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The Transition into Renewable Energy

A feasibility with economic, social, and political constraints

Abstract

Looking at the transition into renewable energy production and deciphering its feasibility considering its multiple constraints constraints. It is mostly socially desirable but there are extreme difficulties. Since the world has been mostly reliant on fossil fuel consumption it is a difficult area to change. This paper is on the complexities of the transition to renewable energy including the economic perspectives on the issue while including social and political issues. I approached this issue with a data driven mindset because many opinions of this can be skewed due to political affiliation. I saw this how an energy producer would want to see it, all facts and they can make their opinion based on the pros and cons while considering policy, political, and economic factors. I found that this transition is supported by state governments and oil companies. This is incredibly important because some fossil fuel companies are recognizing their potential future and taking that as an opportunity to invest in a growing industry but also investing in their self-preservation. I also found that this industry is growing at the mercy of constant innovation to attract investors and out of fear of global warming. This is important because this is a business transition but is heavily inspired by the dangers of global warming.

Table of Contents

Background.....	3
Global Warming.....	4
Politics.....	5
Renewable Energy Market.....	8
Economic Impacts.....	9
Policy.....	14
Policy Encouraging Renewable Energy.....	15
Barriers of Growth in the Renewable Energy Market.....	16
Insight from Rob Godby.....	18
Conclusion.....	23

Background

Having strong background knowledge is very important when it comes to looking towards the future of renewables. This is because renewables aren't a new idea, but with climate change concerns they have been very popular in climate arguments since their main purpose is to produce energy with little to no pollution. Something else to consider is the social desirability of renewables and the controversial nature of the climate change argument. Even though some this is very controversial it turns out that both conservatives and liberals generally accept renewables like solar and wind. Some of the controversy comes from the potential loss of jobs that could result from a transition in industry, but there has been the combining of renewable and non-renewable companies. This can be seen in companies like BP who have been buying and investing in renewable companies. After all the controversy there is the importance of the economic gain that comes from this transition. This can be seen in new jobs, innovation, and new markets like the renewable energy credits (REC) market. So, with all those factors combined, the renewable industry has potential for substantial growth. I aim to find how renewables can have a majority share in the energy industry.

Global Warming

The issue of climate

change is becoming more of

an issue every year as we

see temperatures rising,

some plants and animals

going extinct due to the

change of weather and

water temperatures resulting in the destruction of habitats (environment.co). The industrial

revolution as shown in an article by the Carbon Brief explaining “Somebody living in the

1830s or even the 1890s would not have been able to distinguish that there was this change

afoot”. “It’s by having this long record now that extends almost 200 years from that point

that we can go back and say Well, this was when the changes first started” (Abram, 2016).

As you can see in figure one, NASA that shows the parts per million (PPM) of CO₂ in the

atmosphere over the past millennia through measurements of ice cores. There are

fluctuations over the hundreds of thousands of years but right around the late 19th century

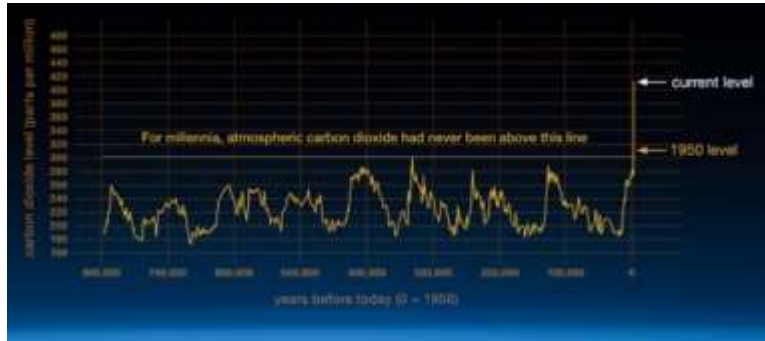
it begins to rise, when it hits the 1950 marker as they have highlighted it, the PPM

skyrockets. Much of this unnatural rise can be accredited to the use of fossil fuels in the

many different engines that have been used throughout history. Carbon dioxide is a

greenhouse gas that absorbs and radiates heat meaning that it is one of the big reasons why

