Should the Biomass PPA be Renewed?
From the Lens of Offshore Wind Farms and the People

Team Biological Windmill
Bridenbecker, Bronitskiy, Clark, Davis, and Ginos
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—Abstract

This essay explores the residential and demographic impacts of the RCEA continuing a power purchase agreement with a biomass energy plant or switching to an offshore wind farm on the population of Humboldt County. We considered five main factors: the environmental and human impacts, economy, cost, reliability, and timeline. During this study, allowing the biomass plant to continue operating as it has been would be detrimental to health on an individual and environmental scale. We found biomass plants to be more reliable than wind turbines for all metrics. Developments in research are helping to close that gap in wind's favor. We also found that it is more cost effective and better for the economy to transition to wind farming. One major downside to offshore wind farms is that the planning period and implementation thereof will take a considerable time. Our recommendation is that the RCEA renew their contract with the biomass power plant while they research and permit offshore wind farms. This will allow for a smooth and stable integration of wind into the grid.

—Introduction

In an effort to create a community fully powered by clean renewable energy, the Redwood Coast Energy Authority (RCEA) is looking at wind and solar power as alternatives to a biomass power plant. Currently, there are two biomass facilities in Humboldt county. DG Fairhaven in Samoa and Humboldt Redwood Company in Scotia. The former is closing down and RCEA is at a crossroads with the latter. A decision needs to be made on whether or not the 5-year power purchase agreement (PPA) with the Scotia biomass plant should be renewed. RCEA is interested in developing solar and offshore wind power as two primary long term energy solutions in Humboldt County [1]. Figure 1 (below) shows the general layout of the current source, the Scotia biomass power plant. This facility offers 32.5 MW of power generation [2].

