Project Development Final Report

California Maritime Academy Collegiate Wind Team 2023

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Executive Summary

The California Maritime Project Development Team (hereafter, referred to as "CALMARITIME") has set out to develop a 370MW wind farm off the coast of Fourchon, Texas. After analyzing multiple factors regarding siting characteristics, environmental analysis and financial validity. CALMARITIME has developed a business plan to develop an offshore wind farm in the heart of the Gulf of Mexico. This project seeks to provide not only clean renewable energy, but also an opportunity for economic expansion into renewable energy.

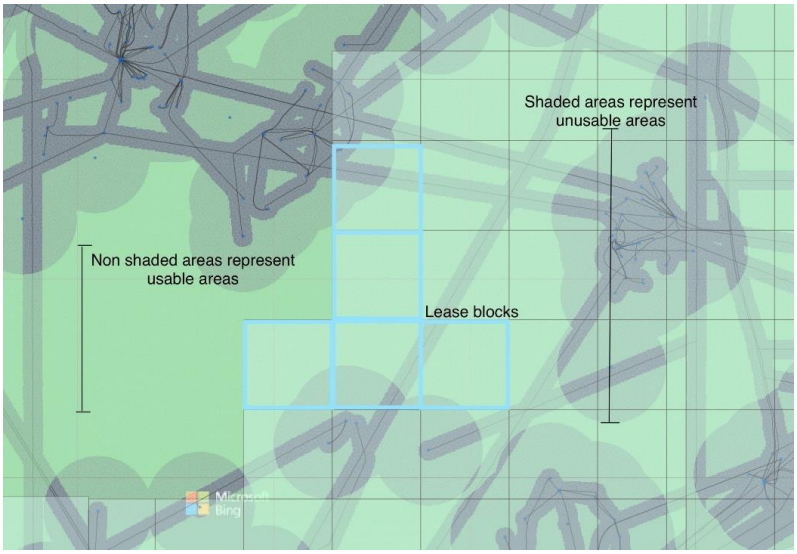

Figure 1: Openwind software displaying a Validity layer of selected lease blocks.

Site Analysis

When analyzing which lease blocks would be most suitable for selection, CALMARITIME utilized the use of Openwind, a GIS program designed to aid in the placement

and planning of wind farms. It works by the user inputting in multiple data sets, which will compile into a layered map of information. CALMARITIME's layer was built from data that included: bathymetry, shipping fairways, underwater infrastructure, wind speeds, oil platforms and active lease blocks, as exhibited in figure 1. These data sets created a validity layer (displayed in figure 2), which shared where we could practically site the farm's location. Another factor that was incorporated in selection was the large open space south of the sited blocks. This area has minimal existing infrastructure and could allow for potential expansion of the farm in the future.

