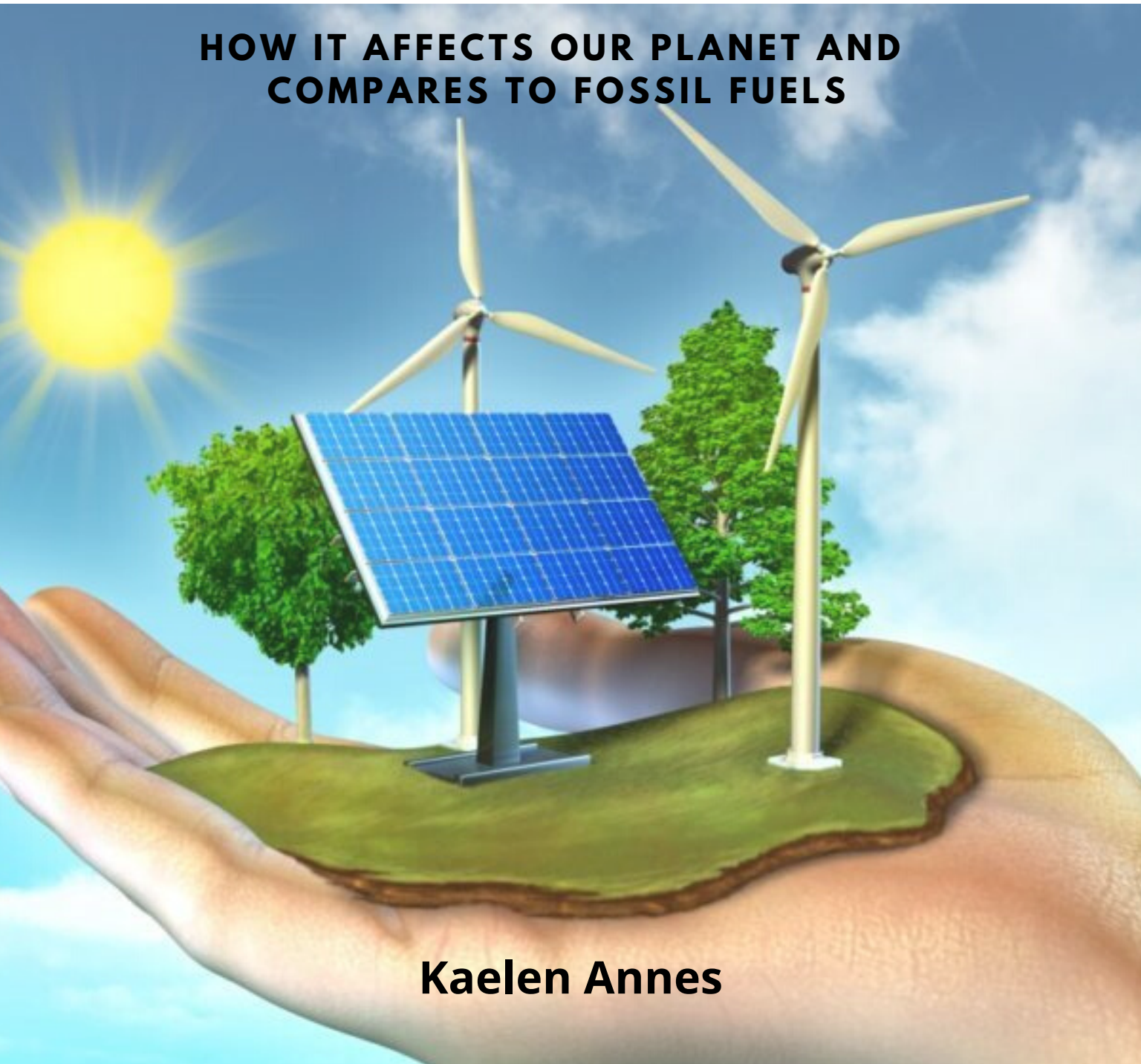
CLASS OF 2020 • INDEPENDENT STUDY

RENEWABLE ENERGY

HOW IT AFFECTS OUR PLANET AND COMPARES TO FOSSIL FUELS



Kaelen Annes

CONTENTS



Image of Phoenix-Press Windmill

3 *INTRODUCTION*

6 *TRIP TO PHOENIX PRESS*

9 *INTERVIEW WITH TODD CORT*

14 *DATA*

17 *WINDMILL PROTOTYPES*

22 *RESEARCH PAPER*



INTRODUCTION

I go to Cold Spring School (CSS) in New Haven, CT. In sixth grade, everyone at CSS picks a topic relating to sustainability. Sustainability means the ability to be maintained. Most students pick topics that are related to environmental sustainability. Once we select a topic we: (1) research it; (2) write a report about it; and (3) create a physical project (e.g. mine was to make a mini windmill to power up an LED bulb). At the end of the year, we have an exposition, or as we like to call it, the Expo where we display our work

For my topic, I decided to study renewable energy. Renewable energy is related to sustainability in many ways. One of the biggest ways it affects sustainability is just it existing and being used at the rate that it is used. Since renewable energy emits less greenhouse gases than fossil fuels, it helps stop major problems. Fossil fuels are the leading polluter of greenhouse gases, which in turn are the leading cause of climate change. As we all know, climate change can hurt animals, melt ice (causing sea level rise among other problems), and eventually harm us. Although renewable energy is very good, it also has some downsides, such as it hurts animals to get the materials we need to build it or the fact that it's not always available. I will talk more about this in both my interview with Todd Cort and in my research paper. As soon as I realized renewable energy had this many effects on the planet, I decided to study it.

I faced a few challenges throughout the process. My first challenge, and probably the hardest, was something as simple as deciding on a topic. I thought it would be pretty simple, turns out there are many different choices in the field of sustainability. As I said, I choose renewable energy because of all the effects it has on the planet, but I thought about many others as well.

