OSMOTIC POWER

When freshwater meets saltwater, for example where a river flows out into the sea, enormous quantities of energy are released. This energy can be utilised to generate power through the natural phenomenon of osmosis.

WHERE THE RIVER MEETS THE SEA

In an osmotic power plant, we feed fresh water and seawater into two chambers, separated by a membrane. The salt in the seawater then draws the freshwater through the membrane, causing the pressure on the seawater side to increase. This pressure corresponds to a water column of 120 metres, similar to a large waterfall, and can be utilised in a turbine to generate electricity.

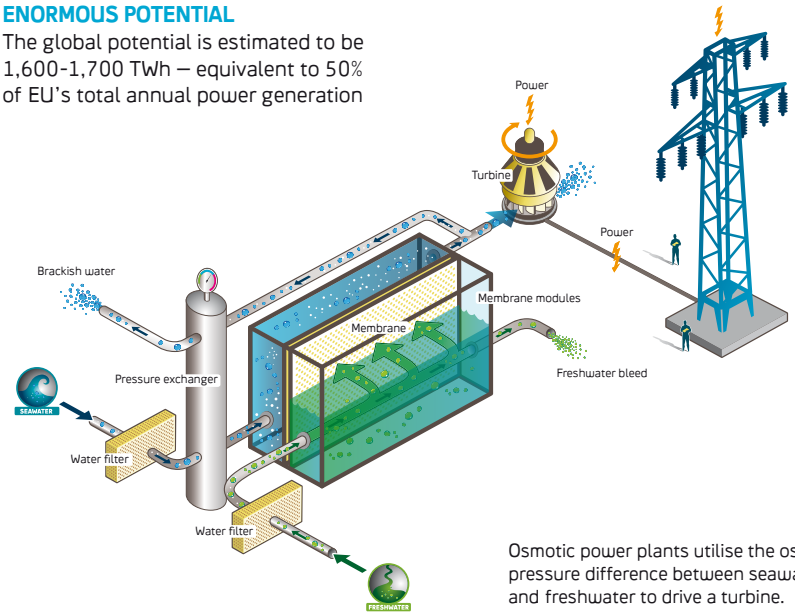
Osmotic power plants can be constructed anywhere freshwater flows out into the sea, provided that the salt concentration is sufficiently high. Unlike solar power and wind power, osmotic power plants are not affected by fluctuations in the weather and will produce continuous and predictable electricity. Most river outlets around the world represent a potential location for a plant, even though some rivers need more cleaning of the water than others.

ENORMOUS POTENTIAL

The global potential is estimated to be 1,600-1,700 TWh – equivalent to 50% of EU's total annual power generation today. In Norway alone, we could be able to generate 12 TWh per year – equivalent to around 10% of our total power consumption. Osmotic power can become an important contributor to the generation of clean, renewable energy.

ENVIRONMENT-FRIENDLY ENERGY

Around the world, rivers flow out into the sea in urban and industrial areas where it will be possible to construct osmotic power plants. A power plant the size of a football stadium could supply around 30,000 European households with electricity. These power plants can be built underground, e.g. in the basement of an industrial building or under a park, minimising their visual impact. Osmotic power plants produce renewable energy with no polluting discharges to the atmosphere or water.



Osmotic power plants utilise the osmotic pressure difference between seawater and freshwater to drive a turbine.

