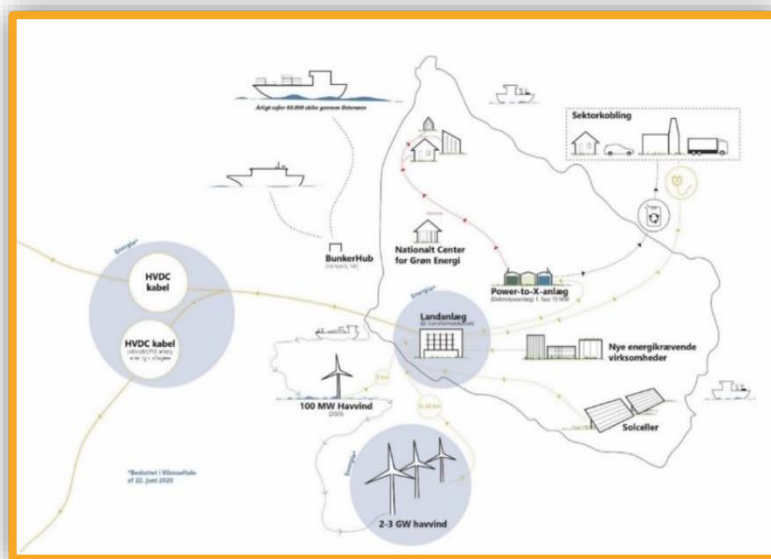


Using Recycled Wastewater to Become an Energy Island

Bornholm has used a feasibility study to examine a question that could turn the entire Baltic Sea Region into a major player in renewable energy: Could recycled water be used to produce the hydrogen needed to store wind energy? The answer is yes – and it is significantly more cost-effective than using desalinated seawater. But the right conditions have to be in place.



Bornholm – energy island

Large offshore wind farms are being built around Bornholm and plans for the island as an energy hub are taking shape. But electrolysis, the process used to generate green hydrogen as a storage medium for wind energy, requires enormous volumes of highly purified water, known as ultra-pure water (UPW). Ever since

Bornholm set out its vision of becoming an “energy island,” the question has been on the table: Where will this essential resource for hydrogen production come from? This question is especially relevant because Bornholm, like many coastal regions around the Baltic Sea, is humid but not free from water scarcity. The island extracts around three million cubic metres of drinking water from groundwater each year – a resource that already comes under strain during the summer months, when visitor numbers on the tourist island peak. Climate projections indicate that availability will not improve. Using significant amounts of groundwater for industrial electrolysis would therefore be both ecologically and ethically problematic. So the next obvious source to consider is seawater – of which there is certainly no shortage here.

These were, in very brief terms, the first considerations that ultimately led Bornholm to rethink its approach to water management – and eventually to carry out an initial feasibility study. It examines the question: Should the water required for the planned hydrogen production really come from desalinated seawater, or

would it be better to recycle municipal wastewater instead? Both options are technically feasible. Seawater is nominally unlimited, but desalination is energy-intensive and expensive. Treated municipal wastewater, on the other hand, is a continuously available resource located close to the point of demand.

Until now, wastewater recycling has generally been considered relatively expensive – at least when it comes to producing drinking water. But with regard to the planned hydrogen production, the feasibility study assumed that wastewater recycling could be highly advantageous both ecologically and economically, provided the entire life cycle and local conditions were taken into account. And this assumption was confirmed.

Municipal Foresight: Wastewater Becomes a Resource

“Our life-cycle analysis showed that treated wastewater can reduce energy consumption and the CO₂ footprint by up to 44 percent compared with seawater desalination,” explains Paulo Silva, the study’s project manager at the municipal water supplier BEOF. “Of course, this effect only applies if wind power is used for wastewater recycling. But those synergies exist here on Bornholm.” The analysis outlines supply pathways for both a 25 MW electrolyser and a large-scale 800 MW scenario. In both cases, treated wastewater can reliably provide the required volumes of water.

That such a study was initiated at all is remarkable – not least because of how it came about: it was not an industrial company but the municipal water supplier BEOF that launched it, an integrated public utility whose primary task is to supply drinking water to the population. “Bornholm’s drinking water resources are limited. Using them for industrial processes like electrolysis would not only be risky but ethically questionable,” says Silva. “With the study, we wanted to show that sustainable alternatives exist — and that municipal actors can take responsibility at an early stage.” The aim, he says, is to create a solution based on the use of treated wastewater that meets environmental standards, is economically viable, and protects drinking water resources.

