SEAWATER AND HYDROGEN

The production of green hydrogen through the electrolysis of seawater has become a lot more economically attractive. Wageningen scientists have proven with a pilot plant that it is possible to extract the Ultra-Pure Water (UPW) from seawater. The energy for that process comes from the residual heat of the electrolyser.

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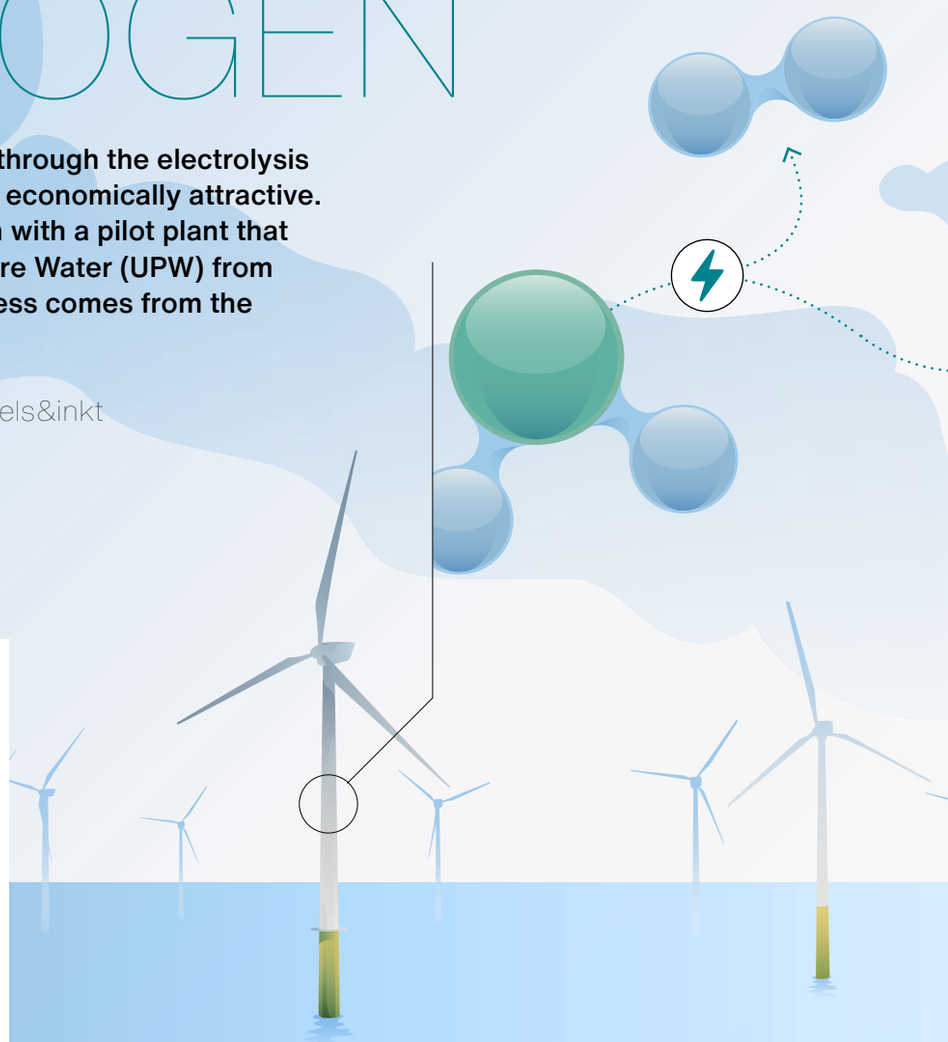


HYDROGEN: WHY

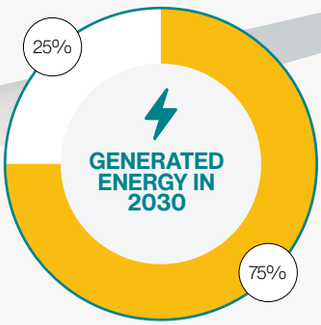
In the electricity grid, supply and demand must be balanced. No electricity must be 'thrown out': that's the law of conservation of energy, $E_{in} = E_{out}$. So when offshore wind energy production exceeds demand, wind turbines have to be shut down – unless the energy surplus can be used for electrolysis. Then the electric current is used to split the compound water (H_2O) into oxygen O_2, and hydrogen H_2, an energy carrier. In the process, about 20-25% of the electricity is converted into heat, which is otherwise usually lost. Electrolysis requires Ultra-Pure Water (UPW), water without the carbonate and magnesium and calcium ions that are still present in demineralized water. The best-known methods for extracting UPW from seawater are reverse osmosis and membrane distillation.

- Hydrogen (H_2)
- Oxygen (O_2)

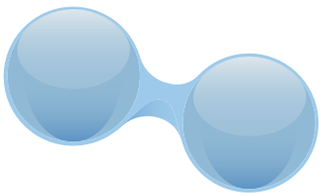
1 **MEMBRANE DISTILLATION** is a separation process in which two aqueous solutions at different temperatures are separated (by evaporation and condensation) via a microporous hydrophobic membrane that is gas-permeable. The success of the pilot plant brings several plusses with it:

- ⊕ No chemical pre-treatment of seawater required.
- ⊕ The salt content of the residual seawater is not much higher than seawater.
- ⊕ Energy-efficient: residual heat from the electrolyser is (pretty much) the only source of energy for the membrane distillation.
- ⊕ Ultra-Pure Water as valuable surplus yield: the residual heat from the electrolyser can be used to produce 3 times more UPW than is needed for electrolysis.

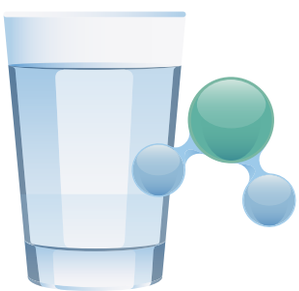
The Netherlands wants to generate 21 gigawatts of offshore wind energy by 2030, which is about 75% of the country's electricity consumption.



2 REVERSE OSMOSIS demineralizes seawater by pushing it through a very fine membrane under high pressure (around 80 bars). The chief disadvantages of this production method for Ultra-Pure Water are that the seawater requires pre-treatment with chemicals and the salinity of the 'residual water' is twice as high as that of seawater. Plus, it requires a lot of electricity.



HYDROGEN
(officially: dihydrogen) is an energy conductor. The energy is released by creating a controlled reaction with oxygen via a fuel cell, with water and heat as the only emissions:
$2\ H_2 + O_2 = 2\ H_2O$. That water can be reused.



SURPLUS YIELD
The principles of the trial can also be applied onshore, and using 'surplus' solar energy. This could be particularly valuable in the summer, when solar farm production peaks at the same time as demand for freshwater. The surplus Ultra-Pure Water yield that is not needed for electrolysis can be used for horticulture or drinking water.

PROJECT SEA2H2
This project is part of Wageningen Food & Biobased Research's work on Water Technology for the Energy Transition. It is headed by Jolanda van Medevoort and is part of the Water Treatment and Technology programme led by Irma Steemers-Rijke.