CO₂ as Parts Per Million (PPM) in the Atmosphere (Figure 1)



we are worried about global warming and the melting of the

polar ice caps. This also

means that we will see

temperature changes

annually. Based on the

National Centers for

Environmental

Information (NOAA) in

figure 2, the predicted

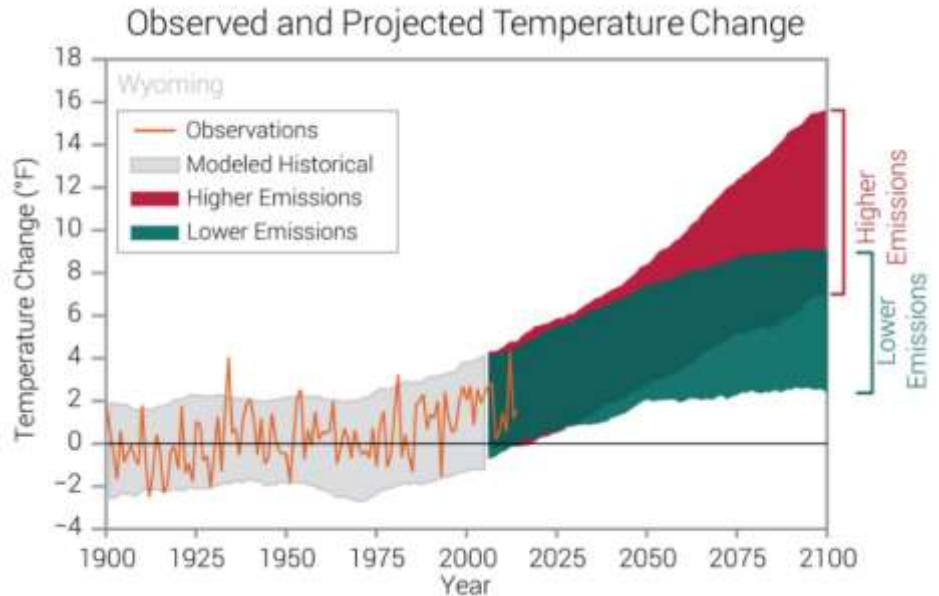
temperature changes in

Wyoming based on multiple levels of emissions. Even though the small degree changes

don't seem significant, they really effect more ecosystems because these temperature

changes may not be tolerable for them (environment.co, 2020).

Observed and Projected Temperature Change in Wyoming (Figure 2)



Politics

According to a 2019 Pew Research study, about 90% of democrats and 39% of republicans believe in climate change. That is a large difference between the two and it shows how divided we are in the US on this issue. According to the same study 90% of people are in favor of solar panel farms and 85% are in favor of wind farms. So, those numbers tell a different story, those renewable resources show that many people across

the political spectrum are willing to try these new energy resources. They are in support of it for different reasons though, some could say that it is clean and healthy for the environment and others say that there are more opportunities to generate energy across the US.

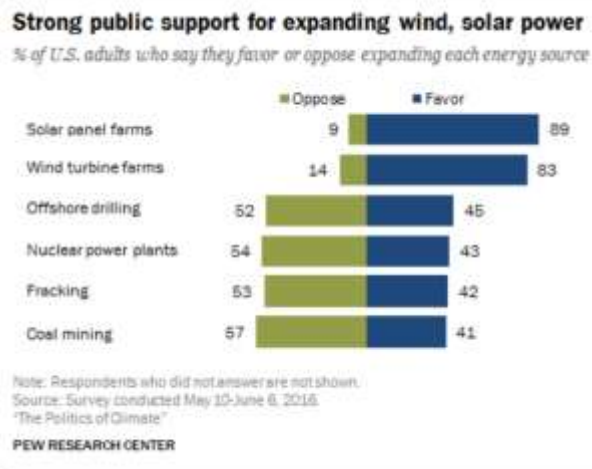
Public Support

What can be done to reduce CO2 emissions? Renewable energy. Renewable energy is a new option to produce energy with minimal CO2 emissions. That means using things like wind turbines, solar panels, and hydroelectric dams for power. These options are essentially ways we can make energy out of natural occurrences like sunlight, wind, and water flow. Since this is an emerging technology there are many

skeptics about its effectiveness, so it is still controversial when it comes to things like a vote for wind turbines in Wyoming. I say this because many people have their opinions on these big machines that they aren't used to seeing and it impacts everyone differently. As time has gone on

many have become more accepting of renewable energy as shown above. Looking at figure 3 you can see renewables are at the top while the remaining four are just about split down the middle. So, when we look at a large group of people where there are no specifics on really anything about the people including age or political views. Currently, it seems so many personal opinions are associated with a political party.

