The Market Solution to Climate Change: How Renewables Could Overtake Fossil Fuels in Powering Industries and Homes

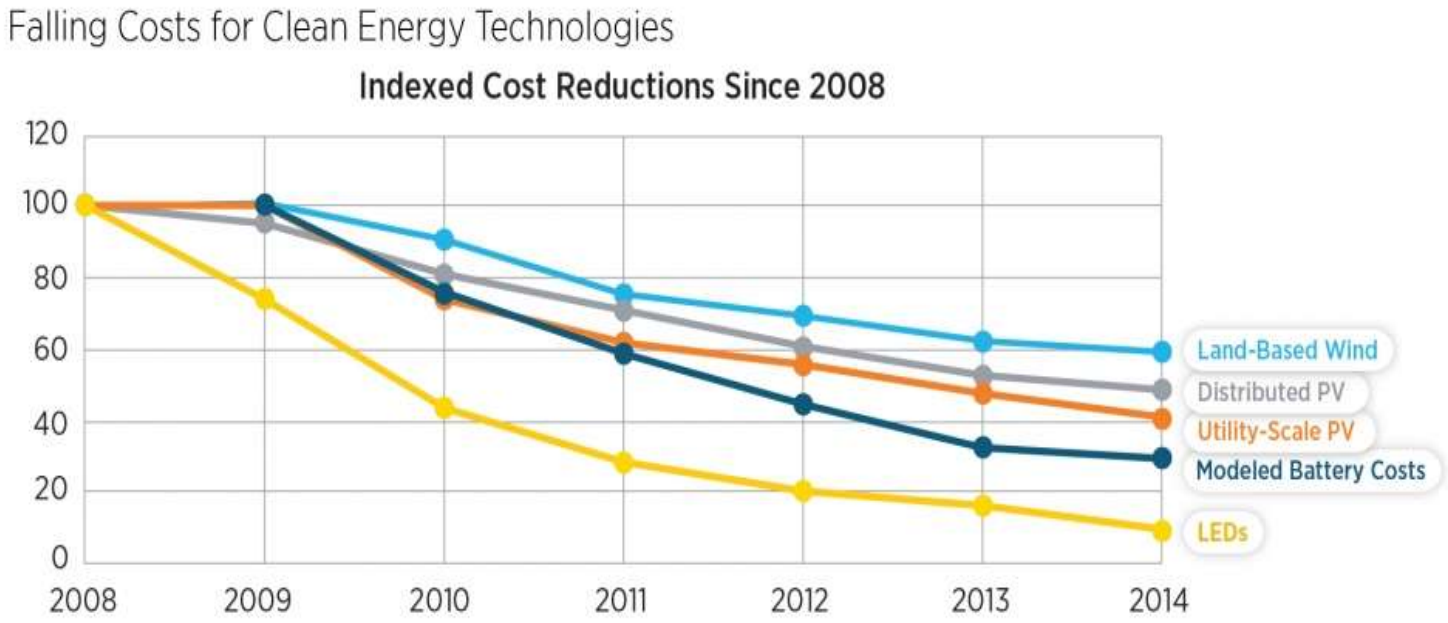
With Falling Costs and Rising Efficiency, it may only be a Matter of Time

Introduction:

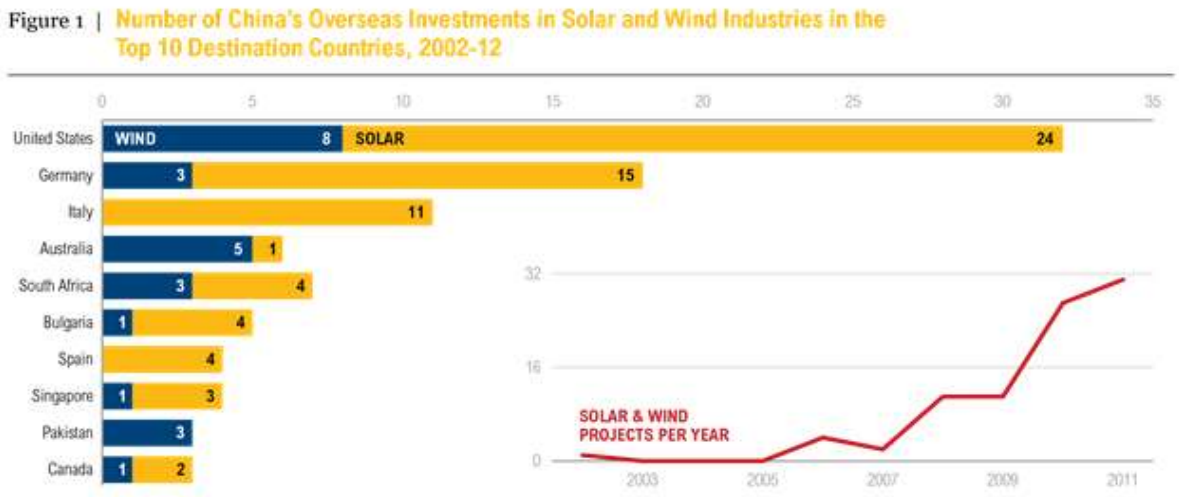
"Cutting carbon emissions will hurt the economy." You've probably heard this before, as it is a common argument against switching from fossil fuels to renewable energies. Ten years ago this statement might have been correct; however, a great deal can and has changed in ten years. Astounding progress has been made in renewable energies, solar and wind especially, resulting in a rapid drop in costs for these energies. Renewable sources of energy are an ever-developing and increasing investment opportunity for businesses and corporations, which in turn has led to more supportive legislation that benefits renewables, such as an extension of tax credits for renewable energy. Because of these factors, measures to limit carbon emissions by switching over to renewable sources of energy can be implemented with potential gains to the current economy. As countries are able to move beyond outdated ideologies and special interests, such as those of oil companies, taking care of planet Earth will and has become good for the economy.

