Power Plants

I. ABSTRACT

We have been using fossil fuels which are coal, oil and natural gas as our main energy source for a long time. Burning fossil fuels for energy produces harmful carbon dioxide, which is one of the greenhouse gases and contributes to global warming. We want to stop using bad energy sources and come up with a cleaner one. Our vision is to use photosynthesis to take energy from plants and convert it to electrical energy to power buildings. This will not only take harmful carbon dioxide out of the air but also create renewable electrical energy. We have a vision of every building being covered with plants which would generate enough energy to power each building. So, instead of using harmful power plants that use fossil fuels, we will use power from the plants!

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II. DESCRIPTION

1. Present Technology

Fossil fuels are today's biggest energy source. These are causing pollution, global warming and climate change. Fossil fuels such as coal, oil, natural gas and gasoline are burned to produce electricity and power. This causes air pollution.

Figure 1: Power Plant

The problem with burning fossil fuels is that it causes carbon dioxide to go into the atmosphere where it traps heat. The heat from the sun gets in and warms the earth but the heat can't get out. This is called the Greenhouse Effect. Too much carbon dioxide raises the earth's temperature.

Global warming harms us and the earth in a lot of ways. Global warming is

making the earth hotter. This means there are more heat waves, which are getting so hot, that people are dying of heat stroke. The heat also causes bad ozone in the air to increase, and that makes more smog and pollution. Another problem with the heat is that diseases spread by insects are spreading to more parts of the world. Animals are also suffering and dying. They are losing their habitats because they can't adapt to the changes quickly enough. We are also harmed because there are more droughts, and that affects our water supply. It also means that plants and trees will die and they won't be able to suck up the carbon dioxide in the air that is causing global warming, and that means that more wildfires will be caused by the heat and the drought. The heat and the drought make it harder for crops to grow, and we might not have enough food in the future. The last problem is that ice is melting in the Arctic so sea levels are rising and coastal areas are flooding. Global warming is making the earth a harder place for humans, animals and plants to survive.

2. History:

HISTORY OF FOSSIL FUELS

Fossil fuels have been around millions of years. "The burning of coal to generate electricity is a relative newcomer in the long history of this fossil fuel. It was in the

1880s when coal was first used to generate electricity for homes and factories. By 1961, coal had become the major fuel used to generate electricity in the United States."[1]

HISTORY OF PHOTOSYNTHESIS FOR ELECTRICITY

Dutch researchers at Wageningen University in the Netherlands first patented the process of making electricity from plants in 2007. They invented the Plant-Microbial Fuel Cell. Bert Hamelers thought of the idea, and David Strik did the first tests. On November 23, 2012, Marjolein Helder presented her research on this fuel cell at Wageningen University. She had found a way to make electricity using the fuel cell, which worked in the soil where the plant roots interacted with bacteria and created electrons.

On February 16, 2010, the French National Center for Scientific Research (CNRS) published their discovery of a different way to use photosynthesis to make electricity. They had made a biofuel cell that uses the products of photosynthesis (glucose and O_2) and is made of two electrodes that were put into a living plant. The main goal of this experiment was to make a biofuel cell for medical devices, but scientists also thought it might have other uses for clean energy in the future.

Then in 2013, researchers at the University of Georgia in the US created a new way to use plants to make electricity. When a plant divides water atoms during

[1] "MS_Coal_Studyguide_draft1.Pdf." Energy.gov, 2013.

photosynthesis, it produces electrons. The electrons help make sugars for the plant to grow. The new method captures those electrons before the plant uses them, and converts them to electricity. An assistant professor who worked on the research said, “In the near term, this technology might best be used for remote sensors or other portable electronic equipment that requires less power to run.”[2] The technology needs to become more stable to be as useful as solar panels are now.

3. Future Technology

Our vision is to use photosynthesis as a renewable and clean energy alternative to fossil fuels which produce carbon dioxide that harms us. We propose to have the plants on all the walls of a building and the top of the building. We will use the energy they produce through photosynthesis and convert it into electricity that that building can use for computers, lights and anything else that needs electricity. See Figures 2 and 3.

