UMass Amherst Renewably Sourced Electricity and CBPPAs

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1. Executive Summary

In order for UMass to lose its title as the state's highest carbon emitter and make good on it's promise to achieve carbon neutrality by 2030, it must invest in clean energy. Without doing so, UMass will continue to rely on grid energy that won't be carbon neutral until 2050, thereby delaying its own carbon neutrality and contributing further to the climate crisis. The best option for UMass to make the switch to sustainable energy is by signing a cross border power purchase agreement (CBPPA). A CBPPA is an agreement between an electricity supplier and an energy consumer, in this case UMass. A CBPPA secures a fixed long-term cost and allows UMass to contribute to the global energy transition. Factors such as UMass's location, the recent energy policy released by the Biden administration and technological advancements make offshore wind energy a smart option for UMass to invest in. Of all sustainable energy sources, offshore wind turbines consume the least amount of energy and release the least amount of CO2. This agreement also allows UMass to consider and have a say in social equity problems such as the effects on the surrounding community, the environment, and marine life. Signing a CBPPA is the best option for UMass to be able to call itself carbon neutral and become a leader in the battle against climate change.

2. Introduction

As the reality of climate change unveils before our eyes, new attention is being paid toward how we can save energy, emit less fossil fuels, and slow the warming of the planet. A problem as dangerous and extensive as climate change necessitates sweeping, drastic change. The University of Massachusetts campus in Amherst acts as a microcosm of the challenges that humanity faces surrounding global warming and thus faces the question: How do we achieve net-zero carbon emissions? UMass Amherst has made an extensive carbon mitigation plan to achieve net zero emissions. The plan, however, fails to include the last missing piece of the puzzle: where will electricity be sourced before the MA power grid goes carbon neutral in 2050? In answering this question, UMass Amherst can push the envelope of renewable energies for the whole state by investing in the creation of new technology and the prosperity of MA communities.

UMass Amherst could also choose to source their energy in a way that does not make any lasting change and pushes the burden of their emissions on to the backs of another institution. UMass Amherst, as both the largest state emitter of carbon and a state institution that teaches and employs tens of thousands of people a year, has the responsibility to lead the change and the fight toward a cleaner future. Because a sustainable future requires a commitment to social justice, UMass's plan to achieve net zero carbon emissions must also take into account the social equity impacts of the changes they implement. Without a commitment to social equity, and true net zero carbon emissions, UMass Amherst will fall short of their motto, "Be Revolutionary." [1].

3. Problem Statement

While the original Minutemen had to be ready at a moment's notice, UMass has been given years to fight the battle against climate change. In trying to achieve net zero carbon emissions after being the highest emitter in the state, UMass Amherst has crafted one of the more revolutionary plans that includes expanding the use of renewable energy along with transitioning away from steam, ceasing the burning of fossil fuels, and accelerating energy efficiency. However, UMass Amherst still plans to get their energy from the grid. If UMass Amherst wants to achieve net-zero carbon emission by 2030, they cannot rely on dirty grid energy, as the Massachusetts power grid will not be net zero until 2050. If UMass Amherst wants to take control of where their energy comes from, push the envelope on renewable energy, and truly call themselves "net-zero" by 2030 they need to take control of their power sources and invest in renewable energy. Because of UMass Amherst's particular location west of the eastern seaboard, along with new policy put out by the Biden administration, and technological advancements that are reducing pricing, offshore wind energy seems like the best option for UMass's investments in renewable energy. To ensure that all of its energy is sustainably sourced, UMass Amherst must determine what role it can play as a state institution, while also vetting any proposed solution for the environmental and social impacts.

Since offshore wind farms are a relatively new technology, not a lot is known about the long term environmental impacts. However, most offshore wind farms have been constructed in Northern Europe, where they have paid close attention to and monitored the immediate effects the farms have had on wildlife. The most significant effect has been construction noise. It can temporarily disrupt and displace certain fish and marine mammals, as the construction sounds can be heard up to 20km away. When there are energy leaks from the turbines, sharks that use electromagnetic fields to navigate and hunt can react poorly. That being said, in some cases, underwater foundations have transformed into active reefs, benefiting from the lack of fishing around turbines [2]. Offshore wind is set to become the national hub for offshore wind energy off the east coast and is currently the largest in state source of clean energy for Massachusetts. The Massachusetts Center for Green Energy is currently working on accelerating the development of offshore wind, as well as involving Massachusetts institutions in this process [3]. This would be a great opportunity for UMass to participate in and benefit from a promising new technology.

