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Title

Self-Sustaining Research Lab

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Publication Date

2021-03-09

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Peer reviewed

Self-Sustaining Research Lab

Team: Tier 5 Inc. - Group General 2 (GE2)

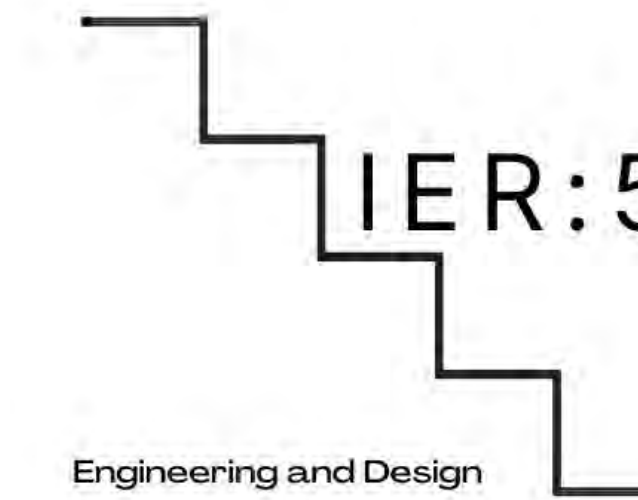
Client: University of California, San Diego

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Industry Advisors: James Bucknam, Brett Kaufmann S.E., & Estefany Gonzalez

Senior Practicum Winter Design Review 2021



Project Description

The General Civil Engineering Group 2 (G2) alongside PJHM Architects and VCA Structural, is working on designing self-sustainable research labs located near the University of California, San Diego (UCSD). This pair of labs will be placed on a 120 ft x 320 ft site consisting of hilly terrain, and will have 10 South facing and 10 North facing semi-flat terraces.

The objective of our project is to develop each and every terraces for our researchers goal of self-sustainability by implementing existing technologies, emerging technologies, and novel concepts

Design Approach

Our design is focused on renewable energy, and the facility is designed to be 100% self-sufficient. Given the locale of Southern California we will use solar energy to its maximum efficiency by combining traditional solar panels with the new photovoltaic glass panels which is also part of our greenhouses design.

We have designed the valley to have 20 individual tier which is held up by cantilever retaining wall and are connected by a pair of funiculars. We have created a gravity driven irrigation system together with a water reclamation facility located at the bottom of the valley to collect and recycle water used in the facility. We have also incorporate the use of 5G antennas and drones to monitor and care for the plant life in the laboratory.

Design Constraints & Parameters

This project is subject to the following constraints:

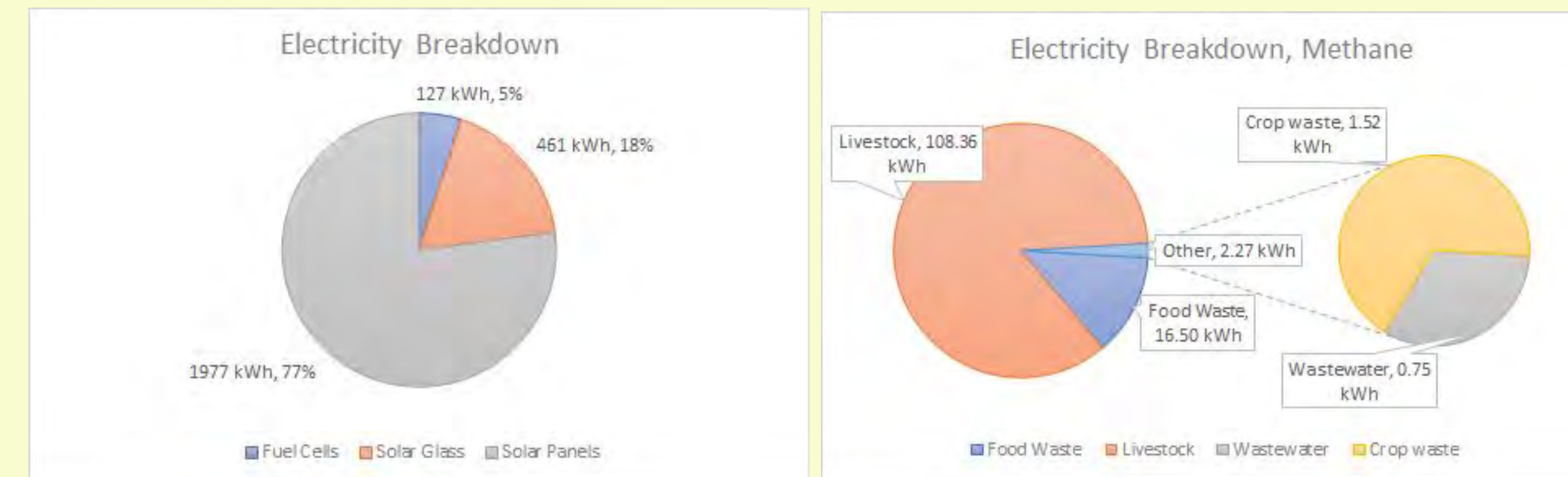
- Self-sustaining energy use and source
- Sloped terrain
 - Minimization of fills and cuts
- Self-sustaining food source
- Sand and clay like soils
- Local Building Codes
- Minimize fertilizer and pesticide use
- Water Allocation

