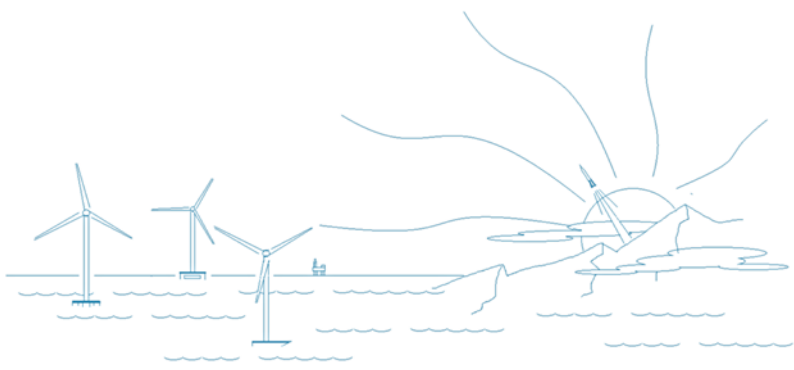
CIERCO

CADEMO

OFFSHORE WIND DEMONSTRATION PROJECT

LOMPOC, SANTA BARBARA COUNTY

CALIFORNIA



Project Report

Prepared by CIERCO Projects Corporation

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1. INTRODUCTION

1.1. Background

CIERCO Corporation, (CIERCO) proposes to develop an offshore wind demonstration project offshore of Vandenberg Air Force Base (AFB) in Lompoc, Santa Barbara County, California. The project, known as the CADEMO Floating Wind Energy Demonstration Project (hereafter referred to as 'CADEMO'), will consist of the installation and operation of four 12-15MW offshore wind turbines installed upon innovative floating foundations that will be moored to the seafloor. Each turbine will link to one another to form one communication and transmission connection from the center turbine to a substation at Surf, via an offshore cable that will land just south of Point Arguello on the Vandenberg Air Force Base and will continue on an overhead line to the Surf substation (see figure 1).

The nearest turbine is approximately 2.9 miles (4.65 km or 2.5 nautical miles) seaward of the nearest mean higher high water and the entire development will be capable of producing up to 60 megawatts (MW) of renewable electricity. This report is provided in support of an application for development approval and a submerged lands lease for the CADEMO project.

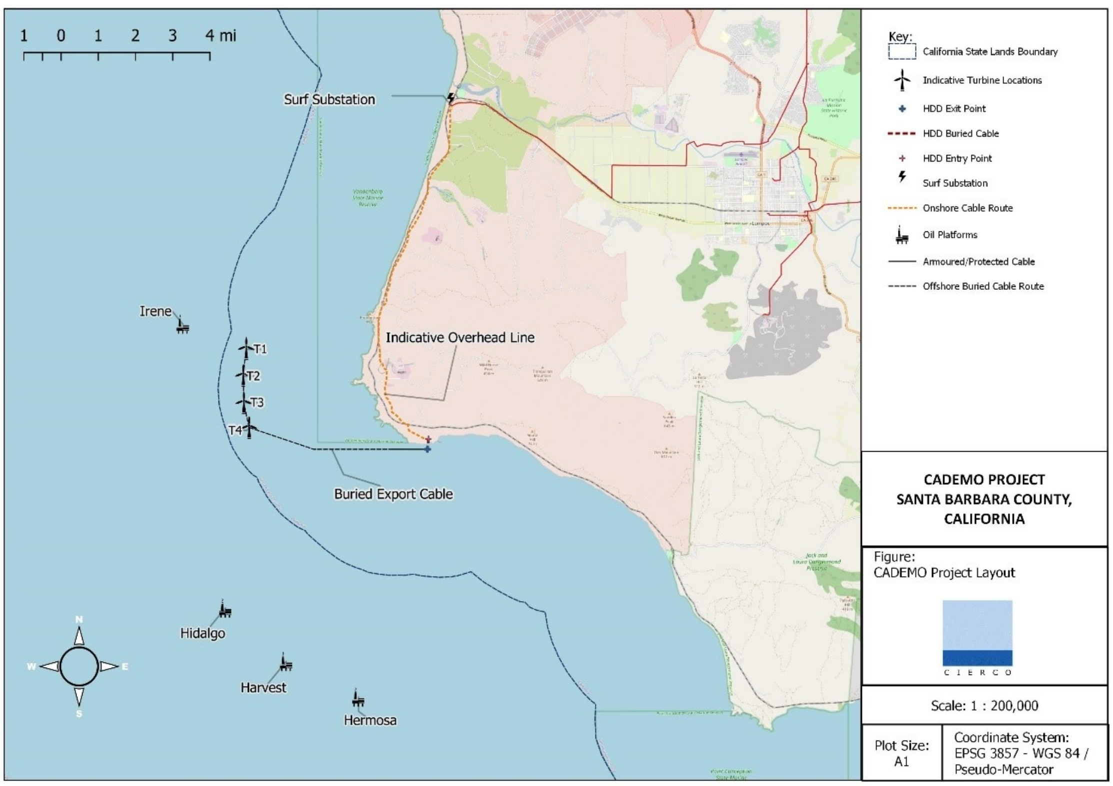


Figure 1 - The CADEMO Project Location

Project Element	Latitude	Longitude	Water Depth
Turbine 1 (T1)	34.59061535	-120.70016552	85 m / 279 ft
Turbine 2 (T2)	34.58022300	-120.70154258	92 m / 302 ft
Turbine 3 (T3)	34.56964036	-120.70131307	92.5 m / 303 ft
Turbine 4 (T4)	34.56000143	-120.69878845	96 m / 315 ft
HDD Entry Point	34.55555981	-120.61436430	n/a
HDD Exit Point	34.55154540	-120.61484007	9.6 m / 31.5 ft

1.2. The Developer

CIERCO Projects Corporation is the developer of the CADEMO Project. The CIERCO Projects Corporation is an American renewable energy development company based in Palm Springs; California established with the aim to facilitate the commercialization of new marine renewable energy technologies into the marketplace. Further information on CIERCO can be found at www.CIERCOenergy.com.

1.3. The Need and Purpose of the Proposed Development

Offshore wind can make significant contribution to a clean, affordable, and secure US national energy mix. In particular, the State of California has great potential for offshore wind renewable energy development. The National Renewable Energy Laboratory (NERL) estimates that California has the potential to provide 112 GW of power, or 150% of the State's electricity demand[1] from offshore wind sources. In addition, the generation profile between offshore wind and solar technologies (where wind power ramps up in the afternoon when solar begins to ramp down) provides a significant benefit in helping to stabilize the grid infrastructure. The large generation potential of the wind resource and its compatibility with other renewable resources, means offshore wind can provide a significant asset to assist California to reach its goal under SB 100 of 100% clean energy by 2045.

Offshore wind technology has witnessed significant advances over the last 4 years when, back in 2015, it was considered that a wind turbine capacity between 6 to 9 MW was at the cutting edge of technology demonstration. That number has now increased to between 12 and 20 MW per turbine. In addition, the industry view was that floating wind was as an embryonic idea and the only commercially available offshore wind turbines had to be anchored to the seabed via a fixed-bottom platform. This restricted development of offshore wind farms to shallow waters up to 50m deep, ruling out development off the Californian coast due to its bathymetric profile, where water depths get very deep near to the coast.

We are now at a stage where developments in floating offshore wind (utilizing oil and gas technology solutions) are beginning to show a path to commercial viability and are on the cusp of a major enterprise opportunity for the State of California to secure a local source of electricity supply and stimulate a new source of economic prosperity. However, it is also recognized that to responsibly explore and understand this major opportunity, there is a need to approach offshore wind development in a stepwise fashion. In other words, to develop a relatively small-scale demonstration project before wider commercialized roll out. This approach will enable the supply chain, local infrastructure, environmental regulatory bodies and key stakeholders (such as the Department of Defense and local fishing industry) to adapt, develop, learn and understand in a practical sense the challenges, issues interactions and solutions involved in floating offshore wind development in preparation for the eventual development of larger floating wind commercial arrays.

1.3.1. Purpose of the Development

From a technology perspective, the overall purpose of the Vandenberg Offshore Wind Demonstration Project is to provide a facility "*to demonstrate new models of floating offshore wind technology, which will be used to generate clean electricity from a renewable source of energy, the wind*". Specifically, this project will enable the turbine technology to validate the following:

[1] https://www.nrel.gov/docs/fy16osti/65352.pdf

- Assembly processes.
- Turbine and floating foundation performance.
- Load simulation models.
- Offshore installation processes.
- Validation of the tooling and equipment specifically designed for the turbine and foundations.
- Development of the local supply chain.
- Maintenance and servicing arrangements.

The development rights are focused to achieve 2 distinct and separate floating foundation technologies which individually have a need for demonstration to allow progress to deployment at commercial scale. However, the project reserves the right to deploy a single or alternate floating foundation technology, should the project development process determine that a multi-technology approach is not possible. The individual technologies are addressed separately later within this document. The initial focus of this report is on the wider CADEMO project and the outstanding floating wind industry requirements in California to proceed to future commercial scale deployment.

1.3.2. Need for Floating Foundation Demonstration

As stated previously, floating offshore wind is an evolving technology that has the potential for less foundation material, shortened installation and decommissioning periods, and additional wind power generation at water depths exceeding 50 meters - currently beyond fixed-bottom mounted structures. CIERCO's objective in establishing the 4-turbine floating wind demonstration project is to generate knowledge and experience to:

a) demonstrate 2 different full-scale offshore floating wind technology solutions with a >12MW turbine in Californian waters. This is a key aspect as the projects' ultimate goal is to demonstrate each technology as a unique and first of a kind deployment.
b) optimize the design of floating wind arrays to bring the costs down for large scale floating offshore wind developments on the west coast of the US and further abroad.
c) contribute to the accelerated development of the US Floating Offshore Wind Industry by being a pathfinder project in piloting the development, construction, installation, and operation of floating offshore wind at scale in US waters. It will provide an opportunity for the US policy makers and regulatory authorities to meaningfully consider potential short- and long-term impacts to sensitive environmental habitats, historical and cultural landscapes as well as the commercial fishing industry and existing maritime users.
d) contribute to the learning of how floating wind interacts at scale with the natural environment and local interests, such as the local fishing industry, the DoD and other marine users to understand the benefits and challenges of floating offshore wind in the US. In doing so, it is hoped that practical solutions can be found not only to address these issues, but also to potentially enhance the local environment and / or maritime resource for other users.
e) identify and maximize the potential opportunities and benefits to the local Californian supply chain and employment opportunities (including port infrastructure, professional services, technology maintenance and operations and maritime logistics).
f) fully utilize development capital expenditure across a number of innovative floating technologies to reduce the future technology risk profile and address the barrier of high development costs by

sharing key development costs (in areas such as consent application, environmental surveys, assessment, monitoring, grid access and infrastructure).

g) Address and reduce both the technology and investment risk profile for offshore floating wind in advance of commercial scale development projects.

The CADEMO project forms a key element of the wider CIERCO Corporation business plan to introduce floating offshore wind at commercial scale before 2030. The establishment and successful deployment of the CADEMO project will ultimately provide a pathfinder project to larger scale commercial deployment of floating offshore wind technology for future commercial leasing rounds in the United States and the United Kingdom, and wider deployment globally.

1.3.3. Understanding the Technology – the floating platform

An offshore floating wind structure provides a platform base for a wind turbine in deep offshore waters as an alternative to fixed bottom foundations (which are limited from a cost and technical perspective to shallower water depths). A floating wind substructure has three key components:

a) A **mooring** system – which anchors the structure to the seabed.

b) A **substructure** – a floating structure made from concrete and/or steel that supports the wind turbine; and

c) A **transition piece** – that provides the connection between the substructure and wind turbine tower.

There are three main technology design concepts for a floating offshore wind platform (see Figure *2* - Floating Wind Platform Technology Types). The CADEMO project is focused on the demonstration of 'Barge' and 'Tension Leg Platform' technologies. A barge solution provides a buoyant stable platform anchored to the seabed with catenary mooring lines - stability is achieved by the barge hull intersection of a large area with the water plane surface. A tension leg platform (TLP) achieves its stability through line tension on its mooring lines and a submerged buoyancy tank.

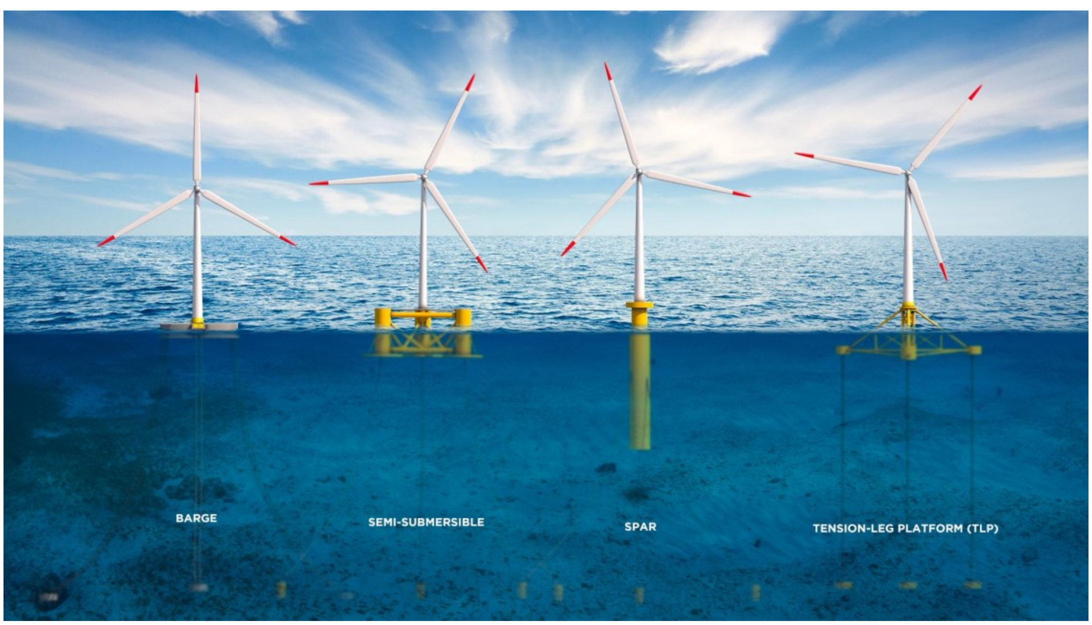


Figure 2 - Floating Wind Platform Technology Types

Both types of platform are relatively large but have low drafts, which provides a number of distinct advantages for installation in the Californian environment:

- the technologies can be installed in a range of water depths.
- they do not require specialist vessels for installation (essentially only tugs and anchor handling vessels).
- they provide more flexibility on onshore port requirements for manufacture. Manufacture can be done on a modular basis (ideally within California).
- turbine assembly can be done onshore.
- major maintenance overhauls can be done port side.

The CADEMO project will bring forward a barge and a TLP technology for installation offshore the Vandenberg AFB. The reference technologies for the project are the SATH barge technology developed by Saitec Offshore and a TLP technology developed by SBM Offshore - a description of the technologies is provided in section 2.5 of this report. From a technical evaluation criteria perspective, the floating technologies to be installed will be considered at Technology Readiness Level (TRL)[2] 6/7 at the time of installation, reaching TRL 9 once it has been installed, commissioned and operated for a period of time.

1.3.4. Understanding the Technology – the turbine

Wind turbine technology has seen significant year-on-year increase in generation capacity over the last few years. In 2017, the average capacity of new offshore wind turbines installed was 5.9MW (a 23% increase on 2016) and now turbine technologies providing 10 MW are commercially available on the market. The increase has been enabled through small changes to the industry standard 5-6 MW turbine platform that was originally introduced in 2005. The small steps in evolution have been based upon years of industry learning and experience in rotor control, load reductions, and the emergence of a mature supply chain. This experience has allowed the industry to 'stretch' the turbine platform in both generator capacity and rotor diameters to enable 6MW turbines to become 8+MW and 7MW to become 10MW.

In a similar way to CIERCO's view of the development of the offshore wind industry in California, the incremental "stretching" of the current baseline turbine platform was enabled through a stepwise approach, with each step reducing risk. This has allowed the implementation of each next generation larger capacity turbine within existing commercial projects, without the need to validate the new aspects of the technology. This could be achieved up to now as the turbine technical and physical dimensions were the same or with relatively minor changes. However, we have now reached the limit to what is capable of being stretched within the existing turbine platform and the next generation larger turbine platform requires a fundamental redesign.

The next generation turbine platform design can be described as more of a technology leap rather than an incremental design step; for example, the turbine dimension increases from a 155-164m rotor to a 220-230m rotor (an increase of almost 47%). This fundamental re-design raises new challenges in offshore installation, internal turbine engineering and nacelle layout, performance, wear and tear, maintenance and operation and turbine behavior. The design requires the technology provider to address issues that

[2] As defined by the Department of Defense "Defense Acquisition Guidebook" (2010); available from https://www.army.mil/e2/c/downloads/404585.pdf

have been far outside the established offshore wind industry "know how" on many aspects of design, such as solutions for bolt connections, capacities of Glass Reinforced Plastic (GRP), etc. As a result, this next generation turbine platform requires the demonstration of the technology in an environment where it is expected to be installed and operated commercially. It is anticipated that, at the time of the projected 2024 installation, activities the Vandenberg Floating Offshore Wind Demonstration project, a 14 MW turbine will have been demonstrated on a fixed pile foundation and demonstrated in commercial projects in Europe, but not on a floating platform.