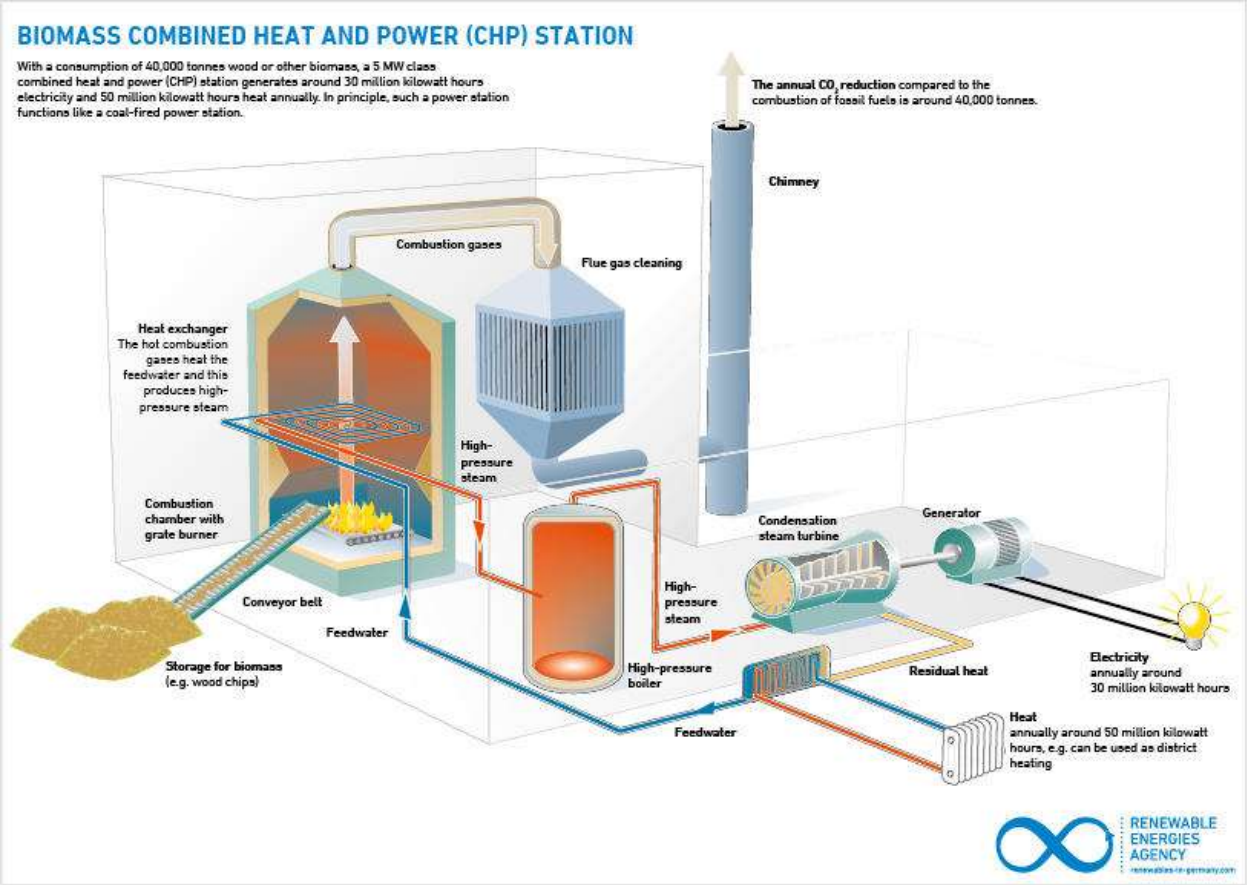

Figure 1: Diagram of Biomass Power Plant [3]

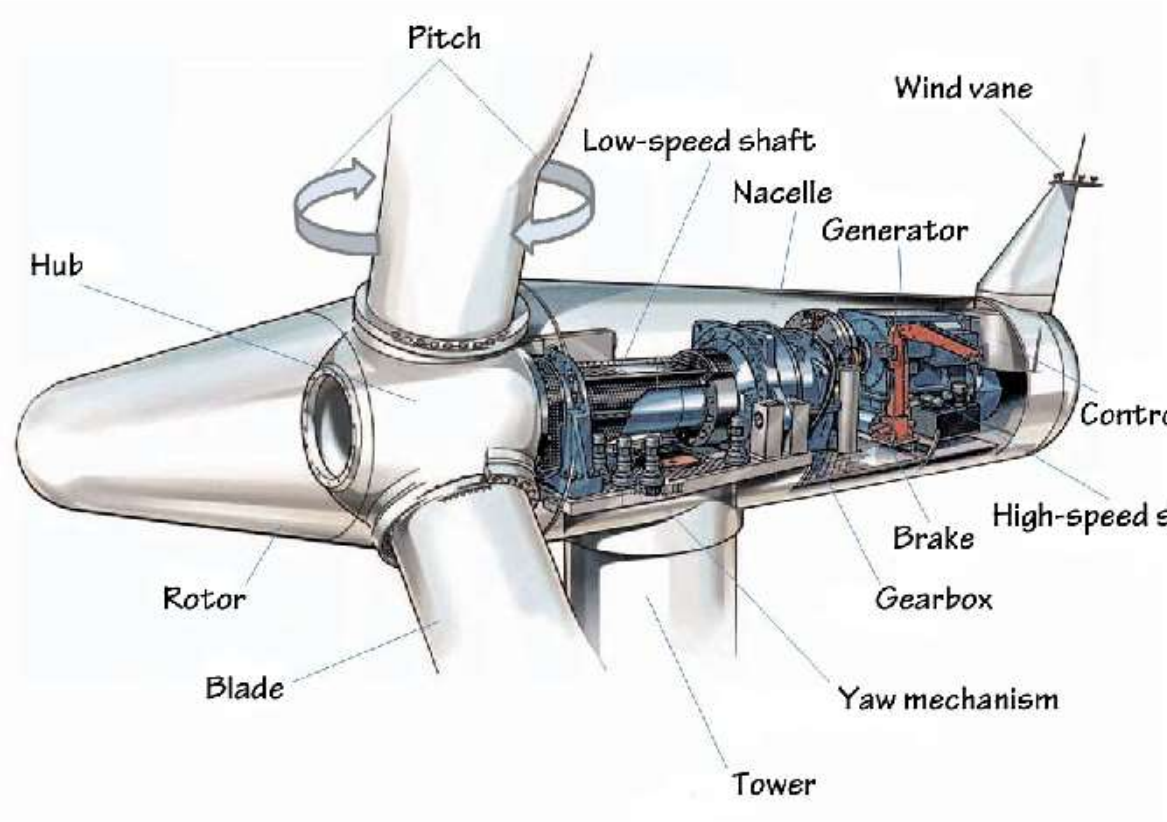

Figure 2: Cutaway View of Wind Turbine [4]

A cutaway diagram of a wind turbine similar to those that would be used in a wind farm to replace Scotia can be seen in Figure 2. The offshore wind farm is expected to have a capacity of 40 MW [1]. This report analyzes the benefits and burdens to the local and widespread communities of implementing a strong offshore wind farm in place of the biomass facility.