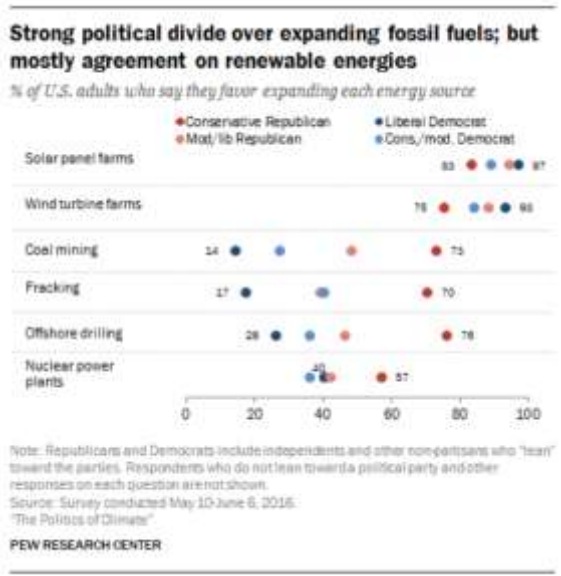
Public Support for Energy Sources (Figure 3)



Looking at the political associations in the 2016 Pew Research Center study in figure 4

the last study is more understandable. The two renewables are more favored across both

Political Divide Over Fossil Fuels (Figure 4)



parties. While the non-renewables are favored by republicans there is a noticeable difference with

the democrats. This is an emerging technology so that means there will be quite a few skeptics.

Like all new technologies it will take time to fully accept it, but it is always improving and

eventually when it shows more promise than fossil fuels. However, that situation is very far in

the future and right now it is a matter of fossil fuels and renewable sources working together. A

good example of is someone getting the two to work together would be T. Boone Pickens, especially when he says that America is too reliant on OPEC oil and that we need a modern energy grid so we can build more renewable energy producers like wind turbines and solar panels (pickensplan.com). Pickens is someone that is forward thinking and acts both republican and democrats values when it comes to this issue. He appeals to the republicans "American made" ideals because he wants America to be energy independent. He also appeals to the democrats by promoting clean energy. Showing that there are benefits for both political parties that appeal to some of their unique values.

Renewable Energy Market

According to Forbes, “Renewable energy continued its blistering growth pace in 2019, globally increasing by 12.2% over 2018. Over the past decade, renewable energy consumption has grown at an average annual rate of 13.7%.”. An average of 13.7% per year is an incredible number to achieve and this makes for a very bright future for renewable businesses because there is stable growth that can help boost the innovation to make more efficient methods of producing energy. According to [companiesmarketcap.com](https://www.companiesmarketcap.com/), LONGi Green Energy Technology has a market cap around \$67.5 billion in January of 2022. This is compared to their \$9.73 billion market cap in January of 2019. LONGi is one of the biggest renewable companies in the world and understandably so, they have multiplied their market cap in just a few years. As for the government, there have been some ambitious spending bills passed over the recent years. One good example was a December 2021 spending bill, described by Environment America:

“Congress appropriated billions to aid our nation’s transition to clean, renewable energy — setting aside \$35 billion for clean energy research and development as well as the extension of critical clean energy tax credits, which help put solar panels and other clean energy technology within reach of millions of Americans. The bill also reserves \$2.6 billion for the U.S. Department of Energy’s sustainable transportation program and \$1.7 billion to help low-income families install renewable energy sources in their homes. Last but not least, the bill will also phase out 85 percent of hydrofluorocarbons (HFCs) — “super greenhouse gases” that speed up global warming — by 2035.”