Longer term, it is anticipated that the next generation platform will follow a similar technology path once the turbine is established (i.e. stretching the production capacities once loads and controls are established). The learning on the project will provide the opportunity to understand the integration of the larger turbine and floating platform, offering future turbine designs to stretch over 17MW (based on the same relationship as the 6-7MW stretching) utilizing the same rotor diameter of 225 meters for the commercial stage of offshore wind development in California; even possibly in the long term to further optimize and stretch each turbine capacity to circa 20MW.

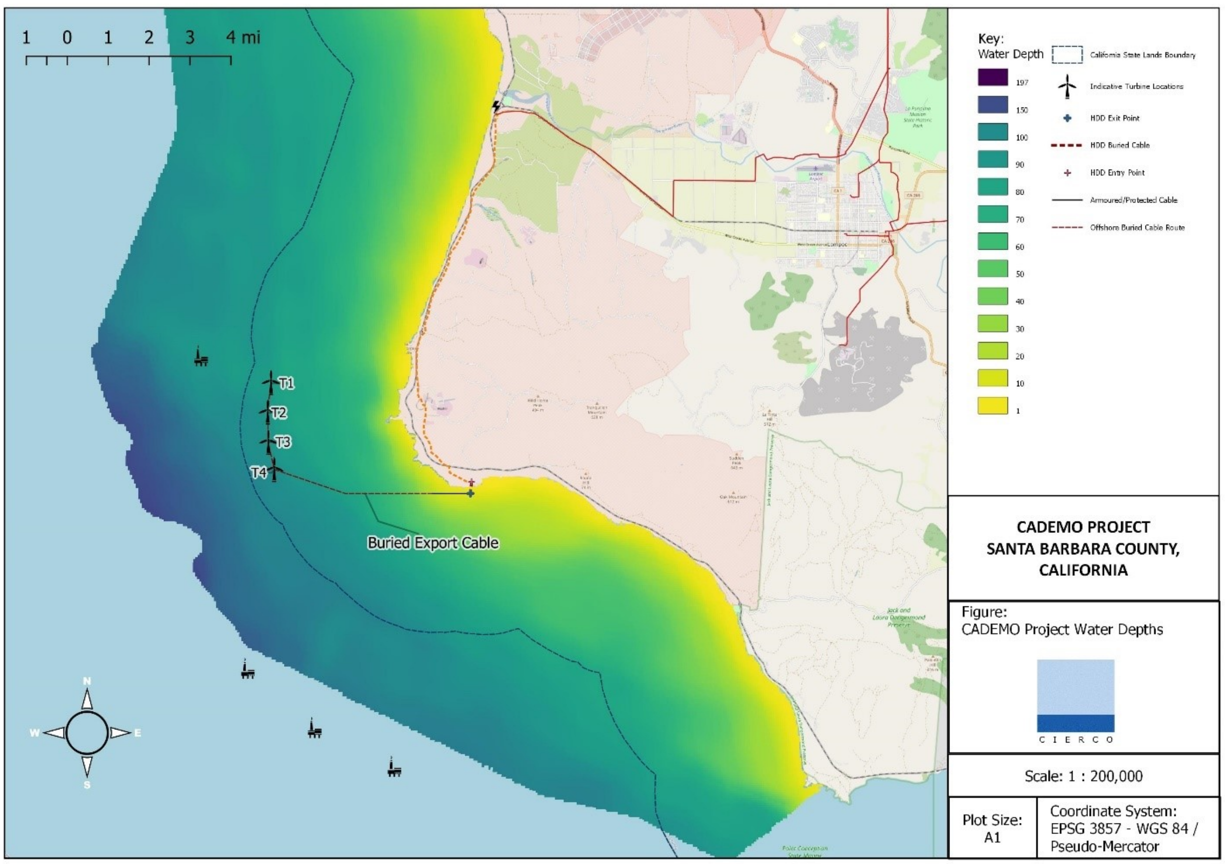


Figure 3 - Water Depths Offshore the Vandenberg AFB

1.4. Site Selection and Project Alternatives

During its initial interest in developing offshore wind projects in California, CIERCO carried out a series of desk-based assessments to determine which sites offshore California had the potential to be taken forward through the permitting and construction process on both a demonstration and commercial scale.

Specifically, the following initial considerations for a small-scale demonstration project were applied during the site selection process:

- Areas within Californian State Lands to simplify the permitting process.
- Areas with depths of between 60 to 100m.
- Areas were then refined to those that within an economic distance of available grid connection points and suitable ports for construction and O&M activities.

This initial process identified the Vandenberg Air Force Base area as a preferential location as there are viable zones outside designated protected areas, available offshore seabed profile, proximity to an available grid connection at surf beach and significant available environmental information gathered as part of the CalWave project.

A number of areas around Platform IRENE and Vandenberg AFB were assessed, with the preferred location being selected on the following basis:

- The most favorable location for wind resource and yield (i.e. highest wind).
- Few environmental constraints (it avoided activities within the Vandenberg State Marine Reserve).
- Favorable geotechnical and seabed conditions for mooring design.
- It avoided areas of high coastal population and minimized visual intrusion.

These assessments led to the selection of a reference lease area for the Demonstration project which formed the basis of the SLC lease and permit application. During the SLC application, a dialogue was opened with the Military Aviation and Installation Assurance Siting Clearinghouse (The Clearinghouse) on the specific locations for the floating offshore wind turbines. At a meeting on the 22 May, the Clearinghouse provided feedback to the original CADEMO reference locations identified were military incompatible. This led to the identification of a revised configuration that is considered by the Clearinghouse as mission compatible with mitigation.

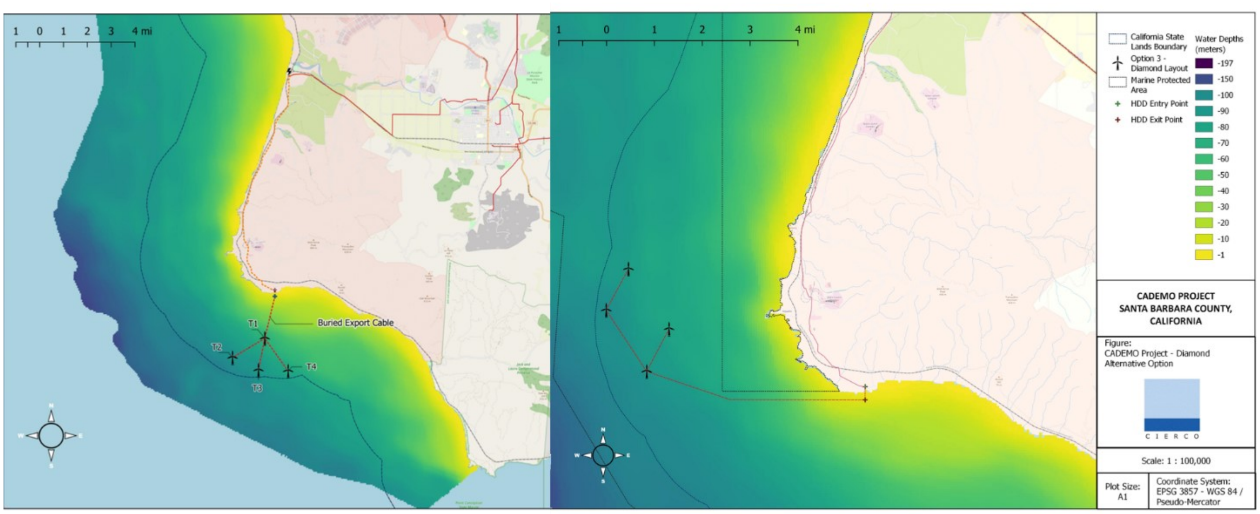


Figure 4 - Alternative Turbine Locations / Layouts Considered

1.5. Potential Benefit to the Californian State

The principal benefits associated with the Demonstration Project to the Californian State are considered to be:

- Economic and employment benefits arising directly and indirectly from the project.
- Opportunity to harness the Californian natural resource potential and mitigate the effects of climate change.
- Exploring the offshore wind opportunity to improve California grid stability.
- Establishing the project as a pathfinder for the necessary permit and authorization processes to prepare the State for large scale offshore wind development; and
- Supporting the opportunity to establish California as the world center for floating offshore wind.

(a) Potential Economic and Employment Benefits of the Project to the Californian State

Whilst the CADEMO development is relatively small scale in terms of offshore wind development and general financial investment, the establishment of the project is likely to stimulate significant economic benefits, locally, state-wide, and nationally as a precursor to larger commercial development opportunities. These can be summarized as increased investment in infrastructure, development and diversification of industry, increased income, employment, and skills (including the opportunity to transition workers in legacy industries) and reduced negative economic impacts of climate change.

The appropriate infrastructure must be put in place to support the development of the project. Port and construction facilities will be required, and a supply chain of sufficient scale will be critical in terms of manufacturing, especially during construction, and servicing during the operational life of the Development. There is the potential for new engineering and other businesses to be established which can exploit the opportunity to be gained from domestic and export markets in a nascent industry. The project is also likely to stimulate capacity strengthening measures in the form of education and training infrastructure and initiatives necessary for the provision of up-skilling and the transfer of skills required to accommodate the offshore wind industry.

The project will enable the identification and establishment of areas where new employment opportunities will support established communities, encouraging regeneration of local economies, and underpinning the sustainability of neighborhoods. Once a critical mass of offshore wind-related businesses develops in California, more investment, businesses, and labor will be attracted.

(a) Opportunity to harness the Californian natural resource potential and mitigate the effects of climate change

To combat climate change, the State of California has adopted legislation and set binding targets for reductions in carbon emissions and corresponding renewable electricity power generation targets, leading to 100 percent clean energy by 2045 under SB100, which was signed into law in 2018. The project will offset greenhouse gas emissions and help to achieve the renewable energy targets for the State (both in direct generation but also as setting the environment and processes for larger offshore wind roll out).

Offshore wind could provide a critical element to ensure the Californian State carbon emissions targets are met as part of the wider international climate change reduction commitment. This is in itself a benefit.

An industry report suggests that California's offshore renewable resource has the potential to deliver 18 Gigawatts (GW) of installed offshore wind capacity by 2045[3]. There are also indirect economic benefits in terms of avoiding the consequences of unmitigated climate change. This single project must be viewed within the context of the state, national and international drive to reduce CO2 emissions in the medium to long term, thereby stabilizing climate patterns and reducing the incidence of extreme weather events. Mitigation of climate change will therefore reduce wasteful expenditure on the emergency responses and clean-ups which are necessitated by extreme events.

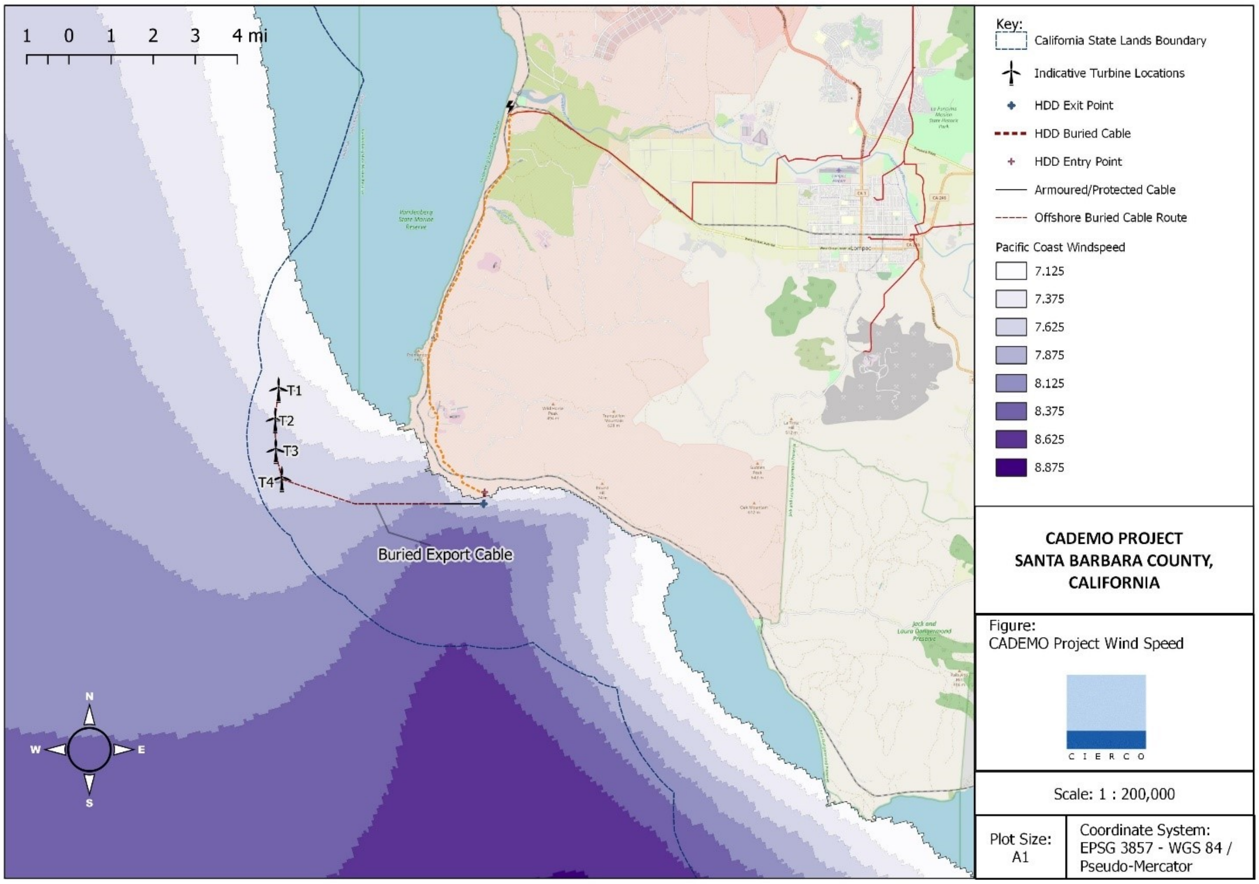


Figure 5 – Wind Power Offshore the Vandenberg AFB

The Demonstration Project itself will provide renewable electricity throughout its operational life. The number of home equivalents that can be supplied with energy generated by the Project has been calculated using the following equation:

Homes Supplied = C x 0.43 x 8760/10399

Where:

C Is the Installed Capacity of the Project, which on the base assumption of 4 x 15MW turbine is 60 MW (or 60,000 kW);

[3] The American Jobs Project (2019) "The California Offshore Wind Project: A Vision for Industry Growth" - available from: http://americanjobsproject.us/wp/wp-content/uploads/2019/02/The-California-Offshore-Wind-Project-Cited-.pdf

0.43 Is the decimalised capacity factor for CADEMO project;

8760 Is the number of hours in one year; and

10399 Is the average 2017 US household energy consumption in kW (as per the US Energy Information Administration)

Applying this equation to the project and using the assumptions above, it is estimated that the project will produce enough renewable electricity each year to meet the needs of the equivalent of over 21,700 US households (or more than sufficient to meet the household requirements of nearby Lompoc City[4]).

According to the California Energy Commission, the state currently generates about 30 GW of renewable energy and has achieved a level of 34 percent renewable resources provided by the state's utilities. Given that current generation capacity is about 45 GW and demand may continue to grow, California will need to add at least another 15 GW of clean energy generation to meet SB100's target of 100 percent clean energy sources by 2045. This energy must come from a broad range of renewable resources, and offshore wind can make a significant contribution to the mix of resources.

(c) Exploring the offshore wind opportunity to improve California Grid Stability

Offshore wind can provide value to the Californian grid by balancing solar generation. During the day, the winds off the coast of California generally blow steady, potentially providing a consistent source of electrical supply. However, more importantly, the offshore wind resource potential increases as wind speeds ramp up during the later afternoon and early evening, which will complement the State's large installed solar capacity, which fades, and then stops providing power during these times of day. The state's high solar penetration has resulted in curtailment of renewable energy and the need for other resources to supply energy when the sun sets. The evening electricity requirements are typically met by conventional fossil fuel generation. As coastal winds pick up later in the day, offshore wind turbines could deliver higher power output during peak demand periods and assist more renewable power onto the Californian grid.

The American Jobs Project report[3] states "*As California integrates more intermittent renewable sources and retires old power plants, state regulators must continue to balance fluctuating electricity supply and demand, prevent blackouts, and reduce fossil fuel dependence. There is also a long-standing debate in the state on how best to satisfy the Renewable Portfolio Standard with in-state and out-of-state resources. Growing California's in-state renewable energy generation is critical to pave the way for a secure energy future, offering another reason why offshore wind uniquely matches the state's grid stability needs*."

