



A game-changer in offshore wind

Offshore wind is one of the main trends in the energy transition and it is growing rapidly. In fact, the offshore wind industry is amongst the world's fastest growing sectors. It has the potential to transform and decarbonise the electricity market. Its global market is estimated to grow at a CAGR (Compound Annual Growth Rate) of 11.5% the next three decades.

Existing solutions are bottom-fixed or floating wind turbines, both based on Horizontal Axis Wind Turbines (HAWT) technology with certain limitations. Bottom-fixed turbines can only be installed in waters of maximum 50-60m of depth while existing floating turbines struggle to produce energy at a competitive cost, due to their high capital and operational expenses.

SeaTwirl offers an innovative floating offshore wind turbine design which meets the challenges of floating offshore wind: it is easier to install, operate and maintain than the traditional HAWT's, translating into lower cost compared to other floating wind turbines.

Innovative and cost-efficient

The SeaTwirl innovation is based on a Vertical Axis Wind Turbine (VAWT) combined with an efficient spar buoy.

- **Easy access means simplified maintenance:** The location of the generator housing close to the sea surface (instead of 100-150 metres up for HAWT's) provides easy access to

essential parts from sea level. Maintenance can be carried out using smaller service vessels eliminating the need for large offshore crane vessels, reducing OPEX (Operational Expenses).

- **VAWT's are independent of wind direction** and therefore SeaTwirl turbines don't require any yaw system to turn them towards the wind direction, keeping complexity and costs low and minimising downtime.
- **VAWT's are highly scalable** and research shows that VAWT's could reach 30MW in the future, while HAWT's according to the same source have a maximum size of about 15MW.

The SeaTwirl turbine and spar buoy are fixed together and rotate as one unit in the water. This minimises the bearing loads, allowing use of less complex, thus cheaper bearing solutions. Outside the rotating axis, the generator housing is fixed to the seabed by a mooring system using traditional anchors and mooring lines instead of bottom-fixed foundations, leaving a green footprint. This mooring solution also allows relocation of the complete SeaTwirl unit.

The powerful inertia of the SeaTwirl technology allows the unit to store kinetic energy providing means for grid stabilization, potentially saving up to €70k per MW installed.

High reliability and availability results from reducing the number of components. SeaTwirl focuses on a robust design to create the cost-efficient solutions of tomorrow.

The bottom line – Levelized cost of energy (LCOE)

The annual offshore wind growth investment is increasing rapidly. This growth is expected to continue. Global offshore wind capacity is projected to increase fifteen-fold to 2040, becoming a €900 billion industry over the next two decades. The main trend is to expand into deeper waters and reach higher capacities with bigger rotors. Vertical axis turbines will drive this growth. Sandia Labs (a leading renewable energy research institute) has concluded that offshore VAWTs will have a 20% lower LCOE (Levelized Cost of Energy) than HAWT's. This correlates well with LCOE estimates carried out for SeaTwirl, resulting in an average estimation of 21% lower LCOE.

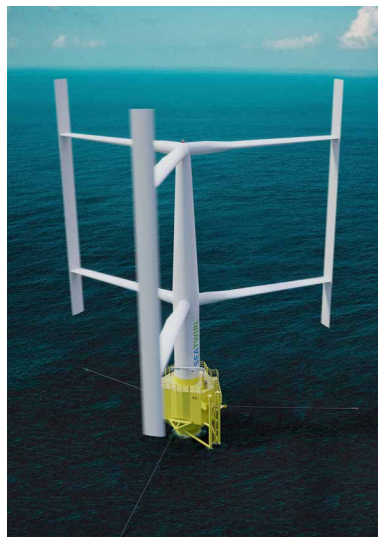
SeaTwirl is currently developing a 1 MW floating offshore wind turbine, "S2", which will be installed at a test site in Norway 2021. Analyses which have been third party verified, show that the S2 VAWT will be able to produce energy at a mature LCOE of below €50/MWh.

Oceans of opportunities

The 1 MW S2 builds on the success of the 30 kW "S1" prototype, which was developed and deployed in 2015 in the waters off Lysekil, West Sweden. The S1 prototype has been exposed to the harshest of conditions when the storms "Gorm" and "Helga" (with winds up to 36 m/s; i.e. hurricane strengths) passed by late 2015, and "Knud" in September 2018. SeaTwirl S1 was grid connected in July 2015 and has since then been generating electricity to the grid.

To fast-track commercialisation of the SeaTwirl technology, the S2 is used to approach market segments normally neglected by the larger "conventional" HAWT manufacturers: remote islands and coastal regions, marine aquaculture projects (fish farms) and for offshore oil & gas applications. Although these markets might not seem significant, a TAM (Total Available Market) assessment has concluded that these three segments in Europe have an immediate need of almost 30,000 S2 1 MW offshore wind turbines, corresponding to a sales value of more than €89 Bn. For SeaTwirl S2 we have identified a SAM (Serviceable Obtainable Market) of more than 2,500 units with a sales value of over €7,4 Bn.

The supply of electricity within these segments are usually from diesel generators. Compared to off-grid diesel generation, S2's initial LCOE is more cost effective even at the early stage.



Top: Artist's rendition of SeaTwirl S2. **Below:** SeaTwirl S1, grid connected since 2015.

Want to be part of SeaTwirl?

We are a small but highly skilled and extremely motivated team with a strong drive to provide sustainable energy to the world. We will offer our customers a turnkey solution by establishing partnerships with key players within essential disciplines such as e.g. manufacturing, assembly, installation and O&M.

SeaTwirl as a company was formed in 2012. The company's shares are listed on Nasdaq First North Stockholm since December 2016 under the ticker STW. The intellectual property behind the unique design is well protected by several patents.

We already have a letter of intent for co-operation on energy supply at remote locations and fish farms. Metcentre in Norway is working on our test site concession for the S2 pilot. Recommendation letters from Vattenfall and Simply Blue Energy show a genuine interest for our value proposition as does the fact that we already have a power purchase agreement with Haugaland Kraft in Norway for the S2.



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