This bill is very important to make things like solar panels more affordable for average Americans which is great for the environment but also the renewable industry to help grow the companies so they can produce more. This also helps normalize having solar panels because right now it is a unique thing to see on a house, but this bill might help make it seem like a more normal thing. A good investment of renewable energy is the Rail Tie Wind Project where ConnectGen, a wind turbine company, is planning to build roughly 120 wind turbines in Albany County, WY. Even though this was a very controversial project it was approved for construction, and some see this as a step in the right direction to become more reliant on renewables.

Economic Impacts

Since there is evident growth in the renewable energy market through examining companies like LONGi Green Energy Technology, how is this being adopted by large companies like BP? According to the New York Times “BP is the standard-bearer for the hurry-up-and-change strategy. The company has announced that over the next decade it will increase investments in low-emission businesses tenfold, to \$5 billion a year, while shrinking its oil and gas production by 40 percent.” (New York Times, 2020). This is a stunning statement considering the size BP, which has a value of nearly \$23.3 billion in 2022 (statistica, 2022). Shrinking their main source of income by 40% while multiplying their renewable investment 10x within the next decade shows how committed these large companies are to producing clean

energy. Now I can speculate some different factors that might influence such a large change because they are most likely not making these changes out of the kindness of their hearts.

There is also most likely monetary and social incentives for this change. Starting with the social incentive, these fossil fuel companies have been projected as heartless corporations over the years because their work has been polluting the planet for many years. However, with climate change being such a hot topic in the news they now have some urgency to change their look.

What is a better way than investing in some renewable companies and growing from there?

This could be social concern for the environment. Now they have a more positive outlook, and they can continue with their new business investments. With this higher opinion of the public, they may have an opportunity to include new investors that want to encourage this transition into renewables. BP made this announcement around August 4, 2020 when the stock price was at \$22.98, now it is at \$32.15 so they are beginning to see some positive results. It looks like investors are beginning to see the potential in this industry on paper, not to mention the positive impacts on the environment.

On the surface this can be seen as a political issue, given that major parties in the US have taken sides, resulting in most Americans falling in line with what their respective party says. They would not be wrong that this is a political issue, but all of this is determined by the economic constraints that companies are willing to work with. Meaning that many can think from a long-term perspective and see the environment falling into more danger, so we want to solve that problem. Energy companies can receive subsidies and tax breaks for increasing their renewable output. An everyday person can take advantage of these opportunities, for example, someone who purchases a hybrid or electric car will get tax credits of varying amounts. So, the

US government isn't sitting idle, so why haven't we seen dramatic change? From an economic perspective we can see a slow transition into renewables, but our economy has been built off cars, trains, carbon-based manufacturing, etc. and we can't just switch over easily. There is still a very large market for fossil fuels especially when it comes to transportation, this also means that when compared to renewable innovation, there just aren't as many job opportunities as possible for people. On the other hand, fossil fuel involved companies are much more well established given their longer history and that will appear more desirable for many workers. So, this isn't that one is better than the other, the problem is more that the renewable side is less mature and needs time to develop. Now it might sound like renewable energy will take a long time to take the place of fossil fuels but considering that the government is providing incentives to grow the industry and even fossil fuel companies are beginning to invest, this beginning growth period may be very successful and develop into the norm for energy production.

It is believed that markets foster competition and thus innovation, when applied to renewable energy this can be seen in the use of renewable energy credits (REC). One REC credit equates to one MWh of electricity that is created carbon free or carbon reduced. REC credits can be held on to by a company and sold later, creating a market. Most producers are required to create energy at a certain renewable standard in the states that don't allow REC trading. However, in the states that do allow trading, producers can produce more and sell the remaining rec credits to those that haven't produced enough and vice versa. Between the trading and non-trading states they are most likely producing at their desired renewable portfolio standard (RPS), a specified % of electricity that a state requires to be clean. RPS slowly require states to begin using renewable energy through requirements. The states have target