Establishing the project provides the potential for facilitation of offshore wind research and academic collaboration through a joint industry projects or academic program to explore, on a practical basis, the characteristics of the floating offshore wind generation to grid and its ability to integrate and balance the local electricity grid network – informing the future grid infrastructure needs and design for commercial scale offshore wind development.

[4] Number of households in Lompoc = 13,410 according to US Census Bureau June 2019; data accessed from: http://worldpopulationreview.com/us-cities/lompoc-ca-population/

(d) Establishing CADEMO as a California State Pathfinder Project

Predicting and understanding the significance of the environmental and social consequences of any novel technology deployed into the marine system, presents challenges in the measurement and prediction of environmental impacts. As offshore wind in general is relatively new to the US, and floating wind in California in particular, there has been limited opportunity to exercise the Federal, State, and local permitting processes and procedures for this new technology.

CADEMO can therefore be used as a pathfinder project to test, modify and clarify the procedures for obtaining permits and authorizations before a number of commercial applications are brought before the regulatory authorities.

In addition, the project provides the opportunity to test and demonstrate the effectiveness or otherwise of post-permitting management and monitoring measures in California. It will also be an early opportunity to understand and clarify stakeholder views on potential effects of floating offshore wind development on a smaller scale and may provide the ability to prove or disprove potential negative environmental effects prior to applications for larger commercial arrays.

(e) Supporting the opportunity to establish California as the world center for floating offshore wind

The global potential market for floating wind is significantly larger than that for fixed offshore wind due to the extent of deep waters which are suitable for floating but commercially unviable for fixed foundations. This creates a tremendous supply chain opportunity if the support and development conditions are right. Supporting the development of the CADEMO floating offshore wind demonstration project could establish the foundation stone for the floating offshore wind industry, not only in California and on the US west coast, but also worldwide.

The CADEMO project offers the first opportunity for the local Californian supply chain to enter a new market on a small-scale basis in preparation for a burgeoning industry. The floating offshore wind opportunity is a knowledge-based proposition, from design and professional consultancy opportunities to installation and operations activities, the technical and practical “know-how” gained by local Californian companies in this project will act as springboard for wider commercial deployment across the US west coast and further afield.

Table 1 provides a summary of what aspects the CADEMO project will address and provides a summary of the opportunities associated with the development of the project.

Table 1 - Need and Opportunities of the CADEMO Project

Perspective	Aspect	Issue	How it is addressed CADEMO project
Global US National California State Local	Technical	How is the project maximized to balance values and risk	CIERCO Projects Corporation (CPC) has developed this CADEMO project based on an evolution of previous CalWave and WaveConnect project proposals to one that is more suitable for floating offshore wind demonstration. The recent progression of offshore wind turbines to larger generation capacity necessitates a larger grid connection capacity than was previously required for wave demonstration projects. The previous wave projects were restricted to a capacity of 25 MW through a connection dependency to the decommissioned O&G platform Irene infrastructure. The CADEMO project has identified a more efficient and larger capacity option (which also reduces the length of the offshore electricity export cable) through a new landing and onshore connection point just south of Point Arguello. This option enables a greater capacity and the option to install 4 units of up to 15MW each. The larger grid connection potential also retains the ability to connect future wave demonstration technologies in the area should they get to the stage of being commercially and technically viable. This however would be subject to a separate application and is not within the scope of this project proposal.
Global US National California State	Technical	Currently there are no test sites in the world to demonstrate the next generation of wind turbines up to 15MW with floating foundations.	The project will offer three sites for the next generation turbine to be deployed, advancing its position and commercial status. As such, this CADEMO project could be a leading test field of its kind in the world.
Global US National California State	Technical	There are several floating platform foundation types and designs that require demonstration	The project will offer first deployment of three different designs, advancing them one step closer to commercial deployment

Perspective	Aspect	Issue	How it is addressed CADEMO project
US National California State Local	Fabrication	There is a need to establish the tooling and resources requirements for building these very large foundations in a series deployment	The first fabrication of the three different foundation designs will build understanding and quantification of three different processes and designs that will allow the scaling process to be understood better and enable planning for serial production.
Global US National California State Local	Cost of Energy (LCOE)	Cost are still high for floating foundations. The technologies need to mature, be optimized, and drive the cost down through demonstration in real environments where they will eventually be deployed commercially.	The Project will facilitate a first step in Cost of Energy reduction as it will allow for three types of floating foundations to advance through the first key step of Pilot: providing major optimization and risk reduction opportunities. This includes the opportunities to tune the wind turbine controls and behaviors to optimize the design to harmonize with the various floating designs in a real environment.
US National California State Local	DHS/DOD	Will the introduction of offshore wind inhibit military operations; or will it enhance and provide additional defense capacity/capability opportunities?	The CIERCO Projects Corporation has identified several considerable opportunities to enhance national safety, security, and wider DOD values through utilization of floating offshore wind. These opportunities relate to integrating compatible technologies into the floating structure, making fuel, water, incorporate data centers and monitoring equipment in a unique way around points of interest and bases around the world.
US National California State Local	Commercial	How do we really know what capabilities and costs are related to offshore wind?	Having three leading floating technologies and fabrication processes with detailed costs and understanding of processes (perhaps 3-5 years in advance of any commercial deployment) will allow quantification and understanding on how this can impact the California; both from a cost of energy standpoint and how it will integrate at a much larger scale into the economy. This will clarify the requirements for further refinement of planning and the investment case needed to make this happen.

Perspective	Aspect	Issue	How it is addressed CADEMO project
US National California State Local	California Employment Opportunities and development of the Supply Chain	Changes in the global economy over recent decades has seen the restriction of employment opportunities in the areas of larger scale marine fabrication, construction, and engineering in California.	Offshore wind brings considerable opportunity in employment both in fabrication and manufacturing as well as in installation and operation of floating wind plants, far beyond any other energy source considered. Whilst the development is relatively small scale in terms of offshore wind development and general financial investment, the establishment of the project is likely to stimulate significant economic benefits, locally, state-wide, and nationally as a precursor to larger commercial development opportunities. These can be summarized as increased investment in infrastructure, development and diversification of industry, increased income, employment, and skills (including the opportunity to transition workers in legacy industries) and reduced negative economic impacts of climate change. The CADEMO project will provide an opportunity to introduce a much larger base of companies to get involved in various ways in the proposition. The greatest opportunity is in the foundation building. Here each device can be up to half a soccer field in size, either as casted concrete, welded steel, or a hybrid thereof. This will result in building a competence within local companies for export opportunities.
California State Local	State environment goals	The State of California needs to reach 100% renewable energy content by 2045 and is facing a potential shortfall in its ability to generate sufficient renewable energy within the state to meet both security of supply and its 2045 aims.	Specifically, the project will generate an additional 136 GWh annually towards the 2045 goal. However, the major opportunity in establishing the CADEMO project is through the introduction of a new source of renewable generation. The knowledge, skills and infrastructure capability that will be brought by the CADEMO project has significant potential to stimulate a capability that could built out a multi GW capacity across the State of California, becoming a major contributor to reaching the 100% renewable generation goal.

Perspective	Aspect	Issue	How it is addressed CADEMO project
Global US National California State	Fabrication	Need to establish if California has the facilities, capability, and infrastructure to build floating wind platforms. The limited experience elsewhere in the world has seen floating platform units built in one country and then shipped into another country, undermining potential local benefits.	The exploration of fabrication and facilities for first fabrication of the three different foundation designs will be done locally in the area. CADEMO is committing to ensuring that the three floating technologies to be deployed on the project will be fabricated in the US (and with a preference for within California). Through the CADEMO project the three floating platform technology companies will establish their individual detailed resource needs and requirements to fabricate their component of the project. This will essentially prepare local facilities for fabrication, with the potential to advance readiness for the next stage of multiple series production to meet the eventual commercial scale offshore wind developments across the US west coast and further afield.
US National California State Local	Employment	Currently there is limited experience among local companies to build floating wind platforms, will this potential employment benefit go abroad?	The CADEMO project is committed to ensuring that the floating platforms will be built locally. This will provide employment opportunities, advance technical learning, promote advanced skills and create readiness for larger deployments. The CADEMO project also offers a basis to engage with all tiers of public authorities, schools, universities, and research organizations at an early stage of the formation of this new industry. The project will engage with companies, legislators, and State Departments to introduce learning and understand the wider opportunities in a new sector with full large-scale technologies but on a limited scaled project in advance of wider commercial roll out.
Local	Security of energy supply to the VAFB	The VAFB has an issue today of blackouts of the base, where PG&E grid network and energy usage profiles contributes to these events. The base needs a more resilient system with higher redundancy with a means to balance local variable power generation.	The project capacity of 45-60 MW and generation of some 185 to 200 GWh per year, provides a steppingstone alongside the VAFB 25MW solar facility to ensure security of supply to the local VAFB energy network. There is also the potential to introduce a battery storage option as part of the CADEMO project.

Perspective	Aspect	Issue	How it is addressed CADEMO project
Global US National California State Local	Other new renewable technologies	Will the establishment of the CADEMO project remove the opportunity to test other technologies, such as wave power in the locality? .	CIERCO Projects Corporation is very aware of the potential value of other energy technologies such as wave, tidal, water making systems, hydrogen and liquid ammonia generation for clean fuels, data centers offshore with ideal cooling, and many more. In a similar fashion to floating wind technologies, these related technologies need a place for test and demonstration. In our view, the CADEMO project potentially enhances the opportunities for testing other renewable technologies by providing the necessary infrastructure, that doesn't exist at the present, to allow testing. In fact, CIERCO Project Corporation views the CADEMO project as a potential test field where other renewable technologies could be explored as an extension to the project. By installing cabling with either 66kV or 115kV, there could be some additional capacity made available to allow this to happen.
Global US National California State Local	Research community	As a new field of renewable energy production there is a need to ensure that local educational centers can build an understanding of the technology, wider industry, and the environment that it is deployed in.	The existence of the CADEMO project as a test field will attract industry and research community from both US and Europe. The CADEMO project has the potential to become a cornerstone for accelerating and promoting educational research learning and understanding in a wide range of technical fields, such as the environment, technical engineering, socio-economic and economic values, fabrication processes, material perfection, etc.

2. PROJECT DESCRIPTION

2.1. Introduction

This section of the report presents a description of the project design and describes the activities associated with the construction, operation and maintenance (O&M), and decommissioning of the CADEMO Project. CIERCO is proposing to install 4 offshore wind turbines with a nominal capacity of between 12MW to 15MW in water depths ranging from 220 feet (67m) to 322 feet (98m), depending on the final location and layout arrangements.

The Development application is based on a ‘design envelope’ which captures the full range of potential design options and is intended to provide enough flexibility to accommodate further expected refinement in design as the Development moves through the permitting process towards construction. This section sets out the design options and parameters, for which maximum values provide a ‘realistic worst-case scenario’.

The design envelope has been informed by a range of technical and environmental constraints including the spacing requirement between the turbines and the proximity to other marine infrastructure.

2.2. Site Location

2.2.1. Offshore

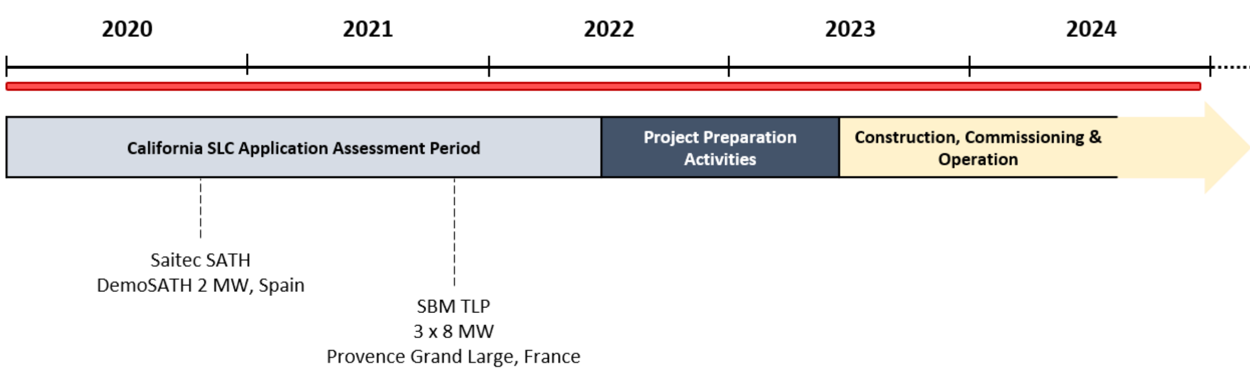
The proposed project is located to the west of Vandenberg AFB in the Pacific Ocean within California State Lands, with the turbines located approximately 2.9 miles offshore from the mean higher high-water mark.

2.2.2. Onshore

It is anticipated that the onshore substation and control building will be located near to the point of cable landfall (by the directional drill site) on the Vandenberg AFB. All required works are standard electricity network works (i.e. the same for any other conventional electrical connections) with existing facilities utilized where possible.

2.3. Project Timelines

CIERCO has reached agreement with two separate floating wind platform technology companies to develop the CADEMO project. The technologies selected (Saitec and SBM) were identified as best meeting the specific considerations of the CADEMO project. The technologies are at least at TRL 5 or above and have already been deployed offshore, or are due to be deployed, before the point of the Final Investment Decision (FID) for the CADEMO project.



3. THE TURBINE TECHNOLOGY

The turbine design is visually similar to a 'conventional' offshore wind turbine, although it is technically different (it is larger, has a higher generation capacity and has a different internal technical design). The technology represents the latest in cutting-edge turbine engineering, presents new challenges for offshore installation and operation and has not been demonstrated at this scale with floating foundations in the offshore environment before. The US turbine design consists of a three-bladed upwind horizontal axis wind turbine with a rotor diameter of up to 225 meters with a rated power of at least 12MW. The turbine rotor and nacelle are mounted on top of a tubular steel tower with a hub height of 137.5 m above Highest Astronomical Tide (HAT).

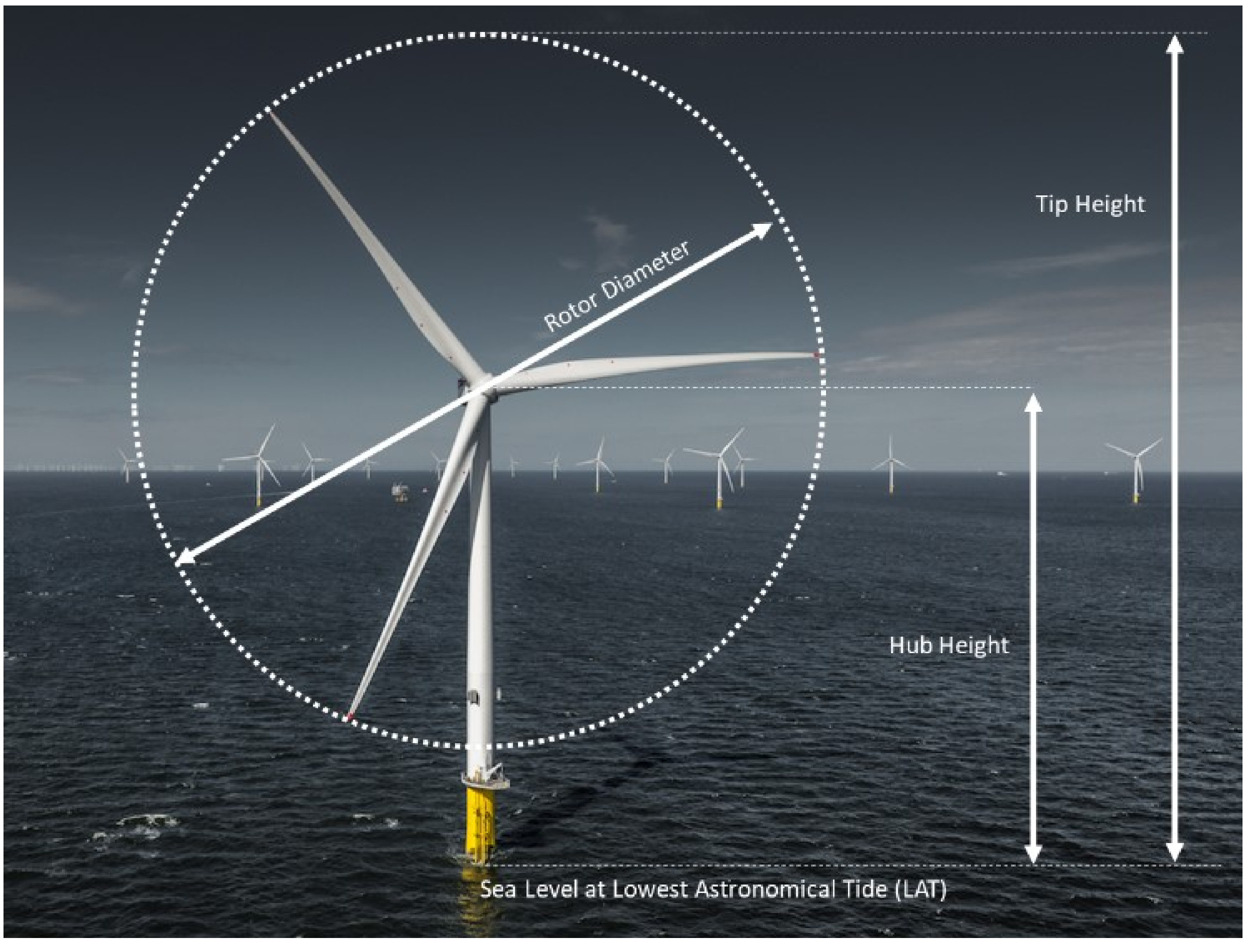


Figure 6 - Turbine Parameters

The wind turbine will employ an active yaw control (designed to steer the wind turbine with respect to the wind direction), active blade pitch control (to regulate turbine rotor speed) and a variable speed generator with a power electronic converter system. The rotor blade airfoils transition along the blade span with the thicker airfoils being located inboard towards the blade root (hub) and gradually tapering to thinner cross sections out towards the blade tip.