Summary of Evidence:

The cost of clean energy technologies is going down every year, with a range of 40% to 90% over the past 6 years, as can be seen in the graph below from the U.S. Department of Energy (USDE):



In fact, clean energy is such a good investment that China is investing in clean energy around the world, with the U.S. being the country that has received the most Chinese investment in solar and wind energy. The U.S. better catch up before China owns all of our clean energy!



This graph comes from Yingzhen Zhao of ChinaFAQs and of the World Resources Institute.

Legislation and Executive Decisions Supporting Clean Energy:

There have been many key executive and legislative decisions that are crucial for the success of renewable energies in the past 10 year. Without these pieces of legislation and executive decisions, renewable energies would be in a much worse position, therefore, it is important we cover them first.

The first important executive decision is the Clean Power Plan (CPP), which is currently going through the DC court of appeals to determine its legality. The CPP is a set of pollution standards that power plants are required to meet, which was issued by the EPA in 2015 in consultation with the public, industry, and states in order to combat and limit climate change. It is very flexible and allows states and industry to meet the standards through a wide variety of strategies, including use of renewables, natural gas, and energy efficiency, according to Dr. Joe Romm, who is the Founding Editor of the Climate section of ThinkProgress.org. If the CPP were to be implemented, it would spell doom for coal powered energy production (Romm 2). Although the CPP's fate looks grim, it is an important piece of legislation that will be referred to many times throughout this paper, because predictions about the future of the energy market are based on the premise that the minimum standards of the CPP will be followed.

A second important executive decision is the Obama administration emissions regulations on "mercury, ozone, soot, and other coal-fired pollutants". Although the future of these regulations is uncertain with the upcoming change in president, its effects on the energy sector, especially coal, are at this point irreversible, according to Michael Grunwald of *Politico*. Coal's decline, which was already happening as a result of natural market forces, has sped up through the implementation of these regulations. The coal industry adapted to meet these requirements by shutting down many older coal plants that would have become unprofitable with these regulations in place. Now, even if the regulations are struck down, it will too costly to bring back these old plants, thus hastening coal's decline (Grunwald). With coal power fading out, renewable energies and natural gas become much more incentivizing for investment.

This is a problem, because on its own natural gas would outcompete renewable energy for a few decades before renewable energies would catch up (Romm 2). However, according to Romm, "[t]hanks to recent decisions by the GOP-controlled Congress and the Roberts Supreme Court, renewable energy (and energy efficiency) have been given a major boost." Romm states that the extension of the solar and wind energy tax credits in particular, voted on in 2015 for 2016, is large enough "to wipe out the natural gas renaissance that had been recently brought on by cheap shale gas." The tax credits allow for businesses and homeowners who install solar and/or wind energy to be eligible for tax deductions, assuming the solar project starts construction before 2021 and the wind energy project starts construction before 2019 (Runyon). This incentivizes businesses and people to install renewable sources of energy rather than pay for natural gas, because it is cheaper to do so (Romm 3).

These tax credits are important because without these tax credits, the lowest cost plan for power plants to comply with the Clean Power Plan would be Natural Gas Combined Cycle (NGCC) generation (Romm 2). With these tax credits, clean energy can out-compete natural gas decades earlier than expected, assuming the Clean Power Plan minimum guidelines are met (Romm 2). And in most regions, they are.

In fact, "[a]n analysis of government energy data provided to *Politico* by the Sierra Club, which has led a national Beyond Coal campaign to try to kill the industry, shows that U.S. power plants are on track to emit 1.76 billion metric tons of carbon this year, a 27 percent reduction from 2005. That's already below the Clean Power Plan's interim goal for 2024, and most of the way to the 32 percent reduction the plan envisions for 2030. If you subtract emissions from the 71 operating coal plants that already have announced retirement dates, the electric sector has just about met the plan's final emissions goals 15 years early, even though the plan does not now have and may never have any legal teeth to compel compliance" (Grunwald).

Because the CPP guidelines are being met and even exceeded in the majority of regions across

the country, data that is based on the premise of the tax credits and the CPP being in play is still valid. And the data shows that these tax credits will propel renewable energy to overtake natural gas decades earlier than it would have otherwise. Natural gas will no longer be needed as a "transition energy" from coal and oil to renewables. Here is a graph from that details just how much of an impact this will have.

Figure I: Change in generation from AEO2015 reference case, 2015-2030

Source: Rhodium Group analysis. Note: "Wind and Solar" includes utility-scale generation only. "Other Fossil" includes combustion turbines, oil/gas steam, and carbon capture equipped units. "Other Clean" includes nuclear, hydro, and biomass.

While the results may not be quite as remarkable as the above graphs due to a few regions in the United States that are not complying with CPP guidelines, since the large majority of regions are (Grunwald), the results will likely still be close to the above graph.

