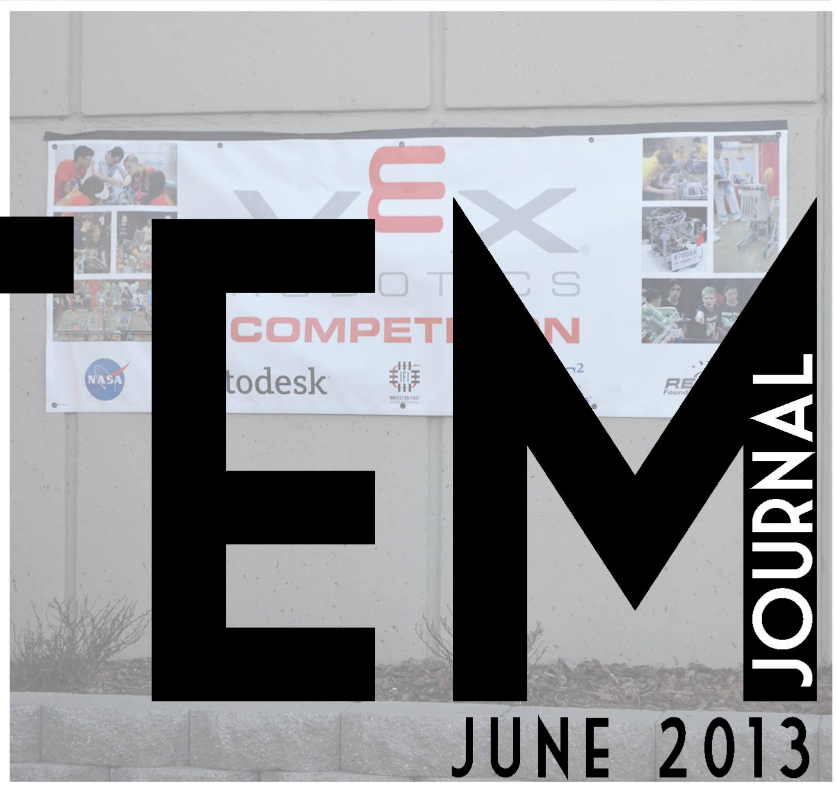




STEM JOURNAL

JUNE 2013

Editor's Note

Welcome to The STEM Journal, our new publication showcasing the independent, classroom based, or competition driven research of STEM high school students. This journal not only establishes a platform to share our work with fellow STEM students and our community, but also provides students with an opportunity to practice reporting their work, editing journal submissions and producing a science-oriented magazine.

The online publication of this journal (located at stemjournal.wordpress.com) includes opportunities for STEM students to get involved in; this includes internships, competitions, and classes. We hope to ignite students' interest in conducting their own studies and delving further into the STEM areas that interest them most. We encourage members of the STEM High School community to submit their work, to be published in the next edition of The STEM Journal, to thestemjournal@gmail.com.

I would like to thank the staff and the contributors to this first edition. Without your enthusiasm and hard work, this first edition would not have been possible.

Madison Minsk

Find us at:

http://stemjournal.wordpress.com/

Reach us at:

thestemjournal@gmail.com

1st Edition

June 2013

In This Issue:

The STEM Journal

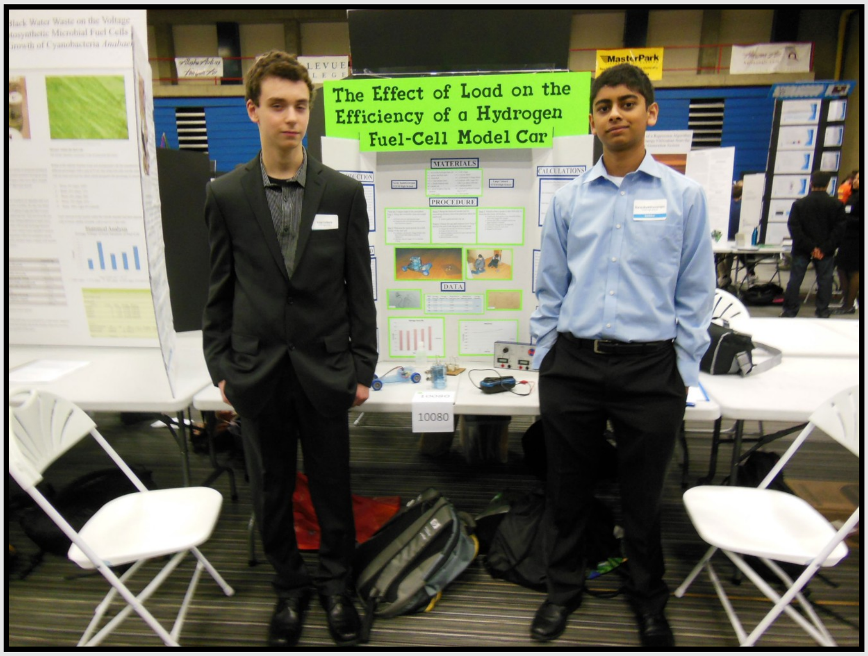
The Staff

The Effect of Load on the Efficiency of a Hydrogen Fuel

Luigi Coltorti and Suraj Buddhavarapu

Summary

Our goal in this experiment is to understand the relationship between load and efficiency and to be able to apply that to real-world applications. In addition, we would like to learn the feasibility, usability, and practically of hydrogen fuel cells when they perform in the real world. We can determine these things by examining times for recharging, the distance our model car can travel, the time that it takes to empty the fuel cell, and the effects of load and how it affects a fuel cell.



Luigi Coltorti and Suraj Buddhavarapu

Introduction

The laws of physics predict that the efficiency shouldn't change as load increases—since there is a set amount of energy going into the fuel cell. In addition, the output, measured through Force and Distance are decreasing proportionally, making work be the same. Nevertheless, this experiment is designed to test this in the real-world. The experiment will also reveal the efficiency of the car, which has important real-world implications for the possibility of using Hydrogen Fuel-Cells for real-world transportation. A hydrogen fuel-cell generates electricity through an electrochemical reaction where oxygen is combined with hydrogen to produce water. In the fuel cell used here hydrogen is produced through electrolysis of water; a process in which an electric current meets water in a special membrane that separates the oxygen from the hydrogen.

In this experiment efficiency of a hydrogen fuel cell was tested using a model car. Efficiency is defined as a measure of work output to energy input. The independent variable used in this experiment was load. The load was applied through a small card-board sled that was attached to the back of the model car. The objective was to use different loads and determine which combination yielded the best efficiency.

Question

How does efficiency of a model hydrogen fuel-cell car vary under different loads?

Hypothesis

If the load on the hydrogen fuel cell car is increased the efficiency of the car will proportionately decrease.

Background Info

Hydrogen is the lightest and most plentiful of all the elements, yet it has the highest energy content per weight of any fuel currently used to power vehicles. Its energy density is 141.86 Mega Joules per Kilogram, or 39.72 Kilowatt Hours per Kilogram, which is 3 times more than gasoline (which has 46.4 Mega Joules per kilogram). Hydrogen is environmentally friendly, as it causes little to no pollution. It is also odorless, colorless, tasteless, and nontoxic. In addition, hydrogen is extremely flammable but not in the small quantities used in this experiment.

As oil eventually becomes scarce, a competent substitute must be available. Electricity may be one of the solutions, but it relies on burning coal and oil which is not safe for the environment. Hydrogen fuel cells have potential to become a competitive energy source as it is plentiful and does not add to pollution. A deeper understanding of hydrogen fuel cells must be gained before this happens. The purpose of this experiment was to measure one aspect of the hydrogen fuel cell, its efficiency. Through the knowledge we acquire from such trials, hydrogen can become the ideal fuel for the future.

Materials

- 1- reversible hydrogen fuel cell
- 1- gallon distilled water
- 1- stopwatch
- 3- (+/red) banana leads
- 2- (-/black) banana leads
- 1- model car
- 1- set of weights (10g-50g needed)
- 1- hand crank
- 1- roll of tape
- 1- Current Meter
- 1- Differential Voltage Meter
- Computer with Logger Pro 3.8.4.2 (or later) Software Installed
- 1- LabQuest Mini
- 1- piece of cardboard (larger than 3”x4”)
- 1- force probe

Variables

There are two different things to measure in this project, the input (in power) that is going into the fuel cell, and the output (in power) that is coming out of the hydrogen fuel cell system and a sled.

- The manipulated variable is the load (in grams) added to the model car
- The responding variable is net efficiency of the model car at each load amount—calculated by measuring distance and force
- The controlled variable is the power going into the hydrogen fuel cell. The same charging method will be used. It will be turning the hand crank.
- Another controlled variable is the way the reversible hydrogen fuel cell is positioned.

Procedure

There are 5 major steps in the procedure.

Step 1: Setup the reversible fuel cell model car for the tests

Step 2: Measure the input power for each full charge of the fuel cell

Step 3: Setup the fuel-cell model car for measuring distance travelled and time taken for each load

Step 4: Charge the car and measure how long it travels and how long it travels for each load. Repeat for each load.