Every renewable energy investment plan needs to be vetted for the plausible social equity impacts. The future of offshore wind in the US depends particularly on a socially just energy transition. Because vast implementation of offshore is not possible or morally responsible without considering the social equity impacts, UMass Amherst must complete a review of the possible social equity impacts prior to implementation of their investment plan. A lack of public support could inhibit the implementation of any renewable energy investment plan. Beyond community support, successful implementation of offshore wind also requires community benefits such as community funds, ownership, jobs, or educational programs [4]. Investment in offshore wind technology without compensation from the coastal community is not only morally reprehensible, but could inhibit the success of the project in the long run. The possible ways to involve the coastal communities in the planning, implementation, and benefits of any renewable energy investment plan cannot be known without full analysis and consideration [5]. In deciding how UMass Amherst plans to source their power, the social equity impacts need to be a driving force in the decision.

Both wind and solar are great options to consider when looking at renewable energy sources to switch into. One wind turbine only requires three-quarters of an acre on a piece of land that is relatively flat in order to generate as much electricity as 48,704 solar panels. In addition to that, they release less CO2, and consume less energy [6]. Some wind farms, like the buffalo dunes wind farm, are community owned. The farm not only provides energy to the community, but also economic growth, since the un-consumed energy can be sold back to the grid. That being said, if wind power is not consistent with the cut-in wind speed and rated wind speed at 3m/s and 13 m/s respectively, then the farms total capacity will go down and it will not be profitable. Solar, on the other hand, is a great option for almost all community owned renewable energy projects -- every dollar invested in solar creates $1.20 in benefits for the local economy. In addition to that, they last 10 years longer than wind turbines, require less maintenance, and can be installed very close to the consumption site without loss in efficiency and effectiveness. Sadly, it is not as productive as wind energy. If it were to be implemented on campus, solar would barely scratch the surface of renewable energy needed. Take the University of Illinois - Urbana Champaign for example: they dedicated 21 acres to a solar farm that will only supply 2% of their yearly electrical demand.

Overall, there are many factors to consider when thinking about using offshore wind energy. It is vital for UMass to examine where its energy is coming from to truly consider itself net-zero, as well considering both the environmental impact and social equity factors such as how implementation affects the surrounding communities. These are all important aspects to evaluate when choosing an option from the carbon mitigation plan.

4. Solution Technology and Implementation Plan Explainer

In keeping with their theme of "Be Revolutionary", UMass Amherst plans to achieve carbon net neutrality by 2030. The UMass Amherst Carbon Mitigation Task Force has outlined a plan to reduce emissions and increase efficiencies on campus but intends on sourcing 96% of their power from the Massachusetts grid before it goes net-zero in 2050. The energy that UMass acquires from the grid comes from a myriad of sources that are likely not carbon neutral. If they truly want to be "revolutionary", push the envelope on renewable energy and achieve carbon net neutrality, UMass Amherst needs to find ways to ensure their electricity comes from renewable energy sources.

Of the technologies available, offshore wind is the most promising solution for UMass Amherst to acquire enough energy to power the campus. UMass Amherst's location west of the eastern seaboard, new policy put out by the Biden administration, and technological advancements that are dropping the price of offshore wind drastically every year, make offshore wind an attractive energy source with promising energy outputs that could sustain the UMass campus even before the grid goes carbon neutral. In an attempt to ensure that all of its energy is sustainably sourced, our team believes that UMass Amherst must use offshore wind technology to power it's campus.