Furthermore, the recent Supreme Court decision in *FERC v. Electric Power Supply Ass'n* that "demand response" is legal to be regulated by the FERC significantly increases potential for use of renewable sources of energy (Romm 2). Many people were worried about the transition period between a fossil fuels powered grid to a renewable energies with battery storage facilities powered grid. The primary concern was that the intermittency of renewable energies without enough electricity

storage facilities would lead to “intermittency problems”, which is where there wouldn’t be enough power available during peak power usage hours. “Demand response” helps to alleviate this. With “demand response,” consumers receive financial incentives in the form of rebates and money back on their utility bills for cutting energy use at peak times or when a power shortage is predicted, as well low prices for electricity being during non-peak hours. As a result, demand for energy at peak times, when the grid would potentially be the most stressed, decreases, while demand at energy off-peak increases. These changes make renewable sources more efficient to use than they were and result in less need to rely on natural gas, as natural gas would only fill gaps in power instead of supplying the entirety of the grid’s power.

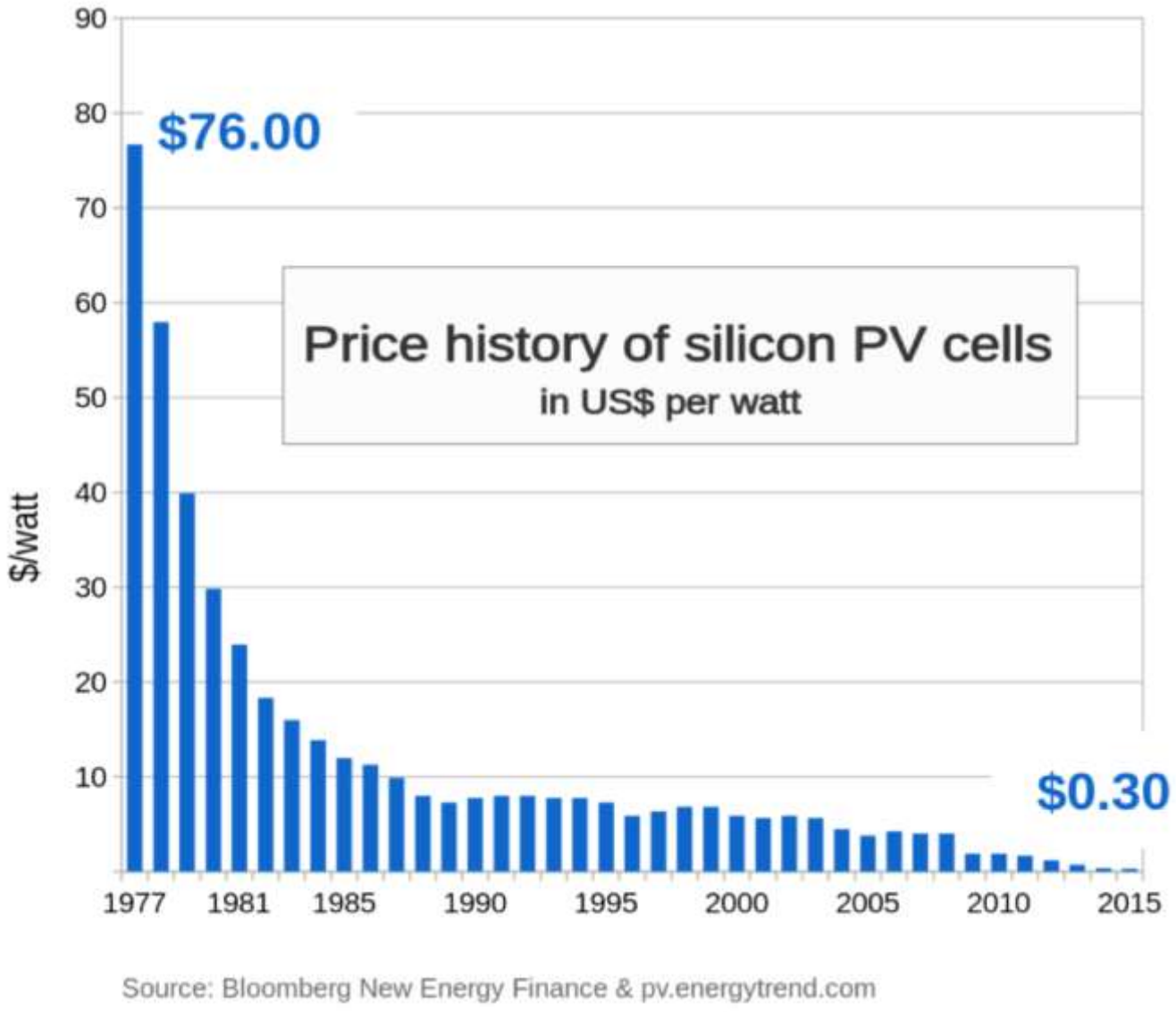
To conclude, these legislative victories and executive decisions have set up a roadmap for energy production in the United States to be dominated by renewable energies. This dominance will spur investments globally because the United States is crucial to the world’s economy.

Investment in and Reductions in the Cost of Renewable Energies:

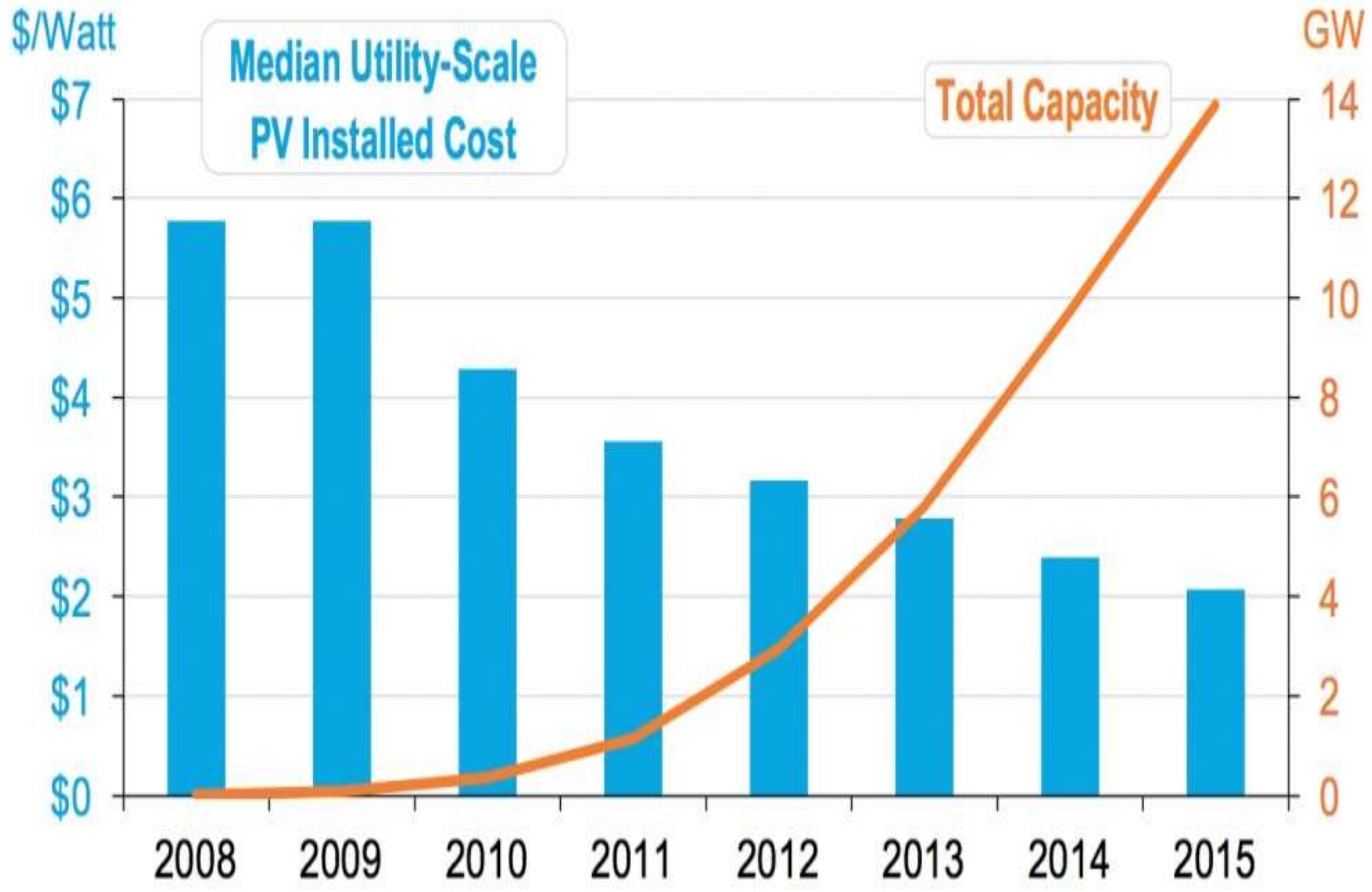
Despite all of these legislative battles that have been going on in the United States, renewable energy technology has been making progress, both in the United States and globally. This progress is especially true for solar and wind, which will be focused on primarily in this paper.

Investment and Reduction in the Cost of Solar PV:

Solar power is declining in cost at an unprecedented rate (Romm 3), dropping from $76 per watt for a solar PV cell in 1977 to just $0.30 per watt for a solar PV cell in 2015, as can be seen from the following graph:



As the price of solar energy has plummeted, the overall capacity, which is the amount of energy available, from solar has skyrocketed. As can be seen from the graph below from the U.S Department of Energy (USDE), the cost of solar energy in 2008 was almost $6 per watt and very little solar energy was available. By 2015 the price had dropped to $2 per watt and 14 gigawatts is now available.