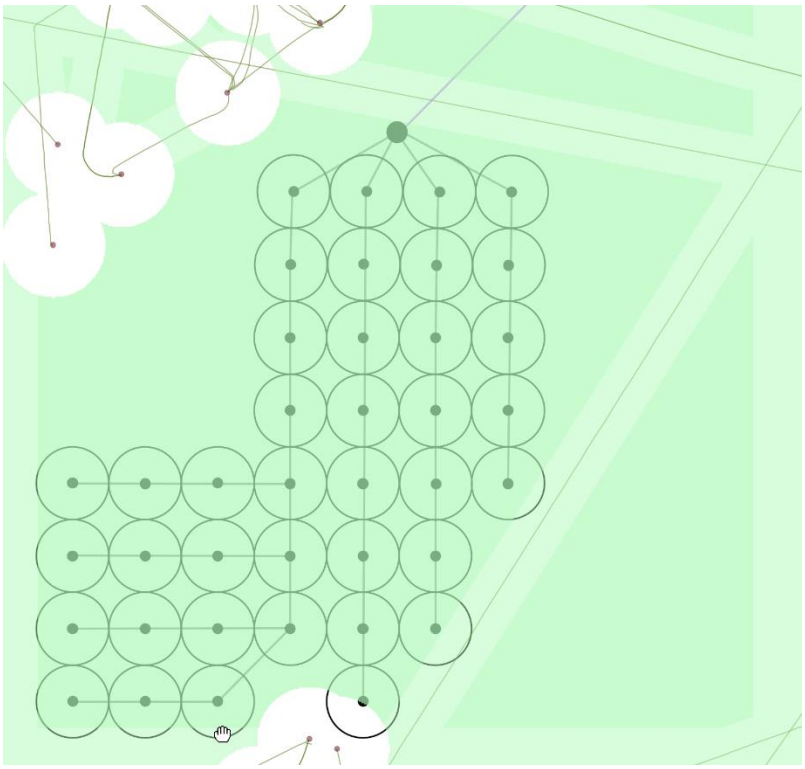

Figure 2: Openwind software displaying selected lease area and transmission plan. Along with shipping fairways, pipelines, platforms, and bathymetry layered.

Wind Resource/Turbine Information

When researching which lease blocks would be suitable for selection, CALMARITIME's research found that the average wind speed to be 7 to 7.5 m/s, with a nominal wind speed of 7 m/s. These wind speeds will power 39 Vestas 164MW turbines with a total operational capacity of 370MW. The reason for choosing the Vestas 164 9.5MW turbine was due to its reliability in the industry, high yield, and proven platform. These factors allow the use of this turbine to be profitable and efficient.

Vestas V164-9.5 MW Turbine						
Rated Power	Rotor Diameter	Hub Height	Cut-in Speed	Cut-Out Speed	Nominal Voltage	Wind Class
9500 kW	164 m	160 m	3 m/s	25 m/s	66 kV	IECS

Bathymetry/Geotechnical data

The selected lease blocks bathymetry consists of an average water depth of 20m with slight variation. CALMARITIME's chosen lease blocks are located north of any significant depth changes found on the Texas-Louisiana shelf.[1] This mitigates the need for any subsea depth alterations, minimizing environmental damage. The selected lease blocks' geotechnical data is a composition of recent sediments with a cohesive consistency and a steady mix of sedimentary rocks. The lease location has little to no obstructions that would require any dredging or adjustments to the seafloor. The only alterations that would be needed are found at the foundation and subsea cable locations.

Foundation

To minimize environmental impact while maximizing construction efficiency the farm will utilize a twisted jacket foundation, formally known as the Inward Battered Guide Structure (IBGS).[2] This foundation can partially be constructed on shore prior to offshore installation. This minimizes offshore and underwater construction work, enhancing safety.[2] Modifications to the seafloor are minimal and would only consist of moving obstructions in the foundation site.[3] When installing the foundation, the only equipment needed will be hydraulic or vibratory hammers.[3] The twisted jacket foundation is proven to resist hurricane damage, which is essential as the lease blocks chosen to reside in a hurricane prone location.[3]

Transmission Plan

Port Fourchon will serve as the point of interconnection for CALMARITIME's farm. This location was chosen for multiple factors, which include market need, existing pipeline locations, an established grid, and distance from selected lease blocks. An offshore substation will be constructed in the northernmost lease block connecting to a subsea high voltage alternating current transmission line (HVAC). 28 Due to the expansive array of pipelines found in the Gulf, the cable route has been optimized to have the minimal amount of pipeline crossings necessary. This slightly increases the cost of the cable's construction due to an increase in length. However, it will significantly minimize the risk of crossing pipelines. The cables' length still permits the use of an HVAC rather than a high voltage direct current (HVDC) cable, as the distance is less than the 50 km mark. Which requires an HVDC cable to minimize transmission losses. Once shoreside the cable will run along Highway 3090 before turning left onto Cheramie Senior Road ending with a connection to a substation located adjacent to Slip C.

CALMARITIME plans to construct a 230kv substation located on the currently unused and empty land found between Slip C and Slip D. This land will also be developed to sustain Staging along with Operations and Maintenace. Developing an entirely new substation will offer an efficient means of supplying the Port directly with clean renewable energy.

