UC San Diego

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# FOOD

## UC SAN DIEGO'S CARBON FOODPRINT

LOCAL CLIMATE SOLUTION REPORT SUBMITTED FOR BENDING THE CURVE:
SOLUTION TO CLIMATE CHANGE (WINTER 2019)

# UC San Diego's Carbon Foodprint

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# I. Executive Summary

"We are living in a world of over seven billion people, with annual greenhouse gas emissions of approximately 50 billion tons a year and rising steadily. If continued unabated, the world is on target to warm by about 2 °C in less than 40 years, pushing the climate to a regime unlike any that has been witnessed in the last million years."[1]

Anthropogenic climate change threatens the global population in such a way that those contributing the most to emissions are harming those most vulnerable. As students of University of California San Diego (UCSD), we have an ethical responsibility to acknowledge our role in climate destruction and do our part to mitigate the consequences. The University of California, as a world leader in sustainability, published a report in 2015 that established a framework for climate action. The report, titled *Bending the Curve: 10 scalable solutions for carbon neutrality and climate stability*, presents practical strategies for achieving carbon neutrality and climate stability that can be scaled up to be effective in local communities, California, the United States, and the world. More than 50 researchers and scholars from a wide range of disciplines across the University of California system—including our very own Dr. Veerabhadran Ramanathan and Dr. Fonna Forman—came together to identify solutions that can cut emissions of carbon dioxide and short-lived climate pollutants (SLCPs) in order to effectively bend the projected curve of global temperature rise, shown in Figure 1.

[1] Ramanathan, V. et. al. (2016). Bending the Curve: Ten Scalable Solutions for Carbon Neutrality and Climate Stability. *Collabra*, 2(1): 15, pp. 1–17, DOI: http://dx.doi.org/10.1525/collabra.55

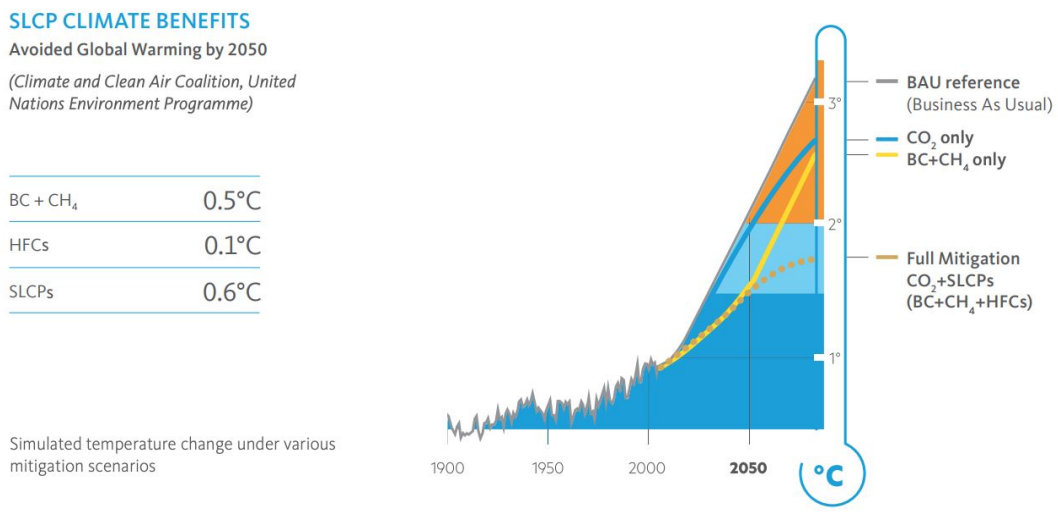


**Figure 1. Predicted changes in global temperature under various mitigation scenarios. This figure illustrates the idea of "bending the curve", by decreasing the trajectory of current temperature rise patterns[2].**

Of the 50 billion tons of greenhouse gases emitted each year, 8% is the result of food waste. Food waste refers to the discarding of food that is safe for human consumption. Food loss, on the other hand, refers to any food that is lost in the supply chain between the production facilities and the retailer. Roughly one third of the food produced in the world for human consumption every year — approximately 1.3 billion tons — gets lost or wasted. This issue is especially relevant on college campuses, which often house multiple dining halls, restaurants, and markets where food waste can occur. In order to effectively address this issue on the UCSD campus, mitigation strategies must align with the six clusters outlined in the "Bending the Curve" report: Science, Technology, Governance, Social Transformation, Market- and Regulations - Based Solutions, and Ecosystem Restoration.

Therefore the objective of this report is to address the issue of food waste at UCSD based on these clusters. Each section in this report tackles the issue of food waste from a different perspective, and proposes plans for action to reduce food waste and carbon emission at UCSD.

[2]Ramanathan, V. et. al. (2016). Bending the Curve: Ten Scalable Solutions for Carbon Neutrality and Climate Stability. *Collabra*, 2(1): 15, pp. 1–17, DOI: http://dx.doi.org/10.1525/collabra.55

Currently UCSD has no way of managing or accounting for the amount of food waste or emissions produced, and there are no proposals to establish a system that will allow UCSD to have full control of where the food on campus is coming from and how much of it ends up in landfills. Such proposals will be necessary in order to determine the best future course of action.

The UCSD campus also appears to have little control over the food portions at restaurants located in Price Center, which depend entirely on the vendor itself. If UCSD established control of all its on-campus food vendors, they would be able to implement multiple portion options and allow for more plant-based alternatives to menus which would prevent food from being thrown away.

UCSD can also reduce food-associated plastic waste by implementing reusable alternatives to single-use items such as to-go cups and food containers. This requires the implementation of innovative proposals such as the Freiburg Cup Initiative or reusable bamboo cups, which must also be backed by awareness campaigns in order to change the campus attitude toward the consumption of single-use items.

The adoption of technologies such as anaerobic biodigestion can also help UCSD divert food waste away from landfills, and provide a carbon-neutral energy source. By focusing on partnerships both within the community and with third-party organizations, sufficient supply of organic material could be obtained to make a large scale anaerobic digestion facility at UCSD feasible.

The plans for action proposed in each of these sections directly address different clusters from the “Bending the Curve” report, visualized in Figure 2.

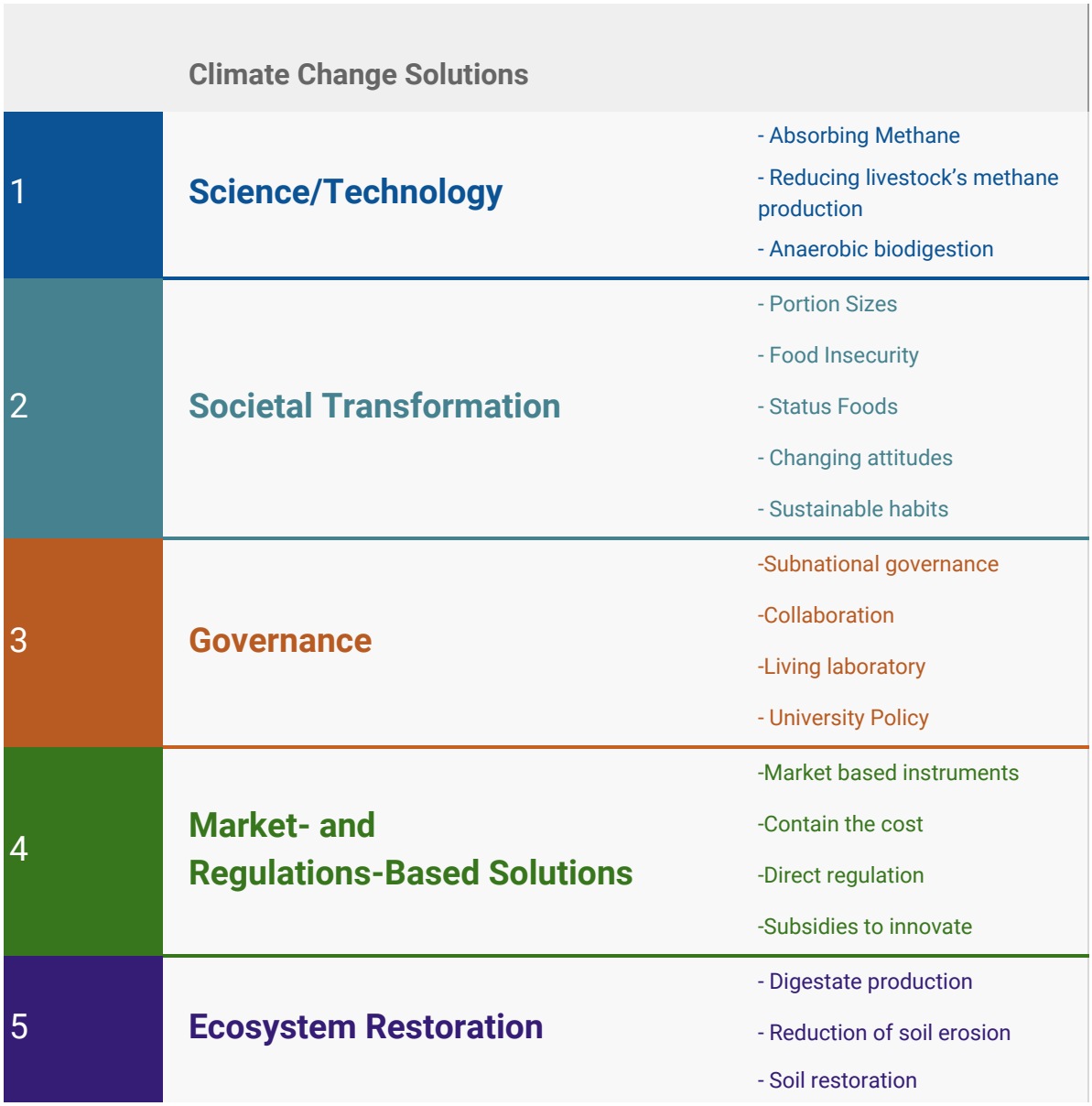


**Figure 2. Visualization of how the solutions proposed in this report fit into the categories of the five solution clusters from the Bending the Curve report.**

# II. Introduction

The University of California (UC) system has been around since 1869. It began with just 10 faculty members and 38 students but 150 years later it has become home to over 238,000 students and more than 190,000 faculty and staff. The Scripps Institute of Oceanography was first established in 1903 and later just a few miles away the University of California, San Diego opened its doors in 1960[3]. It is the seventh oldest of the 10 UC campuses and offers over 200 undergraduate and graduate degree programs, enrolling approximately 30,000 undergraduate and 8,500 graduate students[4].