There are two viable options when considering how to invest in and use offshore wind energy: renewable energy certificates (RECs) and power purchase agreements (PPAs). Of the two, PPAs may be considered the most promising.. PPA's can ensure that the electrons we consume do come from clean energy sources through a 'private wire' with the energy plant. They can also be very similar to RECs, where they offset any grid energy that UMass purchases. PPAs are formed between an energy producer and an energy purchaser. The buyer funds the development of the project, in this case, an offshore wind farm. In exchange they receive a fixed rate when buying the energy produced from the project. This rate is typically lower than the rate for other buyers. The other option, RECs, are created every time 1-megawatt hour of renewable energy is produced and put onto the national energy grid. Their purpose is to track the amount of clean energy that is on the grid. The certificates are given to the producer of sustainable energy who can choose to keep and use the energy for themselves or sell them to energy purchasers. When the full megawatt-hour of energy is used, the REC is retired and discarded.

There are a number of reasons why we believe the university should invest in PPA's instead of REC's. PPA's would hold UMass more accountable as they would be signed into an agreement of continuously using clean energy, whereas they would need to purchase a new REC every time the megawatt hour of energy is used. The PPA also gives more room for UMass to hold the developer accountable to any social equity problems that may arise. By funding and signing this agreement, UMass has the power to list any terms and conditions such as making sure that the surrounding community is being looked out for and there is no harm to marine and wildlife.

PPAs are a heavier investment for the university, but give more benefits in return, and can be modeled to be tailored to our needs of safety and reliability. They are rapidly growing in popularity, with the Bloomberg New Energy Finance reporting earlier this year that companies around the world consumed a record 23.7 GW of clean energy through the Corporate Power Purchase Agreement in 2020. This was up from 20.1 GW in 2019 and 13.6 GW in 2018 [7]. Part of the reason why there was such positive growth comes from the fact that commercial and legislative levers are becoming more and more prominent. Another reason why PPAs spiked this year was because of the versatility of ways in which they can be constructed. Projects can be physically connected to the corporate consumer or supply electricity via the local transmission or distribution system. In addition to this, PPAs can be either a physical supply arrangement or a financial product providing price certainty to both parties without a physical supply of electricity [8]. The development of PPAs makes it clear that consumption through them around the world will only go up. Just last week, Estonian utility Eesti Energia and Danish project developers European Energy signed a 10-year offshore wind farm power purchasing agreement that would deliver 3.8 terawatt-hours over a ten-year period, making it the largest PPA in the Baltics to date. The agreement would make it so that half of Estonia's annual electricity consumption would be coming from renewable energy [9].

If there was any time to get involved in the offshore wind market, our team believes that time is now, and the best way to do so is through a cross-border power purchasing agreement (CBPPA). It would allow for the University to become a key player in the offshore wind market in the state, and in all of New England. UMass Amherst is the top greenhouse gas emitter of all state-owned facilities in the commonwealth, contributing to 14% of all emissions by the state [1]. In addition to that, it is the biggest public school in the state, and it operates like a small city. These characteristics make the university a driving power, which means that our involvement would give investors more certainty to keep the projects going. The stance we take regarding offshore wind energy could push the state's agenda to keep creating more mandates and incentives that would grow the industry. The usage of this cross-border PPA would allow for the University to play a role in the offshore wind system, without putting all of our eggs in one basket. With a CBPPA, we could overcome some of the regulatory barriers in the Massachusetts markets, choose projects with the best capacities around New England -- for example upstate New York for onshore wind and southern New England for solar. This would be described as a multi-technology approach in multiple geographies. We would combine our electricity consumption across several states with different laws and regulations and contribute to the development of additional solar and wind projects [10]. In order to do this, the university must create a power purchasing agreement with a constructor company with established facilities or ongoing projects nearby. The vicinity of some of these projects would allow for an on-site and near-site generation. This means we would have a 'private wire' by-passing the grid, providing the most direct link between the renewable generation and our consumption, which would allow us to avoid charges where regulations allow. If the company's offshore project is too far away for a 'private wire' to work, then part of the CBPPA could work as an investment directly in this offsite renewable power asset. This would provide the university with active returns, though it would also require more involvement in the development, construction, and operational risk of the project [11].

