A new generation of floating wind power

Verti-Go, 2MW

Co-funded by
the European Union

SEATWIRL

The global challenge

Our planet is facing a complex mix of challenges. At SeaTwirl we want to make our contribution to the green transition and eliminate the use of fossil fuels and reduce its devastating long-term effects on the environment and climate. We define the challenge as addressing three important goals:

CO2 Reduction
Reducing carbon emissions to a sustainable level, a.k.a. a net zero carbon footprint. We want to be actively involved in keeping the global rise in temperature below the two degree threshold.

Critical resources
Our whole design philosophy is to minimise the need for resources. That is both for materials like steel and rare earth minerals but also precious capacity in important supply chains.

Local energy = Local independence
We believe that clean and affordable energy is vital for societies to prosper. Enabling floating wind in places with limited resources or infrastructure can build independence and resilience.

A new generation of floating wind power

Wind power is an endless source of renewable and clean energy. As wind power on land and near shore are facing increasing challenges, the focus is now on enabling wind power on the deep oceans. Commercial offshore wind power is currently built almost exclusively on bottom fixed foundations in waters up to approximately 60-80 meters. More than 90 percent of the world's oceans are deeper and would require floating turbines.

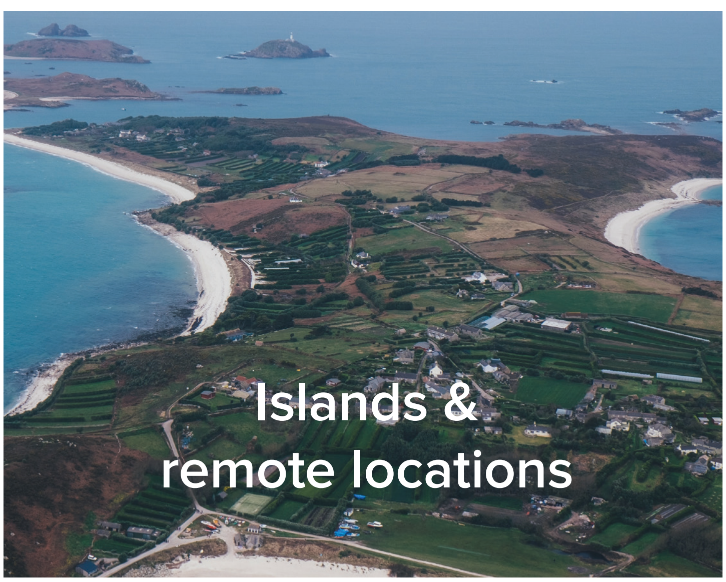
The vertical-axis wind turbine on a rotating spar is a robust solution designed for the deep-water offshore environment from the start. A low centre of gravity, enabled by integrating the tower and the SPAR into one rotating unit, provides many beneficial qualities. It means the floater can use less steel than conventional floating solutions, the Gendeck enables easier access for service and maintenance which results in lower maintenance costs and the possibility of using smaller vessels and eliminates the need for large offshore cranes.

A fundamental focus for nearly 15 years has been the development of modelling and simulation tools of floating vertical axis turbines. These, combined with the control system, is now a world-leading toolbox of software and know-how that can open a new chapter in the offshore wind industry - A new generation of floating wind turbine technology.

Markets

The combined demand of niche markets like offshore oil & gas assets, islands, remote seaside communities, aquaculture, and subsea military applications is substantial. Starting with pilot projects of a few MW in size, scale and cost-out should make it possible to achieve an LCOE competitive in merchant market conditions in the early 2030's.

Near term application areas:



Utility scale:

Why SeaTwirl's solution?

