# Reverse Electrodialysis Power Production

## *Progress in the development of an innovative system*

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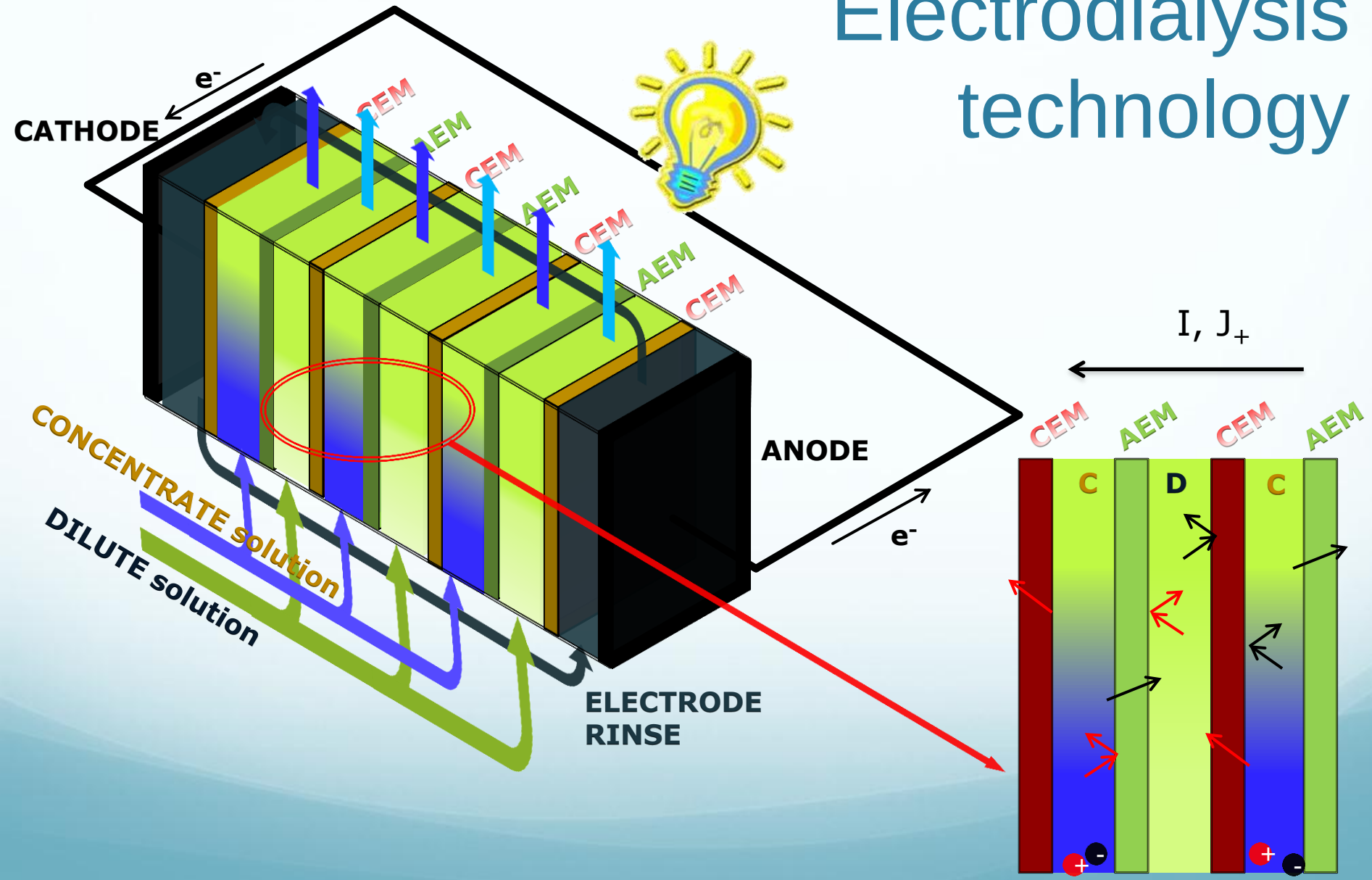
# Main facts

- Project name: ***Reverse Electrodialysis for Alternative Power production - REAPower***
- Collaborative project - FP7 (FET)
- *Starting date:* 1 October 2010
- *Closing date:* 30 September 2014