Despite their 150 years of existence the UC's did not begin their Institutional Sustainability Commitment until 2003, lead by a student initiative that prompted the UC Regents to adopt the Presidential Policy on Green Building Design and Clean Energy Standards in 2004, which was later titled it the Sustainable Practice Policy[5]. The policy outlines UC's commitment to a sustainable foodservice, with a goal to procure 20% of all sustainable food products for campus and all health location foodservice operations. This policy also aims to certify at least one foodservice facility on each campus and health location as a green business, all by 2020. When looking at UCSD independently, we find that the campus and medical center food purchases are actually on track to be 30% sustainable rather than 20 by 2020[6]. UCSD also has one of the strongest fair trade policies of any university in the nation. This policy marks the school's commitment to promote fair trade certified products, support sustainable business practices, and prohibit the use of child labor. The signing of the policy was not just monumental for the campus but also a massive step forward in the U.S. fair trade movement. UCSD's willingness to stand behind a student led initiative and make real tangible changes on

[3]Office of Student Research and Information, Institutional Research, Academic Affairs. (n.d.). *UC San Diego Student Profile 2017-2018*. Retrieved from: https://ir.ucsd.edu/_files/stats-data/profile/profile-2017-2018.pdf

[4] UC San Diego. (n.d.). *Campus Timeline*. Retrieved from: https://ucsd.edu/timeline/

[5]University of California- Policy on Sustainable Practices (2019, Jan. 1). *ES – Energy & Sustainability*. Retrieved from: https://policy.ucop.edu/doc/3100155/SustainablePractices

[6] University of California: Office of the President. (n.d.). Sustainability. *Sustainable Foodservice*. Retrieved from: https://www.ucop.edu/sustainability/policy-areas/sustainable-foodservice/index.htm

the campus demonstrates that student voices are not only heard but capable of making changes happen.

UCSD currently has a “Strategic Plan” in place which focuses on four research avenues: understanding and protecting the planet; enriching human life and society; exploring the basis of human knowledge, learning, and creativity; and understanding cultures and addressing disparities in society[7]. The “Bending the Curve: Ten Scalable Solutions for Carbon Neutrality and Climate Stability,” report led by our very own Dr. Veerabhadram Ramanathan, was only the start for UCSD and its faculty. A large sum are currently actively leading engaged scholarship on climate change, not just in San Diego but among the border region as well. Dr. Fonna Forman’s work with EarthLabs is a prime example of this. Earthlab does outreach to at-risk and disadvantaged communities, primarily K-16, sharing with them biodiesel and algae research. Extending the scope by which these students see the world and the disastrous consequences climate change will bring.

UCSD has already invested over $100M in energy retrofits. The on-campus microgrid generates about 85% of our electricity and meets up to 75% of the university’s peak energy demand[8]. They also have an EV purchase and lease discount program for employees that has recently been taken UC-wide. Along with 35 buildings LEED-certified (including 4 Platinum) or under review, 65% of the campus shuttles are alternative-fuel, and they are currently constructing two light rail transit stations on campus. With all the money and motivation UCSD has put into the renewable energy realm and its expanding presence on the campus, it is time they take the same energy and address the large food waste problem the campus is currently fighting. With over approximately 2150 tons of food waste being created per year, based on the national average, in order to reach true neutrality we must address it and here are some ways in which they can do just that.

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[7]UC San Diego. (n.d.). *Strategic Plan*. Retrieved from: http://plan.ucsd.edu/

[8]University of California: San Diego. (n.d.). *Second Nature*. Retrieved from: http://secondnature.org/awards/university-california-san-diego/

In this report, a review of UCSD's current initiatives, such as their newly piloted composting program and the addition of new dining plans, will be evaluated. Following this review, a series of proposals will be detailed in an attempt to promote the elimination of food waste on the UCSD campus and its effects on mitigating climate change. These proposals include the changing of consumption habits by educating the campus on how different types of food contribute more to emissions, the replacement of single-use coffee cups, and the addition of anaerobic biodigestion technologies on the UCSD campus.

## III. UCSD's Current Initiatives

UCSD's student lead incentives, working to diminish food waste and food insecurity on campus, are making big waves.

### How much Food waste does UCSD really produce?

Before any problem can be resolved, it must first be recognized. We cannot eliminate food waste on the campus and address its effects on mitigating UCSDs emissions, if we do not know how much is actually being produced.

UCSD's Housing, Dinning, and Hospitality (HDH) reports that they composted 141 tons of food waste in 2017, bringing the total to over 1700 tons since they began composting in 2001[9]. At the time both the pre- and post- consumer waste produced on the campus was sent to MiraMar Greenery. However, in recent years due to the high-levels of contamination rising from post-consumer waste, and complaints from MiraMar Greenery, HDH decided to remove the composting bins from the dining halls. The change from post- and pre-consumer to only pre-consumer compost will and has affected HDH and UCSD greatly when it comes to mitigating their emissions. This is in part because post-consumer waste is arguably much greater than post-consumer, especially in a school totaling more than 1,976 acres. UCSD currently has 6 dining halls, 5 specialty full service restaurants, and six markets operating on the campus and with the construction of the 7th and 8th college already in the works we can expect to see at least four more foodservice centers being built[10]. On top of UCSD not having a real gauge as to how much food is actually being wasted on a daily basis, expansion will only work to make this issue worse. Each market, dining hall, and specialty restaurant is producing their own waste, both pre- and post-consumer, and some food is even being thrown away before it even makes it to the shelves or is used in preparation. In an attempt to come up with some viable approximation of the amount of food wasted on the campus we took into account a study done by RecyclingWorks, a program in

[9]UC San Diego. (n.d.). *Food*. Retrieved from: sustainability.ucsd.edu/focus/food.html

[10] THE TRITON. (2018, Nov. 30). *HDH Unveils New Locations for Seventh and Eighth Colleges.*

Massachusetts that argues that the average student generates 142 pounds of food waste a year[11]. That would mean that UCSD, by these metrics, produces 2150.235 tons per year. This number however is not reliable considering it relies heavily on the amount of students on the campus and the amount of dining options and locations each University has.

UCSD is at a distinct disadvantage when it comes to finding manageable ways to track food waste because of its massive size. Not only is the main campus part of the calculation when it comes to food waste but so is the Medical Center and the Early Childhood Education Center located in graduate housing, both contributing to UCSD's overall food waste. One of the most basic and simple ways for tracking to take place can be via scales. If each dining hall, restaurant, housing, and food service center has a scale to weigh trash bins every night then it will allow for a steady set of data to be collected. This idea however is not bulletproof and will bring a lot of challenges. There will have to be various steps put in place to allow for the accurate disposal of food and to make sure that no utensils, plates, or single use plastics are in the same container or else all the data collected will be skewed. This solution is less than ideal, since it requires students directly handling the waste when they are disposing of it in dining halls, so another way to address the issue would be to install a converter belt in kitchens where workers manually separate the food from the dishware. This solution would also require the use of scales, which would be an upfront financial investment by the University, but would later save the school much more. Not only on the amount of food they buy, which would be significantly reduced in an attempt to eliminate the waste they are now aware they create, but also on the transportation costs. It is a costly investment by the school to have tons of food and single waste plastics transported from the university all the way to the landfill and recycle centers. Not only will the food waste produce large amounts of methane in landfills but the CO2 emitted by the

[11][11] Poon, Linda. (2015, Feb. 27) *When Food Is Too Good To Waste, College Kids Pick Up The Scraps.*

vehicles transporting the waste will contribute to the 409.95 parts per million (ppm) already in the atmosphere[12].

Another potential solution would be for UCSD to create a system that is entirely restorative and regenerative. This is commonly known as circular economy, a system created to phase out waste by keeping products and materials in constant use. By creating their own reusable packaging system consisting of dishware, coffee cups, and even utensils, they will be cutting out almost all the single plastic waste in their campus dining halls. This same economic strategy can be used to combat post consumer waste by creating a link between food waste, compost, and soil quality. This system would also allow for students and faculty to be aware of their own specific impact since the circular model would need to be under direct supervision to avoid the loss of any items.

## Student Action Regarding Food Waste and Insecurity

Student Activism has been prominent on college campuses since the 1960s. It has proven to be an influential and effective means for students to make real political and social changes. UCSD's sustainability movement, and its leaders, have yet to reach national recognition but their drive to make a change, beginning with their home campus, is proving to be a force to be reckoned with.