requirements for renewable consumption, sometimes by size as a method of setting the standard. The difference is that in the trading states there is more opportunity for individual producers to grow their business by producing more, resulting in more competition. Those producers now have the incentive to produce more than they have been before since they can sell more RECs. This results in more excess credits being produced and most likely the state will feel more comfortable rising their RPS percentage more since they know they are able to produce more MWh carbon free or carbon reduced. While in the states that don't allow trading, producers produce what they are required to since there is no incentive to produce. This is supporting why competition is good since it pushes producers and markets. In the defense of the states that don't allow out of state trade, there are good reasons to do so. This can allow the creation and security for jobs in this field, this is especially important for states that aren't as well established in renewable energy production and need to encourage workers to work for their companies. This is when restricting REC trading to stay in-state can be ideal since there will be competition to push the producers locally as an incubation period until they are more properly equipped to compete and trade with other states.

There are many reasons to why this is a good idea given that it adds a market for just energy producers, and it sets them to compete against each other which will boost their eagerness to innovate. This also fosters a positive socioeconomic impact since this makes for a more competitive and most likely fast-growing economy and that might allow people to be more willing to invest in renewable companies. There is also the factor that people can have more of a reason to invest in local businesses that are related, which has a chance to stimulate

one's local economy. Aside from all of that there is also the intended benefit towards the environment and the economy.

In an article by The Harvard Review, they stated that:

“The clean electricity that a wind farm produces, for example, is fed into the utility grid for distribution regardless of what becomes of its associated RECs. Those RECs are handled independently; they may be sold for a lot or a little, immediately or sometime in the future. Right now, huge surpluses of low-priced RECs are flooding the market, and the cost of an REC represents just a fraction of the added expense of making green power. Therefore, the purchase of a kilowatt-hour worth of RECs does not necessarily displace a kilowatt-hour of dirty electricity; nor, by extension, does it reduce the amount of CO₂ entering the atmosphere.”(Schendler, 2006).

So, the concept of the REC credits is good, but it might require more regulation for them to serve their purpose more accurately. The REC credits might represent some of the cost of producing green energy, but they don't represent all of it. This can be attributed to how relatively young this industry is and lack of streamlined production. This is because the technology is constantly evolving, and it is difficult to narrow down a value per kilowatt hour. The market will most likely saturate at a high level of technology, so the innovation process will be stretched out more and that will allow more consistency in the price per kilowatt hour at the standard level of technology. In this event REC credits might be more accurate for most companies. So, the lack of accuracy in the REC credits may be a con for many, especially those that are new and experiencing higher costs of production due to their energy production not being as streamlined compared to the more well-established companies. Given this problem we see a dangerous problem and that is a rising cost of entry into producing renewable energy (if

they want to make money from selling credits). To build off the point that the renewable energy market is still very young, there is also the fact that parts for these projects can be very harmful for the environment. A good example of this would be how wind turbine blades aren't recyclable, this is because of their composite/carbon-fiber materials and when the blades aren't fit to be used anymore, they go to a variety of areas which includes but is not limited to "graveyards" of blades and landfills. That is just one of many examples to why renewable energy isn't entirely green and how these REC credits might not represent entirely renewable energy, or even energy that is much cleaner than fossil fuels.

Policy

The government has a large impact on companies' ability to produce renewable energy as well as phasing out fossil fuels. In the past and currently, they have been using tax incentives and subsidies among other methods to encourage the use and production of renewable energy. That is something majority of the population will agree is a good thing, but if there isn't time for people to transition and adjust some might become weary of the new policies. There have been talks recently in the Biden administration of cutting some or most subsidies that assist fossil fuel producers, not that this is a good or bad idea, but this is a reason for small town, fossil fuel reliant residents to worry. A good example of this would be Appalachian coal. Over recent years there have been more and more coal mines shutting down which is leaving many people with no work. That is an example of policies that are implemented faster than they should be, but with our current pro-renewable policies that give financial incentives.

