California Coastal Turbine project

Proposal, Technical Project
Plan A
To be presented on 5/9/23

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1. Introduction

The state of California suffers from massive blackout problems as the weather in the state fluctuates. A blackout occurs when the electricity supply stops, causing power outages in the entire region (in which they share the same power supply source). Once electricity is out, the entire power supply in the area is cut off, stopping all that functions with electricity. Such a situation can lead to massive damage to property, community, and lives. In California, common causes of blackouts are heat waves and wildfires, damaging energized lines and equipment, and disrupting the power supply.

1.1 Problem Statement

Data collected by Bloom Energy shows that from 2017-2019 blackouts in California affected more than 50 million people. This is a drastic number, putting California at the top as the state with the most blackouts in the US. The primary cause of these electrical problems is the extensive strain the power grid faces when a natural disaster such as a heatwave occurs. This lack of proper cooling for people leads to dangerous environments in intensive heat. These temperatures can endanger the lives of children, the elderly, and all in between.

1.2 Background

In response to the common blackouts and energy shortages, the state of California has set up temporary power generators that are to be deployed during a grid emergency due to a sudden energy supply shortage, designated and directed by the California Independent System Operator. Temporary electric generators in California are gas turbines that operate from natural gas and are designed against extreme heat waves or wildfire events. The state is also seeking additional energy supply, as well as promoting the state's transition to clean electricity. Installing offshore turbines could supply the energy needed while reducing the state’s impact on climate, contributing to a shift to clean energy.

1.3 Needs Statement

In the event of an electrical power outage, other sources of electricity could continue to provide electricity. This could be considered something that people in the state of California could want, as electricity can be used for different purposes.

1.4 Objective

Our main mission is to bring relief from the fear of blackouts to the state of California. Blackouts and power outages due to heat waves can be deadly for both the young and elderly when temperatures rise. In order to subside this problem, we propose to construct a wind farm to generate clean and renewable energy that will be able to supply the power grid with much-needed energy in case of emergency. This addition would increase the energy capacity of the affected area which in turn would decrease the strain that a heatwave would have on the city. In order to make this happen we will need funds from the state government, government approval for this project, and testing sites for materials being used.

2. Technical Approach

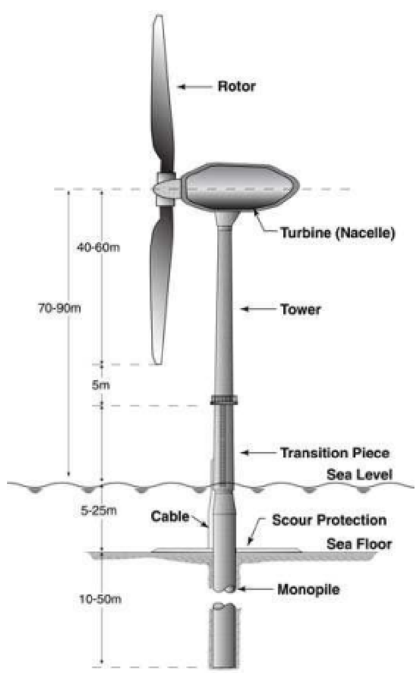
The proposed plan is to install a series of wind turbines off the coast of San Francisco in Gray Whale Cove State Beach that will be able to deliver power to San Francisco. The design of the wind turbine that we will follow is a design known as monopile. A monopile wind turbine design was decided as it seems to be the most stable and structurally sound design for a wind turbine. A monopile turbine is a design in which the base of the turbine is fully driven into the ground. The use of industrial-grade submarine power cables will connect the turbines to the power grid of San Francisco. Before this plan can begin we would need the foundation for the wind turbine to be scouted out first. A team of bathymetric surveyors comes and checks the depth of the ocean floor before establishing a foundation for the wind turbine. Once we have a measurement of how far down the depth is to the ocean floor, we can send an assembly crew out by boat to lay the foundation. The foundation essentially consists of an 80-meter-long monopile weighing 1000 tons being driven into the ground. After the monopile is set and it is prepped for assembly we can begin to build up the turbine and hook it up to the cables transferring the energy to the power grid. This will be a multiple-day process using both engineers and construction crews working off of multiple boats to put together multiple windmills.

2.1 Requirements

It is important for environmental scientists to check whether the site is safe to install turbines, as well as the surrounding environment. The data for sea level and wind speed and weather will also be recorded for the final installation of the turbines. Such data matter to install turbines in a site where the environment is least affected, installed turbines are safe from human activities, and calculate the expected lifespan of turbines for replacement. Data will be collected using underwater cameras and satellite images. Software for water movement will measure the tides, and data will be used to set up the measurements and building materials of the turbines.

