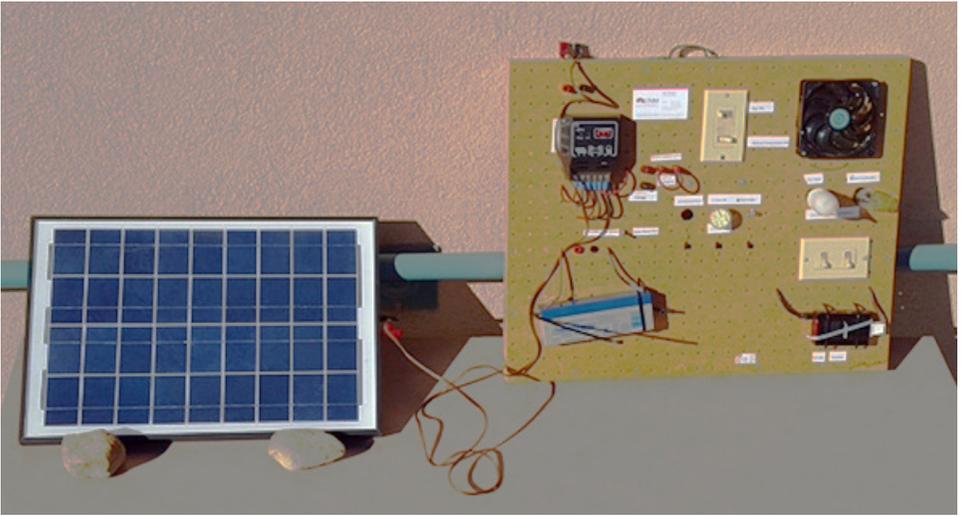


Creating Resources for Solar Outreach

Outreach involves more than standing in front of a group of students, talking and demonstrating processes and concepts. Outreach can also involve designing and building resources to support learning. Three QESST projects demonstrate this kind of outreach activity.

The Solar Energy Board

Working with a team of QESST students, University of New Mexico Outreach Coordinator Stefi Weisburd designed and built a board that demonstrates how a home solar system works (solar cell, inverter, battery, charge controller) with loads including an incandescent, LED and compact fluorescence light and a fan. The board essentially consists of basic electrical elements such as a fan and a few lighting components that are driven by a solar panel through a charge controller. It also has a 12V battery which can be charged by the solar panel. When they use it for outreach demonstrations, the New Mexico team usually packages it as a “virtual” home that could be run entirely on solar power and the battery could be used to store charge during the day to be used later. With regards to the lighting components, there are a couple more concepts that can be demonstrated using this setup. It consists of DC lamps (incandescent, LED, halogen) and AC lamps (incandescent and CFL) and an inverter between the two lamps. The team uses this to explain the differences between the energy produced by the solar panel versus the conventional city electricity supply. Also, even amongst the DC or the AC lamps, we could use the different types as in hal-



ogen vs incandescent vs LED to demonstrate which one of these is the most efficient by measuring the voltage and current (the board has hookups for this too). Learn more about this project on the QESST Education website.

Tonto Creek Solar Install Project

QESST graduate and undergraduate students at Arizona State University, the University of Arizona, University of Delaware, and Caltech banded together to design and build a stand-alone photovoltaic energy system. The student-led project aims to design, build, and install a PV battery demo system for use at Tonto Creek Camp, a new QESST Education partner. The energy generated from this student-initiated and student-led project could be used to provide power for lighting or electrical outlets to power a myriad of energy needs for campers. Educational materials and activities are being developed around the installation so that it can serve as an educational resource for campers. QESST Scholars Pablo Guimera Coll and Sebastian Husein are leading the project, with support from University Student Liaison Officer Michael





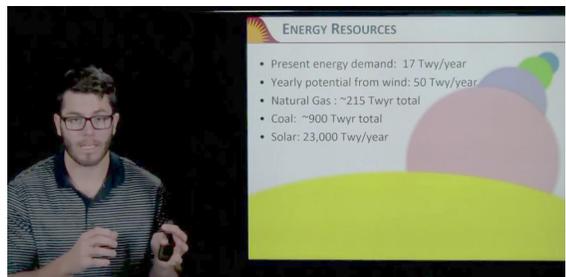
Goryll, Education Director Michelle Jordan, and QESST faculty Stuart Bowden. QESST students from four partner universities participated in the first planning meeting. Several of our solar industry partners contributed mentoring and materials. QESST scholars see this student-initiated project as a way to learn hands-on skills in PV installation, thereby gaining broad knowledge to situate their research in the larger applied picture. Find solar installation documentation for this project on the QESST Education website.

Audio-Video Lecture Series on Photovoltaics

Edward Lebeau, ASU undergraduate in Electrical Engineering and Barrett Honors student, completed his honors thesis project with QESST in spring 2017. Edward created an animated lecture series, All about Photovoltaics, aimed at a high-school/early college level audience. Having worked in the ASU Solar Power Lab during his sophomore year, Edward knows the complete cell process. The lecture series includes 10-minute videos recorded in a colloquial style appealing to a broad audience. Edward's intention was to completely document the process of making silicon-based solar cells to help train students. The five-part lecture series is available on YouTube; the links are also posted to the QESST Education website. This kind of "outreach" has the potential to impact thousands of people who may click on these links for years to come. This project was supported by Michael Goryll, Edward's thesis director, as well as Stuart Bowden, Chris Honsberg, and Som Dahal who provided materials and assistance.

