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\$10,000 "Eat it!" Lemelson-MIT Student Prize Undergraduate Team Winner

The BioEnergy Project – Repurposing Food Waste

The Challenge: In the United States alone, [40% of all food produced is wasted](#) and dumped into landfills (that's 133 billion pounds of wasted food annually), according to the U.S. Environmental Protection Agency. Once this food decomposes in landfills, it releases methane into the atmosphere, constituting [8% of total anthropogenic greenhouse gas emissions globally](#). If food waste was a country, it would be the third largest emitter of greenhouse gases in the world, according to the [Food and Agriculture Organization of the United Nations](#). The BioEnergy Project team noticed that harmful food waste practices were happening in their own backyard. Many of the restaurants on the University of California San Diego campus were not enrolled in a composting program. Furthermore, the team witnessed grocery stores throwing away shopping carts full of food every day. The alarming food waste statistics, coupled with unsustainable practices in their own community inspired the team to invent a solution.

The Solution: The BioEnergy Project team built a compact and scalable food-waste-to-food-and-fuel-system that converts food waste from dining halls and restaurants into both nutrient rich organic fertilizer that can be used to grow food, as well as electricity generated from biogas. The system can tackle the environmental and agricultural concerns of food insecurity, the need for renewable energy sources, and climate change by capturing and diverting a methane source that would otherwise be released into the atmosphere from landfills.

The BioEnergy Project has four main components: the anaerobic digester, digestate processing system, biogas purification and storage, and composting. All four components were separately tested and then combined at Roger's Community Garden and Living Laboratory, a garden on the UC San Diego campus. The garden is designed for student gardeners and researchers to create food-waste-to-food-and-fuel systems. The BioEnergy Project begins with the anaerobic digestion system,

where food waste is first inserted into a standard restaurant sink, ground up by a food disposer, and pumped into gravity-fed digestion tanks where the food waste is broken down by anaerobic bacteria to produce biogas and solubilized nutrients. Next, the digestate enters the processing system, which filters and aerates it to kill off the anaerobic bacteria and convert ammonia into nitrates that are more accessible to plants and particularly suitable to leafy greens. The digestate processing system then leads to a reservoir that houses the aerated fertilizer and pumps it through a recirculating series of hydroponic trays, towers, and deep-water culture full of leafy greens and nitrogen-loving plants such as Bibb lettuce, tomatoes, beans, and basil. At the same time, biogas is collected in gas bags, purified through H₂S and CO₂ filters, and compressed into propane tanks to be used to generate electricity or produce heat. The compost additionally provides nutrient-rich soil from which to grow fruit trees.

Commercialization: The four products produced from the food-waste-to-food-and-fuel-system—organic produce, organic soil and fertilizer, biogas for electricity and heating, and food waste collection—all have the potential to be commercialized in universities, dining areas in malls or airports, K-12 schools, grocery stores, and other locations that demand food waste collection services and fresh produce. The prototype is scalable to meet customers' needs and would have a manufacturing cost between \$10-\$15k. The team hopes to work with more higher education institutes in the U.S. in the near future.



Figure 1: Prototype of The BioEnergy Project at Roger's Community Garden and Living Laboratory. Photo credit: Zachary Osborn.