SeaTwirl started designing a floating wind power system from a blank sheet of paper. Founded in 2012, our purpose is to enable floating wind wherever it is needed, with a focus to develop wind turbines specifically for the deep waters. The design philosophy was to remove hurdles in deploying floating wind power while maintaining robustness, reliability, and a competitive cost level. With a purpose to enable floating wind wherever it is needed, SeaTwirl's wind turbines are smaller and can be installed and maintained with significantly less infrastructure than conventional turbines. It is therefore a clear ambition to meet a demand that is normally difficult to electrify – and to reduce the so called hard-to-abate emissions.

SeaTwirl has a unique and patented floating wind turbine technology, based on vertical axis turbine on a rotating SPAR foundation. The main advantages of the design are; no pitch- or yaw-system, low center of gravity, standardized drivetrain components, infrastructure-light installation, and easy access for maintenance. SeaTwirl installed its first prototype in the sea in 2015 and has been listed on Nasdaq First North Growth Market since 2016.

ROBUSTNESS

SeaTwirl's stall-regulated wind turbines have removed pitch- and yaw-systems, eliminating a major contribution to maintenance. The rotor is a fixed structure with a low rotational speed reducing risk of blade erosion, noise, bat- and bird-impact.

RELIABILITY & REDUNDANCY

The SeaTwirl drivetrain design is using multiple standard components instead of large single ones. This enables the turbine to continue operating with reduced power also during some failures. Maintenance is also less complicated with smaller components.

GENDECK NEAR THE SURFACE

With all mechanical and electrical components parts requiring maintenance and service are inside the Gendeck, which is easily accessible, right above water level and below the wind turbine.

FLEXIBILITY

SeaTwirl offers a solution that is flexible and scalable for different types of applications and sites.

The basic principles of SeaTwirl's concept

The turbines consist of three main parts: the **SPAR foundation** providing buoyancy and stability, the **Gendeck** containing all systems where the rotation motion is converted to electricity, and the **Rotor** transforming the kinetic energy from the wind into rotating motion.

The Gendeck is connected to the mooring system anchored to the seabed which restrain the unit's motion both in displacement and rotation. The power is exported from the wind turbine via a power cable connected to the bottom of the lower part of the Gendeck.
Reduction of the number of moving parts, robustness, ease of maintenance, and infrastructure-light installation have been the design drivers behind SeaTwirl's concept.

Our products and services

SeaTwirl offers turbine designs for different applications and sites. The designs are flexible and can be developed for different requirements. SeaTwirl is a global leader in the simulation and evaluation of floating vertical axis wind turbines and our proprietary in-house tools enable accurate energy yield assessments for any site. The offering entails detailed load simulations and structural analyses from fundamental idea to detailed design —providing all the insights needed to assess the feasibility of potential projects.

Our turbine design portfolio ranges from 200kw to 6MW designs and battery storage and power management systems are now an integrated part of our turbine designs.


SEATWIRL
01
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03
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01 STRUTS
02 BLADES
03 TOWER
04 GENDECK (NACELLE)
05 MOORING
06 FLOATER (SPAR)

SeaTwirl Verti-Go 2MW

The Verti-Go turbine is SeaTwirl's largest stall-regulated turbine with a rated power of 2MW. Verti-Go is intended for larger electrification applications such as Oil & Gas platforms, islands, aquaculture, fishfarms and remote isolated markets.

