Conceptual design of a salinity gradient energy demonstration unit at the Magdalena River mouth

Roldan-Carvajal. M[1,2,3], Álvarez-Silva. O[4], Maturana-Córdoba. A[5], Cala-Barceló. A.V[5], Solano-Trujillo. S[4], Pérez-Grisales. M.S[1], Arias-González. M[1], Sánchez-Sáenz. C.I[1,2], Andrés F Osorio[2,6].

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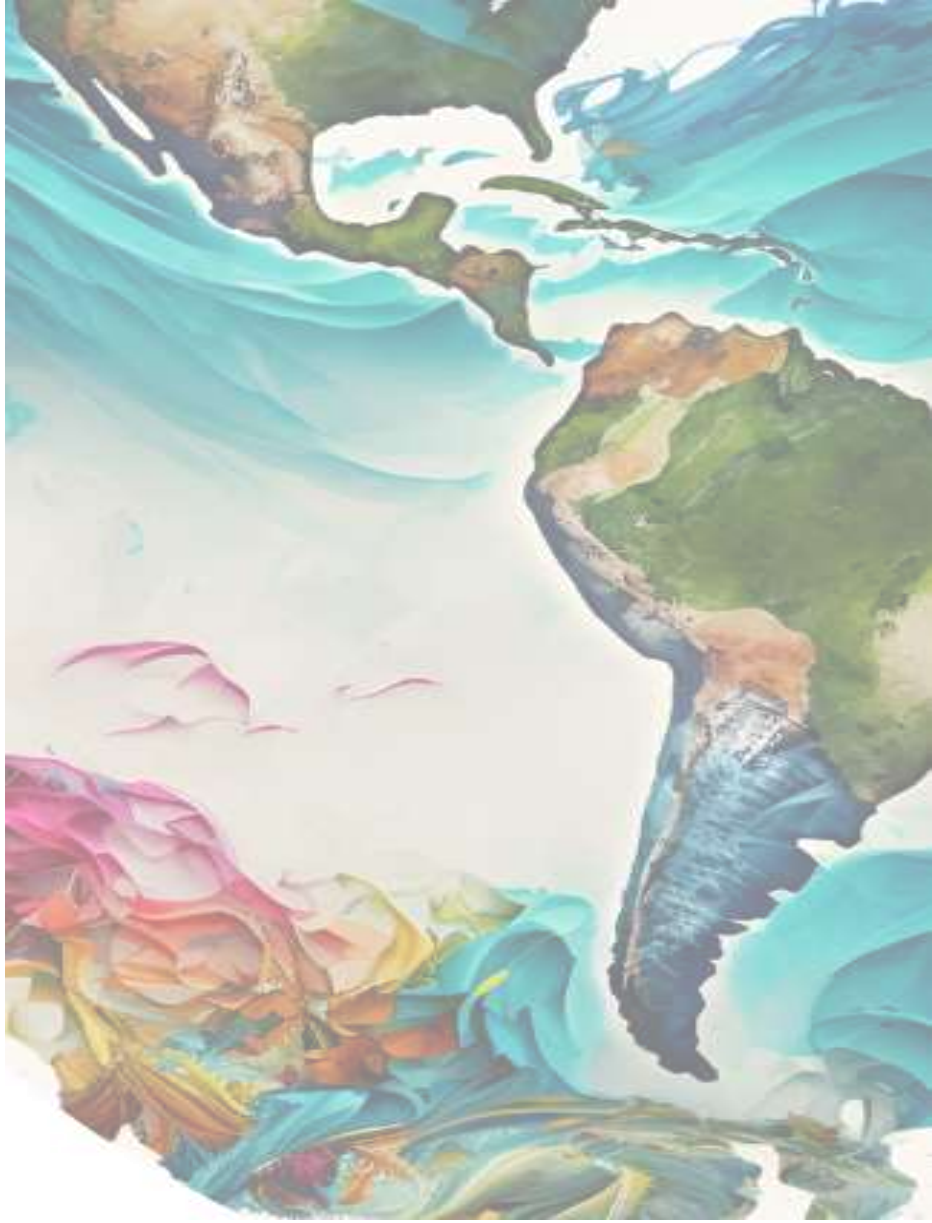