—Summary of Research

The Environmental and Human Impact

Humboldt county is a coastal county with a mixture of three different ecosystems: coastal, redwood forest, and pinewood forest. The biomass station, located in Humboldt, is only 800 meters away from the nearest Elementary school making the children there prone to illnesses that come from living near a plant such as Asthma and lung cancer. It also goes to show that much of the town's business is also within 800 meters of one biomass plant and another town is within 3200 meters of another biomass plant [5].

In terms of the biological benefits, the plant is a good way for local lumber mills and forestry services to get rid of unusable wood. As such, forest fires can be avoided by removing the wood that would otherwise add fuel to the wildfires. This facility and others burn around 200,000 tonnes over the five year contract [2]. That means shipping the unusable wood to another facility 2,000 miles away that would be an estimated 6.472*10^7 kg of CO_2 emitted from the trucks [6]. This is comparable to the 46 kg/kW created by each of the biomass when it's in operation [7]. Humboldt County consumes around 825 GWh of electricity each year [8]. Over five years that is estimated to be 1.8975*10^11 kg of CO_2. In comparison, wind farms only produce 11 kg/hr of CO_2 which is an estimated 4.5375*10^10 kg of CO_2 over five years of operation [7].

Figure 3: Population's Proximity to the Biomass plant; the circles are representative of 1000 meters away from the biomass plant [5]

Wind turbines have few environmental disadvantages. For instance, turbine blades can birds that are unfortunate enough to fly through the wind turbines. Luckily, as the turbines get larger the speed of the blades decreases and offshore wind farms are leading that charge. The slower speed of the blades assists in the decrease of murdered birds. There are only 573,093 that have fallen victim to wind farms over the past year [9]. This is insignificant compared to cars, powerlines, cats, and buildings.

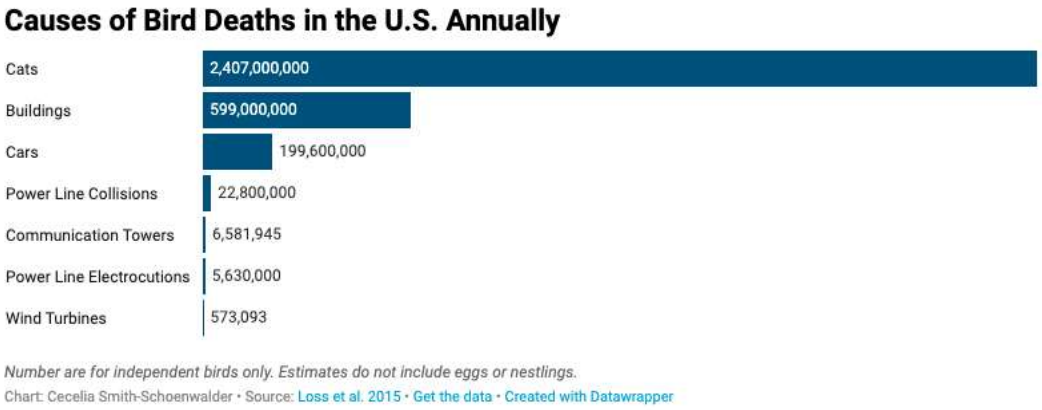

Figure 4: Leading Causes of Bird Deaths in the U.S. [9]

Economy

As the relationship between producers and consumers, the economy of a community is its lifeblood. With a flourishing economy, a county's residents are able to earn higher incomes and take more vacations [10]. This results in a happier and more productive community [11]. There are several ways the transition from biomass to offshore wind could impact the local economy with regard to energy and other disciplines. In this section, we analyze the economical impacts on the residents and demographics of Humboldt County.