UMass is an ambitious institution, setting out to have a net-zero campus by 2030 as outlined in the Carbon Mitigation Plan. However, to be a net-zero campus, UMass needs to be aware of where its energy is coming from. As a reminder, 96% of UMass's energy is non-renewable, which means that sweeping changes need to be made to reach the ambitious goal by 2030. Offshore wind and specifically a CBPPA with an energy company is a great way for UMass to position itself at the forefront of renewable energy in the New England area, as well as paving the way for other huge institutions to reach their renewable energy goals. While this energy is rather new to the United States, it is proven to be a clean and reliable source of energy in Europe, and with more and more technological advancements every year, the cost of building wind farms is dropping quickly. Even though RECs provide a good short-term solution for the unavoidable consumption of non-renewable energy, it would mean that UMass would not be creating a demand for more renewable energy, just taking from what is already available. Overall, agreeing to wind farm PPAs would make UMass a key player in moving New England towards a sustainable future.

5. Project Pros/Cons

Although UMass Amherst has made a revolutionary claim to achieve net zero carbon emissions by 2030, their plan does not include a commitment to electricity sourced by renewable energy sources. In order for UMass Amherst to truly claim carbon neutrality, they must source their energy from renewables before the Massachusetts grid goes carbon neutral in 2050. The most impactful way for UMass Amherst to meet its electricity requirements using renewable energy is through a Cross Border Power Purchase Agreement (CBPPA). A CBPPA is a long term contract with a renewable energy provider that allows both the consumer and the provider to establish a mutually beneficial relationship. Through a CBPPA the client benefits from having a larger stake in the provider's projects, because they can be investors and/or continuous consumers. The provider benefits from the client's larger share because they have the income security of a long term consumer. CBPPA's also push the envelope for renewable energy as a whole. If a large state institution, like UMass Amherst, buys energy from a renewable source at a fixed rate it will give other providers the security needed to further develop renewable energy projects. While signing a CBPPA with an energy company that has multiple renewable energy sources, UMass Amherst could agree to utilize a portion of each project. For example, by consuming energy directly from an onshore wind farm close enough to the campus in upstate New York through an established private line, and/or indirectly from an offshore wind farm in Maine, which is too far for a private line to be established. Indirect consumption is required when it becomes impractical to create a direct line between a renewable energy source and the campus. In the case of indirect consumption, certificates that represent the rights to the generated renewable energy can be utilized to offset UMass Amherst's energy consumption. In 2020 about 12,500 metric tons of carbon dioxide were released through purchased electricity [1]. Signing a CBPPA would allow UMass Amherst to receive its energy directly from the renewable sources, offset the energy that it consumes through purchasing tailored certificates, or a combination of both. UMass Amherst should add CBPPA's to their carbon mitigation plan as it would have the potential to eliminate or offset UMass's contribution to carbon emissions to truly boast net zero carbon emissions.

A major benefit of implementing a CBPPA at UMass Amherst is the potential influence that a large state institution, like the university, will have on the contract language. UMass can influence contract stipulations that can mitigate any potential negative impacts that the CBPPA would have on the environment, economy, and community. Implementation of any renewable energy source requires construction, land use, and community cooperation. Because of the diversities that exist within economies and cultures,each community is affected differently by the implementation and use of renewable energy has the potential to benefit differently from a CBPPA. Communities that are impacted by the implementation of renewable energies need to play a major role in the CBPPA, along with the university and the energy company, making sure jobs, education, and funding are included for its members. Stipulations to protect the fisheries that sustain coastal communities throughout construction of the offshore wind farms could be implemented to protect coastal economies. While implementing a CBPPA into the framework of

UMass's carbon mitigation plan, UMass has the responsibility to protect the communities impacted by their investments.

