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## Motivation

To meet the world energy demand in a sustainable way, new renewable energy sources need to be investigated. Salinity gradient energy (SGE) has gained attention during the past decade showing an increased potential. SGE is the available energy from mixing seawater and river water. By using Reverse ElectroDialysis (RED) with ion exchange membranes (Fig 1.), energy is harvested.

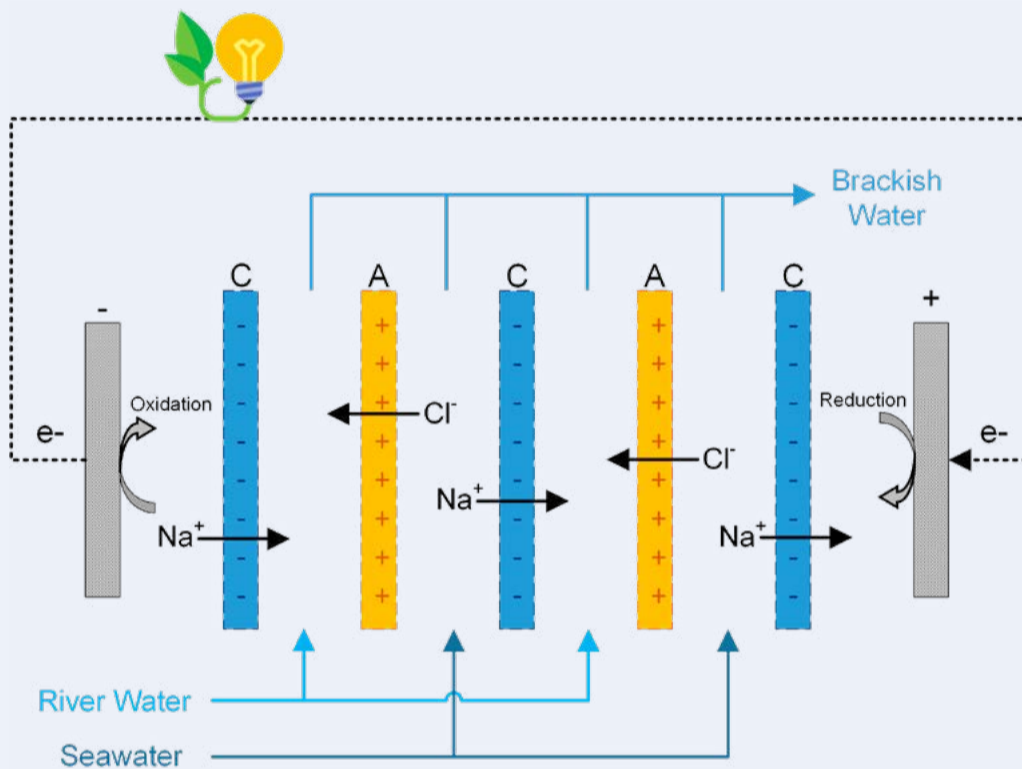


Fig 1. Principle of RED in scheme. The anions and cations selectively cross the anion and cation exchange membranes, respectively. At the electrodes, redox reactions occur which allows the ionic current to be transformed into electrical current.

As a result of Wetsus research, RED has been brought from idea to a pilot scale at the Afsluitdijk, where the IJsselmeer and the Wadden sea meet (Fig 2.). Henceforth studies can be conducted regarding the scale-up and new concepts in real-life conditions.



Fig 2. Full scale RED research facility at the Afsluitdijk, The Netherlands, built in 2014 [1].



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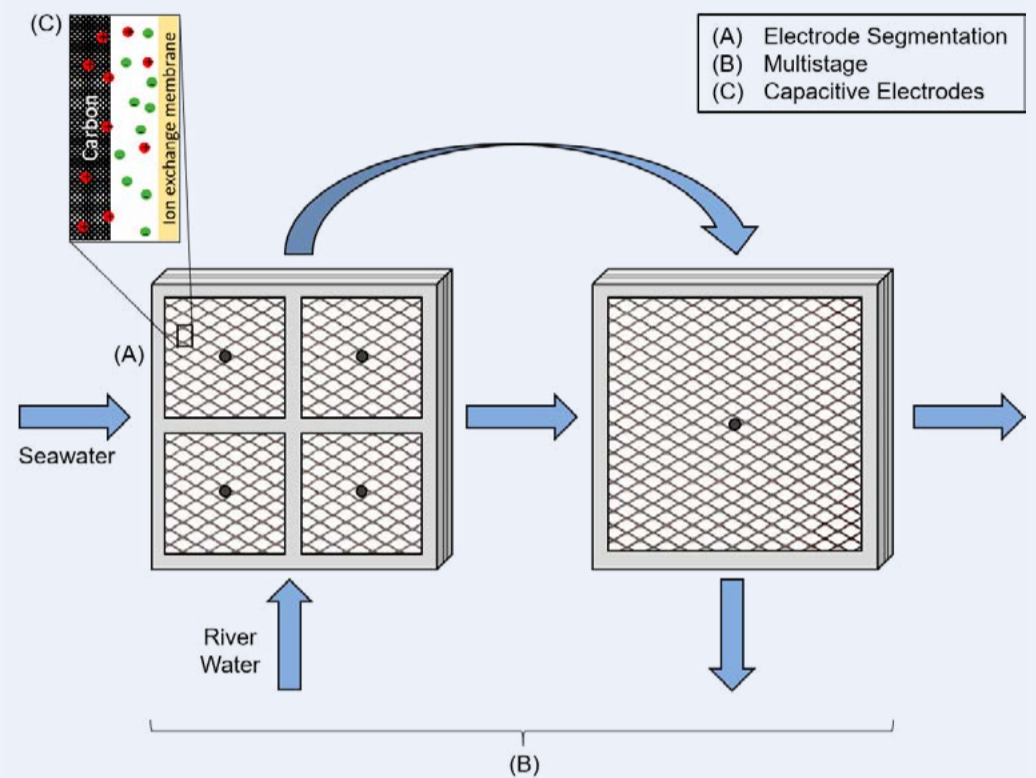


Fig 3. Different concepts to be investigated. (A) Electrode Segmentation. (B) Multistage. (C) Capacitive Electrodes.

## Technological challenge

Up to now, most research focusses on a single pass continuous operation of RED stacks. To overcome existing limitations in RED performance and to become economically attractive, new operational concepts will be developed and further investigated (Fig 3.) [2,3].

In addition, current RED stacks use a redox component at the electrode compartments. A system without expensive materials, hazardous chemicals, and possible unwanted by-products, would be both more sustainable and economical. The first direction towards a redox free operation can be the use of capacitive electrodes [4].

## Research goals

The aim of this research project is optimizing the RED process performance by developing new operation modes. This includes:

- Investigation of the gradient behaviour within the stack by electrode segmentation and multistage operation.
- Study of capacitive electrodes to achieve a redox free operation.
- Scale-up optimization under real-life conditions.

### References

- [1] redstack.nl
- [2] J. Veerman et al., Chem. Eng. J. 166 (2011) 256–268.
- [3] D.A. Vermaas et al., ACS Sustain. Chem. Eng. (2013).
- [4] D.A. Vermaas et al., Energy Environ. Sci. (2013) 6, 643.