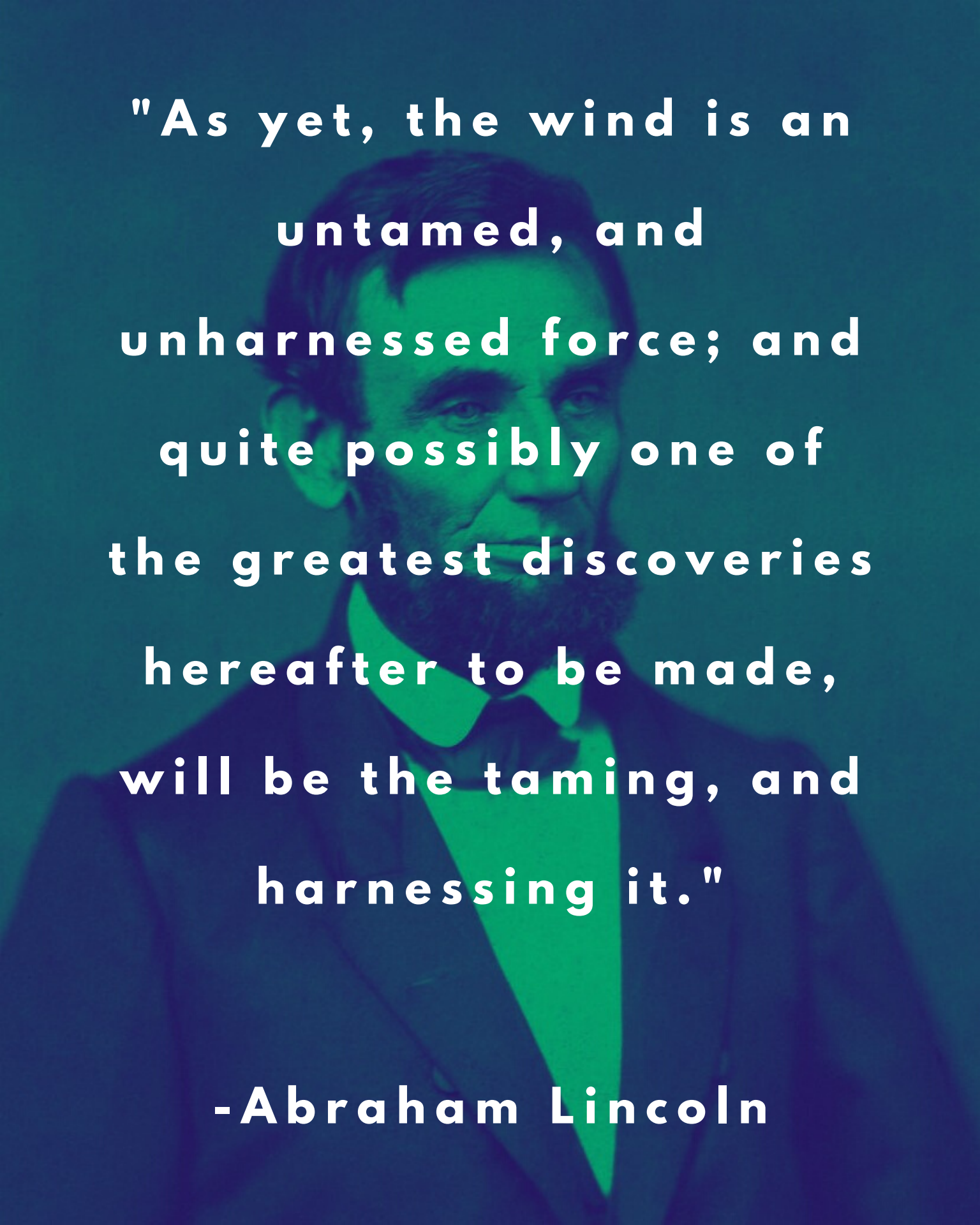


Another big challenge that came up much later on in the process, was deciding how I should set up my research paper. My choices were: 1) chronological; 2) order of importance; and 3) how each topic (and subtopics) relate to one another. I decided to order it with all three, as you'll see later in this book. First I introduced the first big event, the Industrial Revolution, which is the chronological part. Next, I introduced the types of energy and their benefits and downsides, which were ordered by importance. Then, I gave an idea that would help to mediate all the downsides. There were many other challenges throughout the process, but these are the two biggest for me.

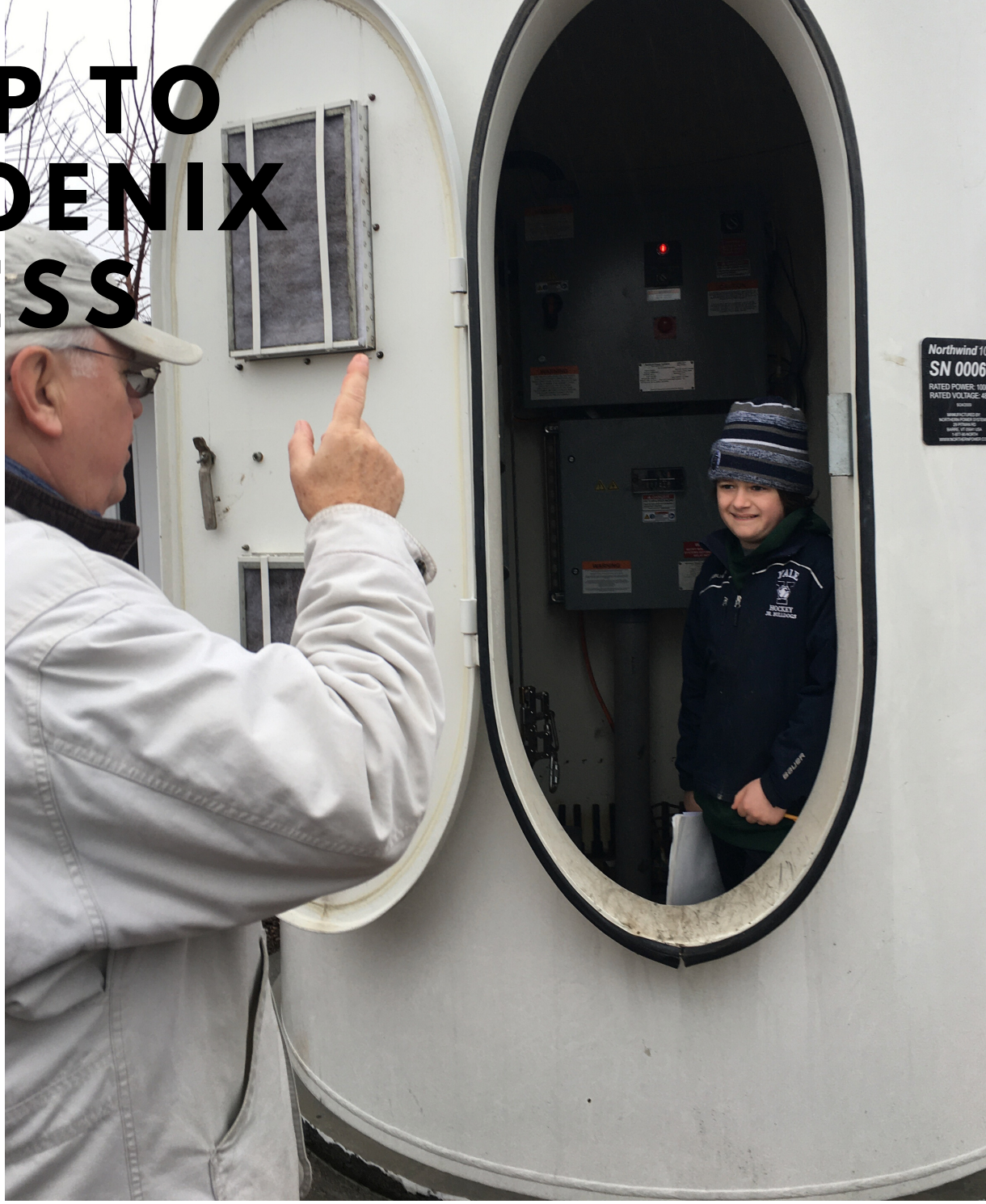
A few questions I still have about sustainability even after studying renewable energy are:

- What is considered "sustainable" and not "sustainable"? E.g. solar energy is much more "sustainable" than fossil fuels, but they only last as long as we have the elements for it, so are they sustainable?
- What needs to be considered when deciding which of the choices, whatever they may be, are more sustainable?
- How will the pandemic affect the usage of energy?
- Are there more forms of renewable energy that we can utilize?

The thing I am proud about most in this eBook is my research paper. The paper is a result of all the information gathering I did and the information from my interview and trip to the Phoenix Press windmill. I am proud because this represents all the hard work I put in, throughout the whole process.


"As yet, the wind is an untamed, and unharnessed force; and quite possibly one of the greatest discoveries hereafter to be made, will be the taming, and harnessing it."
-Abraham Lincoln

TRIP TO PHOENIX PRESS



During my study, I went on a trip to Phoenix Press. Phoenix Press is a printing company across the street from Cold Spring School that owns a windmill that they use to power their company. At Phoenix Press, I learned about the windmill, how the company saves money with it, and got to see the inside of a windmill for the first, and as of right now, only time. On the next page, there are some more pictures of my trip to Phoenix Press in addition to the one above. Thank you, Brian!



Me in front of Phoenix Press



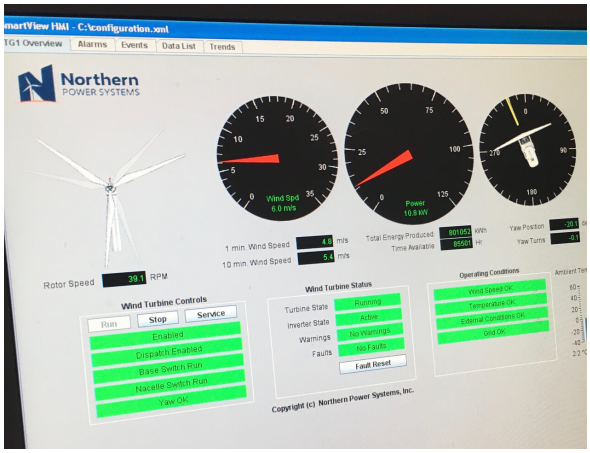
Brian and I talking in front of the windmill