2.2 Architecture Design

The main reason for choosing this area for the project is due to the remote nature of the location in proximity to the city, but still close enough to where the transfer of energy is not hindered in any capacity. Another reason for this location is due to the lack of residences nearby, meaning that property values would not decrease due to the construction of the turbines in front of them. The design of the turbine will follow the standard monopile wind turbine design of 2.5 Mw wind turbines. These turbines have a rotor diameter of 80 meters, and the ruling is that wind turbines should be installed approximately 5 rotor diameters from each other. Thus, the wind turbines must be installed at least 400 meters apart from each other to meet safety guidelines. The turbines should be installed at least 15 miles from the coast (Bloomberg Law, 2019). The monopile for the foundation is 80 meters long, and the transition pieces are 30 meters long.



Wind Turbine System Components (Malhotra, 2007)

2.3 Implementation Design

Turbines will be installed 15 miles away from the shore. To install the turbines, an excavation crew would be sent out in order to create holes of proper fitting for the foundation elements to be properly installed. Then the building crew will first transport the monopile and transition pieces through the ship to the site, and install the foundations on the seafloor then transition pieces will be installed on the monopile. Once the foundation is finished, the tower can be transported and installed. After the tower is completed, a nacelle is installed (the main piece of the turbine to which the blades are attached to), along with a transition system and remote control (pre-assembled before installing on the tower). Each blade will be installed separately. After the installation, heights can be adjusted. There are two ways of building, and both require a crane.

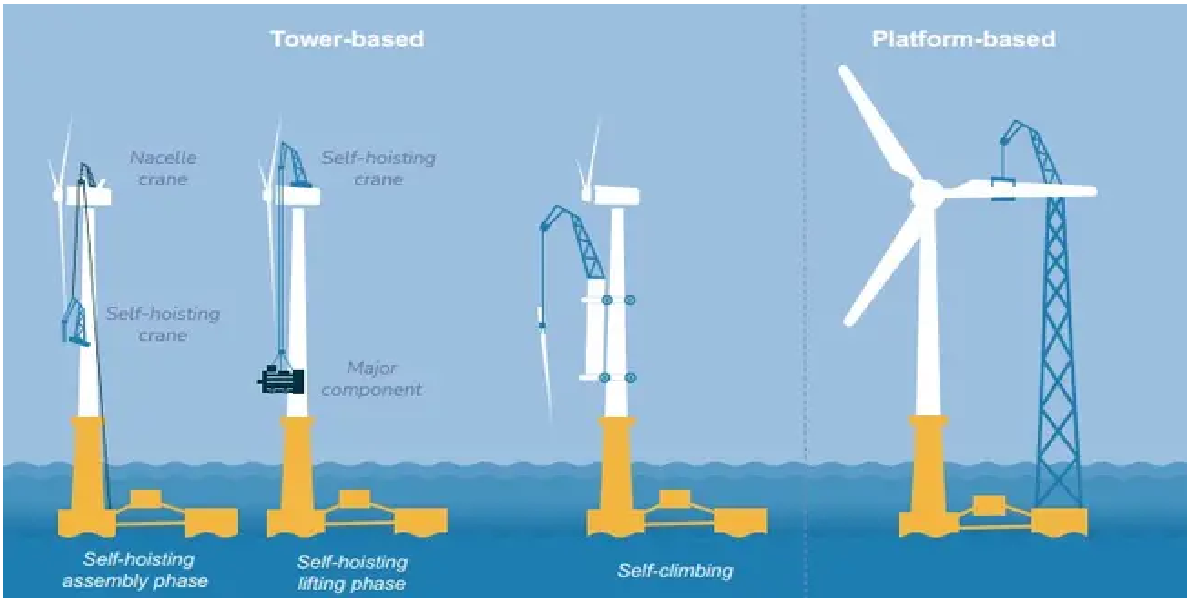
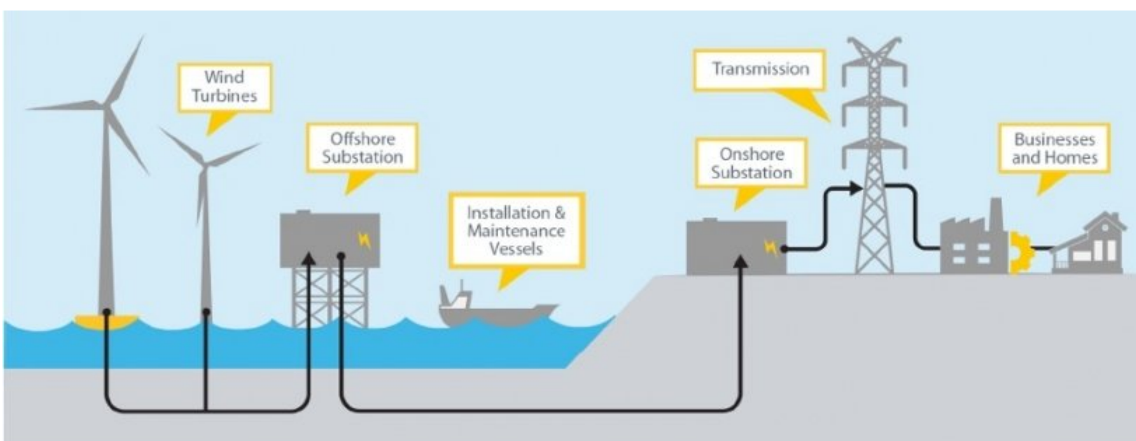


