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## Education

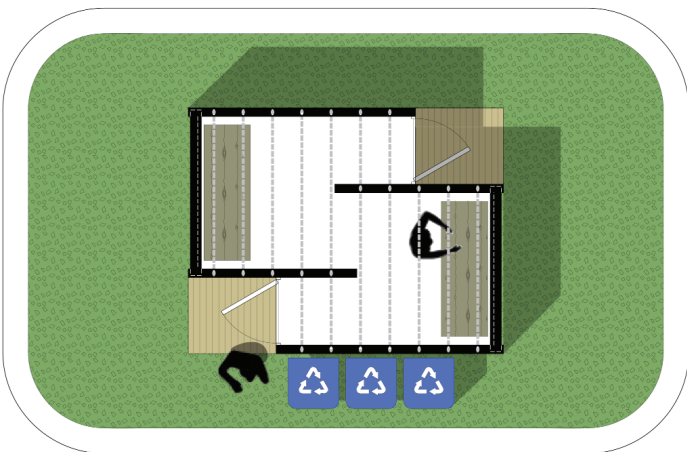
M.Arch - Rhode Island School of Design (2023)

MS - Worcester Polytechnic Institute (2015)

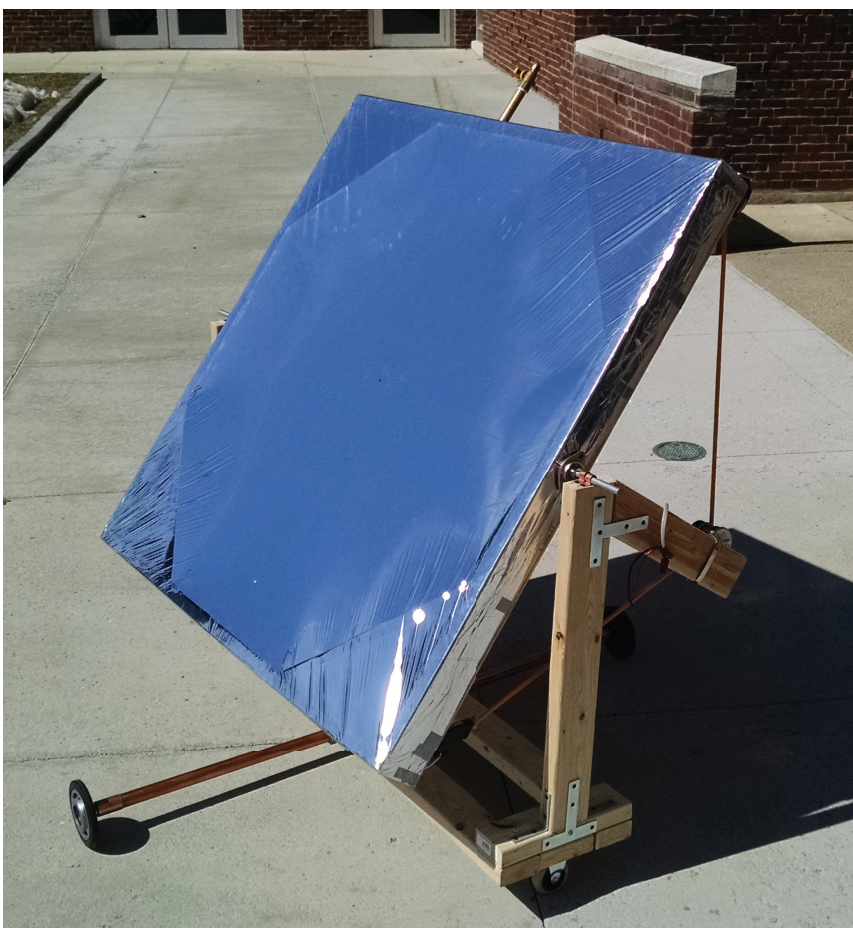
BS - Worcester Polytechnic Institute (2015)

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Plan Scale: 1/2" = 1'