Inside of PhoenixPress



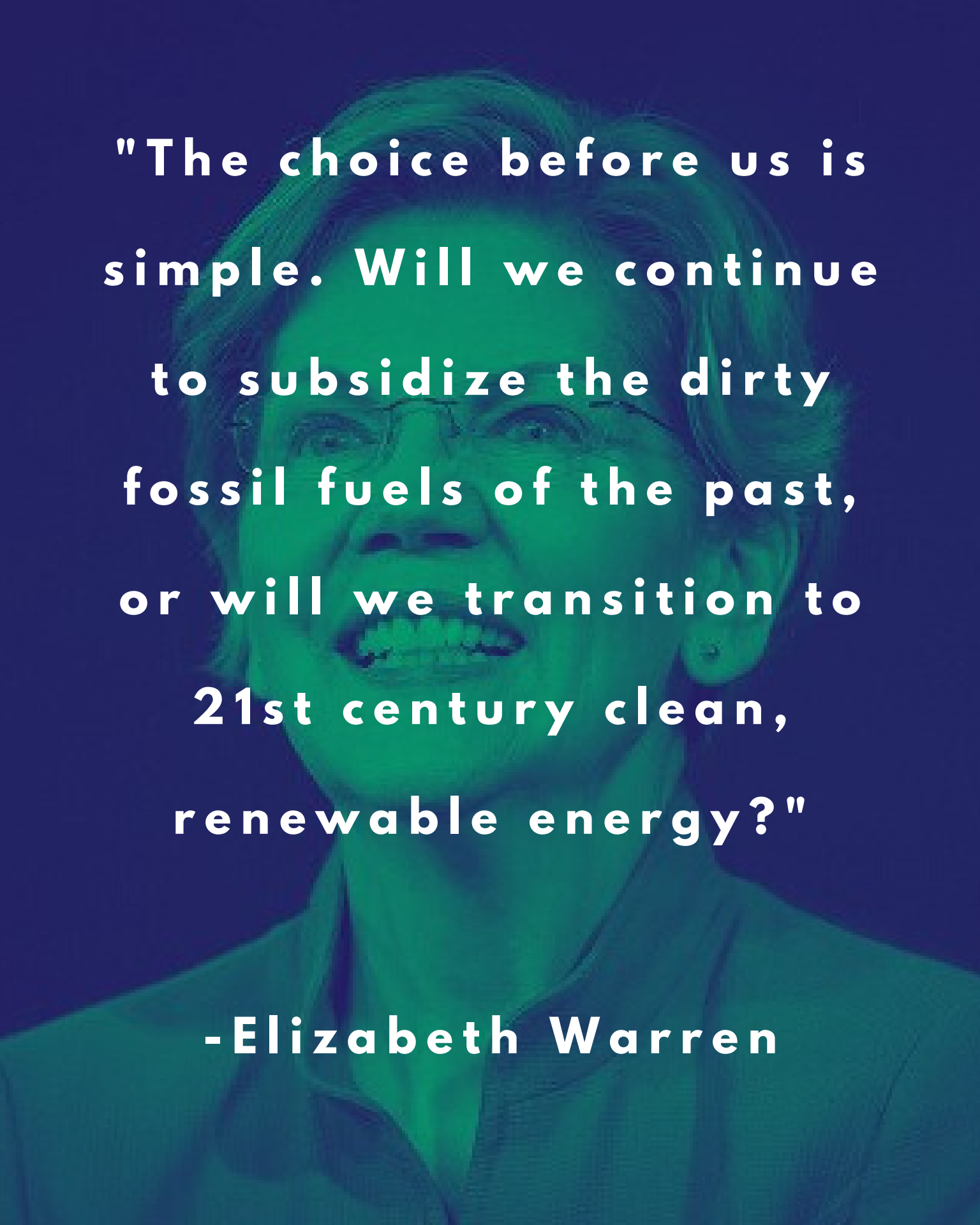
Brian and I in front of the computer



Picture of computer screen that helps Brian keep track of the windmill



Brian showing me photos from when they installed it


"The choice before us is simple. Will we continue to subsidize the dirty fossil fuels of the past, or will we transition to 21st century clean, renewable energy?"
-Elizabeth Warren

INTERVIEW WITH TODD CORT

I conducted an interview with Todd Cort along with Ruby Tackas. Todd Cort (pictured below) is a Professor of Sustainability at Yale. Here is the transcript of the interview and some of the things he showed me:

Question: How does solar energy compete with other renewable energy sources?

Answer: Compete means a couple of things, so the current mix of renewable energy is 80% non-renewable energy, so coal, natural gas, oil, and about 20% of our energy comes from renewable.

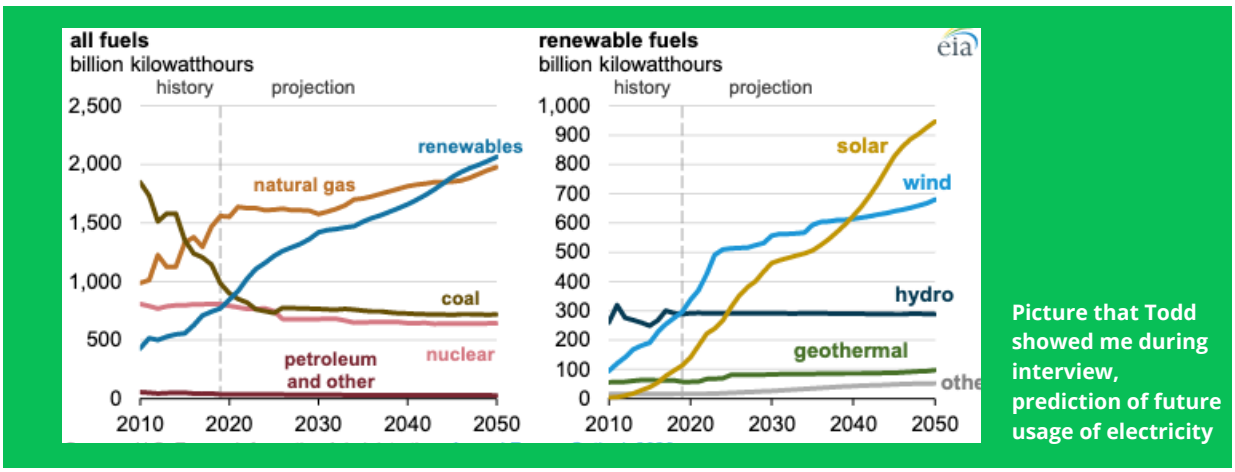
And of that 20%, the big bulk of it is hydropower (which is dams); then you got windpower, then solar, bio-power which refers to ethanol or waste, and then a little on geothermal and ocean, so that's, at a very broad level, is how it competes. Another main element of how it competes is how much it costs in the market, so how much do I have to pay to either build that plant or to source that electricity, so you know I pay an electric bill every month, you do too. I don't like to pay extra, especially in CT, because its expensive. So the other question is how it competes in terms of cost so one of the big things that has happened in the last decade in our world, is that a couple of these have flipped so if I look at over time if I look at the cost per kWh per electricity production so how much does it cost to produce one unit of electricity,



so solar got cheaper and cheaper, coal's been getting more expensive, and natural gas has been getting more expensive. So now we're at the point where coal is the most expensive then solar and natural gas, so what does that mean? Well, what that means is that it's electric generators are saying it's too expensive to produce coal, so if someone else sells electricity with another generator, a non-coal one, I'm gonna lose business because coal is more expensive. So you'll see there is almost no new coal plants in the US because they're too expensive but there's a lot of natural gas because it's cheaper, that doesn't mean we don't have a lot of coal because no one wants to spend the money to get rid of the coal or convert them. So solar is going up really fast, so that's been one of the really big changes so solar and wind are getting close to competing with natural gas. So natural gas is the leader followed by oil than wind than solar. Producing the photovoltaic cells for solar is getting cheaper and cheaper because we're finding more ways to do it.

Question: When will solar pass natural gas in usage?

Answer: Ah, so that's a good question.There are so many theories. If you go to an organization called the EIA, which is the Energy Info Agency, and IEA, which is an international energy organization, so if you look these guys up, these are big companies, and one of the things they do is scenarios, so projections into the future, so you'll see diagrams for every 10 years. So they'll say the total amount of energy, they'll use how the economy grows, and how the prices change so based on the economics so they'll predict how much of each we'll use. So they say that coal will slowly decrease. It's not big changes things move slowly in this world-- so in 20 years, coal will drop 5-8%, and they predict the natural gas will go up a little because the price will stay similar. Solar and wind will go up so the renewables will go up and the non-renewables won't.



