

COVER PAGE  
Distributed Power Generation Project Proposal

Submitted by: UC San Diego ESW

Project Title: Solar Tree Project

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Total Funding Requested: \$ 9900

Authorizing Signatures:

  
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ESW Faculty Advisor

1/20/2011  
\_\_\_\_\_  
Date

  
\_\_\_\_\_  
Student/Project Leader

1/20/2011  
\_\_\_\_\_  
Date

### **Executive Summary**

After a brief review of extant projects regarding the feasibility of Solar Photovoltaic (PV) Charging Stations for Electric Vehicles (EVs), we propose to build a demonstration Solar PV Charging Station for UC San Diego’s electric cart fleet. UCSD has many locations with high pedestrian and utility cart traffic, offering both practical use and high visibility for building maximum awareness about sustainability utilizing the latest in non-carbon emitting technology.

A well placed off-grid solar PV electric cart charging system for utility carts will fulfill a couple of key roles. It will provide a location for utility carts to keep their voltage levels up, extending battery life. It will result in lower emission levels because its energy will be 100% solar and off-grid; the project may even result in cost savings and a potential for better energy-resource allocation as less carts require energy from UCSD’s main grid. The station will also serve as a location of interest for students, faculty, visitors and media to use and ask questions about, garnering attention for ESW, SunEdison, the UCSD-student partnership and the greater mission of sustainability.

### **Review of Similar Projects**

Although a relatively recent concept, there have been a number of companies pursuing the creation of solar PV charging stations for EVs around the turn of the century. In 2009, Chicago revealed its first solar PV EV charging station, and as far back as 1998, the city of Santa Monica moved to authorize a 31 kW solar carport for the Civic Auditorium, which could easily be used to charge EVs. The need for such stations is underscored by a 2010 Electrification Coalition report that indicates, “75 percent of light-duty vehicle miles traveled” could be electric by 2040.

Goal setting for EV use is a step in the right direction for sustainability in the United States, but to meet these goals would clearly require the implementation of an extensive network of EV charging stations, much like the 2007 Economic Census’s estimated 117,908 gasoline stations for current vehicle use. In that spirit, ECOTality’s October 2010 announcement of a partnership with BP Products North America to test their Blink EV DC fast chargers at 45 locations is promising. Quick-charging stations are essential to the future of EV accessibility to the greater public.

### **Project Proposal and Anticipated Benefits**

We propose to meet the objectives of the “Green Island” RFP by demonstrating a utility cart recharging station using 100% clean renewable energy for use in daily operations by the UC San Diego Transportation Services Department. By placing solar panels on an aesthetically pleasing structural canopy in a centralized, high-visibility location, we will make renewable energy available for recharging batteries of all types, in places where electricity is needed most: where none exists now.

UCSD central campus open spaces are a series of small parks between classroom buildings. These are locations where people congregate and co-incidentally, where service vehicles are frequently parked nearby. (See Figure 1) A Green Island power

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“Green Island” utility vehicle and electronics solar charging station for UCSD campus station can generate power from the sun even on a cloudy day. For the students who visit the Green Island, they can re-charge the batteries in their portable electronic devices at outlets at the perimeter of the structure and beyond. This is a practical, useful and unique extension of the Green Island concept. We feel our team and our support groups can make this happen.



**Figure 1: Utility vehicles surround the grassy park near Warren College, a popular hangout on sunny afternoons.**

UCSD has already done the hard work; they’ve replaced many of their gas engine utility vehicles with a fleet of plug-in electric utility vehicles. We want to make a good system even better. An off-grid PV charging system adds value to the university by extending the range of its service fleet, allowing drivers the ability to accomplish more before having to return to the central charging location. (Figure 2)



**Figure 2: At the Gilman parking structure, at the SE corner of central campus, two electric utility vehicles take a break from active duty.**

With over one hundred EVs and PHEVs at UCSD, many campus vehicles sit idle at indoor charging stations. Green Island charging stations could improve usage patterns by letting vehicles recharge nearer to areas where they are used, cutting unnecessary ‘logistical’ return trips, and possibly freeing parking spaces for other uses.