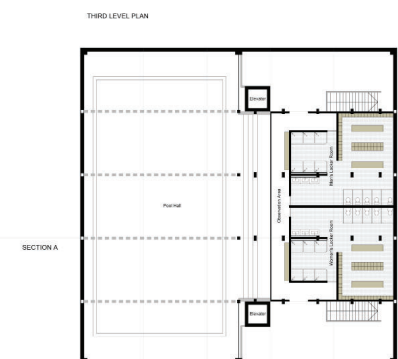
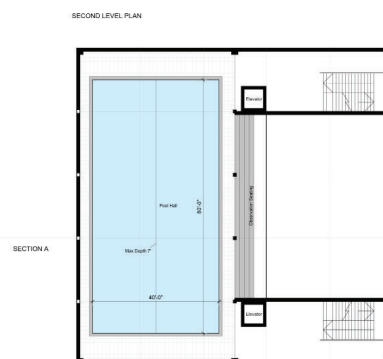
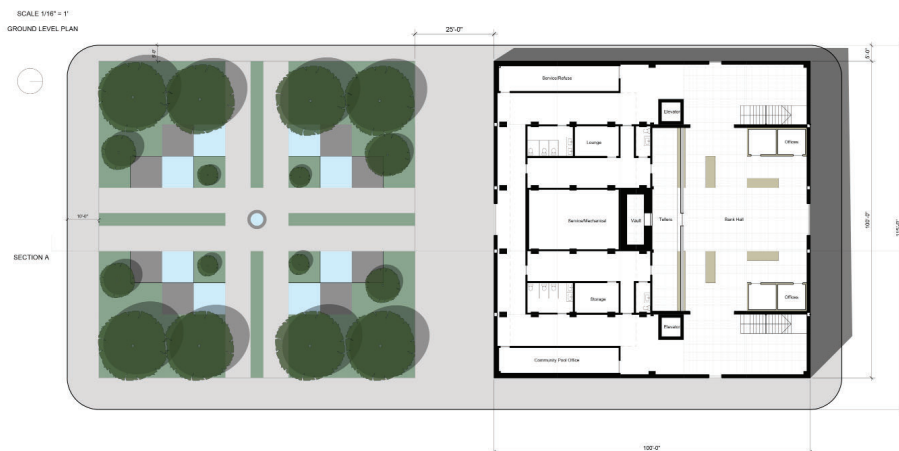
