EcoSwing - Energy Cost Optimization using Superconducting Wind Generators - World’s First Demonstration of a 3.6 MW Low-Cost Lightweight DD Superconducting Generator on a Wind Turbine

Project Information

**EcoSwing**

Grant agreement ID: 656024

Closed project

**Funded under**

H2020-EU.3.3.2.4.
H2020-EU.3.3.2.2.
H2020-EU.3.3.2.1.

**Overall budget**

€ 13 846 593,75

**EU contribution**

€ 10 591 733,64

**Coordinated by**

ENVISION ENERGY (DENMARK)

APS

Denmark

Periodic Reporting for period 3 - EcoSwing (EcoSwing - Energy Cost Optimization using Superconducting Wind Generators - World’s First Demonstration of a 3.6 MW Low-Cost Lightweight DD Superconducting Generator on a Wind Turbine)
MISSION ACCOMPLISHED: The EU-funded EcoSwing project ended as scheduled on 30.04.2019.
EcoSwing successfully aimed at demonstrating world's first superconducting low-cost and lightweight wind turbine drivetrain— on a large-scale commercial wind turbine.

During the 4 year project the EcoSwing ambitions were high, the consortium aimed at nothing less than the following objectives:

* Designing, developing and manufacturing a full scale multi-megawatt direct-drive superconducting (HTS) wind generator including a dedicated power converter suitable for current mass mainstream markets.
* Installing this superconducting drive train on an existing modern wind turbine in Denmark.
* Operating the superconducting drive train for at least one year, giving the community confidence in superconducting wind generators.
* Proving that the new HTS drive train is cost competitive to state-of-the-art direct-drive permanent magnet generators of world class suppliers.
* Proving that the new HTS drive train can be cost competitive to state-of-the-art geared drive trains in series production.
* Developing and manufacturing a cost-efficient cryogenics package that can be maintained atop a wind turbine by regular service people.
* Developing and manufacturing a low-cost and maintenance-friendly HTS coil package based on second generation (2G) wire. This contributed to maturing and stabilizing the European Superconductor industry.
* Addressing unique aspects of HTS drive trains (for instance in terms of hazard analysis) and providing a way for type certification.
* Developing a risk technical & financial management strategy in order to pave the way for market entry of HTS drive trains.

SUCCESS RATE
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Relative to these demanding ambitions EcoSwing has performed impressively. We scored the worldwide first superconductive generator on a commercial wind turbine. EcoSwing generator and power converter reached target range +3 MW. Beforehand, the EcoSwing generator was successfully tested at the Fraunhofer IWES laboratories in Bremerhaven and certified for prototype installation by DNV-GL.

Due to accumulated project delays, we did not reach a running time of one year. However, we logged 650 h of grid-connected operation (mostly in automatic mode). Many Danish households could claim "powered by superconductivity".

Core technologies like the cryogenics showed more than 7 months of stable and reliable system operation. Also the superconducting rotor coils showed great performance and reliability. According to schedule EcoSwing has been switched-off for decommissioning on 25.4.2019.
ABOUT THE INSTALLATION SITE
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The lead partner, Envision, provided for EcoSwing one of the most modern wind turbines in the market. The GC-1 is a 3.6 MW wind turbine with 128 m rotor diameter, and full power converter. It used to have a conventional direct-drive permanent-magnet generator. GC-1 is located at a demanding coastal site in Western Denmark, Thyborøn, near-shore to the North Sea. The environment is characterized by 9.7 m/s average wind speeds. There are also low turbulence conditions from the sea and high turbulence from the south caused by industrial buildings and additional near-shore wind turbines. The design features already partial pitch and 2-blade design for low extreme loads and endurance in onshore and offshore typhoon areas. Main facts of GC-1 project are available on a dedicated site: project-gc1.com.

ABOUT SUPERCONDUCTIVITY
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Superconductors are capable of conducting electricity without resistance. They are thus highly complementary to energy efficient technologies as a substitute to copper. In comparison to copper they can carry 100x times the current density, making electrical machinery compact and lightweight. Vastly reduced material usage contributes to making this technology highly competitive to conventional machinery.

Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far

The EcoSwing project culminated in world’s first superconducting drive train mounted on a commercial wind turbine. The work can be broken down into the following main elements:

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* Installing this superconducting drive train on an existing modern wind turbine in Denmark.
* Operating the superconducting drive train for at least one year, giving the community confidence in superconducting wind generators.
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**Progress beyond the state of the art and expected potential impact (including the socio-economic impact and the wider societal implications of the project so far)**

Accomplishments of this reporting phase significantly strengthen the European industrial technology base:

- Major impact was on quality and stability of European HTS wire manufacturing capability. We are on a very good path to reaching the projected lifts of TRL and MRL.
- Additionally, a conventional workshop for coil winding was successfully introduced into handling superconducting wire – lifting TRL and MRL for coil manufacturing to the projected levels.
- The consortium has identified near-to-commercial solutions for the cryocooling technology such as cryocoolers and helium couplings. Experimental qualification will commence shortly.
- The stator concept is pushed significantly beyond conventional state of the art technology by means of a conservative and robust approach.

![Wind turbine nacelle during installation – place of the EcoSwing generator (Courtesy: Envision)](image)