Step 5: Attach a force probe to the sled only to measure the force of friction.

Details for each step follows.

Step 1: Setting up the fuel-cell car for the tests

Set up your reversible fuel cell following these instructions:

- Place the reversible fuel cell upside down (numbers facing down) on the flat surface.
- Remove the stoppers.
- Pour distilled water into both storage cylinders until the water reaches the tops of the small tubes in the center of the cylinders.
- Tap the reversible fuel cell lightly to help water flow into the area surrounding the membrane and metal current- conducting plates.
- Add more water until it starts to overflow into the tubes in the cylinder.
- Place the stoppers back onto the cylinders. Make sure no air is trapped inside the cylinder. *Note: a small air bubble in the order of 0.5mL will not cause problems and can be ignored.

Step 2: Measure the input power for each full charge of the fuel cell

- Take out the hand crank and attach the POSITIVE (red) lead into the POSITIVE (red) side of the current probe. Then, take out a POSITIVE (red) lead from your extra leads and connect the NEGATIVE (black) side of the current probe to the POSITIVE (red) socket of the fuel cell. Third, take the NEGATIVE (black) lead from the hand crank and attach that into the NEGATIVE (black) socket of the fuel cell. Next, attach the POSITIVE (red) lead from the Differential Voltage Meter onto a part of the metal connecting the POSITIVE (red) lead from the current probe into the fuel cell. Do the same with the NEGATIVE (black) lead from the Differential Voltage Meter to the NEGATIVE (black) lead from the hand crank to the fuel cell. Lastly, take the connector chord from the 2 probes and connect them into the Channel 1 and Channel 2 analogue ports of the LabQuest Mini. Plug the USB from the LabQuest Mini into the computer and start up Logger Pro. The software should optimize the program for the two probes that are plugged in. Refer to Diagram 2* if needed. You are now ready for testing.

- To begin the test, have your partner press “collect” the same time you start to turn the crank. Make sure to be fast enough that the small green light turns on. Try to be as smooth and continuous as you can. Continue to turn the crank until almost all of the water from the hydrogen side of the reversible has moved to the top of the fuel cell. Hit the “stop” button the moment you see the first bubbles coming from the bottom tank to the top tank of the hydrogen (H_2) side, as this means the fuel cell is fully charged.

- Find the average for both the Current and Voltage. The power going into the fuel cell is Current multiplied by Voltage.

- Repeat this test 2 more times to make sure you have the same power going into the cell. To drain the hydrogen in the fuel cell, plug it into the car and let it run with the wheels proper up, so the wheels are running free to drain the power. Note: you can use the same water as before.

Step 3: Setup the fuel-cell model car for measuring distance travelled and time taken for each load

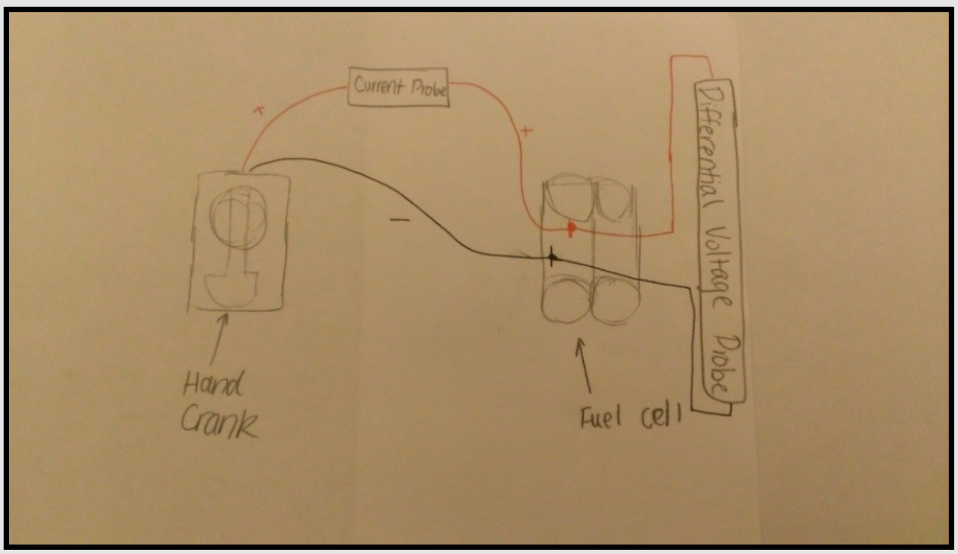
- 6. Create a small sled made out of cardboard. Cut out a small (3” x 4”) piece of cardboard. Crease one of the flat edge in approximately 1 cm and fold it out 90 degrees.
- 7. Cut a small hole in the center of the fold. Connect the sled to the hole in the back of the hydrogen fuel cell car using either a paper clip, string, or wire. Place the car on the ground and connect the charged fuel cell into the car, making sure not to spill any water from the top that is open. Be sure to only plug in one of the corresponding leads from the car to the cell, the other will be plugged in at the moment you start testing for real. It does not matter which lead you plug in and which you leave out for now.
- 8. Make sure that you have a flat and smooth surface to work on. It should be around 5 feet by 5 feet. Then, turn the front axle of the model car to the right. This will ensure that the car spins in a clockwise and you can count the number of revolutions that it takes.

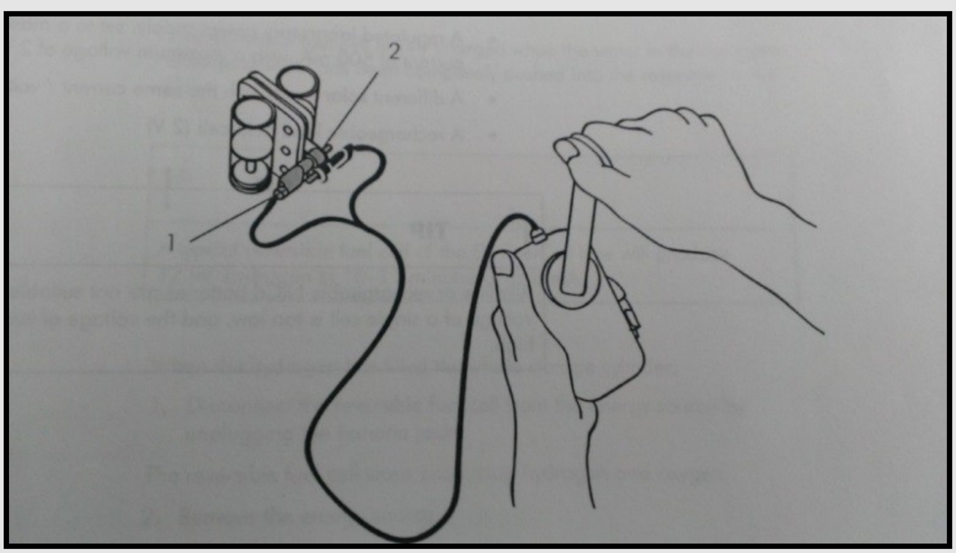
Step 4: Charge the car and measure how long it travels and how long it travels for each load. Repeat for each load

- 9. Charge the fuel cell once more, this time normally. Refer to Diagram 1* if you need it.
- 10. Have your partner have the stop-watch ready to start.
- 11. When your partner says GO, he/she will start the stopwatch as you simultaneously plug in the other lead into the corresponding socket and the car should take off.
- 12. Make sure that while one partner has the time clock, the other counts the revolutions that the car does until it runs out of energy completely.
- 13. Allow the car to completely deplete all of its energy, and wait until it is at a complete standstill. Once it has completely stopped, stop the stopwatch and record the time under the “Time à Trial 1” section of your data table that is in the 0 grams row.
- 14. Also, measure the exact distance traveled by determining the circumference and multiplying that by the revolutions that it took. The circumference of one circle is 239cm. Multiply this with the number of revolutions to get the final distance for this trial. Record this distance under the “Distance à Trial 1” section of you data table that is in the 0 grams row.
- 15. Repeat this process of charging and running the fuel cell car two more times for Trials 2 and 3.
- 16. Now, prepare for each of the 5 load changes. For this, first add 20 grams to the model car by taping 20 grams worth of weights on the car.
- 17. Repeat charging and running the fuel cell car with all the different masses. Remember to do 3 trials for each mass.
- 18. Once you have done that, you need to calculate the force exerted to pull the sled under different masses.