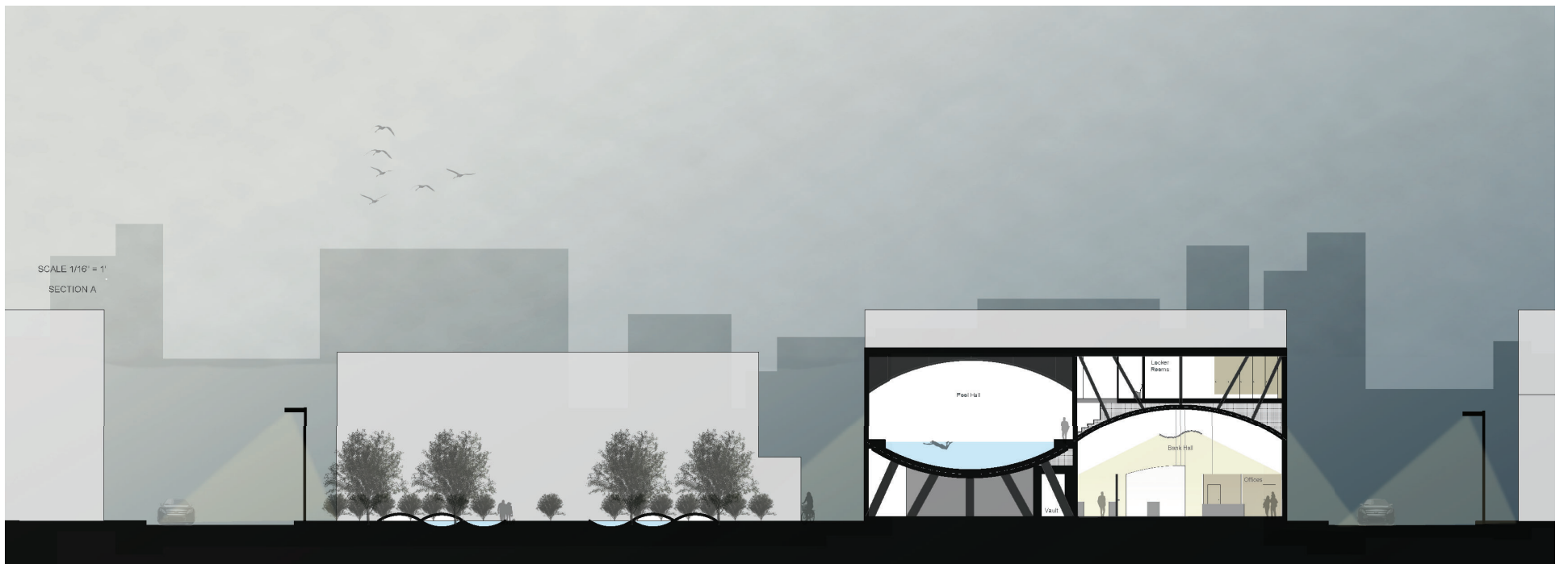
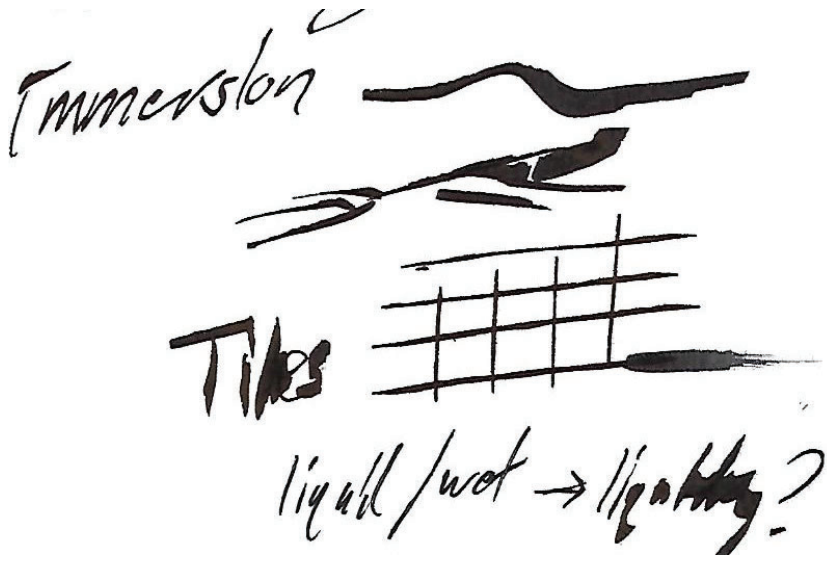