Political Room for Manoeuvre and Technical Clarity

Technically, many things would be possible. But the study also shows that political decisions must provide the framework. The construction of a central wastewater treatment plant that could supply high-quality effluent on a larger scale was unfortunately postponed during the timeframe of the feasibility study. Until now, the 588-square-kilometre island has had 12 small and medium-sized wastewater treatment plants that treat municipal wastewater locally before returning it to the natural cycle. The large central treatment plant, initially envisioned for Rønne or a

more central inland location, would have provided a major efficiency gain for hydrogen production. In the feasibility study's economic calculations, it functioned almost like an extra booster. For a brief moment, it seemed as if the booster could materialise sooner than expected. When local political priorities changed, however, the plans reverted to the original, longer-term schedule.

It will be interesting to see how things develop over the coming years. But even with decentralised treatment plants, recycling wastewater for hydrogen production would be viable. "The feasibility study takes a long-term perspective anyway, and municipal planning processes sometimes move slowly. That is precisely why the study is so important," says Silva. "It provides robust data on which political decisions can be based – and at the same time raises the question of what role municipal companies should play in these developments." As the municipal utility, BEOF does not see itself as the operator of a hydrogen plant, but as an enabler: a provider of fit-for-purpose water for industrial use produced from circularly reused wastewater. The responsibility for the final purification into ultra-pure water lies with the PtX operator. However, under Danish law, a municipal supplier is not permitted to deliver industrial process water below drinking water quality directly. BEOF is therefore considering establishing a sister company exclusively responsible for industrial water needs. Such an organisationally separate structure would guarantee legal clarity and protect the public drinking water supply.

Legal Certainty Through New Structures

"We absolutely do not want to hinder industrial development – but it must be sustainable," emphasises Silva. "By establishing a separate water system for industrial purposes, we can open doors without putting the population's water security at risk."

The study also does not shy away from critical aspects. A particularly critical issue is the handling of the saline waste stream, the concentrated salt residues that result from reverse osmosis during water purification (the so-called RO brine). In the large-scale scenario (800 MW), the volume of RO brine could amount to as much as 25 percent of the wastewater treatment plant's inflow – an environmental burden that cannot simply be discharged into the Baltic Sea. A functioning concept for treating this brine is therefore essential. The study recommends piloting under real conditions to test practical feasibility, purification performance, and regulatory compliance before significant investments are made. Logistical and permitting issues also remain to be clarified: ideally, a wastewater treatment plant would be built close to the PtX facility, but available land is scarce. Currently, the scenario is based on using the existing facility in Rønne and transporting the water to the planned PtX site near the substation.

A Model for the Entire Baltic Sea Region

These questions relate not least to Bornholm's specific local conditions. Yet the broader significance of the project is already clear. Across many parts of the Baltic Sea Region – from Sweden to Poland and northern Germany – plans for green hydrogen production are emerging. And everywhere, the same question arises: Where will the ultra-pure water come from? Bornholm is setting an example by having municipal actors strategically consider how resource protection and industrial development can be brought together – and how wastewater recycling can become a key factor in the green transition.

Bornholm illustrates a challenge shared by many coastal regions around the Baltic Sea: being located in a humid climate does not automatically guarantee secure water availability. Around three million cubic metres of drinking water are extracted from the groundwater each year; total available water resources are estimated at around five million cubic metres annually. Against this backdrop, allocating significant amounts of groundwater for industrial electrolysis would be problematic in many regions – both ecologically and ethically. The water demand of hydrogen production is not a minor issue. It is a central lever for achieving climate goals while protecting scarce resources. Bornholm has demonstrated how to approach this question systematically and provides a toolkit for other regions that wish to take similar steps. "Drinking water extracted from groundwater is reserved for the population. Industry receives fit-for-purpose water from alternative sources – that is the clear line," says Silva, referring to Bornholm's "Wastewater as a Resource" strategy.

Knowledge Creates Room for Action

Feasibility studies like the one carried out on Bornholm are not mere theoretical exercises. They are tools for informed decision-making and help create political scope for action. Above all, they show that sustainability always requires organisation, responsibility and the willingness to think ahead.

The planned centralisation of municipal wastewater treatment would create a reliable, high-quality source for water recycling – and the hope is that the necessary investments will soon be approved. The feasibility study now puts this vision on a firm footing: it quantifies technical options, costs and environmental impacts and translates them into concrete scenarios. In doing so, it supports decisions that can serve as a model far beyond Bornholm. As a result, the island has not only delivered a technical answer to the water question, but also a clear signal of what becomes possible when local actors take the lead in the energy transition.

About the WaterMan project

WaterMan promotes a region specific approach to water recycling, which intends to use the alternation of too much and too little water that has become typical in the Baltic Sea Region to make the local water supply more resilient, and supports municipalities & water companies in adapting their strategies.

More information: <https://www.eurobalt.org/WaterRecyclingToolbox/>
<http://interreg-baltic.eu/project/waterman>

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