Improving Campus Sustainability and Quality of Life

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Abstract

This proposal report examines two issues, namely UC Merced's effort to achieve its net zero energy 2020 Triple Zero Commitment and the lack of shade on campus. The paper works to solve these issues through the construction of a shaded walkway that is roofed with solar panels. The goal of this report is to make it clear why solving these issues is vital and to show how a shaded walkway can work to resolve the lack of shade on campus and help achieve UC Merced's net zero energy of 2020 Triple Zero Commitment.

Introduction

UC Merced forges on in its effort to meet its Triple Zero Commitment by 2020, an ambitious plan to produce zero waste, zero net greenhouse gas, and consume zero net energy. Solar energy comes to mind as the natural solution to this effort of consuming zero net energy, especially considering the sunny state and location that the university resides in. UC Merced has already begun to utilize this renewable energy, but it can be expanded by introducing a shaded walkway on campus that is roofed with solar panels.

Such a walkway does more than just close the gap between renewable energy production and total energy consumption. Students or faculty looking to traverse the campus while remaining in total shade lack any respite. Shade coverage across campus is inconsistent at best, and often entirely absent. This fact turns into a glaring oversight when taking into consideration the location of UC Merced, a university founded in the middle of a dry semi-desert where the sun bakes the earth nearly all year long. This ubiquitous heat presents a very real danger to the community. Heat illnesses affect thousands in California every year, and UC Merced lies in an area that is especially prone to such dangers.

Literature Review

Research into climate change has uncovered some worrying implications. Greenhouse gases have contributed to a significant warming beginning in the 20th century, a phenomenon spurred by the onset of human industrialization. Temperatures before this period only fluctuated about 0.2 degrees Celsius over the course of a few decades, but after this largescale greenhouse gas pollution was introduced, this rose to increases of almost one degree Celsius in a fraction of the time, with models indicating an exponential increase in the future (Crowley, 2000). Increasing temperatures are leading to a rise in sea levels, which threatens to displace millions from thriving

urban centers along the coasts and overwhelm current immigration policies (Byravan & Rajan, 2015). The possibility of economic collapse fueled by climate change could create conflict, pitting migratory bands of people against each other for the control of scarce resources (Allen et al., 2009). Due to climate change, food production runs the risk of decreasing, possibly exacerbating world hunger issues and preventing developing nations from closing the poverty gap (Fischer et al., 2004). Research has even shown that climate change and the events brought about by it can be taxing on mental health. Destruction of homes, schools, and workplaces was found to harm the ability to properly nurture relationships, and more significant climate change events, like Hurricane Katrina, left some people with mild to severe cases of posttraumatic stress disorder (Gifford & Gifford, 2016).

While these implications are sobering, solutions have been proposed to combat climate change, including solar energy. Solar energy development has the potential to reverse disastrous trends while only introducing minor inconveniences. Through careful deliberation in choosing construction sites, building solar plants, at worst, can create an excess of dust that reduces road visibility and increases air pollutants, contaminates water reservoirs, and reduces the efficiency of solar panel absorption (Allen et al., 2013). In California especially, solar energy presents unique opportunities. One study found that if every suitable rooftop in California were outfitted with photovoltaic panels, almost three fourths of the electricity sold by state utilities in 2013 could have been covered (Elmore et al., 2016). Most areas of California average from 5 to 6 hours of sunlight daily, an exceptional amount when compared to other states (Solar Direct, 2016). These properties unique to California make solar energy a popular renewable energy source for the state.

Although the consistent sun coverage may act as a boon for solar energy systems, the heat that accompanies it brings health risks. Over the course of one decade, nineteen heat events were

responsible for over 11,000 excess hospitalizations across California (Basu et al., 2014). Because of standardization, only six of these events were declared under a heat warning from the National Weather Service, leaving thousands ignorant of over a dozen heat waves. Without shade and proper hydration, areas more prone to heat dangers were left especially vulnerable (U.S. Department of Labor, 2011).

Proposal

It is understandable why the university goes to such lengths to meet its sustainability goal. Climate change is steering our environment down a path to total catastrophe, and global temperatures are rising at an alarming, unprecedented pace. Intelligent minds all over the globe have focused their attention on this foreboding climate change issue, and one solution offered is the adoption of renewable energies, which will eventually allow us to abandon fossil fuels and drastically reduce humanity's carbon footprint. Renewable energies (solar energy, wind power, hydropower, etc.) are energies that can naturally replenish relatively quickly and for the most part "burn" cleanly. Contrasted with fossil fuels, which develop over much longer periods of time and release potentially harmful byproducts such as CO2 when used, it is obvious to see the benefits of transitioning. UC Merced is working at the helm of this transition, but there is still progress to be made before its zero-net energy goal is met.