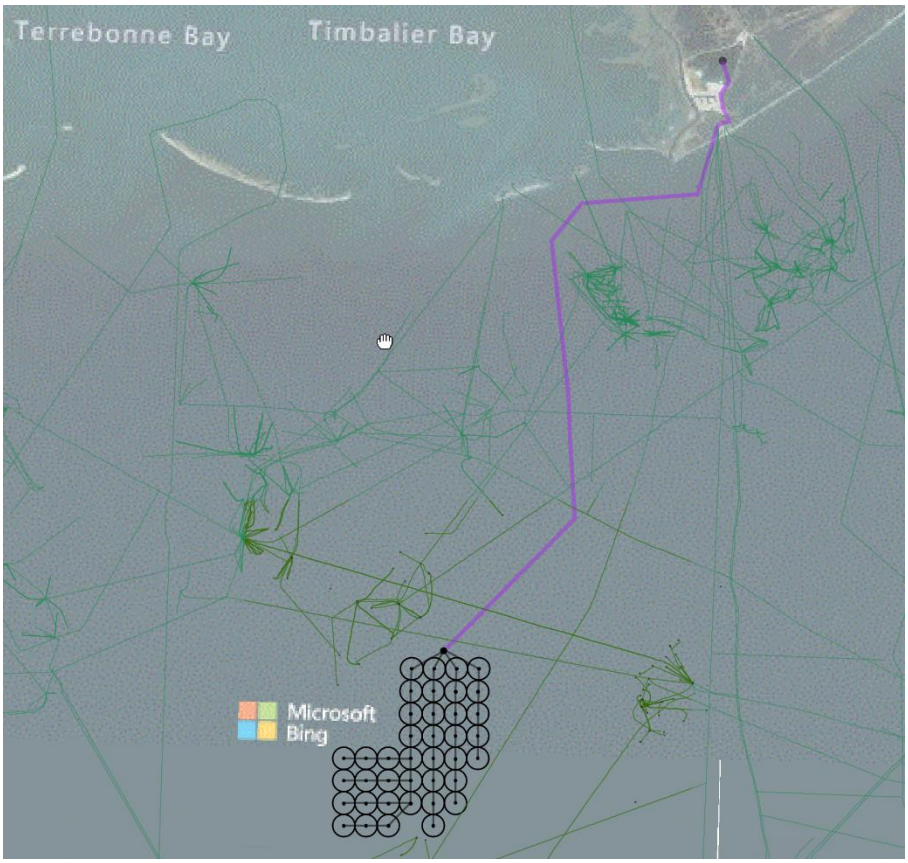

Figure 3: Transmission plan

Site Development/OM

To properly carry out the staging, operation, and maintenance phases for an offshore wind farm, Cal Maritime has been exploring all options. There was a lot of interest in using the only Jones Act compliant Wind Turbine Installation Vessel, known as the Charybdis. This jack-up vessel is owned by Blue Ocean Energy Marine, which is a subsidiary of Dominion Energy. As beneficial as it would be to have this wind turbine installation vessel as a resource for Cal Maritime's Wind Farm, there is only one in the United States currently being constructed. Upon completion in December of 2023, it's set to be contracted out until 2027 for two major projects: the Eversource/Østred Sunrise and Revolution and the Dominion Energy Virginia CVOW project.[4] In terms of CALMARITIMEs wind farm, construction is planned to take place before then, making the use of the Charybdis unfeasible. That leaves an exciting opportunity to think outside of the box about how Cal Maritime will build their farm. Edison Chouest Offshore has been creating a name for itself since 1960 as a prominent marine transportation company, based out of Cutt Off, Louisiana. This company has a plethora of vessels totaling 216 ranging from 87 feet to 525 feet valued at $1.33 billion.[5] For this project to be completed Cal Maritime will need Service Operation vessels (SOV's), Crew Transfer vessels (CTV's), Wind Turbine Installation vessels (WTIV's), Hotel vessels and Field Development vessels (FDV's).[6]