We propose to design and test a system that will make university investments last longer, by preventing battery failure through over-discharge. This approach would maintain a higher average state of charge during round-trip transit, when the vehicle is away from the Transportation Department and Facilities Management recharging locations. When

“Green Island” utility vehicle and electronics solar charging station for UCSD campus

batteries under load fall to deep depths of discharge, (See Figure 3) it is crucial to recharge without undue delay. Drivers would be informed of Green Island remote location charging for emergencies.



**Figure 3 – Hybrid Vehicles have reliable long-lasting batteries because the system is designed to keep the batteries in the safe State-of-Charge area (Blue line). The green island in a convenient central park location, like above, can put batteries back into the safe zone for the return trip.**

EVs are often driven to deep levels of discharge, shortening battery life and decreasing efficiency. A Green Island can recharge before the return trip and avoid the danger zone. Solar PV for EVs may result in fewer towing maintenance calls due to depletion and cost savings for the university – we would like to work with UCSD to determine the cost effect on servicing. We propose to examine the effect on vehicle performance and any changes to driver behavior and pattern. If there is a cost savings, ESW, SunEdison and participating donor organizations will be acknowledged for the achievement.

When a Green Island utility vehicle returns to the Transportation Services Facilities, it will need less power to recharge, lowering demand for imported power from the local municipal utility grid and thereby helping UCSD to come one step closer to realizing its goal of 90% self-generation by 2011. Solar PV charging for vehicles benefits all citizens by reducing emissions from UCSD and SDG&E’s centralized power generation facilities. Recharging batteries directly from the sun increases the overall efficiency of the vehicle and charging infrastructure, avoiding the long-range transmission inefficiencies and infrastructure costs involved in maintaining and expanding utility transmission for the growing market of electric vehicles.

Our approach will put solar power at eye-level, and within arms reach, where the students, faculty and visitors can see it in use. Successful completion of this project will require teamwork among university students and co-operation with university officials. Our efforts will be rewarded with increased exposure for the donor and participating organizations, for the university, and for the students.

This project will make it easier for a new organization to bring together a community of Solar PV, EV and environmental enthusiasts. They’ll have a great sense of pride and accomplishment when they see the Green Island utility vehicle on campus being used. Students’ interest will be piqued in ESW for the privilege of recharging their laptops in additional convenient locations on campus. The contacts that we make and the bonds

“Green Island” utility vehicle and electronics solar charging station for UCSD campus

that are formed, will serve as the foundation for more student participation and membership activities for years to come.



**Figure 4 – a lightweight steel frame Envision Solar 2.4 kW off-grid PV system charging two NEVs at an amusement park. An Envision 1.4kW Solar Tree is a great shade-maker.**

The ‘Green Island’ EV charging is a relatively new concept but there are many component products available today. Off-grid charging in remote locations is a safe way to re-charge away from the home or office. Standard 120v AC service is available through a variety of off-the-shelf products at reasonable prices, like this 200 watt wall or roof mounted SmartBox solar panel from Clarion Power. (see figure 5). The \$800 SmartBox is compatible with any welded steel or extruded aluminum frame PV structure. Smart Box solar panels are modular and output standard household current. Because the inverter is included, passers-by can plug-in directly to a solar panel.



**Figure 5 - SmartBox**

The UCSD has an Advanced Zero Emission Vehicle Project already underway to eliminate greenhouse gases and air pollutants by using secure, domestic, renewable energy resources to charge a variety of vehicles. (see figure 6)



**Figure 6 – NREL Solar Tree**

The US Department of Energy and the California Energy Commission have provided \$2.5M funding for UCSD to develop strategies for mitigating the negative impacts from high penetrations of solar systems on a distribution grid. In keeping with the University’s architectural style, we plan to heed the lessons already learned and build something similar in aesthetics, but more versatile in function. While the costs of recreating a system as large as UCSD’s

## ESW & SunEdison

“Green Island” utility vehicle and electronics solar charging station for UCSD campus established charging stations are beyond the scope of the current request for proposal, we feel an off-grid solar PV charging system for utility vehicles and accessory convenience charging is within the RFP guidelines and meets the goals and spirit of the Green Island concept.