# Works of Friction

## Bank & Pool

The goal was to discover relationships (friction) between two randomly chosen programs primarily through physical model making explorations and hand drawing. Those relationships would then inform the architecture of the building and site. While working through the problem of harmoniously integrating a bank and community pool, I identified key words that blur the line between program and architecture: liquidity, reflection, vault, stability, weight, branch, waves, and immersion. While the design evolved and took different forms, my early sketches (at left) are an echo of the final design that incorporates both the wave and the grid.



# Market to Metacom

## Envision Resilience - Warren, RI

Tidal flooding events in Warren are expected to worsen to the point of residential and commercial property loss by 2035 and continue into the future. The primary goal of the project was to develop an urban design strategy for the higher elevation area on Metacom Avenue. My goal for the new residential neighborhood is to accommodate as many displaced residents as possible while maintaining a sense of individual ownership and private space. Solar panels supply green energy, significantly reducing utility bills. Housing construction utilizes hemp-lime material for walls and roof insulation (model at left).

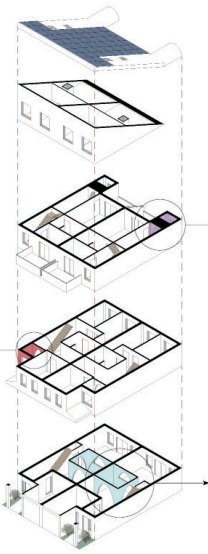


### Metacom Housing Typical Layout (mirrored units)

Hemp wall construction will fill any formwork, thus it lends itself to curved interior surfaces. Archways are employed to create more private and intimate spaces within the home. Filleted corners soften the feel of the interior and create a more welcoming environment.



**Table Nook**  
An intimate gathering place for card games and conversation.

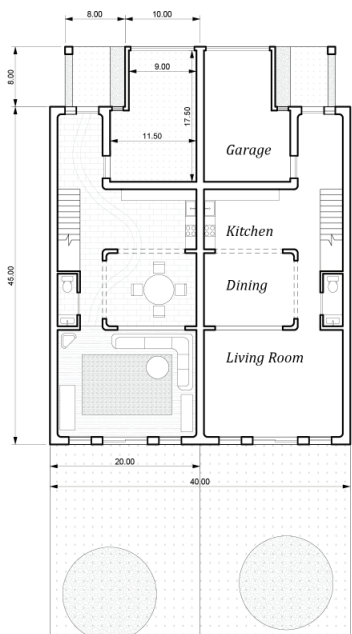


**Reading Nook**  
An ideal space for quiet reflection.

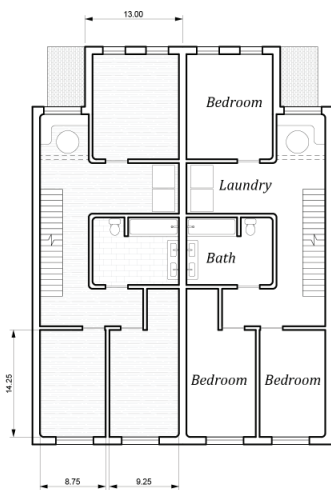


**Dining Nook**  
The Dining Nook serves as the central gathering space for family meals.

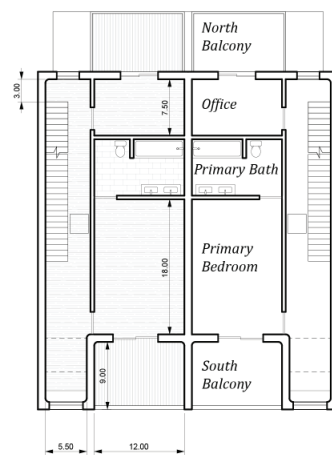
**Ground Floor Plan**  
Scale 1/8" = 1'



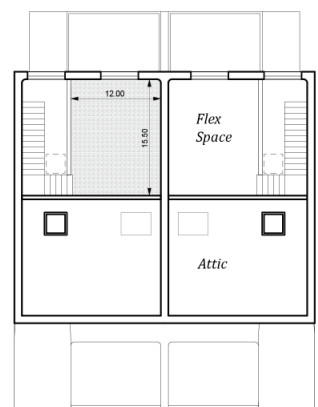
**Second Floor Plan**



**Third Floor Plan**



**Fourth Floor Plan**



**Energy Recovery Ventilator (ERV)** exchanges air and regulates humidity, resulting in Minimal Heating/Cooling Demand

**Roof Mounted Solar Panels** provide estimated 16,500 kWh/unit annually and serve as a rainscreen

(See Detailed Wall Section)  
Continuous Insulation  
Airtight Envelope  
Thermal Bridge Free Design

