# Solar Cars 101

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In visits to classrooms, students make and race Pitsco SunEzoon solar cars after an interactive presentation about engineering, solar energy and solar vehicles. I adjust the content of my presentation according to age. For example, I might talk about pn junctions with high school kids and how LEDS and solar cells are essentially the same device just driven in opposite ways, but with younger students I only show them the semiconductor neighborhood of the periodic table along with a photo of a pile of sand next to a solar cell and then a slide of a silicon ingot and wafers to show how they are made.

I can do the activity without much help for 5th graders on up. For children younger than 5th grade, I need additional adults to help the students put their cars together. I also preassemble some parts for younger kids. For example, getting the big gear on the axle is very difficult, so I do that for them. Because there is not that much time in one classroom visit, I make individual kits for each student beforehand. I also show 3 slides to help with construction – one names all the parts in their kits, the second one shows a photo of a partially constructed car emphasizing the first steps (find the tiny, easily-lost 4 axle bearings and put them in the chassis plate, 2 or 3 slots from the edge) and a photo of a finished car pointing out the most critical step of the construction (sticking the motor mount on the chassis so that the motor gear and the axle gears are intermeshed only very loosely). I offer printed instructions if students prefer. I only give out the cardboard cover at the end of the class. For older students, I also leave the entire gear set so they can explore gear ratios later.

## Material

- Unfortunately, Pitsco Sunezoon cars are not cheap. With an Amazon Prime account, you can often get a better deal ($11.66/student) including free shipping than going through Pitsco with an educator's discount.
- A slightly less expensive Pitsco car is the SunZoon Lite ($7.97/student in a classroom kit).
- There are alternatives for creating solar cars out of less expensive materials on the Internet, but the solar cells are still pricy. You might keep the solar cells after the activity and give the students batteries (and a holder) instead.

These are the main ideas we try to get across:

1) Engineers solve important problems and improve people's lives (e.g., solar-powered lights for 1.4 billion people who have no access to safe, affordable lighting)
2) The word photovoltaic comes from photons (packets of energy from the sun) and Count Volta (said with a vampire accent), an Italian scientist who lived in the 18th/19th centuries.
3) The first person to observe photoelectric effect was 19 years old Edmond Becquerel. Einstein received his only Noble Prize for explaining the photoelectric effect.
4) From a mere pile of sand we can make amazing devices in our everyday lives: solar cells, LEDS, and computer chips.
5) Solar energy is clean, renewable and abundant, but has some disadvantages for use in cars (clouds, night, need heavy batteries, low efficiency implies need for lots of surface area).
6) Students (not much older than you) who compete in the *World Solar Challenge* in Australia and the *American Solar Challenge* are driving remarkable advances in solar car technology.
7) One student group designed and built a car (called Stella Lux; https://solarteameindhoven.nl/stella-lux/) that is breaking all kinds of records, is the first "energy positive" family car and is street legal in the US and the Netherlands. I usually show a video about this group from YouTube (google "YouTube Stella Lux").

From making the solar car, we hope the students gain an appreciation of how the motor gear drives the rear axle gear, how switching the PV contacts on the motor change the direction of the car, that the car goes fastest when the PV panel is facing the sun, and that the car stops as soon as it goes into shadow. With respect to the latter, some students (and teachers!) sometimes confuse the solar cell with a battery and are surprised that the cars stop so fast.

Questions to Guide Thinking During Solar Car Activities

- Show a slide showing different people's attempts at making solar cars in the past and ask, "What do you notice about solar cars?" (They are flimsy, hold one person)

- Why are we interested in solar? (clean, renewable and abundant energy, climate change)
- Why do you think you don't see solar cars on the street? (panels are not very efficient so need large areas, need batteries if you want to drive at night or when it's cloudy)
- What happens if you switch the solar panel's alligator clips attached to the motor? (the car goes the opposite direction)
- What orientation of the PV panel to the sun makes the car go fastest? (Perpendicular)
- How do you think you could improve your car's speed? (additional or more powerful solar panels, lighter materials; depending on the students' background knowledge, you can bring in the ideas of series/parallel and gear ratios)

What I like about Outreach using Solar Cars

We have been making solar cars with students at Title I, minority-majority schools in New Mexico for nearly five years. New Mexico has the highest rate of childhood the nation poverty and always scores last or near last in the annual Annie E Casey Kids Count reports, so it is extremely gratifying to be able to send the cars home with the children. Most students cannot believe that they get to keep their car. We are now at the point where we are meeting students who say their older siblings received a car, and now they get one of their own. I also meet a lot of older students in other contexts who tell me that they still have their cars.

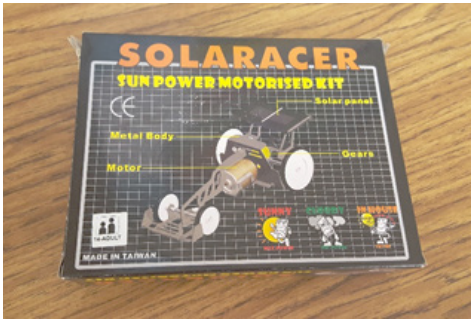
I also cherish the notes and pictures I get from kids. One of the more memorial ones was from a girl who said she did not plan on being an engineer, but she really appreciated the car because it gave her something to do with her younger brother – they took it apart and put it together a million times. Here's a note another non-engineer girl slipped into my pocket as I was leaving her class: "Hey Steffie! Thanks for stopping by our class today to give us those AMAZING solar powered cars! When I grow up I want to be a zoologist! Even though I'm not going to become an engineer I still think that building and creating things should be my part time job! :)" She drew a picture of herself and a lion standing on some boulders. It was all done in purple ink.