Key Data and Dimensions of the CADEMO Turbine	
Number of blades	3
Orientation	Upwind
Direction of Rotation	Clockwise
Rotor Diameter	225 meters
Length of blade	109.5 meters
Blade swept area	39,804 m^2
Hub height	137.5 m HAT
Tip height above HAT	250 m HAT
Blade Clearance to HAT	25 meters
Rated Capacity	12 - 15 MW
Voltage	66 kV
Converter	Full size
Structure	Tubular Steel Tower
Foundation	Floating Platform and mooring system
Design Life	25 years
O&M Access	Primary: Boat Optional: Helicopter

Table 2 - Key Technical Features of the Turbines

3.1. Turbine Appearance and Markings

During operation of the development it is proposed that the wind turbines will be marked as follows:

- The bottom end of the structure will be painted yellow (RAL 1004 Golden Yellow) from the level of Highest Astronomical Tide (HAT) up to 15 meters.
- Above 15m the structure, turbine and blades will be painted grey (RAL 7035 Light Submarine Grey)
- Each turbine will have a unique identification (ID) number, which can be seen by both vessels at sea level and aircraft from above.
- Each turbine will display identification panels with black letters and numbers on a yellow background visible in all directions. The ID numbers will each be illuminated by a low-intensity light visible from a vessel thus enabling the structure to be detected at a suitable distance to avoid a collision with it. The size of the ID characters in combination with the lighting will be such that, under normal conditions of visibility and all known tidal conditions, they are clearly readable by an observer stations 3 meters above sea level and at a distance of not less than 150m from the structure.
- The ID panels will be placed on the wind turbine structure 15m above HAT to provide adequate visual coverage and can therefore be read from all directions.
- Subject to agreement with the Federal Aviation Administration and the US Department of Defense, CIERCO propose that each turbine is fitted with a single 200 candela red aviation hazard light, with fixed illumination (i.e. not flashing) on the top of the nacelle. During routine operations (i.e. no search and rescue (SAR) operations in or around the turbines) this light shall be switched on.

CIERCO do not intend to install any other permanent structures apart from the proposed wind turbines. The final marking and lighting plan (LMP) will be agreed with the local port authorities and US Coastguard prior to construction. As part of the process, CIERCO will also consult on the details of the LMP with the State Lands Commission, the California Coastal Commission, BOEM, the US Coast Guard, the Department of Defense, U.S. Department of Fish and Wildlife, California Department of Fish and Wildlife, and other local stakeholders.

4. FLOATING FOUNDATION TECHNOLOGIES

The CADEMO project has chosen to deploy two differing floating platform technologies utilizing, for the first time, a 12MW or greater turbine. The technologies, illustrated below, are:

1) A floating barge utilizing a single point mooring (SPM) arrangement.

2) A Tension-Leg Platform (TLP) utilizing a three tensioned bundle mooring system.

The combination of the two design concepts will demonstrate different design principles with two differing fabrication processes. Whilst each platform has a different mooring system, the general installation and connection process are very similar. A generic description of each class is provided within this section.

4.1. The SATH Floating Barge

The SATH Floating Barge is a twin hull (two cylindrical horizontal floating elements made of longitudinal reinforced concrete), ship-shaped floating barge type. The platform stability is achieved by the hull intersection of a large area with the water plane surface. On installation, the platform is connected to a single point mooring turret which allows the platform to free weathervane, being co-directional with the wind direction.

4.1.1. The SATH Floating Structure

The hulls are two identical horizontal cylinder elements with ovoidal cross section closed at their ends with conical shells or folded plates. The floaters are shell structures of reinforced and post-tensioned concrete. In the longitudinal direction, there are 2 horizontal beams integrated into the floaters on the upper and on the lower edge respectively. These beams transmit and distribute the longitudinal loads applied on its ends to the cylindrical shells.

Table 3 - Dimensions of the SATH Floating Barge

General Dimensions of a SATH System Floating Barge	
Material	Concrete / Steel
Hull Height (m)	16 meters
Draft (m)	9.5 meters
Length (m)	105 meters
Width (m)	50 meters

In order to obtain suitable natural periods in pitch and roll oscillations and a good response in terms of motions of the structure, the floating elements are attached to flat and horizontal panels arranged submerged in the lower area of the platform. These elements are made of solid slabs lightened with a ribbed structure.

Figure 7 - SATH Floating Barge Technology General Layout

Reinforced concrete will be used in the whole structure, as well as longitudinal pre-stressed concrete in some of the elements, e.g. cylinder floaters and beam frames. Pre-stressed concrete is used as it does not pose fatigue issues and has excellent response under marine conditions.

4.1.2. The SATH Mooring Arrangement

The mooring system used for one of the candidate floating platform design is based on a "Single point mooring" (SPM) system. The SPM consists of a turret assembly that is integrated into the vessel through beam frames and permanently fixed to the seabed by means of six mooring lines.

SATH Mooring System Design	
Configuration	Catenary
Material	Chain / Synthetic rope combination
Mooring Line Length	Dependent on Water Depth - circa 1000 meters
Number of Mooring Lines	6
Anchor Type	Drag Embedment Anchors

The turret system contains a bearing system that allows the floating platform to rotate around the fixed geostatic part of the turret, which is attached to the mooring system. Allowing the floating platform weathervane until its principal axis is self-aligned to the wind direction offers a flexibility for a wide range of met ocean conditions, optimizing the loads on the platform and the mooring system. The rotating electrical connection is made via a swivel or slip ring that allows the transmission of power from the stationary (moored part) to the rotating platform. This arrangement is commonly used in the turret elements of Floating Production Storage and Offloading (FPSO) units in the oil and gas industry.

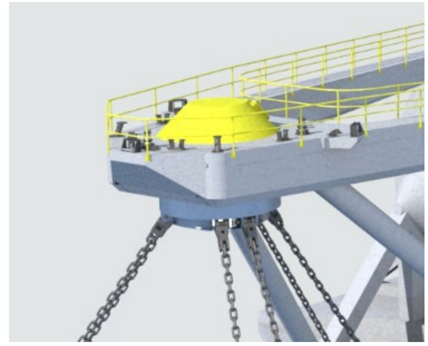


Figure 8 - The SPM Connection

The SPM configuration allows for an easy plug-in and plug-out of the platform to the electric grid since all the operation shall be done at the deck of a vessel.

The station keeping system for the SATH technology will be designed for the CADEMO Project location and the wind turbine capacity. The mooring system design will withstand the loads generated from the environmental conditions (wave, wind, currents, water level variation, etc.) and the ones induced by the wind turbine and will address the following forces:

- Steady forces: constant thrust (wind turbine) & mean drift force (wave spectrum)
- Dynamic forces: turbulent forces from the wind; dynamic loads from the waves; slow drift motions.

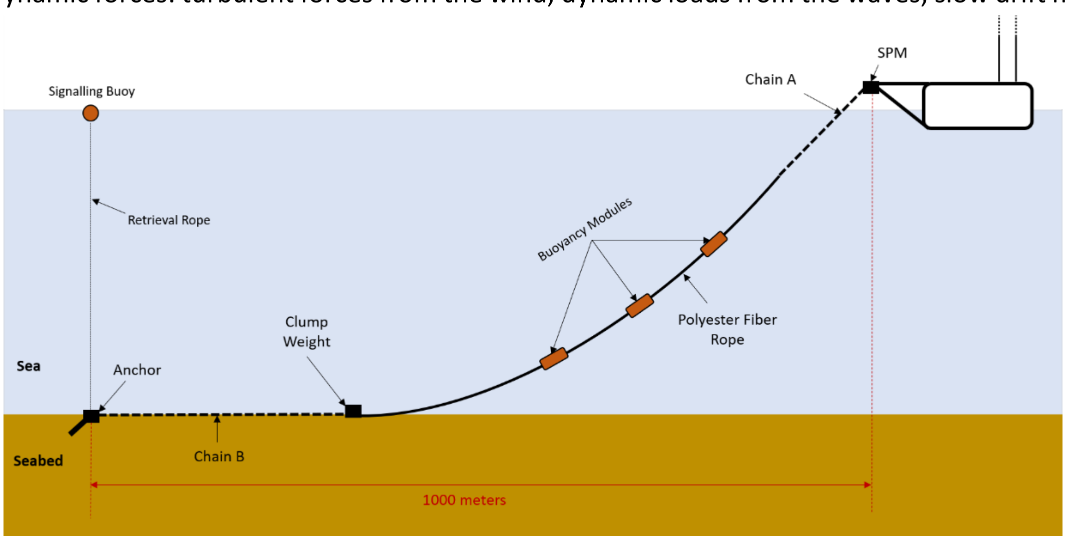


Figure 9 - The Single Point Mooring (SPM) Line Scheme

Further to confirmation of acceptance of the application by the State Lands Commission, a mooring system detailed design will be delivered that will identify the most optimum solution for each mooring line to satisfy the requirements imposed by the acting loads in all possible scenarios, the installation requirements and the total cost.

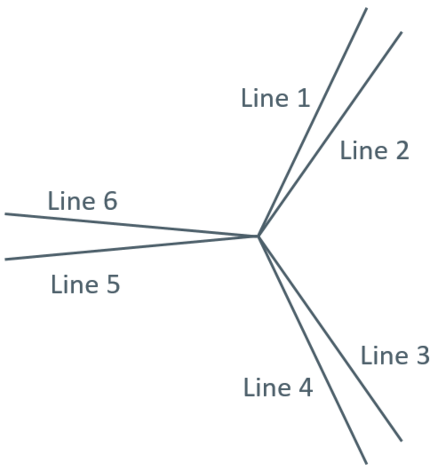


Figure 10 - SPM Mooring System Layout

In general, the SPM mooring system configuration consists of 6 lines deployed as shown opposite. This configuration ensures that the system will resist the environmental conditions within the 360º mooring circle. A Lazy Wave configuration incorporating a dynamic cable system to address the requirements of water depth, excursions of the system and loads on the mooring system. An example of the configuration is shown in Figures 4 and 7. Each mooring line is made of a first stretch of chain, a stretch of dynamic cable, a clump weight, a second stretch of chain, an anchor and all the necessary connectors to join the different elements and 3 buoys.

The only elements in contact with the seabed are the clump weight, the chain B and the anchor. A distributed clump weight will be used along the seabed over chain B, which is 100 meters long with a total width of 0.167m.

4.1.3. The SPM Electrical Connection

The connection point for the SATH mooring platform will be at the turret of platform as can be seen in Figure 6. It allows an easy plug-in and plug-out of the platform to the electric grid as all operations will be done at the deck of a vessel.

Figure 11 - Electrical Cable Connection to a Single Point Mooring

Once the mooring system is installed, the dynamic inter array cable will be connected to the platform. A service vessel will pick-up the pre-laid cable, that is attached to a signaling buoy, and will tie its pulling head to the rope of a winch that is located inside the turret. The cable will be pulled by the winch through a pull-in cone and will be fixed with a hang-off device.

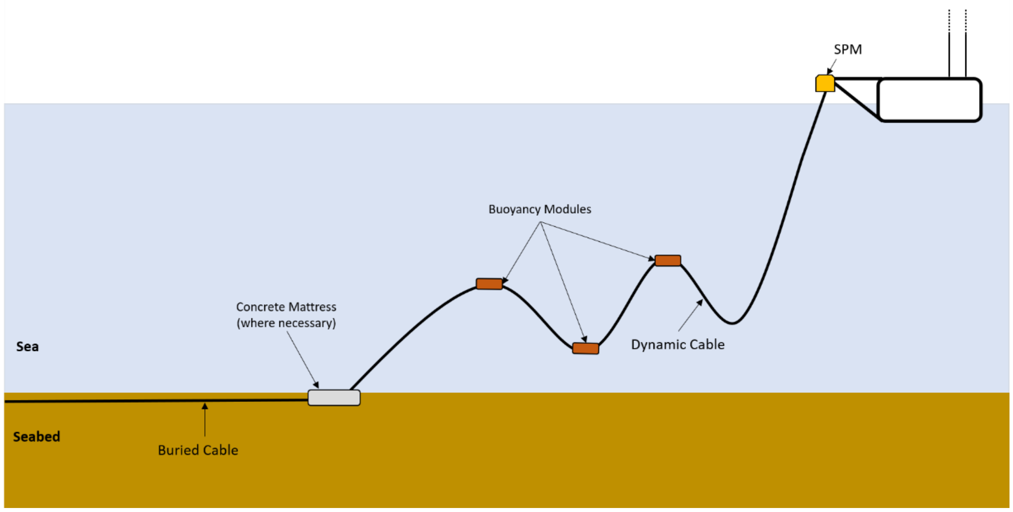


Figure 12 - Electrical Dynamic Export Cable Arrangement for the SPM Floating Technology

4.2. The SBM Tension-Leg Platform Technology

The Tension-Leg Platform (TLP) is a triangular lightweight floater made of steel. In operational conditions, most of the structure is submerged well below the sea surface, thus avoiding the action of waves.

The mooring arrangement is similar to conventional offshore applications with chain and wire components and the installation is also conventional and uses pulling means. In addition, the inclination of the mooring legs creates a fixed point at a location close to the nacelle, enabling outstanding performance in terms of horizontal motions (relative wind velocity, nacelle acceleration) and inclinations. This TLP concept offers a reduced tower base moment due to the low operational angles and to the behaviour whereby the floater inclines towards the wind in operation, leading to the moment due to nacelle weight counteracting the wind moment.

Figure 13 - The SBM Offshore Floating Wind Technology

4.2.1. The TLP Floating Structure

The Floating Submersible Structure (FSS) is an assembly of four buoyancy modules and a bracing system that links them together and connects them to the transition piece, which serves as interface with the WTG.

Table 4 - Dimensions of the TLP

General Dimensions of the Tension-Leg Platform	
Material	Steel
Length (m)	85 meters
Width (m)	72 meters
Height (m)	45 – 49 meters
Draft (m) during construction	<10 meters
Draft (m) during operation	30 meters

The central buoy function is to bear the weight of the WTG, while serving as central node for the bracing that extends to the three side buoyancy modules. The three side buoys modules play a role during both towing and operational configurations. During the towing phase, the floater floats onto the side modules which generate hydrostatic restoring, thus giving stability in roll and pitch. During operation, the floater is submerged and the side buoys they generate the required pretension in the mooring legs. Each side buoyancy module consists of two side cans linked together by a structural node. Such structural node also connects to the bracing system and the mooring bundles. The balance of buoyancy distribution between the buoys and bracing is conceived to optimize stress distribution in the structure and hence reduce the weight (and cost) of the system. Buoyancies structure is a closed cylinder built on the stiffened shell principle. The top and bottom plates and the rolled cylindrical side shell are designed to bear the pressure exerted by the static water column and the design wave loading. Their arrangement is optimized to minimize the necessary weight.

Figure 14 - TLP General Layout

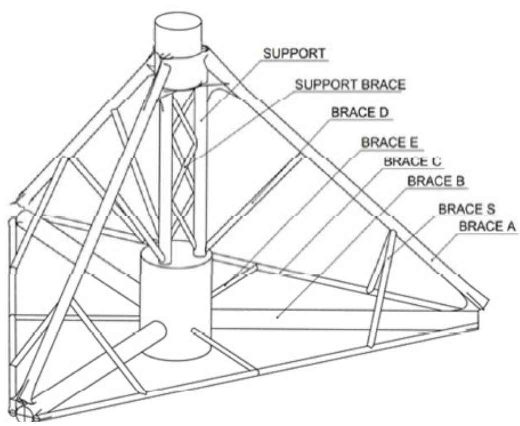


Figure 15 - The TLP Bracing System

The bracing system links the buoys and the transition piece together, while keeping the wave loading at minimal level. The bracing are sub-divided in primary and secondary. The primary system – braces A, B, C and central column – is designed to transfer the loads from the WTG to the moorings, whereas the secondary bracing stabilizes the load sharing, limits the buckling length of the primary system and provides the sufficient stiffness to the assembly.

The transition piece acts as interface between the structure and the WTG. It is connected at the top of the floater, linking the central column to the A-braces to ensure a smooth load sharing between the two bracing sections. At the top, a machined flange serves as interface onto which the WTG is secured by means of pre-stressed bolts, following WTG supplier requirements.