Student run initiatives have begun to take the issue of food waste and insecurity into their very own hands with the establishment of The Food Recovery Network and the future commencement of The Campus Kitchen Project. The Food Recovery Network is a student movement aimed to fight waste and feed people in need. It was established in 2011 and has now expanded to over 198 chapters in 44 states, all of which have recovered over 1.6 million pounds of food[13]. The Campus Kitchen Project was founded ten years prior in 2001, helping students transform unused food from their dining halls, grocery stores, restaurants, and farmers' markets into meals for their community. Both nonprofits have hundreds of students worldwide working together to

[12] CO2.Earth (2018, Nov. 30). Earth's CO2 Home Page. *Atmospheric CO2.* Retrieved from: https://www.co2.earth

[13]Food Recovery Network. (n.d.). *California.* Retrieved from: www.foodrecoverynetwork.org/california

eliminate food waste on a global scale and since their start at UCSD, they have been able to save 15802.83 pounds of food from ending up in the landfill. Recently the Student Sustainability Collective, a subdivision of UCSD's Associated Students, launched a composting pilot in partnership with HDH and Roger's Community Garden. The project was spearheaded by three students whose mission was and is to drive the implementation of sustainable practices and policies at UCSD. This pilot however would have never been implemented if it were not for who the three students are. All three hold director positions at The Student Sustainability Collective and help run The Sustainability Resource on campus, and one even happens to work for HDH. Early on in your college career you figure out how important connections are, especially when it comes to working with people who have the power to make real change. When speaking to Braynt Jew, Director of Energy and Waste at the SSC and the pioneer behind the pilot, we learn that HDH is not entirely an easy entity to work with, "It became really difficult to understand what they wanted from us. I think they assumed we knew what their protocol on this type of thing was but we had no idea. I had never taken a policy directly to the people who could implement it. It was hard to get them to listen but because of the connection we had it made it a lot easier." By connection he is referring to a member of both the SSC and the HDH zero waste team, who facilitated conversation between the agencies. There were numerous meetings and countless hours spent formulating a proposal, ironing out any issues that either side might have, and creating a concrete education plan. Their goal was to create a three week program starting on February 4th and ending February 23rd that would utilize social media platforms to promote the new addition to 64 degrees, a UCSD dining hall located in Revelle College. During the first weeks they invited student waste educators, who they refer to as 'trash talkers', to help students navigate the world of composting and set the baseline for what the comparative data in this pilot would be. On the last week of the program they no longer had the student educators present in the dining halls, instead they released an educational video shared on a variety of platforms that aimed to teach all students, not just those that were able to speak to the educators, about compost.

Figure 3 details their findings throughout the three week pilot. The program ended up being a huge success and is now being expanded and implemented across the campus. Students who do not have the connections that those three did, would not have been able to implement such an idea. In order to bring more awareness to the issue of food waste and more diversity into the those who are attempting to find a solution we must make administrative access much simpler. This program also helped provide 145.1 pounds of food waste for the student-run “micro digester” currently running in Rodger’s community garden.

**Table 1. Composting Program Results. Highlighted are prominent discoveries that help illustrate how much food is on our campus**

| HDH Trial Period | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Total Weight (lb) | Bucket Number | Total Waste Weight (lb) | Single use container weight (lb) | Reusable container weight (lb) | Food Weight (lb) | % Contamination | Weekly Average Food Waste (lb) | Std Dev (lb) | Weekly Total Food Waste | Error(lb) |
| 2/4/19 | 18.2 | 1 | 4.2 | 0.1 | 0 | 4.1 | 2.4 | 4.8 | 1.2 | 35.7 | 0.2 |
| 2/5/19 | 18.4 | 1 | 4.4 | 0 | 0 | 4.4 | 0 | | | | |
| 2/6/19 | 20.4 | 1 | 6.4 | 0.05 | 0 | 6.4 | 0 | | | | |
| 2/7/19 | 17.3 | 1 | 3.3 | 0 | 0 | 3.3 | 0 | | | | |
| 2/8/19 | 18.2 | 1 | 4.2 | 0 | 0 | 4.2 | 0 | | | | |
| 2/9/19 | 20.2 | 1 | 6.2 | 0 | 0 | 6.2 | 0 | | | | |
| 2/11/19 | 17.2 | 1 | 3.2 | 0 | 0 | 3.2 | 0 | 23 | 20 | 116.5 | 0.2 |
| 2/12/19 | 40.2 | 1 | 26.2 | 0 | 0 | 26.2 | 0 | | | | |
| 2/13/19 | 79.8 | 2 | 51.8 | 0.2 | 0 | 51.6 | 0 | | | | |
| 2/14/19 | 18.4 | 1 | 4.4 | 0 | 0 | 4.4 | 0 | | | | |
| 2/15/19 | 45.4 | 1 | 31.4 | 0 | 0.3 | 31.1 | 0 | | | | |

## Administration

Student input must be prioritised in order for policies to take effect and last for years to come. No one can eliminate food waste besides the individuals who are causing it and the administration who are allowing it to continue. The partnership between the two has to become a much more prominent issue, one the University will soon be forced to address. With the recent retirement of Dave Weil, former UCSD Director of Campus Sustainability & Carbon Neutrality, an opportunity to allow students to have an active role in deciding who his successor will be. According to Edmund Lau of the Student Sustainability Collective, during the creation of their charter and the establishment of the Sustainability Resource Center they were given permission to send in a representative during administrative hiring, such as HDH's Director of Food, in order to make sure the students who are working to push particular initiatives feel comfortable with the individual responsible for implementing the changes they wish to see. If this allowance was given to not just members of UCSD'S Associated Students and extended to all student organizations, such as UCSD's Movimiento Estudiantil Chicanx de Aztlán (MEChA) and the Black Student Union (BSU), then every newly hired member of the UCSD administrative team would have the backing and approval of the student body.

Food is already a particularly controversial topic on the UCSD campus because of its current dining dollar system. As of now the University offers four different dining plans ranging from $2,850 as its cheapest option and $4,056 as its most expensive.[14] If you are a student living on-campus you must purchase one of the dining plans, there is currently no way to opt out of it. That being said, it has been recently speculated that future students beginning in 2020 will be given the option to not purchase a plan. The dining plan system in place is unique to UCSD and creates a vast array of problems. Some students cannot afford to buy the biggest plan and so must somehow manage to live on a $2,850 budget for three quarters. That would mean they are living on-campus

[14]HDH Residence Hall Dining Plan. (n.d.). *Residence Hall Dining Plan*. Retrieved from: hdh.ucsd.edu/housing/diningplan/pages/ResidenceHall.html

approximately 231 days a year with only $12.33 to spend a day. On the other hand, there are students with so much excess dining dollars they end up selling it at the end of the year. This system creates an abundance of food waste by students who just buy and buy and buy to use up their dining plans and a food insecurity issue for students who have to decide whether they want lunch or dinner. In order to address this problem, UCSD must work alongside students to create a plan in which everyone has enough to eat and no food goes to waste. For that conversation to take place students must have an easier way to contact those who are in charge of University policies and decisions. Change should not just be left in the hands of students who have the right connections, that eliminates almost an entire student body and limits the solution to only a specific few. Food waste can be eliminated on the UCSD campus, it will take time but if we open the conversation to the entire student body we might find that a solution has been there all along we just did not ask the right people.

## Food Insecurity

The Triton Food Pantry, established in 2015 by Associated Students of UCSD, works to provide relief and support for students on and off campus who are in need of food. It is one of the few places where students on the campus have access to a variety of dried goods, canned goods, and fresh produce. The pantry, thanks to AS funding, has been able to bring in weekly produce from the Garden of Eden, an organic and local farm in Escondido. The pantry runs on a point system where every item is assigned a price and registered students are allocated 10 points per week. Though the food pantry does alleviate food insecurity on a variety of levels, it is still lagging behind significantly when compared to other UCs. In 2018, UC Irvine introduced FRESH Basic Needs Hub, a 2,318-square-foot structure containing a fully stocked pantry, refrigerated items, and emergency toiletries. In addition to the pantry, UC Irvine also offers an emergency meal swipes program which allows students who qualify to receive 10 free meal swipes per quarter. Programs like those recently introduced in Irvine do exist on the UCSD campus, they are currently housed under UCSD's Basic Needs Center affectionately

known as the Hub. These programs are just not accessible to students, not because they do not exist, but because students simply do not know about them. The 2018 University of California Undergraduate Experience Survey (UCUES) revealed that from a pool of 7,888 UCSD students, 26% reported very low food security with an additional 21% reporting low food security. That means that 3,723 students out of 7,888 have to go about their day thinking about how and where they will find their next meal[15]. If we were to take the difference between the two numbers and apply it to the entire 30, 285 undergraduate population we find that approximately 14,233 students on this campus are touched by food insecurity. The concept of food waste existing in a food insecure world is not new, in fact according to the Food and Agricultural Organization, one fourth of the food wasted each year could feed all of the world's hungry people, some even more than once. Food waste is not just an issue in terms of its GHG emissions and contributions to rising temperature, it is also important to recognize that all the food that is thrown away via any avenue whether it be in the production chain or by consumers, could still be used in some way, shape, or form.

Food waste is not an independent variable, it doesn't just exist on its own and affect nothing in its path. It has very real effects both on our very own campus and internationally. It is not just a post consumer problem. Food is being wasted at every single level of the supply chain. From farm to distribution and from store to home there are hundreds of pounds of food thrown away every day.

[15]University of California. (2018, Dec. 18) *University of California Undergraduate Experience Survey (UCUES) Data Tables*. Retrieved from: www.universityofcalifornia.edu/infocenter/ucues-data-tables-2018.

# IV. Impacts of Meat Consumption

## Introduction

It would be extremely tedious to analyze every meal purchased at UCSD, but there should be an overall knowledge of how each food choice affects the environment. The consumer should not only be aware of how portion sizes can affect personal health from overeating, but also how much gets thrown away. Human body types range greatly and therefore require different amounts of food for sustainability. Being such, there should also be more individual choice in how much food is served to meet the individual's needs. Portion sizes need to be more flexible to prevent increased waste.

Vast amounts of greenhouse gases are produced during the life cycles of food. However, some produce less than others. A concentration on one life cycle in particular will give a focused insight into what exactly goes into the production, distribution, consumption, and disposal of a cheeseburger. This focus will detail how a burger becomes a burger and the various kinds of greenhouse gases that are produced during the entire process. The main focus of this section of the report is to give an understanding of how individuals can play a role in curbing carbon emissions by being aware of foods that are key emitters.

The common mindset is that meat is something to be consumed regularly. At UCSD, burgers and beef can be purchased at multiple locations around the campus. However, there are not many options to substitute beef for a different protein for a burger. At most restaurants, portion sizes are almost double the actual amount an average adult should consume on a daily basis. There is a figure provided further in the report displaying the difference in size.