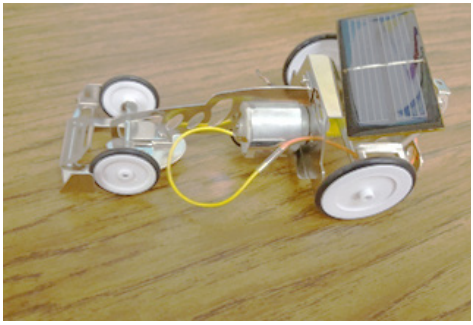
An alternative is Lego Solar cars, which use lego parts and gears, lego motor and small solar panels. The following solar car activity was designed by Joycetta Yazzie, a 2016 QESST RET who teaches sixth grade at Kayenta Unified School, Kayenta, Arizona.

## Solar Racers from Ms. Yazzie's class

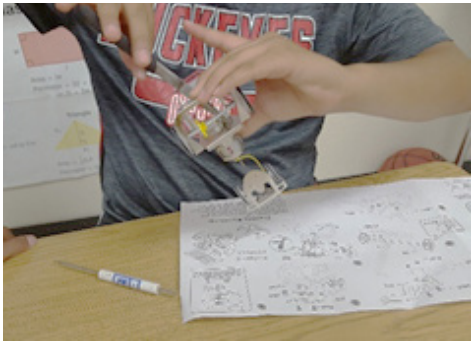
There is a global demand for energy which leads to a focus on sustainability. On the Navajo Reservation, located in parts of Arizona, New Mexico, and Utah, Native American tribes are becoming more interested in methods to sustain energy. The notion of teaching renewable resources to students can broaden their understanding towards different types of renewable energy, spreading the awareness of sustainability practices related to energy generation and energy use.

Students in Ms. Yazzie's class built their Solar Racer cars using Solaracer kits. They tested their cars multiple times, graphed results, and made their analysis.



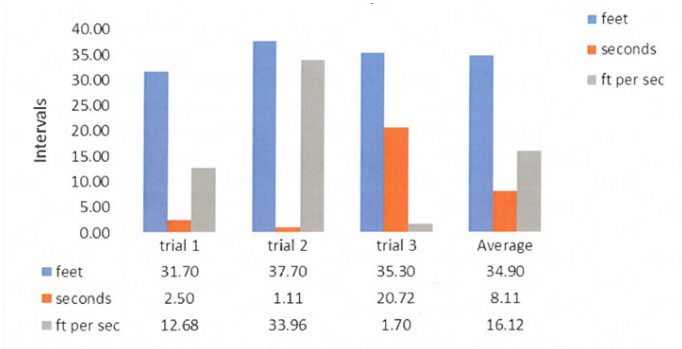



Students were EXCITED to see their Solar Racers working as they were being tested for the first time. They tested their solar cars on three different surfaces; asphalt, concrete, and dirt. The weather was not always cooperating with the activity, either. "CLOUDS, our nemesis!" As one student said.

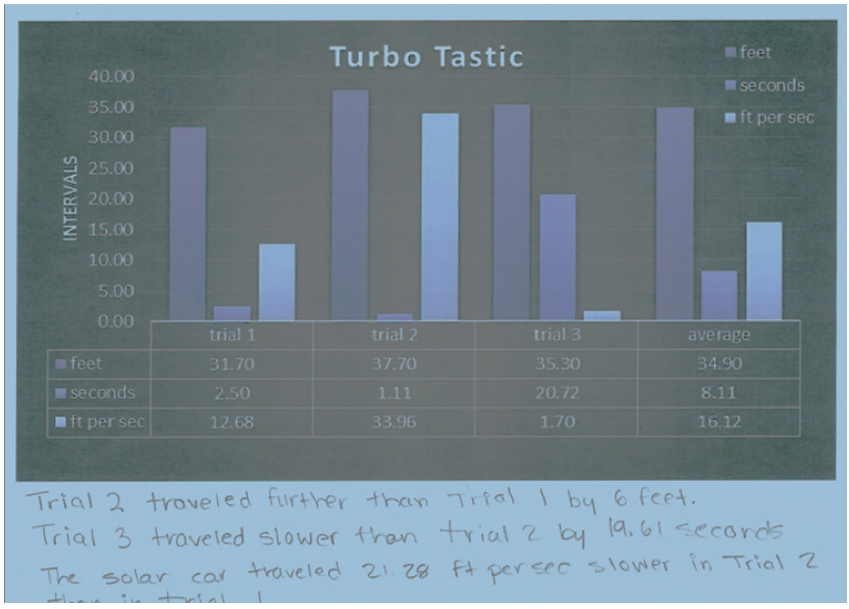


Students tested their Solar Racer on cement in three trials. They had to measure how far their solar car went in feet and in how many seconds. Testing the solar cars on three different types of surfaces did not work out because the Solar Racer cars were starting to fall apart after testing them for three trials on the concrete. Students were starting to lose their bolts to their cars. They tried to make adjustments here and there to keep them intact, but we knew that they were going to keep falling apart. So, the teacher made the final decision to test the Solar Racer only on the concrete.

Students learned to collect and analyze data using a bar graph created in Excel. They compared their findings on a bar graph rather than a line graph because it was easier to compare the differences between feet, seconds, and feet per second.




1.) The solar car traveled 6 ft. farther than Trial 2 than in Trial 2.
2.) The difference between Trial 1 and Trial 2 is 1.39 seconds.
3.) The solar car traveled 21.28 ft. per sec. slower in Trial 2 than in Trial 1.




Trial 2 traveled further than Trial 1 by 6 feet.
Trial 3 traveled slower than trial 2 by 19.61 seconds
The solar car traveled 21.28 ft per sec slower in Trial 2