Image credit: WFO

There will also be an offshore substation and an onshore substation connected to the turbines, which then send electricity to the transmission system.



EERE Offshore Wind Energy Strategies Report (January 2022)

3. Quality Assurance Plan

To ensure menial error is created there has been a quality plan put in place before any construction can commence. Before parts for turbine assembly are placed on boats and shipped out for assembly we will have a group of structural engineers inspecting each part to make sure it's up to safety code. Our structural engineers will ensure each piece can withstand the circumstances it will be placed under such as salt water, erosion, stress points, etc. There will also be mapped out routines of installation and assembly to ensure there are no mistakes or errors while assembling the wind turbines. We will also receive active weather alerts to warn the crew of weather conditions to decide if the crew can go out and assemble the turbines on any given day. With these measures being put into place we can mitigate the possible risks we could face while proceeding with this project.

3.1 Risks

Possible risks within the offshore turbine are as follows:

1. Offshore turbines are in danger of ocean weather, including hurricanes and sea level rise (which causes flooding). While California is generally safe from tropical cyclones, the state is still under the impact and goes through sea level rise. Also, while there were only 8 tropical hurricanes in California in the past, the possibility of hurricanes cannot be neglected. Such a situation may damage turbines or connecting cables. This potential risk may be controlled by a weather forecast system and strong design to endure the force.

2. Ocean’s environment, especially salt, may damage turbines. The foundation in the seafloor is at risk of corrosion, and sea wind may cause erosion. Such problems cannot be prevented, and turbines must go through maintenance on a regular basis.

3. Maintenance of turbines requires money and human resources. Offshore turbines are likely to be damaged more often and severely than on land. Blades and cables are damaged often. They also have higher maintenance costs than on-land turbines.

3.2 Risk Mitigation

1. To keep the turbines safe from the sea environment, they should be designed to withstand wind speeds of at least 70 meters per second (m/s) or roughly 140 knots. Turbines should be designed to turn off when wind speeds reach 50 m/s, which raises the inference that the turbines do not continue to generate energy at such wind speeds.

2. The tower should be built using tubular steel which is highly resistant to corrosion.

3. Turbines should go over maintenance on a regular basis. This process could be handed over to the state government. A turbine must be checked at least three times per year, and more are recommended.

- Blades are made of fiberglass and need to be repaired often.
- Cable failures could commonly happen. Therefore, a quick response team should be ready at all times.

3.3 Consideration in testing

The money and permission being given to use by the California Energy Commission, the California Environmental Protection Agency, and the state treasury would go towards the quality assurance testing and planning. Using a combination of mathematics, engineering, and earth science we will be able to consider how our turbines would withstand harsh weather conditions, stress points, environmental conditions, and technical malfunctions.

3.4 Expected Project Results

The expected immediate results from this plan are the supplementation of power into the main power grid of the city of San Francisco. This would allow for the city to have a cleaner source of energy and become a stepping stone for greater clean energy generation projects. Though the main goal and long-term effects of this plan would be to help power homes, businesses, and other essential buildings in the event of a blackout due to heat waves or wildfires. This is built to mainly affect those that may suffer from power outages the most during a time of intense heat, such as the elderly and sick. We also expect to have little effect on the surrounding ecosystem, as well as fully preserved property values. In some cases even increased values due to the incentive of clean energy. Overall, we are looking to see how successful and effective the wind turbines are at mitigating an energy crisis if or when one is to come. From this we would be able to expand these designs to various other coastal cities through California and potentially the rest of the U.S.