Step 5: Attach a force probe to the sled only to measure the force of friction

- 19. Hook up the force probe to the LabQuest Mini and open Logger Pro again.
- 20. Hook the sled ONLY to the force meter using the same piece of string, paper clip, wire etc. you used to hook the sled to the fuel cell car.
- 21. Adjust the graph on Logger Pro so it takes only 4 seconds (approx.) of data.
- 22. The moment your partner hits “Collect”, start pulling the sled across a smooth table. Make sure to keep pulling the force probe with the sled at a constant velocity.
- 23. Once you have done that test, highlight the main section of he recorded graph and hit the “Stat” button at the top. From there, record the mean for that trail into your data table.
- 24. Repeat these steps for trials 2 and 3
- 25. Repeat steps 24-26 for all masses (0g, 20g, 30g, 40g, and 60g)





Data Table: Measuring the Distance Traveled Under Different Loads

Mass (g)	Force (Newtons)				Distance (meters)			
	Trial 1	Trial 2	Trial 3	Average	Trial 1	Trial 2	Trial 3	Average
0	0.086	0.082	0.090	0.086	121	118	116	118
20	0.110	0.109	0.102	0.103	100	95	96	97
30	0.127	0.134	0.135	0.132	84	78	81	81
40	0.162	0.153	0.150	0.155	71	67	73	70
60	0.211	0.204	0.205	0.206	63	59	56	59

Calculations: Calculating the Electrical Power Being Produced

Mass (g)	$Watts = Volts \ x \ Amperage$	Final Answer
N/A	$.65 \ x \ 1.607 =$	1.01 Watts

Calculating the Energy Going Into the Fuel Cell

Mass (g)	$Joules = Watts \ x \ time(s)$	Final Answer
N/A	$1.01 \ x \ 188.2 \ =$	197 Joules

Sample Output: Calculating the Work Done by the Car

Mass (g)	$Work = Force \ x \ distance$	Final Answer
40	$.155 \ x \ 70 =$	10.85 Nm

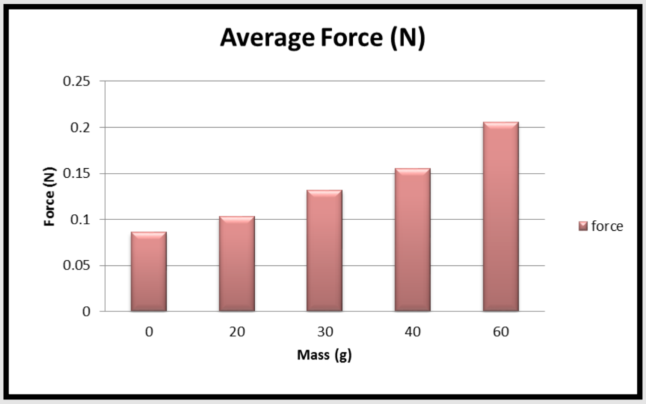
Efficiency: Calculating the Efficiency of the Hydrogen Fuel Cell

Mass (g)	$efficiency = \left(\frac{Work}{Input}\right) x \ 100$	Final Answer
40	$\left(\frac{10.85}{197}\right) x100 \ =$	5.5%

Totals:

Mass (g)	Average Force (N)	Average Distance (m)	Work Done at Each Mass (Nm)	Efficiency at Different Masses	Average Efficiency
0	0.086	118	10.192	5.1%	5.4%
20	0.103	97	9.991	5.0%	
30	0.132	81	10.692	5.4%	
40	0.155	70	10.85	5.5%	
60	0.206	59	12.154	6.1%	

Determining Percentage Different For Efficiency



Analysis

In this experiment, we got two results. First, we found that the efficiency of the fuel cell car was not going down when load was added. After completing the experiment we can understand why this happened. The work done by the car is force times distance. As the load increased the distance travelled decreased. So the work done was not changing a lot. This result also showed that he fuel cell was producing same amount of power even if loads changed.

Second, we found that the efficiency of the fuel cell was 5.4%. The reasons for this low % could be two things. The fuel cell in the model car might be an inefficient one because it is just a model kit. Another reason can be our experimental decision. We ignored the work required to pull the car itself because we created a flat sled that has a lot of friction. So we assumed that the work required to pull the sled is much more than work required for pulling the car. That could have been a wrong assumption.

Conclusion

In this experiment, we predicted that the efficiency would decrease as the loads on the car increased. The experimental data and calculations that we conducted did not support our hypothesis. We found that the efficiency of the fuel cell remained the same even as the load was changed. There were small differences in the efficiency for different loads but the values were close to the average value 5.4%. What this shows is that the fuel cell is producing a predictable amount of work on a full charge which is a good thing for real world applications. Our experiments also determined that the efficiency of our fuel-cell model car was 5.4%. In general, fuel cells that are used commercially can give more than 50% efficiency.

Overall, this was a very interesting and very challenging experiment. Fuel cells are fun to work with. There is a lot more research to be done and fuel cells will become common in the future.

Works Consulted

"Heliocentric: Solar Cell." Heliocentris. N.p., n.d. Web. 10 Jan. 2013. http://www.heliocentris.com/academia-angebot/information/die-technik-erklaert/solarzelle.html.

"How Hydrogen Cars Work." HowStuffWorks. N.p., n.d. Web. 14 Jan. 2013. http://auto.howstuffworks.com/fuel-efficiency/hybrid-technology/hydrogen-cars.htm.

"How Solar Cells Work." HowStuffWorks. N.p., n.d. Web. 14 Jan. 2013. http://science.howstuffworks.com/environmental/energy/solar-cell.htm.

"Hydrogen Fuel." Hydrogen Fuel. N.p., n.d. Web. 19 Jan. 2013. http://www.fueleconomy.gov/feg/hydrogen.shtml.

"Fuel Cells 2000." Hydrogen Basics. N.p., n.d. Web. 18 Jan. 2013. http://www.fuelcells.org/fuel-cells-and-hydrogen/hydrogen-basics/.

Morgan, Sally. *From Windmills to Hydrogen Fuel Cells*. Chicago: Heinemann Library, 2007. 16-50. Print.

Kallen, Stuart A. *Renewable Energy Research*. San Diego: Reference Point Press, 2011. 65-76. Print.

Muller, Richard A. *Energy For Future Presidents*. New York: W.W.Norton & Company, 2012. 167-236.

C.O.R.E.S.

(Collection of Renewable Energy Systems)

Kanaad Deodhar, Aaron Johnston, Richard Wen, Robert Wicks, and Christopher Yu

Summary

The Collection of Renewable Energy Systems consists of various modules designed to allow homeowners to gradually improve the sustainability of their home without a significant initial investment.

Introduction

One of the biggest roadblocks between homeowners and a sustainable home powered by alternative energy is the high initial investment that they are required to put in. Many solar arrays and wind turbines are very expensive, offered only as large installations and necessitating a full and intense commitment before purchase. With the C.O.R.E.S. modular collection, homeowners need only invest in a single solar panel or windmill module, and are subsequently able to extend their arrays. The collection itself features six modules, two of which are specialized in power generation. One of these, the Solar module, is a 3 foot by 3 foot photovoltaic panel with standardized, interlocking edges that allow large surfaces to be covered easily and in stages. The other is the Wind module, a small and efficient windmill that turns with the wind and features magnets in the rim, improving efficiency by eliminating friction-inducing components normally found in the

Christopher Yu, Aaron Johnston, Kanaad Deodhar, Richard Wen , and Robert Wicks

An Active Hot Water module heats water with the sun's rays, decreasing demand on traditional, fossil-fuel using water heaters. Two modules, the Garden and Composter modules, work hand-in-hand-- the Composter module uses warm waste water, such as from showers or dishwashers, to aid composting of household organic wastes, and the nutrient-rich compost is used to fertilize the garden in order to provide fresh and organic vegetables. Finally, a Smart Charger module creates a convenient charging point for electric vehicles, encouraging their use and using excess energy from the electricity-generating modules. The Smart Charger module is also capable of employing net metering by selling power back to the electric company when prices are high and buying it back when they are low, effectively using the power grid as a battery and making money for the homeowner.

The main appeals of the C.O.R.E.S. system are its extensibility and customizability. Based on the region that a homeowner lives in, their collection can be customized with different numbers of modules, ensuring maximum efficiency. Furthermore, that system can be expanded upon as the homeowner see savings add up or government incentives increase.

C.O.R.E.S. Cont.

The C.O.R.E.S. project consists of five components. A tri-fold board allows visitors to easily obtain information about the purpose of the project, its benefits, and some examples of how it could be used. Complementing the tri-fold is a series of handouts, containing various data about state-dependent generation potential. A 3-Dimensional physical model of an example house that employs all six modules is present, color-coordinated and containing short paragraphs that detail the direct savings provided by each module. It is also able to open, revealing the charger module and the layout of the house. Fourth, there is a digital model of a similar house, providing a more realistic portrayal of a suburban household that has been converted into a sustainable design. Finally, a website mimics the online presence of a corporation employing this collection, with information, research, benefits for each module, and an interactive customizer that allows users to select their state, learn about initiatives, and make an informed decision about their purchase.