Picture that Todd showed me during interview, prediction of future usage of electricity

Question: How have the sources evolved?

Answer: So solar panels have gotten cheaper and more efficient for a variety of reasons.One reason is that the minerals we put in them are getting cheaper to get so if I'm

building a solar panel,I pay less to buy them. The second thing is that the scale has gone up so there are more people buying so for the companies to stay alive, they can sell it for less. Also, new panels have come out like thin film which is smaller. Also, governments are subsidizing it, and there are other innovations on the financial front so we figured out how to make mass installations so we can use fields and just cover them in panels. On the other side, for coal, they're gonna start to tax for greenhouse gas emissions in the US and are already doing it in Europe, and China started doing it. This is a bit of the reason why natural gas is cheaper because it pollutes less which saves money. We've also had significant improvements in the wind power; they usually were fast things going really fast which kills birds and collects less, and when they're slow, they're more efficient. We now have offshore wind which is very efficient and even deep sea, so they don't have to be connected to anything. This helps because people don't want them in their backyard, but they don't care if it's in the middle of the ocean. The short story is that renewable is getting better and fossil fuels are getting worse. It's a slow process.

Question: What do you expect the future to look like?

AnswerL The future, I always give two messages. We are transitioning, but it's too slow, and there's a variety of reasons for that but we need to replace fossil fuel with renewables faster than we are now. One of the reasons is that even though solar is cheaper, one of the big challenges is that solar never works at night. So in order to do that I have to have batteries so I can store the electricity generated during the day. So, let's say this is the 24-hour clock from midnight to midnight-- so in the middle of the night we don't use much electricity because everyone is asleep. Then, in the morning, the people turn on the lights. Then it stays pretty high while people are working. Then, in the evening, it goes up and then drops back down later at night. So for the middle of the day, the solar can feed the day because the sun's shining, assuming it's not a rainy day, but at night when it's peaking because there's no sun, we need some way to take care of this. So, one solution is batteries so we just store it and turn it on at night or on a rainy day when we need it but this is pretty expensive. Another solution is peaking plants which are natural gas plants that only turn on in the evening to make up the extra. It's not as bad as a normal natural gas plant because it would run less, so pollute less. You could also turn this on a non-windy day.

Question: Although solar, wind, and hydro don't pollute, they hurt animals and other things around it. Which do you think is the most sustainable?

Answer: Hydro hurts animals the most because we're flooding the damn. For wind, the tech has gotten so much better so it doesn't hurt as many animals., most of the problem with wind is in the construction so animals don't wanna hang around while you're banging



Paris accord signers

away into the sea bed. And solar-- the harm on animals for solar is in the mining of the minerals for the solar panel, and there's a little bit in the use if we had a lot of panels sitting in the desert, then it could disrupt the animals. But hydro has the biggest impact on species and ecosystems, and there's not a way around that, and there's a reason they're not putting a lot of plants and they're actually taking some out. Fish ladders are somewhat effective; they're not great but it's one way to try to save them.

Question: Is it possible for other renewable energy sources besides solar to be put on someone's roof?

Answer: If you went over to Yale, they had an engineering building with ten windmills on the roof. They looked like house fans but they didn't work that well. Now that doesn't mean it's not possible. A more common one we see is thermal water. This is used to heat and cool buildings. They run water in black tubes and let the sun warm the water up so they have a bunch of warm water and they convert the heat to energy. But solar panels are the most efficient and the cheapest.

Question: What is the Paris Accord?

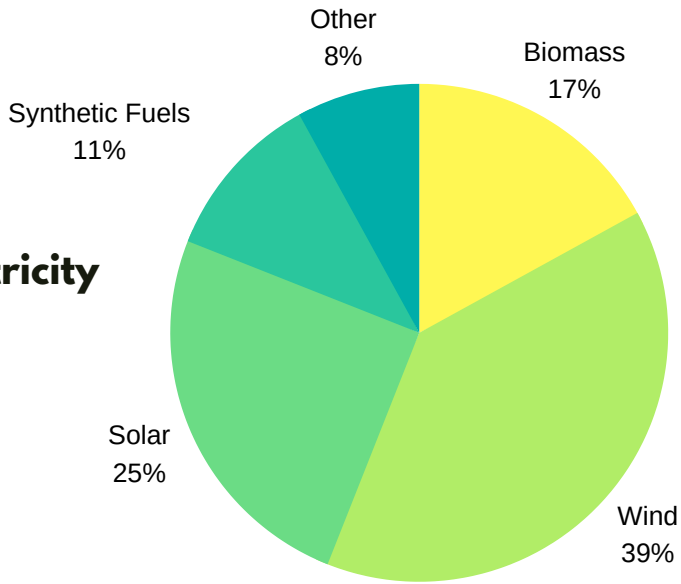
Answer: In 2015, the International Panel on Climate Change-- so every year they get representatives from around the world, and in 2015, a couple of big things happened. All the countries that signed this are agreeing to voluntarily reduce their energy so they're ratcheting down their greenhouse gas emissions every 3 years by about 1.5%. They got 192/194 countries to sign the agreement. We've never seen that kind of agreement since World War II, and the only countries that didn't sign were Nicaragua and Syria. Nicaragua didn't feel like they were getting enough benefit out of it, and Syria was having conflict troubles and couldn't sign. Nicaragua has since joined, but the US dropped out. All the other countries are doing it-- so they are voluntarily dropping, and the first ratchet was two years ago. A couple of countries said they made progress, but they weren't willing to ratchet down too much. The second big thing was the governments said we need the businesses to join, and they joined on as well. This is really significant because it costs money, and businesses have more money than governments.


The future is green energy, sustainability, renewable energy.
-Arnold Schwarzenegger

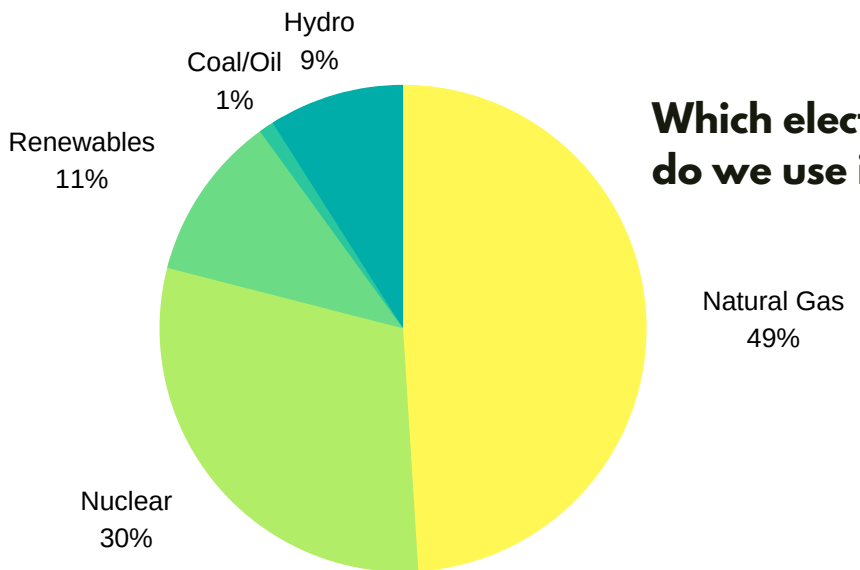
DATA

On these next few pages I will represent the data I gathered throughout my research using graphs.