4.2.2. The TLP mooring arrangement

The mooring arrangement is composed of three tensioned bundles, each of them linking one anchor to one pair of the floater side buoys. Each line is composed of a double articulated uni-joint, a wire rope segment, a chain tail and a double articulated chain connector. Wire rope replaces standard chain in the active part of the leg for its lighter weight, thus avoiding the slackening of lines in harsh environment.

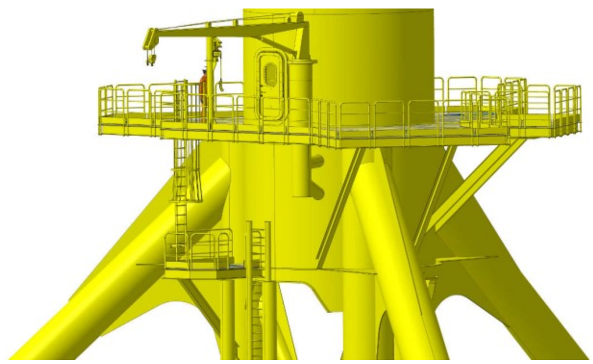


Figure 16 - The TLP Transition Piece

Two lines connect each leg to its anchor via a single-articulated yoke plate, sharing efficiently the overall bundle pretension between the two lines. Such arrangement allows a low usage factor in extreme conditions and an optimization of the tension fatigue in the mooring system. The final robustness of the mooring is therefore enhanced, thanks to the full redundancy of the mooring lines per bundle. An additional advantage of such arrangement if that top and bottom lever arms, together with the top and bottom double articulations, control the out-of-plane bending fatigue of the chain links. Finally, the TLP technology has a very limited footprint on the seabed, eliminating major constraints in the definition of the wind farm required area while reducing the final environmental impact and facilitating other marine activities in the area.

The TLP type floater has no restriction in terms of soil properties. The anchors used as part of the mooring system can be designed and installed in any type of soils. Depending on the soil characteristics, suction pile, driven pile, grouted pile or hybrid suction/gravity anchors could be used.

Tension-Leg Platform Mooring System Design	
Configuration	Taut
Material	Chain - Steel Wire Rope combination
Mooring Line Length	Approx. equal to the Water Depth
Number of Mooring Lines	6
Anchor Type	Dependant of the soil

4.2.3. The TLP electrical connection

The inter array cable will access the floating platform via a J-Tube along the central tower and enter the transition piece where the hang-off equipment are located. Thanks to the limited floater offset, it can be envisaged to consider a simple catenary configuration for the inter-array cables and avoid lazy-wave configuration and associated buoyancy modules. This shall be further studied with cable data and specific environmental conditions.

4.3. Electricity Export Cable

Export cables will transmit electricity from the center turbine (T2) to an onshore connection point. The preferred option for the CADEMO Project is to take the export cables to a landing point west of the boat dock (just south of Point Arguello) and then connected overland (by wood pole) to the grid substation. Each turbine will deliver electricity at 66kV through a dedicated cable connecting to the center wind turbine (turbine 2). At turbine 2 platform, all three turbine cables at 66kV will be joined for an offshore export cable to shore. A high-level electrical connection diagram is provided in Figure 19.

In the diagram, an option of transforming the 66kV voltage to 115kV offshore is described as D2 (on the bottom right). An onshore option is also provided in the diagram (on the left), which is the base case.

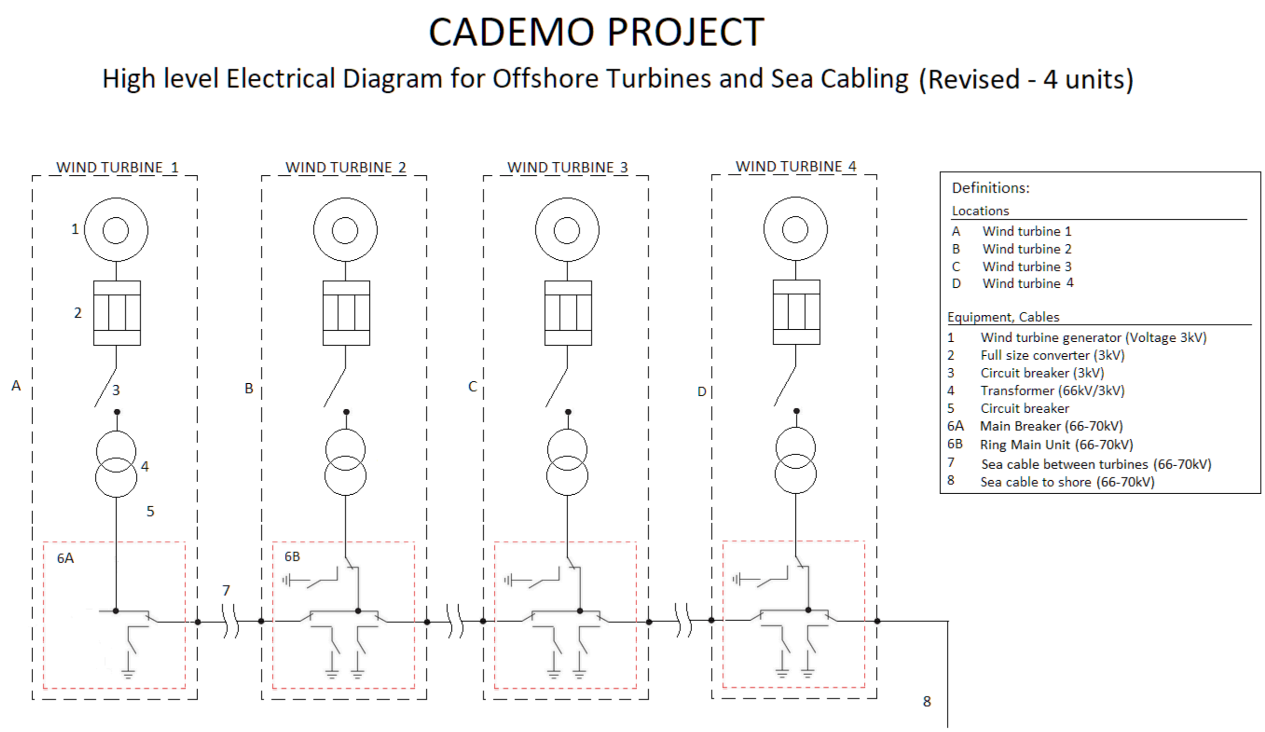


Figure 17 - High Level Offshore Electrical Diagram

The sea cable connection to shore will be circa 4.7 miles in length (circa 4 nautical miles). The cables will be buried in either single cable trench to a target depth of 1.0 – 1.5m. Depending on seabed material, there may be some sections of the cable route where the cables will need to be laid on the seabed and protected by a suitable method (such as concrete matressing or rock dump).

A 20 mm^2 fiber optic communications cable will run alongside the power cables to link each wind turbine to the SCADA system.

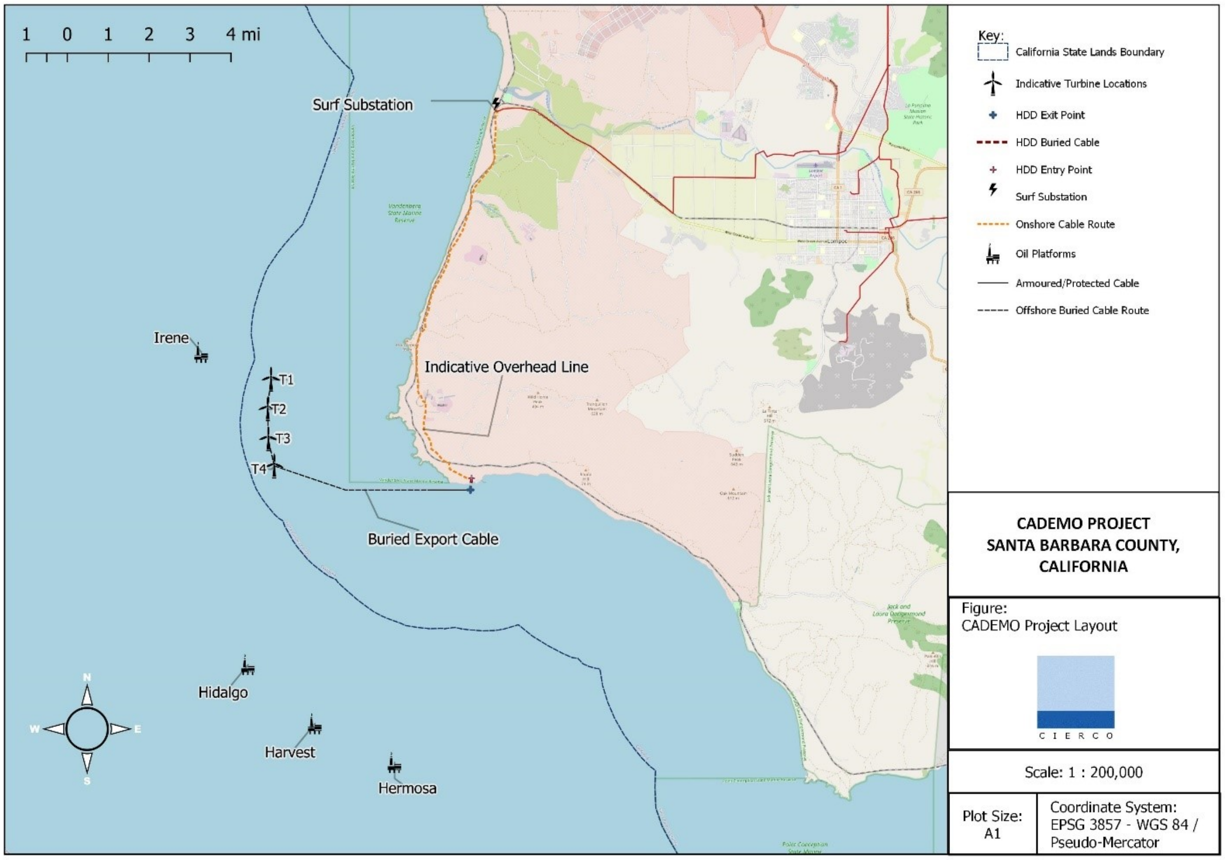


Figure 18 - Electrical Connection - Direct to Vandenberg AFB

5. CONSTRUCTION AND INSTALLATION METHODS

Construction of the offshore floating turbines will take place over a 6 to 9-month period, after which the turbines will undergo testing and commissioning. The Development will be operational for a period of 25 years from final commissioning.

An indicative schedule of activities is shown in table 5 below. The main construction phases and likely sequence (with overlap between phases) are as follows:

- Onshore site preparation for foundation construction.
- Assembly of the turbines and foundation platform and sail out to site.
- Installation of the floating wind turbines.
- Concurrent offshore site preparation and installation of electricity inter array and export cables.
- Commissioning and energy export.

The installation sequence is anticipated as provided in the table below; however, the final construction methods will be determined after detailed design is completed and provided to the State Lands Commission prior to commencement of the construction.

Offshore installation Activity	2024									
	J	F	M	A	M	J	J	A	S	O
Preparation work (onshore)										

Offshore installation Activity	2024									
	J	F	M	A	M	J	J	A	S	O
Turbine and Foundation Construction										
Export Cable installation										
Floating Turbine installation										
Commissioning										

Table 5 - Indicative Offshore Installation Program

5.1. Assembly and Preparation

As the turbine and floating platforms to be deployed offshore Vandenberg AFB are demonstration units, it is anticipated that they will be of a bespoke design and manufacture. The completed turbines, which will be supplied by a US turbine manufacturer, will be readied for assembly and then transported by road/rail/sea to a central assembly facility (most likely at a Port with sufficient infrastructure on the Californian coast) that has direct access to waterways suitable for onward transportation to the installation site.

As far as is practicable the components of the turbine will be delivered to the assembly site as pre-tested modules. The assembly of the turbines will be carried out in a predetermined sequential manner by a suitably qualified and experienced (SQEP'ed) contractor. Prior to shipping, systems will be commissioned and tested as much as practical, to de-risk offshore activities and minimize commissioning time.

In a similar fashion it is anticipated that the fabrication and production of the floating foundation system will be undertaken by a Californian fabrication contractor to an approved design specification. The contract will include the fabrication, testing and inspection of the main structure, access systems (including the boat landing system), all secondary steel, cable channels and necessary ancillary items. Once fabricated and painted, the completed structure will be transported to the deployment location.

5.1.1. Pre-Installation Activities

Before the turbine and cables are installed, preparations works will be undertaken as follows:

(a) An Unexploded Ordnance (UXO) survey

A UXO survey along the route will be undertaken and the results supplied to State Lands Commission prior to the commencement of installation activities. These surveys will be used for identifying potential obstructions from the route, such as boulders and fishing debris.

(b) Pre-lay Grapnel Run

Dependent on a review of site data, a pre-lay grapnel run will be undertaken along the export cable route to confirm the complete clearance of any abandoned fishing equipment or other debris. This will be undertaken by a fishing vessel or similar vessel deemed suitable for the task.

(c) Boulder Clearance

Where boulders are present within the cable route, a boulder clearance campaign will be undertaken using a dedicated boulder grab to pick up larger boulders (>30 cm) and moving them approximately 15 meters perpendicular to the cable route. No boulders will be removed from site during this operation.

(d) Onshore Cable Duct Installation

The inter-tidal/shore approach section of the cable route will use a duct to protect the electricity export cables, circa 1200m in length. The cable will make landfall a minimum of 50 m landward of the extreme high-water mark and will be located in a transition pit. The duct will be buried wherever possible and externally protected with rock bags or concrete mattress. The duct will be made from High Density Polyethylene (HDPE) material with a design life of 50 years.

A cable duct will be installed by Horizontal Directional Drill (HDD) onshore at the Vandenberg AFB with an exit point below the extreme low water mark. The precise plan for this arrangement will be finalized on completion of the offshore cable route survey and location of the onshore jointing pit to ensure there is a straight run from onshore to offshore for a simple pull-in.

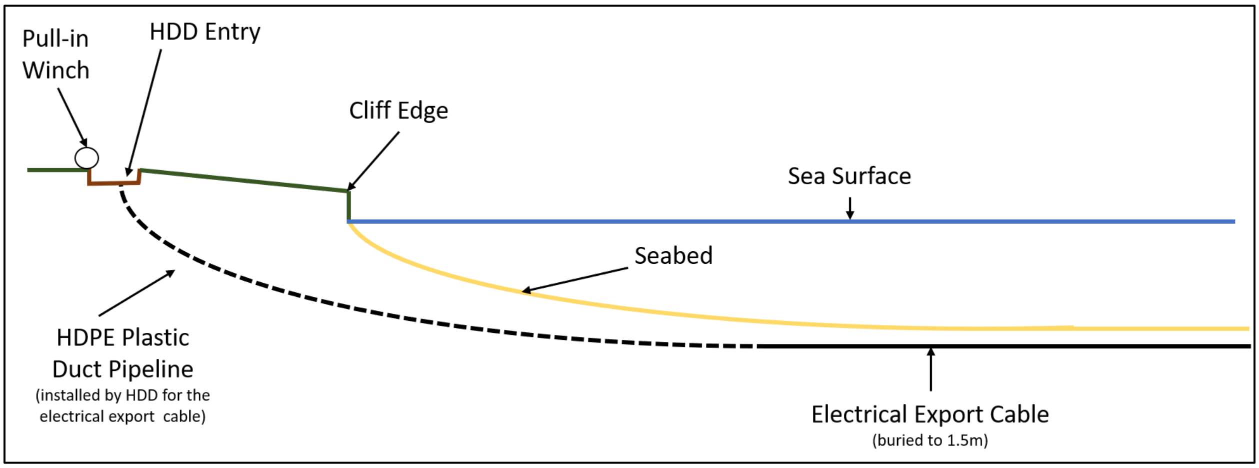


Figure 19 - Cable Landfall Cross Section

At installation, the cable will be supplied with suitable wire sock cable grips which will facilitate the pull-in operations to shore and for the turbine. The cable grip will be connected to messenger wires at the foreshore (secured in position by an anchor plate at the junction pit) and at each turbine for pull-in operations. After the securing of the cable end onshore, the cable is then paid out to the seabed from the cable lay vessel.

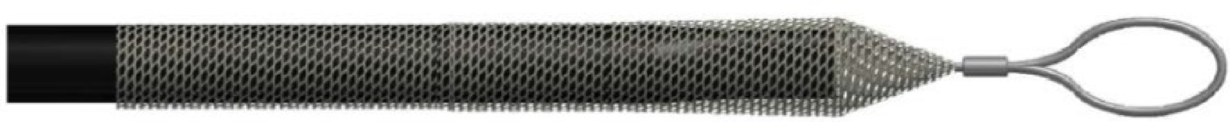


Figure 20 - Cable Grip arrangement for the Cable Pull

At the initial installation and shore pull stage of the operation, the vessel will set-up as close to shore as feasible, ideally during highest tide to maximize the working depth. The messenger wire (attached to a winch onshore) will be towed out to the cable lay vessel by a RIB (rigid-hulled inflatable boat) and then connected to the first end of the cable. The cable will be over-boarded over the vessel chute and pulled into the beach using floats or roller stands as required.