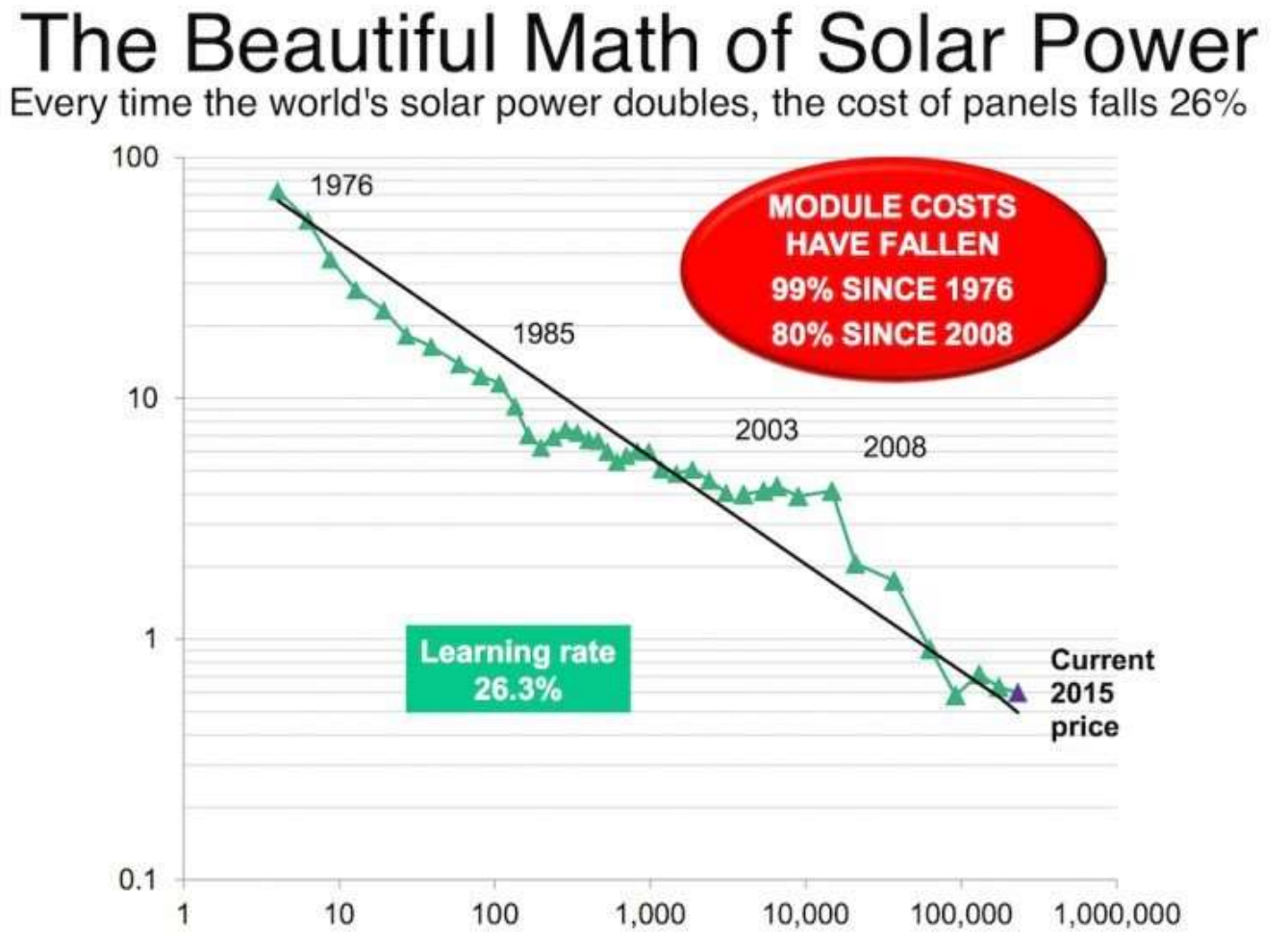
This massive drop in price and consequent increase in availability has been spurred by billions of dollars of investment in the past decade, particularly in Germany and China. However, because of the recent tax credits talked about earlier, solar power is expected to be a financially competitive source of energy in the United States as well, which will lead to billions in investment. In fact, the U.S. and India plan to reach 100 gigawatts installed capacity by 2021 and 2022, respectively, while China plans to hit 150 gigawatts installed capacity by 2020. 100 gigawatts is sufficient energy to power 16,400,000 homes (Romm 3). On the next page is a chart that breaks down the units and numbers and makes them easier to understand.

Watt = the basic unit of energy conversion when talking about electricity.
1 Kilowatt = 1,000 Watts

Number of homes powered annually:

1 Gigawatt (=1000 Megawatts)	1 Megawatt (= 1000 Kilowatts)	1 Kilowatt
164,000 homes	164 homes	.16 home

This planned investment by these countries is important, because, "[o]ver the past four decades, for every doubling in scale of the solar industry, the price of solar modules has dropped roughly 26 percent" (Romm [Solar]). Therefore, for every time the number of jobs, installed panels, investment, and infrastructure in the solar industry doubles, the price of solar panels drops roughly 25%. Romm showcases this phenomenon with a graph from data compiled by the Bloomberg New Energy Finance:



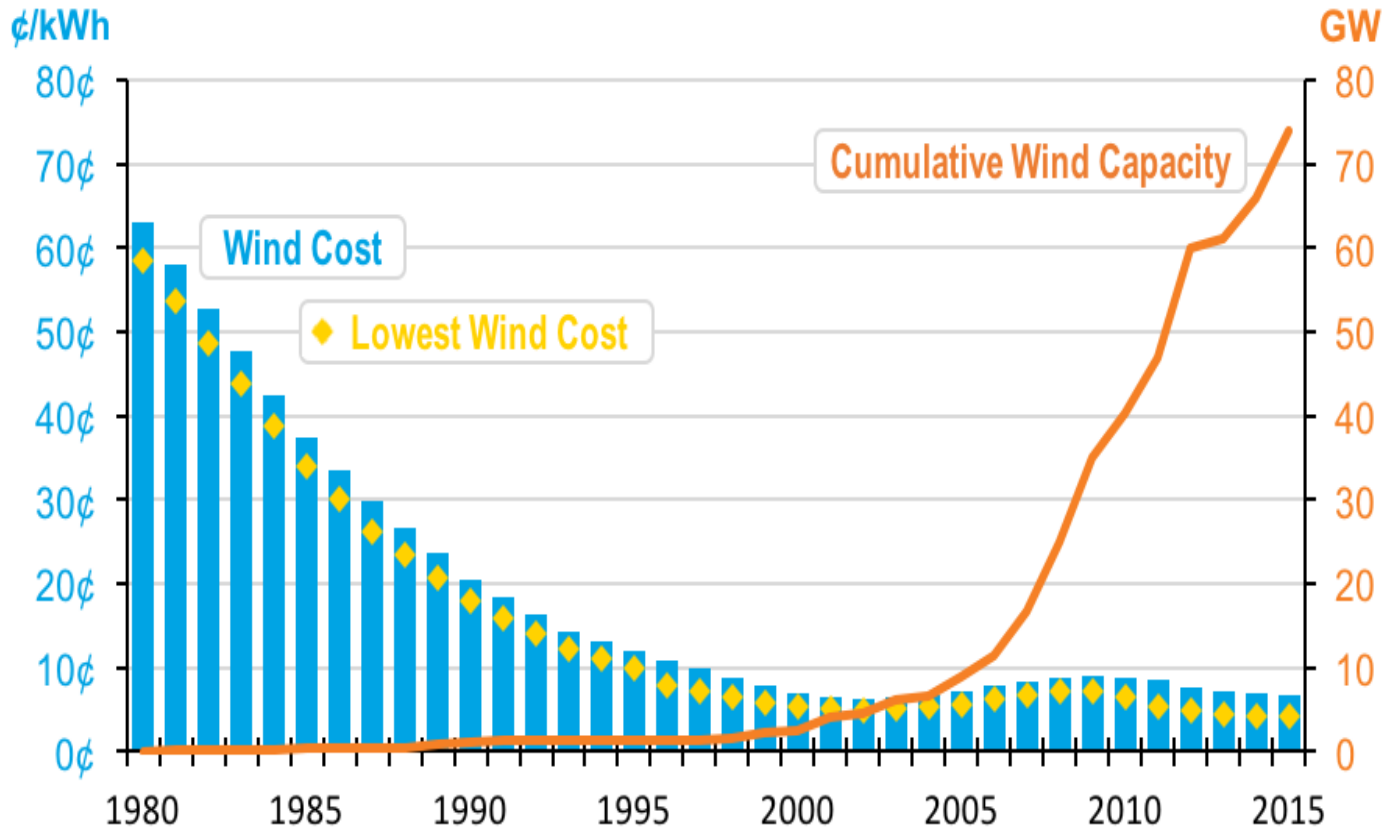
However, this probably all seems theoretical right now. For a great example of the decrease in solar power's cost, we can look to Dubai. According to Joe Romm in his article about solar power, ". . . Dubai received a bid recently in 2016 for 800 megawatts of solar at a stunning '*US 2.99 cents per kilowatt hour'* unsubsidized. For context, the average residential price for electricity in the United States is 12 cents per kilowatt-hour". Romm continues by explaining that this 2.99 cents bid is a little over half of a 2015 deal Dubai signed for more than 1000 megawatts at 5.84 cents over 25 years. This means that Dubai has seen a 48% price drop in solar in a mere 18 months! Not only that, but the bid for solar power was cheaper than all the bids for fossil fuels in a nation whose economy deals a lot with fossil fuels.

Investment and Reduction in Cost of Wind Power:

As mentioned earlier, the Clean Power Plan is currently going through the U.S. Court of Appeals for the D.C. Circuit to determine its legality, and it is unlikely to be upheld. Despite its status, many states are already on track to meet the requirements of the CPP as a result of massive decreases in price of wind power. According to Isak Kvam of the *Morning Consult*, "Wind power has become one of the most cost-effective sources of electricity in the nation. Due to siting and technology improvements, the price consumers pay for wind power has dropped 66 percent [nearly 2/3] in the past 6 years. Simply put, wind power has become increasingly affordable". Kvam says that wind power is growing faster than any other energy source in the nation, and this growth is only expected to progress increasingly faster. Even if the CPP is not upheld, the U.S. has already passed the "tipping point" in the transition to wind power, which in many regions, such as Colorado, will out compete fossil fuels even without the CPP in place (Kvam).

This is because wind power is very inexpensive, a fact that electric utilities have begun to notice. In fact, in 2015, "8.5 gigawatts of wind energy were installed in the U.S., more capacity than any other source of electricity generation and 65 percent more than in 2014" (Kvam). According to Kvam, Xcel Energy, the nation's leading electric utility provider of wind energy, recently released a request for

proposal for 1,500 MW of additional wind and plans to reduce its carbon emissions by 60 percent by 2030 from 2005 levels, which is far more than required by the CPP requirements. Why? Because they have found wind is the lowest-cost option for the future of their business. With 91% of Americans support expanding wind power, "[t]he wind industry is undergoing massive growth, and it shows no sign of stopping anytime soon". The following graph from the U.S. Department of Energy (USDE) shows both the cost and amount of wind power installed in the United States:



Here is the chart from earlier to that helps break down all of the units:

Watt = the basic unit of energy conversion when talking about electricity.
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Furthermore, wind power is emerging in unexpected places. According to Daniel Cusick of the Scientific American, Google is working to create a dominant presence in Africa by developing a renewable energy infrastructure that will allow for extensive telecommunications infrastructure, because sub-Saharan Africa is one of the largest markets opening up for advanced telecommunications and digital networks. This strategy has led Google to invest in a $700 million wind energy project, known as the Lake Turkana deal in Kenya, which is the largest energy project on the African continent to date. This is because Google executives see "a large opportunity in fast-growing markets with rich renewable energy resources" (Cusick). Furthermore, Google plans to make additional investments in renewable energy projects in the region to make Google a key player in the energy market in sub-Saharan Africa, as there will be few companies that will be able to match a giant like Google.

Google has not only invested in projects in Africa, however. In fact, "[i]n total, Google has committed more than $2.5 billion to renewable energy projects around the world, mostly through power purchase agreements and direct ownership of wind and solar farms, officials said. Much of its purchased power goes to support massive Google data centers in the United States and Europe" (Cusick).

It is telling when behemoth companies like Google and Xcel Energy start to invest in wind energy projects in order to power their businesses. Just like solar, it is not a matter of if, but when, wind will become a dominant player in the energy field.