Figure 2: A building covered in plants that will produce energy

[2] Hataway, James. “Power Plants: UGA Researchers Explore How to Harvest Electricity Directly from Plants.” *UGA Today* 12 Dec. 2017, news.uga.edu/power-plants-uga-researchers-explore-how-to-harvest-electricity-direct/.

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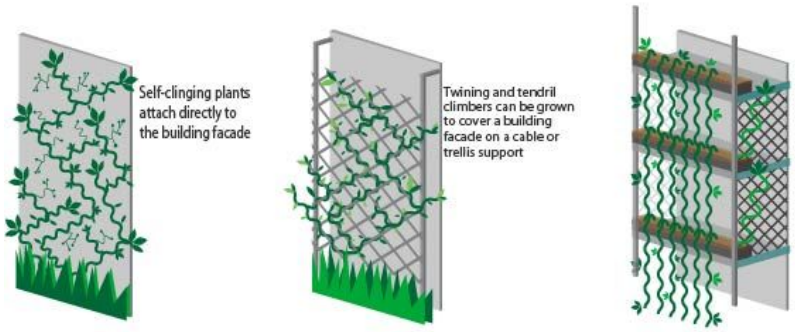

Figure 3: A picture showing how we will attach the plants to produce the energy for the building.

We needed to learn about matter and energy to understand how plants will give us electrical energy. We learned everything is made of matter. Matter is made up of atoms. Atoms are so small that a million of them in a row are smaller than the size of a human hair! Atoms contain a center, called a nucleus, and an outer part, called a shell. The shell is made of particles called electrons. Electrons are in motion and fly around the nucleus. Electrons are even smaller than atoms. When the electrons are freed from the shell of an atom, they can move to other locations. This is a form of energy called current or electricity. When electrons move through matter, the matter is known as a conductor. An example of current is lightning, which is electrons moving through the atmosphere. The atmosphere is a conductor. When you plug in a lamp at home,

the cord carries current or moving electrons to the light bulb to make light. The cord is known as a conductor. Current is also used to make heat in a hair dryer.

We use energy when we play, talk, and even type. We learned energy is something that cannot be created or destroyed. This means when we eat food, the energy in the food becomes energy we use in our bodies. Plants can convert energy through a process called photosynthesis. This is a process in plants that uses sunlight to convert carbon dioxide and water into food, such as sugars. In photosynthesis, energy from sunlight is converted to chemical energy in the food. The energy from the sunlight does not disappear, it is changed to chemical energy in the food. When we eat the food, our bodies use the energy to move and to think. When photosynthesis converts carbon dioxide and water into food, it splits water into hydrogen and oxygen and this frees electrons.

Researchers at the University of Georgia found a way to capture the freed electrons from photosynthesis. They interrupt the photosynthesis process by capturing the electrons before the plant uses them to make sugars. Usually, the energy from the electrons is converted to sugars inside the plant's thylakoids. We learned that these are places in the plant cell that capture and store the energy from the sunlight. The

researchers changed the thylakoids so the energy could be captured before the plant uses them to make sugars. (Figure 4)

The electrons are then carried away in conductors called nano-tubes. Nanotubes are advanced, emerging technology. These nanotubes are specially designed round carbon structures that are much smaller than a human hair. The nano-tubes carry the electrons to a wire, which can be used as a source of electricity. A picture of a carbon nanotube is shown in Figure 5.