The biggest impact is caused by oversized portions. A significant amount of food gets thrown away. More surprisingly, most waste that comes from a simple burger is pre-consumer, not post-consumer. Both pre-consumer and post-consumer have significant impacts on greenhouse gas emissions. The production of meat emits more

carbon dioxide and methane than the production of vegetation. The demand for more meat in daily diets requires larger slaughter farms. This demand will continue to increase climate change. Additionally, there is an issue with how vegetation food that has less of an impact on CO2 levels but it is more expensive to purchase.

This section will also provide solutions into how society can cut back on beef consumption by making meatless Mondays and also by having multiple plant/vegan/vegetarian alternatives. These alternatives will allow consumers to try an option beside beef and see if they enjoy it. Another solution discussed later in this report includes adapting cows into producing less methane. Smaller portions will contribute to having less food waste, which will in-turn soften the demand on more meat production.

## Cow Analysis

A typical cow releases between 70 to 120 kg of methane per year[16]. It is produced from methanogenic microorganisms that live within a cow's stomach. Methane is about 20 times stronger greenhouse gas than carbon dioxide in trapping heat in the atmosphere and the livestock sector contributes about 25% of anthropogenic CH4 production. When a cow is made into meat, only about half of a cow is actually able to be made for consumption once all of the bones and fat are taken off.

[16] Huhtanen, P., & Ramin, M. (2012). Evaluation of the Nordic dairy cow model Karoline in predicting methane production. *Acta Agriculturae Scandinavica: Section A, Animal Science*, 62(4), 295-299. DOI: https://doi.org/10.1080/09064702.2013.770914

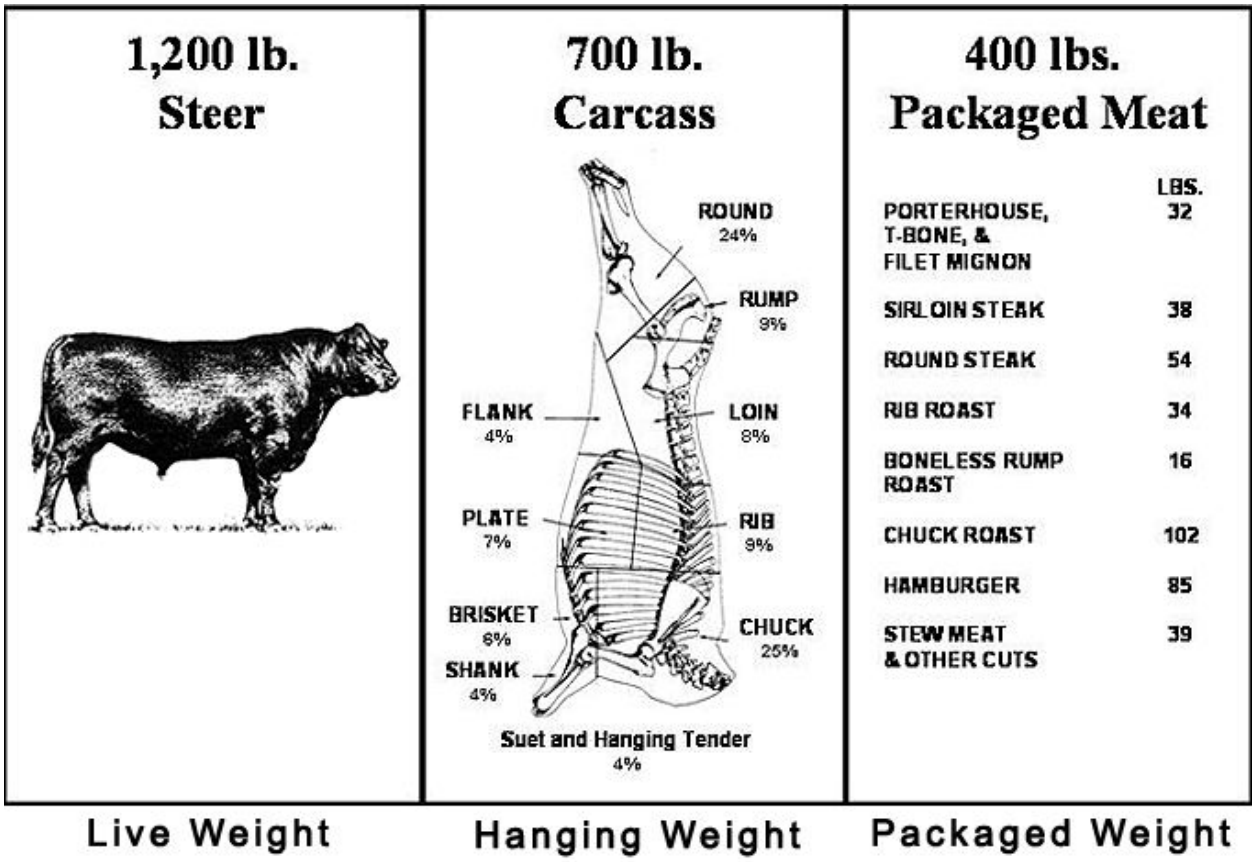



**Figure 4. This gives a numerical representation of how much a cow is usable for consumption[17].**

## Life Cycle of a Cheeseburger

A typical cheeseburger consists of a beef patty, lettuce, two buns, tomatoes, and cheese, but let's just look at the beef patty aspect alone. It is likely that little brainpower goes into deciphering how and where a burger comes from when it takes less than an hour to purchase and consume one. Diving deeper into the understanding of how much greenhouse gas a single burger produces takes a widened approach.

We will look at where hamburger meat comes from and what processes it goes through before it can be purchased by a consumer. First, the source of a burger comes from a cow which generates methane daily due to their digestive processes. A cow also requires to be fed and have access to water, which takes energy and resources to

[17] Eagle Springs. (n.d.) Image retrieved from eaglespringsfarm.com

supply food and water. The hay that nourishes cows also requires being watered and then being harvested by fuel burning tractors. This food usually needs shipped to the farms that house cows since it would require a lot of land to have both crops and livestock. Once a cow reaches maturity, around one and a half years old, it is taken to a slaughter house to be made into different forms of meat. An average cow makes about 430 lbs of retail cuts which would make around 900 hamburgers if the average burger patty is ½ lbs or less[18]. Getting to a slaughter house requires the cows to be transported via trucks therefore creating more greenhouse gases. The machinery that is required to break down a cow, which entails grinding meat multiple times, sorting it based on fat consistency, then packing into a burger shape is also using energy resources during the entire process. The product is inspected and packaged then taken through another round of transportation arriving at the desired destination. It quickly becomes a cooked product that a consumer will ingest. Cooking a burger also uses energy through the use of gas to cook it. Since portion sizes are grossly exaggerated, a good portion of that burger gets thrown away in the trash. That burger in the trash will then be taken to the landfill via a garbage truck which will then go through the process of decomposition and produce even more greenhouse gas. When added all up, a typical burger has 8 separate cycles of production, increasing the amount of greenhouse gas that is into the atmosphere. The combined total amount of CO2 from the production of a burger, transportation, and food processing is 766g to 3000g, then the methane produced from a cow divided into burger sizes is roughly 2.6kg CO2-equivalent[19].

Now, let's look at the opposite example of a vegetable or fruit that is grown for consumption. They also require water and tractors to harvest them. They also are distributed with fuel driven trucks and any waste potentially goes into a landfill. The difference is that livestock requires plants to be grown in order to feed them so the carbon production happens twice unlike plant production. Another huge difference is

[18] Oklahoma Dept. of Agriculture, Food, and Forestry (n.d.). Food Safety Division. *Meat Inspection Services.* Retrieved from: https://www.oda.state.ok.us/food/fs-cowweight.pdf

[19] Cascio, Jamais. (n.d.). *The Cheeseburger Footprint*. Retrieved from: http://www.openthefuture.com/cheeseburger_CF.html

that the plants that produce the fruit do not release methane when waiting for harvesting whereas a cow actively produces it during its life cycle.

## Effects on Emissions

Social transformations at UCSD and understanding why certain items should be consumed less frequently are core examples for this section in curbing the amount of impact on global warming. A significant change is needed to understand how the carbon cycle is affected by overconsumption of meat products. If UCSD leads by example by having a decreased demand for meat products, then there could be a decreased demand for cattle farms necessary as society adjusts its ways. Meat consumption also has the stigma of being a higher societal food in developed and developing areas. Historically, meat was mainly attainable by wealthy individuals who had land and resources available to raise livestock. This idea that meat is more desirable is still a part of today's society. Meat consumption has been growing and is being demanded more frequently. It is common for the average American to have a meat product in every consumed meat throughout the day. The UCSD campus for example has dining halls in every corner of the campus and almost all of them offer burgers throughout the day, every day.

A higher production of beef can also be attributed to the fact that it is difficult to go to any establishment and not see a product on the menu without meat. There are limited alternatives for not eating beef in many restaurants with only one or two options. This means that there is regular consumption of beef among individuals and not much thought into changing eating patterns. Another impact is that most adults believe their correct portion size is much larger than it really should be. Food is produced at a higher rate to meet the demand of larger portion sizes. The average portion size an individual is supposed to consume is almost half of what is actually served to individuals. Even if an individual wants a smaller portion size, there is usually not an option for it. “Kids sizes” are mainly allowed for people of a certain age but generally those sizes are what an average adult size is supposed to consume. Take for example Price Center at

UCSD, the retailers that are allowed to serve food in the building do not offer different portion sizes and the option of kids meals are taken off of the menus. The extra amount of food that is excess is either thrown away or consumed. Once the food is thrown away, it usually ends up in a landfill which will contribute to the amount of greenhouse gas from going through anaerobic digestion. If the food is over consumed, then it harms the individual through weight gain. In essence, the larger portion sizes harms society as a whole. The diagram below shows an average portion size that's served versus the amount that should be consumed.