A secondary vessel may also assist in supporting the cable in the shallower water depths and feeding the cable into the shore approach section. The cable will be pulled through the installed duct to the beach area and secured in the jointing pit allowing the lay vessel to move off and commence lay of the remainder of the cable to the turbine.

5.1.2. Electrical Cable Installation Activities

The final detailed location of the turbines and route of the export cables from each turbine will be based following geophysical, geotechnical, and benthic surveys. However, to aid identification of the key issues, indicative locations and cables routes, based on best estimates, have been identified. The cable route trenching, duct installation and cable installation activities are scheduled to be undertaken over a period of 7 to 14 days.

Following removal of boulders that have the potential to prohibit cable laying and burial, the cable installation will be undertaken by a dedicated cable laying vessel (CLV), supported by a Remotely Operated Vehicle (ROV). The CLV is designed to perform all the activities related to the laying of the electrical cables. (e.g. load at the cable manufacturer, storage in carousels, burial the cable into seabed and others). The CLV will perform a pre-lay survey as part of the cable installations, this will be done after the vessel is loaded and has arrived at site to ensure no changes that will affect the cable installation has occurred since the previous surveys. An ROV will be used to carry out the pre-lay survey. The cable will be installed by utilising a cable plough or trenching tool (either mechanical cutting or jetting depending on the seabed material encountered). The cable will be laid within the trench and then buried to the required depth. Post cable lay surveys will be undertaken to ensure that no unintentional berm formation has occurred due to the potential build-up of seabed material caused by the trenching and cable lay operations. Should any unintentional berm be identified it will be removed using standard marine operations.

Method 1 – Jet Trenching

Jet trenching burial operations is the preferred method for cable burying for the CADEMO project, where the soil conditions allow, as it offers the lowest risk of cable damage. The jetting burial option is carried out by a tracked trenching machine (a remote operated vehicle), which will bury the cable to a target depth of 1.5m by use of water jetting. This technique, which is suited for areas where the seabed material can be fluidised (such as areas of sand and clays), also minimises seabed disturbance. It may be the case that cable burial by jet-trenching is considered the most reliable and cost-effective form of cable protection. When seabed conditions are suitable it is also a relatively efficient process of installation.

Jet trenching ROVs use nozzles mounted on jet swords to inject water at high pressure into the soil surrounding the cable which fluidises the seabed in the immediate vicinity allowing the cable to sink under its own weight, before the soil resettles over the top. To maximise post-trenching cable cover and to minimise the disturbance of sediment away from the trench, site specific trencher settings will be derived based on the soil conditions to ensure disturbed sediment is monitored and managed efficiently throughout operations. The jet trenching technique allows the cable route width to be narrowed to about 300-400mm between the jetting swords (as opposed to 3 meters using the ploughing method). In areas where jet-trenching may not be possible due to the presence of stiff sediments a hybrid tool capable of both chain cutting and jet trenching will be used.

Following the first trenching pass depressor depth data will be evaluated to determine whether the target burial depth has been reached. If necessary, a second trenching pass will be completed in either jetting or cutting mode of the hybrid tool to ensure the cable is adequately buried.


Figure 21 - A Jet Trenching ROV (DEME trenching Tool CBT1100)

Method 2 – Ploughing

A common electrical burial method in offshore wind farms is by use of a subsea cable plough which is towed on the seabed behind the CLV (or by a ROV as a separate activity). Ploughing involves the CLV surface laying the electrical export cable in a single pass from the HDD exit point to the central collecting turbine. As the cable is laid it is passed through the plough and is buried into the seabed. The plough lifts a wedge of sediment so that the cable can be inserted below, thus minimising seabed disturbance to a very narrow corridor. Burial speed depends on cable type and seabed conditions but for an armoured cable, the burial speed is typically 0.2 km/hr.

Figure 22 - A Cable Plough

Following plough burial, a post lay burial and inspection is normally carried out in areas where the plough could not bury.

Alternatives to Cable Burying

Cable burial is the preferred method of cable protection as it largely protects against bottom-contact fishing activity as well as vessel anchorages. However, burial may not be achievable along the entire length of the cable route due to the sediment depth. If the minimum depth of burial of the cable cannot be achieved, protection of the cables will be provided in the form of rock placement. Rock placement is carried out under highly controlled conditions to place a layer of rock over the cable at the pipeline crossing location, to add a final protection layer. The created rock berm is designed to minimise risk to fishing gear by specific selection of rock size and berm side slopes. Rock placement is considered the best and most effective means for the protection of submarine power cables.

There may be specific areas where consideration of the following cable protection measure may be utilised in localised areas, where it may be appropriate.:

- **articulated ducting / armoured cable** (a manufactured product that provides a protection ‘sleeve’ around the cable to protect it from abrasion, environmental conditions and provides it with impact resistance),

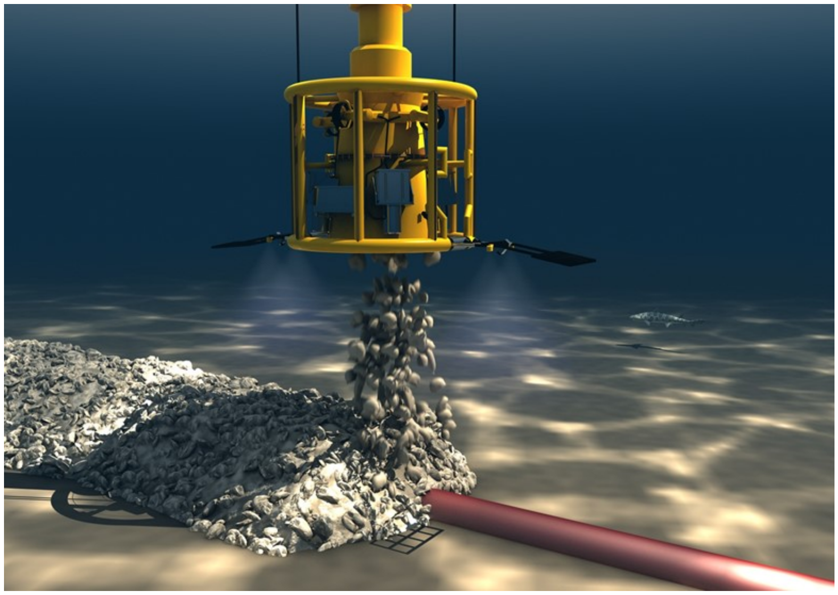
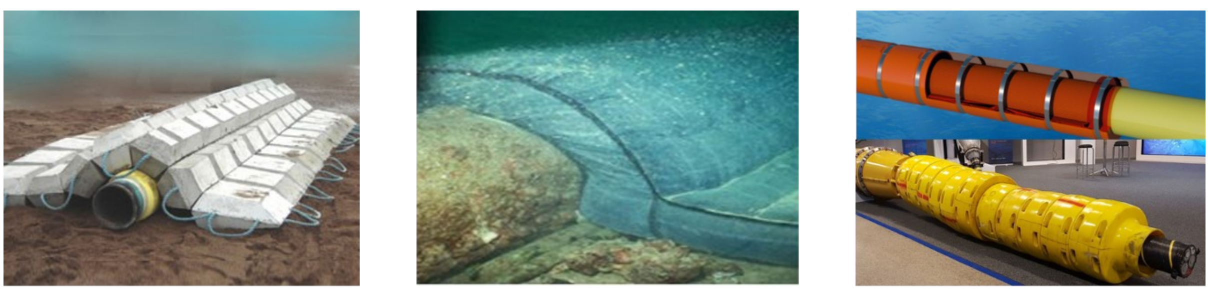


Figure 23 - Illustration of rock placement over a cable

- **grout bags** (bags of hardened gravel, sand / cement grout or concrete placed over the cable), or
- **concrete mattresses** (pre-formed articulate mattresses comprising a mesh of concrete block that are placed across cables)



Concrete Mattress | Grout Bag | Articulated Ducting / Armoured Cable

Figure 24 - Examples of Cable Protection Systems

Based on sediment depth data gathered around the area by the US Geological Survey during the period of 2008 to 2012, it is estimated that cable protection measures will be required from the HDD exit hole out a distance approximately between 0.36 to 0.4 miles (645-704 yards / 590-691 metres) before a suitable sediment depth is reached to allow cable burial at 1.5m.

Areas, where the protection measures provided above may be used, will be identified following a cable burial risk assessment (Carbon Trust Cable Burial Risk Assessment, 2015) as part of the detailed cable design process prior to installation activities. Alteration of hard substrates is not proposed.

5.1.3. The inter-turbine electrical cables

The inter-array cables (i.e. the cables linking the turbines) will be installed to form a 'string' from each turbine to a central collecting turbine. It is intended that the inter-array cables will be maintained within the anchor patterns proposed between turbines, and as such are not planned to be trenched/buried, unless required for physical stabilisation on the seabed. However, to provide a worst-case scenario, an allowance is given to burial of the inter-array cables between each turbine.

Figure 25 - The Inter-array cables

The installation is similar to that of other fixed base wind farms with the only difference in the inter array cables strings, that have one section of dynamic cable at each end to connect with the floating platforms. These cables sections are continuously subjected to bending and twisting forces caused by the currents and floating platform motions and require an appropriate mechanical strength that is provided by a wire armour reinforcement that surrounds its core (bend stiffeners).

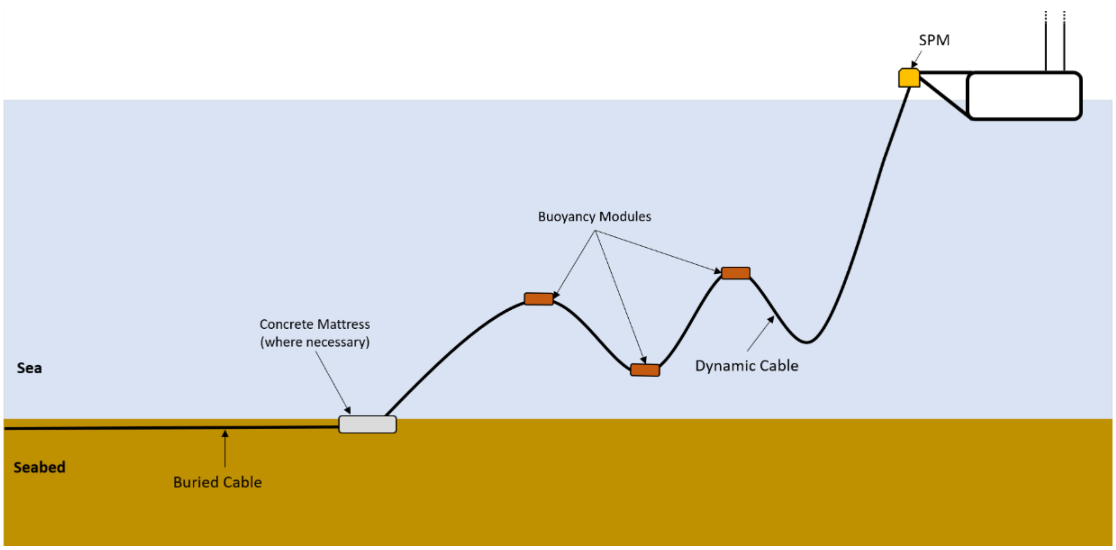


Figure 26 - Illustration of the Lazy Wave Dynamic Electrical Cable Configuration

The dynamic cables also use distributed buoyancy modules and clump weights to obtain Lazy Wave shapes with a higher flexibility to avoid over-stressing. The touchdown part of the dynamic cable is provided with a special protection cover.

The installation of the offshore floating turbines will require an AHV, supported by a tug and auxiliary support Vessel. It is anticipated that the actual hook-up operation for each floating platform will take around half a day (6 hours, weather exclusive), with remainder of the day involving hooking up the floating platform to the electricity export cable.

Depending on ground conditions, the 66kV electricity export cable will be buried to a target depth of 1.5m. Due to local seabed conditions this burial depth may be exceeded and in some areas not achieved (therefore a “target” burial depth).

5.1.4. Burial dimensions of the Export Cable

As stated previously the electricity export cables will be buried to a target depth of 1.5m. Under a worst-case scenario (i.e. 3m wide, 1.5m trench and burial of all inter-array cables), the estimate of seabed disturbance is as follow s:

Table 6 - Cable Burial Parameters

Cable	Width	Depth	Length	Displaced Materials	Surface Area
1	3 m 3.28 yd	1.5 m 1.64 yd	6,366 m 6,961 yd	28,647 m^3 34,244 yd^3	19,098 m^2 22,832 yd^2
2	3 m 3.28 yd	1.5 m 1.64 yd	1,094 m 1,196 yd	4,923 m^3 5,885 yd^3	3,282 m^2 3,923 yd^2
3	3 m 3.28 yd	1.5 m 1.64 yd	1,174 m 1,284 yd	5,283 m^3 6,315 yd^3	3,522 m^2 3,851 yd^2
4	3 m 3.28 yd	1.5 m 1.64 yd	1,160 m 1,269 yd	5,220 m^3 6,240 yd^3	3,480 m^2 3,805 yd^2
Total			**9,794 m** **10,710 yd**	**44,073 m^3** **52,684 yd^3**	**29,382 m^2** **34,411 yd^2**

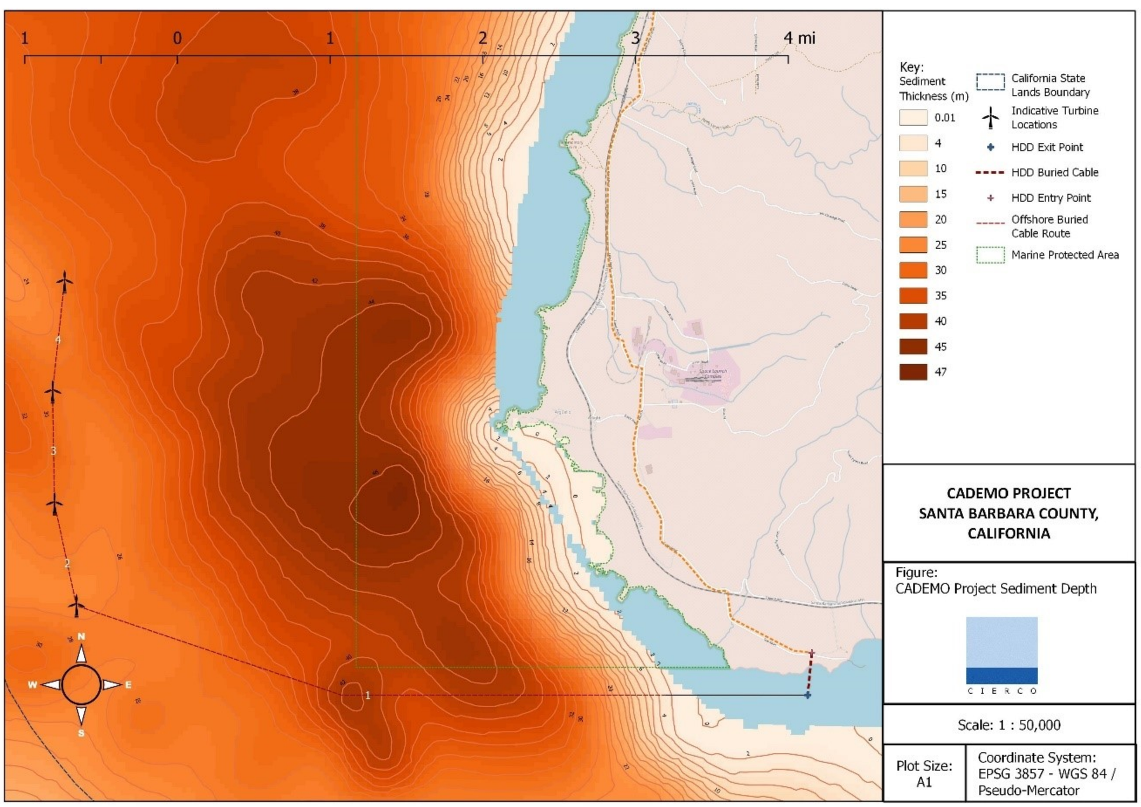


Figure 27 - Sediment Depths and Export Cable Route

5.1.5. Best Management Practices for minimizing turbidity during excavation activities

Generally subsea cable installation has the potential to create seabed disturbance with an associated increased in turbidity during the construction period. Although the CADEMO project is relatively restricted in its spatial extent, it has incorporated advice from the OSPAR Commission Guidelines on Best Environmental Practice (BEP) in Cable Laying and Operation[5], to ensure the following environmental control measures and strategies have been built into the cable layout design to minimize the risk of turbidity during constriction:

- The turbines connect to one another to string a single export cable back to shore (as opposed to a single cable from each turbine back to shore),
- The route is the shortest possible cable route distance back to shore,
- The route selected does not pose a risk of crossing with existing cables and pipelines,
- The CADEMO project has selected installation techniques which minimize seabed disturbance and contain the excavation corridor to 3m,
- The cable area is designed to avoid sensitive habitats (e.g. protected marine reserves) and has provided an appropriate buffer protect sensitive areas from accretion of suspended sediment,
- A project construction schedule will be developed to avoid sediment disturbance during sensitive life stages (e.g. migration and spawning) of sensitive fish and shellfish species present in the area.

