UC DAVIS PROGRAM FOR INTERNATIONAL ENERGY TECHNOLOGIES

SUSTAINABLE CAMPUS SUSTAINABLE CITIES UC DAVIS

UC DAVIS FACILITIES MANAGEMENT
Energy Conservation Office

Introduction

Rühstaller brewery has just purchased a 5-acre property in Dixon which they'll be developing into their new full-scale brewery and tasting room as they scale up their business. The new facility is a blank slate and Rühstaller wants to take advantage of this opportunity to design it from the start to be not just sustainable, but also independently self-sustaining - they're interested in opportunities to go off-grid and utilize all available resources on-site including energy, water, and waste. Our graduate student team, which includes backgrounds in energy systems, civil and environmental engineering, and business management, will be helping them to identify viable technologies, processes, and practices to maximize the sustainability of their operations and integrate them into a comprehensive roadmap - their Sustainable Master Plan.

Objectives

Identify technically feasible and economically viable solutions to maximize sustainability of Rühstaller's operations, focusing specifically on:

- Renewable Electricity Generation
- Process Heating & Cooling
- Water Resources & Wastewater Management
- Organic Waste (Biomass) Management

The technologies we recommend should allow Rühstaller brewery to manage their natural resources sustainably, but must also fit with their culture and values. Through conversations with owner JE Paino, we determined the guiding priorities for our Master Plan:

- Be sustainable and **independently self-sustaining.**
- **DIY** solutions preferred.
- Create an experience for **customers.**
- Hiring is hard - **minimize additional labor time** for operation and maintenance.
- Focus on solutions best built or installed before or during **initial construction** - avoid expensive retrofits later.

Research Questions

How much of Rühstaller's **electricity** demand can be met using renewable energy produced onsite? What would it take for Rühstaller to go off-grid and cut the cord with PG&E?

How much of Rühstaller's potential **propane** usage can they avoid, and what would it take?

- Electrify
- Reduce with Solar Thermal
- Displace with Biogas

How can Rühstaller **shift their power loads** to better align with variable renewable supply availability, and what would it take?

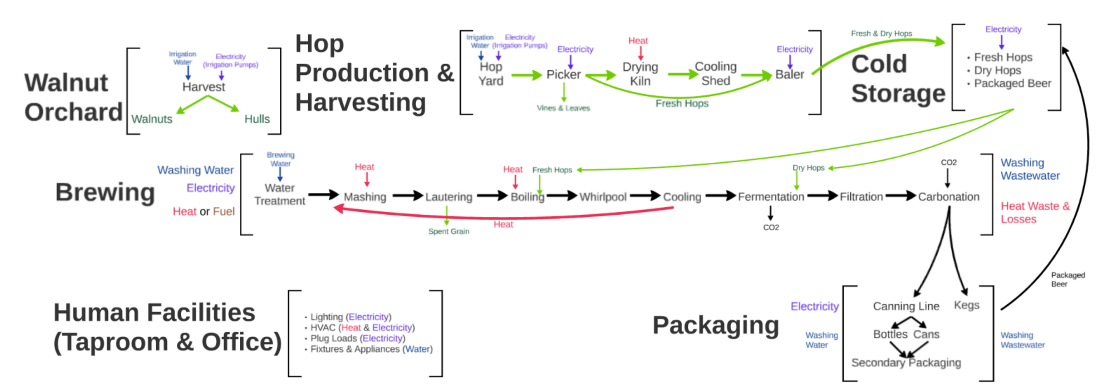
How can Rühstaller **store** excess energy from non-dispatchable resources in a dispatchable form? What other dispatchable resources can they utilize to fill the remaining gaps between supply and demand?

How much of Rühstaller's **potable water** needs can be met with rainwater.

What are the water quality requirements for different end uses within the brewery?