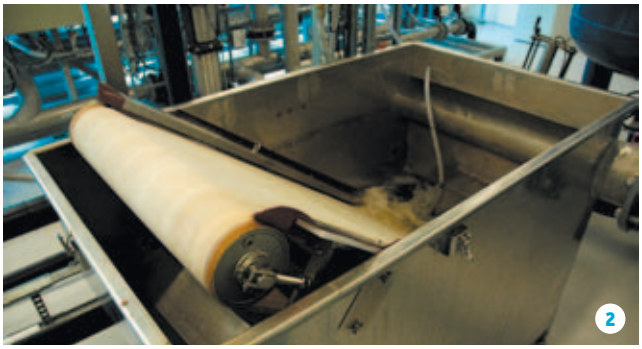
FACTS ABOUT OSMOSIS

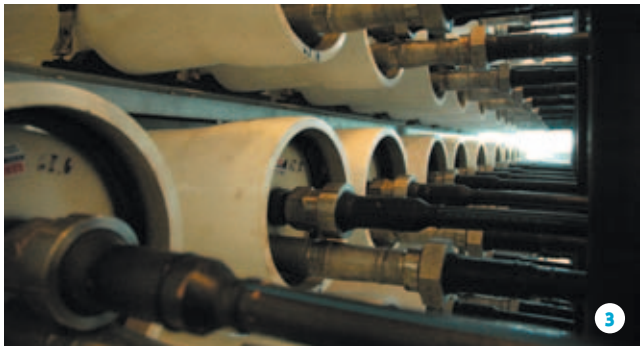
- Osmosis is the transport of water from an area with low concentration of dissolved substances (e.g. salt) through a membrane to an area with a higher concentration.
- The membrane is semi-permeable. It allows some substances to pass through, but stops other substances.
- Nature will seek to equalise the difference in concentration between the two sides of the membrane. It is this mechanism which enables plants to absorb moisture through their leaves and retain it.
- As water is drawn through the membrane one way only, a pressure is generated on the "inside", which in an osmotic power plant can be utilised to generate electricity.

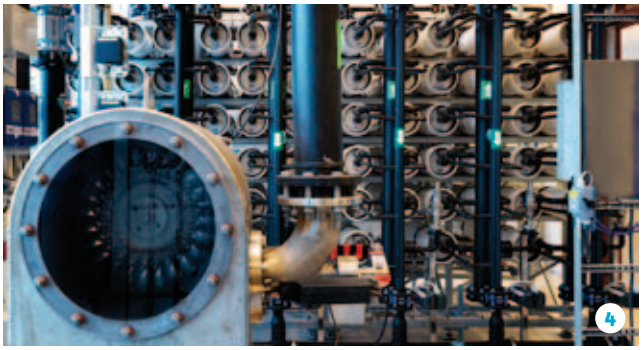
Statkraft
PURE ENERGY

Background

- During the 1970s, Sidney Loeb develops membrane technology for the desalination of seawater, and also discovers the possibility of generating osmotic power.
- Statkraft together with SINTEF start a feasibility project on osmotic power in 1997 spurring the development of a new, renewable energy source.
- During the years since 1997 Statkraft together with several international partners has made great improvement of the osmotic power membrane.
- In 2003, Statkraft is awarded its first patent for osmotic power membranes and opens a test facility at Sunndalsøra.
- In 2009, the world's first complete osmotic power prototype is constructed at Tofte in the municipality of Hurum, southwest of Oslo.
- In November 2009, the operation of the prototype starts and for the first time the feasibility of the osmotic power concept is demonstrated.
- Statkraft aims to develop osmotic power for commercial operation from 2015.
- Today Statkraft are heading the development of osmotic power, but there are several other groups working on solving the critical challenges.







1: The prototype at Tofte, south of Oslo. **2:** Water is filtrated to avoid clogging of the membranes. **3:** Membranes are coiled up inside pressure vessels. **4:** The pressure is utilised in a turbine to generate electricity.

Statkraft has constructed the world's first osmotic power prototype

Statkraft put the first osmotic power prototype plant in operation in November 2009, at Tofte outside Oslo. The main objective is to verify the technical feasibility of the concept, as well as increase the understanding of the environmental impacts. In particular, the prototype will be used for testing and improving individual components such as the membrane, and also for system optimization. Last, but not least, the prototype will be a meeting place for all stakeholders in the development of osmotic power, such as research, industry and governmental representatives.

ABOUT THE PROTOTYPE

The prototype plant is located in an industrial area with ample supply of both freshwater and seawater. The water is fed into the plant through pipes, via filters that remove humus and particles that may clog the membranes.

The membrane system is the core of the plant. The membrane is made from polymers and is coiled up inside pressure vessels. The prototype has approximately 2,000 m^2 membrane installed. Other equipment includes pipes, valves and pumps for transport of water, turbine, pressure exchangers, water purification and membrane cleaning systems.

THE WAY FORWARD

More efficient membranes is a key development area. The membrane initially used has a capacity of less than 1 watt per square meter – the target is 5 watt. The prototype is dimensioned for 10 kW and is expected to be in operation for 2-3 years. Following continuous improvements and upgrading of the prototype, the next phase will be a pilot plant of 1-2 MW. Statkraft aims to start building a full-scale osmotic power plant by 2015.