**Figure 5. This figure gives a visual and numerical representation on how distorted portion sizes are for an average consumer[20].**

[20] Neubauer, Kristin (2015, May 8). HealthComU. *Portion Distortion "Normalizes" Larger Portions.* Image retrieved from: https://www.healthcomu.com/2015/05/08/portion-distortion-normalizes-larger-portions/

## Solutions

There are multiple solutions to help curb the amount of greenhouse gas effect that is caused by beef production. The most immediate impact that can be made is in reducing the amount of methane that a cow produces by improving a cow's feed. Different feed compositions can either increase or decrease the amount of methane a cow produces. Another recent methane reduction strategy includes the introduction of methane inhibitors, both biological and chemical, to kill off or at least reduce the activity of the methanogenic microorganisms in the gut[21]. A second solution is to change the way society views beef as a main source of nourishment. There are multiple alternatives to achieving the same amount of protein consumption without the need for beef. Aside from the obvious proteins of chicken and fish, there are many forms of proteins in plant based sources like beans, quinoa, and lentils. If society could make the adjustment from seeing meat as a high status food to seeing plant based food as a sign of wealth, then cutting back greenhouse gas emissions would happen at a faster rate.

Portion sizes should also be viewed in a different light. Instead of wanting more than we can healthily consume, society should be demanding more options to suit individual needs. "Kid sized" portions should not have an age restrictions especially on items that do not have refills anyways. It is understandable that all you can eat establishments would have different prices due to age but not places that you are paying for exactly what you order. Another solution is starting habits that will work on the UCSD campus with trends like Meatless Mondays. Being able to get the campus wide support for having a meatless day will impact the amount of meat that gets consumed. It will also change the viewpoint on how necessary meat really is to the overall diet of individuals. The implication could also get students to think twice before purchasing beef on a regular basis. The last solution is by making awareness groups who can understand and promote the effects that beef consumption has on climate change.

[21]GHG. (n.d.). *Methane Sources-Ruminants.* Retrieved from: http://www.ghgonline.org/methaneruminants.htm

Making the switch from a beef centered consumption will be difficult but with the right motivation and message, it is possible. It is a necessary change since cattle is a large contributor to the increase in greenhouse gas emissions both in the natural release of carbon and in requirement of land. People need to have more access to information and the ability to be in control of the portion sizes to fit their individual needs. With a decrease in the demand for beef, there would be more land that could be converted back into forests and restored back to its natural ecosystem.

# V. Implementing the Freiburg Cup Initiative

This chapter will focus on how UCSD can make changes that benefit both the students and the campus at large by curbing packaging and food waste. By utilizing better techniques for the recycling of edible food and implementing the use of reusable utensils, this will cut down on the manufacturing of one-time use products and the emissions released during their entire life cycle. This section will also cover a variety of ways food can be repurposed, the different projects already implemented at UCSD, their challenges and limitations, and the opportunities offered by reusing coffee grounds. This will help in the reduction of greenhouse gas emissions by diverting food from going into landfills and diminishing the overproduction of specific foods. Concerning the method, it is important to explain that most of the background information came from interviews in this Chapter.

## Reuse solutions on UCSD campus

UCSD has already begun an impressive number of projects for reusing food waste on campus. However, this progress is small in comparison with the progress that has been made at UC Irvine, which is one of the most advanced campuses in the UC system concerning food waste reduction. UCI has achieved a diversion rate of 80 % (waste that gets recycled, composted, reused or donated) which is remarkable. Concerning UCSD, we have found no data concerning the campus's diversion rate. The reuse dimension of the project will follow the diversion rate approach which contains the following clusters: recycling, composting, reusing and food donations.

The Eco container program has been launched during the winter quarter 2019 at UCSD. Each student has been offered a credit for two Eco-containers with their student ID card and that they could get at Pines and Roots [22]. However, the eco-containers can

[22] UC San Diego: HDH. (n.d.). *Sustainable Dining*. Retrieved from: https://hdh.ucsd.edu/dining/pages/Sustainable.html

be returned at every dining place on campus. This program has faced some difficulties according to Colin Moynihan (Sustainability Manager for Housing, Dining, and Hospitality, including composting). Indeed, he has observed that students using the eco container do not bring them back. We propose adding a deposit for each container as an economic incentive to bring back the container. For example, at the University of Geneva, the cafeteria put a ten dollar deposit for the eco container which is an important amount that draws the student to give back the container. Before extending the eco-container program, we should try a deposit of five dollar on the student ID card for every container available at Pines and Roots. If a change in the student's behaviour toward the return of the container can be observed, then we should expand the program to other dining houses. Indeed, the use and amount of the deposit should be implemented as an economic incentive to bring the container, however, the deposit should not be a barrier in the student's choice between a container or single-use item.

Composting at UCSD is part of the "Reuse" dimension which proposes an impressive number of opportunities to innovate and improve the projects that have been launched. UCSD has diverted 141 tons of food waste to composting during the 2017-2018 academic year.[23] The majority of composting at UCSD is from pre-consumer food waste. We need to increase the amount of post-consumer food waste being composted. To tackle this issue, the Econauts (Student association working on Sustainability projects at UCSD) have started the Tiny Bin Tim pilot program which consist of a bin for the post-consumer food waste that can be composted[24]. We should support their effort in order to increase the amount of bins available to improve the amount of post-consumer food waste composted. Roger Community Garden is a major actor in the composting program at UCSD. They are actually picking up around 2000 pounds of food waste each week.[25] RCG are using a pick-up truck to collect around 100 pounds at a time. We should limit GHG emissions from the food waste transportation by

[23] UC San Diego: HDH. (n.d.). *Sustainable Dining*. Retrieved from: https://hdh.ucsd.edu/dining/pages/Sustainable.html

[24]UC San Diego: HDH. (n.d.). *What We Do*. Retrieved from: https://hdh.ucsd.edu/sustainability/pages/WhatWeDo.html

[25] UC San Diego. (n.d.). *Composting*. Retrieved from: https://www.rcgucsd.com/student-projects/composting

thinking about powerful, light vehicles with a high loading capacity to limit the number of round trips.

The reduction of single use items is another issue to tackle to achieve the Zero Waste by 2020 (UCSD commitment). Price Center on Campus has many chain restaurants who do not possess dishwashers and they offer only single used items for eating “here” and “to go”. The waste management at Price Center seems to be done by UCSD and not the restaurants according to Colin Moynihan. Colin Moynihan decided to put me in contact with Hugh Hagues, the Assistant Director of Retail Services for University Centers. He could be able to explain to us why only single used items are served at the Price Center in order to be able to propose feasible solutions which will take into account the lease agreement between the Campus and the private restaurants.

## Coffee cup initiative

To continue, we first discussed solutions that have already been implemented or at least started and how we could improve them. In this second part we will now present a new project that our team would like to bring to UCSD concerning the use of disposable coffee cups.

Most of disposable coffee cups are in paper but contain 5 % polyurethane plastic so it is very hard to recycle or compost them if they are compostable, those cups will generally go to the landfill[26]. Indeed, I met the Manager of Pinpoint Cafe (Cafe in front of Eckart building), they started to use compostable single-used cup but finally discovered that there is no place in San Diego County to manage them so it generates more waste that goes to the landfill. After this experience, PinPoint Cafe has launched the Mug share program that allows you to drink your coffee to-go in a Mug and bring it back when you want without deposit. The mugs proposed were old ones brought from their

[26] Garcia, Taylor. (2019, Jan. 22). Innovations to Recycle Spent Coffee Grounds - Healthy Ecology. *Achilles Coffee Roasters San Diego*. Retrieved from: https://Achillescoffeeroasters.com/Wp-Content/Uploads/2018/08/Logo-2-Color.png

houses or friends in order to avoid the production of new mugs and its environmental consequences and having the smallest implementation cost for the project. This is for the short and long term an easy solution to implement and a collection of mug could be done on campus to limit the cost of implementation. A deposit should be considered if the mugs are not returned as PinPoint Cafe observed sometimes. A positive point is that in most of the cafes at UCSD if you come with your own thermos you will have a discount of around 20 cents. Colin Moynihan explained to me that UCSD had decided to offer reusable coffee mugs through Housing, Dining & Hospitality Services to all in-coming students but he observed that students have very personal choice around the colour and design so most of them do not use them. I can also imagine that this behaviour is linked to the unwillingness of students to carry a thermos in their bag all day, lack of space or too heavy to carry on and then they have to wash it. Thus, this is why we propose alternatives as the implementation of the Freiburg Initiative at UCSD but first we will discuss disposable coffee cup consumption at UCSD.

There are 50 billion disposable coffee cups wasted each year in the US and we have done the estimation for UCSD by the following calculation.Coffee to go is popular in Freiburg were the Initiative started they measured that each year 12,000,000 cups are wasted in the city and the city's population is around 230 000. For Freiburg it means that per head they use around 52 disposable coffee cups. We then multiply it by the number of students at UCSD (35 000): 52 x 35 000 = 1 560 000 single used cups per year for UCSD Student consumption[27]. This number is only based on student consumption but does not take into account all the professors, employees on campus. Each disposable coffee cup is responsible for 0,24 lbs of carbon dioxide (CO2), with 1,560,000 cups for UCSD consumption it represents 374 400 lbs of CO2. These numbers might be really underestimated, but we can observe that by cutting down the use of disposable cups we could mitigate CO2 emissions.