A CBPPA has several negative environmental impacts that depend on the renewable energy source. Although UMass Amherst's CBPPA has the flexibility to utilize all types of renewable energy sources it will rely heavily on offshore wind energy, which is a relatively new technology especially in the US. There have been no studies on the long term impacts offshore wind farms could have on marine species, but studies have been completed on the long term impacts of wind farms on bird and bat populations. Between 140,000 and 500,000 birds and around 888,000 bats are killed at wind farms every year [12]. The collision risk is also predicted to be higher in offshore wind turbines, since they are taller, have longer blades, higher tip speeds and create more turbulence. Most seabirds fly low above the surface, around the approximate height of the wind turbines. From the short-term research that does exist, it is known that the most severe consequence for many marine mammals occurs during the construction of offshore wind. These consequences are likely due to the mammals' evasion of noise and general construction turbulence [13]. These disturbances have been shown to lead population displacement, which has been shown to increase mortality. Despite the clean energy benefits of offshore wind, there are known, harmful, short term impacts that offshore wind farms can have on nearby ecosystems, and unknown long-term effects on marine life.

Although the purpose of a CBPPA is not to save the university money, implementation of a CBPPA could save over $1 million per year. Out of the 146,000,000 kWh of energy that UMass Amherst consumed in 2019, 68% was generated by the Central Heating Plant, 4% was generated by photo-voltaic production, and 28% was purchased from the grid. According to the EIA, less than 10% of the MA grid is generated by renewable energy sources. Because only 10% of the electricity that UMass Amherst buys from the grid can be guaranteed as renewable, the university cannot boast carbon neutrality. After calculating the estimated CO2 emissions for the MA grid and applying it to the 42,000,000 kWh of energy that UMass consumed from the grid in 2019, our team calculated that UMass Amherst emitted a total of ~12,500 MTCO2e, as shown by figure 7 in the CMP 4, which has been added to the appendix. This electricity consumption equates to $7,750,000 a year in electricity from the grid, at $0.185 per kWh. When the contract is being developed, a private line can be established with a nearby solar panel plant. The electrons bought through this private line would be at a fixated price of around $0.09, which would be higher than the average solar market price, but lower than the average price in the state, setting a good deal for both parties. The total adjusted price of the CBPPA could be around $0.16 per kWh, which could save the university $1,047,382 per year. Other creative solutions such as the one previously mentioned could be explored with a CBPPA, making it an economically beneficial solution.

Without the support of a large institution, communities affected by the implementation of offshore wind farms cannot play a role in the CBPPA, because the initial investment is too high.

The offshore wind projects would negatively impact coastal communities through a reduction of legal fishing areas, real estate prices, and tourism-- without experiencing any of its benefits -- lower energy costs, return on investments and incrementation of jobs. Large state institutions, like UMass could mitigate these negative social impacts on coastal communities by including them in the CBPPA. Future advancements in technology and policy could lower the initial investment to the point where smaller communities could play a bigger role. Because offshore wind based CBPPA's do not allow small community participation, coastal communities could be negatively impacted.

For UMass Amherst a CBPPA is a path towards true carbon net neutrality. As of right now, our team believes that this pathway has few negative aspects. Those being the unknown long term environmental impacts of offshore wind and its inability to allow for communities to play a role by themselves. If a responsible and creative agreement is made, a CBPPA has positive economic and social equity impacts to the UMass community and beyond. Because there are many potential positive impacts of a correctly implemented CBPPA and only a few unknown, but potentially negative impacts, a CBPPA should be included in UMass Amherst's carbon mitigation plan to achieve carbon neutrality by 2030.

6. Conclusion

Without the inclusion of ways in which the University can consume clean energy from the grid, we cannot call ourselves truly carbon neutral. Though we should praise the efforts to drive down emissions around campus, our team believes a big part of the problem has been left out. Since it cannot be blamed as direct carbon emissions coming from the campus, Umass Amherst is able to make its claims of carbon neutrality while also not addressing its grid purchasing problems. Our team truly believes that the most impactful way for the university to meet its electricity purchasing needs while also using renewable energy is through a Cross Border Power Purchase Agreement (CBPPA). Through oru solution, we are allowing for safe investments to be made, reliable and constant renewable energy to be consumed, and social and environmental state agendas to be pushed. The benefits the client and the provider would get from this contract are clear, as well as the message the university would be sending. We would be pushing the envelope for renewable energy as a whole in the state -- giving providers the security needed to further develop renewable energy projects. Most revolutionary of all would be the social equity impacts of a properly crafted CBPPA, which could include conditions that protect the communities that surround the projects and assure that jobs are provided to these individuals. The combination of all of these things would make our university a state pioneer in both offshore wind energy and social equity. Without a complete plan on how to become carbon neutral, we will never truly “be revolutionary” because we would be repeating the same behavior that has characterised our society for so long: Celebrating false victories. We thought the civil rights act of 1964 was revolutionary, we thought the clean air act of 1970 was revolutionary, we thought the 2016 peace treaty in Colombia was revolutionary, when in reality they lacked the teeth to truly make the changes we were promised. We should learn from these failures, and strive for true change. A way to do that is to go head first into our problems, think outside of the box, and not be afraid of radical projects.