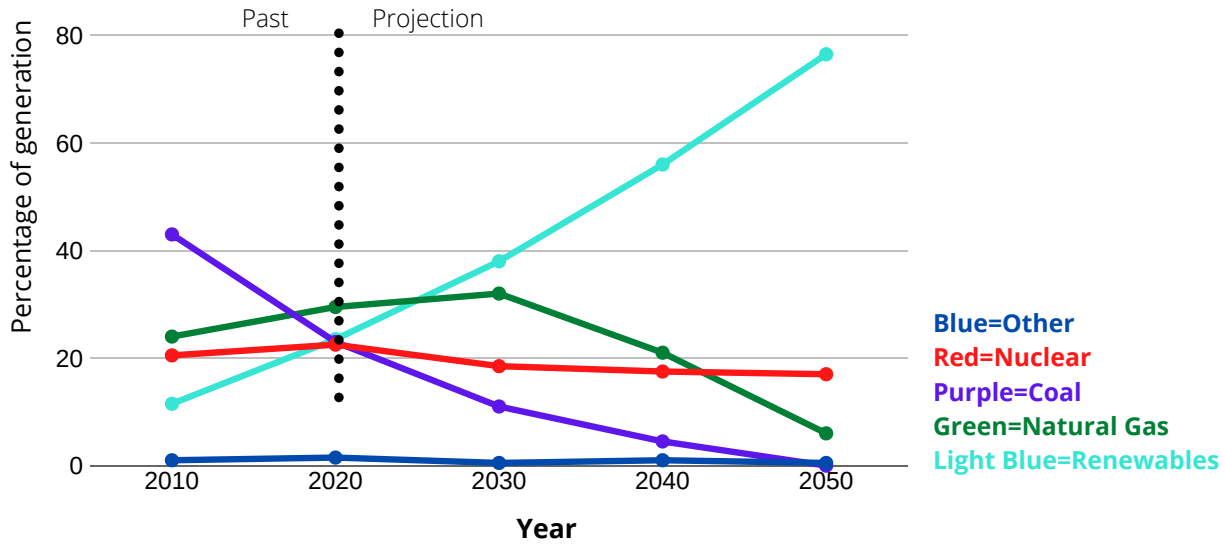
Which renewable electricity sources do we use in New England?



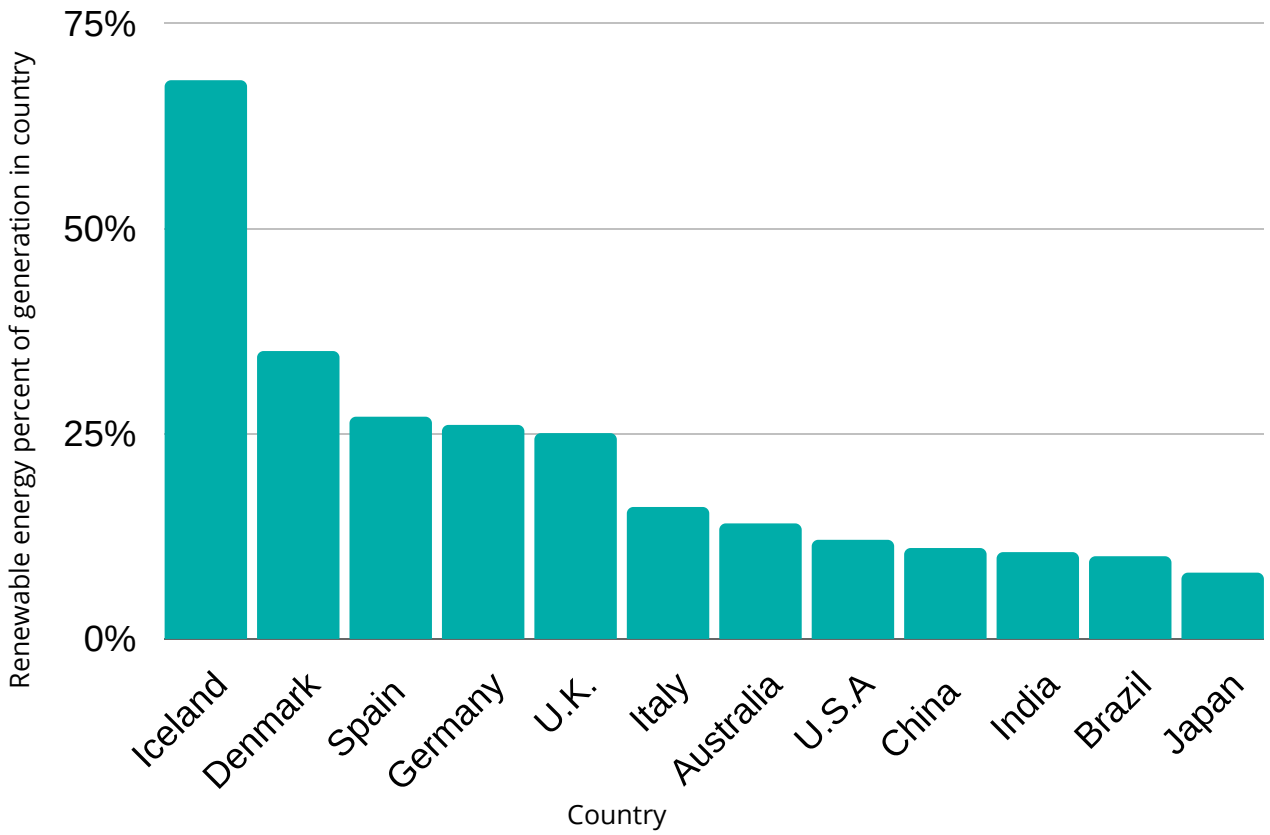
Which electricity sources do we use in New England?

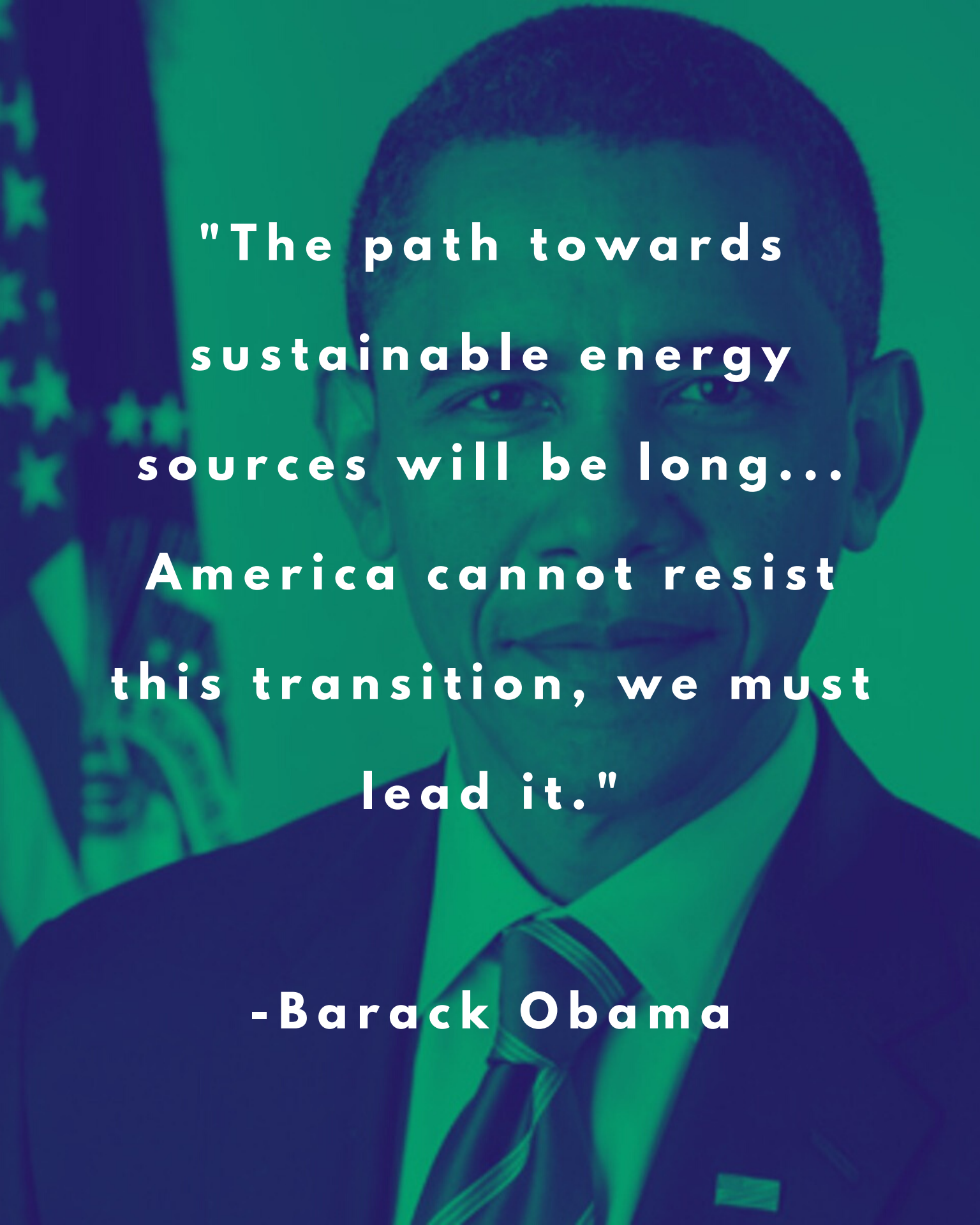


How should we generate our electricity in the future if we want to hit climate change goals? My prediction



Who is leading in renewable energy?