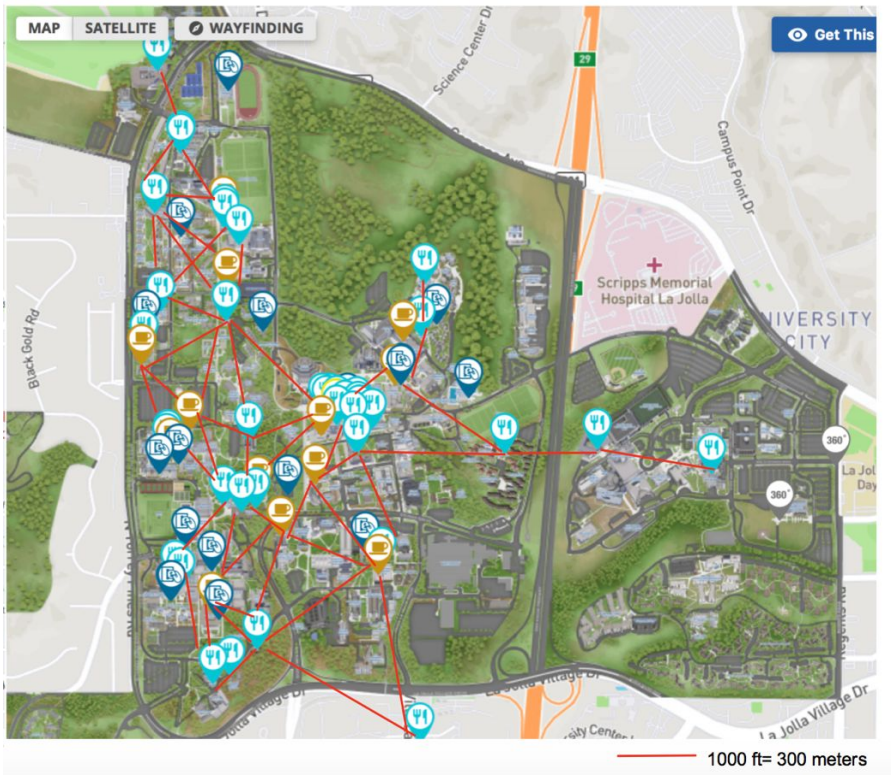
[27]UC San Diego. (2018, Oct.) *UC San Diego Campus Profile*. Retrieved from: https://ucpa.ucsd.edu/images/uploads/UC_San_Diego_Campus_Profile.pdf

Disposable coffee cup consumption at UCSD

| Student population at UCSD | Disposable cup wasted / year at UCSD | CO2 emissions for 1 disposable cup (lbs) | Total CO2 emissions at UCSD/year from disposable cup |
|---|---|---|---|
| 35,000 | 1,560,000 | 0,24 | 374,000 |

## Proposal for UCSD campus

The project we propose concerns the Implementation of the Freiburg Cup Initiative. The idea consists of proposing hard plastic cups (to go) available at every place on campus that serves coffee. Those cups can be reused 400 times and the cups are dishwasher safe. The consumer can return the cup at every dining and cafe on campus when he wants to. We are thinking about a deposit of 2$/cup requested during the payment as an incentive to not throw them away or keep them. Colin Moynihan and UCSD have already found a way to charge the deposit on the student ID card and by doing so it makes the deposit easy, fast and the customer should not feel economically constrained. The repartition of the dining and cafes on campus makes the implementation of the Freiburg Cup very interesting. As we can see on the maps below, there is a cafe or a dining house every 300 meters on average no matter what direction you are following.




## Challenges in the implementation process

The project is facing several challenges, the first one will be to have all the places serving coffee on board with the project. If we want them to agree the cost of implementation of the project and the cost of washing the cups should be financed by UCSD.

The second one is to make the return of the cup as easy as if the customer was throwing away his cup. Thus, the customer should not have to do the line to return the cup. To do this, we are thinking about an electronic bin in the cafes and dining houses that allow you to return your cup by opening the bin with the student ID card and have the deposit back instantly. Indeed, I was able to observe how the method for returning the cup and the deposit is crucial when a student at the University of Geneva tried with me to order a coffee in a reusable plastic cup (new alternative). However, when he wanted to turn back his cup at the end of the day the cafe was closed and he had to carry the cup with still some coffee inside his bag and wait the next day to get the

deposit. The next day after having his deposit back, he chose to order his coffee in a single use cup. An additional issue is that not all the dining and cafe places have a dishwasher, we are now trying to know how many places have one because we want to limit the transportation needed with the coffee cups, thus limiting GHG emissions. Concerning the return and the washing of the cup I met a group of design student at UCSD developing a type of electronic distributor for reusable cup which give a cup in exchange of a deposit in a credit card and you have to return the cup to the same distributor which will then wash the cup for another customer. The last major issue we are facing is the modification of the lease agreement between UCSD and the coffee/dining companies. How can we convince a company like Starbucks to accept the use of different coffee cups without their own logo on it? This led me to contact Hugh Hagues (Assistant Director of Retail Services for University Centers) which has important information about lease agreements in UC Centers.

### Alternative to the Freiburg Cup Initiative: Bamboo Cup

After having considered the advantages and limitations of this project, we should also have a look at another solution available and already implemented at some universities. A colleague at the University of Geneva received during its exchange at the National University of Singapore a reusable coffee cup made only from bamboo, very light and simple with a bamboo lid on top of the cup. Bamboo is biodegradable and sustainable, and it continues to grow naturally after being cut. Additionally, it can also reduce CO2 and generate 35% more oxygen than equivalent trees. Furthermore, the manufacturing process for a bamboo cup is low carbon dioxide-emitting and the production of bamboo fibre is low energy consuming.

We should consider if  offering all UCSD students a cup made from bamboo (with a cost-efficient and sustainable production process)would be less expensive and more simple to implement compared to the implementation of the Freiburg Cup. This alternative could avoid the need for the campus administration to modify the lease agreement with cafes on campus and the limits caused by the lack of dishwashers at

cafes. However, this solution requires the students to take the time to wash their own reusable bamboo cup and become aware of the problem behind the usage of single use plastic.

# VI. Utilizing Anaerobic Biodigestion Technology

Anaerobic biodigestion is the process by which organic material, including food waste, is decomposed by bacteria without oxygen, producing methane and carbon dioxide "biogas". The methane produced by this process has been used as a source of energy by humans since as early as the tenth century, however as petroleum began to dominate the energy market as the cheapest and most efficient option, investment into biodigestion as a large-scale energy source was never initiated to the same scale.[28] Today, as concerns about our energy and climate future are growing, many are looking towards anaerobic biodigestion as an alternative energy source to fossil fuel, and as a path to reduce landfill use and climate pollutant emission. The technology necessary to harness the energy potential of anaerobic biodigestion already exists, however large effort to scale up the use of this technology, and to build the infrastructure necessary to integrate it into people's lives is necessary. This chapter will evaluate how anaerobic biodigestion can be implemented on the UCSD campus, as a way to reduce food waste, and to help us reach our climate initiative goal of becoming carbon neutral by 2025.

## Background

There are several ways in which anaerobic digestion helps to reduce food waste and mitigate carbon emissions. The first is by reducing greenhouse gas emissions from landfills. When organic material enters a landfill, the tightly packed waste creates an anaerobic environment. Therefore as this waste decomposes, it produces methane and carbon dioxide gas. When these gases are produced in a landfill, unlike in anaerobic biodigestion, they are generally just released into the atmosphere.[29] Carbon dioxide and methane are both well characterized climate pollutants, and methane is approximately 28 times more potent than carbon dioxide in its heat-trapping potential.[26] Landfills are

[28]Agathe Auer et. al., (2016). Agricultural anaerobic digestion power plants in Ireland and Germany: policy and practice. *Journal of the Science of Food and Agriculture*, 97(3), p.719-723.

[29]Gies, Erica. (2016, Oct. 26). Landfills Have a Huge Greenhouse Gas Problem. Here's What We Can Do About It. *Ensia*. Retrieved from: ensia.com/features/methane-landfills/

currently the third largest source of methane emissions in the United States, and although technologies for methane recapture from landfills are improving, they are not widely used or efficient enough to stop emission completely.[30, 31] One popular alternative to divert food waste away from landfills is composting, which is frequently confused with anaerobic biodigestion.[32] The main difference between these two processes is that composting takes place in a mainly aerobic environment. Although composting does release some carbon dioxide, it is overall a much more environmentally friendly alternative to decomposition in a landfill since it does not release methane, and the decomposed material from this process can be used as fertilizer in place of fertilizer produced from fossil fuels.[33] Although the diversion of food waste into composting rather than landfills is an extremely important endeavor, anaerobic digestion is unique in that it provides the same benefits of composting in terms of emission reduction and diversion from landfills, but it also reduces climate pollutant emissions in a second way, by providing a clean energy source and alternative to fossil fuels in the form of the biogas which is captured during decomposition. This biogas has the potential to reduce fossil fuel use in residential, industrial, and transportation sectors, since it can be burned to produce heating, electricity, and can even be used to power vehicles.[30] Although the burning of biogas also releases carbon dioxide, this carbon comes from plant material that captured carbon dioxide from the atmosphere, rather than from carbon deposits.[34] Therefore this creates a closed carbon loop, and results in net-zero carbon emissions. The widespread use of biogas as an alternative to fossil fuels has great potential to reduce global carbon emissions, therefore anaerobic digestion can play a vital role in the process of climate mitigation, in addition to providing an alternative fate for the food

[30]Ramanathan, V et al., (2016). Bending the Curve: Ten Scalable Solutions for Carbon Neutrality and Climate Stability. *Collabra*, 2(1): 15, pp. 1-17, DOI: http://dx.doi. org/10.1525/collabra.55

[31]EPA, Environmental Protection Agency. (2019, Feb. 23). *Basic Information about Landfill Gas.* Retrieved from: www.epa.gov/lmop/basic-information-about-landfill-gas

[32] Gies, Erica. (2016, Oct. 26). Landfills Have a Huge Greenhouse Gas Problem. Here's What We Can Do About It. *Ensia*. Retrieved from: ensia.com/features/methane-landfills/

[33] A. Lanfranco & Associates Inc. (2017, Feb. 23). *Composting vs. Anaerobic Digestion, and the Potential of Biogas*. Retrieved from: alanfranco.com/composting-vs-anaerobic-digestion-potential-biogas/

[34]Environmental Protection Agency (2015, Oct.). *Anaerobic Digestion and its Applications* (EPA/600/R-15/304). Cincinnati, OH: U.S. Retrieved from https://www.epa.gov/sites/production/files/2016-07/documents/ad_and_applications-final_0.pdf

waste we produce.