IEC 10A
Turbine class

2MW
Rated power

80M
Turbine diameter

100M
Height above sea level

75M
Rotor blade height

65M
Draught

6 000M²
Projected area

50M/S (70M/S GUSTS)
Designed for extreme wind speeds

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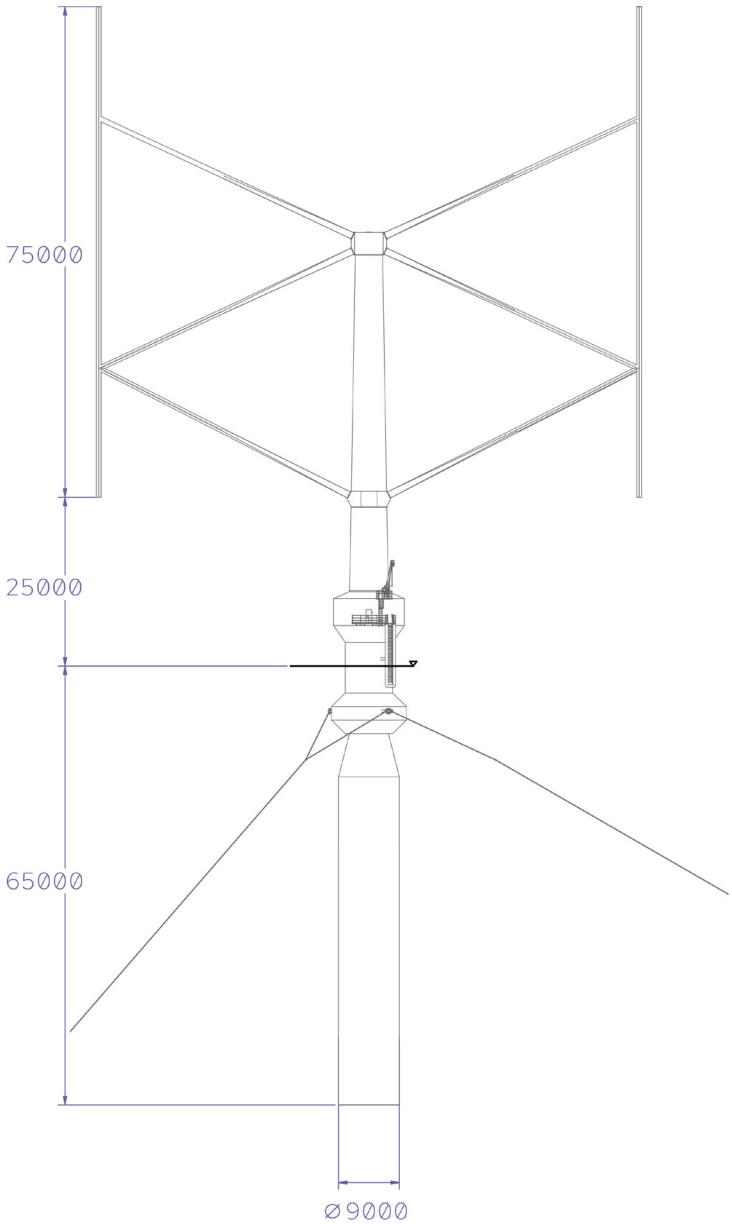
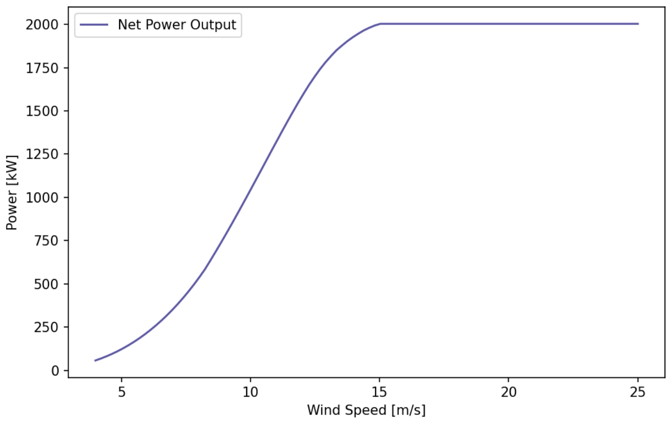
Turbine & Operating data

Power regulation	Stall regulated with adaptive rotational speed control
Rated power	2 MW
Cut in wind speed	3 m/s
Cut out wind speed	25 m/s
Service life	25 years
Number of blades	2
Material	Fiber reinforced plastic
Electrical frequency	50/60Hz
Converter	Full scale
Export voltage	1kW-66kW
Floater	Spar type
Material	Steel
Ballast material	MagnaDense and water
Mooring system	4-line mooring system with a bridle connection to the turbine



