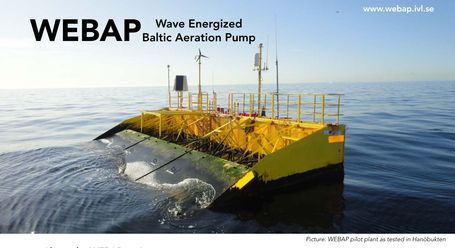
www.webap.ivl.se

WEBAP Wave Energized Baltic Aeration Pump



Picture: WEBAP pilot plant as tested in Hanöbukten

About the WEBAP project

The main objective of the project is the demonstration of a cost effective wave powered device, entitled the "Wave Energized Baltic Aeration Pump (WEBAP)", that mitigates the problem of oxygen depletion ("hypoxia") in coastal zones. Specifically, the project aims at reducing problems with dead bottoms and algae blooms in the Baltic Sea by aeration of oxygen depleted bottom water layers.

WEBAP is a pump that exclusively uses the natural resources of oxygen rich surface water and wave energy. Together with measures to reduce nutrient loads from the mainland, the aeration pumps is to enhance the restoration of the self-purifying biogeochemical processes of the Baltic Sea. Inorganic phosphorous that has been dissolved due to the current hypoxia is expected to return to be bound to the bottom sediment, thus reducing the algal bloom.

The temporal measure that this project aims to demonstrate is expected to generate several favourable effects on species that are dependent on a balanced oxygen situation at some phase of their life cycle. In the long run, an improved oxygen situation in the Baltic Sea will also have positive effects on tourism and the fishing industries.

Accomplished so far

Though the WEBAP project is currently ongoing, a number of results and outcomes can be listed from the project activities. It is important to recall that this project is not only a demonstration project but it also acts as a pioneer project involving numerous authorities, problem owners and companies becoming aware of the situation and the need for actions.

Outcomes and results of the WEBAP project:

- Two pilot plants, one wave powered and one electric oxygen pump, have been in operation for over a year
- Basin tests at Aalborg University, which confirm the concept
- Measurements confirm the estimated pumping capacity at different wave heights
- Measurements and mapping of the lack of oxygen in the area indicate that the lack of oxygen in the pilot areas is more widely spread than previously estimated
- Large datasets for marine research (outside the project)
- Large scale implementation modelling establishing that the technique does not affect the salinity stratification
- Tests with sediment and organisms from the pilot sites show no adverse effects of oxygenation
- Measurements show that oxygenation decreases the concentration of dissolved phosphorus in deep water
- Competence and knowledge-building among project partners, other involved partners, and networks
- Development work and collaboration with various stakeholders initiated
- Oxygenation in Kanholmsfjärden
- Modelling for the Gotland Deep show oxygenation of the whole area down to the seafloor after only five years
- Modelling of pump power in Kanholmsfjärden shows effect of oxygenation not only in Kanholmsfjärden but also in adjacent bays due to the high water exchange

With the contribution of the LIFE financial instrument of the European Community and the Foundation IVL.

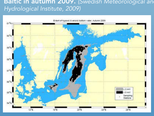
WEBAP - Wave Energized Baltic Aeration Pump

Picture: Possible layout of a full scale WEBAP plant

2008 - 2009
The WEBAP project is initiated by the project partners as an attempt to directly contribute to improve the hypoxia problem in the Baltic Sea. All project partners grant own resources in order to realise the project.

2009

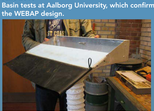
Extent of oxygen depleted bottom water in the Baltic in autumn 2009 *(Swedish Meteorological and Hydrological Institute, 2009)*



2010

June-July 2010
Mapping of state in Kanholmsfjärden, Handbukten and southern Baltic Sea finalised.

June 2010
Basin tests at Aalborg University, which confirm the WEBAP design.



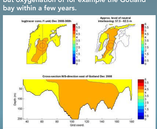
September 2010
WEBAP seminar *"Ongoing actions for a better marine environment"*, Stockholm.

