PV Solar Integration at Russell Ranch

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ABT289 ZNE Project - Professor Kurt Kornbluth

Purpose

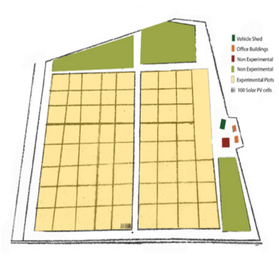
To research and analyse solar photovoltaic (PV) technologies, and provide recommendations for how to integrate PV systems onto agricultural land while minimizing agricultural land use and powering the farm's well pumps.

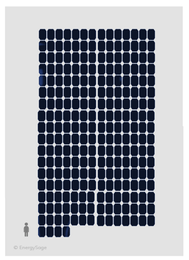
Scope

Our team will research innovative methods to implement photovoltaic cells (PV) to provide the farm on-site energy collection for the Russell Ranch Sustainable Agriculture Facility. The factors considered in the project are specific to the client's needs such as minimal use of agricultural land, offsetting well pumps, and a cutting edge approach to tackle energy use on the facility. The project focused on comparing four types of solar techmologies that showed a range in cost, feasibility, land use, and availability: standard solar panels, solar towers, solar greenhouses, and mobile repurposed benches

Problem Statement

Given the spatial constraints of the farmland, how might we creatively implement solar PV to Russell Ranch to offset well pump electricity use?





Methodology

Assumptions

- Russell Ranch has readily available energy data
- unknown budget
- we are only offsetting the well pumps
- energy is behind the meter
- we used average monthly electricity to size our PV system
- solar tower panels are the same efficiency as the generic PV.
- transmission losses are negligible

Constraints

- minimal land use
- limited scope based on the data presented
- non-existant infrastructure
- lacking distribution method

Considerations

- time of production
- the end user
- power demand
- what they need it for
- how much radiation is in the area
- climate
- land available
- maintenance of the system
- overproduction

Results and Findings

Based on Russell Ranch's monthly PG&E average energy use data, radiation data from energysage.com, and solar panel data from Sunpower, we calculated that 82.2 kW system would offset the two wells energy usage

Solar Tower

Mobile Repurposed Shade Benches

Solar Greenhouse

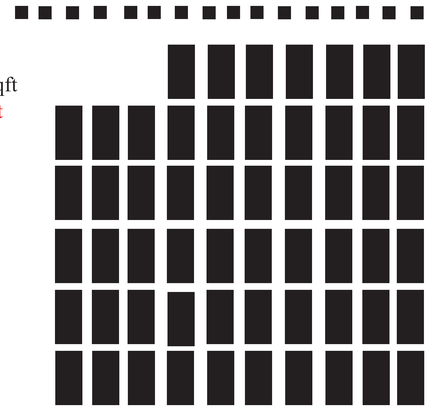
Standard PV Panel

Solar Towers

Wiocor Energy Model:

16 panels each tower (34Wx16) 34.44sqft
base 242 panels = 16 towers: 551.04sqft

cost: **>$242,000** most expensive



Solar Greenhouse

Soliculture Model:

(1440W)12ft x24ft = 288sqft base
57 greenhouses: 16,420sqft

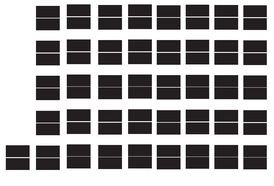
cost: **$1,710,000**

Mobile Benches

Repurposed Mobile Bench

105.2sqft land cover
242 panels = 41 benches: 4,313sqft

cost: **$303,500**

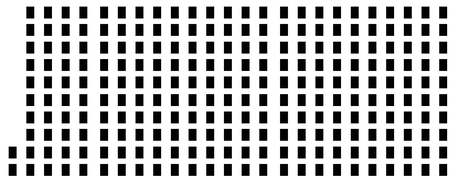


Standard

X Series Sunpower Module: (340W)
3.43ft x 5.11ft

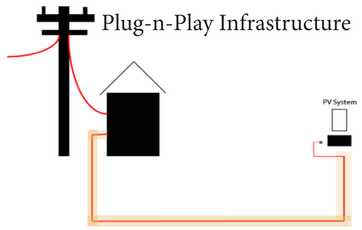
242 panels: 8,274sqft

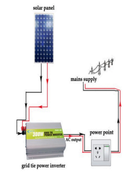
cost: **$242,000**



Considerations

Plug-n-Play Infrastructure





The purpose of placing the main conduit underground is to provide a stable and protect environment for the cabling to be laid. Having a plug-n-play system, the mobile collectors (mobile benches and solar towers) are able to be moved into the areas that are fallow for the season.

Overgeneration Solutions

Selling back to the grid

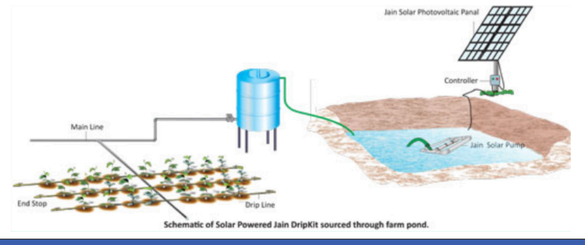
During times of overproduction sending energy back to the grid will offset anual energy cost.

Collaboration with neighboring facilities

Sharing surplus energy could build future partnerships and offset neighboring energy costs and emissions.

Water tower storage system

During peak energy production hours the well pumps can be used to fill the water tower to store water to be used during times of low energy production.



Schematic of Solar Powered Jain DripKit sourced through farm pond.

Recomendations

Based on the qualitative comparison of the four technologies we researched considering size and cost of the system, we would reccomend Russell Ranch to incorporate the standard PV system.Incorporating the solar towers and the mobile benches would require the installation of new infrastructure that would make these options cost prohibitive.

We would reccomend the standard system because when scaling the system it takes up less than half an acre, is the most cost effective, and is the most feasible to install.
The 242 panels should be placed around the perimeter of the ag land, between the pumps. This installment would not take up ag land because the farm has enough perimeter area to house the standard system.