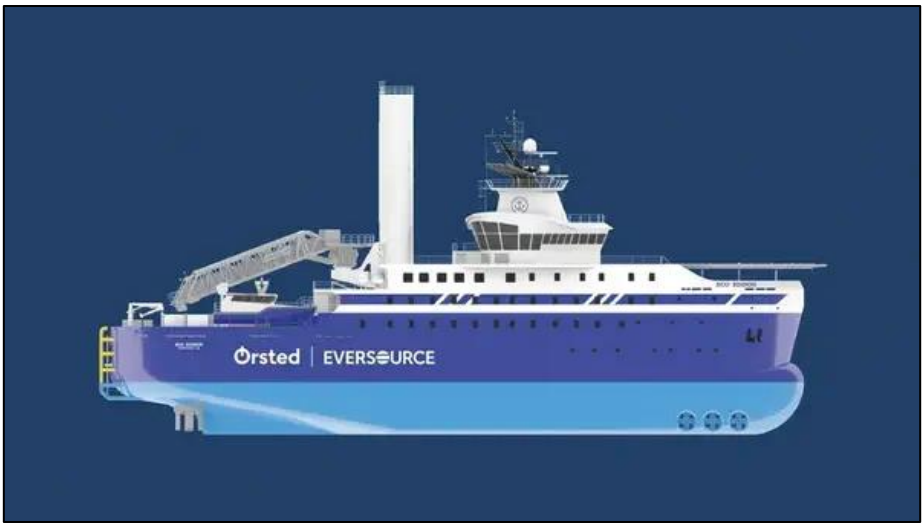

Figure 4: First Jones Act-Compliant Offshore Wind Farm SOV Hits Halfway Mark, 2023

CTV's will aid in ferrying working personnel to the wind turbine installations for day-trip operations, maintenance, and inspections. These vessels can seat up to 36 crew members. CTV's can be Offshore Supply Vessels or Small Passenger Vessels less than 100 GRT and inspected under 46 CFR Subchapters "L" or "T". They are typically the Catamaran Type and travel around 20 kts. These vessels will contract from Edison Chouest.

SOV's are dynamic positioning enabled vessels that platform assist for wind turbine operation and maintenance work. Along with accommodations for more than 40 individuals, these vessels house gangways and 10-ton cranes that may house retrievable daughter-crafts to transport technicians to different locations across the wind farm. As there are currently no Jones Act-compliant SOVs in service, the Eco-Edison from Edison Chouest is the most prominent pick for our proposition.

Set to be delivered in 2024, this vessel will provide "operational support out of Port Jefferson, New York, for Ørsted and Eversource's joint venture offshore wind portfolio" [South Fork Wind, Revolution Wind and Sunrise Wind]. The Eco-Edison will serve its purpose during the O&M phases of the wind-farm projects as a "sea base of operations to accommodate and transfer technicians, tools and parts" While it is set to complete projects in the New York Area for the time being, future ventures aiding in wind farm construction in the Gulf may be a plausible prospect.[7]

FDV's are field development vessels designed to lay cables to connect offshore wind structures to the vital structures on shore delivering electrical energy from the field. According to the US Coast Guard, there are no Jones Act-compliant FDVs.[8] Because of this, our best option is cable-laying vessels. These ships are equipped with one or more turning tables which allow for the load and installation of long cables.[9] As cable-laying is an integral part of the installation phase, negotiating with the Huisman Company to employ their Motion Compensated Cable-Lay System, for installation and repair would be advantageous.[10]

Hotel Vessels will provide safe and secure housing facilities for the crew of this windfarm. Hotel vessels are separated into three distinct types: platforms, vessels and most recently barges. Taking both cost and maneuverability into account, vessels and barges would be best for maintaining proper positioning across our location if needed.[11] Referenced above, the Eco Edison has the capacity to hold 60 individuals.

Wind Turbines Installation vessels, also known as WTIV's provide installation and construction services. They can self-elevate in shallow water and operate as heavy lift vessels in deeper seas. These vessels are designed with a cargo deck for the transportation of turbines, blades, and equipment. They have a crew holding capacity of 50+ personnel.[12] As revealed above, the Charybdis, owned by Blue Ocean Energy Marine is the only compliant vessel of its kind within the US.