4. Qualifications

Our team consists of four mechanical engineers: Stephen Sarno, Rajesh Narine, Daeeun Kim, Edgar Loja Espinoza:

Stephen Sarno majors in mechanical engineering with a concentration in the field of manufacturing. He has an interest in solving natural disasters and weather crises because he feels they are an issue with minimal solutions. His focus is to manufacture systems and machinery that can help the population in the event of a natural disaster. He hopes that his style of problem-solving will be able to innovate other engineers to shift their focus and do the same. Some of his technical skills include CAD modeling and drafting on programs such as Autodesk Inventor and Fusion 360, engineering circuit systems, and assembly of engines and generators.

Rajesh Narine focuses on mechanical engineering in a concentration of aerodynamics and fluid mechanics. He is very interested in sustainable wind-based energy generation, trying to find the best and most efficient solutions. He hopes that his ideas would be implemented into creating some of the best clean energy in the world. Due to this background, he is able to better find designs that have the greatest yield in terms of power vs carbon emissions.

Daeeun Kim focuses on mechatronics and manufacturing. He seeks efficient manufacturing systems and mechanical systems. He pursues a better, environmental machine system that is durable and reliable, as well as an efficient manufacturing system that could bring it to life. It includes from design to the building process. Some of his skills include computer-aided drafting and Python.

Edgar Loja Espinoza is going for a Bachelor of Engineering (B.E.) in Mechanical Engineering. Once obtained, he can use knowledge about mechanical systems. By focusing on manufacturing, he can contribute to discussions of mechanical systems that are beneficial.