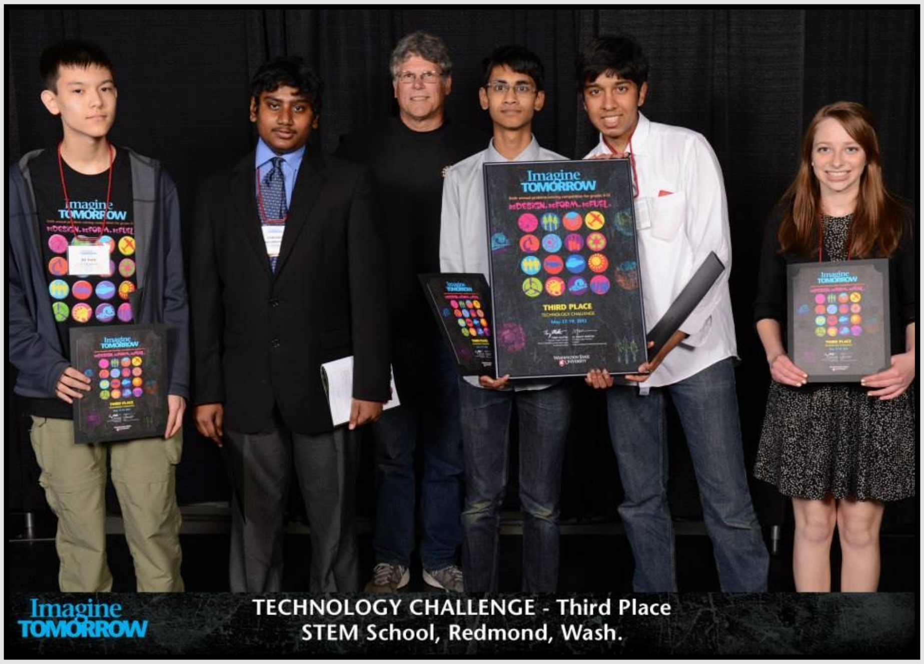
Our group hopes that the C.O.R.E.S. system can provide an answer to the problem of inaccessibility regarding sustainable design choices.

Environmentally Sustainable Desalinization

Abhishek Sangameswaran, J-D Daly, Madison Minsk, Mrigank Bhardwaj, and Pranav Vasudha

Summary

783 million people around the world do not have access to clean drinking water ("Clean"). As a result, fresh water is one of the most sought after resources on Earth. Traditional desalinization methods utilize fossil fuels as their major energy source; the most common being oil, a limited resource. Using solar thermal power to fuel the desalinization process is one step toward a clean future. However, the challenge lies in the entirety of the process. How do we achieve an environmentally sustainable process for making fresh water for every step of the desalinization process; beginning with seawater through the disposal of the leftover brine?



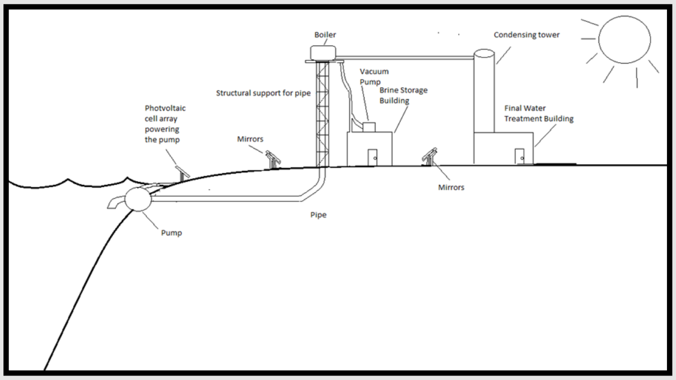
J-D Daly, Abhishek Sangameswaran, Pranav Vasudha, Mrigank Bhardwaj and Madison Minsk

Each step of the process must be environmentally sustainable, or the positive impact of using solar energy is inadequate. After careful research, two designs have been proposed: Prototype A and Prototype B. One is to desalinize water using solar thermal energy, and the other is to desalinize water and generate electricity using solar thermal energy. In each case, seawater will be pumped using photovoltaic cells, an innovative eutectic mixture will be used in the boiler, and the brine will be disposed of in a

Evaluation of Potential Clean Energy Sources for a Desalination Plant
Factors: Cost, Efficiency, and Practicality
Solar vs. Wind Power:
Solar power is more cost effective, efficient and practical than wind power to fuel a desalination plant. Wind turbines are towering structures, which require significant space, making them less viable in urban areas where fresh water is in high demand. Solar energy can be used in many places as opposed to wind energy, which is only optimal in windy places. Further, wind turbines require more maintenance than solar thermal plants. Though the initial cost of wind power is lower, solar power is the better investment because solar power pays for itself in a shorter period of time. Also, solar thermal plants have a much longer life span compared to wind farms, partially due to the lack of moving parts. Finally, wind energy suffers from a lack of energy density compared to direct solar radiation. Solar thermal plants have an efficiency of about 50% (Brightsource) whereas wind turbines have an efficiency rate of about 30% (California). Therefore, solar thermal plants take in more energy and are more efficient enabling greater energy production than wind turbines.

Solar vs. Hydro Power
Solar power is more practical, cost effective and efficient than hydropower for desalination applications. The large dams used for hydropower can have a negative impact on aquatic life, for example by disrupting salmon migratory patterns. Dams eventually alter the natural water table level and can lead to geological damage, which may lead to earthquakes. In addition, the water and geological requirements for hydropower limit the places it is practical. Also, though hydropower plants do not require as much maintenance as wind power plants they still require more maintenance than solar thermal plants. Further, large dams are more expensive to construct than solar thermal plants. Finally, though hydropower plants are 70% (California) efficient compared to the 50% (Brightsource) efficiency of solar thermal plants, the resource requirements of hydropower are very limiting. Solar thermal has an edge because it can be used in many places without disrupting the environment.

Solar vs. Biomass
Solar power is more practical and efficient than biomass. Crops for growing biomass resources require space that could instead be used for growing food. Also, burning biomass for energy produces pollution and greenhouse gasses making it a less green alternative than solar energy. Solar thermal plants have an efficiency rate of 50% (Brightsource) whereas biomass has an efficiency rate of about 1% (Biomass). Finally, solar thermal plants are much more viable for large-scale energy needs.



Prototype A- Purely Desalinization

Overview
Prototype A is a solar thermal plant meant solely for use in desalination. It will be built in places like the Middle East where it makes economic sense to desalinize, but not to generate power. This is because it is difficult to compete with the cheap oil that currently fuels most of the Middle East's power plants.

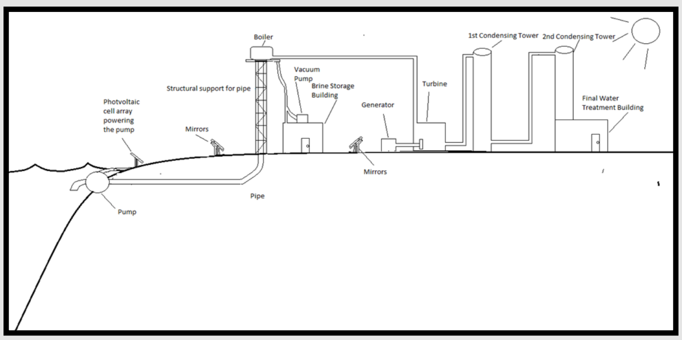
From Ocean to Land
An array of photovoltaic cells is used to generate electricity in order to power an underwater pump. This pump will be used to gather seawater.

Mirrors
The boiler is surrounded by mirror units, heliostats, polished with silver (as it is very reflective). These mirror units focus the sun's radiation onto the boiler where the seawater is vaporized. The mirrors can pivot on the x and y axes to account for the sun's path of travel during the day and time of year. They keep the sun's radiation focused on the boiler at all times, maximizing exposure of the seawater to the sun's rays.

Boiler
The pipe carrying the water from the pump travels underground and comes up, out of the ground to meet the boiler positioned at the top of a tower. After the boiler is filled with saltwater, a valve separating the pipe and the boiler closes. Then, the saltwater is boiled to a little over a 100°C. The water vapor (now fresh water) is vented out through a pipe to the condensing tower. The valve opens again to let in water and the cycle repeats.

Condensing Tower and Final Water Treatment
The condensing tower is where the steam is allowed to cool down into liquid water. The steam is channeled through a tube spiraling to the ground, while being surrounded by cold seawater to ensure more complete condensation. The water then enters a building, in which the liquid, distilled water will be given minerals and other essentials to make it better for human consumption.

Brine Collection Unit
The brine that is left behind in the boiler is directed through another pipe leading down to the brine collection building. The pipe is gravity fed as it goes straight down from the boiler..



Overview
Prototype B is also a solar thermal power plant, which boils seawater and creates supercritical steam at a temperature of about 500^0C. This steam then runs through a turbine to generate electricity, and is cooled in condensing towers. The condensed water/steam is free of brine and can be made drinkable. This prototype is targeted for desert countries like Australia and Chile, which do not have cheap resources to generate electricity like the Middle East. Prototype B is structurally similar to Prototype A except for the addition of a turbine, more mirrors (because water is being heated to 500^0C, not 100^0C), and a eutectic mixture in the boiler for purposes of thermal storage.

Turbine and Generator
Superheated steam from the boiler drives a turbine, which turns a generator shaft to generate electricity.