All the vessels mentioned above have been developed or modified to help sustain offshore wind farms, excluding the WTIV. Due to the sheer size of the Cal Maritime Wind Farm, which will house 39 Vestas 164 9.5 MW turbines, an installation vessel is the most efficient and ideal method of development, as they have the capability to drive the foundation into the ocean floor and are large enough to transport an average of five disassembled wind turbines and can lift 700 tons 125 meters high.[13] Since the only Jones Act compliant WTIV will be occupied until 2027, Cal Maritime has decided to work around this problem by creating a mutual beneficial agreement with Edison Chouest. This contract will state that if Edison Chouest fronts the total capital of roughly 500 million and takes on the construction of a WTIV vessel, Cal Maritime will agree to sign a nonnegotiable capital guarantee for 10 years, with the agreement that Cal Maritime will have full control over the vessel for their wind project. Day rates for the WTIV vessel will be roughly $220,000. Specifics of the contract will state that Cal Maritime will front fifty million at the signing of this contract to then take ten percent equity from the vessel. This will be a financial lease, where Chouest has little involvement in the use of the vessel after the construction phase. The reason for this type of lease is because it is very beneficial on the lessor end regardless of the mutual parties' advancements in their projects. These contracts lock in the lessee and if they try to terminate it, they will have to compensate the lessor.[14] Regardless of the outcome development for the wind farm, Chouest will be taken care of financially. After the ten-year mark, the wind turbine installation vessel will fall back under Chouest's control, but Cal Maritime will still rack in ten percent of equity of all projects that the WTIV is involved in. This will cover staging and operation phases of the development for the wind farm

State and Federal Policy

Under Act 443, Louisiana state legislation only governs wind leases within three nautical miles of its shore. Louisiana's state laws do not affect CALMARITIME's site as it is outside the reach of their three nautical mile zone. The Energy Policy Act of 2005 allows BOEM to issue leases that allow for renewable energy development on the outer continental shelf. BOEM has established Intergovernmental Renewable Energy Task Forces in states that have expressed interest in offshore renewable energy. The Gulf of Mexico Intergovernmental Renewable Energy Task Force contains state, federal, and local government officials. These stakeholders include the Louisiana Department of Natural Resources, Louisiana Department of Environmental Quality, and the Louisiana Department of Wildlife Fisheries, among others.[15] These task forces gather relevant information from these stakeholders that assist BOEM in their decision-making process for the lease and development of offshore energy sites.

The Inflation Reduction Act (IRA) is designed to grant incentives to the offshore wind industry. Section 50153 of the IRA allocates $100 million for assembled stakeholders and the transmission development for offshore wind energy.[16] The energy investment tax credit (ITC) is a federal tax provision supporting offshore wind developments. This provision yields a 30% tax

credit for offshore wind developments that begin construction before January of 2026. With this tax credit, we will receive an inflation-adjusted credit of 2.6 cents per kWh for the first ten years of electricity generation.[17] According to the Inflation Reduction Act, the environmental impact statement and permits for the offshore wind site will need to be completed before 2025 to remain profitable.

Jones Act

The Jones Act stipulates for ships to have cabotage, they must be U.S. flagged, U.S. built, and that 75% of the crew must be U.S. citizens or permanent residents, including the officers of the vessel. However, the experience the European wind market has over the U.S. is significant.[18] Incorporating the use of contracted European labor and equipment may be essential during construction phases and save a few expenses. After construction, U.S. vessels and crew will be hired for domestic transport.

Military and Airspace

Naval Air Station Joint Reserve Base New Orleans (NAS-JRB) is a base within close range of the proposed site. It is home to multiple Navy, Airforce, and Marine Corps fighter wings and Coast Guard Helicopter units.[19] As per construction, the FAA (Federal Aviation Administration) will be contacted to know the location to update flight maps. Infrared devices will be installed to protect monitoring equipment. CALMARITIME will contact the Base Commander of NAS-JRB New Orleans too to ensure military operations are not interfered with by the site's position. If conflict arises from the location, radar installations will be a priority to ensure there is no interference. Adding infill radars onsite will maintain existing radar coverage which will minimize any issues. Increasing the spacing between each turbine will create less of a disturbance. We have checked the airspace and confirmed that we are not interfering with any nearby air traffic.