### **Conclusion**

The Solar Charging Station is a perfect fit for a Green Island Project. The system’s energy source will use solar panels for a variety of off-grid applications, including charging electric utility cart batteries and charging students’ laptops. The use of renewable solar energy is important for overall resource management. As part of the project we plan to study the use of the carts during the day (the energy demand), in relation to the available solar energy, which should be useful for any future solar projects or projects involving the management of the UCSD cart fleet.

Furthermore, this project is a perfect fit for the mission, vision and values of ESW and SunEdison. Our project utilizes the most plentiful and sustainable form of energy in existence. The application of charging student laptops is a convenience that makes life easier and builds awareness for using technology and creativity to solve global concerns.

We recognize that our project is a small part of a larger struggle for innovation and sustainability. We will engage the local UCSD community and we hope that our project will contribute to a sustainable future. We believe both this project and these ideals fall under the shared values of SunEdison and ESW: practical action, environmental accountability, partnerships & collaboration, innovation, people and relentless passion.

### **Supplemental**

#### **Budget**

All figures are estimates. Final product selections and component configuration will be determined in a trade-off feasibility study. Additional funding for equipment purchases and donated equipment may be available from supporting groups.

#### **Total Budget - \$9900**

- Marketing materials to recruit the project team / student support: up to \$200
- Solar panels: Modular systems, as many as needed, up to \$4,000
- Converters, Battery management system, charge controller, inverters, connectors, containers and electrical supplies – \$1,500
- Batteries: Individual cells, as many as needed, 5-6 kW Li-Ion or equivalent Lead-Acid - up to \$2,200
- Structural Materials (Aluminum extrusions, frame) - \$2,000

Federal, State, and local tax rebates and incentives are available to offset some of the costs, so that the actual budget may be substantially lower. Final design and commitments to equipment purchases will not exceed \$9,900.

### **Timeline / Milestones**

The following estimates are based upon concurrent milestone progress from existing support groups and new member student support. We propose a divide-and-conquer approach to assemble teams based upon skills and experiences, so that independent tasks can advance at the same time. The total project duration therefore is shorter than the sum of the estimates.

We feel the entire project could be completed within one year, assuming a moderate level of student interest. Some tasks take less than a month, but for the purposes of this request we round up to the nearest month to allow for unforeseen circumstances. One of the biggest variables is student scheduling. Another is university participation and approval process. Considering the recent member and volunteer activity for ASES and the prompt and enthusiastic responses from UCSD officials, we are confident. We are flexible in our product design and will strive to remove and limit undue complexity. We plan to provide ESW with regular progress reports.

#### **Total project duration = 7 - 10 months.**

1. Perform a feasibility study product matrix of available products that satisfy the criteria of Green Island Concept. (1 Month)
2. Announce the project through marketing materials, campus news, and internet sites to recruit new member student and community support. (1 Month)
3. Design a solar tree with products chosen from the data in Step 1. (1 Month)
4. Identify potential Green Island sites based upon driving patterns, usage and availability of parks in high visibility areas on Campus. (1 Month)
5. Gather feedback from university officials regarding location choices and design. (1 Month)
6. Choose location from list of UCSD approved locations. (1 Month)
7. Build and test the design, monitor for charging and use data. (2 Months)
8. Review and approve compliance with University guidelines for safety and use. (1 Month)
9. Install at the approved location, test and monitor data. (1 Month\*)
10. Deliver metrics, data analysis and project review to ESW. (1 Month)

\*With permission from university officials, the test design in Step 7 may be built on-site at the approved location, and in that case Step 9 would be unnecessary.

#### **Sources**

<http://energystrategy.calit2.net/> (UCSD’s “The Endgame”)  
<http://www.businesswire.com/news/google/20090408005380/en>  
<http://www01.smgov.net/cityclerk/council/agendas/1998/s1998072806-F.html>  
<http://electrificationcoalition.org/reports/EC-Fleet-Roadmap-screen.pdf>  
[http://factfinder.census.gov/servlet/IBQTable?\\_bm=y&-geo\\_id=&-fds\\_name=EC0700A1&-ds\\_name=EC0744I1&-\\_lang=en](http://factfinder.census.gov/servlet/IBQTable?_bm=y&-geo_id=&-fds_name=EC0700A1&-ds_name=EC0744I1&-_lang=en)  
[http://www.ecotality.com/newsletter/10132010\\_BP\\_Blink\\_DC\\_Fast\\_Charger.html](http://www.ecotality.com/newsletter/10132010_BP_Blink_DC_Fast_Charger.html)  
<http://www.envisionsolar.com/>