Boiler
The boiler is divided into two compartments, the outer shell, and the core. The core is where water enters the boiler to be vaporized. The space between the core and the outer shell is filled with a eutectic salt mixture. The purpose of this mixture is to store the thermal energy of the sun into the night so that electricity can be generated for a few hours after dark.

The Eutectic Mixture
A eutectic mixture is a mixture of salts that has a lower melting point than the substances it is made of. They are used as heat exchangers in commercial products such as coolers and hot cases. Eutectic mixtures have low melting points (takes less energy to turn them into liquid), and a high specific heat, which enables them to store thermal energy for prolonged periods of time.

The Ivanpah solar thermal power plant uses a thermal salt storage system of a eutectic mixture of sodium and potassium nitrate salts. This heat exchanger is called Hitec XL. However, it could be replaced with a eutectic mixture of lithium nitrates, sodium nitrate, potassium nitrate, cesium nitrate, and calcium nitrate.

Composition of Eutectic Mixture

Component	Weight Percent	Mole Percent
$LiNO_3$	8%	15%
$NaNO_3$	6%	10%
KNO_3	23%	30%
$CsNO_3$	44%	30%
$Ca(NO_3)_2$	19%	15%

This is an improved eutectic mixture because it has a melting point of 65^0C and thermal stability at 561^0C, as opposed to Hitec XL, which has a melting point of 140^0C and thermal stability at 500^0C. The usage of this mixture will be more efficient, and require less thermal energy input. It can also retain energy for a longer time into the night.

Prototype A Compared to Traditional Desalinization
The traditional desalination plant used in this comparison is the oil fired Fujairah Phase 1 plant. The advantages of using Prototype A instead of this plant includes, no oil cost and no CO_2 emissions. One challenge put forth by the traditional desalination plant is a slightly higher water output for less power because this plant can operate for 24 hours a day, compared to our plant which can operate for a maximum of 12 hours (the amount of time for which most deserts receive intense sunlight). Another challenge put forward by this plant is cost, but this challenge is short term. Since Prototype A does not use oil, it costs significantly less to operate, thereby saving the difference in cost in approximately **26 days**.

Comparison of Prototypes A and B to a Traditional Desalinization Plant And a Solar Thermal Plant

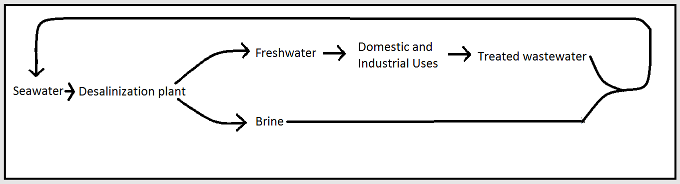
Comparison Category	Traditional Multistage Flash Desalination Plant (Fujairah Plant in Abu Dhabi)	Ivanpah Solar Thermal Plant	Prototype A (Only Desalination)	Prototype B (Electricity and Desalination)
Cost	$ 1.2 billion	$ 2 billion	$ 1.36 billion	$ 2 billion
Thermal Output in MW	760MW	784MW	784MW	784MW
Electrical Output in MW	0MW	392MW	0MW	392MW
Gallons Output/Day	3,960,000 gal.	0 gal.	3,560,000 gal.	4,000,000 gal.
Barrels of oil used/day	6175 bbl.	0 bbl.	0 bbl.	0 bbl.
Cost of oil/day	$617,500	$0	$0	$0
Cost of oil/year	$225,387,500	$0	$0	$0
Pounds of CO_2/day	6,743,100 lbs.	0 lbs.	0 lbs.	0 lbs.
Pounds of CO_2/year	2,461,231,500 lbs.	0 lbs.	0 lbs.	0 lbs.

Prototype B Compared to a Traditional Desalinization Plant and a Solar Thermal Power Plant

Prototype B, compared to both the Ivanpah plant, and the traditional desalination plant, has all the advantages of Prototype A, plus electricity generation. It is also better than the Ivanpah plant because it uses a new eutectic mixture which has a lower melting point than that used by Ivanpah (**65^0C vs. 100^0C**). The two mixtures still have the same stability temperatures of 500^0C. The advantage of having a low melting point is that it takes less thermal energy to bring the eutectic mixture to operating temperature.

Brine Disposal Methods Disposal of Brine in Treated Waste Water and Gray Water

Our proposal suggests a plan to mix leftover brine from the desalination of seawater into treated waste water (water that originated from a desalination plant) before being discharged back into the sea. This makes sure that the net salinity does not increase over any one area. This is an improvement over existing facilities which discharge concentrated brine into the sea, increasing salinity in the area of discharge, and thereby harming marine life.



Water Sources in Abu Dhabi

Groundwater: 71%

Desalinated water: 29%

Primary Water Uses

Agriculture: 70%

Artificial recharge points replenish this water to aquifers.

Domestic and Industrial uses: 30%

The primary source for this water is the sea. A very small percentage of this water is actually consumed by humans. Most undergoes at least secondary sewage treatment before being discharged into the ocean, including what is known as gray water.

Oil Well Brine Disposal Calculations for the Middle East

This is a case study of the possibility of brine disposal during oil drilling. Most of the aging Middle Eastern oil wells now use a secondary oil recovery method that involves pumping sea water into oil wells to displace the oil for extraction. The seawater cannot affect any terrestrial or marine ecosystems, as it is so deep underground. Water is saturated at about 35% salt; hence we can mix all the brine produced by desalination into this water, which will be stored permanently in the oil wells. Our calculations assume the oil wells are full, and that the oil statistics are accurate. In reality, the oil wells have been drastically emptied. Thus, we can likely pump more water into the wells. The Middle East's statistics of the amount of reserve left is also likely not true. This is a political issue; the actual amounts are not disclosed so as to keep the prices high. Since this information is confidential, it could not be included in the calculations.

Amount of oil in the OPEC: 1200 billion barrels
Share of the Middle East: 66% or 792 billion barrels
Amount of salt that can saturate that saturates water: 35g/100g of water
Salinity of the ocean: 4%
The amount of brine the sea water can take: (35-4) = 31g/100g of water

Grams of water in 792 billion barrels: 792,000,000,000 (no. of barrels) X 160 (liters in barrel) X 1000 (grams in a liter) = 126,720,000,000,000,000g

Amount of salt that can be mixed into this water = 39,283,200,000,000,000g of salt or 39,283,200,000 tons of salt can be disposed this way until the oil reserves last.

Disposal of Brine Using an Electromembrane Dialysis

If there is extra brine left over after desalination, it can be split by using electromembrane dialysis. This is currently the most efficient process by which we can produce sodium hydroxide (NaOH), and chlorine (Cl_2) which are widely used in the chemical industry. We can source sulfuric acid for this process from coal burning power plant exhaust, and use it as a source of hydroxyl ions to make sodium hydroxide (NaOH). Using electromembrane dialysis of brine allows us to get rid of excess brine, and at the same time cut sulfuric acid emissions from the power plant. We can power this process with PV cells in the case of Prototype A, and in the case of Prototype B we can utilize the electricity generated.

Viable Locations Criteria

- Dry and sunny weather
- Proximity to a large city
- Proximity to a salt water body, like a sea or ocean

Criteria Specific for Prototype A

- Proximity to an oil well (for disposing brine)

Criteria Specific for Prototype B

- No cheap energy fossil fuel source (Prototype B cannot compete with cheap fossil fuels)

Prototypes A and B are aimed at two different markets to make current economic sense. Prototype A is purely desalination, and it is more economical in regions like the Middle East where they have cheap oil to generate electricity, the governments of these countries will simply not adopt solar power plants at this point because they have oil fired power plants. However they could adopt solar plants that just desalinize because the **startup cost of Prototype A is almost the same as their existing desalination facilities**.

Countries/cities that meet criteria for Prototype A:

- Abu Dhabi
- Dubai
- Saudi Arabia
- Sharjah
- Oman
- Kuwait

Prototype B would also be aimed at coastal sunny regions, but the country would not have access to cheap fossil fuels. In the regions where this requirement is met, governments will be eager to utilize this new technology.

Countries/cities that meet criteria for Prototype B:

- Australia
- California
- Chile
- Southern Coastal regions of India
- Northern Africa
- Egypt

Limitations of Our Research

- We do not have a precise number for the specific heat of the new eutectic mixture. Because this mixture is in development, the physical and chemical properties are confidential. As a result, we could not determine the exact numbers for heat holding capacity. However, we do know that this new mixture will hold heat longer because of the difference in melting points.
- Many Middle Eastern countries are reluctant to provide accurate data on oil supplies, costs, and facilities; this affects the accuracy of some of our calculations.
- If increased oil supply, from tar sands in Canada and new horizontal drilling technologies, is made available internationally, the price of oil in certain parts of the world can decrease and impact locations of prototype B plants.
- Climate change can impact locations of our plants.