Humboldt Redwood Company (HRC) supplies the RCEA with electricity from their biomass plant in Scotia. To do this, the plant employs 20 hard working individuals to generate at a rated power of 32.5 MW [2]. As for wind, there are multiple areas where one may find work. A 50 MW landbound wind farm normally takes six months to erect [12]. Offshore wind farms on the other hand can take between five and ten years to permit and build at nearly three times the cost [12, 13]. This is discussed further in the cost analysis. While being made, the wind farm will provide jobs in construction and manufacturing. Once finished, the wind farm will offer jobs in operation and maintenance although these only account for 5% of the jobs available through a wind farm's lifetime, see Figure 5 below [14, 15].

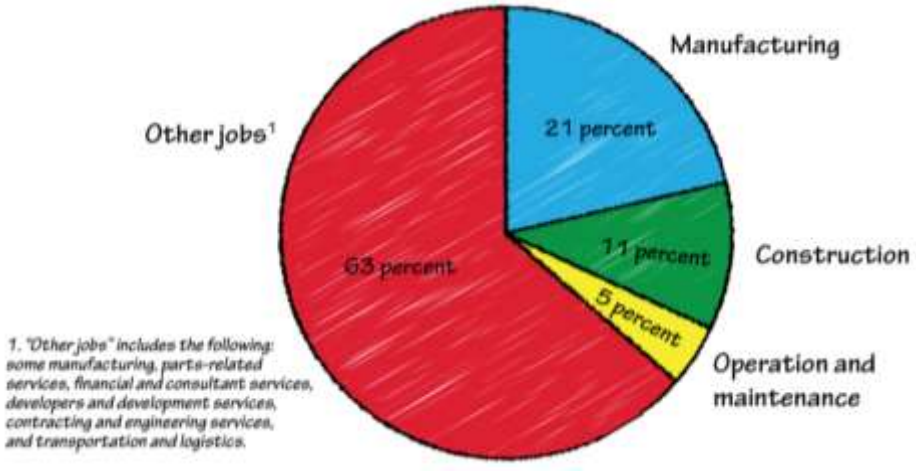

Figure 5: Wind Power Jobs [16]

If the offshore wind farm is built to replace the biomass plant, all of the saw mill waste previously burned for electricity will still be in need of disposal. There is a healthy amount of alternative uses for the mill waste including but not limited to; briquets, insulation, fertilizer, structural filler, and gasification [17]. Jobs in these fields would stimulate the local economy in addition to the job requirements of establishing an offshore wind farm.

Finally, with regard to demographics, Humboldt County is currently 73.8% white alone, 1.5% black, 12.1% Hispanic or Latino, and the rest are other minorities [18]. Across the nation, construction workers are almost half Hispacnic or Latino and African Americans make up just over 13% of all production workers [19].

Cost

An important factor to consider is cost. It is fundamental to understand present and future costs when considering to install anything in general. First of all, cost depends on how long a certain project has been around. Compared to the standard land-based structures, offshore wind has been around for a short time. This makes the cost projection for the market in the U.S. difficult as many regulations and technicalities have not yet been established. There is not that much experience for the offshore wind projects. Some sources support this claim: "We estimate technical uncertainty and input cost uncertainty to calculate whether investments in offshore wind technology are profitable today [20]" and "cost projections of [offshore wind projects] for the U.S. market are difficult because of the many regulatory and technical uncertainties and the lack of U.S. market experience [21]." Land wind turbines have been around longer and observed more, so engineers have a better understanding how to have them function. Offshore wind turbines will start off expensive because of investment uncertainty and their scarce deployment. Also, there is pressure due to exchange rates between the dollar and euro changing. [22] provides a graph showing how the exchange rates between the dollar and euro have fluctuated from 1999 to the present day.