Policy Encouraging a Renewable Energy

In recent years, policy that encourages renewable energy production and discourages fossil fuels has become more common than before. An example of this would be the Off Fossil Fuels for a Better Future Act in 2018 which was passed to eliminate some subsidies that benefited the fossil fuel industry. Another would be the Clean Energy for America Act in 2019 which was passed to replace current tax credits with technology neutral tax provisions which would “incentivize the use of low and zero-emissions technologies, including clean electricity, clean transportation and energy efficiency.” (essi.org, 2019). Knowing there are recent bills being passed to encourage the transition into renewable resources, why haven’t we seen very dramatic increases in renewable energy use and a decrease in fossil fuel use? A good example of this can be seen in the transportation industry, where electric vehicle technology is relatively new and the infrastructure is underdeveloped compared to gas and diesel vehicles. So, the policy encouraging the use of renewable energy is just one of many milestones that will need to be reached before it can replace fossil fuels. However, this can be a fast change considering the financial incentives from the government for both consumers and producers. Especially considering the tax incentives for low and zero-emission technologies as noted on the Clean Energy for America Act which can stimulate the demand and subsequently the innovation for those products. So even though these tax changes may seem like they would have a simple effect on those who are directly involved in the renewable market, it can be enough to really stimulate the market to encourage new producers and consumers to get involved due to the speculated industry growth and the increasingly ease of entry. Ease of entry could be seen on many different scales, but considering the individual, someone can buy a new Nissan Leaf for

\$28,425 which sounds like a lot, but it isn't much compared to the average cost of a new car which is at \$47,000. This is just a sticker price, and I am not taking into account for the tax credit the buyer receives which will lower the car related costs, so for someone that wants to enter the market, there are financially feasible methods of doing so.

Barriers for Growth and Entry in the Renewable Market

Like many businesses, it is difficult for a company to get started, but the energy market provides some additional barriers. To start, it is difficult to compete with the already well-established renewable companies that have received large investments from oil producers. Innovation can become very difficult for young companies given that the large ones have the financial means to invest large amounts into new technologies. Some of those large investments can also include production costs.

For example, an 11-yard-long sheet of fiberglass costs about \$60 on Amazon, fiberglass is a component of wind turbines and it commonly found in the three 100-foot blades. This shows how much it would cost to make these components. There will need to be layers of this fiberglass on each blade and now it is easier to understand the cost of a material that makes for less than 11% of the entire wind turbine.

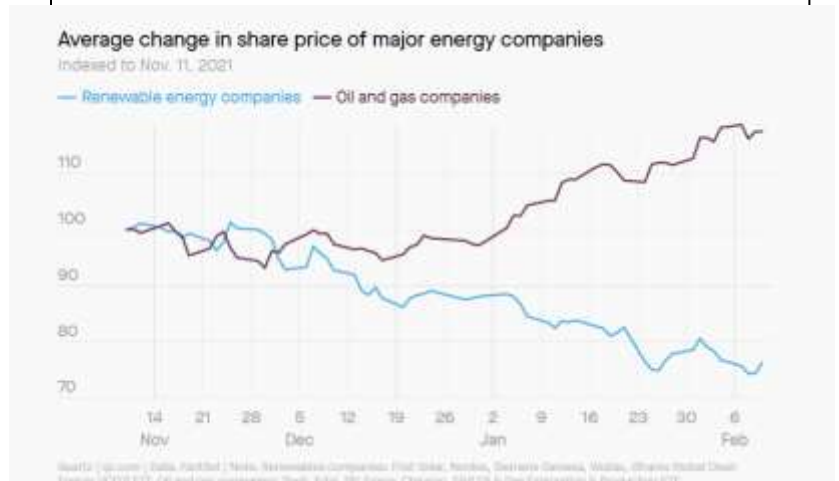
Overall, the average wind turbine costs about \$2.6-4 million. That is a very large barrier for an aspiring young company and presumably a deterrent for many. There is also the consideration that on top of hiring for business positions, these companies will need to make a large investment in engineers to make these goods and that is another area where they can be

dominated by the competition. The bigger companies have the financial means to offer competitive wages and hire more people.

So, aside from a small company trying to begin, what about the well-established ones attempting to grow? Especially considering those who are owned by oil companies. They now have an owner that can limit their innovation to maximize short term sales.