September - November 2010
Construction of WEBAP I finalised. Installation and operation started.

2011

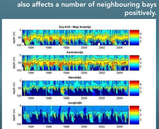
April 2011
After delays due to one of the coldest winters in Sweden, WEBAP II is launched and installed in Kanholmsfjärden.

2011 - 2012
Modelling of oxygenation based on pilots' data indicates no alternation of salinity stratification but oxygenation of for example the Gotland bay within a few years.



2012

2011 - 2012
Modelling of oxygenation based on pilot data indicates that oxygenation in Kanholmsfjärden also affects a number of neighbouring bays positively.



May 2012
Opening of the WEBAP exhibition with an interactive model and WEBAP portal for realtime information.

Summer 2012
The WEBAP pilot pump efficiency meets after first data elevation expectations.

April - August 2012
Oxygenation of the test site Kanholmsfjärden and connected bays. Test fishing results in cod catch.

2013

Planned activity: May 2013
WEBAP conference - Presentation of actions to authorities, municipalities and other problem owners and decision makers.

Planned activity: 2013
LifeCycleAssessments will compare the WEBAP concept with other abatement measures. LifeCycleCosts analyses will provide the total costs per kilogram phosphorous removed.

Related activities by the project partners

It is important to understand that the proposed oxygenation cannot replace additional necessary efforts to reduce nutrient load to the aquatic environment but is only a necessity to keep the ecosystem alive. The main project partners are engaged in a number of activities aiming at minimizing the negative impact of our society on the aquatic environment.

- R&D facility Hammarby Sjöstadsverk where IVL and KTH with partners develop new technology, approaches and educates for a better wastewater treatment and nutrient recycling (www.hammarbysjostadsverk.se)
- Ditch filter for phosphorus recycling from agricultural leakage (IVL, Simrishamn)
- Biofuel production from fish waste and by-catch to reduce marine pollution (IVL, Simrishamn)

Related other projects and activities

In order to evaluate the effect of enhanced ventilation/mixing of hypoxic bottom water layers and the ecosystems, modelling of the near environment of the demonstration using observations and results is required.

This includes results and findings from other ongoing or finished projects, for example

- **BEVIS** (A joint decision support system for effective water protection measures in the archipelagos of Turku, Åland, and Stockholm)
- **BONUS** (Baltic Organizations' Network for Funding Science EEIG)
- **MARE** (Marine Research on Eutrophication)

Modelling of the nutrient dynamics of the coastal filter has been successfully performed in the BEVIS project and these models are available to the present project.

In addition, a number of projects have been initiated that study the oxygenation of aquacultures and oxygen-depleted regions. Data and findings are shared in order to facilitate a better understanding of the processes.

- **BOX** (Baltic Deepwater Oxygenation) University of Gothenburg, Sweden
  Wave-powered oxygenation of aquacultures on Åland Islands
- **SEABED** - Phosphorus from the seabed and water quality in the archipelago - modelling attempt
- **PROPPEN** - Controlling benthic release of phosphorus in different Baltic Sea scales

Remaining actions within the project

The collected data from the pilot tests will be used to evaluate and assess the efficiency of the approach using wave energy for oxygenation. This includes the assessment of how, where and when the technology is suitable for full scale implementation in aquatic systems suffering from lack of oxygen. The project will also perform a simplified life-cycle assessment and life cycle cost analysis.

What happens after the project?

From the start, the aim of the WEBAP project has been to mitigate problems caused by oxygen depletion. The project will present possible solutions and their environmental impact and costs to various problem owners and decision makers such as the municipalities around the Baltic Sea, Environmental Protection Agencies, etc. Further, the production and further optimisation of the benefits of the proposed technology will be made available to private companies in order to create a benchmarked product at lowest possible cost.

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Duration: 2010-2013
Partners: 3

Project partners

Collaboration partners