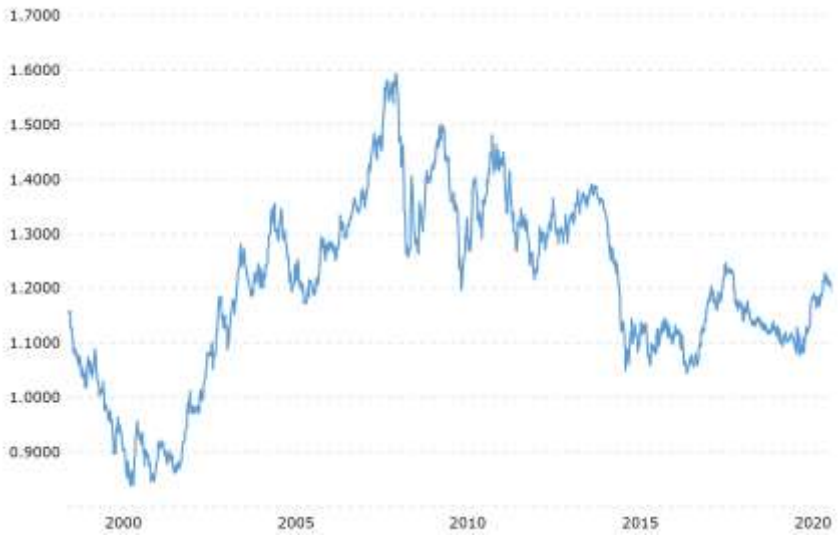

Figure 6: Exchange Rates between the U.S. Dollar and the Euro, 1999-Present

According to European Wind Energy Association, “In the last 20 years, more than 2,000 MW of offshore wind capacity have been installed in Europe [20]. Several industry and academic publications cite actual capital costs and projected levelized costs of energy (LCOE) for these installations.” Europe has an advantage over the U.S. in this business, so the States will definitely be trying to gather insight to install in their own way on their own soil. Offshore wind farms in the U.S. will have to take examples from other nations that have experience and results. There will be differences. For example, the U.S. will have to account for their lack of infrastructure to support the wind turbines. The U.S. metocean and environment is different and has deeper waters and more tropical storms than European countries.

In general, the cost of offshore wind turbines can be categorized as: the capital cost required to install the system and the life-cycle cost (LCC). Capital costs are fluctuations in exchange rates, commodity prices, labor costs, etc. Life-cycle costs take into consideration energy production, operational costs, long-term reliability, etc. In other words, LCC is the cost of energy production throughout the life of the project, which is generally considered to be 20 years. Yet, LCC assessments are more uncertain due to the freshness of the business, so capital costs are a useful way to analyze the cost. [20] shows several market studies done on this data, one of which will be presented for a real-world understanding of the matter. Costs have been rising throughout the 21st century. [20] states that “[Figure 7] gives a range of estimates of future offshore project capacity-weighted costs from $3,921/kW for near-term U.S. projects to $4,431/kW for near-term European projects." This range of estimates is consistent with the stated opinions of developers, who expect costs to stabilize or rise from 2009 levels. Note that the cost projections of U.S. developers are about 13% lower than the cost projections of European developers for 2010 to 2015.”

Metric for Calculation of Future Offshore Wind Project Cost	Arithmetic Mean (US$/kW)	Capacity-Weighted Average (US$/kW)
Installed 2009 projects	4,252	3,964
Proposed 2010 projects	3,965	3,905
Proposed U.S. project 2010–2015	4,191	3,921
Proposed European projects 2010–2015	4,411	4,431
Proposed projects 2010–2015	4,327	4,259

Figure 7: Capital Costs for Offshore Wind Turbines

From Figure 7, one can see that capital costs are increasing for offshore wind turbines. In addition, [20] shows that the life-cycle costs of offshore wind turbines is about twice as big as the comparable land-based turbines, and this is due to the factors of capital cost rising as well as higher O&M costs. O&M (Operational and Maintenance) costs are also high due to uncertainty in the field and lack of necessary information on how to construct them. So, the cost will rise with the implementation of offshore wind turbines.

Reliability

Reliability is the ability of a system to perform its specified function under normal conditions over an extended period of time. When discussing the reliability of any complicated system, there are many factors which must be considered. Reliability is paramount in a power-generation system. This matters as, while the minor impacts of this occurrence may lead to some loss of profit, the major ones may lead to loss of life. We will outline some of the main factors surrounding the reliability of both offshore wind turbines and biomass power plants.

Biomass:

Biomass power plants can operate as combined heat and power units [23]. They use much of the same technology as the ubiquitous liquid natural gas steam power plants, only using recycled biomass for fuel. This means many of the critical components have a developed track-record. Since biomass uses a steam power cycle, it is very easy to scale up and down power production while providing a baseload power [24]. This allows for the installation of separate and redundant generation systems, where the installed power capacity can exceed what is necessary and excess generation can be turned on or off as needed.