# The Reverse Electrodialysis technology

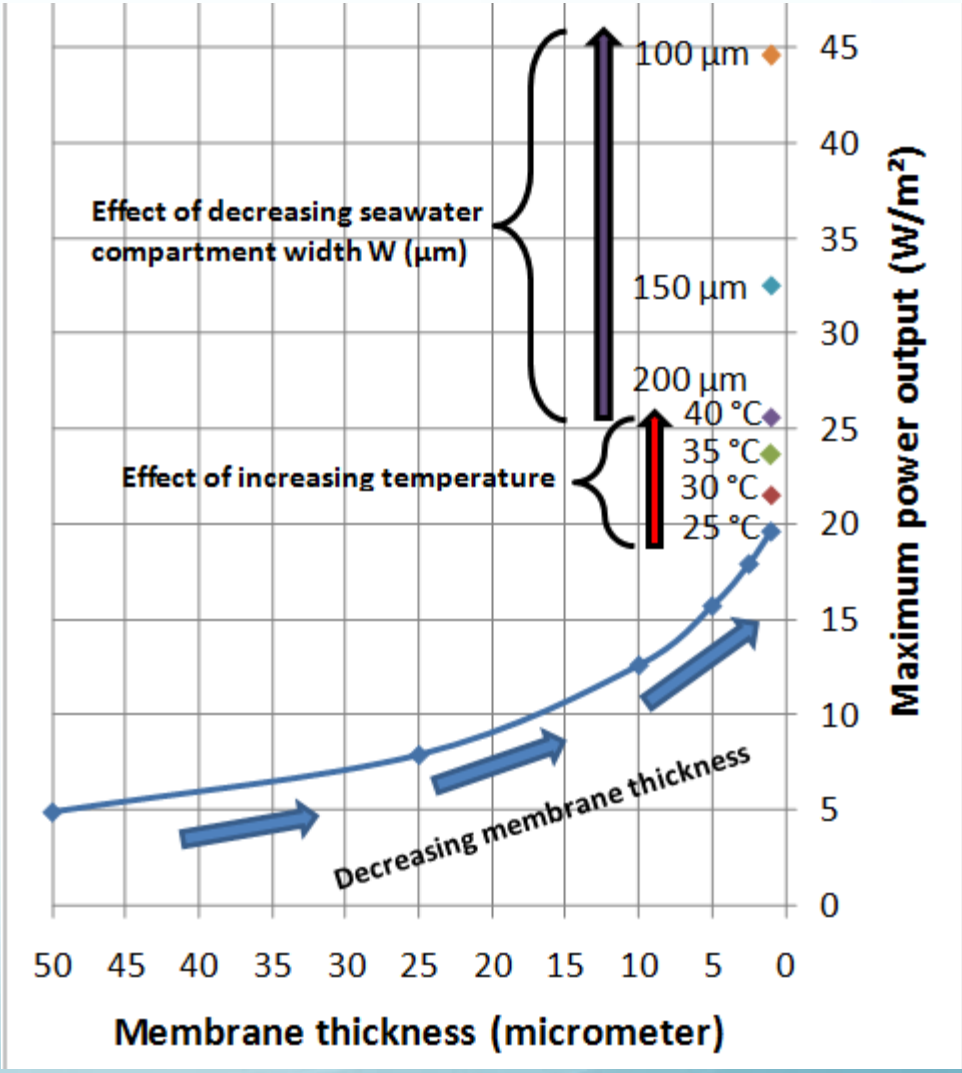


# The concept

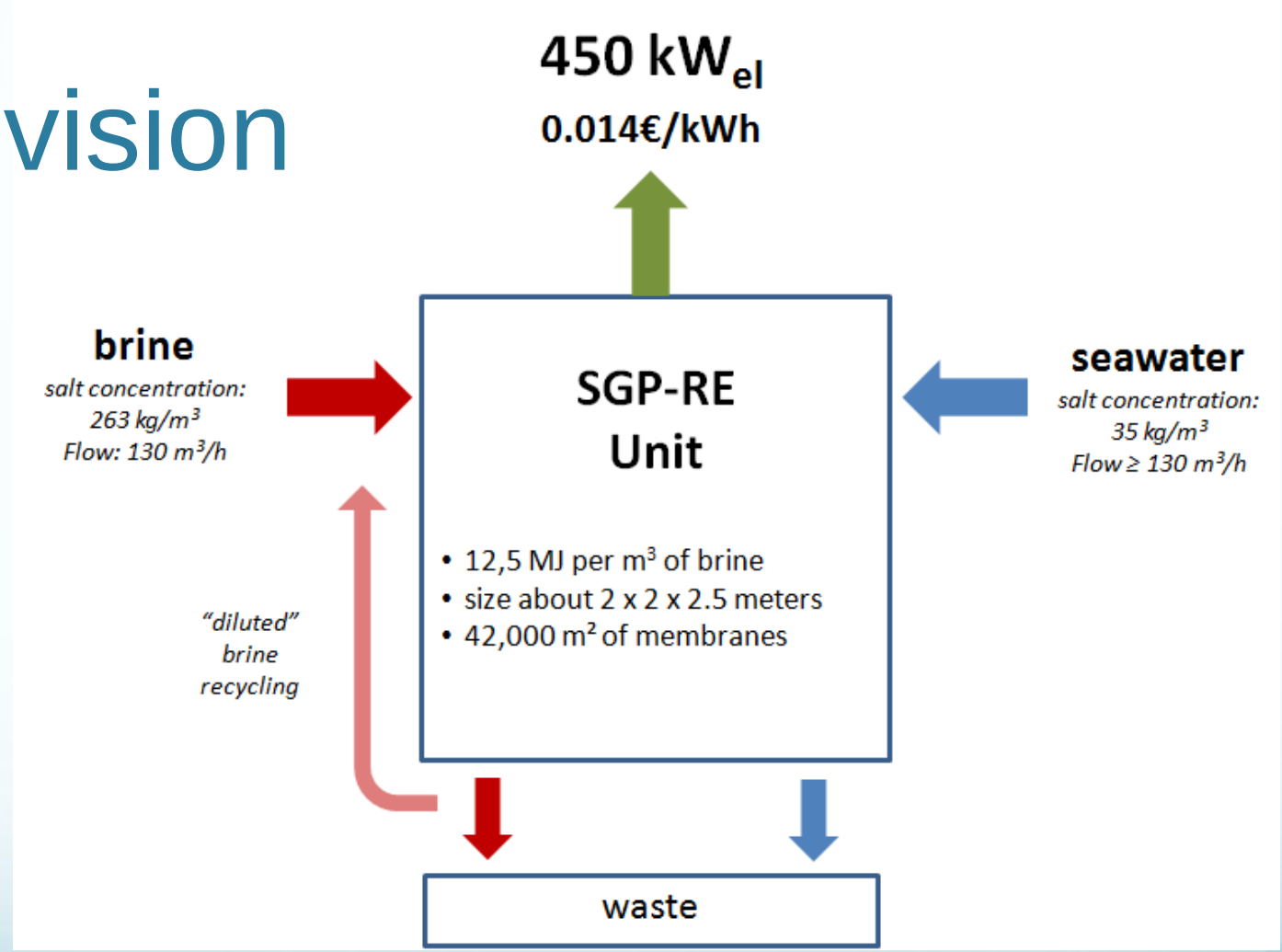
**To produce energy from salinity gradients generated by ultra-concentrated brines and sea- or brackish-water**

Technological benefits for the SGP-RE process

New potentials for the exploitation of brines



# The vision


450 kW$_{el}$
0.014€/kWh
brine
salt concentration:
263 kg/m$^3$
Flow: 130 m$^3$/h
SGP-RE
Unit
• 12,5 MJ per m$^3$ of brine
• size about 2 x 2 x 2.5 meters
• 42,000 m$^2$ of membranes
seawater
salt concentration:
35 kg/m$^3$
Flow ≥ 130 m$^3$/h
"diluted"
brine
recycling
waste

# The objectives

i) Define and optimise materials and components tailored to the requirements of the technology;

ii) Optimise the design of the SGP-RE cell pairs and stack using computer modelling tools;

iii) Validate the model and assess the developed materials, components and design by laboratory stack tests;

iv) Evaluate and improve the system performance through tests on a prototype fed with real brine;

v) Analyse the “economics” and assess the perspectives

vi) Define the next R&D steps

# Achievements and perspectives

## IEMs performance enhancements

Increased permselectivity → Membrane materials have been improved to achieve permselectivity of 84% for the CEM and 65% for the AEM ($Na^+$ is smaller than $Cl^-$ and can go through the AEM easier) (measured between 0.5M and 4M NaCl)