To date the available information has not indicated the presence of any sensitive species along the cable corridor route, however should the CADEMO project receive the appropriate lease and permits, the route corridor will undergo an appropriate level of sites investigation and cable burial risk assessment to ensure that the optimal burial methods (from the techniques described previously) are selected for the cable installation activities.

5.1.6. Anchor Types

Both the SBM and Saitec technologies are installed to pre-laid mooring systems (i.e. mooring systems that are installed prior to the turbine installation). Installation of the mooring lines require an Anchor Handling Vessel (AHV) or an Anchor Handling Tug Vessel (AHTV). Anchors being considered include:

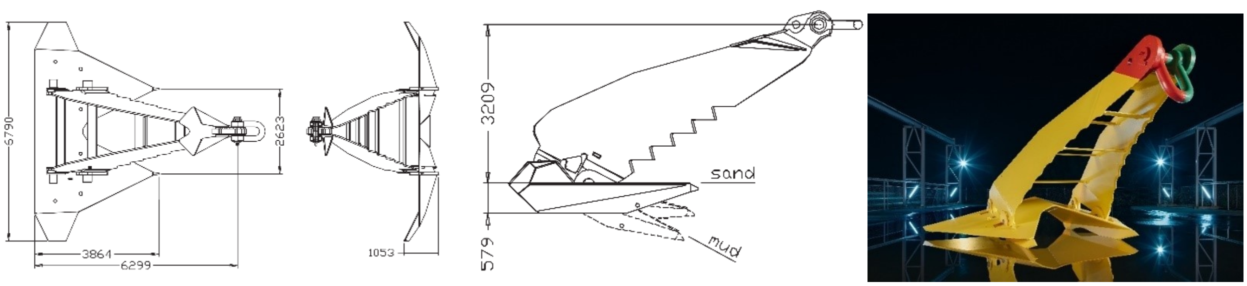


Figure 28 - Example of Drag Embedment Anchor (a Vryhof StevShark Mrk 5 - Courtesy of Vryhof)

[5] OSPAR 12/22/1, Annex 14. Agreement 2012-2

Drag Embedment Anchors

Based on a preliminary review of the site's seabed and environmental conditions, it is anticipated that a drag-embedment anchor will be used. The anchor weight will be approximately between 15-20 tons and will be approximately 5.8m long, 6.3m wide, with a height of 3.3m. The anchor will use a drag and penetration arrangement, with a penetration of 2.5 meters anticipated. An example of the type of anchor to be utilized is shown in Figure 1 below.

Suction Bucket Anchor

Originally the Suction Bucket (or caisson) anchor system was developed for floating offshore platforms in the oil and gas industry, with the technology recently being adapted for use in offshore wind (including the Hywind Project in Scotland). The suction bucket concept comprises of a steel cylinder skirt (shaped like an upturned bucket with a shaft on top) that penetrates into the seabed initially due to the weight of the structure and then sinks further into the seabed through the application of a suction vacuum in the suction bucket. The vacuum is created by pumping the water inside the bucket out, thereby creating a negative pressure inside that pulls it into the ground. Installation is finished once the 'bucket' is fully submerged in the seabed. A generic video explaining how an offshore wind turbine suction bucket is installed and works can be found on the following website: https://www.youtube.com/watch?v=l52K67vyGVA. The size and diameter of the suction bucket are determined by the soil/sediment conditions of the seabed.

Vertical Loaded Anchor (VLA)

The Vertical Loaded Anchor (VLA) is designed to allow uplift at the anchor point, which is required in semi-taut or taut leg mooring systems. The VLA consists of an anchor fluke which is connected with wires to the angle adjuster. The VLA installs as a normal drag embedment anchor, where the angle adjuster changes the anchor from the installation mode to the vertical (or normal) loading mode, resulting in an instant 3.5 factor of increase in holding capacity. Since its introduction in 1996 hundreds of permanent and mobile moorings have been successfully performed worldwide.

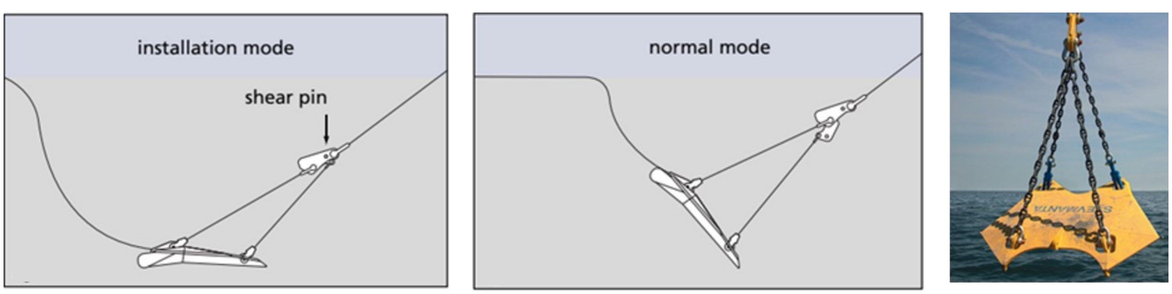


Figure 29 - Example of Vertical Loaded Anchor (a Vryhof Stevmanta VLA - Courtesy of Vryhof)

5.1.7. *Installation of the Anchors and Mooring Lines*

Anchors and chains are lifted by an onshore crane onto the AHV deck area where are fastened for transport. The installation technique is as follows:

- Once at site, the anchor is connected to the chain line and lowered from the stern utilizing the winch mounted on the AHV deck. To ensure that the drag anchor will reach the seabed in the right orientations, a supporting second line may be used, which is later disconnected from the anchor.

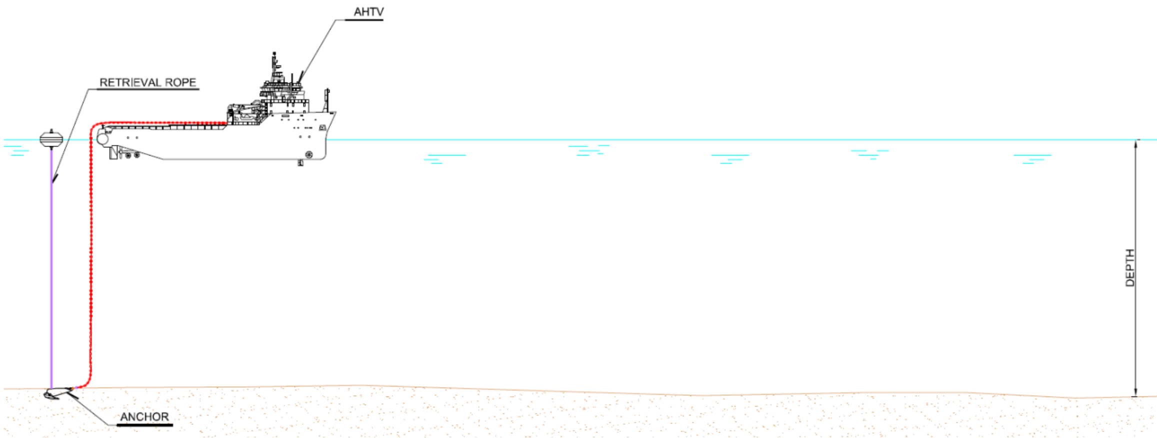


Figure 30 - Positioning of the Mooring Anchor

- Once the anchor has penetrated by itself, due to its own weight, the AHTV moves forward. The vessel thrust and the angle between the fluke and shank makes the anchor embed into the seabed. Tension is applied to the anchor, typically by using a reaction anchor with a tensioner. The tension in the line is monitored and before the line is paid out completely, the AHTV will carry out the anchor proof test, applying its bollard pull for 1 hour. This is done in order to allow the anchor to penetrate until it is in the correct position.

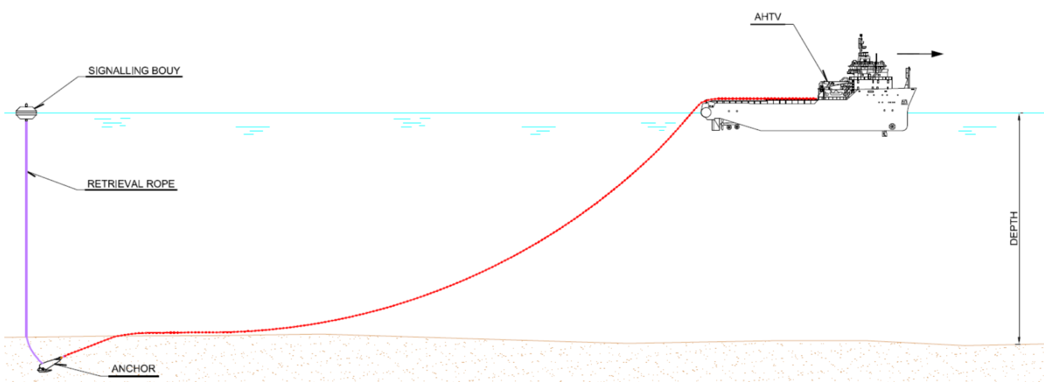


Figure 31 - The Anchor Proof Test

- Finally, the end of the line is connected by means of an auxiliary rope to a buoy to ensure an easy pick-up for the Hook-up phase. The mooring design will be developed more in detail as the detailed design progresses but is anticipated that the mooring lines could consist of a combination of Steel bridle, chain and/or synthetic rope.

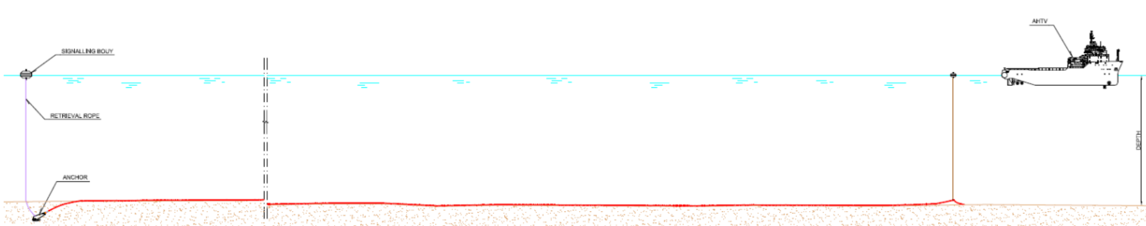


Figure 32- Installed Anchor and bottom chain

It is estimated that the installation of the anchor and chain for 6 mooring lines can be performed in 3 days weather exclusive (or 3 days per turbine); meaning that the total time required to install the mooring systems for the CADEMO project will be 12 days on the assumption that two AHV's are used for all four turbine locations. There is no seabed preparation requirement prior to installation of the mooring systems. There are, however, operating limits criteria for weather conditions which limit mooring installation to weather windows. The maximum criteria for all marine operations are:

Maximum wave height (Hs): 3 meters

Maximum Wind Speed: 30 knots

Maximum Current Speed: 2 knots

It must be noted that some marine operations have lower maximum operating limits (for example ROV launching has a maximum Hs of 1.5m).

The mooring installation approach for all floating platform technologies will follow the guidance as described within the Regulatory Expectations on Moorings for Floating Wind and Marine Devices (HSE and MCA 2017[6]) or equivalent as recommended by the regulator, with the principle of prevention of unplanned incidents being used throughout the construction process for the mooring system. The following steps will be undertaken in the installation of the mooring lines, irrespective of the floating technology used:

(a) Pre-lay Survey

A pre-lay survey will be performed to identify and remove any debris along the route of the mooring lines.

(b) Mooring Line deployment

The mooring lines will be deployed by connecting the chain to the anchor on the back deck of an Anchor Handling Vessel (AHV). The anchor will be lowered, using the mooring chain, to the seabed into a pre-determined target box and orientated to face the proposed offshore wind turbine location. The location of the anchor on the seabed will be recorded for comparison with the post embedment location.

The chain will then be deployed using established practices from the offshore wind industry. Once the laying operations are complete, the chain end will be transferred onto the main winch wire.

(c) Anchor Embedment and Laydown

The embedment of the anchor involves the AHV applying a large horizontal thrust to the mooring ling which will act to pull the anchor into the seabed. The load will be applied gradually up to the maximum design tension with the offshore wind turbine platform and held for a period of time to ensure that further movement of the anchor is prevented.

The anchor will embed to a depth well below the seabed level and as such, the monitoring of its final position can be determined accurately by measure the movement of a pre-defined point on the mooring

[6] Regulatory Expectations on Moorings for Floating Wind and Marine Devices – August 2017; Health and Safety Executive and Maritime and Coastguard Agency; available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/640962/Regulatory_expectations_on_mooring_devices_from_HSE_and_MCA.PDF

line (e.g. the shackle connection). The length of the chain can then be adjusted to compensate for the drag distance of the anchor.

5.2. Offshore Floating Turbine Installation

The installation of the floating wind turbine follows the same principle for the installation of any other floating structure (e.g. floating production, storage, and offloading vessels (FPSO's), dry-tow or oil drill rig). The project will utilize the experience gained by vessel operators and crews from other sectors such as oil and gas exploration and production.

(a) Preparation and tow

Before the floating offshore wind turbine is installed, its certificate for worthiness for sailing will be required from a Marine Warranty Surveyor, which will typically include (but not limited to) the following checks:

- Towing calculations.
- Specification of towing equipment.
- Towing vessel audits and assessment of suitability.
- Towage route and safe havens / sheltered locations.
- Necessary permits and notifications for the towing operations.
- Contingency and emergency procedures.
- Checks of all hook-up equipment (e.g. winches); and
- Confirmation of a suitable weather window.

As the wind turbine will be on the platform for the installation tow out, it is unlikely for a tow to take place in a weather windows higher than Beaufort Scales > 7, with Hs > 5 m, and wind speeds > 17 m/s.

Towing the assembled floating platform with turbine can be performed with a conventional tug/transport vessel of 60 – 100 metric ton BP (Bollard Pull) with dynamic positioning and one auxiliary tug vessel of 50 metric ton BP.

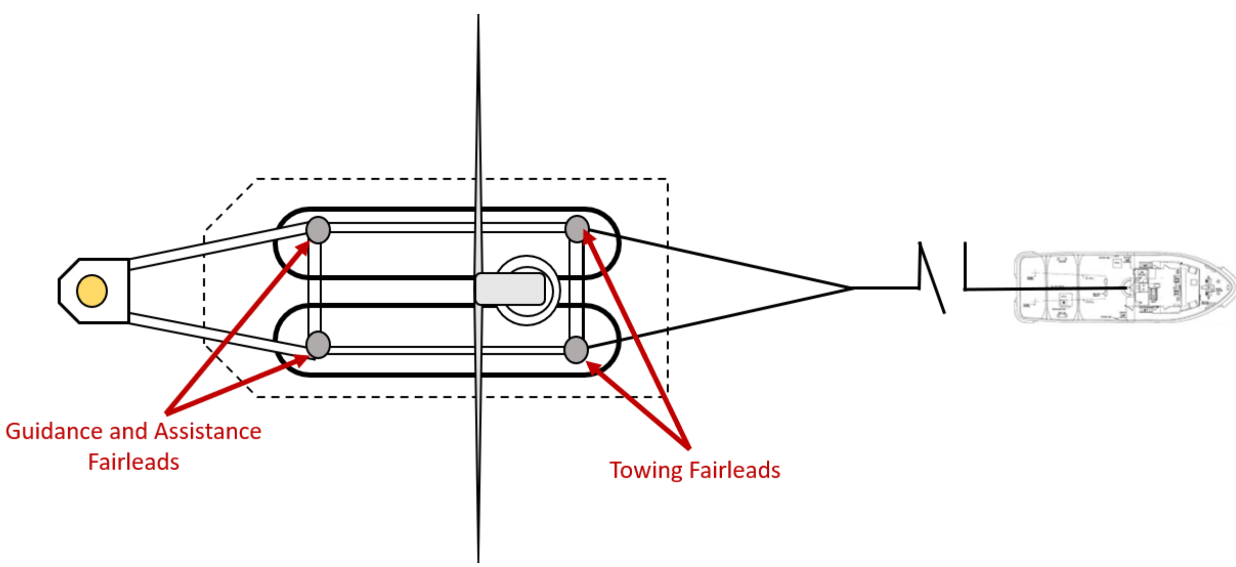


Figure 33 – A SPM Platform towing points illustration

(b) Hook-Up actions

Prior to the floating offshore turbine arriving on site, a survey and preparation of the mooring system and cabling will be undertaken to confirm that no damage has occurred prior to hook-up. This will probably be performed by a Remotely Operated Vehicle (ROV) from the Anchor Handling Vessel (AHV).

The operation to perform the hook-up will generally follow immediately after the towing operation, effectively as part of the same operation. The hook-up activities require an AHV of conventional size (around 100 metric ton BP) that will perform the linkage of the pre-laid mooring chains with chain section that hang from floating platform. The transport tug vessel with dynamic positioning and head to wind will maintain the floater in the required position in each installation phase. The auxiliary tug vessel will be used to control the platform orientation.