Other Renewable Energy Investments and Reduction in Costs:

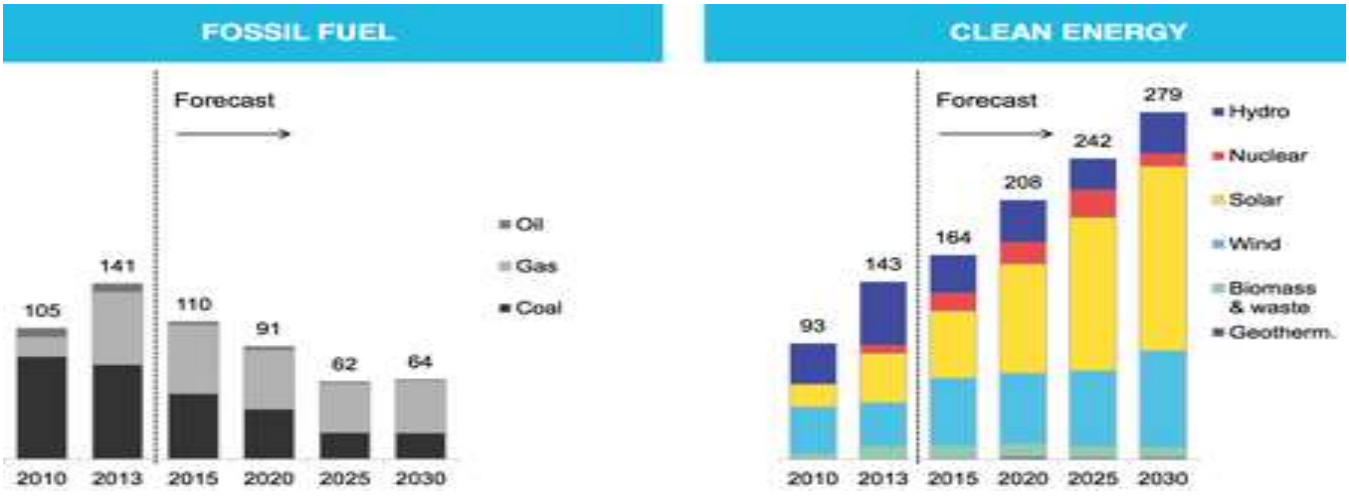
There are other, less talked about forms of renewable energy that have made modest gains in the market. Solar thermal is a form of solar power that uses heat energy to make electricity instead of light energy. It has seen a decline in price which, while not as significant as solar PV, is still noteworthy. The price has gone from 5c per kilowatt-hour in 2010 to 2c per kilowatt-hour in 2013 and is expected to continue to fall (Romm, [Solar]). Solar Thermal also looks like it will have a promising future in

Egypt, because according to an interview of Solar energy expert Hany El-Nokrashy, who is an advisor in the current Egyptian president's administration, conducted by Mohamed Farag of *Daily News Egypt*, the president of Egypt plans to continue to install solar thermal stations gradually through 2050 to help power Egypt as its population continues to grow. In fact, "[i]f Egypt starts building a number of solar thermal power stations gradually, it will save $1tn by 2050." Assuming Egypt sticks to the current plan, solar thermal will have a key place in the Egyptian energy market.

Tidal energy is also likely to enter the market for the first time in the UK with the Swansea Bay Tidal Lagoon project set for government review. Once the review is complete, barring no major objections, the £1.3bn tidal lagoon project will be one of the first of its kind. According to Robin Mckie of the Guardian, the lagoon could, " . . . generate 350 megawatts of power – enough to supply 150,000 homes with electricity – and could be in operation by 2019." The situation for this lagoon is still uncertain, but it is probable that it will be given the greenlight. If the project is successful, it could potentially spur a series of tidal lagoon projects in Britain that would cost £15 billion but would be much more energy efficient than the one lagoon in Swansea Bay (Mckie). These lagoons would help start an entirely new energy industry.

Geothermal and hydropower have made minimal progress.

The graph below comes from Tom Randall of Bloomberg, and helps summarize everything



about the changing energy market that has been discussed:

Economic Benefits of Renewable Energy Sources:

Renewable energies have many benefits, both in the short term and long term.