Military Employment Considerations

With the United States Military's SFL TAP program, we can hire military personnel leaving active duty to be hired on to work on our windmills. The SFL TAP program is a military program intended to reintegrate military personnel into civilian life with a better job opportunity.[20] One of the job options is Windmill Technician. With that opportunity, we can contact local military installations to allow a set up an opportunity for hiring veterans to be a part of the windmill technician teams to provide maintenance to the site. Due to the training provided, as well as background in the Armed Forces, the candidates brought over to the site would be above average compared to regular hires without experience. With this, not only would we be able to get potential new hires but assist US military veterans in gaining employment after their active-duty service.

Wave Height

The average wave height analyzed in selected lease blocks came to 1 to 3 meters, depending on weather conditions and the season.[21] These wave conditions are an insignificant size to impose any serious effects during construction and once the farm is operational there will be little to no effects. The location of CALMARITIME's farm rests in a hurricane prone area, and the average wave height will increase significantly during times of heavy weather. To reduce damage caused by the hurricane prone region, CALMARITIME's team is implementing the use of a twisted jacket foundation. This style of foundation has been proven in the oil industry to withstand extreme weather brought on by hurricane conditions.[2]

Risk Management

The location of the site can pose a few unique risks, as it is overwater. This Section will provide issues and solutions for proper operation for the wind farm. Due to the location on water, proper lighting, alarms, and "no trespassing" signs will ensure no civilian guided vessels will collide into the turbine. Alarms, fencing, and monitored security systems will be placed to ensure vandalism and theft is minimal. Security cameras will be installed during construction and operation of the location. The security cameras will be secured by bolting them down and will be waterproof to ensure they are secure for high wind speeds and high tides. CALMARITIME will also utilize drones to monitor security risks and commercial vessel traffic in the area.

Weather around the location site can have extreme weather all year round. Hurricanes are abundant and common within the site. Hurricane season runs from June 1st through November 30th.[22] Category 5 hurricanes have wind speeds of 157 mph or more. Reasonable mitigation measures will be made by increasing the design reference wind load, ensuring that the nacelle can be turned into the wind, and shutting down turbines during said high wind speeds.[19] Structure and design are key to withstanding wind speeds, and installation of Lightning Diverter Strips to protect from the damage of possible lightning strikes.[23] Testing of the integrity of the turbine to see if it is structurally able to withstand high wind speeds will be on the list of priorities before installation. If damage were to occur to the turbine, proper cleanup repair crews, including scuba divers, will be dispatched to fix any underlying issue and retrieve fallen parts.

Environmental Social Governance (ESG) Strategy

CALMARITIME longs to not just produce clean, renewable energy for people to use, but to be a mentor and guide for the offshore wind industry as well. The local economy of the area will be at the forefront of our ESG strategy. The Port of Fourchon area has great education on the wind industry, with the University of New Orleans possessing a wind energy hub.[24] The business will offer internship positions to students participating in the program to further their experience and connections within the industry. The oil industry in the Port of Fourchon will benefit from the offshore wind platform because it will lower their energy costs and encourage them to use more viable, green sources for their business.

Because we will be investing in offshore wind energy infrastructure, the development of the CALMARITIME wind platform will benefit the Port of Fourchon as well. CALMARITIME will do so by supporting Edison Chouest in developing WTIVs to more efficiently construct offshore wind platforms that will increase supply chain development by establishing effective

logistics networks and promote investments.[25] We will also be investing and building infrastructure, such as a switch and O&M yard at the port. From decommissioning to the life cycle of our offshore wind platform will prove beneficial to the busy port.

CALMARITIME will ensure that the offshore wind platform not only places little to no effect on the marine environment, but also benefits it as well in encouraging coral growth. The offshore wind platform can develop artificial coral reefs by providing a safe space for the coral to grow and prosper. The Gulf used to be a place full of coral, but due to coral bleaching and hurricanes, coral has disappeared. To help restore the coral reefs that will bring about a more biodiverse and lucrative environment, CALMARITIME will support coral nurseries in the area and provide the bottom of the offshore wind platform as a habitat for the growing coral.[26] The offshore wind platform will provide the ideal environment because the corals will grow close enough to the surface to capture sunlight, but not so exposed to high temperatures to induce coral bleaching events.

