed ABS plastic with a UV resistant add in to limit aging due to the UV light to limit cost
- Long lifetime due to UV resistance, high working temperature, and strong seal to minimize the wear from the elements on the rotational systems and electronics

# G.A.T.O.R.S - GROUND. ATTACHED. TWIST. OPERATED. REFLECTIVE. SURFACE.

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C2: Optical Loss Mitigation	Ś			B) O ext
C3: Reflection Geometry			-	C) M light
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C4: Cost		_	-	E
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C5: Operational Lifetime				F) Azir
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C12: Parts Cost				
C13: Thermal Power Sustained		-7	-	P) T rec
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C14: Concentration Ratio	1	-		receive
C15: Innovative Features				R)
C16: Size to Reflective Area		1	-	S) Tota
C17: Control/Automation	- 11			T) Con
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C18: Locational Environment	)		-	U) De
				VIM
C19: Motor Use				47.14

tal collection of heliostat rea is less than 1 m^2 Optical losses must not xceed 40% (0.5 deg.) lust be able to redirect ht to a 100m tall tower MIRRO Cost below \$100/m^2 Must last 20 years imuth tracking of greater than 150 degrees vation tracking of greater 90 degrees beginning at 10 degrees ithstand 500psi from 1 ft ROTATI t not react with deonized SU water ety factor greater than 2 K) Must withstand eratures from 120 to -30 100 C degrees Fahrenheit Must withstand 60mph wind ncludes 4-16 heliostats ax interference is 30% PROTECT SU ustom parts cheaper or ual value to OTS parts Thermal irradiation for ceiving tower is 1 MW tal solar collection area to ver area ratio greater than 1000 Driving mechanisms losed of cheap electrical gear motor al area to reflective area SUPPOR atio less than 4 m^2 nputer systems fit into a 3×3×2 (in) box signed on flat mounting surface lotors must connect to 110-120V grid

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stems move freely on both axes to minimize losses that wont exceed 40%	
gles ensure light reaches a height of 100m	
ed the trade-off between price and quality extensively to keep the price down	
I with high quality materials, high corrosion resistance	
nal connections paired with the worm gears o ensure the mirror will be in the correct orientation	
A stepper motors and worm gears help to achieve this accuracy	
support on the back of the mirror helps to withstand this water pressure	
material is anti-corrosive, and will not react	
y factor was calculated to be much greater than 2	
in can withstand temperature values above and below this range	
m was tested to withstand winds of 80mph	
m was tested to withstand winds of 80mph Design includes 4 heliostats	
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he Raspberry Pi easily fits in the box

ounting surface was kept completely flat

HA stepper motors connect to this grid