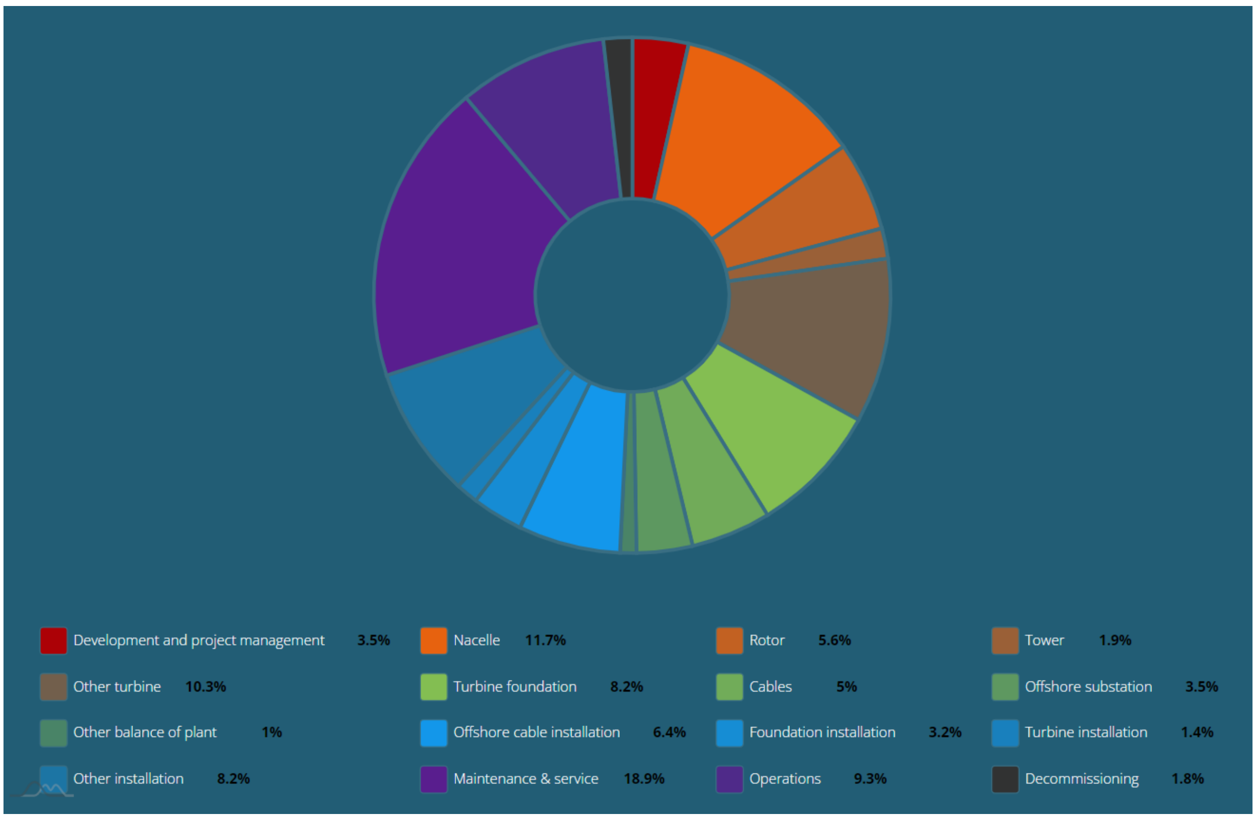
5. Schedule

Installing the foundation and tower could be done in around 24 hours, and installing the parts takes time similarly. However, the process could be delayed due to weather conditions. At a fast rate, installing a single turbine could be done in a week. Installing all the turbines (at least 15 turbines) and adjusting, including the height and cables should take no longer than two months (under no severe weather problems).

Best time to install the turbines would be between May to September, which is called 'Dry Season' for less rain. During this season, the state is free from tropical cyclones, which causes severe rainfall in California from October to April.

The average lifespan of offshore turbines is approximately 20 years. The towers should go over maintenance every three months, and blades every month.

6. Budget



(Wind Farm Costs, Catapult)

6.1 Direct Cost

Billing	Quantity	Per Unit Cost	Total Amount
2.5 Mw Wind Turbines (See Below)	15	4,000,000	60,000,000
Mechanical Engineers	4	30,000	120,000

Civil Engineers	4	30,000	120,000
Environmental Engineers	4	30,000	120,000
Electrical Engineers	4	30,000	120,000
Construction Crew	20	14,400	288,000
Materials Transportation	n/a	n/a	50,000
Jack-up Barge	1	2,000,000	2,000,000

Turbine Parts	Cost
Nacelle	1,000,000
Rotor	475,000
Tower	175,000
Other (Assembly, etc…)	850,000

Balance of Plant	Cost
Cables	170,000
Turbine Foundation	280,000
Offshore Substation	120,000
Onshore Substation	30,000
Operations Base	3,000

Installation	Cost
Foundation Installation	100,000
Offshore Cable Installation	220,000
Turbine Installation	200,000

(Table 1, 2, 3, 4: Evaluation of direct cost of the turbine and installation)

These billings were created based off of recent listings for similar jobs or jobs in this field. The work/ labor costs also are to be contracted for about 2- 3 months of work in which this planning and construction would take place. The total cost of this project is predicted to be 64,000,000 dollars to build, along with about $50,000 for operating and maintenance costs.

6.2 Indirect Costs

Financial Consideration	Price
Insurance	500,000
Land Surveyor	5,000
Contract Fees	30,000

(Table 5: Evaluation of indirect cost spent for turbines)

7. Conclusion

With power outages resulting in a loss of electrical power, many people can be affected. The state of California has been affected by natural disasters, heatwaves and wildfires, losing access to electricity. It leads to a need for another power source, safe from heatwave and wildfires, that could support in case of power outages. Installing offshore turbines could solve the problem by setting up another power source than previous facilities, ones that are environment friendly. The project, once finished, would provide a sustainable solution to the energy problems the state is facing, and even improve the energy system.

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Audience Analysis

Reader's Name: Gavin Newsom

Reader's Job Title: Governor of California

Education: Bachelor in Political Science

Professional Experience: Mayor of San Francisco, 49th Lieutenant Governor

Job Responsibilities: Ensure state law is enforced, and decide on various bills and legislation.

Personal Characteristics: Good Communication Skills

Cultural Characteristics: n/a

Attitude Toward the Writer: Trusting, the team of engineers seeks to improve the energy crisis

Attitude Toward the Subject: Stands firmly against power outages, looking for new solutions

Expectations About the Subject: Addresses the energy problems California has been facing

Expectations About the Document: It will lay out a clear and concise plan for implementing

Reasons for Reading the Document: to understand and learn more about solutions to the problem

Ways of Reading the Document: Would read a portion to get the gist of what it is about.