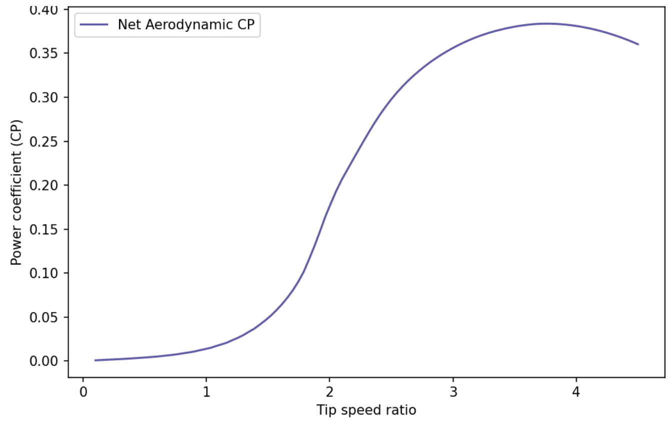
Power curve for Verti-Go 2MW



All WTG losses included. Constant wind.

Standard air density	1.225

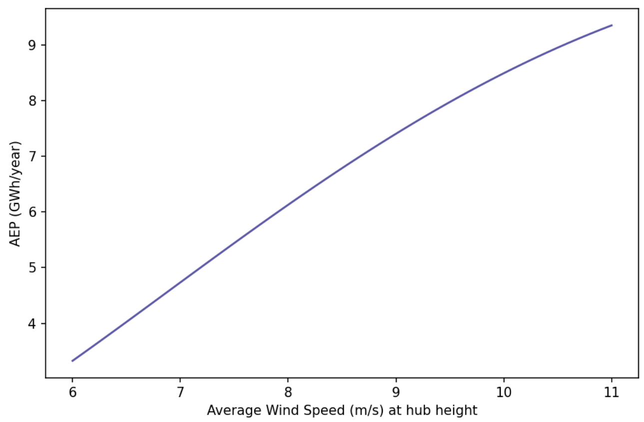
Power coefficient for Verti-Go 2MW



Simulated using Acylum, limited to aerodynamical properties.

Standard air density	1.225

Expected annual energy production for Verti-Go 2MW



All WTG losses included.

Availability	100%
K factor	2
Standard air density	1.225

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PATENTS PENDING

Installation

To make floating wind a scalable and global solution, we must design with accessibility in mind. Our purpose; to enabling floating wind wherever it is needed— starts with smart and inclusive design criteria. A key enabler is the ability to utilize a broader range of ports, especially underused ones that might not be suitable for the large conventional turbines. As major ports face congestion and capacity limits, where the demand for wind energy is increasing in locations that doesn't have the large ports required, unlocking the potential of more ports becomes essential. The potential to adapt the installation to the available infrastructure reduces cost and levelized cost of energy (LCOE).

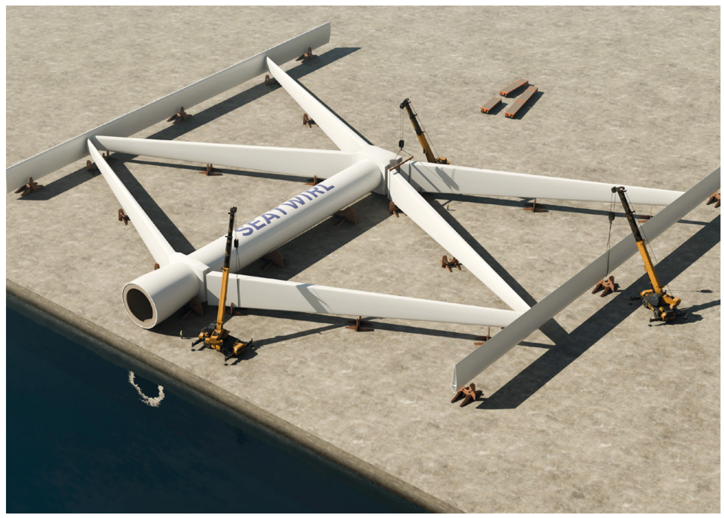
SeaTwirl's concept is engineered to avoid oversized or overly heavy components. By optimizing weight distribution and modularity, it enables transport, assembly, and deployment using smaller cranes and existing port infrastructure. This expands the geographical scope for project development and lowers entry barriers for new markets.