Cost Estimation

• Lab Construction:	\$510,000
• Energy Infrastructure:	\$2,120,000
• Tier Construction:	\$1,160,000
• Funicular Carriers:	\$180,000
• Funicular Concrete Columns:	\$64,000
Total Estimated Cost	\$4,034,000

Preliminary Design Results

- We were able to cover the total power usage by laboratory.



Figures 1 - 2: Electricity Breakdown, and Methane Electricity Breakdown

- The cantilever walls are up to ACI code and can support the load of each tier individually

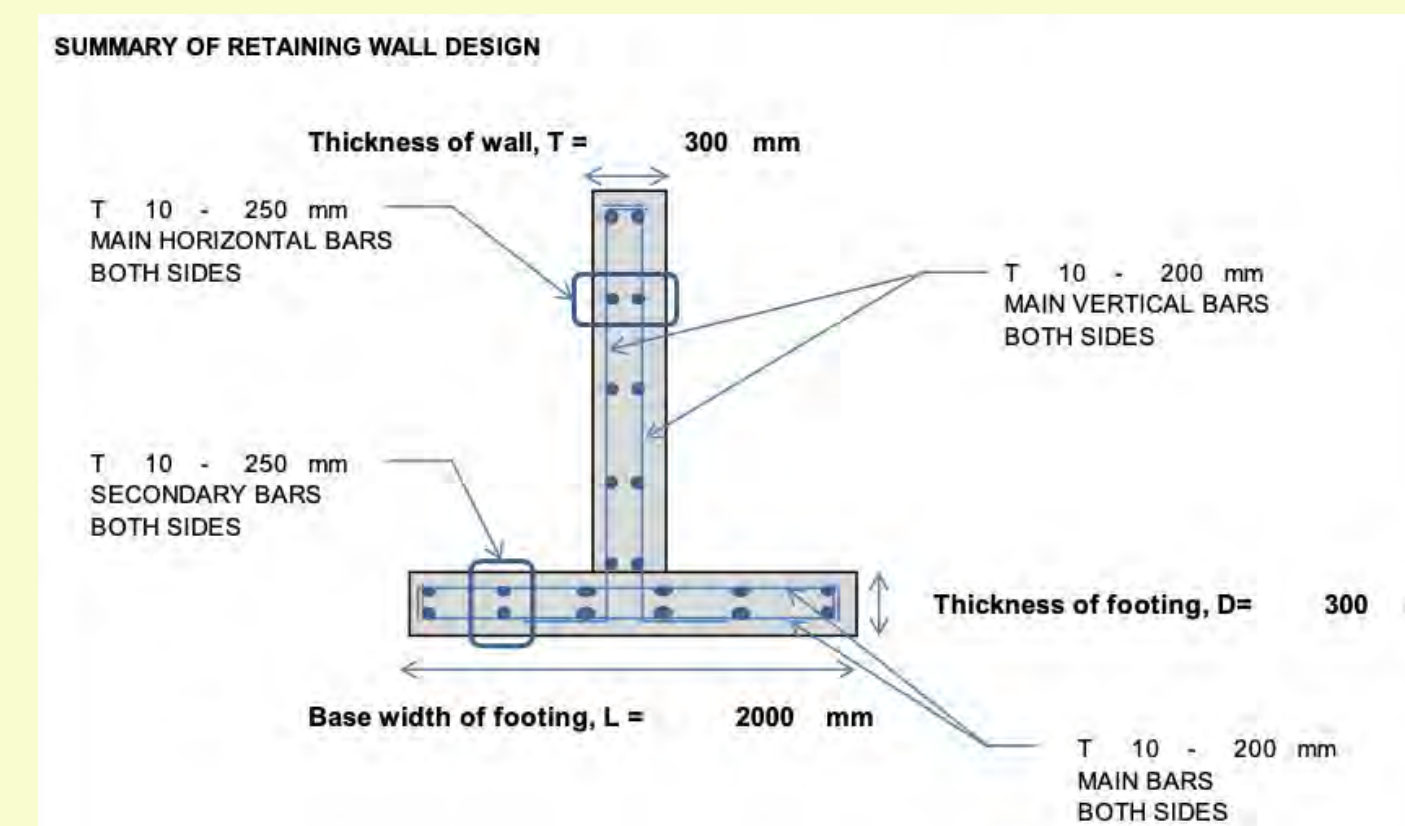


Figure 3: Initial Cantilever Retaining Wall Design

Lab Structure

The laboratory and greenhouse will be built using a combination of 3D-fabricated concrete and steel moment-frames. The idea is to have builders manually position rebar beams in locations where the concrete structure has dried and hardened. Machines will extrude additional concrete to cover the steel. Builders will coordinate the timing of their construction by following the machines' path.

The interior sections of the lab will be constructed of concrete which will be automatically extruded using 3D-printing technology. The exterior walls, which must support greater loading will employ the combined technique.

Plan for Next Phase

- We will optimize our power consumption
- Potential incorporation of Mechanically Stabilized Earth retaining walls
- Develop a counter weight system to reduce funicular required power
- Develop revenue model based on crop harvests and ongoing costs
- Develop water use and recycling plan