Reduced membrane resistance → Membrane specific resistance is below 1.5 $\Omega.cm^2$ @ 100 µm. Further reductions will come from thinner membranes

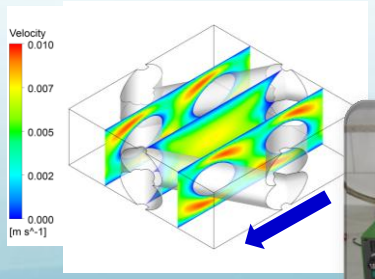
# Membrane Integrated Spacer and fluid dynamic optimisation

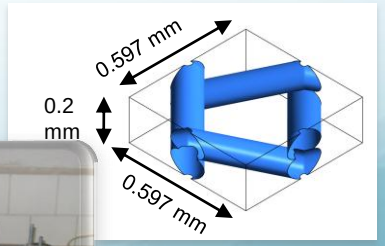
Membrane Integrated Spacer

Tests are being performed for the preparation of **Membrane Integrated Spacers**, aiming at membrane thickness in the range **10-20 μm**

Choice of spacer thickness and geometry

**CFD simulations** have been adopted along with experimental characterisation of different spacer thicknesses and geometries



# Redox couples and stack design

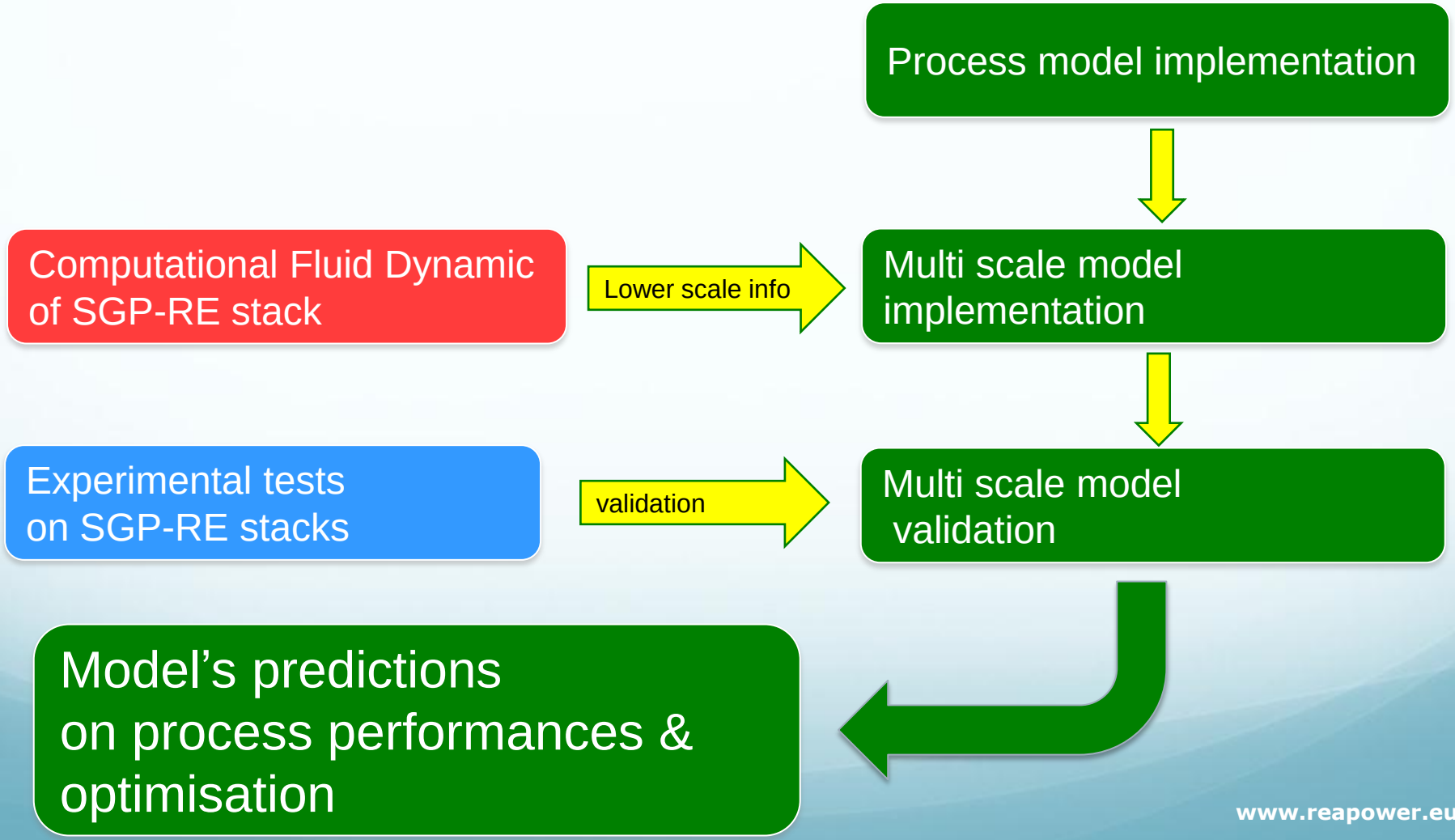
Redox couples selection

Several redox couples have been tested under different conditions, finding the most promising for the SGP-RE prototype:
$FeCl_3/FeCl_2$; Water/$Na_2SO_4$;
$[Fe(CN)_6]^{3-}/[Fe(CN)_6]^{4-}$

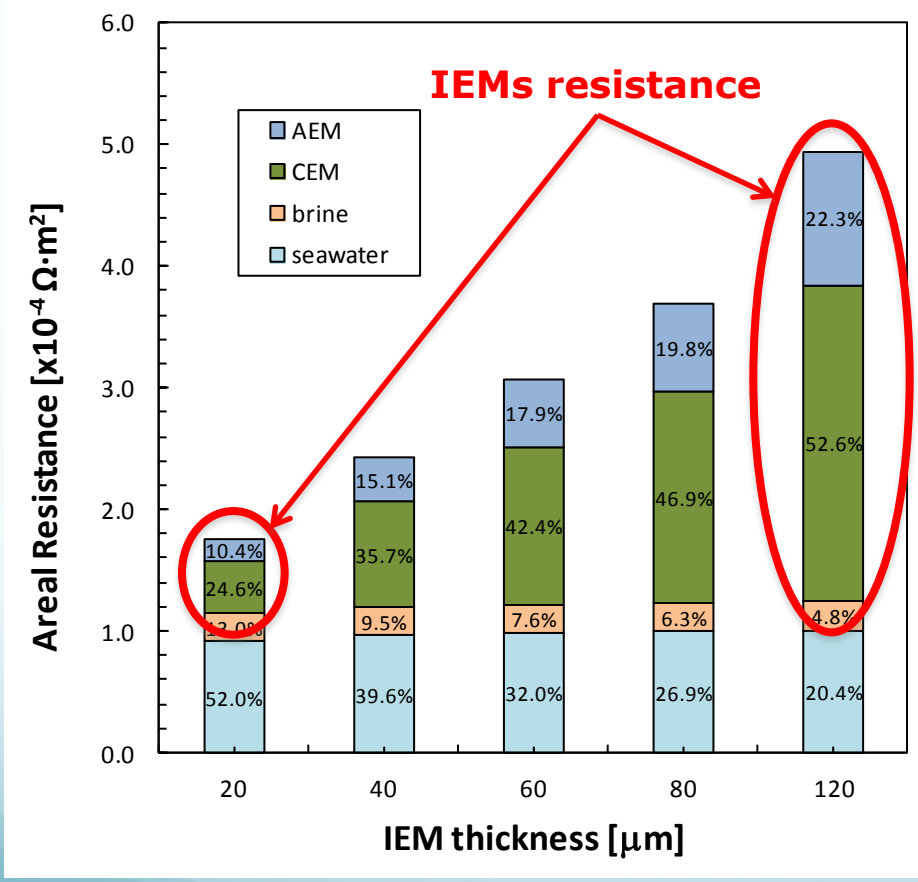
2 stack generations already designed and tested