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9. Appendices

a. Calculation of Metric Tons Of CO2 emitted by the University of Massachusetts at Amherst.

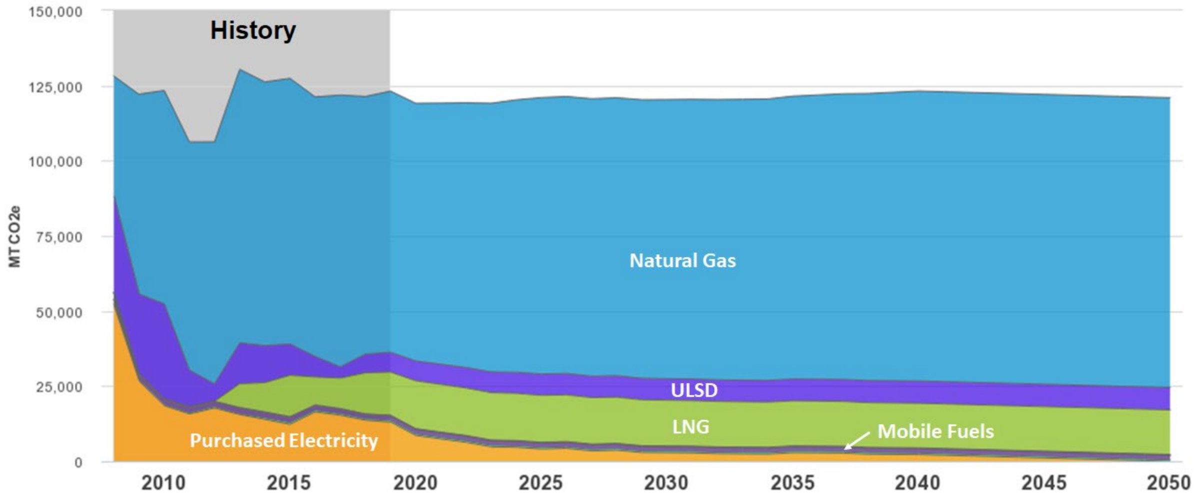

Table 1: Metric Tons of CO2 emitted by source.

b. Comparison of wind speeds on shore on counties surrounding the University of Massachusetts at Amherst and the offshore coast of Massachusetts

Compared data on a 48 hours span, from July 30th, 2018, to July 31st, 2018, between the counties that surround the Amherst area, and offshore wind records off the coast of Massachusetts. The counties used for this data were Worcester, Hampsden, and Franklin, which had average wind speeds of 3.3 m/s, 2.9 m/s, and 3.5 m/s respectively -- Hampshire county does not have any land based stations that record the data and thus why it's not included. The two offshore stations were stations #74491514775 and #44037, which had an average wind speed of 10.7 m/s and 6.6 m/s respectively. These averages are meaningless unless we look at the interval of function of most wind turbines, which is between 3 m/s and 25 m/s, according to the The Wind Power Wind Energy Market Intelligence. Outside of this "sweet spot," the wind turbines are shut down, either because there's not enough wind to get them going, or the wind is too strong and will cause damage in the system. This "sweet spot" is crucial for energy generation, and the less volatile wind speeds are, the better the turbine will perform. Table 2 shows the consistency of offshore wind speed. Table 3 further shows this consistency by comparing the amount of hours the wind turbine had to be turned off during this 48 hours period. This graph clearly shows that the onshore wind turbines would be very inefficient around the amherst area, and almost always under production while off shore. Finally, using table 4 -- the power curve of the GE Energy 1.85-87 model, which is the most popular type of turbine in the United States -- we can calculate the amount of energy a wind turbine would produce in each one of these locations for the 48 hour time period. The outcome is:

- Worcester: 14100
- Hampden: 10700

- Franklin: 14800
- Offshore site #1: 38400
- Offshore stie #2: 48300

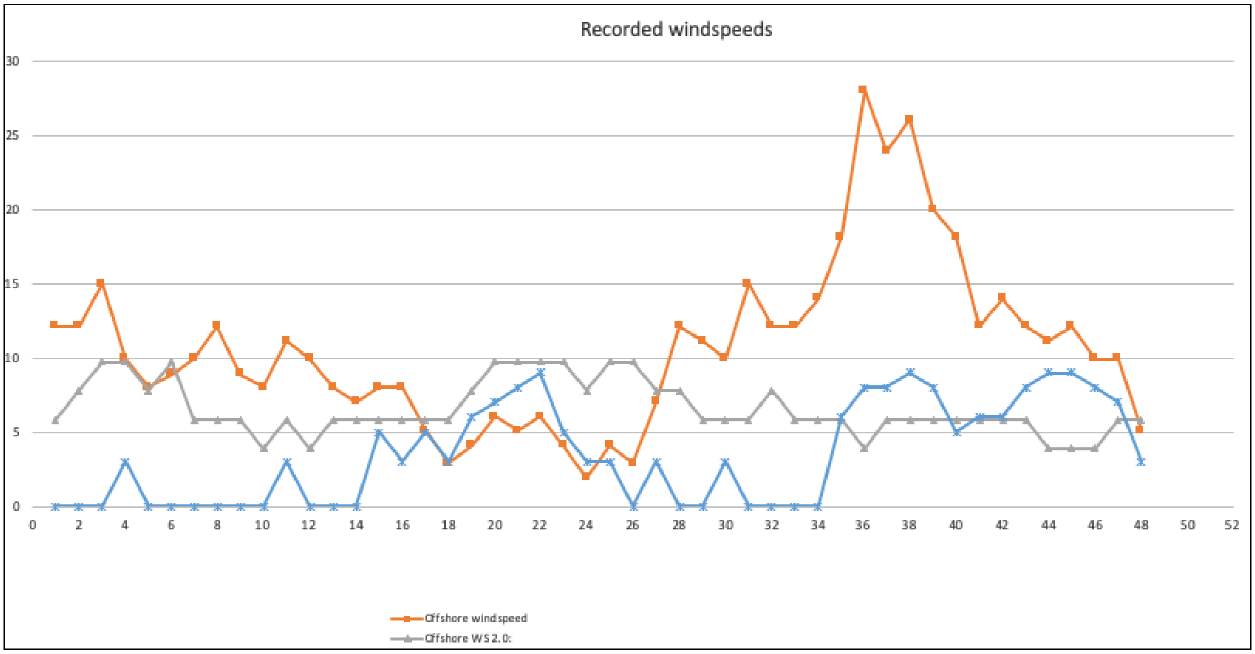

Table 2: Wind speed in meters per second.