Their ambitions may be limited by the parent companies' desires when they were first bought out. Other limitations for large companies that mass produce renewable sources could be the current (2021-2022) supply

Average Change in Share Price of Major Energy Companies (Figure 5)



chain issues which has made it increasingly difficult to build things like wind turbines and solar panels. As shown on figure 5, we can see that the blue line which represents renewable energy companies had been trending down from November 2021 to February 2022. This is compared to the black line which represents the top oil and gas companies within the same timeframe. This separation is seen to be caused by the increasing cost of supplies needed to build renewable energy production while the already established fossil fuel extraction methods remain the same and are valued more since they can produce at the same rate. So, existing means of production are a barrier to renewable energy's growth are a significant factor given its volatility in uncertain economic times.

Insight from Professor Rob Godby of the University of Wyoming

After a talk with Professor Rob Godby of the University of Wyoming, he brought up some interesting points and perspectives that are very important to viewing this transition. Some of which include geopolitical events like Russia's invasion of the Ukraine and other issues like building proper infrastructure and energy storage. Starting with the geopolitical importance in this transition we can determine some countries reliance on newer renewable resources through the impact of a market shock. This shock can be seen when Russia invaded the Ukraine and many countries set sanctions on many of Russia's exports like oil. This shock is forcing some countries to find new sources for their energy, this is especially important for European countries that are more reliant on Russia's oil. "On 22 February, Germany scuttled its approval of a newly built gas pipeline from Russia and is now planning to import liquefied natural gas from countries such as Qatar and the United States. Belgium is reconsidering its exit from nuclear power, while Italy, the Netherlands and the United Kingdom are all accelerating efforts to install wind power. Fertilizer plants across Europe have announced they will scale back production, and 31 countries around the world have agreed to release oil from their strategic reserves." (nature.com, 2022). The market shock in the nature.com quote can be seen as some countries being restricted from their original source for oil.

As it is shown on “Where Europe gets its Gas”

Where Europe gets its Gas (Figure 6)

(figure 6), there are countries that were

significantly reliant on Russia for energy,

and this leads them to a difficult decision.

Follow in Germany’s footsteps and rely on

a different country for oil, or be like

Belgium, Italy, Netherlands, and the United

Kingdom to use this as a point where they

can invest in their own countries through

building more green means of producing

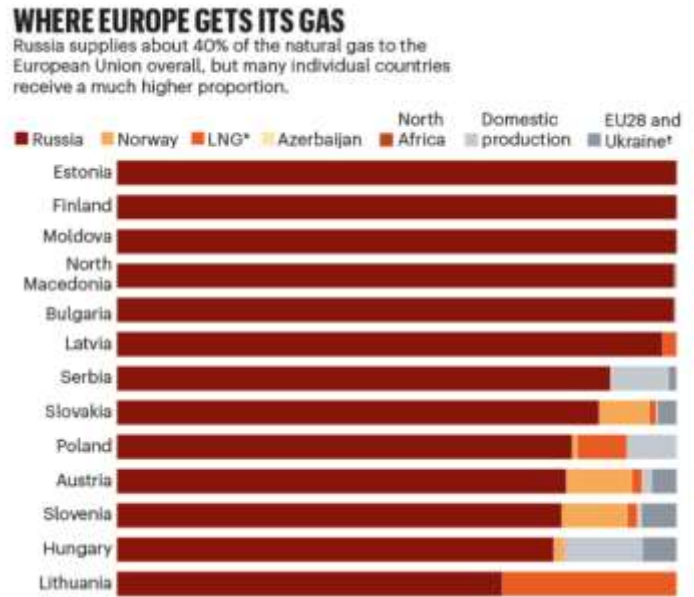
energy. This is the importance of geopolitics and extreme circumstances where demand for

renewables can become highly desirable within a short amount of time since countries will be

able to become more self-sustaining with energy. That was a more extreme example, but there

can be smaller events like changing of leaders in importing or exporting countries that can

significantly impact how much or little oil will be encouraged in their future.