Reading Skills: University level English Comprehension

Reader’s Name: David Hochschild

Reader’s Job Title: Chair of the California Energy Commision

Education: Masters in Public Policy from Harvard University

Professional Experience: Vice President of Solaria Corporation’s External Relations

Job Responsibilities: Decides on projects and facility management of energy related projects

Personal Characteristics: Good Communication skills

Cultural Characteristics: n/a

Attitude Toward the Writer: Trusting, the team of engineers seek to improve the energy crisis

Attitude Toward the Subject: Feels very strongly about clean energy and solving the energy crisis

Expectations About the Subject: Properly addresses the problem in an effective way

Expectations About the Document: Hoping that it illustrates a concise and efficient plan

Reasons for Reading the Document: to bring about sustainable energy to california

Ways of Reading the Document: study it

Reading Skills: University English Comprehension

Stephen Sarno’s Engineering Proposal Reflection Paper

This engineering proposal project was a collaboration for the entire group. Each of us got together and helped fulfill the requirements of the project, which were: To write an engineering proposal document, create a powerpoint presentation on our document,and create a website based on our document. Throughout this project the group had split the work to make sure it would get done in a reasonable amount of time and in a reasonable way. At the beginning I had worked on the abstract with my team and as we got closer to the start of the project each group member was assigned a different section to write. As the paper began to come to an end we would separate one more time into creating the powerpoint and website. The website had an initial design to it and I helped plan the layout of how everything should be structured initially. I would eventually start the powerpoint part of this assignment to help save on time. I designed and filled the powerpoint with information pertaining to what we had written about. I helped aid it with some visual images and designs. My main priority was to make sure the powerpoint had all the important information and not too much filler information when I was filling out the slides. I don't want to lose my audience or the people I was presenting to with too much information. I would also help aid in the refined design of the website to help make it more streamlined and easier to navigate and understand. However my main contribution was working on the different segments and sections for the overall document as a whole. Each person worked on multiple different parts of the paper as did I. I had also tried my hardest to get everyone in the group together to help work on the project and to ensure that it would be completed in full.

Those were all the contributions I had made to this project, and it was oddly satisfying to manage. This project was a very ambitious project and it had a lot incorporated into it but as a project coming at the end of the year, I would expect no less of a challenging task.

Rajesh Narine's Engineering Proposal Reflection Paper

The engineering proposal project was a collaboration of an entire team to make this happen. With each person giving input, such as ideas on different projects, or just enhancing an already displayed idea. The goal of the project was to create a multimedia presentation and proposal about a solution to problems that arise from natural disasters. The assignment consisted of 3 parts, the proposal document, the website, and the power point presentation. The project started with collaborating with my team to create an abstract, this is a brief summary of the company and the project idea. Originally the idea that had been pitched was lackluster, and so I came up with a new idea for offshore wind turbines. This was a new and fresh idea that breathed new life into the thinking process. Once the idea was decided on, now was the time to iron out all the details. Such as who our audience was , where exactly was this going to be built, and how much it would cost. Now that we had all of this information in line, it was time to have sections delegated to one another, in order to improve the group's efficiency. My main priority of the project was to help fully realize the idea of the wind turbines by using my prior knowledge to help make decisions on the project. Next I was tasked with the architectural design of the project. Figuring out how exactly the system of turbines would be generated. Then I was tasked with creating a budget for the project, finding a price for whichever parts I could and coming up with a cohesive cost for everything. Lastly was finding and creating the audience analysis sheets and researching what type of people and background that have. The work I completed as part of this project isn't exclusive to the parts mentioned, but these parts are ones which I had the most influence with.

Daeeun Kim

For the project, our group had to write an engineering proposal. We had to write a proposal, and also create a website on WordPress. The goal of the project was to come up with a sustainable solution to natural disasters and write an engineering proposal for the solution. We had to write, create a PowerPoint, and create a website. The abstract was the basic idea (or the company idea) that installing offshore turbines in the State of California. Once we did that, we separated the roles and tasks. The audience for the proposal and presentation, as we intended, is the State of California government, especially the energy department and environmental protection department. My main priority in the project was to find a way to materialize our idea to life and to come up with a specific plan to do so. Then I focused on the schedule, how the turbines will be installed, and how they should be maintained. I researched for parts, how long it takes to install, how often they should be checked and repaired, and the building materials for the turbines and other components. Once finished, I worked on the website, uploading the content our group created to the pages. Then our group worked together on the job listing, in which we listed down the jobs (or human resources) needed for the project. We worked together and were able to get things done. Through this project, I've learned to develop and engage in the collaborative and social aspects of writing processes, engage in genre analysis and multimodal composing, and practice using various library resources, online databases, and the Internet to locate sources appropriate to my writing projects and strengthen my source use practices. I had to research academic sources for accurate data from databases including the college's, had to cite them in the reference following APA format, and went beyond writing to creating website pages.