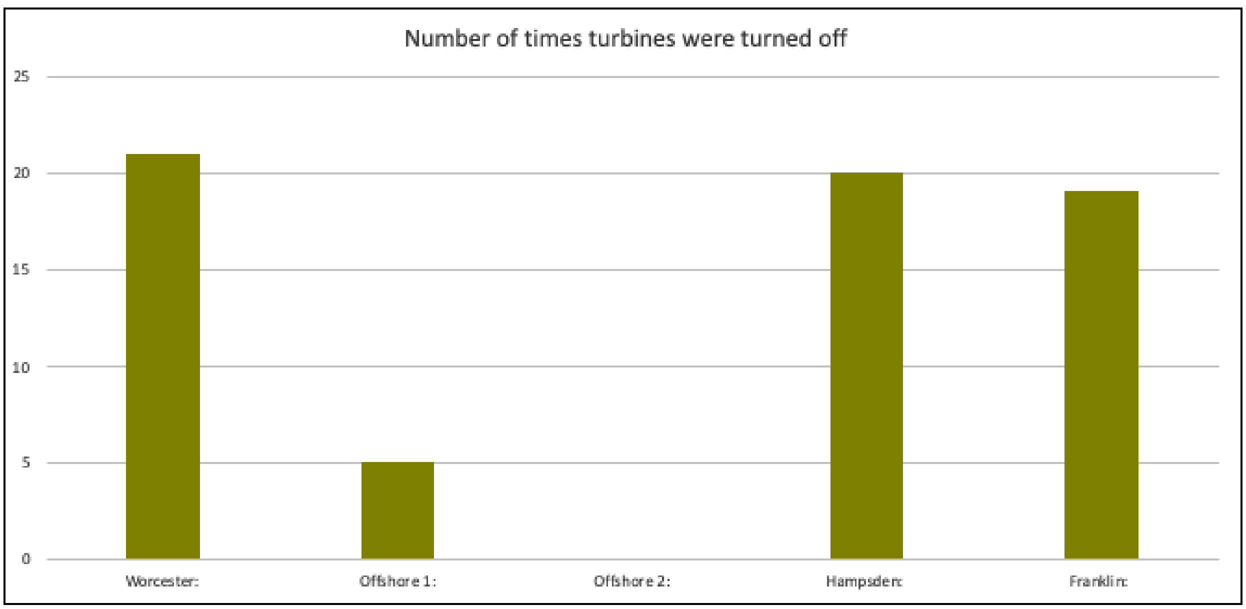

Table 3: Hours in which wind turbines had to be turned off between July 30th, 2018, and July 31st, 2018.

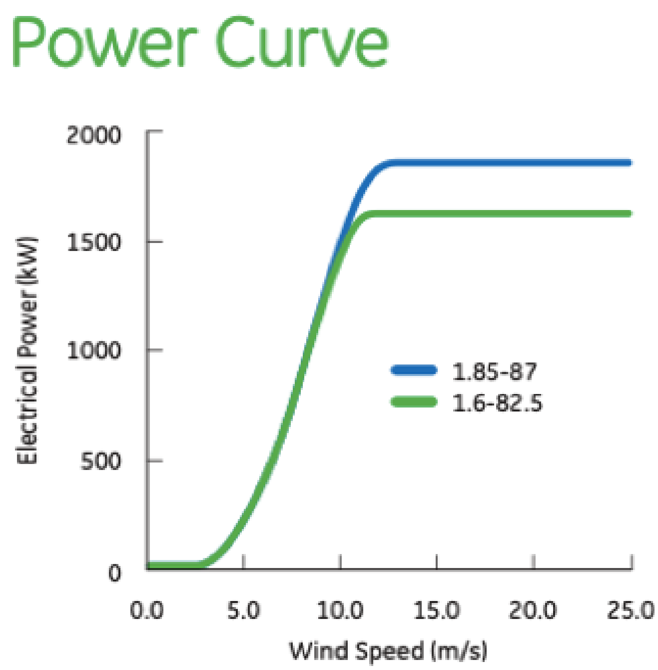

Table 4: Power curve of turbine model GE Energy 1.85-87

c. Amount of money saved by the University of Massachusetts at Amherst through the implementation of a Cross Border Power Purchasing Agreement.

Taking the average cost of a kilowatt hour in Massachusetts and multiplying it times the total purchases from the grid, 41,895,302 kWh as reported by the university in 2019, we get a total of $7,750,630.92 spent on electricity. If we follow through with our implementation of a CBPPA, we could be consuming energy directly at a cost of $0.16 per kWh, which would mean the university is spending $6,703,248.36, and saving a total of $1,047,382.56 every year.

Total purchased in kWh:	41,895,302
Dollars per million Btu:	$24.90
Dollars per kWh:	$0.185
Total purchased in $:	$7,750,630.92
Estimated per kWh:	$0.16
Estimated purchased in $:	$6,703,248.36
Estimated savings:	$1,047,382.56

Table 5: Estimated savings through implementation of CBPPA