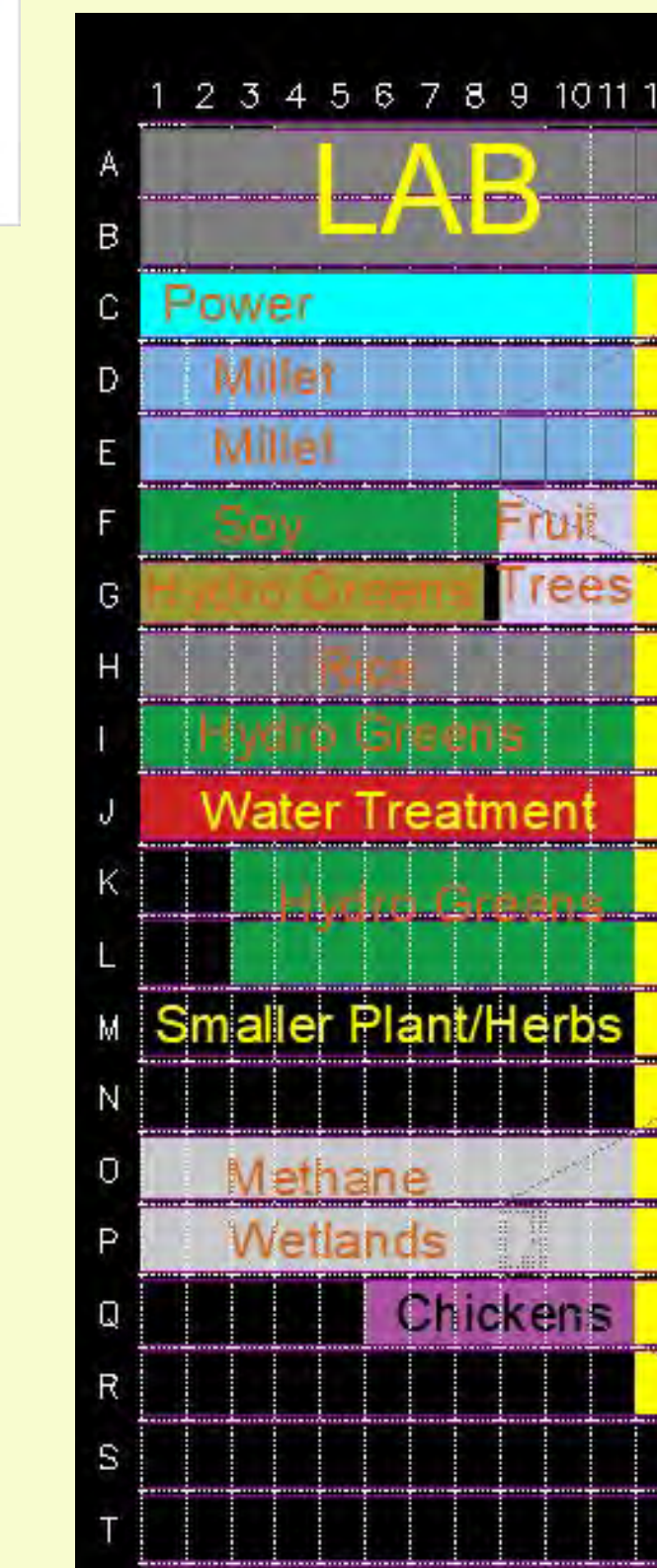


Figure 4: Site Layout

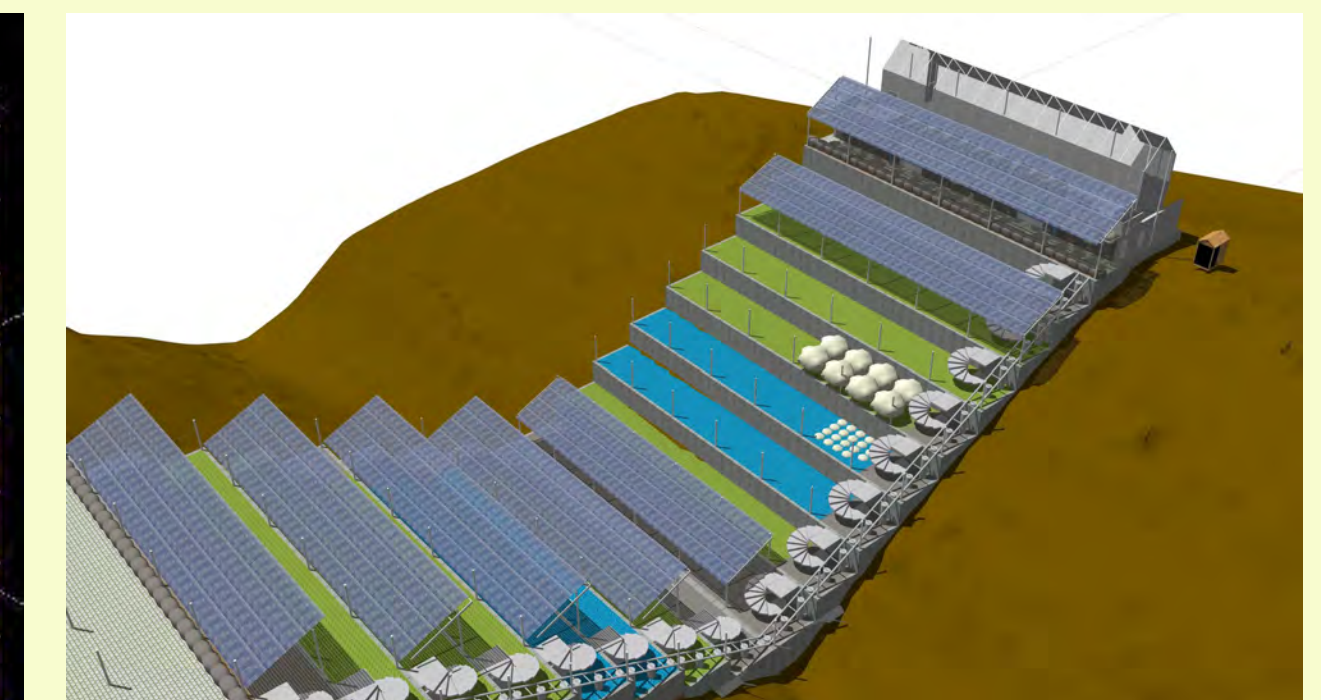


Figure 5: Site Plan Design

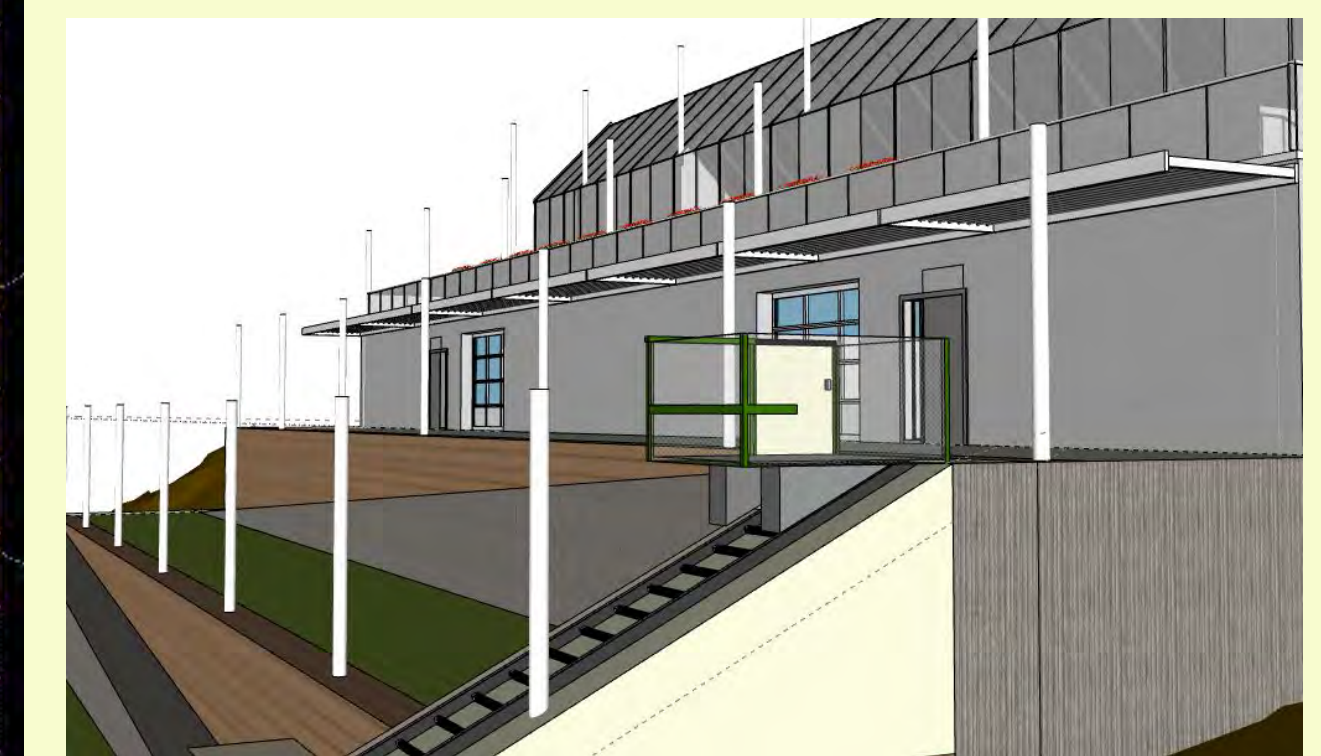


Figure 6 : Funicular Design

Acknowledgements

Tier 5 Inc. are appreciative of Professors Steve Bucknam and Joel Lanning, as well as Muslim Abdulkarim for taking the time to provide guidance and advice in this project. Our team would also like to thank our industry advisors James Bucknam, Brett Kaufmann S.E., & Estefany Gonzalez for their guidance.