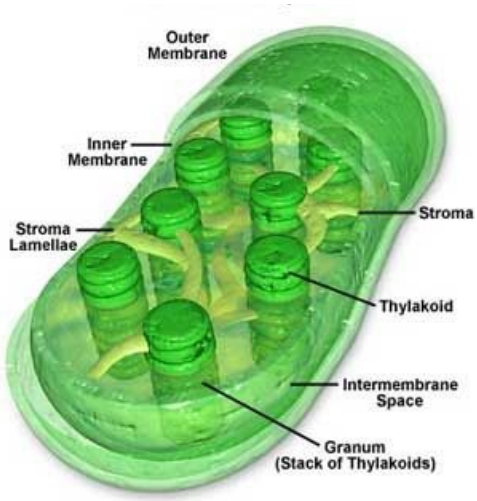

Figure 4: A picture of a chloroplast, where the plant's thylakoids are.

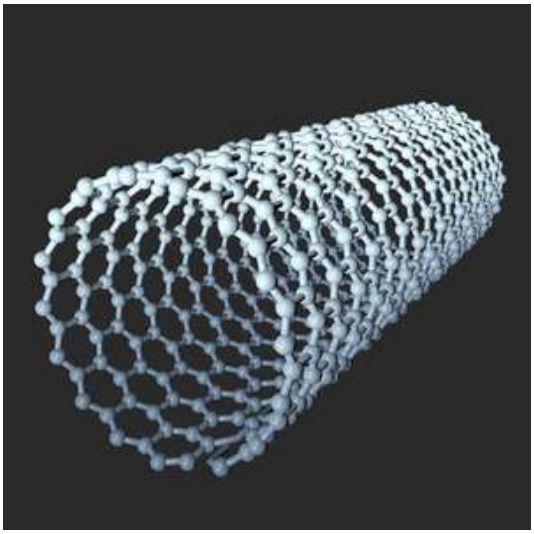

Figure 5: A Carbon Nanotube

4. Breakthroughs:

So far, the scientists have figured out how to get electricity from photosynthesis in a few different ways, but the power they have collected is not really powerful and not enough to power a whole building. We need to a major breakthrough to get more energy from a plant so we can power an entire building.

For us to make a breakthrough, we need to conduct two tests. The first test is to see how much total power we need for different types of buildings and how much power we can get from the photosynthesis process. We learned power is measured in watts. We conducted a test to determine how many watts are needed to power a laptop computer. See Figure 6.

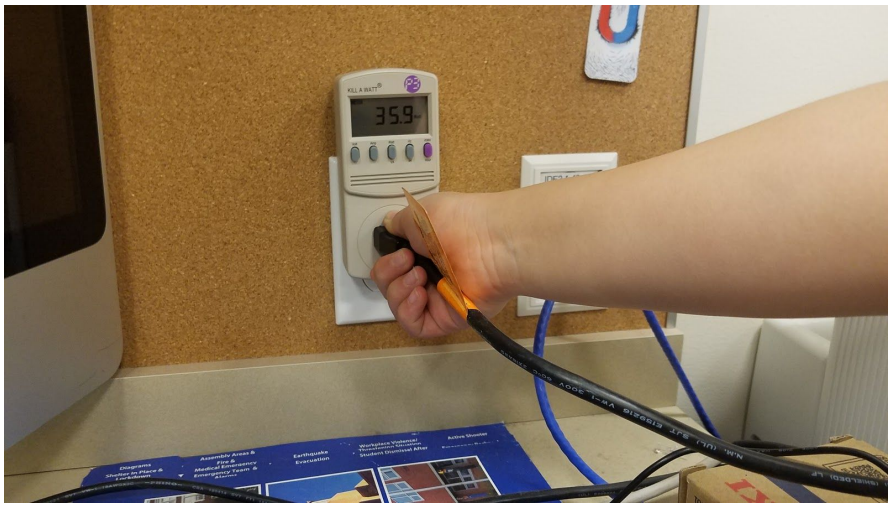

Figure 6:

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The second test is to grow different types of plants to figure out which one can create more power. We need to see if we can change the way plants grow and make a super plant so it can create enough energy so we can use it for buildings. We would do a smaller test first to make sure the plants can power the computer or lights before we would test a building's needs . We did a model as seen in figures 7 and 8.