In addition to installation, service and maintenance have been designed around the use of existing, non-purpose-built vessels that are trading on the spot market around the world. This approach significantly reduces operational costs and carbon footprint while creating local job opportunities and boosting regional economies. Increasing the number of vessels qualified for service will increase competition and reduce day rates, as well as potentially improving turbine availability.

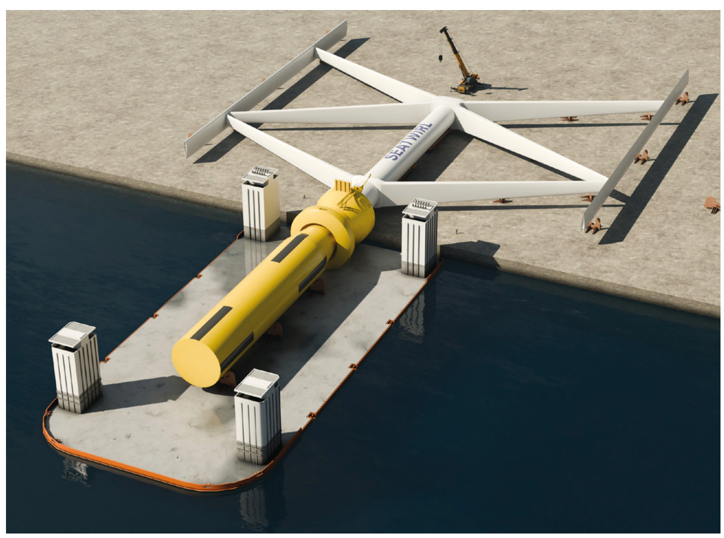
Finally, this methodology ensures that manufacturing and assembly align with regional supply chains and capabilities, facilitating easier certification and faster execution. This is not only about engineering feasibility but about unlocking floating wind for real-world deployment, also when major infrastructure is not available.

The turbine geometry also scales favourably for methods used in other wind turbine installations on Spar platforms.

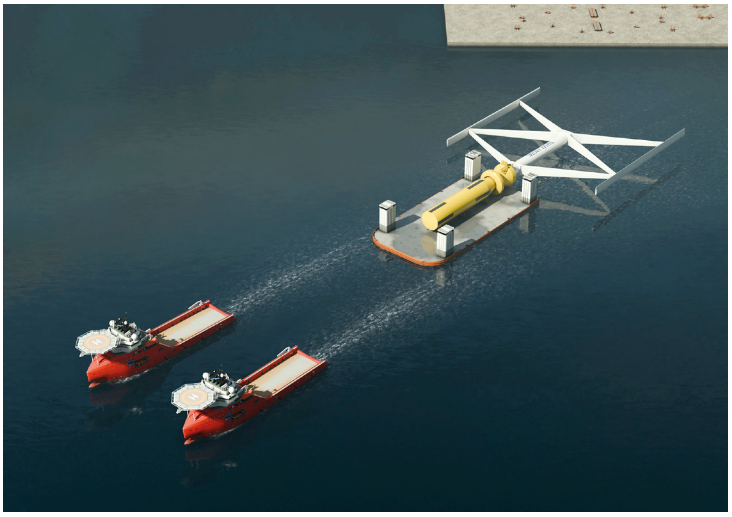
01 The SPAR floater is fabricated and transported to assembly site where it is attached to the horizontally positioned Gendeck on quay side. It is then launched into the water either by submersible barge or crane(s).