A survey by the EPA conducted in 2017 estimated that there were 184 anaerobic digester facilities in the US that were operational in 2015, and that the annual total amount of food waste processed by these facilities was 12,730,657 tons, in addition to non-food waste like municipal or livestock waste.[35] Using this waste, these facilities produced a total of 812 million kWh of energy annually, which is enough to power 66,842 homes for a year.[32] If this technology could be applied to UCSD, it offers the potential for us to find an environmentally friendly way to deal with the food waste we produce, and help us to provide heating and electricity without the use of fossil fuel.

## Current UCSD Projects on Micro Digestion

Currently, UCSD supplies a portion of its electricity from biogas produced at the Point Loma Wastewater Treatment Facility. The biogas from this facility is used to generate electricity on campus using UCSD's fuel cell bank and storage system. This biogas provides UCSD with 2.8MW of electricity per day. This is enough to supply power to the campus medical center on a typical day, but does not supply 100% of UCSD's energy needs.[36]

UCSD also currently has a small, student-run "microdigester" operating in Rodger's community gardens. This digester takes waste from multiple sources across campus including Price Center and 64 Degrees dining hall. It takes mainly pre-consumer waste (which has not been served to students), but recently piloted taking post-consumer waste from the composting bins which were set up in 64 degrees. In a twelve day trial period, 145.1 pounds of food were collected from post-consumer food waste, with a very small percentage of contamination from non-organic material. This

[35]Environmental Protection Agency (2018, Sept.). *Anaerobic Digestion Facilities Processing Food Waste in the United States in 2015* (EPA/903/S-18/001). Philadelphia, PA: U.S. Retrieved from: https://www.epa.gov/sites/production/files/2018-08/documents/ad_data_report_final_508_compliant_no_password.pdf

[36]Biofuels Energy, LLC. (2016, Oct. 27). *Turning Waste Into Renewable Natural Gas Point Loma Wastewater Treatment Plant Case Study- Five years after Commercial Operation.* Retrieved from: https://www.socalgas.com/1443740098116/Biogas-to-RNG-at-Point-Loma-Wastewater-Treatment-Facility.pdf

pilot was very successful, so the digester project members hope to expand the program to the other dining halls across campus.[37] In total, the digester takes an average of about 2000 pounds of food material each week. Materials which are fed into the biodigestor include mainly carbohydrates and proteins, which are typically not as useful in traditional compost.[38] When materials arrive at the biodigestor, they are rinsed in the sink and fed through a standard garbage disposal which grinds the scraps before they enter the digestion tanks. The first tank contains anaerobic bacteria which break down the food into small organic molecules, then the material is fed into a second tank containing methanogenic bacteria, which produce methane biogas along with other byproducts. The biogas that is produced has to be cleaned to remove gaseous byproducts like hydrogen sulfide before it can be used. The biodigestor in Rodger's garden produces approximately 0.1-0.2 cubic meters of biogas every day. The liquid digestate byproduct of this process is aerated so that it can then be dried and utilized as fertilizer for their hydroponic growing systems.[39] Currently, the system of biogas production, cleaning, and collection is being improved, but in the future the project leaders hope to be able to use their biogas in combination with a solar setup to create a small microgrid system which will supply all of the garden's power needs. They also hope to be able to use the biogas in the future in order to power things around campus such as the grills outside 64 degrees, or outdoor heaters that will be built in the new construction on campus.

[37](Enid Partika, personal communication, Feb 24, 2019)
[38] (Enid Partika, personal communication, Feb 24, 2019)
[39] (Enid Partika, personal communication, Feb 24, 2019)

Microdigester operating in Rodger's community gardens on UCSD campus. This project is student led and constructed.

There are also plans for another microdigestor to be installed in the newly constructed sixth college, which will be provided by a third party company called Impact Bioenergy. This company plans to work with the members directing the Rodger's garden digestor in order to set up their system, and find ways in which to use digestion byproducts.[40] The relatively low cost of setting up and maintaining the biodigestor in Rodger's garden shows that it is completely feasible for UCSD to expand this program by installing multiple small digesters in other parts of campus.

However, none of these current projects are ideal solutions to UCSD's food waste problem. We are already using about ⅔ of the total biogas produced at the Point Loma Wastewater Treatment Facility, and this still does not supply all of UCSD's energy needs. While this system is beneficial in helping to reduce UCSD's reliance on fossil fuel energy, it does nothing to utilize the food waste that we produce on campus. In addition, UCSD must purchase this biogas based on a contract with the Point Loma facility. Therefore operating a digester that is University run would both eliminate this

[40] Ranken, Tom. (2018, June 1) Impact Bioenergy Is Building Digesters in California and Pennsylvania. *CleanTech Alliance*. Retrieved from: www.cleantechalliance.org/2018/06/01/impact-bioenergy-is-building-digesters-in-california-and-pennsylvania/

extra cost of purchasing biogas, and would help us to utilize the organic waste we are producing.

There are also some inherent problems with operating microdigesters at UCSD. Although these are a viable way to divert UCSD's food waste away from landfills, due to the low amount of waste these digesters can take, operational costs will be higher than the profit that they can produce. It is estimated that any digester operating on less than 20 tons of material per day will be operating at a net financial loss. In addition, the amount of biogas produced by a large scale digester would be substantial enough to provide significant electrical power to campus, while the biogas produced by microdigesters is only sufficient to provide power to small devices such as outdoor grills. [41] Therefore because microdigesters will be operating at a net loss it is unlikely that their widespread use is financially feasible, which limits the impact that anaerobic digestion can have on our campus. Therefore, for UCSD to produce a profitable system of anaerobic biodigestion, it is necessary to think on a larger scale.

### UC Davis as a Model System

One example of how large-scale anaerobic biodigestion has been successfully integrated with a college campus is from the University of California Davis. The university opened its "renewable energy anaerobic digester" (READ) in 2014. The READ facility was built on the university's former landfill area, and occupies about three acres.[42] It was built in partnership with the company Cleanworld, which specializes in developing anaerobic biodigestion facilities for companies and communities. This facility takes in approximately 50 tons of organic waste each day.[43] About half of this is food waste from UC Davis facilities, and the other half is agricultural waste from the surrounding farmland.

[41] (Brian Dewaele-dillon, personal communication, March 19, 2019)
[42] UC Davis. (2014, Apr. 22). *Biodigester Turns Waste into Campus Energy at UC Davis*. Online video clip retrieved from: https://www.youtube.com/watch?v=AgwHi6ogBpM&feature=youtu.be
[43] CleanWorld RSS. (n.d.). *Delivering the Power of Organic Waste.*Retrieved from: www.cleanworld.com/

UC Davis READ facility. This biodigestion facility can take in up to 50 tons of organic material each day

This facility is one of the most state-of-the-art and efficient digester systems operating within the country. It produces approximately 12,000 kWh of energy every day, and is expected to reduce carbon emissions by 13,500 tons every year. This facility is extremely beneficial to the university, since all of the electricity generated is directed to the UC Davis power grid, and the university gets all of the green energy and carbon credits.[44] It also benefits the surrounding farms and communities since they receive all of the digestate byproduct to reuse as fertilizer.[45] This exemplifies how partnership is necessary for the success of large-scale biodigester operation. The partnership between UC Davis and Cleanworld provided both the funding and the technology to make the construction of the facility possible, and the partnership between the university and the surrounding community provided the volume of material necessary to keep the facility profitable, as well as an outsource for the byproducts produced. Therefore the key factors necessary to ensure the success of a similar facility at UCSD are

[44]CleanWorld. (n.d.). *UC Davis READ BioDigester*. Retrieved from: http://www.cleanworld.com/wp-content/uploads/2012/04/ucdprofilewebversion.pdf

[45]The Regents of the University of California, Davis Campus. (2015, Feb. 2) College of Engineering UC Davis, *UC Davis Biodigester Turns Campus Waste into Campus Energy*. Retrieved from: engineering.ucdavis.edu/blog/uc-davis-biodigester-turns-campus-waste-campus-energy/

partnership both within the community, and with external parties such as Cleanworld. While the READ facility is a valuable model for a similar facility at UCSD, because UCSD and UC Davis are located in very different areas, plans for a digester facility at UCSD must also be adjusted to fit the UCSD community specifically.

## Potential Future Initiatives

One important difference between the UC Davis and UCSDcampuses is their location. Because UC Davis is in an area surrounded by a great deal of farmland, this provides an ideal resource for additional feedstock waste needed to keep the READ facility operating at a profitable level. However because UCSD is situated in a mainly residential area, we do not have the advantage of such easily accessible, high volume organic waste. Therefore, the main limitation on a large digester facility at UCSD is being able to supply a large and constant enough feedstock supply to make the facility profitable. To do this we must partner with the community surrounding UCSD, and look to other potential resources for maintaining waste supply. One suggested resource for this supply is spent grain from breweries.[46] The La Jolla and San Diego areas have many local craft breweries, which all produce spent grain during production. These breweries have no use for this byproduct, therefore it is generally collected by farmers for free for use as animal feed. However, this grain would be an ideal feedstock source for a UCSD biodigester facility since a sufficient collection could provide the necessary volume to supply the facility, and because spent grain has a relatively high biogas yield (about four times that of general food waste).[47] One potential problem is that farmers generally collect this waste for free, while digester facilities normally charge a tipping fee of about $30/ton for feedstock collection.[48] While this tipping fee may be negligible to some breweries that produce a smaller amount of spent grain, in order to make this

[46] (Brian Dewaele-dillon, personal communication, March 19, 2019)
[47] Brian DeWaele-Dillon. (2018). *Anaerobic Digestion at UCSD: A Feasibility Study*. Retrieved from: https://www.ucop.edu/carbon-neutrality-initiative/_images/cni%20posters/2018/brian-dewale-dillon.pdf