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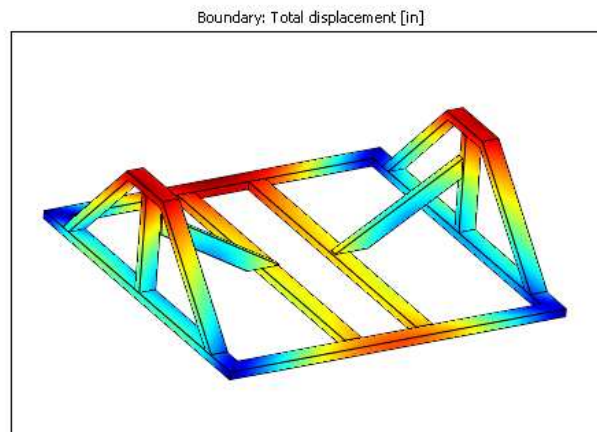
January 19, 2011

Joseph Ocampo  
Project General Manager  
University of California San Diego  
jmocampo@ucsd.edu

Dear Joseph,

I am pleased to support your efforts to develop a "solar tree" charging station at UCSD, as outlined in your application to ESW. In particular, as a California registered professional engineer, I will provide such structural analysis and design as may be required, free of charge.

In this connection I should mention that I have previously performed analysis of wind-loaded solar-reflector structures using finite element modeling, as well as of various welded trusses, as in the example below:



The concept of a solar "tree" or "island" for non-grid charging of electric vehicles is a much-needed innovation which will go far in reducing our carbon footprints.

*Kurt Lund*



Charlie Quux Johnson  
Founder, Wipomo LLC  
charlie@wipomo.com  
760-809-3391

As an energy efficiency spokesperson and a dedicated researcher of alternative fuel vehicles, I am thrilled to work with UCSD officials and student groups to accomplish the goals of the ESW / SunEdison "Green Island" renewable energy project. This is not my first experience in project management of this type. A few years ago I was the volunteer organizer for Solar 2008, an international ASES conference, with thousands of attendees and more than a hundred of volunteers. In 2010, I founded a systems integration company called Wipomo to provide energy efficient aftermarket hybridization solutions for retrofitting existing inefficient vehicles. My personal PHEVs are solar powered, as is my home, so my enthusiasm and industry experience will certainly apply. I will seek to define the "Green Island" project in realistic terms and help to organize a group of volunteers that have knowledge in specialized areas relative to the many difficult tasks involved.

For your reference, my background is in software engineering (12 years). I have a BA in English and Creative Writing from the University of Michigan, Ann Arbor. I have five years experience in computer design, database management, reporting and analysis for the \$1 Billion fundraising campaign for UCSD "Imagine What's Next". I have also developed the Solar Water Heating Pilot Project intranet web site for the CCSE, a national leader in renewable energy and energy efficiency program administration.

I look forward to demonstrating success. We will move the project forward as a team, stay on track with our tasks and timeline, and operate within the requirement guidelines and protocols of the university.

Thank you for your consideration,

A handwritten signature in black ink, appearing to be 'Charlie Johnson', written over a printed name.

Charlie Johnson



9500 GILMAN DRIVE  
LA JOLLA, CALIFORNIA 92093-0908

Re: **ESW UC San Diego Bid for SunEdison Green Island**

1/21/11

Dear Reviewer,

This letter is in support of **UC San Diego's ESW/ASES project proposal for a solar charging station** under the joint ESW/SunEdison grant. As a nationally recognized leader in sustainability, UC San Diego is committed to supporting projects that will help the campus and region achieve carbon neutrality by mitigating greenhouse gas emissions, while promoting the use of clean renewable energy. To this end, UC San Diego strongly supports the goals of this proposed project. In addition to meeting the goals of the joint ESW/SunEdison grant, this project will bring more sustainable and renewable energy sources to the campus, as well provide a stimulating educational resource to students and faculty.