Infrastructure is also an important thing to consider especially since in some countries like the US where we have a power grid that was mostly built in the 1950-1960s and has a life expectancy of about 50 years. This power grid has 3 sections which are the east, west, and Texas sectors. So, considering the Texas power outage of 2021 it is more understandable why that large of an area lost power and that the less resilient old energy infrastructure is difficult to rely on today.

“In a digital, connected world, Americans increasingly rely on readily available and uninterrupted electricity. Over the last four years, transmission and distribution and reliability-focused pipeline investments have increased, and outages have declined slightly. Annual spending on high voltage transmission lines grew from \$15.6 billion in 2012 to \$21.9 billion in 2017, while annual spending on distribution systems — the “last mile” of the electricity network — grew 54% over the past two decades. Utilities are taking proactive steps to strengthen the electric grid through resilience measures. However, weather remains an increasing threat. Among 638 transmission outage events reported from 2014 to 2018, severe weather was cited as the predominant cause. Additionally, distribution infrastructure struggles with reliability, with 92% of all outages occurring along these segments.”

(infrastructurereportcard.org, 2021).

Considering this quote from infrastructurereportcard.org it is easier to understand the difficulties with our power grid even more. It is past its life expectancy, fragile to severe weather, and experiencing a constantly rising usage. This is difficult to overcome as Professor Rob Godby highlighted, this is because renewables produce mostly electricity and there isn't a good method of distributing that power reliably with our current means. So, to properly accommodate for a growth in electricity production there needs to be a significant improvement in how consumers can receive it and store it. This is the next important issue of batteries for storage. Considering that there is a potential for a sudden loss of power that is being supplied to homes and businesses from a renewable producer, there needs to be a way to minimize the impact of that. Our current issue with batteries is that they can't charge, store, and discharge as much as we need, not to mention their high prices and their potential danger.

There are alternative solutions other than batteries. “Other renewable energy storage solutions cost less than batteries in some cases. For example, concentrated solar power plants use mirrors to concentrate sunlight, which heats up hundreds or thousands of tons of salt until it melts. This molten salt then is used to drive an electric generator, much as coal or nuclear power is used to heat steam and drive a generator in traditional plants. These heated materials can also be stored to produce electricity when it is cloudy, or even at night. This approach allows concentrated solar power to work around the clock.”. This is where the need for innovation can be seen in renewable energy. It is currently in its wild west stage and companies, engineers, and inventors have the freedom to come up with creative solutions to problems like these. So, while there is various battery projects out there for smaller scale individual consumer needs, things like storing sunlight as heat is an example of a large scale method of storing energy and it is something that can be used in an unpredictable event that.

Conclusion

As shown before, there are a lot of variables contributing towards this economic, social, and political problem. So, understanding some of these variables, what is the timeline for the implementation of renewables over fossil fuels given the growing threat of climate change? It depends on the large scale, but with smaller statewide initiatives like Colorado planning on requiring all companies serving 500,000+ people to be using 100% clean energy. There are some timeframes being set, and that is promising for the future. Along with companies like BP

buying out renewable companies, there is beginning to be some acceptance and adjustment by some companies. On the "World Electricity Generation by Source" model (renewablesnow.com 2020) there is a speculated break out of renewables taking over the fossil fuels while accommodating for the increase in demand that is more than likely to happen. This is impacted by the increasing demand for renewables through financial incentives and concern for the environment. Not to mention the continuous innovation from producers so they can produce at a low cost and high volume. Reaching a mostly renewable energy output can be predicted to happen around 2030-2050 with these variables in place. While the market is naturally accepting renewable companies more through increasing investments in their companies, policy is a very important factor. This is because the policy begins to push this transition forward through RPS, for example, and it gives a deadline for some companies to achieve, and this is supported by REC's for companies that aren't able to meet certain deadlines. This availability of support is very important for sustainable growth in this industry. This is promising for the industry since there are requirements that meet the growing investment and output of renewable energy.

Overall, this is becoming an inevitable transition, not entirely for fighting climate change, but also as a new way to produce energy and a new investment. Luckily, this hasn't been as controversial transition for fossil fuel companies as some might think since they are investing in this new transition. This is good because even though renewables are a highly debated topic, there is progress in implementing them.

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