02 The rotor is assembled horizontally on quay side and positioned with its tower interface towards the water. Regular crawler cranes can be used for all lifts and operations.



03 The floater has ballast (MagnaDense) pre-installed and is loaded on submersible barge. The barge is then positioned against the bottom of the rotor tower. The floater and rotor are aligned and connected before the floating barge is de-ballasted and moved to the offloading location.

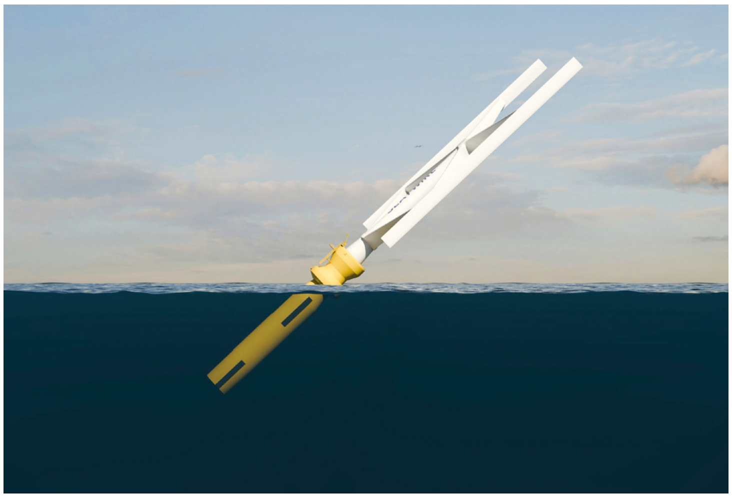


04

The semisubmersible barge and the turbine can then be towed out to the float-of position.

05

At the float-off position, (which may be already in the port) the turbine and barge are splitting ways and the turbine continues towards the upending location at a slight angle that keeps the blades and struts clear of waves.



06

At the upending location the upending process is initiated by adding water ballast. The MagnaDense will start to shift towards the bottom of the Spar and trigger the turbine to rotate towards its vertical position.

07

After towing the turbine to its final position and connecting to mooring and inter array cables the turbine is commissioned and enters the O&M phase.

PATENTS PENDING

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Operations & Maintenance

SeaTwirl's turbine designs improves uptime and reduces complex and costly marine operations.

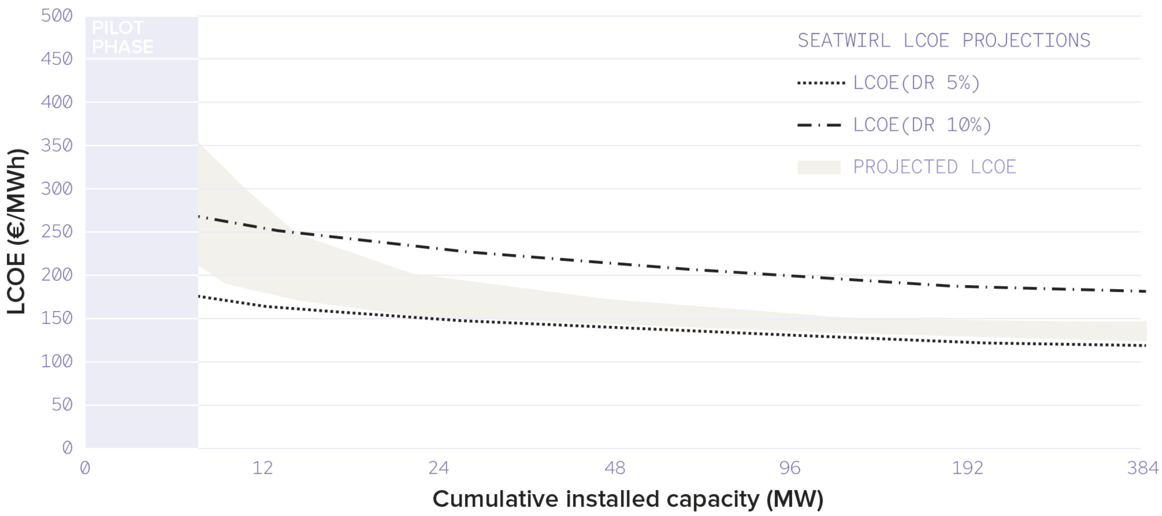
This is achieved by utilizing the placement of the Gendeck close to the water surface where the critical equipment can be easily replaced on site with the use of a Service Operation Vessel equipped with a standard 10 to 20mTon capacity crane.