Use of Funds			
Cost Type	Subtype	$	% Breakdown
Developing and Financing		$32,520,000.00	4.09%
Turbine			
	Total	$370,000,000.00	31.76%
Balance of System			
	Turbine foundation	$129,000,000.00	16.21%
	Cables	$73,000,000.00	9.17%
	Offshore substation	$65,200,000.00	8.19%
	Other balance of sytem	$32,500,000.00	4.08%
	Offshore cable installantion	$205,000,000.00	25.76%
	Turbine instalation	$16,800,000.00	2.11%
	Foundation instalation	$16,125,000.00	2.03%
	Onshore Substation	$75,250,000.00	9.45%
	Other installation	$150,520,000.00	18.91%
	Total	$763,395,000.00	95.91%
Total		**$795,915,000.00**	**100.00%**

Figure 5: Use of Funds

Capital Expenditures

When researching the financial framework of this development CALMARITIME analyzed multiple variables including equipment, infrastructure, turbines, substations, and cables. The cost of commissioning these structures is also factored into this amount.

Financing

Funding for this project will be provided through investments from various private entities and government grants. These investors include J.P Morgan, Goldmans Sachs and Morgan Stanley. The negotiated contracts will consist of a 99/1 flip structure, which works by the investor gaining 99% of the tax benefits along with 10% of overall profits.

Operations Costs

When analyzing the cost of yearly operations and maintenance CALMARITIME estimated the cost per Megawatt to be $48,000. The project's overall size is 370MW, which equates to $17,760,000 yearly. This covers insurance, repairs and the upkeep of the farm including vessel contacts over the 25-year lifespan of the project will cost around $444,000,000. This number is based on the idea the farm will run without compromise from factors such as mechanical failures, weather damage and unpredictable events.

Optimization

When developing the farm CALMARITIME utilized Openwind to find the most optimal layout of all 39 turbines. This was done by calculating the distance required between turbines to mitigate wake losses and maximize spacing within selected lease blocks. Openwind was also used to create a validity map that consisted of layers of established fairways, pipelines and platforms. SAM financial software was also used to establish the financial legitimacy of the project.

Environmental Impacts

Despite shipping traffic, Louisiana has had recent successful efforts in trying to restore their coast that once served as nesting spots of endangered sea turtles, such as the reappearance of two species of sea turtles on the eastern islands.[27] The Migratory Birds Treaty protects the plethora of birds that migrate over the Gulf of Mexico, to and from Louisiana's coast, so construction will seasonally occur and will use technology to mitigate damage. For example, CALMARITIME will participate in curtailing wind turbines when receiving knowledge that an endangered bird is nearby and opt into any solutions, like IdentiFlight, which identifies birds using artificial intelligence, when it is economically viable.[28] The Endangered Species Act protects sea turtles in Louisiana’s coastal waters and requires agencies, like the Coastal Protection and Restoration Authority (CPRA), to enforce sustainable practices and continue to restore their coast. The Louisiana coast acts as a habitat to several endangered sea turtles—the Hawksbill, Loggerhead, Kemp’s Ridley, Leatherback, Loggerhead—whose recovery cannot be interrupted.[29] Endangered clams, like the Fat Pocketbook and the Pink Mucket, reside in the region, whose endangerment is due to increases of sedimentation and an altered and degraded habitat because of urban development.[30] Offshore wind has been suspected of causing fishers to catch in regions that are less sustainable and enable other species within the wind farm’s proximity to take over.