A shaded walkway would not just help the university progress towards meeting a Triple Zero goal and walk us down the path of sustainability, where our energy needs in the present are met without compromising the well-being of future generations; this walkway would also provide a solution to a glaring problem on campus: a lack of shade. Students and faculty of UC Merced, attending a university in an area of California that lends itself to sunny days for a majority of the year, have unsurprisingly come into contact with issues related to the heat. There is no consistent

source of shade anywhere for someone looking to make the trek from one end of campus to the other. This is concerning, because from 1999 to 2009 heat waves in California were responsible for 11,000 excess hospital visits, and only 6 of 19 heat waves earned a public warning (Basu et al., 2013). Exposure to heat can leave one feeling faint, dizzy, and weak. In extreme cases of heat illness, even vomiting can occur (U.S. Department of Labor, 2011). Building a shaded walkway with solar panels attached to the rooftop will protect people from such dangerous heat exposure and allow them to safely reach their destination.

The efficacy of having such a structure at UC Merced is plain to see. In their study on the application of solar and wind energy in Hungary, Lakatos et al. found that solar energy could provide "free" energy for half of a day during three of twelve months (2011). In California, where the majority of the year consists of sunny days, the timeslot where panels can receive such high solar radiation levels is greatly increased. In fact, members of the National Renewable Energy Laboratory found that 74% of the energy sold by utilities in 2013 could have been provided by solar energy if every suitable rooftop in California was outfitted with a panel (Elmore et al., 2016). This means that a roof of solar panels on the walkway could make great strides towards meeting the campus's zero net energy goal. As far as environmental effects go, building the walkway on land that has already been developed would have very little negative impact. Water usage could vary depending on the use of a wet or dry cooling system for maintenance, but virtually all systems require at most only small amounts of water for upkeep (Allen et al., 2013).

Although this walkway will provide the essential safety need of protection from sunlight, it still has the potential to provide students and faculty with much more. Design options will need to be carefully considered in order to meet that potential. For example, it may be beneficial to have the walkway raised at some parts (such as the road separating the SSM and SSB buildings from

the rest of campus) so as not to impede traffic, making it safer for pedestrians and drivers. There could also be locations along the walkway that house misting stations, where anyone feeling overheated could manually activate a spray of mist to cool down. Students and faculty may enjoy listening to ambient sounds playing from solar-powered speakers along the walkway, potentially reducing stress. UC Merced might also be able to promote campus pride and a sense of community by allowing university members to display their art in designated places along the walkway. Community feedback and inclusion will act as a guiding compass for this project, leading to a well-approved structure that will improve the lives of all those at UC Merced.

Benefits/Feasibility

The elegance of constructing a shaded, solar panel-roofed walkway lies in the fact that it addresses two pressing problems while offering promising possibilities for improving the quality of life at UC Merced. This walkway would aid the university in fulfilling its environmentally responsible 2020 goal of achieving zero net energy consumption; such a walkway would also offer the campus community consistent protection from the nearly year-round onslaught of the sun. Besides solving problems, the walkway can house a selection of community-backed features, ensuring optimal satisfaction in its construction.

Because community inclusion is such an important aspect to consider, just showing that such a walkway could solve campus problems is not enough. There needs to be proof that the community itself would be interested in seeing such a project come to fruition. In order to address this, I published an online survey, collecting a total of 48 unique responses from the campus community. The data collected presented some telling results. Out of these 48 students, almost 90% expressed interest in seeing the construction of this walkway. Extrapolating this result to the total student population of UC Merced, 6,685 reported last academic year, and using a confidence

level of 95%, this means anywhere from 5,412 to 6,567 students would like to see a shaded walkway roofed with solar panels built. That is an overwhelming majority of students even in the worst case, and presents strong evidence of community support for such a project.