**High Performance Inset Windows** provide shading to balance solar heat gain

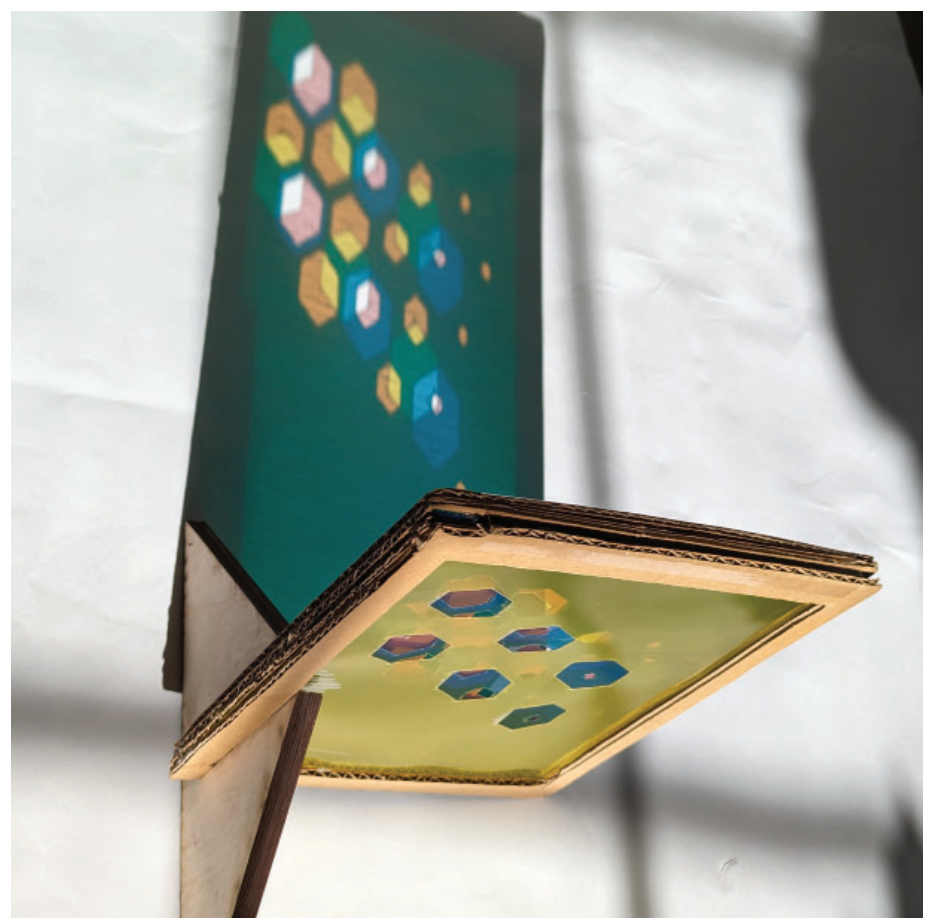
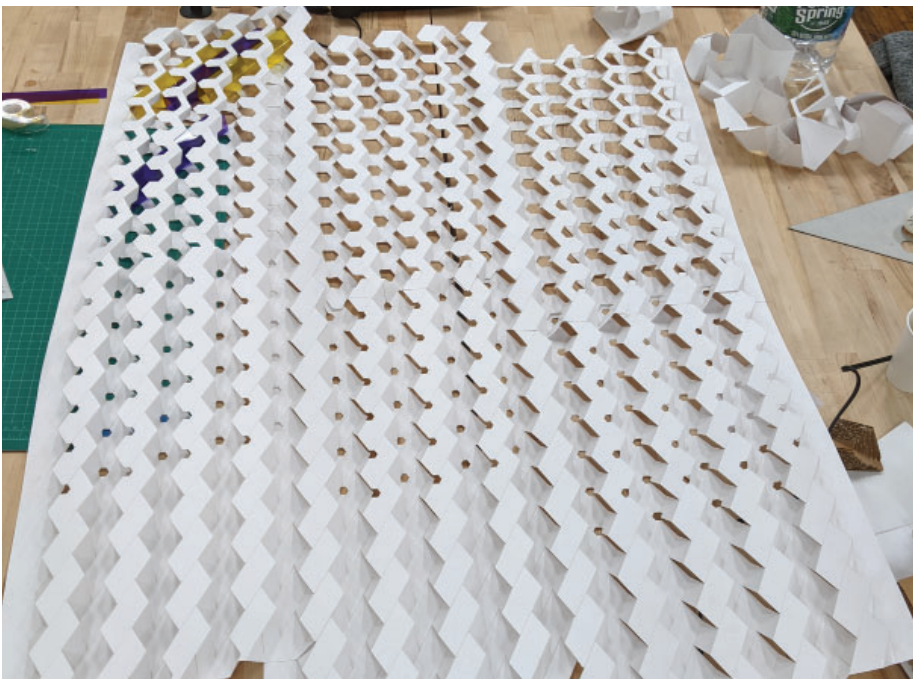