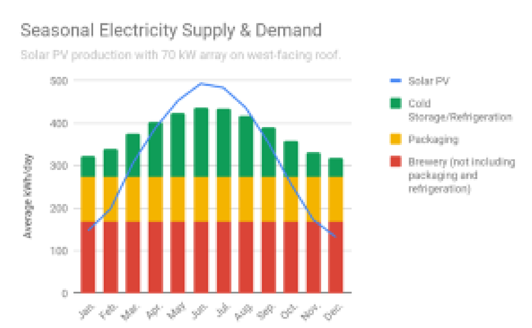
Systems Analysis

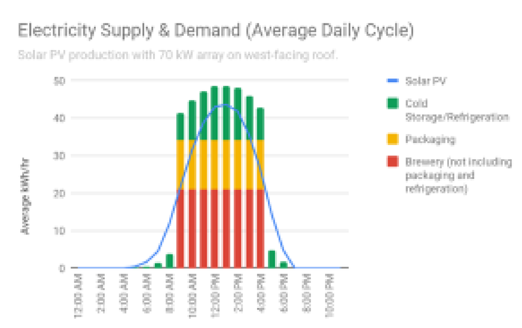
Inputs & Outputs Throughout On-Site Operations



In order to better understand the onsite operations at Rühstaller's new location, we created a process diagram identifying all expected inputs and outputs.

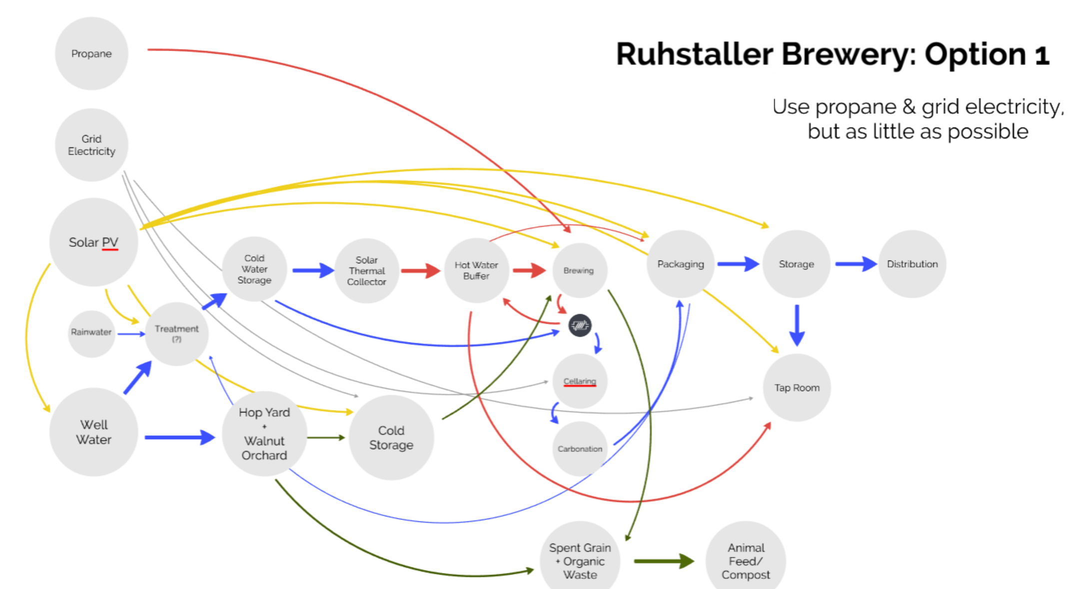
Resource Supply & Demand Profiles - Electricity