Recommendations for Future Research

- Research economic ways to make the Prototype B Desalination Plant more attractive in the face of low international oil prices.
- Investigate how a Prototype B Desalination Plant could be an integral part of self-sustaining community in situations ranging from a refugee encampment, to a village setting, to a modern city.
- Examine using a eutectic mixture to cool the water inside the condensing tower, in place of cold sea water. Low desert temperatures at night will cool the eutectic mixture, which will then retain the lower temperature.

Works Consulted

Background

"Clean Water Campaign." unicef. N.p., n.d. Web. 16 Mar. 2013. <http://www.unicefusa.org/work/water/>.

Statistics, Bloomerg. "Energy & Oil Prices." Bloomberg. Bloomerg, 31 Jan. 2013. Web. 31 Jan. 2013.

Edkins, Max. "The Case for Concentrating Solar Thermal Power in South Africa - Assessing the Contribution of CER and TREC Financing | Max Edkins - Academia.edu." The Case for Concentrating Solar Thermal Power in South Africa - Assessing the Contribution of CER and TREC Financing | Max Edkins - Academia.edu. Academia, 5 Sept. 2008. Web. 31 Jan. 2013.

Alternative Energy

Brightsource Energy, n.d. Web. 19 Mar. 2013. http://www.brightsourceenergy.com/search/index.php?findtext=turbine+efficiency.

Biomass. Colorado.edu, 10 Jan. 2011. Web. 15 Apr. 2013. <http://www.colorado.edu/geolsci/courses/GEOL3520/Biomass.pdf>.

California Energy Center. "Consumer Energy Center Renewable Energy." Consumer Energy Center Renewable Energy. N.p., n.d. Web. 15 May 2013. <http://www.consumerenergycenter.org/renewables/wind/index.html>.

Oil Well Brine Disposal Calculations for the Middle East

"OPEC Share of World Crude Oil Reserves." *OPEC :*. N.p., n.d. Web. 14 Apr. 2013. <http://www.opec.org/opec_web/en/data_graphs/330.htm>.

Hamdan, Sara. "As Days of Easy Oil Fade in Middle East, Firms Turn to Newer Techniques." *The New York Times*. The New York Times, 09 Dec. 2010. Web. 12 Apr. 2013.

"Solid-liquid Phase Diagrams: Salt Solution." *Solid-liquid Phase Diagrams: Salt Solution*. N.p., n.d. Web. 12 Apr. 2013. <http://www.chemguide.co.uk/physical/phaseeqia/saltsoln.html>.

"Salinity and Concentration." *Www.cposcience.com*. N.p., n.d. Web. 3 Mar. 2013. <http://www.cposcience.com/home/Portals/2/Media/post_sale_content/PES/PES_Chap_21/SkillandPracticeSheets/21_2_Salinity_and_Concentration_Problems.pdf>.

Disposal of Brine in Treated Waste Water

"Environment Agency - Abu Dhabi - Abu Dhabi Emirate Water Resources." *Environment Agency - Abu Dhabi - Abu Dhabi Emirate Water Resources*. N.p., n.d. Web. 14 Apr. 2013. <https://ead.ae/en/portal/abudhabi.water.resources.aspx>.

Our Calculations: Comparison of the Four Plants

New eutectic compound

"Halotechnics." - *Power through Electricity Storage*. N.p., n.d. Web. 11 Apr. 2013. <http://www.halotechnics.com/>.

Ivanpah operates 6 hours at night

shanthi shankar

"Solar After Dark: BrightSource Adding Molten Salt Storage for Power Plants." - IEEE Spectrum. N.p., n.d. Web. 11 Mar. 2013. <http://spectrum.ieee.org/energywise/green-tech/solar/solar-after-dark-brightsource-adding-molten-salt-storage-for-power-plants>.(solar

Sat 5/11

"Solar After Dark: BrightSource Adding Molten Salt Storage for Power Plants." - *IEEE Spectrum*. N.p., n.d. Web. 11 Mar. 2013. <http://spectrum.ieee.org/energywise/green-tech/solar/solar-after-dark-brightsource-adding-molten-salt-storage-for-power-plants>.

Pounds of CO_2/gallon of oil

"Carbon Calculator Methodology." *National Geographic*. N.p., n.d. Web. 11 Apr. 2013. <http://environment.nationalgeographic.com/environment/energy/great-energy-challenge/methodology/>

Oil price per barrel

"Crude Oil Price, Oil, Energy, Petroleum, Oil Price, WTI & Brent Oil, Oil Price Charts and Oil Price Forecast." *OilPricenet RSS*. N.p., n.d. Web. 11 Mar. 2013. <http://www.oil-price.net/.>

Energy in a barrel of oil

"Energy in Natural Processes and Human Consumption - Some Numbers." *www.ocean.washington.edu*. University of Washington, n.d. Web. 15 Mar. 2013. http://www.ocean.washington.edu/courses/envir215/energynumbers.pdf.

Ivanpah Turbine efficiency

www.brightsourceenergy.com. Brightsource Energy, n.d. Web. 19 Mar. 2013. <http://www.brightsourceenergy.com/search/index.php?findtext=turbine+efficiency.>

Traditional Desalination plant

"Abu Dhabi Water and Electricity Company - Existing Projects." *Abu Dhabi Water and Electricity Company - Existing Projects*. N.p., n.d. Web. 10 May 2013. <http://adwec.ae/Existing.html>.

Water being used for oil drilling

Hamdan, Sara. "As Days of Easy Oil Fade in Middle East, Firms Turn to Newer Techniques." *The New York Times*. The New York Times, 09 Dec. 2010. Web. 12 Apr. 2013.

Percentage of salt in water at saturation point

"Solid-liquid Phase Diagrams: Salt Solution." *Solid-liquid Phase Diagrams: Salt Solution*. N.p., n.d. Web. 12 Apr. 2013. <http://www.chemguide.co.uk/physical/phaseeqia/saltsoln.html>.

Ivanpah turbine and generator cost

"Ivanpah Solar Electric Generating System." *www.blm.gov*. N.p., n.d. Web. 2 May 2013. <http://www.blm.gov/pgdata/etc/medialib/blm/ca/pdf/pdfs/needles_pdfs/isegs0.Par.16786.File.dat/All-Public-Comments.pdf>.

Boeing 787

"Boeing 787 Delivery." *The Seattle Times*. N.p., n.d. Web. 8 May 2013.

"Commercial Airplanes." *Boeing: Jet Prices*. N.p., n.d. Web. 8 May 2013.

Living the Eco Friendly Design

Christina Dias, Hana Keller, Lynsey Liu, Catherine Yao, and Jennifer Yeh

Summary

We addressed various environmental issues in an apartment complex called "The Elements." Our ideas were based off first diagnosing the problem that the fast-paced development of modern communities has collectively produced environmental hazards that have contributed to the greenhouse effect and many types of pollution. Consequently, we created an environmental friendly complex designed to achieve maximum environmental sustainability and provide an economic option for those looking for affordable places to reside. When asked to describe the main mission of the building, we emphasize how this approach emphasizes how various environmental features can be incorporated into any person's daily life to take the world just one more step in the right direction.

Hana Keller, Jennifer Yeh , Catherine Yao, Lynsey Liu, and Christina Dias

Our inspiration for the project was the Living Building Challenge, although it is difficult to achieve in an apartment building because it is nearly impossible to control how much waste, energy, and water residents use. However, we believe that our design could help raise awareness in the Redmond community about the importance of green living and saving the world's limited natural resources.

Project Light: Declassified

Brittany Quan, Aashray Anand, Pavan Kumar, Jay Tayade, and Srikar Murali

Summary

The Project Light: Declassified is a behavioral project that deals with convincing the general public to replace their incandescent and fluorescent light bulbs with the more efficient LEDS. The project convinces the public of the benefits of using LEDS by calculating the money saved, and the decrease in the amount of CO2 saved. Also included in the project is information on general ways to save power such as showers vs baths , passive solar heating, etc and information on the main renewable and non-renewable energy sources used in the US.