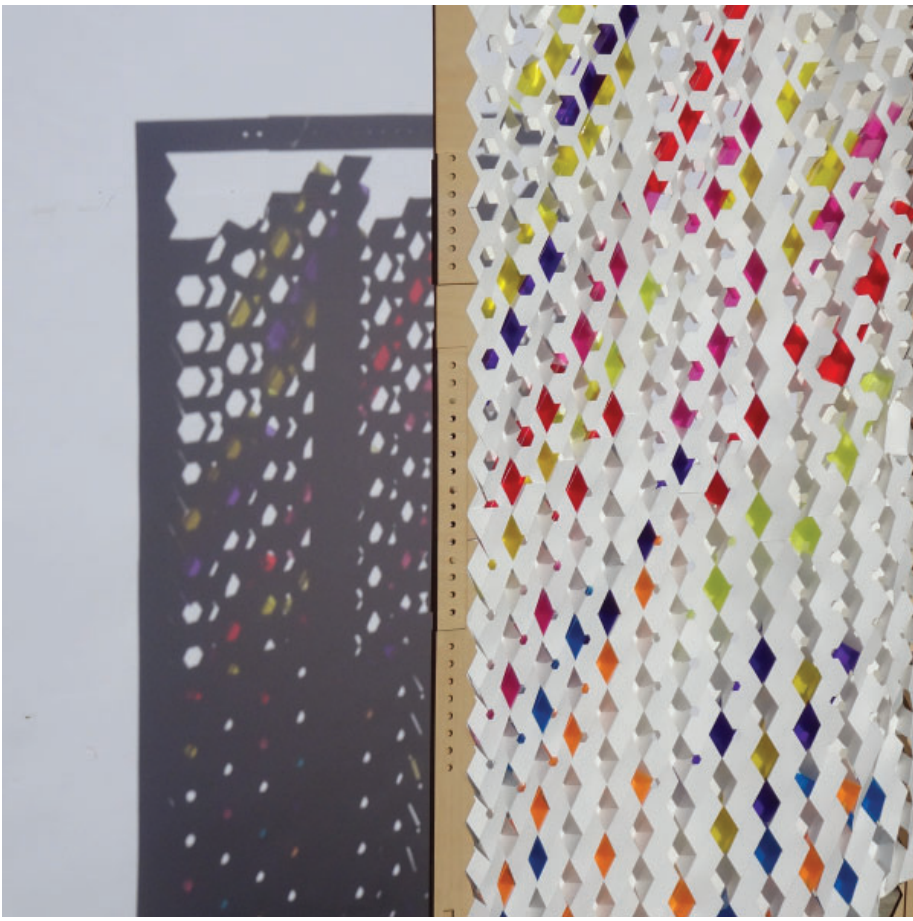
**Estimated Sequestered Carbon for site**  
~11.3M lb CO<sub>2</sub> gross  
~1.25M lb CO<sub>2</sub> net