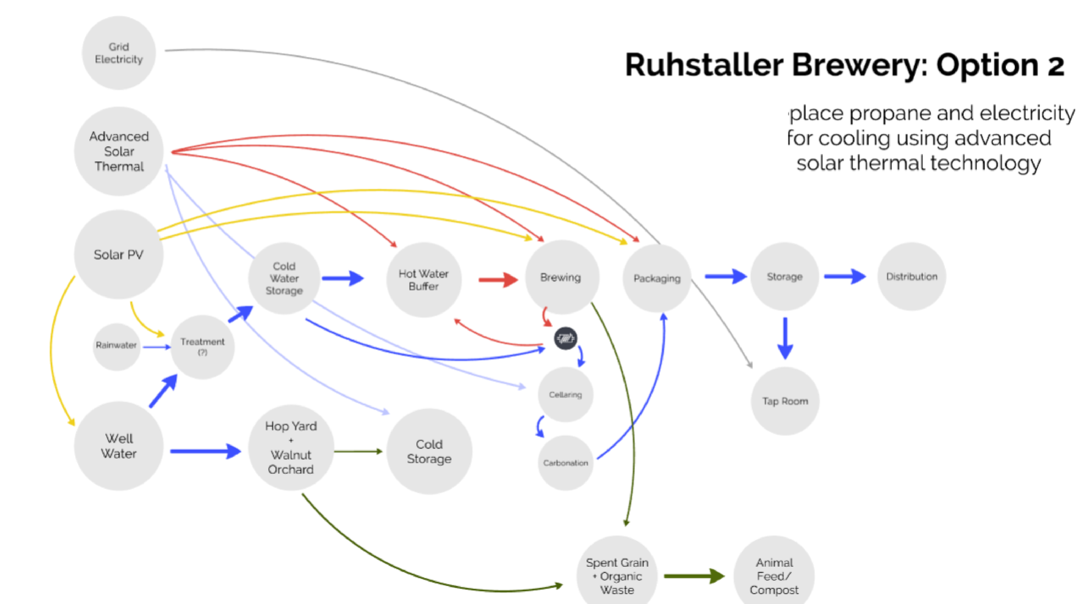




Using resources from NREL and the American Brewers Association, we also quantified the supply and demand profiles for onsite PV generation and electricity. The majority of electricity consumption is compatible with the PV supply profile; cooling beer during fermentation, tap room operations, and providing cold storage for hops are the only non-flexible nighttime loads.

Conceptual Diagrams





In order to help our client visualize the process, we made conceptual designs incorporating the technologies we discussed throughout the quarter. The first graphic represents a system where waste heat recovery, water reuse, and conventional solar hot water are used to minimize fossil fuel use. In the second option, advanced solar thermal replaces propane and minimizes grid reliance for cooling.

Potential Solutions

Conventional Solar Thermal

Flat-plate solar water heaters are a well-established technology. This hot water can be used for consumable water– for example, to clean bottles and equipment, and preheat water before it undergoes the brewing process. According to NREL's FEMP calculator, the payback period is under a year as the technology displaces propane.

Rebates/policies: 26% Federal if installed before 2021
Contractors: Sun Light and Power, Berkeley, CA
Case studies: Milwaukee Brewing Company, Lucky Labrador Brewing

Advanced Solar Thermal

Commercially available technologies exist that can heat water up to 300F (ErgSol) and even generate steam (Artic Solar). In these cases, solar thermal would simply replace the propane boiler and operate as a closed loop system. These systems have an added benefit of providing cooling, minimizing the need to draw electricity from the grid at night. Since they will only brew two-to-three times a week, extra storage capacity will be required.

Rebates/policies: 26% federal if installed before 2021
Contractors: ErgSol, Fairfield, CA; Artic Solar, Jacksonville, FL
Case studies: Goess Brewery, Austria

Solar PV

According to NREL's FEMP calculator, the expected payback period for a 50kW PV system is 3.96 years. Given the extensive amount of roof space available, this is a good option for electricity. Rühstaller can maximize their use of solar by making behavioral modifications such as only brewing during the day, pumping water during the daytime to store and use at night, and compressing air for cleaning and packaging during the day.

Rebates/policies: 26% federal if installed before 2021; Production Tax Credit
Contractors: Sun Power
Case studies: New Belgium, Sierra Nevada, many others.