Brittany Quan, Pavan Kumar , Srikar Murali , Aashray Anand, and Jay Tayade

Project Light: Declassified

Research:

Company Name	State	Average Retail Price (c/pKW)
Puget Sound Energy	WA	10.26
Tacoma Power	WA	10.79
PacifiCorp	WA	8.47
Chelan County Utility	WA	8.61
Douglas County Utility	WA	8.39
Grant County Utlity	WA	9.8
Mason County Utility	WA	14.96
Snohomoish County Utility	WA	11.52
Klickitat County Utlity	WA	NA

Light bulb types	Wattage
Standard incandescent	60
Standard Compact Fluorescent	15
Standard LED	8

Programing Calculations

General Input

Energy provider = x1

X1 charges $0.___ kWH

Calculating original cost

For all Rooms with Incandescent Bulbs:

Number of bulbs = Incandescent * 60 avg watts * hours used/day = x2 ($ used per day in Room 1…2…3)

x2 * 365 days/yr= $x3 (money used in 1 year on incandescent)

x3 * 10 years = $x4 (money used in 10 year on incandescent)

For all Rooms with CFL Bulbs:

Number of bulbs = CFL * 15 avg watts * hours used/day = y2 ($ used per day in Room 1…2…3)

y2 * 365 days/yr= $y3 (money used in 1 year on CFL)

y3 * 10 years = $y4 (money used in 10 year on CFL)

For all Rooms with LED Bulbs:

Number of bulbs = LED * 8 avg watts * hours used/day = z2 ($ used per day in Room 1…2…3)

z2 * 365 days/yr= $z3 (money used in 1 year on CFL)

z3 * 10 years = $z4 (money used in 10 year on CFL)

Total Cost in one day: P1= x2+y2+z2

Total Cost in one year: P2= x3+y3+z3

Total Cost in 10 years: P3= x4+y4+z4

Calculating Cost if all bulbs switch to LED

For all Rooms with bulbs ≠ LED = T1

T1 * 8 watts * hours used/day = $T2 (Money used to run LED's)

P1-T2= $S1 (Money saved per day by using LED vs others)

S1 * 365= S2 (Money saved per year)

S2 * 10 = S3 (Money saved in 10 years)

Calculating Current Carbon Output

(More research must be done to see where each Energy company gets energy from via coal burning etc.)

For all Rooms with Incandescent:

Number of bulbs in Room 1..2…3…etc * input carbon produced/ yr= C1

For all Rooms with CFL:

Number of bulbs in Room 1..2…3…etc * input carbon produced/yr = C2

For all Rooms with LED:

Number of bulbs in Room 1..2…3…etc * input carbon produced/yr= C3

Total Carbon footprint in 1 year: O1 = C1+C2+C3

Calculating Potential Cut Carbon Output

Number of Incandescent bulbs in Room 1…2…3…etc + Number of CFL in Room 1…2…3…etc = B1

B1 * input carbon produced by LED /yr = B2

O1- B2= O2 (New CO2 footprint)

These numbers are used in determining calculations for how much a certain person could save in money each year based on where they live and their yearly electrical payment. By using both numbers from how much less carbon is produced and how much money is saved, it is easy to persuade and convince consumers. Unfortunately, human psychology dictates that most people are skeptical on how much money will be saved unless they actually have physical money to be shown. We hope that this application will greatly influence the general public and thus fits in with the behavioral challenge.

Solar Energy: Solar energy is energy derived from the rays of the sun through the use of photovoltaic cells, and makes up 0.1 percent of energy demand. Solar energy is a clean energy source that produces no greenhouse gases, is inexhaustible, and can be used to generate energy for far out places such as satellites.

Wind Energy: Wind energy is energy that is derived from the uneven heating of the earth, which creates wind that can be harvested through the use of giant 20 foot turbines of windmills. Each of these turbines can supply around 600 homes and used in multiple in a place called a wind farm, windmills give off no air or water pollutions, and once erected has limited maintenance costs.

Light Switches: Turning off light switches will allow for energy and money to be saved as less energy is used when the lights are on.

Showers VS Baths: Taking a shower over a bath usually saves more water and energy. Though the main factor in determining water loss is the time and amount of water used showers are considered to save more water. In order to minimize water consumption limiting shower time, using low flow shower heads, and turning off supplemental showerheads save the most amount of water.

Blinds: Blinds can be used to help save energy by conserving energy. Blinds can be opened during the summer to heat up the house, and can be closed during the night or winter so that energy does not leak out from the house.

Unplugging Appliances: Unplugging specific appliances can allow for the saving of energy . Unplugging rarely used appliances, appliances that go into standby, and kitchen appliances that are not used often can save lots of energy. Appliances that go into stand by consume power while in a dormant mode and can consume power while in this state, putting these appliances on a switchable surge protector can prevent power drain.

Blinds Benefits: Blinds keep in heat during the winter and help keep houses warm, while during the summer they prevent excess that and light from entering the house and heating it up too much.

Overhang Benefits : The overhang is used to block excess sunlight from hitting the house and overheating it.

South Facing Windows benefits: During the winter south facing windows absorb heat from the sun to heat the house, while during the summer the homes have a thermal mass to keep the building cool

Oil: Oil is one of the three main fossil fuels used for energy and the second cleanest among the three in terms of greenhouse gas emissions. It is used for a variety of things and tasks such as making drapes, powering cars, and some medicines.

Natural Gas: Natural Gas is one of the three major fossils and the cleanest in terms of greenhouse gas emissions. It is burned to create energy for industrial use, commercial use and other things.

Main Sources of Energy used in the US:

Coal-33 percent

Problems: Coal is the major source of energy in the US and is a fossil fuel. This means that it produces major amounts of CO2 which contributes to the greenhouse effect, and global warming. Coal burning also releases harmful pollutants such as sulfur dioxide, nitrogen oxides, and mercury which can be harmful to human health. These can cause health problems such as black lung disease, loss of IQ, and some types of cancer.

Oil-30 percent

Problems: Oil is one of the most used sources of energy and is used for transportation and is used in motor vehicles , it is a fossil fuel and contributes to the greenhouse effect including, such as global warming. Oil can also cause major environmental problems such as destroying habitats due to spills and can cause air pollution from the burning of it.

Natural Gas-25 percent

Problems: Natural gas is one of the major fossil fuels and is composed mainly of methane. It is burned and used by towers to make energy. Natural gas can cause several health problems such as reparatory diseases, and also have a psychological effect on people. The odor has particulates that can cause dizziness, headaches, Natural gas can create smog and cause air pollution. Natural gas towers burn methane and release toxins into the air which affects the air quality.

Nuclear Energy-8.4 percent

Problems: Nuclear energy is a major source of energy for the US. There are several problems caused by it though. One problem with Nuclear power is that disposing of waste, the waste has to be buried in tanks and put underground, however leakage may occur which could affect the area near the storage tank and cause environmental problem for the environment. Nuclear power can also cause health problems from the radiation. People who breath in the radiation or are exposed to dangerous doses of radiation can develop cancer. Reactors can also be dangerous for people and release harmful residues if a meltdown occurs. A meltdown occurs when the core heats up too much, and could release harmful particles into the air that once breathed cause disease and respiratory problems such as lung cancer.

Acid rain is a type of wet and dry deposition that has higher than normal nitric acid or sulfuric acid content. Acid rain can come from a variety of sources, such as automobile fumes. Cars can give off exhaust, which is fossil fuels being combusted, these can go into the atmosphere and react with water to become acid rain. Cars give off exhaust, which have Nox and Sox and mix with the vapor in the air to create acid rain.

Coal that is burned in coal burning power plants releases harmful toxins that can be harmful to the lungs. Burning of coal can release emissions such as carbon and sulfur. If these are breathed into the lungs, they can reduce life expectancy, cause respiratory problems, and cause diseases such as black lung diseases. For babies that are affected with the emissions can lose IQ and have mental problems when they get older

Works Consulted

http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/public-benefits-of-renewable.html

http://www.solarschools.net/resources/stuff/advantages_and_disadvantages.aspx

http://www.ehow.com/how-does_5040406_window-blinds-work.html

http://www.lni.wa.gov/TradesLicensing/Electrical/Install/Puds/default.asp

http://science.howstuffworks.com/environmental/energy/question481.htm

http://www.instituteforenergyresearch.org/state-regs/pdf/Washington.pdf

http://ezinearticles.com/?Showers-Vs.-Baths---Which-is-Better---WeDecide&id=344505

http://www.api.org/oil-and-natural-gas-overview/classroom-tools/teaching-tools/facts-fossil-fuels

http://www.energyquest.ca.gov/saving_energy/

http://nuclearenergyfactssite.com/

http://energy.gov/energysaver

Developing an Incentive for Algal Tertiary Wastewater Treatment

Dipti Dhond, Maya Ganesan, Alka Pai, Reksha Rathnam, Saakshi Dulani, Pavitra Siva

Summary

The majority of wastewater in the United States only undergoes secondary treatment, which does not remove many of the nutrients (such as nitrogen and phosphorus) from the water. This water is emptied out into lakes and rivers, and the influx of excess nutrients causes algal blooms and therefore dead zones, destroying aquatic ecosystems.

Our proposed project would incentivize tertiary wastewater treatment. In tertiary treatment, the nutrient-rich secondary-treated water is run along gullies or canals through a wetland, and the plants soak up the nutrients. This way, the water that is dumped into local bodies of water is free of the nutrients that cause eutrophication. The biggest impediment to tertiary treatment, however, is its expense.

To encourage municipally-owned wastewater treatment plants to perform tertiary treatment, we will set up wetlands of algae through which the secondary-treated reclaimed water can be channeled. The algae strain will be Nannochloropsis oculata, the species that produces the most oil. Tertiary treatment will allow the algae to take up the nutrients they need while also producing oil that the treatment plant can sell.

Maya Ganesan, Pavitra Siva, Alka Pai, Saakshi Dulani, and Dipti Dhond

Selling the oil would mitigate the costs of setting up this type of tertiary treatment system.

