Policy Proposal for California State Polytechnic University, Humboldt to Increase On-Campus Renewable Energy Generation to Reduce Dependence on Fossil Fuels.

"Our dependence on fossil fuels amounts to global pyromania, and the only fire extinguisher we have at our disposal is renewable energy." -Hermann Scheer (Former President of Eurosolar and General Chairman of the World Council for Renewable Energy)

Executive Summary

The goal of this policy proposal is for Cal Poly Humboldt (CPH) to reduce its reliance on fossil fuels and transition to renewable energy sources, primarily through the implementation of bio-digesters and concentrating solar-thermal power (CSP) on campus. By implementing these two types of renewable energies, CPH could significantly contribute to the university's and California State University (CSU) systems' resilience goals, while reducing its carbon footprint and setting a model to follow for other universities.

On the CPH campus, Facilities Management is responsible for campus energy infrastructure, and would play a crucial role in implementing these systems into the university. This proposal focuses on the benefits of integrating bio-digesters and CSP within the current campus energy framework.

CPH's campus is ideal for implementing renewable energy sources due its proximity to an abundance of biomass resources, ample sunlight in drier seasons, and a sustainable campus culture. CPH has many environmental programs and a lot of community support for sustainable practices. This provides a perfect environment for renewable energy projects, as they align with campus values and local resources.

CPH has had many sustainability initiatives that align with the broader goals of the California State University (CSU) system. The CSU system has committed to carbon neutrality by 2045, which has been mandated by the state of California.[1] CPH relies heavily on fossil fuels for a significant portion of its energy consumption, including natural gas. The implementation of both bio-digesters and CSP would be crucial steps to reaching the CSU's climate goals.

Bio-digesters

Bio-digesters are systems that can convert organic materials- such as compost, tree trimmings, and other biomass- into energy, usually in the forms of electricity and heat. How these digesters do so is through anaerobic digestion, where organic matter is broken down through the lack of oxygen, which produces biogas. This biogas can then be utilized to generate electricity in a generator or to power heating systems.[2]

Bio-digesters can offer significant benefits in achieving renewable energy goals. They provide a solution to manage waste and create a closed feedback loop. Waste, which would otherwise be thrown into landfills or contribute to GHG emissions like methane,

[1] Chkarboul, Christina. "California Colleges Have to Slash Emissions. Here's Why Decarbonization Is Complex and Costly." *CalMatters*, 12 Mar. 2024, calmatters.org/education/higher-education/college-beat/2024/03/california-colleges-decarbonization-2045/#:~:text=Its%20climate%20plan%2C%20first%20published,vary%20in%20their%20individual%20deadlines.

[2] Environmental and Energy Study Institute (EESI). "Fact Sheet: Biogas: Converting Waste to Energy." *EESI*, www.eesi.org/papers/view/fact-sheet-biogasconverting-waste-to-energy. Accessed 13 Dec. 2024.

can be utilized through bio- digesters. All this organic material can additionally be found and used locally, reducing potential emissions from transportation of it to other areas.

For CPH, integrating bio-digesters into the campus's energy portfolio aligns with its sustainability objectives. These systems could contribute to the university's broader renewable energy goals while additionally addressing local waste management issues. Implementing bio-digesters could also have other benefits like creating educational opportunities and initiatives for students studying related fields.

In the fiscal year 2023-2024, CPH had 152.2 tons of green waste, 0.92 tons of pallets, 79.11 tons of compost, 12.48 tons of grease trap, and 7.1 tons of used vegetable oil.[3] A bio-digester designed to process about 250 tons of organic material per year would need a digester with a volume of approximately 20-25 cubic meters. In addition to a bio-digester unit, there would need to be space for organic material storage, biogas storage and other equipment. It is suggested that an area from around 500-1,000 square feet would be needed for this project.[4]

The energy output from a bio-digester depends on several factors, including the type of waste used, the design of the digester, and the efficiency of the system. Based on available data, a typical energy yield from one ton of organic waste can range from 200 kWh to 800 kWh annually. In some optimal and advanced systems, this can reach up to 1,000 kWh per ton.[5] For a 250-ton per year bio-digester, the energy production based on this range can be estimated from 50,000 kWh annually to 250,000 kWh annually.