[Lecture 1: Introduction to the lecture series \(Terawatt Challenge, Motivation\)](https://youtu.be/ETrlygFyZWo)

<https://youtu.be/ETrlygFyZWo>



Lecture 2 Part 1: Operation of Silicon Solar Cells

Topics: operation, generation of band gaps, losses, lifetime, and IV curves of solar cells

https://youtu.be/TZG6J4sYJ_k

Lecture 2 Part 2: Operation of Silicon Solar Cells

Topics: open circuit voltage, contacts, resistance, and reflectance.

<https://youtu.be/2zFTgFi8RAs>

Lecture 3 Part 1: Manufacturing

Topics: touches on physical aspects of a solar cell: wafer, emitter, ARC (anti-reflective coating), BSF (back surface field), front contacts, losses/balance

<https://youtu.be/cj7isZa-q7E>

Lecture 3 Part 2: Manufacturing

Topics: the manufacturing process from sand to cell: Making wafers, cleaning, texturing, diffusion, screen printing, firing

<https://youtu.be/khivg12I1g0>

Partner Universities Participate in Virtual Outreach

QESST Scholars enacted a virtual activity entitled “Visiting College Campuses” for a STEM Saturday outreach event in Spring 2017. This activity was created as one way to involve all QESST university partners in a single outreach event. A Google document was organized by the education coordinator and shared with all QESST volunteers across partner universities. This document was intended to collect ideas about how the scholars wanted to share information about their research, university and themselves. A script was created for them to use to talk to the STEM participants. QESST scholars from the University of Delaware (UD), Caltech, MIT, and the University of Arizona (UA) introduced the STEM students to their perspective labs and talked about engineering and college life in general. Audio-video recordings were made of these interactions and plans are being made to share them in order to inspire and inform future virtual outreach activities.





Flame Challenge

QESST faculty Mariana Bertoni's DEFECT Lab participated in the "Flame Challenge," an international competition in which scientists communicate their answer to a technical question in a clear and entertaining way to an audience of 11-year-olds. Each year, young students from around the world submit their questions as a challenge to scientists who wish to enter The Flame Challenge. Based on popularity, a team from the Alda Center selects an appropriate question and challenges scientists to submit written or visual entries that an 11-year-old would find interesting, understandable, and maybe even entertaining. After screening for scientific accuracy, the entries are judged by thousands of 11-year-olds in schools around the world. The winning scientists are brought to New York to be honored in June at the World Science Festival.

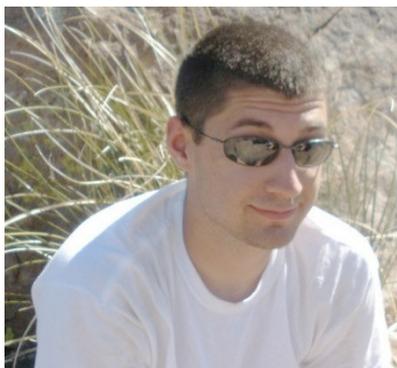
Bertoni and her students submitted a video and written entry answering the 2016 competition question, "What is sound?" Their 5-minute video entitled, "Hello, What's that Sound?" features lab members singing to the tune of Adele's "Hello." It also features multiple shots of the DQESST lab! Their video was close-captioned for people with hearing impairments.

In 2016, about 26,000 students from 440 different schools participated as judges for The Flame Challenge. The United States was well-represented, with 38 schools registered, including a few from Puerto Rico and the US Virgin Islands. Additionally, the contest attracted participation from across the globe, with participating schools including: Australia, China, India, New Zealand, and Thailand among others. Because the contest entries are judged by thousands of 5th and 6th grade students around the world, members of the DEFECT Lab possibly influenced a significant number of young people. You can see their video link here: <https://www.youtube.com/watch?v=U-67VDG244Y>

We challenge QESST scholars to submit to the Flame Challenge next year!

Education Outreach Awards

The “QESST Excellence in Outreach” award is based on number of hours of outreach participated in over the year. QESST seeks to honor scholars’ dedication to educating K-12 students and the greater public about solar energy. Two QESST Scholars received the “Outstanding Outreach” award for 2016: Mark Bailly and Joe Carpenter. The award includes \$500.00 for conference travel.



Mark quotes George Eastman, “The progress of the world depends almost entirely upon education.” Mark writes of outreach, “I would love to have a world full of individuals with a better understanding of the scientific process and how to apply critical thinking to problem solving. So, I figured if I wanted that to happen I should try and make it happen. Education outreach seems like a good way to progress the world, even if it’s just a nudge.”

Joe writes, “As a former tutor, I love to help children learn. With outreach, it is even more fun because they are building something like a solar car. One of my favorite moments was when I was explaining gear ratios to a child, teaching division and fractions, and his father thanked me for giving a real-life application of them.”