"The path towards sustainable energy sources will be long... America cannot resist this transition, we must lead it."
-Barack Obama

WINDMILL PROTOTYPES

As I said in the introduction, my project was making a windmill. In this section, I will share my process for the three designs I made and show pictures to help explain.



DESIGN ONE



After gathering everything I needed, I got to work



The windmill I had built didn't turn out so well. It didn't spin at all in the wind.



I thought it was because there was too much friction, so I changed the axel from a marker to a straw.



TIME TO PROBLEM SOLVE

The straw worked a little better, but it wasn't efficient enough to be spun by a fan so I had a Zoom meeting with my Tinkering teacher, Kyle. He thought that lighter blades with a more efficient axel (instead of straw or marker) would make it spin better in the wind. So I tried paper blades with a rolled up piece of paper around the straw to spin on the axel. This spun more efficiently, and for the first few seconds, spun slowly, before the paper got too weak.







Because the paper was too weak, I tried card stock. It worked better because it's light enough to be blown by the wind, but heavy enough to stay strong.

Conclusion

In this design, I learned that there has to be a good balance of weight and length with the blades. The blades need to be heavy enough to turn and stay strong in the wind, but they have to be light enough to actually turn in the wind. They also need to be long enough to turn. I was surprised that the paper cup and the paper towel roll where strong enough to hold it the whole time that I was messing with the design. My final design spun a little in the wind and could spin for a while after I hit it.

DESIGN 2

While this was happening, I also got a kit to make a windmill from Matt Morissey, who was an expert I was planning to have a meeting with. He is the developer for windmills at Orstead. So, what he does is design the windmills that go into the sea. Because of this, he had access to the models and kits, and was nice enough to give one of each to me.



Here is me working on building the windmill from the kit.



The windmill from the kit turned out like this.



And worked really well, able to light up an LED in the wind. In this photo, the blades are in the front spinning, and you can see them if you look closely. The wires are connected to a board that plays music when there's enough electricity.

Conclusion

With this design I managed to build a windmill to light an LED. It was helpful when I was building the windmill out of my own things because it showed me designs that I could use to make that one.

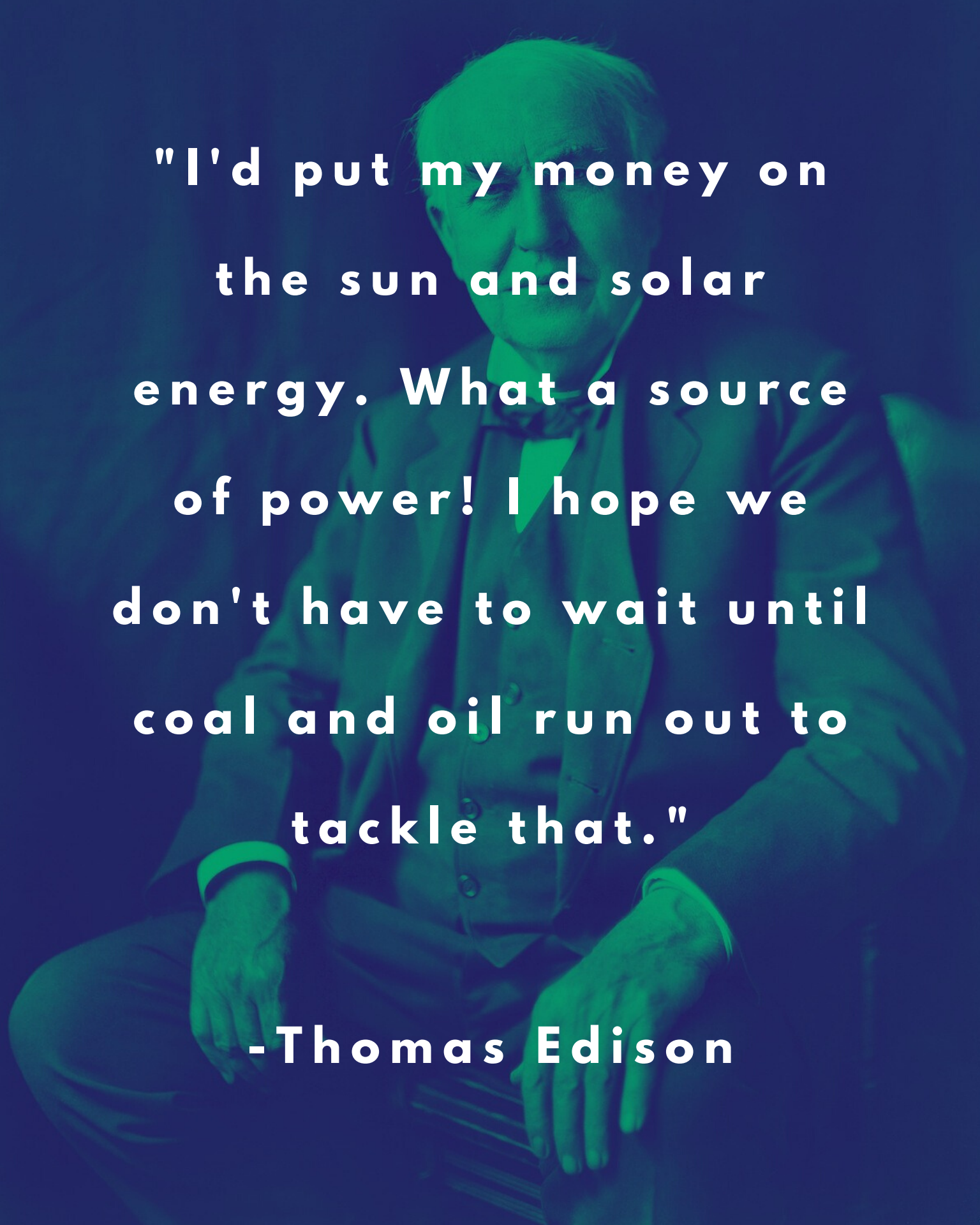
DESIGN 3

Matt also sent me a model of the windmill he designed that will be in the sea generating electricity by 2025. The model came in three pieces and spins a little, although it is made to be a model and not to spin.



Conclusion

This windmill came to me in three parts and was very simple to put together. It was helpful because it represents a real windmill that will be placed in the water. This helped me visualize what a windmill looked like and how I wanted to make mine.


"I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait until coal and oil run out to tackle that."
-Thomas Edison