For the fiscal year of 2022, CPH used approximately 800,000 thermal units of natural gas, or 23,440,089 kWh,[6] representing around 67% of the campus's energy consumption. The proposed bio-digester could offset between 0.21% and 1.07% of the campus's total natural gas usage, depending on the efficiency of the system and the type of organic waste processed. While this may seem like a small percentage, it still is a necessary step towards reducing the university's reliance on fossil fuels and moving towards more sustainable energy sources. To achieve more significant reductions for on-site energy generation, additional renewable energy systems should be considered.

To increase the amount of compost available for the bio-digester to offset more natural gas usage, the campus can take several steps to increase organic waste collection and usage. The university can do so by i) expanding organic waste collection across campus, including food scraps, yard waste, and off-campus sources, ii) partnering with off-campus organizations, farms, and local businesses to get more organic waste, and iii) encourage students living both on and off campus to collect even more compost.

Concentrating Solar-Thermal Power

CSP is a technology that utilizes solar energy to generate electricity through utilizing mirrors or lenses to concentrate sunlight onto some type of receiver. This

[3] *Data accessed from Cal Poly Humboldt's Department of Sustainability.*

[4] "Planning Your Facility with a Biodigester in Mind." *Power Knot*, 5 Dec. 2022, powerknot.com/2022/10/03/planning-your-facility-with-a-biodigester-in-mind/.

[5] Miller, Rill Ann. "Connection: Climate Calculations." *BioCycle*, 19 June 2013, www.biocycle.net/connection-climate-calculations/#:~:text=For%20this%20approximation%2C%20we%20can,M%20stands%20for%201%2C000%20k)

[6] "Energy." *Cal Poly Humboldt*, www.humboldt.edu/sustainable-campus/sustainability-dashboard/energy. Accessed 12 Dec. 2024.

concentrated sunlight generates heat, which goes through some other processes to produce electricity. Solar energy is notorious for being one of the most intermittent renewable energy sources, however, CSP systems can store the thermal energy for later use, allowing for reliable power generation even when the sun is not out. This makes CSP a promising solution for generating consistent energy with use of proper energy storage.

According to solar maps and databases, the CPH campus receives an average of 4-6 kilowatt-hours (kWh) per square meter per day.[7] This amount of solar insolation is ideal for CSPs and gives a high energy generation potential. With thermal energy storage, CSPs typically can have a capacity factor of 40-50%.[8]

After some back-of-the-envelope calculations and with an average solar insolation of 5 kWh/square meter/day- or 1,825 kWh/ square meter/year, the energy yield per acre of land is 7,388,000 kWh/year. If we consider 2-3 acres of land for this technology, then we're looking at between 14,771,039 kWh/year and 22,156,559 kWh/year. Considering an average 45% capacity factor, then it would generate between 6,646,968 kWh/year and 11,821,755 kWh/year.

If CPH installs a CSP system on 2-3 acres, with an average capacity factor of 45%, the campus could generate between 6.6 million kWh/year to 12 million kWh/year. As CPH consumes 39 million kWh/year of energy[9], CSP offers the chance to offset between 17% and 31% of the campus's total energy usage.

CSP provides clean and renewable energy, significantly reducing GHG emissions compared to fossil fuel-based power generation. CSP can also create a reliable power supply for the campus, especially during grid outages. By utilizing the solar resources available at the CPH campus, the university can meet broader climate goals and become overall more sustainable.

Financial Feasibility and Cost-Benefit Analysis

The following table looks at the capital cost, annual operating cost, annual energy savings, the annual energy offset, and the net present value (NPV)for both bio-digesters and CSP.