Biomass Waste-to-Energy

A variety of solid organic wastes (i.e. waste biomass) are produced on-site including spent beer grain, hop vines and leaves, walnut hulls, grass, and more which provide an opportunity for on-site composting or anaerobic digestion (AD). The biogas produced from AD is similar to natural gas and can be combusted in a combined heat & power co-generator to displace propane use. Types of systems vary and must be designed for feedstock quantity and composition or "blend."

Rebates/regulation: AB 1826: Mandatory Commercial Organics Recycling
Contractors: Impact BioEnergy
Case studies: Fremont Brewing Company

The full menu of options presented to the client contains additional information about policy and regulation, incentives, and personal contacts for these technologies as well as others that we have not included in this poster.

CONCLUSIONS

- Focus on maximizing efficiency first. Invest in high-quality insulation to minimize cooling load, and utilize waste heat from the brewing process.
- Wind and solar can meet a significant part of Rühstaller's electricity demand, but not all of it always. Invest in those resources, but maintain your grid connection.
- Continue exploring solar thermal– the reason it hasn't been implemented in breweries before is because it would require retrofitting existing equipment. Rühstaller has a unique opportunity since they're starting from scratch.
- Invest in a rainwater capture system to minimize the need for pumping. Rainwater can meet most of Rühstaller's potable water needs in the rainy season, but they will need to rely almost entirely on groundwater in the summer.
- Establish an off-site option for disposing of waste biomass, run a 1-year pilot for an on-site anaerobic digestion system, and reconsider after pilot.
- Spark a Conversation, Tell the Story, and Invite Your Customers to Be a Part of It

REFERENCES

(American Brewers Association, 2018; Mauthner, Hubmann, Brunner, & Fink, 2014; Schmitt, Lauterbach, Dittmar, & Vajen, n.d.; Weber & Stadlbauer, 2017; Yu & Gu, 1996)American Brewers Association. (2018). *Energy Usage, GHG Reduction, Efficiency and Load Management Manual*.

Mauthner, F., Hubmann, M., Brunner, C., & Fink, C. (2014). Manufacture of Malt and Beer with Low Temperature Solar Process Heat. *Energy Procedia*, *48*, 1188–1193. https://doi.org/10.1016/J.EGYPRO.2014.02.134

National Renewable Energy Lab. (n.d.). FEMP Screening Map. Retrieved June 4, 2019, from https://maps.nrel.gov/femp/?aL=8YxuAg%255Bv%255D%3Dt&bL=clight&cE=0&lR=0&mC=40.21244%2C-91.625976&zL=4

Schmitt, B., Lauterbach, C., Dittmar, M., & Vajen, K. (n.d.). *Guideline for the utilization of solar heat in breweries*. Retrieved from http://solar-publikationen.umwelt-uni-kassel.de/uploads/2012_EuroSun_Schmitt_Leitfaden.pdf

Weber, B., & Stadlbauer, E. A. (2017). Sustainable paths for managing solid and liquid waste from distilleries and breweries. *Journal of Cleaner Production*, *149*, 38–48. https://doi.org/10.1016/j.jclepro.2017.02.054

Yu, H., & Gu, G. (1996). Biomethanation of brewery wastewater using an anaerobic upflow blanket filter. *Journal of Cleaner Production*, *4*(3–4), 219–223. https://doi.org/10.1016/S0959-6526(96)00036-4

ACKNOWLEDGEMENTS

We would like to thank:

JE, Xo, and Ken from Rühstaller for the beer-and-pizza-powered late night meetings with us and keeping it fun and quirky.

Kurt, Lisa, Josh, and Nico for their guidance and feedback.

Our many peers in the ZNE class and at the Energy and Efficiency Institute for their resources.

CONTACT

Mekdem Wright
MBA Candidate
mbwright@ucdavis.edu

Meg Slattery
M.S. Student, Energy Systems
msslattery@ucdavis.edu