Figure 7

Figure 8

5. Design Process:

As a team we were thinking about problems facing the Earth. There is too much carbon dioxide from burning fossil fuels for energy. We were learning about

photosynthesis and how it could clean the air by using carbon dioxide for its process. We learned how photosynthesis could be a clean energy source for our needs too.

Our first idea was to have a plant on each desk and it would have a cord connected so it could power a computer. We realized this would not work for two reasons. One, the plants would have no direct access to sunlight. The other reason was that one plant would not make enough energy to run a computer.

One second idea was to have one side of a building to just have the plants. There would also be something in the ground under the building like hydraulics. It would turn the building towards the sunlight so the plants would get energy throughout the day. The building would have sensors to know when the sun was moving. We decided it would be too unrealistic to have strong enough hydraulics to move the entire building.

The third idea we had was using mirrors. The sun will shine on the mirrors and if the plants didn't get enough sun, the mirrors would shine on the plants and the plants would get enough energy. We decided to reject this idea for our project because plants don't grow as well with reflected light. We could have a mirror out the window and it would shine the light on the plants if the sun wasn't directly shining on the plant. The mirror would go towards a slight angle to the light from the window and it could shine on

the plant to get energy. The mirror might not give enough sunlight to the plant and it might not make enough energy to power whatever it needs to.

6. Consequences:

The consequences of not doing anything is that if we keep polluting the air with energy created from fossil fuels it will continue to cause climate change and extreme weather - more forest fires, more hurricanes, rain and extreme temperatures. This will also cause people to have more trouble breathing since more pollution blocks the sunlight that helps convert carbon dioxide into oxygen.

By using plants and sun to create energy it will lead to cleaner air for people to breathe because we are not burning fossil fuels that will pollute the air. Plants can store energy better than a solar cell and can release oxygen into the air to help other things grow to feed people and animals.

The challenges are that it might be expensive and hard to convince people to use it because it's new technology. Another challenge is that we're still trying to create strong enough energy that the building needs and it may not work well all the time. We think we can overcome these challenges and in the end have energy that is cleaner and cheaper than fossil fuels, gas and coal and won't cause climate change.

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IV. Web Design

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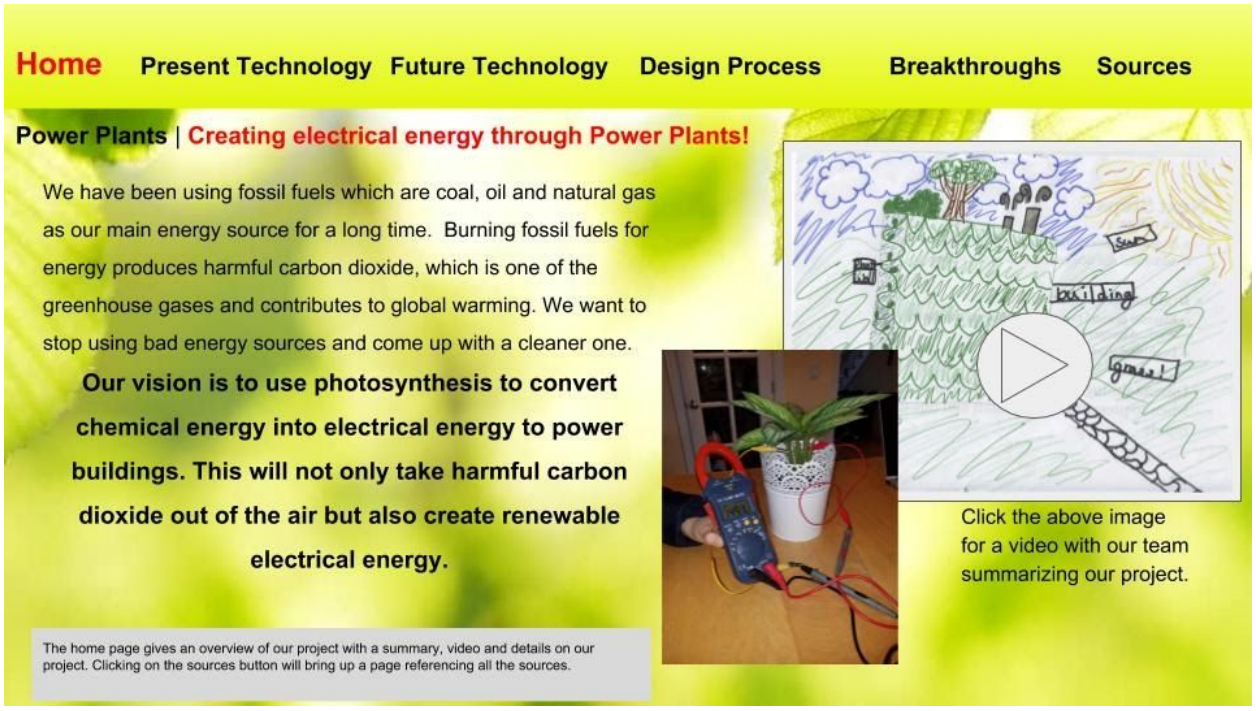