Technology	***Bio-Digester***	***CSP System***
Capital Cost	$500,000-$1.5M	$4M-$8M
Annual Operating Cost	$20,000-$50,000	$100,000-$200,000
Annual Energy Savings	$7,500-$37,500	$990,000-$1.8M
Annual Current Energy Offset	$2,520-$12,840	$990,000-$1.8M
NPV (20 Years)	Negative in early years (until scale-up)	Positive ($11.4M)

Table 1: Cost Benefit Analysis. *The above data came from industry estimates for bio-digester systems[10], general estimates for*

[7] Solar Mentors. "Peak Sun Hours Calculator." Accessed November 1, 2024. https://solarmentors.com/peak-sun-hours-calculator/.

[8] *Concentrating Solar Power*, library.cap-az.com/documents/meetings/10-17-2013/3_Combined_Solar_CSP.pdf. Accessed 13 Dec. 2024.

[9] "Energy." *Cal Poly Humboldt*, www.humboldt.edu/sustainable-campus/sustainability-dashboard/energy. Accessed 12 Dec. 2024.

[10] "Anaerobic Digestion Cost - plus Gate Fees and and Other Rules of Thumb." *IPPTS Anaerobic Digestion Community Website*, anaerobic-digestion.com/anaerobic-digestion-cost-gate-fees/. Accessed 13 Dec. 2024.

maintenance and labor[11], energy production[12], CPH's energy use, and cost of energy[13] and was calculated accordingly.

The bio-digester offers a minimal step towards reducing CPH's reliance on fossil fuels, with energy savings up to $12,840 per year. However, its upfront capital costs and long payback period show that to make it worth it, it may be beneficial to scale up or implement additional waste management improvements.

The CSP system provides substantial energy savings and a positive NPV, making it a highly cost-effective investment for the university. With energy savings up to $1.8M annually, the CSP system gives a good return on investment, while additionally making a difference environmentally.

Together, these systems can be strategic for CPH to achieve its sustainability goals while addressing its energy consumption portfolio and carbon footprint.

Conclusion and Suggestions

Increasing on-campus renewable energy generation at CPH through bio-digesters and CSP systems can be impactful in reducing the university's carbon footprint and promoting further sustainability. As highlighted by Hermann Scheer's quote on the necessity of renewable energy, CPH can lead other universities in addressing the challenges of climate change.

The university's location and community support create an ideal environment for implementing these renewable energy systems. Bio-digesters can efficiently convert organic waste from campus and surrounding areas into energy, while CSP can harness the campus's sunlight for reliable electricity generation. Together, these systems not only align with CPH's sustainability goals, but can also give educational opportunities for students.

To achieve these goals, the following is what is recommended:

1. **Engage stakeholders:** Involve and engage students, facilities management, faculty, the government, and local businesses to get support on these projects.
2. **Conduct Feasibility Studies**: Conducting assessments of the costs, grants/rebates available, legal requirements (permitting), potential environmental impacts, and benefits of bio-digesters and CSP systems should be conducted.
3. **Scale-up Waste Collection:** By scaling up organic waste collection, the availability of compost for bio-digesters can be increased to further benefit from all that bio-digesters have to offer.
4. Facilities Management should first engage stakeholders, conduct feasibility studies for both technologies, and secure funding through grants, rebates, or CSU initiatives.

[11] *Study of the Dynamics and Cost Analysis of the Biogenerator*, ir.lib.uwo.ca/cgi/viewcontent.cgi?article=6280&context=etd. Accessed 13 Dec. 2024.

[12] Iea. "Sustainable Supply Potential and Costs – Outlook for Biogas and Biomethane: Prospects for Organic Growth – Analysis." www.iea.org/reports/outlook-for-biogas-and-biomethane-prospects-for-organic-growth/sustainable-supply-potential-and-costs#. Accessed 13 Dec. 2024.

[13] "Average Energy Prices for the United States, Regions, Census Divisions, and Selected Metropolitan Areas." *U.S. Bureau of Labor Statistics*, U.S. Bureau of Labor Statistics, www.bls.gov/regions/midwest/data/averageenergyprices_selectedareas_table.htm. Accessed 13 Dec. 2024.