[48] Brian DeWaele-Dillon. (2018). *Anaerobic Digestion at UCSD: A Feasibility Study*. Retrieved from: https://www.ucop.edu/carbon-neutrality-initiative/_images/cni%20posters/2018/brian-dewale-dillon.pdf

disposal option more attractive to local breweries, some sort of incentive such as a tax break is necessary to make it more desirable.[49] However at Vermont Technical College, their recently opened digester began operation and collection without requiring tipping fees, in order to incentivize suppliers and to be able to secure the necessary initial supply of waste to make the facility operational. This model without tipping fees is potentially still profitable, so this is another option for UCSD to be able to secure initial waste supply.[50] A second proposed waste supply source is the Miramar Marine Corps Air Station (MCAS), which is approximately 9 miles east of UCSD. The food waste produced at this base offers another valuable resource for securing waste supply to a UCSD digester facility.[51] This would be mutually beneficial to MCAS, by helping them to reach their own food waste reduction goals as well. MCAS recently won the EPAs Federal Green Challenge, for significantly reducing their energy usage, and are in the process of developing their own microgrid system. Partnership with a digester facility could help them to further reduce their climate impact, and reach their goal of reducing waste to landfill by 30%. By offering tipping fees competitive with those of traditional landfill pickup, this could be a secondary source of food waste for a UCSD biodigester, and even an additional revenue source by selling biogas produced at the facility back to MCAS Miramar.[52]

Finally, it is necessary to acknowledge the importance of private partnership in the success of the READ facility. The partnership with the company Cleanworld was vital in the development of this project since they financed the majority of the construction, and helped provide the commercialization necessary to make the project cost-effective. UCSD could make a large scale anaerobic digester facility feasible by partnering with companies such as Sea Hold and Cleanworld, which provide market research into the economic feasibility of large biodigester facilities, as well as research

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[49] (Brian Dewaele-dillon, personal communication, March 19, 2019)

[50]Babcock, Ashley, et al. (2016). Middlebury College. *The Viability Of Biomethane Digesters In Vermont: Barriers and Solutions*.

[51]Brian DeWaele-Dillon. (2018). *Anaerobic Digestion at UCSD: A Feasibility Study*. Retrieved from: https://www.ucop.edu/carbon-neutrality-initiative/_images/cni%20posters/2018/brian-dewale-dillon.pdf

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into the markets for biogas and feedstock procurement. Partnership with such companies would assist UCSD with project planning, and installment.[53]

[53] "Seahold LLC. (n.d.). *Seahold Services - Anaerobic Digesters*. Retrieved from: www.seahold.com/services/

## VII. Food For Thought: Proposing Change in Relation to the Clusters

The overall goal is to keep global warming under 2 degrees Celsius and to mitigate the impacts of climate change. This goal can be achieved by working on individual clusters that will be further explained and are contained in the *'Bending the curve'* report which breaks down the different ways to approach the issue of climate change. Each cluster is impactful in its own definition, but in many instances clusters must work together in order to be the most effective.

### Science/Technology

The *'Bending the Curve*' report states that we must "achieve a more reliable and resilient electric grid with at least 90% of all new generation capacity by 2030 from distributed and renewable technologies, such as photovoltaics, wind turbines, fuel cells, biogas and geothermal."[54] Out of these fossil fuel alternatives, biogas is not only a unique option because it offers both a clean, net-zero emission energy source, but it is also an ideal method for reducing food waste. Based upon the technological solutions cluster proposed in "Bending the Curve", we proposed how anaerobic biodigestion and biogas production can be implemented at UCSD in order to both divert food waste away from landfills, and reduce GHG emissions. An exploration of the innovations existing today for reusing coffee grounds as biofuel and the potential capacity to absorb methane with coffee grounds is a way for making crucial changes in reducing food waste. This will also transform the way individuals view waste, by utilizing this technology waste can be made into another useful product.

### Societal Transformation

In the "Bending the Curve" report, societal transformation solutions are ranked second after the science cluster, signifying the importance of these bottom-up approaches and

[54] Ramanathan. V,. et al. (2016) Bending the Curve: Ten Scalable Solutions for Carbon Neutrality and Climate Stability. *Collabra,* 2(1):18, pp. 1-17, DOI: http://dx.doi.org/10.1525/collabra.55

how closely they are related to each other in changing behavior. The high ranking of societal transformation reflects the understanding that successful climate action requires much more than simply having the appropriate technology and regulatory measures. The solutions under Societal Transformation emphasize the importance of global collaboration, communication, and education in transforming societal attitudes and practices. A lack of awareness and knowledge about food waste can be addressed through a variety of intersectional educational efforts. As a higher education institution and leader in sustainability, UCSD is in a position to create a more integrated curriculum—one that links food waste and its environmental impacts while providing students with the tools to make changes in their daily lives.

Human nature can be extremely impressionable with the amount of change to lifestyle and in understanding what is deemed as moving up in a societal standpoint. Commonly the sign of a wealthy nation is in the amount of items one can consume. This has created a large shift in what is now considered “normalized” portion sizes, causing them to become twice as large as they once were. Portion sizes do not only impact the environment but they are also harmful to individuals. As society is becoming more aware of how overeating is affecting our health, there has been little attempt in changing portion control in the establishments. Another issue is that meat consumption is seen as a higher commodity rather than plant based food. This is apparent in the amount of meat that is sought after by society. A person consumes an average of 200 pounds of meat in a yearly cycle.

The Freiburg Cup Initiative went into detail how our perception and consumption of single use items has to change. Education is crucial for this aspect of societal transformation, we as humans do not naturally think about the environmental impact of using disposable coffee cups and throwing them away. Indeed, some consumers have developed a reflex to throw away food and single used items easily. Why would they take the time to wash ustensiles if they could use disposable ones, throw them away and never have to face them again. In our quest for a more comfortable life, limited by time if people are not aware of their behaviour’s consequences by education program,

the solutions existing will not be implemented without their support. Thus, besides proposing solutions if we want people to accept and use them we need prevention in order to mitigate climate change.

### Governance

UCSD administration plays a key role for implementing and financing the solutions proposed on the campus. Concerning the reduction of disposable coffee cups with the Freiburg Cup initiative for instance, the campus administration will have to take the lead and re-negotiate lease agreements between itself and the private companies running the cafes and dining houses. Freiburg in Germany has been a living laboratory with the coffee cup initiative and with a campus the size of UCSD taking on such a project, with a great chance of success, it could be pushed that all the UC campuses need in order to implement it themselves.

UCSD will also need to work alongside students to make changes to their current dining system. This will work to benefit the school not just financially but also in terms of their satisfaction rates. Students are not currently pleased with the way things are currently running and an open dialogue between the two entities will make it so that both sides are pleased.

### Market and Regulations

In our path to propose solutions for food waste reduction, we considered the different economic incentives that could be used in order to propose efficient measures that allow us to achieve our goals by appealing to customers. For instance, offering a discount for bringing your own thermos at every coffee place on campus instead of wasting a disposable cup. Furthermore, our project takes into account how using reusable cups could allow UCSD to cut costs in terms of waste management, and to what extent these savings could cover the cost of implementing a project as the Freiburg Initiative. In addition, the energy produced from a large-scale anaerobic biodigestion facility offers a significant economic incentive to UCSD, since it would provide a sustainable, and cheaper alternative to purchasing energy from third parties.

## Ecosystem Restoration

The re-utilization of food waste through composting or anaerobic biodigestion results in the production of compost and digestate byproduct. Both can be extremely beneficial to the process of ecological restoration and carbon sequestration. The use of digestate as a source of fertilizer helps to enrich depleted soils with nutrients, and prevent soil erosion. The establishment of healthy soils will help to maintain microbial populations within soils that are vital instigators of carbon dioxide sequestration from the atmosphere.

# VIII. Conclusion

We believe that the solutions proposed in this report have the potential to significantly reduce the amount of food waste produced at UCSD, consequently reducing our greenhouse gas emissions, and putting us on the right path to reach our carbon neutrality goals. By integrating solutions that tackle the issue of food waste from multiple different angles, we are able to address this multidimensional problem, creating the opportunity to make our campus more sustainable and to foster a long-term culture of sustainability and food waste awareness.

By offering more meat alternatives and smaller portion sizes on campus, as well as by increasing student awareness of how beef production and oversized portions contribute to greenhouse gas emissions, we can significantly reduce the amount of food waste produced by UCSD, as well as our climate impact. The reduction of portion sizes could drastically decrease the amount of food thrown away by students in UCSD dining halls and restaurants, and would also help change campus culture, by instilling the idea that you should only take as much as you can eat.

By expanding existing waste reduction programs at UCSD such as the eco-container program and student composting bins, as well as introducing new initiatives such as the Freiburg cup initiative, we can continue to reduce the amount of food-associated waste we are producing from single-use food containers and disposable coffee cups.

The initiation of planning and constructing a large-scale anaerobic digester, would provide UCSD with the means to not only diverte the food waste produced on campus away from landfills, but also to produce biogas as a carbon-neutral energy alternative. This would allow us to cut greenhouse gas emissions produced by landfill waste, as well as the fossil fuels used to provide the campus with electricity. This also could help us to significantly reduce our energy purchasing costs, and would be instrumental in helping us become completely carbon neutral by 2025.

The support and recognition of student-led sustainability initiatives is also imperative to help produce a system of food waste reduction that is in alignment with

students' needs. This will also further develop awareness of the issue of food waste among students, continuing to promote a culture of sustainability on campus.

These solutions that we have proposed, address the issue of food waste from social, financial, and technological perspectives, and address all of the solution clusters proposed in the *Bending the Curve* report. We believe that by tackling the issue of food waste on campus, we are also directly impacting other important issues, like food insecurity and clean energy use. By addressing the issue of food waste, we can positively impact our campus and the surrounding San Diego community in numerous ways. With the initiative necessary to solve this problem, UCSD has the opportunity to become a leader in the field of food waste reduction and climate mitigation, serving as an example to other college campuses and communities. We hope that the solutions we have proposed can not only be implemented for the benefit of our campus, but can be expanded to help address food waste as a national problem, helping to reduce global climate pollutant emissions and bending the climate change curve.

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