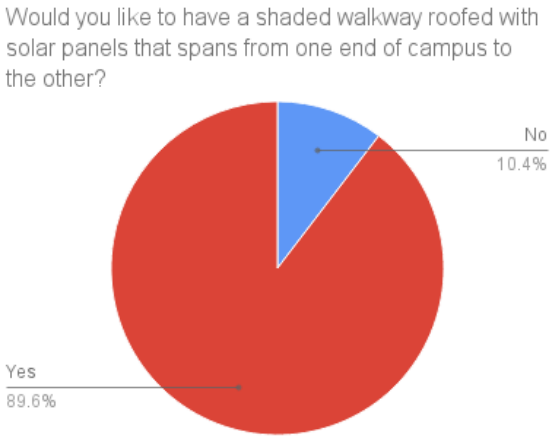

Figure 1: Student Interest Poll

In this same survey, students were also asked for their opinions on some possible walkway features: solar-powered speakers that play ambient noises/music, designated areas for students/faculty to display their art, the possibility of having an entirely raised walkway, the possibility of having a walkway raised at certain locations, solar-powered charging stations, and misting stations. This survey question acted as a gauge of community support for some possible initial features, and informs the Method and Approach section of the report. As seen in Figure 2 below, designated locations for art display was the most popular option, with solar-powered speakers and charging stations coming in second. Designated art displays would provide students and faculty with a platform to express their creative energies, and allow others to appreciate and take pride in the creativity of the community. Solar-powered speakers could possibly act as a catalyst for stress reduction, improving the overall morale of the community. Solar-powered charging stations would allow students to safely store and charge burdensome electronics, reducing

stress on the body. The implementation of each of these promising features is discussed in the next section.

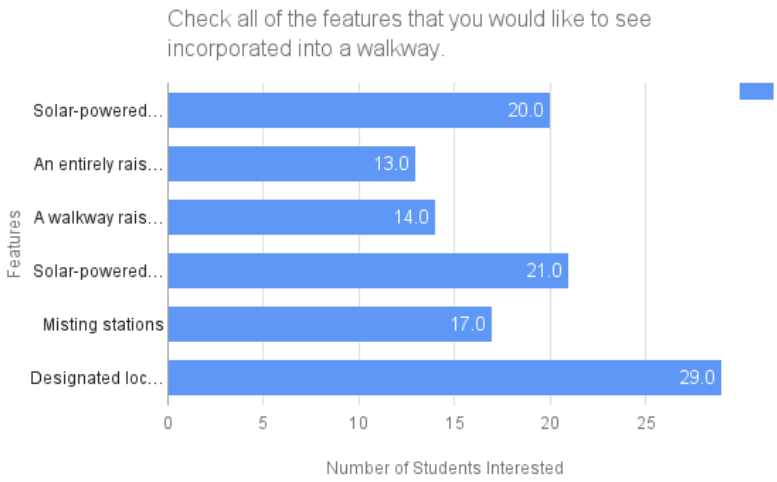

Figure 2: Walkway Features Poll

After establishing strong evidence of community support, the next challenge is ascertaining the feasibility of building such a walkway in terms of energy production. To supply a baseline of costs/production, the simplest approach is to do calculations involving a walkway that travels in a straight line from Lake Lot 1 to the SSM and SSB buildings, a distance which measures roughly 2410 feet in length. Assuming a width of ten feet to provide ample space for traffic, the result is a minimum of 24,100 square feet for placing panels. Approximately 100 square feet of panels produces one kilowatt (kW) an hour, so this walkway could potentially produce 241 kW every hour (Solar Power Authority, 2016). In 2016 UC Merced used a total of 4,389 megawatt-hours (Mwh) from January to September, and in that same period 1614 Mwh of energy were produced by solar assets, covering nearly 37% of the campus's total energy usage. This means that there is still ample room for expanding solar energy production. With the addition of the walkway, solar energy assets would be able to produce 2,051 Mwh of energy in the same timeframe, jumping the

amount of solar energy produced to nearly 47% of the campus's total usage, a significant improvement.

Method and Approach

Keeping in mind the emphasis on sustainability and community-driven design, the framework for creating a shaded, solar panel-roofed walkway is outlined below. Any costs or savings discussed are calculated using the simple straight line design outlined in the previous section, and are meant to provide a lower bound for estimating the actual costs and savings for a walkway that spans the entire campus.

The community was fairly split when asked to decide between a direct route and a scenic route, as seen in Figure 3 below. To accommodate this feedback, one simple compromise would be to create as direct a route as possible with the inclusion of hypoallergenic, floral attractions. This would promote a green, environmentally friendly attitude while also minimizing upfront costs, and should maximize the satisfaction of the community. As more of the 2020 expansion details are revealed, it may become necessary to plan a direct route while taking into consideration upcoming campus additions.