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Much of today's energy sources include fossil fuels, coal and gas. These sources are causing pollution, global warming and climate change. Fossil fuels such as coal, oil, natural gas and gasoline are burned to produce electricity and power. This causes air pollution.

Global warming is caused by fossil fuels like gas, oil, and coal. Power plants, factories, trucks, buses, cars, boats, airplanes and trains burn fossil fuels. The burning of fossil fuels causes carbon dioxide to go into the atmosphere where it traps heat. The heat from the sun gets in and warms the earth but the heat can't get out. This is called the Greenhouse Effect. Too much carbon dioxide raises the earth's temperature.

Click **here** to learn about the harmful effects of global warming.

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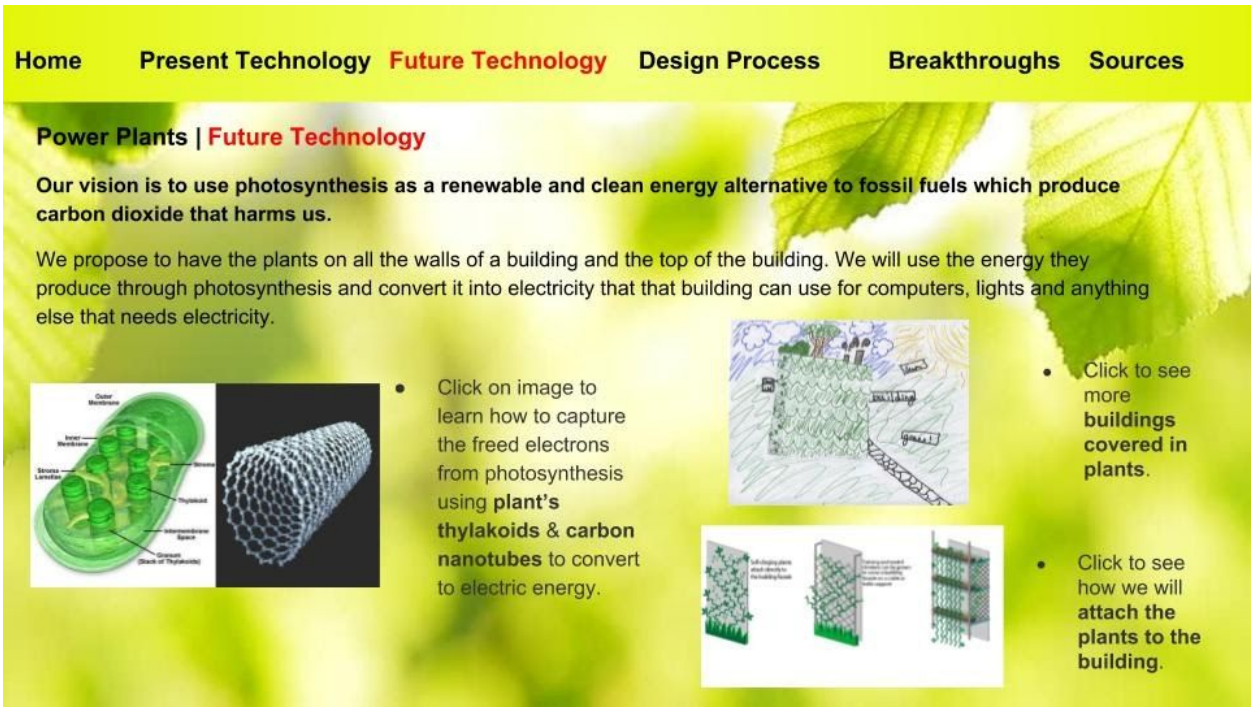