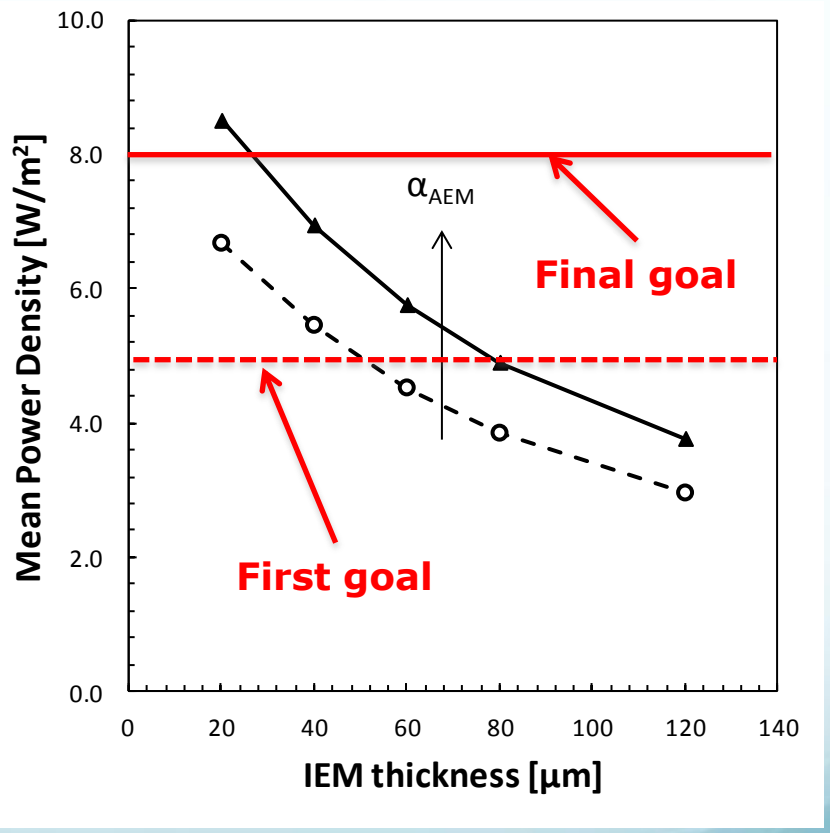
Two different stack geometries have been already designed, constructed and tested and are now available for the consortium

# Multi-scale model implementation



# Power density output: effect of IEMs properties




Simulation of a 1000 cells stack assuming a linear decreasing of IEMs resistance with IEMs thickness. $\alpha_{AEM}$ = 0.65, $\alpha_{CEM}$ = 0.90. Spacer thickness of seawater/brine compartments $\delta = 200\ \mu m$.

# Prototype installation site: Ettore-Infersa saltworks

Direct access to both saturated brine and seawater from open channels

Installation place within an old, restructured WINDMILL

# Which brines for the SGP-RE process?

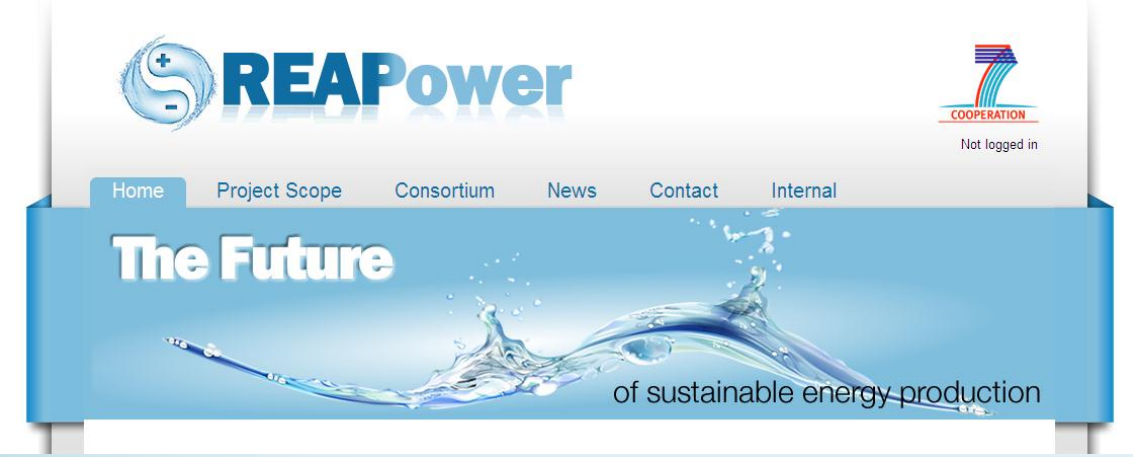
Environmental issues related to brine discharge have become more and more crucial in a number of different situations such as:

Desalination plants | Mining activities | Salt industry

- REAPower can offer a solution as a non-conventional source of minerals and energy, while diluting the brine before disposal

www.reapower.eu

# Thanks for your attention

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