UC San Diego's long demonstrated commitment to protecting the environment has resulted in being recognized as a leader in sustainability. Early campus research by Charles David Keeling, which documented the rise of carbon in the atmosphere and led to development of the Keeling Curve, has been a catalyst for ongoing research and operational projects that continue to promote innovative sustainability initiatives. The campus is LEED certifying multiple buildings, expanding its 1.2 Megawatt PV system, and installing a 2.8 Megawatt renewable energy Fuel Cell. These sustainability projects, including that proposed by the joint ESW/ASES group, have been possible due to the collaborative efforts of organizations, staff, and students to develop and fund these initiatives.

As a result of the campus' environmental leadership, individuals from around the world turn to UC San Diego for ground-breaking sustainable research and solutions. The campus has been ranked as one of the greenest universities in the Nation by Sierra Club, Greenopia, and the Sustainable Endowment's Institute. This project would continue our environmental leadership by demonstrating progressive solutions for electrification of transportation through the utilization of solar electricity. It also provides an opportunity for the students of ESW-UCSD to not only bring more sustainable resources to the campus, but also to have the experience of leadership and hands on work that comes with designing, building and installing a working system.

I encourage you to support the UC San Diego ESW chapter. This grant, by being put in the hands of a dedicated team of students at a supportive university, will improve the campus community on a number of levels and the experience will prepare these individuals to become leaders in their fields. The ESW/SunEdison grant would be well used if given in support of this unique solar charging station.

Sincerely,

A handwritten signature in black ink, appearing to read "Dave Weil".

Dave Weil, PE  
Director, Bldg. Commissioning & Sustainability  
UCSD Auxiliary & Plant Services



Jan Kleissl, Assistant Professor  
DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING (MAE)  
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9500 GILMAN DRIVE  
LA JOLLA, CALIFORNIA 92093-0411

Re: **ESW UC San Diego Bid for SunEdison Green Island**

12/2/2010

Dear Reviewer,

I am writing this letter to **strongly support the ESW bid for the SunEdison Distributed Power Generation project**. UC San Diego is a global climate leader, both in research and operations. Among other accolades, UC San Diego Won the National Climate Leadership Award at American College & University Presidents' Climate Commitment Summit; San Diego was named iHub for Solar Energy Storage by Governor Schwarzenegger; New CA legislation requires the CPUC to consider and determine roadmaps for major electricity providers to procure energy storage systems by the end of 2015; and Greenopia rated UCSD third among U.S. campuses.

DOE announced in August 2009 to make the San Diego region the largest transportation electrification project in U.S. history through a \$99.8 million grant. Additionally, Nissan North America stated, "Based upon UC San Diego's established sustainability goals and its leadership in Smart Grid technologies, Nissan is prepared to commit to a minimum of 20 Nissan Leaf electric vehicles to UCSD. These vehicles are scheduled for initial delivery in the US early 2011, and Nissan further commits to have UCSD among the initial recipients in the US." Furthermore, 142 rechargeable neighborhood electric vehicle carts and 153 rechargeable electric utility carts operate around campus. Electric bicycles are available throughout campus.

Why do we still need the SunEdison/MEMC grant? It is simply because many of these accomplishments occurred solely through research and campus operations. The student component in these project was small or non-existent. This is not because of a lack of enthusiasm, but because many of these projects are governed by complex regulations and require a significant amount of funding. The Green Island project is a perfect fit because it can be designed to be off-grid (i.e. safe) and the equipment purchase will allow a significant investment in solar charging and energy storage that will allow the ESW chapter to get a seat on the table with the 'big guys' on campus. The project will result in high visibility to ESW and SunEdison by opening a centrally located solar charging station to be used by electric carts and vehicles but also to charge student laptops and cell phones.

Electrification of transportation together with solar electricity will yield dramatic reductions in greenhouse gas emissions. I encourage you to support the UC San Diego chapter as we enter this 'Endgame' for making our campus carbon neutral. UCSD's advanced energy storage projects and implementation plans will be applicable to many other large commercial customers & industrial park establishments, premium power parks, and municipal utility systems seeking to improve their energy management, reliability, and security.

Yours sincerely,

A handwritten signature in blue ink, appearing to read 'Jan Kleissl'.

Jan Kleissl