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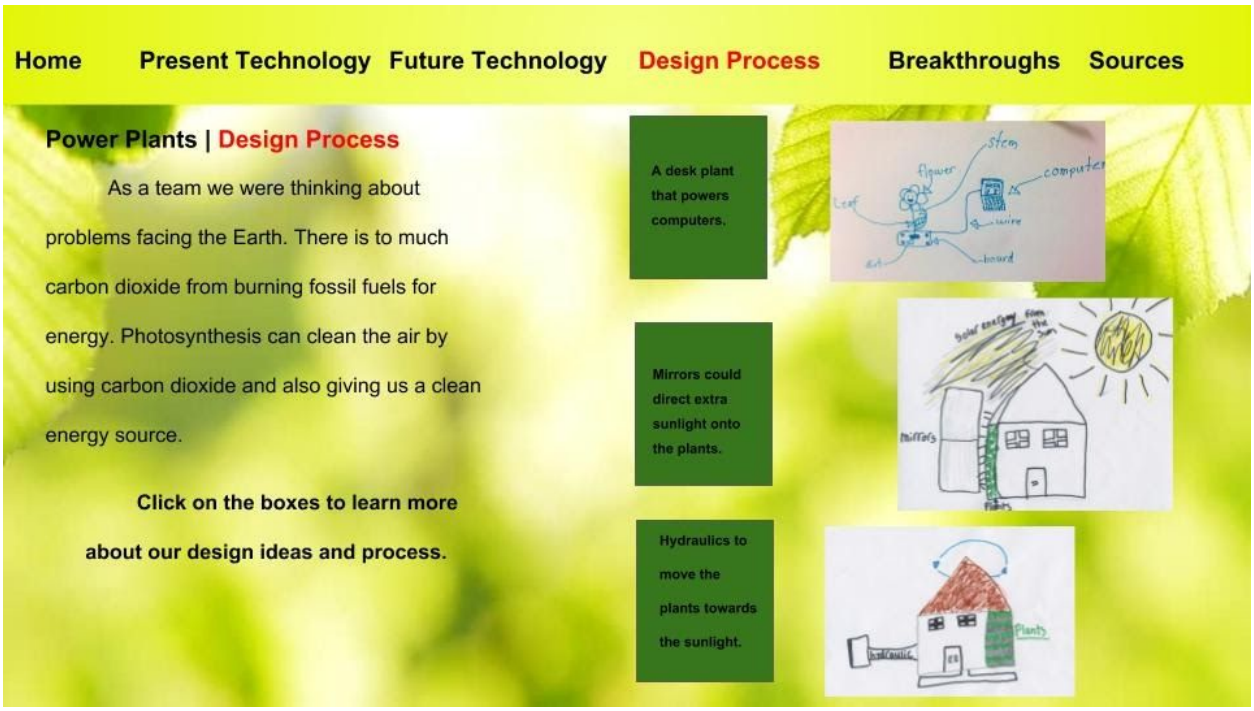

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Figure 2: Click the image to check out a video of the Power Plant Superheros showing the technology breakthroughs and tests.