Marine mammals are protected under the Marine Mammals Protection Act (MMPA) of 1972. It states that “certain species and population stocks” that may be or are in danger of extinction because of human activities must be prevented from declining to the point where they

cease to be a significant working component of their ecosystems. The MMPA protects all marine mammals regardless of their status as endangered, threatened, or stable.[31] Whales are only occasionally sighted in coastal waters and tend to stay 200 nm from the shore in the winter season, making them of little concern when installing the offshore wind platform. The bottlenose dolphin, however, is present in coastal waters and impacts should be considered, such as possible noise pollution making it impossible for the dolphin to interpret the acoustic waves to navigate their environment. There will be minimal vessel traffic after construction, so marine mammal displacement should not be a great deal, but there will be consistent monitoring and researching to ensure harmful effects can be detected and mitigated, as necessary. The Marine Mammal Commission offers science-based oversight for offshore energy to make a thoughtful and deliberate take place for offshore wind energy's potential impacts on the environment. It is required that offshore wind energy conduct a site assessment once CALMARITIME obtains the lease with BOEM to enhance research of the area to best ensure a beneficial impact on the environment as best we can.[32]

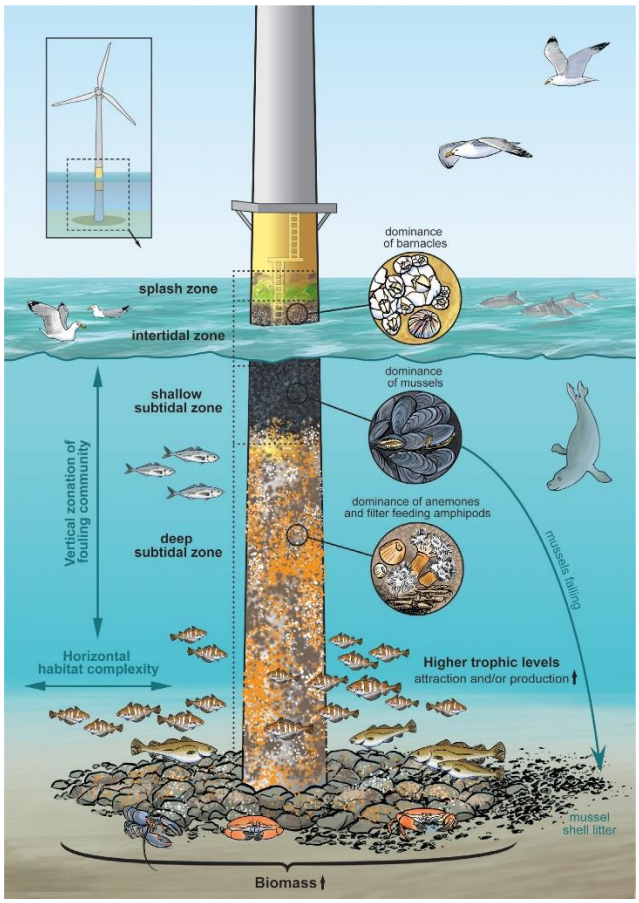

Figure 6: Benefits of Turbine Foundation

In consideration of marine mammals and wildlife, implementing sound barriers to minimize the sounds of pile driving. The Hydro-Sound-Dampener System (HDS System) can be

used to lessen the disruption to marine mammals.[33] Monitoring underwater noise with instruments will also help with noise pollution.

An offshore wind platform here can also prove beneficial to the local environment. In installing a wind platform, we are providing artificial hard substrates that marine organisms can colonize, and species are given a new habitat that can withstand and protect them from recurring hurricanes.[34] Algae tends to form upon the platform, helping the growth of zooplankton, and enhancing biodiversity.[35] The platform will also provide more energy to the population, as winds offshore provide more energy, and be able to help the US reach its goal of zero carbon by 2035.

This area is known as one of the best places for fishing and bird watching, so CALMARITIME needs to ensure that nothing harms the area's tourist economy.[36] Installing an offshore wind platform will also discourage trawling that leads to overfishing, as trawlers fear their nets will entangled around the foundation.[37] The site is near the Greater Mesoamerican Reef, so precautions will be made to mitigate and compensate for any coral damage that may take place during construction.[38] Sand transportation occurs often to protect and restore their islands needs to remain undisturbed, making it pertinent that the wind turbines do not affect the mass transportation of sand or decrease the presence of sand.[39, 40]

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