# Energy storage system of tomorrow

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Invention by Horst Schmidt-Böcking and Gerhard Luther basis for a novel marine pumped storage system developed by the Fraunhofer Institute for Wind Energy and Energy System Technology (IWES) / Tested for the first time in Lake Constance.

How can the enormous amounts of electricity generated through offshore wind power be temporarily stored on site? Until now there was no answer to this question. After several years' research work, the StEnSea project (Stored Energy in the Sea) funded by the Federal Ministry for Economic Affairs and Energy is now entering the test phase. In the framework of this project, IWES, the Fraunhofer institute in Kassel specialized in energy system technology, is now developing to application level the "marine egg" invented by two physics professors at Goethe University Frankfurt and Saarland University in Saarbrücken.

A model on the scale of 1:10 with a diameter of about three meters was brought to the ferry terminal in Constance on 8.11.2016 and lowered on 9.11.2016 to a depth of 100 meters about 200 meters from the shore in Überlingen. It will now be tested for four weeks: "Pumped storage power plants installed on the seabed can use the high water pressure in very deep water to store electrical energy with the aid of hollow spheres", explains Horst Schmidt-Böcking, emeritus professor at Goethe University Frankfurt. To store energy water is pumped out of the sphere using an electric pump and to generate power water flows through a turbine into the empty sphere and produces electrical energy via a generator. Together with his colleague Dr. Gerhard Luther from Saarland University, Professor Schmidt-Böcking filed a patent for their

principle for offshore energy storage in 2011, just a few days before the Fukushima disaster.

The two inventors remember: "The rapid practical realization of our idea is actually thanks to a newspaper article in the FAZ. Georg Küffner, the technology editor, presented our idea for energy storage to the general public - as chance would have it on the 1st of April 2011. Lots of readers doubtlessly thought at first that it was an April Fool hoax, but experts at Hochtief Solutions AG in Frankfurt immediately recognized the idea's hidden possibilities. Within a couple of weeks we were able to set up a consortium for an initial feasibility study with Hochtief's specialists for concrete structures and the experts in marine power and energy storage at IWES in Kassel, the Fraunhofer Institute for Wind Energy and Energy System Technology", recall Schmidt-Böcking and Luther.

Once the concept's feasibility had been proven, the Federal Ministry for Economic Affairs and Energy subsequently funded the StEnSea project so that the innovative pumped storage system could be further developed and tested on a model scale. It is now entering the test phase. Project Manager Matthias Puchta from Fraunhofer IWES summarizes the project's successes to date: "On the basis of our preliminary study, we carried out a detailed systems analysis with a design, construction and logistics concept for the pressure tank, developed a turbine-pump unit, examined how to connect the sphere to the electricity grid, calculated profitability and drew up a roadmap for the system's technical implementation."

He continues: "The four-week model trials on the scale of 1:10 are starting now in Lake Constance. We will run various tests to check all the details concerning design, installation, configuration of the drivetrain and the electrical system, operation and control, condition monitoring as well as dynamic modeling and simulation of the system as a whole."

IWES Head of Division Jochen Bard, who has been involved in marine power research for many years at both national and international level, explains: "With the results from the model trials, we want first of all to look more closely at suitable sites for a demonstration project in Europe. We are aiming at a sphere diameter of 30 meters for the demonstration-scale system. At the moment that's the most practical size in terms of engineering. What's already certain is that the system can only be used economically in the sea at depths of about 600-800 meters upwards. Storage capacity with the same volume increases linearly with the depth of the water and at 700 meters is about 20 megawatt hours (MWh) for a 30 m sphere."

He continues: "There is great potential for the use of marine pumped storage systems in coastal areas, in particular near the coast in highly populated regions too, for example in Norway (Norwegian Trench). But Spain, the USA and Japan also have great potential. With a storage capacity of 20 MWh per sphere and standard technology available today, we can envisage a total electricity storage capacity of 893.000 MWh worldwide. This would make an important and inexpensive contribution to compensating fluctuations in electricity generation from wind and solar power."

Provided by Goethe University Frankfurt am Main

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