This would be especially beneficial as it would 1) further purify wastewater so that it would not dump nutrients into lakes and rivers, thus preventing eutrophication; 2) preserve and protect aquatic ecosystems; 3) allow humans to enjoy the recreational and fishing opportunities provided by a healthy lake ecosystem; 4) produce oil in a clean and environmentally-friendly manner; and 5) allow treatment plants to sell this oil in order to subsidize the costs of setting up the tertiary treatment system.

Works Consulted

http://www.originoil.com/pdf/Scotia_Capital_Algae_Excerpt.pdf
http://www2.epa.gov/nutrientpollution/sources-and-solutions-wastewater
http://css.snre.umich.edu/css_doc/CSS04-14.pdf
http://ir.ihb.ac.cn/bitstream/152342/8934/1/Response%20of%20growth%20and%20fatty%20acid%20compositions%20of%20Nannochloropsis%20sp%20to%20environmental%20factors%20under%20elevated%20CO2%20concentration.pdf http://psrcentre.org/images/extraimages/312073.pdf
http://pubs.acs.org/doi/abs/10.1021/ef900704h

Project Perforation

Amy Zhang, Teri Guo, Emily Yang, and Timothy Atkinson

Summary

In Project Perforation, we decided to change the way six pack soda rings were made by making them safe, easier to use, and still economical. This project was submitted to a national contest called Siemen's We Can Change Contest where we tied for 4th against 50 other teams. In Siemen's, the contest was to create an innovative idea that will help the environment. Our idea for the contest was to add perforations to soda rings to prevent animals from getting their necks caught around the rings while still keeping it economical so companies would use them.

Amy Zhang, Teri Guo, Timothy Atkinson and Emily Yang

Research:

Thousands of marine birds, mammals, and turtles are affected by six pack soda rings every year. Animals can mistake them as food, as when they get caught in the rings, they are helpless as the rings start strangling them or cutting them up. There are very few possible solutions that have been made for this major problem, and the solutions out there have problems with them. Soda rings are clearly very dangerous, which is what inspired our idea. Project Perforation was a project where we made perforated soda rings that we tested numerous times.

We tested for strength of the rings when they were perforated to make sure they could withstand normal abuse. Furthermore, we tried to make them easier to pull apart (which was successful) while keeping them economical so companies would actually consider using them (the perforations wouldn't cost nearly as much as other ideas, just a flat cost for some new machinery). We submitted this idea to Siemen's for a computer science project, and for the chance to present our idea to people who would consider using our idea to help save the environment.

Works Consulted

http://voices.yahoo.com/plastic-six-pack-rings-environmental-threats-6709100.html

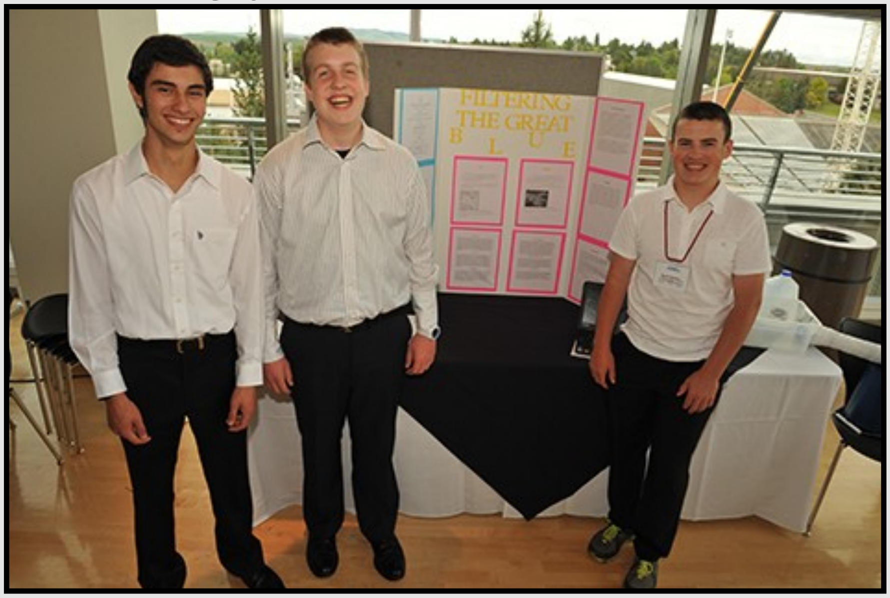
http://www.humanesociety.org/news/magazines/2009/07-08/the_deadly_truth_about_trash.htmlhttp://redmond.patch.com/groups/schools/p/plastic-ring-work-around-redmond-students-named-final3cf3d98409

Filtering the Great Blue

Zachary Moore, Banning Lyth, and Brendan Hobbs

Summary

Our project was a desalinization project that used many types of filters to turn the saltwater into clean drinking water. This was much more efficient than the traditional boiling method. This made our system better than other desalinization plants and made this a great environmental and human benefit. We gave examples of how this system could be implemented in the city of New Orleans, the Netherlands, and other places where the elevation is at or below sea level.



Banning Lyth, Brendan Hobbs and Zachary Moore

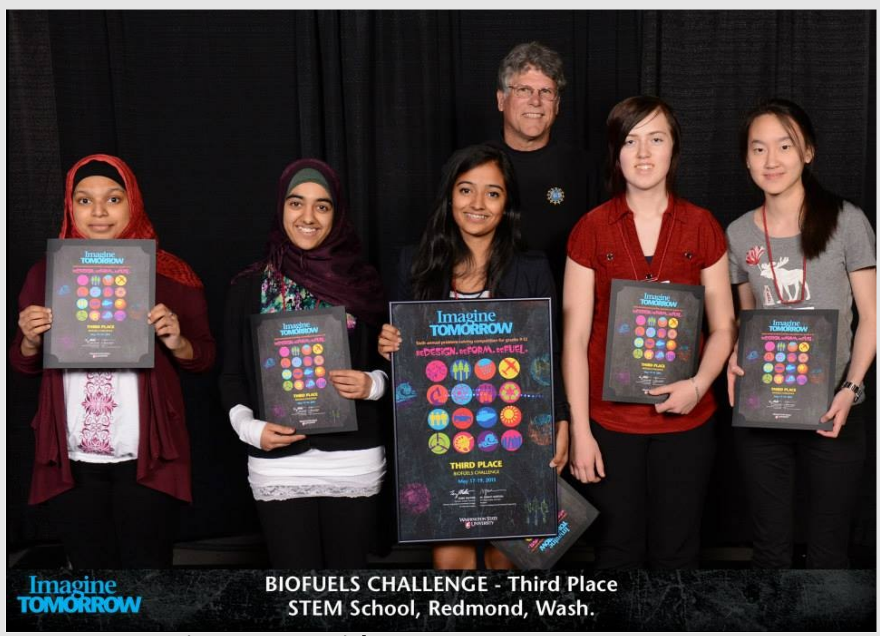
Algal Growth in Wastewater

Meena Meyyappan, Ling Huang, Daaniya Iyaz, Kaimyn O'Neill, and Warisha Soomro

Summary

The days culminating to the competition were the most hectic, trying to put the finishing touches in and practicing our presentation, but the outcome was incredibly gratifying. We were able to place 3rd in biofuels thanks to the encouragement and constructive criticism from the judges which we were then able to build from for the next judge that stopped by. Our project presented that chlorella algae, a type of algae that had 50-60% lipid content and a high photosynthetic rate, be grown in the effluent water (after secondary treatment) as a method of tertiary treatment as well as a source of biofuel. We proposed to grow the algal in a closed loop bioreactor which allows for more sunlight penetration as well as blocks the algae from major contaminants.

Then we would extract the oil using the oil press method which is pressurized algae that releases its lipid content from the cell wall. The algae would need ideal condition with the right amount of sunlight and CO2 content.



Daaniya Iyaz, Warisha Soomro, Meena Meyyappan, Kaimyn O'Neill, and Ling Huang

Too much or too little could inhibit algal growth. The doubling rate of chlorella algae at a normal growth rate is 24 hours but the doubling rate at peak growth is about 3 hours. Since algae needs key nutrients, such as nitrogen and phosphorus, wastewater is a substantial platform to grow algae since wastewater has an excess of nitrogen and phosphorus that needs to be filtered out to lessen the harmful effects of eutrophication on the environment.

Also the algae is able to scrub out CO_2 and methane that is produced by wastewater treatment plant. Our group was able to visit Brightwater Wastewater Treatment facility in Woodinville, WA to get a first hand look at the operation facilities and how they work. We also got the see the construction and the potential for algal growth to be implemented. We were also able to talk to experts at the facility about our proposal and get feedback on it. They were able to provide interesting perspective and answers to questions we pondered. All in all, the Imagine Tomorrow experience was life changing, exposing us to a world of possibility and innovation at a young age where we were encouraged to start thinking about world issues and potential solutions and the fact that we got 3 day get away with our fellow students didn't hurt either.