While it may be easy to step up/down a redundant biomass power plant, it is by no means a minor financial endeavor. This increase in reliability would come at a large cost in equipment and infrastructure [23]. Additionally, while biomass fuel is easy to come by, variations in the quality and consistency of fuel can impact system performance and reliability [23].

Offshore Wind:

Wind power generation reliability is a more complex subject than that of Biomass. This is due to the major reliability factor of wind supply. Variations in local wind conditions can lead to a decrease, and even complete loss, of wind-based power generation [25]. This can occur when the local wind speed drops below the cut-in speed or when it rises above the cut-off speed. Offshore wind power generation tends to have a decent advantage over traditional (onshore) systems [26]. This is due to wide open areas that allow for flow development and consistent strong coastal winds that are generated by the geothermal transition region between sea and shore [26].

While offshore wind tends to be more reliable than onshore, this benefit comes at the cost of a much more hostile installation environment. Float-mounted turbines have to cope with considerable cyclic loading (due to wave action and storms) as well as corrosion (due to salt spray)[27]. These disturbances, coupled with the decrease in installation accessibility (which inhibit inspections and preventative maintenance), make fatigue and vibration-based failure a severe concern [28].

Timeline Impacts

The timeline for construction of new offshore wind farms has important impacts to the community. The HRC Scotia biomass plant has a contract with the RCEA county through 2024. Depending on the technology and contractor selected, construction could take several years. A gap in power generation output between shutting down the biomass plant and the installation of new wind energy could lead to a mismatch between demand and generation.

Offshore wind installation duration

RCEA is looking at partnering with a few different contractors. According to the 2020 Integrated Resource Plan, Solicitation Issuance (bids) for the project will occur in 2024 [1]. This will be around the same time the HRC Scotia biomass plant has their contract up for renewal. RCEA expects commercial operation to begin in 2026. This would mean that the wind plant would likely not begin producing power for two years after the Scotia biomass plant has shut down [1].

Technology and location impacts on installation

Since 2001, the average complexity and distance from shore has been increasing in new offshore wind farms [29]. RCEA is planning on building the wind farm approximately 25 miles from shore in 600-1000 meter deep water. However, distance to shore does not greatly affect installation time per megawatt (Figure 8).

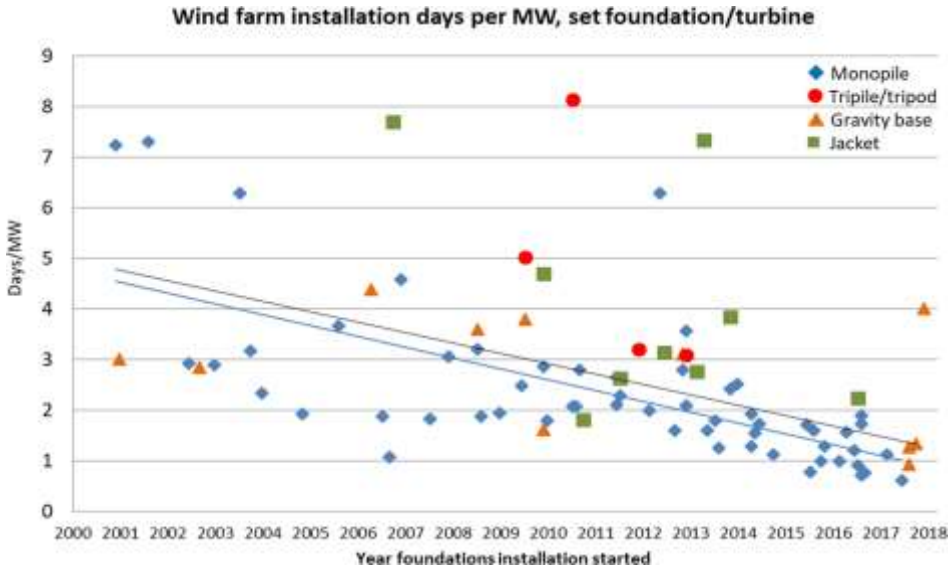

Figure 8: Wind farm installation days per MW [30]

Research by Sarker and Ibn Faiz, cost of the installation is “significantly impacted by turbine size and pre-assembly method [30].” This gives Principal Power an advantage with use of modular prefabricated parts that can be quickly assembled on shore before being tugged out into position to be anchored.