**Detailed Wall Section 01**

- Waterproof Membrane
- 1/2" Plywood Sheathing
- 3/8" Poured in place Hemplime mix
- Drainage Assembly
- 1/2" Lime Plaster
- 12" Hemplime Blocks
- 1/2" Plywood Sheathing
- Roof and Wall assembly 2x6 vertical studs, 24" spacing

## Screen Design

Design and construct a light filtering screen of variable porosity at a size of 24" by 48". The final screen will use one primary material and take advantage of the properties of the chosen material. My screen uses Bristol paper as the base material, embellished with plastic gel sheets folded into square tubes for rigidity. The hexagon shape serving as the screen's apertures was a throughline from early explorations.





# GREEN STIRLING ENGINE POWER PLANT

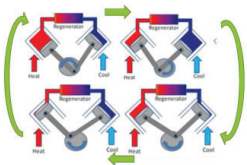
Nathan Costa (ME), Beau Donnan (ME), David Ephraim (ME), Edward Graff (ME), Andrew Havelos (ME), Andrew Larsen (ME), Mikhail Morozov (ME), Mario Rolon (ME)  
Advisor: Professor John M. Sullivan (Mechanical Engineering)

### Abstract

The Green Stirling Power Plant project set out to utilize a Stirling engine as an environmentally responsible means of electrical power generation. The team's efforts centered on repurposing a two-cylinder air compressor to serve as a Stirling engine and analyzing the design's feasibility. The first major objective was the construction and analysis of a parabolic mirror capable of transferring adequate levels of solar energy to power the engine. The other major objective was the creation of a portable package which included systems for the generation, storage, and measurement of energy generated by the Stirling engine. To accomplish these goals, new components—such as the engine heads, flywheel and parabolic mirror—were designed and fabricated and select existing components were modified.

### Background

The Stirling Engine—an external combustion engine that harnesses external thermal energy into mechanical energy.  
• Can use any source of heat that yields the needed temperature differential  
• Typically uses air (sometimes pressurized) to act as the working fluid in the heat transfer processes  
The Stirling Cycle  
• Operates on a closed regenerative thermodynamic cycle



### Project Goals/Objectives

- Adapt a two-cylinder air compressor to serve as a Stirling engine.
- Design and fabricate a pulley system to drive a generator.
- Design and implement an electricity generation and storage system.
- Design and fabricate a frame to hold all components.
- Build and test a solar energy collector to serve as a heat source for the engine.

### The Engine, Frame, and Solar Collector



### Methods/Process

Problems areas targeted and addressed  
• Working fluid leaks, internal friction, insufficient mass transfer, insufficient heat transfer  
Designed and fabricated solutions  
• Redesigned engine heads, head gaskets, mass transfer piping, and flywheel  
• New: thermocouples at critical points, Schrader valve, and crankshaft bearings  
Frame and Transmission  
A frame and engine mounting module was designed and fabricated to house the power plant  
• Constructed transmission to connect engine and generator.  
• Incorporated wattmeter, charge controller and battery to measure, regulate, and store potential electrical power produced by the generator.  
Solar Collector  
Examined solar power viability with a cost-effective parabolic reflector.  
• Determined energy using thermocouple on black aluminum plate.  
• Extrapolated maximum possible energy by accounting for hourly and seasonal solar variation.

### References

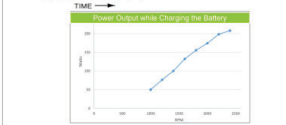
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### Results/Outcomes

- Engine/Generator
- Overall frictional torque was reduced by nearly 90%
  - Generator can produce 200W of power when turning at 2200 RPM
  - Engine was not able to sustain itself

### Solar

- During November solar testing, mean peak solar collection of 527W
- Extrapolated—Maximum temperature 425C/Maximum power 930W



### Conclusions/Recommendations

- Engine
- Incorporate a regenerator and attempt to optimize the current iteration
  - Build a new, possibly different type of Stirling engine
  - Design around solar use and focusing

### Solar Collection

- Make a lighter parabolic reflector, that can track the sun in 2 axes
- Further automate the tracking, and have a function for date and location adjustment

### Acknowledgments

Thank you to Professor Sullivan for his advice throughout this project and to Mr. Peter Hefti for supplying us with tools and testing instruments, and the knowledge on how to utilize them properly.

# Green Stirling Engine Power Plant

The project utilized a Stirling engine as an environmentally responsible means of electrical power generation. A primary goal of the project was to minimize material cost. The team's efforts centered on A) collecting solar energy through a parabolic mirror, B) adapting a two-cylinder compressor engine, which served as a repurposed Stirling engine, and C) convert the engine's power to electricity through a DC generator and battery storage. The available solar energy was calculated and a prototype parabolic mirror was designed, constructed and tested. The engine was modified to and mounted to a test apparatus containing the DC generator, battery storage, and a flywheel.