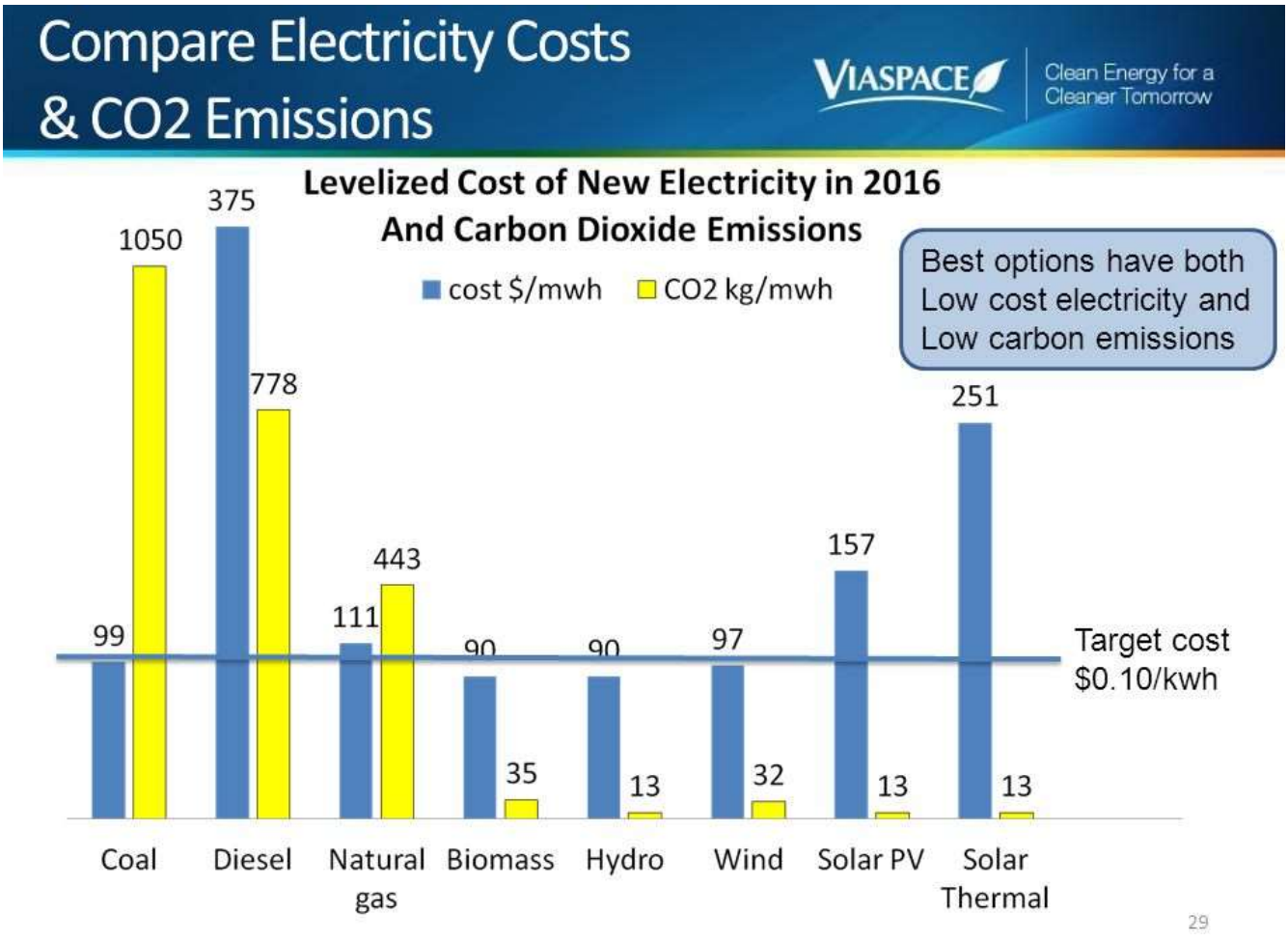
Wind power is a benefit to the economy because this industry employs an ever increasing number of people and helps farmers earn money by hosting wind turbines on their plots (Kvam). In fact, "[t]he U.S. wind industry currently employs 88,000 Americans, and wind technician is the fastest-growing profession in the nation" (Kvam). Farmers who host wind turbines on their land receive $222 million a year nationally as of 2015 in land-lease payments" (Kvam). Wind developers also contribute substantial tax revenues toward rural communities (Kvam).

One big benefit of solar power is its accessibility in remote regions that have lots of sunlight. An example of this can be seen from works done by the Kashi Company for some of its farmers in Bolivia, who grow grains that Kashi uses to make its granola bars. According to a story printed on the back of one of their boxes, because the farmers live in such a remote region, they have to rely on kerosene and candles to light their houses at night. Kashi came in and installed 60 solar panels in the region and now the houses have power. No other electric companies that burned fossil fuels were interested in coming to the region because of how remote it is; but, because solar panels can be deployed and made use of wherever there is sunlight, it can be used to power remote regions.

Another significant benefit to the economy and the world's health that comes from use of renewable energies is that renewable sources of energy cause significantly less damage to people's health than fossil fuels. Billions of dollars could be saved by industry annually that is currently lost to respiratory illnesses caused by carbon emissions, which result in millions of unnecessary and expensive sick days, according to Paul Krugman of the *New York Times*. Krugman also states that all of these health benefits would occur in any geographic area that chose to limit carbon emissions.

An even more important benefit to the economy is preventing unnecessary costs associated with

global warming. Based on the current rate of global warming, the estimated cost of hurricanes in the U.S. in 2025 will be $10 billion dollars, real estate losses will be $34 billion dollars, energy-sector costs for additional air conditioning and refrigeration will be $28 billion, and water costs for the driest and most water-stressed areas of the U.S. will be $200 billion dollars (NRDC). Therefore, reversing the rate of global warming through the use of renewable energy sources is estimated to save $272 **billion** in the U.S. alone as of 2025. These figures do not take into account the potential trillions of dollars of costs between now and 2025 due to other factors that are a result of climate change. The graph below demonstrates the disparity in Carbon Dioxide Emissions between renewable resources and fossil-fuels. The graph comes from Viaspace (Kukkonen).



Conclusion:

Renewable energies, especially wind and solar, have seen a massive decrease in cost in the last ten years. With ever increasing investment in and more favorable legislation towards renewable energies, the cost of solar and wind energy have become competitive with fossil fuels in many regions of the world. The cost of renewable energy sources is expected to continue to decrease, and, as a result, these energy sources will only become an increasingly dominant player in the energy sector. Other renewable energies, particularly solar thermal and tidal power, have also seen some remarkable progress. Renewable energies also come with many health and environmental benefits, will save billions of dollars globally, and have a positive impact on the economy.

To conclude, it is only a matter of time before renewable resources become a key player in the energy market. This eventuality is inevitable; however, the amount of time it will take for this to become reality is up to us to decide.

About the Author:

Will Beaudry is currently an undergraduate attending East Tennessee State University. He is

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