—Discussion

Human & Environmental Impact

The biomass facility creates more CO_2 and is the cause of many other diseases in the population. Overall the environmental impact and human negative impact of these wind farms are almost negligible. Even if the biomass waste is trucked over 2000 miles to a composting facility and added onto the CO_2 created by wind farms as they are being manufactured, wind farms are still better for the environment and the population. On top of the trucks not emitting as much CO_2 as the biomass plant, the emission of other toxins such as SMOG and NOx will not be enough to make an impact on the population. Even though over 500,000 birds die due to wind farms it is not a significant contributor to the endangerment of birds.

Economy

The Scotia biomass facility and the concept offshore wind farm offer similar prospects for long term employment. Without much specific information about the offshore wind farm, we cannot put a number on how many people it would take to operate and maintain. Nonetheless, it is clear the personnel required to maintain the wind farm will be small relative to other major industries. Further, the jobs brought in by the construction of the offshore farm would most likely result in a stimulus of the Humboldt economy. Once construction is complete, it is possible for the workers who established the wind farm to transition to jobs in alternate mill waste processing. With the installment of a new offshore wind farm, people are liable to migrate to Humboldt county for work. As mentioned in the research section, the primary industries tend to have relatively high black and Latino membership. Therefore, bringing in construction and manufacturing jobs will help to diversify the Huboldt demographic.

Cost

Offshore wind turbines are new to the States. They have been thriving in Europe, but the U.S. isn’t as invested in offshore as land-based. This means that the cost of implementing offshore wind farms will be high. The capital costs, or the costs of production and installation, will be high since this business is new and engineers do not know the best ways to construct the wind farms. Another factor of cost is the life-cycle cost (LCC). The LCC is also expected to rise because engineers do not have the operations and maintenance figured out yet for the wind farms, and capital costs might be high for a while, keeping the LCC high as well. RCEA would be expecting many fluctuations in cost if they implement offshore wind turbines. The costs are definitely going to keep rising.

Reliability

As highlighted in our results section, it is clear that biomass is a much more reliable power source than offshore wind. While the reliability of wind continues to improve, it may never overcome the uncertainty of wind variability due to weather, nor will it be able to serve as a baseload for the grid. However, it is worth noting that, as RCEA does not intend for wind to be a sole-source replacement for all power generation, the region may rely on alternative sources in the event that wind dies down. With this in mind, it is worth considering offshore wind, so long as care is taken to plan for the increased maintenance costs and potential weather-based outages.

In fact, by adding offshore wind generation, the RCEA could diversify their energy portfolio thereby increasing overall grid reliability.

Timeline Impacts

The RCEA plans include a 2 year gap between shutting down the biomass plant and completion of the wind farm. This would leave Humboldt county vulnerable to having insufficient supply to meet the power demands of the citizens. The installation time for the semi-submersible design will be small and allow quick deployment. However Humbolt will likely need the biomass plant to continue operation in order to support the community.

—Conclusion

With regard to offshore wind and the community, the RCEA should renew its PPA with the biomass plant for the immediate future but not indefinitely. During their respective operating lifetimes, an offshore wind farm will result in nearly zero particle pollution into the local atmosphere while the biomass plant releases significant amounts of stored carbon and other pollutants. Such pollutants may find their way into the lungs of local residents causing disease and premature death. The development of an offshore wind power generation system would give Huboldt's economy a boost. Additionally, the closure of the Scotia plant would have a minimal economic impact. This would most likely encourage diverse groups to migrate to the area for the construction process. As a result, the community would diversify and strengthen their economy. The installment of an offshore wind farm is a long and expensive process. The capital costs are several thousand dollars per kW. Once complete, the lifecycle cost of offshore wind is an uncertainty as is the reliability. Wind is not a reliable base power source and the mechanical reliability over the open ocean has an exorbitant amount of natural variables. As a supplemental power source, offshore wind can help lead the way to a carbon free future. Although it will take time. An offshore farm would not be complete by the time the current PPA runs out. With this in mind, the PPA between RCEA and HRC Scotia should remain active until the transition to clean renewables is complete.

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