RESEARCH PAPER

INTRODUCTION

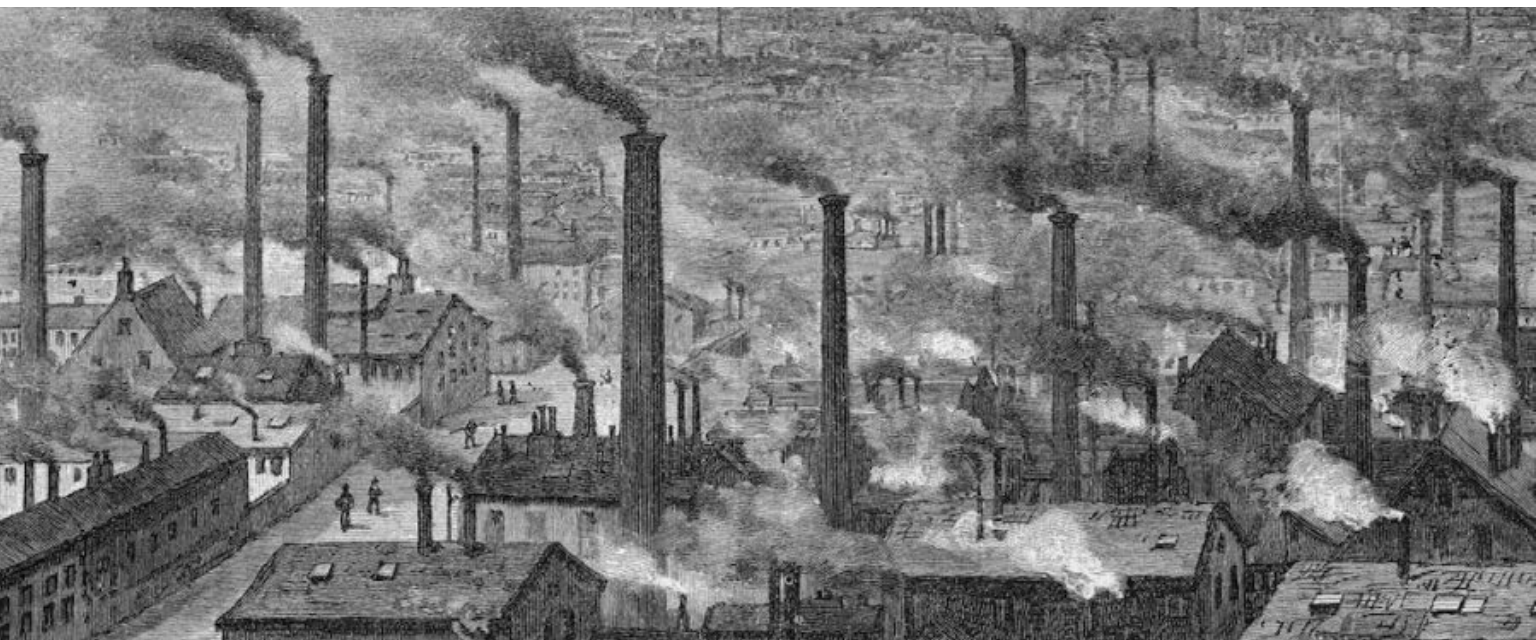
Hi, I'm Ray Keever. I recently bought a new sports complex. This complex has a huge electricity bill and if I'm gonna figure out how to pay for it before going bankrupt, I need to figure out how to lower it really fast. To try to lower the bill, I'm gonna change from where I get my electricity. I don't mean just change providers, well, how could I? There's only one grid. No, I'm gonna change the type of electricity I use. It won't just be what the grid provides me, stuff I have no idea how it got to me and who or what it hurt in the process of generating the electricity and transporting it to me. I need to pick a new electricity source, one that I own, know the problems of, and can control. The problem is I don't know which one is best to use. Should I buy my own fossil fuel plant? If I do, which type? Should I make a nuclear energy plant? What would happen if I got solar panels but then it rained? If I had my own wind turbine, I would have so much electricity, at least when it's very windy! Since I have a river flowing right next to me, I could get hydro. We do throw a lot of food out; maybe I could turn that into electricity using biomass! It can get hot right here in Florida, let's try geothermal energy!

There are many problems and many benefits to each of these choices. Choosing isn't going to be easy. In order to decide, I need to first learn about how all this started and then learn about each of my choices.

THE INDUSTRIAL REVOLUTION

In the 1800s, something amazing was used directly for the first time by anyone on Earth. It was electricity. Electricity is the flow of electrons. There are many different types of electricity and they can be “generated” in many different ways. The generation of electricity is actually just converting energy from one form that we cannot use to one that we can. If we were to take away electricity in modern times, we would lose a lot of key things that hold the economy together.

This high usage of electricity all started in one of the most important and revolutionary times the world has ever seen: The Industrial Revolution. The Industrial Revolution spanned from the late 1700s to the late 1800s during this time the first reliable train was invented, although that uses a different kind of energy called combustion. The lightbulb was invented. The telephone was invented. Thousands of other things that most of us take for granted today were invented. These inventions had a huge impact on our economy. We switched from going across the country in 60-80 days on an unpredictable horse to getting across on a train in less than a week (trains can now get across the country in less than a day). We could now see in the night without the risks that candles bring. The reason we could do these things is we discovered something called “fossil fuels.”



WHAT ARE FOSSIL FUELS?

Fossil fuels are, among others, natural gas (methane), coal, and oil. These are burned to power many things. But there are many downsides to fossil fuels starting with the fact that they are not renewable. Not renewable means that they don't last long as a resource; it will stop doing its job after a certain amount of time. Fossil fuels are made from millions of years of the dead matter being compressed below the surface of the earth. Since it takes millions of years to make it, we are using it much faster than it is getting replenished, meaning that it could run out.

Another big problem with burning fossil fuels for electricity is that it causes pollution when it's burned to make electricity, including: 1) sulfur dioxide (which causes acid rain can hurt anything that relies on water); 2) mercury (which can get into people's bodies and hurt their nervous system, digestive system, immune system, lungs, and kidneys); 3) soot (which gets into your lungs and can really hurt people); and 4) carbon dioxide (the leading cause of global climate change, which is killing wildlife and, eventually, humans). These problems need to be stopped, which is why we are trying to switch to renewable energy.



WHAT IS NUCLEAR ENERGY?

Nuclear energy is energy generated in two types of ways: fission and fusion. Fission is energy generated from the splitting of an atom, which creates heat that is turned into energy. The fuel usually used to do this is Uranium, but Plutonium and Thorium can be used as well.

Fusion is where two types of atoms come into contact at high speed and create energy. Fusion is a great way to create energy, although it's pretty hard to find the correct conditions in a place where there is enough space. Currently, all of our nuclear energy comes from fission because making conditions for fusion is so hard.

Nuclear energy generates about 1,000,000 times more energy per atom than fossil fuels, which can save our resources. Nuclear also pollutes a lot less than fossil fuels-- the biggest problem is the stuff, such as fission rods, that remain after. They can stay radioactive enough to kill someone for 50,000 years. This can present problems as we have no place to keep them. We often place the fission rods in buildings to store it but it takes a lot of money to do it. It also wastes a lot of space and people don't want it near them, understandably so, which makes it very hard to find space for it.



WHAT IS RENEWABLE ENERGY?

Renewable energy is energy generated from a source that does not run out such as: wind, solar, hydro, and geothermal. These sources are considered renewable because they have an unlimited amount. For example, the sun will keep shining until very long after humans are gone so for our needs it is unlimited. Sources like biomass are also considered renewable because they can regenerate really quickly.

Renewable energy is used as the third most resource type that generates electricity around the world, trailing to fossil fuels and nuclear energy. Many countries are trying to switch completely over to renewables. Iceland is 100% renewable and more than 75% of Norway, Brazil, New Zealand, and Columbia are powered by renewable sources.

Renewable energy is third in usage but it is on the rise; in 2010 it represented 12% of the world's energy production, now it is at 20%. If we could switch completely to renewable energy, it would have many benefits.



TYPES OF RENEWABLE ENERGY

There are many different types of renewable energy. The most used is hydro, which represents 44% of renewable energy generation counting tide, which instead of using current uses the tide. Hydro works from the current of water pushing the turbine which converts the kinetic energy to mechanical energy which spins a generator that converts the mechanical energy to electrical energy. Hydro is often debated for whether or not it should be considered renewable. In this paper, I consider it renewable but in my data page, I represent it as its own resource. Wind energy works very similarly to hydro, except the wind spins the turbine instead of the current. Wind represents 17% of renewables.

Another renewable energy source that is very often used is solar. Solar panels are made from the element silicon, which, when sunlight hits it the electrons, which are particles that contain a negative charge, begin to move. This creates a direct current or DC energy. This energy is then sent to an inverter, which converts the energy to Alternating Current , or AC, which we can use on our AC system. Fifteen% of renewable energy is from solar.

Geothermal energy is energy generated using heat from under the earth's top layer. To make it, we drill geothermal wells into the earth's crust and the burning hot water is taken up to the crust. Then the steam from the water turns turbines, which turns a generator generating electrical energy, it represents 0.4% of electricity but a lot more thermal energy.