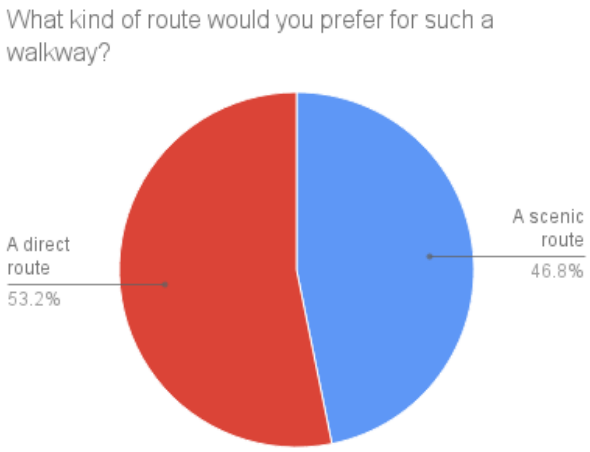

Figure 3: Route Preference Poll

In the spirit of maintaining this green, sustainable theme, recycled building materials should be used as much as possible, and trash, compost, and recycling receptacles should be placed intermittently along the walkway route. Using recycled building materials would not only be viewed as environmentally conscious, it would also reduce costs. Recycled building materials are often cheaper than their unused counterparts, and it may be possible for the university to secure a discount for purchasing large quantities.

Just as important as route design and construction, feature implementation turns community feedback into physical manifestation. The most popular survey option, displays designated for the showcasing of student/faculty art, should also be the easiest feature to implement. Portions of the walkway should be partially walled so that cases for displaying art can be mounted. This would protect the art from the elements while providing a platform for the community to share its creative interests, all with relatively low increase to cost. The more difficult and expensive implementations would be the solar-powered speakers and charging stations. These would have to be designed to be secure, weatherproof, and aesthetically pleasing. The charging

stations could possibly be implemented using a two-step checkout system; if a student scans his or her CatCard and then enters a custom PIN number at an open charging station receptacle, they could leave their electronics and return at a later time, opening their receptacle again with the same two-step process. One way of discouraging theft would be to allow access to the charging stations only during business hours, when the walkway is experiencing regular traffic and charging stations are under crowd surveillance. Beyond non-intrusive placement and weatherproofing, one pressing challenge for solar-powered speakers would be music selection. Finding a playlist appropriate for the whole campus is challenging, but the solution most likely lies with ambient, soothing sounds, such as the patter of rainfall on concrete or the gentle lapping of waves on a beachhead. These simple sounds are universally known and almost certainly accepted, making them the most promising form for auditory stress relief.

The last major factor to consider for building a shaded walkway is costs. No matter how beneficial a project is in theory, it means nothing if there are no monetarily feasible avenues for pursuing production. In terms of electricity costs, where California charges 15 cents per kW, this walkway would save, at minimum, $79,168.50 annually assuming a daily average of six hours of sunlight (U.S. Energy Information Administration, 2016). Residential solar panel purchase and installation currently costs about five dollars a watt (Solar Power Authority, 2016). Only taking into consideration the price, without subsidies, of purchasing and installing 24,100 square feet of solar panels, building a 241 kW walkway would cost just over 1.2 million dollars. It is worth noting again that this figure is an estimate using residential costs. Buying solar panels for utility-scale systems often ends up being significantly cheaper. The walkway would produce enough energy to pay off this baseline cost in just over 15 years, making it a worthy investment in the long run. Even taking into consideration the cost of recycled building materials, payment for labor, and the cost

of implementing the features discussed, a full return on the initial investment can be expected within only a few decades, with nothing but positive returns left to be reaped thereafter.

Conclusion

UC Merced's 2020 Triple Zero Commitment may be ambitious, but that only means every feasible opportunity should be taken to meet the goal. This shaded walkway roofed with solar panels, while accompanied by somewhat daunting initial costs, presents a great opportunity to make a long-term investment that helps the environment, helps the university save money, and helps improve the community's quality of life for generations to come. By setting a stellar example, other universities will be encouraged to adopt practices that will help reverse climate change – and the disasters it entails – and hopefully pioneer a societal shift focused on sustainability and ensuring the posterity of the human race. By promoting a green, sustainable structure that protects the community from the dangers of heat in the Central Valley and incorporates amenities that instill a deeper feeling of relaxation, pride, and comradery, UC Merced is also making a long term investment in its students and faculty. These individuals will remember that UC Merced cared, that it was willing to take an extra step to bring individual comfort and build an environment safe for seeking knowledge and growth. That kind of care is what will set UC Merced apart and add to an ever-growing, noble legacy.

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