Vertical turbines have a lower Tip Speed Ratio which means low, or no blade erosion. The lower blade erosion in combination with an advanced lightning protection system means that the blades can be designed to be in operation for the full lifetime of the turbine. The risk of needing to tow the turbine to port for maintenance or major component replacement should therefore be very low or even eliminated.

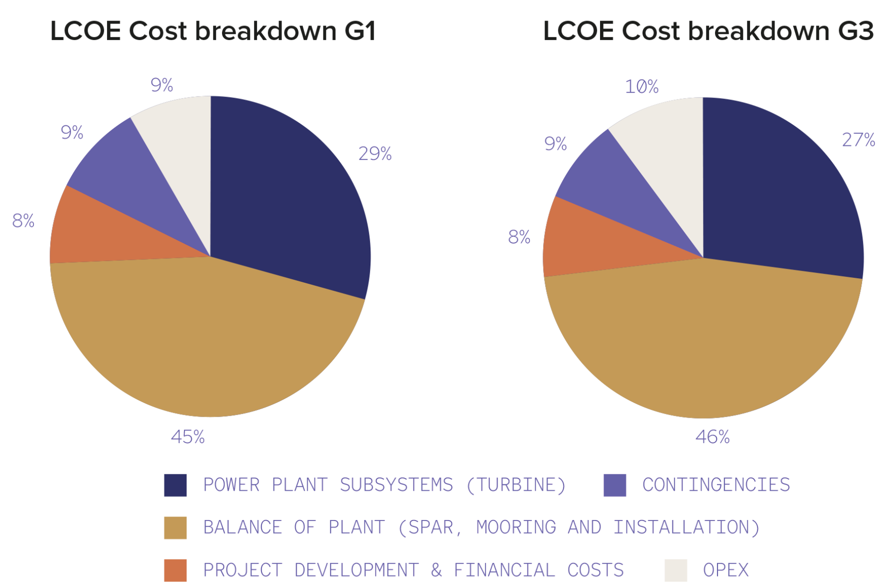
By eliminating pitch and yaw systems, both of which are common sources of unexpected downtime, loss of power and need of unscheduled maintenance is reduced. It is estimated that the maintenance cost can be reduced with as much as 50 percent which would save about 20-30 percent on the total Operational Expenditure (OPEX).

Cost

The Levelized Cost of Energy (LCOE) depends on a number of assumptions, and cost reductions are typically achieved through better design and increased scale. As with any new technology, early prototypes and pilot projects come with higher costs, serving the important purpose of proving and maturing the concept. In a complex system like SeaTwirl's solution, individual components will progress along their own cost reduction paths, depending on their initial level of technical maturity. In the analysis, a higher learning rate of 15% has been applied to newer elements, such as the rotor and power conversion system. More established components, including the spar and mooring system, are assumed to follow a 10% reduction path. Mass-produced, standardized parts are not expected to experience further meaningful cost decreases. Details behind the cost assumptions presented in the LCOE illustration can be shared upon request.



A high cost is expected for the first pilot projects and with more optimisation the composition of cost will change. The estimated cost composition for first and the third generation (approximately 24MW cumulative installation) can be seen below.



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