Biomass energy is energy generated from organic matter. It is located in things like plants and trash these are called “feedstock.” We can use biomass in many ways:

1. You can burn it to create energy. This is what happens when we use wood to make a fire, we can use it to heat things;
2. You can use it for gasification, which is using heat and pressure to convert the feedstock to “syngas,” or synthetic gas, which is burned like natural gas;
3. If you heat the feedstock with no oxygen available for the feedstock, it creates bio-oil, bio-char, or syngas. These are all burned like the fossil fuels but they pollute less than the actual fossil fuels;
4. If you use bacteria to break down the feedstock when there is no air, it produces biogas, which is very similar to syngas and can be burned to generate energy. The burnt feedstock is called digestate and makes a great fertilizer; and,
5. You can take the glucose, which is a sugar that keeps many feedstocks healthy, from the feedstock and convert it to ethanol with yeast. Ethanol powers almost all of our transportation among other things.

The decision of which to use is based almost entirely on how much of the feedstock that is best for each is available. Some of these don’t pollute at all, while some pollute a little, but it is way better than fossil fuels.

					
Solar	Wind	Geo	Hydro	Bio	Tide

BENEFITS OF RENEWABLE ENERGY

Renewable energy has many benefits besides being renewable. The biggest and most important one being its pollution, or its limited pollution. Fossil fuels pollute 1.74lbs of greenhouse gas per kWh while most renewables pollute 0lbs. This means that there will be less to no global warming, thus saving millions or billions of different species, including humans if we switched completely over to renewable energy.

Renewable energy is often thought of as more expensive than other sources, but that’s not entirely true. The initial price to buy the power plant is higher for renewables, but they are much cheaper once they’re up and running. A fossil fuel plant needs fossil fuel to be mined, the fossil fuel brought to the plant, and it needs workers to run it at the plant. This adds up. With renewables, you set it up and that’s all you have to do. No more work.

Another huge reason to choose renewables is the ability to place them so easily. Have you ever seen a fossil fuel plant on someone's house? No, neither have I. Some people own them as backup generators but they are very expensive and pollute a lot; they’re only used in power outages. But you’ve seen solar panels on somebody's house without polluting. This makes a huge difference. Almost all power outages are from the power lines. If a branch falls on the line or the wind blows too hard, many people can be left without power. This is why renewables would be so helpful!

PEAKING PLANTS

One of renewable energy's biggest problems is the fact that they aren't always available. A way to fill in the gaps is to use peaking plants. Peaking plants are fossil fuel plants, usually natural gas, that only run when renewable energy is not enough. If we could use fossil fuels only as peaking plants, we would be running on all renewables until renewables weren't enough. Peaking plants would run on rainy days and at night, saving a lot of resources, and since we're using fossil fuels less, less pollution.

Stepping up to just using peaking plants would make a big difference, but there are some things that get in the way, other than just renewables problems. To turn all those fossil fuel plants into renewables has a high price tag, too high for many investors in renewables. But even if we ignore the price and talk science-- it just wouldn't work, or at least not yet. Many types of renewable energy sources need certain weather patterns, such as a windy or sunny day to power wind and solar. These weather patterns aren't possible in places where fossil fuel plants are.



DOWNSIDES OF RENEWABLE ENERGY

Yes, most renewable energy sources don’t pollute as much as fossil fuels, but they do pollute. Biomass and geothermal pollute some, although it's a lot less than fossil fuels. But other renewable sources pollute in different ways. Renewable energy is a leader in hurting wildlife. Solar panels concentrate the sun which incinerates birds and other animals. Solar also has elements in the panels that need to be mined which hurts many different animals. Wind also kills birds from the birds flying into the moving turbine, although with the recent technology this is happening a lot less often. With the old technology, it used to be small windmills spinning really quickly. Now we have these giant windmills that move really slowly and birds don’t really notice it. The other problem with offshore wind is when they’re installed, the sound can hurt whales’ sonar hunting ways, which can end up starving the animal. Hydro kills almost all sea creatures that swim near it; there are fish ladders but they aren’t that effective. Although renewable energy is very good and would have many benefits to our planet, there are some problems with it. The biggest problem with it is how variable it is-- it can be generating a lot one minute and then the weather changes and it’s not generating all the electricity we need. The biggest renewable energy sources, hydro, solar, and wind are all based on the weather, and the weather is ever-changing, so on a cloudy non-windy day, solar wouldn't work because of the clouds, the wind wouldn’t work because there’s no wind, and the current wouldn’t be that strong because of the absence of wind. Think of a hot muggy evening when there is no sun or wind. This makes it very hard to build a reliable system with only renewable generators.

Someone that relies on wind, Brian Driscoll, to run his company Phoenix Press said, “Even though we have our own windmill, we still need to take from the grid when it’s not windy enough.” Most of the grid is electricity generated from fossil fuels so if we took away the fossil fuels, he wouldn’t be able to take from the grid to run his company. This is an example of net metering. Our electric system is broken up into three parts: generation, transmission, and distribution. Net metering is a way of compensating people with generators on their side of the distribution meter, which basically means they have their own electricity generator, such as a windmill or, more commonly, solar panels. The meter counts how much electricity you take, or sometimes give, to the grid. Having solar panels or a windmill can also save the distribution and transmission fees because it doesn't happen if it's already distributed to you.

TYPES OF ENERGY

Energy is used by us in three ways. First is electricity, which we’ve been talking about, and what my numbers in the data section represent, powers lights. The second type of energy is thermals, heating and cooling buildings. The third type of energy is combustion, which is used in transportation. Electricity is made in the ways we’ve been talking about. Geothermal energy, while sometimes used to create electricity, is more often used thermally. Geothermal energy, working this way, works very similarly to electricity, except the water’s steam isn’t used-- it’s the water itself. The water goes to a boiler which converts the water’s heat into heat that we use to heat our buildings. Another type of renewable energy source that we use to do this is wood. Wood is used to light fires and then heat the water which goes to the boiler. Combustion works by putting a mixture of fuels, such as gasoline (refined oil) and air, then compressing them so that they’re tight and then setting a spark that gets the car moving.

CONCLUSION

After reading this, to you and myself, and learning about electricity, I'm thinking that if I use a renewable power plant, I could save a whole lot of animals, even us! Renewable energy will also be cheaper than fossil fuels in a couple of years! Even nuclear requires me to hire people to work here after I've built the plant, and is very expensive to build. Renewables are expensive to build, but not very expensive, and will run by themselves.

On the other hand, if I get fossil fuel electricity, it will save me more money upfront-- that is, until paying the workers and getting the fuel becomes more expensive in a couple of years. But if I do get fossil fuels, my favorite fish in the river next to us might die. Yes, I must stay away from fossil fuels.

Let me consider nuclear power. If I buy nuclear energy, it would be very expensive to build the plant, but I wouldn't give off pollutants, and I would save my fish. The problem is all of that radioactive stuff. Where would I put that? I run a sports complex. I have no idea how to deal with radioactive metals and chemicals. I guess hiring people that do will cost me money that I don't have.

Yes, when I think about it, renewable energy will definitely be the best. But, which one? If I buy a windmill, I might make money by sending the energy to the grid when there is extra wind to power my complex! But, I might need to take it back from the grid when it isn't windy. I will have to spend a lot of money on buying parts and hiring people to make it. Making it will also cause problems to my whales and other fish that use echolocation.

What about solar? If I put solar panels on my roof, I have to buy the parts, which are a lot cheaper than a windmill, and hire the people. Also, I won't have energy in the winter or when it's raining so I'll have to stay connected to the grid. Staying on the grid can also make me money, like wind. Solar will save me more money than wind when I buy it, but it will be essentially useless in the winter, at night, and when it's rainy, meaning that I will need more money from the grid, and in a couple of years, it will be cheaper to have gotten wind. But is it worth it right now?

I must consider hydro as well. It's the leading renewable energy source. If I get hydro, it would be cheaper to install than wind, but more expensive than solar. I would still have to hire people, and it would kill almost all the fish! I'm going to stay away from hydro.

I'm going to go with a windmill. The windmill is my choice because I am the owner of a big sports complex and will use all of that electricity. The windmill may be expensive, but since it generates so much electricity, it will save me money before it gets too old in approximately a decade. It's also great for me because I'm right by the water; the wind is stronger by the water because there is so much space over the water that there is less friction to stop the wind. If I were in the middle of the city, solar panels might be smarter because then the wind would be slowed by the buildings, and solar panels would be a better idea.

Any of these renewable choices would be great, but please, try and stay away from fossil fuel plants, and until we find a good way to store the radioactive materials, try not to use too much nuclear.