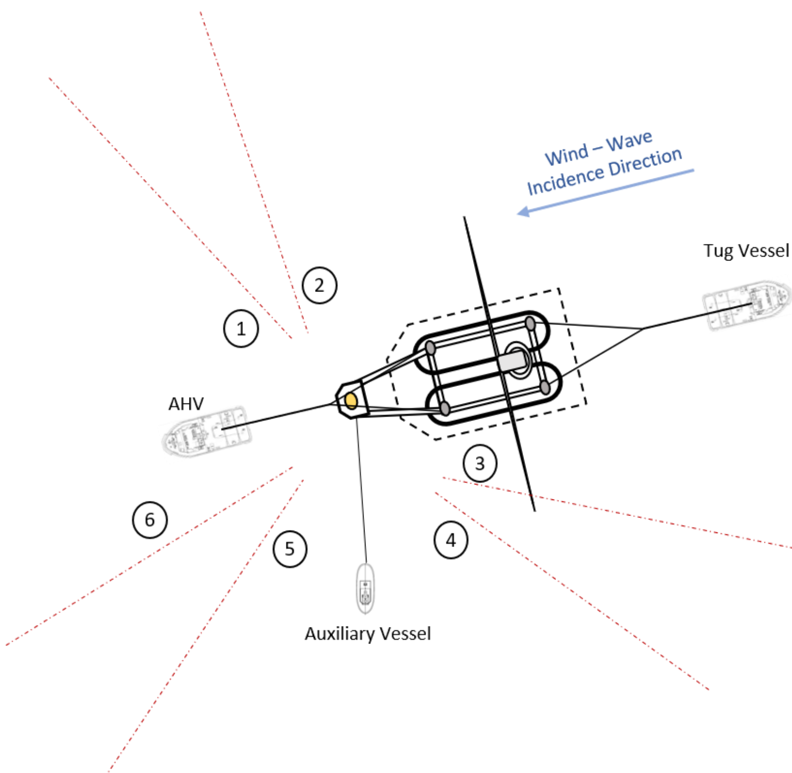


Figure 34 - Layout of the installed for a SPM mooring system

The hook up operation involves the following steps:

- The Floating platform is placed close to the signal buoy.
- The AHV will recover the pre-laid mooring line from the seabed.
- The end of the top chain section is transferred to AHV.
- Both ends are connected on the deck of the AHV by a shackle D type connector.
- The connected mooring line is released
- The process is repeated for the remaining mooring lines 1, 3 and 5 (see Figure 25) in order to ensure appropriate control of the platform. The mooring lines 2, 4 and 6 are then connected using the same process.

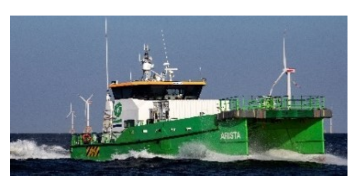
It is anticipated that the hook-up operation for each offshore wind platform will take half a day. Once the mooring system is installed, the dynamic electrical cable will be connected to the platform.

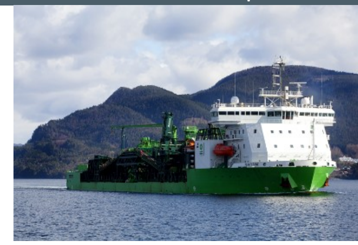
Table 7 - Installation Program and Sequence for each offshore floating platform and turbine

No	Activity	Duration
-	Mobilize vessels from base port to Assembly Facility	*3-5 days*
1	Tow of first floating offshore wind turbine from assembly facility to CADEMO Project site.	1 day
2	Hook up installation of first offshore wind turbine	0.5 day
3	Connection of dynamic electrical cable to platform	0.5 day
4	Return of tow vessel and tug to assembly facility	0.5 day
5	Tow of second floating offshore wind turbine from assembly facility to CADEMO Project site.	1 day
6	Connection of dynamic electrical cable to platform	0.5 day
7	Hook up installation of second offshore wind turbine	0.5 day
-	*Demobilize vessels and back to base port*	*3-5 days*

5.2.1. Project Vessel Information

Table 8 - Construction Vessel Information

Vessel	Number	Role	Total Operation	Vessel Example
Anchor Handling Vessel (AHV) / Tug	2	Anchor Installation	• 36 hours / turbine • 144 hours total	 Damen AHTS 180
	1	Turbine Installation	• 12 hours / turbine • 48 hours total	
	1	Installation of export cable (potential alternative to the CLV)	• 51 hours (based on 200 m/hr and 10,189m to be covered)	
Support Vessel / Maintenance Vessel	1	Anchor Installation	• 36 hours / turbine • 144 hours total	 DEME Arista
	1	Turbine Installation	• 12 hours / turbine • 48 hours total	
	1	Maintenance Activities	• 16 trips (4hr) /year • 64 hours/year	

Vessel	Number	Role	Total Operation	Vessel Example
Rock Placement Vessel	1	Rock placement over unburied cable	• 12 hours (base assumption)	 DEME Flintstone
Cable Laying Vessel (CLV)	1	Installation of export cable (including post lay jet trenching burial)	• 51 hours (based on 200 m/hr and 10,189m to be covered)	 DEME Living Stone

5.2.2. *Underwater Construction Noise*

There is potential for installation vessels and equipment to produce noise during the installation of the mooring lines and electricity export cables. This section provides a quantification of the underwater acoustic noise levels of their construction activities (the estimated duration of the activities is provided in section 5 above). It must be noted that the drilling of the Horizontal Directional Drill (HDD) hole in for landing the cable onshore is not expected to produce any significant noise, as the noise generating equipment will all be located onshore; with the exception of the drill bit and string which will be under the sea floor.

The potential sources of underwater noise that could be generated during installation activities are:

- Use of vessels for turbine placement, installation of anchors, cable laying and rock placement,
- Use of thrusters for dynamic positioning (if required),
- Use of trenching vessels and/or ROV’s for cable burial,
- Operations of maintenance vessels.

There will be no impulsive noise sources associated with the CADEMO construction, operation or decommissioning activities.

Construction noise data has been based on published literature and noise measurements on similar vessels and equipment. Although there is a significant amount of publicly available data relating to sources of construction noise and vessels, the data is not always directly applicable to the types of plant and vessels that will be used for this project. Consequently, proxy data for what is considered to be a similar class of vessel or equipment has been used. Worst case assumptions have been made about the number of sources, duration and noise level.

Table 9 - Source Noise Data for Construction Vessels

Vessel / Activity	Description / Assumptions	Data Source	Source Sound pressure level at 1m		
			RMS dB re 1 μPa	Peak dB re 1 μPa	SEL (24h) dB re 1 $\mu Pa^2 s$
AHV	Tug used as proxy	Richardson (1995)	172	175	221

Vessel / Activity	Description / Assumptions	Data Source	Source Sound pressure level at 1m		
			RMS dB re 1 µPa	Peak dB re 1 µPa	SEL (24h) dB re 1 $\mu Pa^2 s$
Support Vessel	Based on measurements on offshore rig tender support vessel	Mc Cauley (1998)	179	182	228
Rock Placement vessel	'Gerardus Mercator' dredger using DP as proxy	Wyatt (2008)	188	191	237
Cable lay Vessel	'Gerardus Mercator' dredger using DP as proxy	Wyatt (2008)	188	191	237
Small vessels (e.g. tug, ROV, CTV, RIB)	Tug used as proxy	Richardson (1995)	172	175	221
Cable trenching / cutting	Estimated maximum sound pressure levels used for cable trenching / cutting - based on measurements made at North Hoyle, UK during trenching	Nedwell, Langworthy and Howell (2003)	178	181	227

6. OPERATIONS AND DECOMMISSIONING

6.1. Maintenance of the cable during operation

Once the electricity export cables have been installed, an assessment of the potential future risk of cable exposure will be completed. Based on the outcome of the post installation cable risk assessment, visual inspections of the integrity of the subsea cables and their burial condition will be undertaken at an appropriate frequency by the appointed O&M contractor. The subsea cables will be inspected using an underwater ROV from the J-tube of the turbine structure along the route of the cable back to the duct entry point close to shore.

In the event of cable failure or exposure, maintenance and rectification work will be undertaken to ensure that the burial condition of the cable is maintained within the cable burial risk assessment parameters. CIERCO will re-bury the cable, or if this is not feasible, apply additional cable protection material. CIERCO will provide notification to the appropriate authorities in instances of cable failure or exposure prior to undertaking any rectification work.

6.2. Decommissioning

It is too early to state definitively what will happen to the maintenance, upkeep and repair beyond the operational stage of the wind demonstration project in the event that a lease for the offshore facilities is not authorized beyond the initial lease term, as discussions with the Vandenberg Air Force Base and the local utility have not been concluded.

Cierco does commit that in the event of failing to reach agreement on the long-term ownership of the onshore grid infrastructure, an independent onshore decommissioning fund will be established to fund the full decommissioning of the onshore overhead power lines. The financial security will be in the form in an interest earning Escrow Account, administered by a third party, with arrangements allowing the

State Lands Commission or Cierco access to undertake decommissioning activities at the end the CADEMO operational life. The financial contributions to the decommissioning fund will come from the operational revenues of the CADEMO project.

7. CADEMO ENVIRONMENTAL MANAGEMENT ARRANGEMENTS

7.1. CADEMO Project Waste Management Plan

Due to the nature of the floating offshore wind technology, apart from those associated with routine maritime vessel operations, no other significant source of waste generation is predicted during the installation phase of the project. This is because the foundation systems will use an anchoring system and any material excavated or relocated during the cable trenching operations will not be removed from the seafloor.

To manage normal routine maritime waste generation, CIERCO will ensure that appointed installation contractors will be required to effectively implement waste management measures through the implementation and monitoring of the requirements of the CADEMO Project Health, Safety and Environment (HSE) Plan and contractual requirements for the implementation contractors and subcontractors.

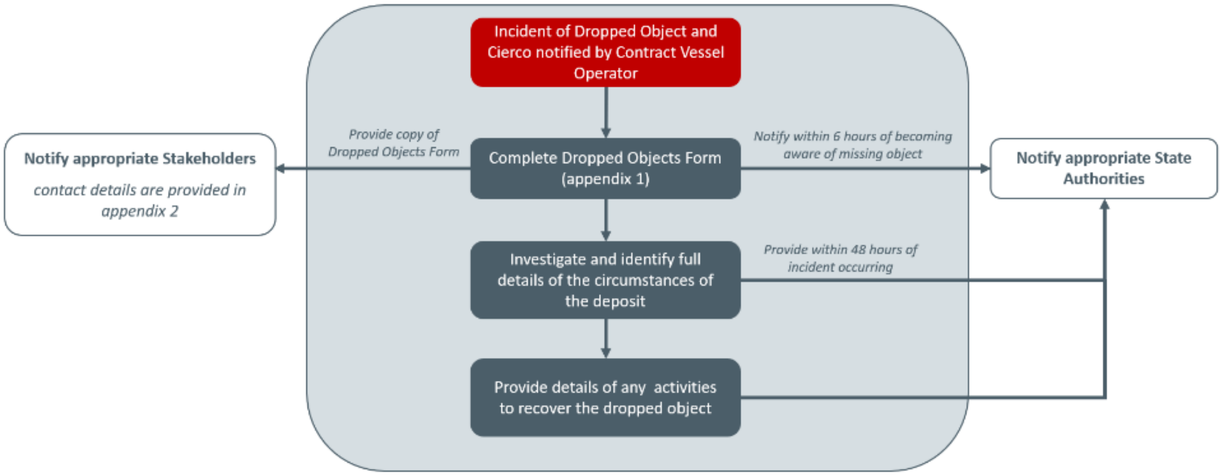
All waste materials shall be disposed of properly and all contractors are responsible for taking the necessary steps to prevent pollution and minimize the generation of waste. Each contractor will maintain a waste management plan, that shall include the following as a minimum:

- Proper identification of each individual waste stream.
- Segregation of individual waste streams (e.g. special, controlled, industrial etc.).
- Proper labelling of contents, markings, manifesting, storage, and shipping of each waste stream.
- Re-use and recycling initiatives.
- Disposal at licensed waste management sites.
- Records of certificates, waste transfer notes, consignment notes, and waste disposal licenses shall be retained for at least 3 years.
- Contractors will maintain a list of licensed waste disposal contractors who may be used.

All offshore construction vessels will be required to:

- Comply with International Maritime Organization (IMO) regulations and will follow The International Convention for the Prevention of Pollution from Ships (MARPOL) requirements regarding discharge of waste, sewage and oil or oily mixtures.
- Manage waste in compliance with the individual vessel's Waste Management Plan.
- Dispose all controlled waste at port via the appropriate legal route.

To address incidents where items may be unintentionally dropped onto the seabed during operations, a Reporting of Offshore Dropped Objects Procedure will be developed specifically for the CADEMO Project. The process will follow the flowchart below:



All other incidents will follow a CADEMO Project Accident and Incident Reporting procedure that will be agreed and implemented prior to construction activity starts.

7.2. Marine Pollution Control Plan

The CADEMO Project HSE plan will include the requirement that the appointed offshore installation Balance of Plant (BoP) / Engineering, Procurement and Construction (EPC) contractor will provide and implement a Marine Pollution Control Plan (MPCP) for the vessels used on the CADEMO Project. The MPCP will define the potential nature and size of spills that may occur on the vessel and will include:

- The emergency response structure along with roles and responsibilities of the individuals.
- Identify and document alternates for key positions within the emergency response team.
- Tier 3 spills should conform to IPIECA (The global oil and gas industry association for environmental and social issues).
- Include potential spill scenarios including that of a fuel spill from a chartered vessel including impact assessment on when to report to authorities.

Each installation vessel will be equipped with Spill kits according to their Ship Oil Pollution Emergency Plan (SOPEP). When the spill or release of a substance (e.g. oils, chemicals, grout etc.) occurs during the work process, the spill or release shall be stopped and/or contained until the proper clean-up procedure can be conducted. If the spill or release poses a reasonable risk to the health and safety of employees, a safety risk to the completion of the process or an undue risk to the environment, the work process shall be stopped, and the release shall be cleaned up or minimized until the risk is reduced to an acceptable level. A competent person, familiar with the process, the released substance and the affects posed to personnel and the process, shall be responsible for determining the risk associated with a spill or release.

The spill kits and booms shall be available on site and shall be of sufficient quantity and robustness to contain any, or all, of the potential spills. In all cases a site-specific risk assessment and method statement will be produced along with data sheets regarding the spilled materials or chemicals

Spill preventive measures shall be followed while handling or transferring substances that poses a health, safety, or environmental hazard. The following spill preventive procedures shall be used while transferring hazardous substances (e.g., refueling and/or servicing equipment on site):

- Position spill pan with absorbents below entry port.

- Ground equipment when transferring flammable substances.
- Transfer fluid at a controllable rate.
- Man the control device (switch, valve, pump, etc.) until the transfer is complete.
- Do not smoke while transferring flammable substances.
- Do not use a cellular phone while transferring flammable substances.
- Do not allow distractions until the transfer is complete.

Contractors will identify suitable local contractors with a capability to respond on site within a 4- hour period to any spill that may occur. Contractors will maintain the appropriate flow-charts for this process. If fuels are being transferred during bunkering operations, then an exclusion zone for all other vessels will be required of at least 750 meters.

7.3. Management Measures to Prevent the introduction of Non-native species

To reduce the spread of invasive non-native species the International Maritime Organization (IMO) developed the International Convention for the Control and Management of Ships' Ballast Waste and Sediments 2004, applies to all commercial shipping designed to carry ballast water, which came into force internationally on 08 September 2017.

CIERCO will require all vessels and structures used on the CADEMO Project to comply with the requirements of the Convention. The project will use local vessels and it is likely that the turbine and structure will be manufactured and shipped from a local Californian port, eliminating the risk of introduction of non-native species.

7.4. Unplanned Archaeological Discoveries

Offshore we are currently unaware of any known marine archaeological sites exist around the turbine locations lease area or cable route areas. However, a UXO survey along the route will be undertaken prior to the commencement of installation activities. The survey should identify any potential anomaly that would indicate the presence of potential archaeological remains.

A Protocol for Archaeological Discoveries (PAD) will be produced for the project in accordance with the standard industry guidance[7] to minimize the risk of damage to any previously unrecorded archaeological remains during construction. In addition, an archaeological Written Scheme of Investigation (WSI) will be prepared for use on the project.

The PAD will also include appropriate archaeological briefings for all personnel involved in the offshore construction activities. The PAD will be in place for the life of the proposed development and will be updated when required should details within the document change.

Onshore, the Vandenberg Boat House is a historic property (former U.S. Coast Guard Station) located near the landing point for the subsea cable. There will be no direct effect on this property. The electrical transmission line route crosses archaeological sites along Coast Road. The project owner will work with Vandenberg AFB environmental staff to site the onshore electrical transmission poles to avoid these locations.

[7] Wessex Archaeology (2014) "Protocol for Archaeological Discoveries: Offshore Renewable Projects", The Crown Estate: Available from: http://www.thecrownestate.co.uk/media/148964/ei-protocol-for-archaeological-discoveries-offshore-renewables-projects.pdf

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