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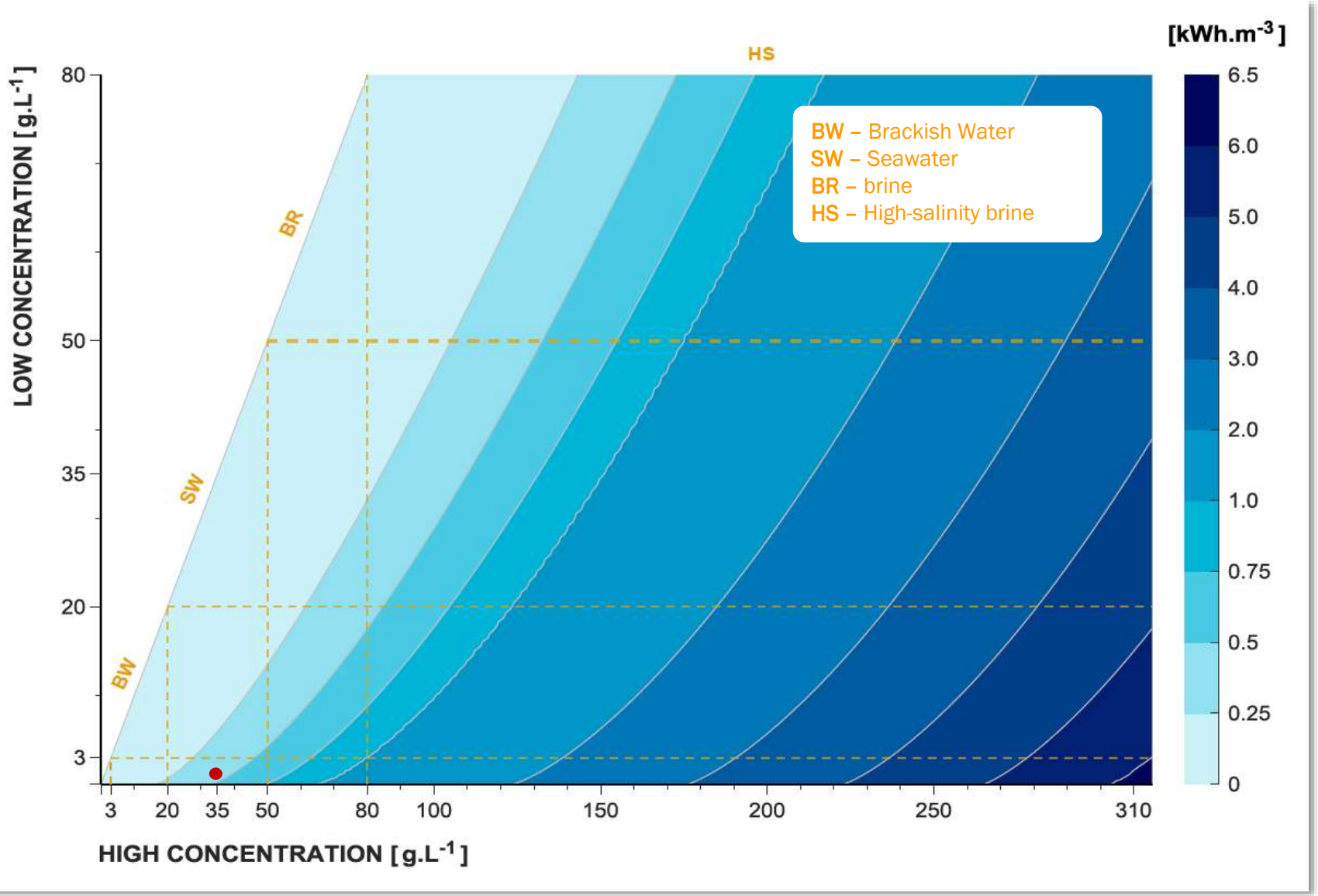
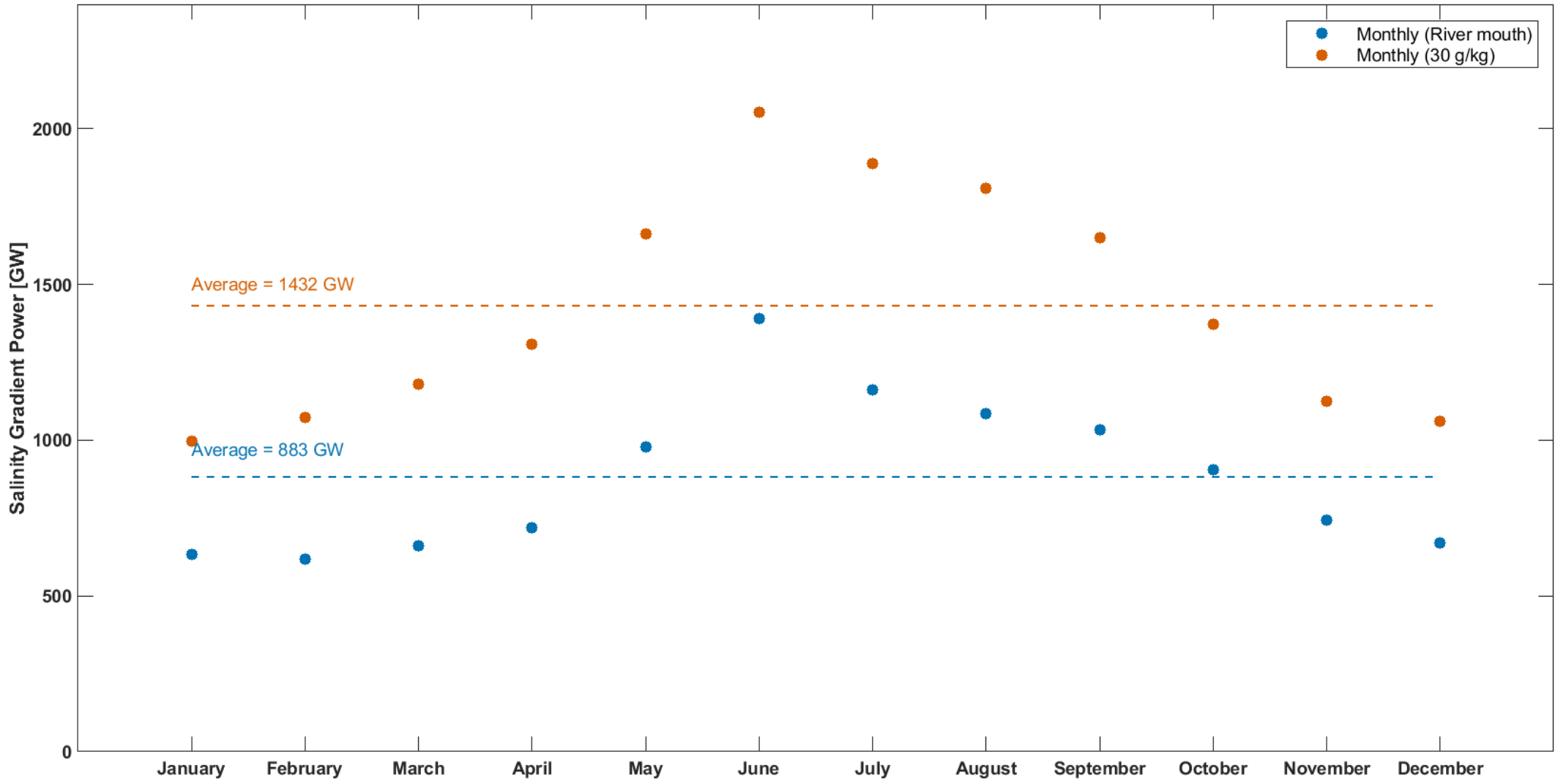
SGE Fundamentals

- Salinity gradients are **chemical potential gradients.**
- **Proposed in the '50s** as a renew energy source at **river mouths.**
- The mixing of 1m^3 of river water 1m^3 of seawater releases **~1.65**
- SGE is **often (mis)named** *"Osmo Energy".*



- Picture from a working paper. **Roldan-Carvajal et.al (2024)**

Worldwide potential at River mouths



- Pictures from a working paper: Alvarez-Silva, O.A, Roldan-Carvajal. M, Arevalo-Mesa, F (2024)

SGE Milestones – some examples

	Installed Capacity (kW)	Energy Density ($MJ.m^{-3}$)	Water flow (m^3, h^{-1})
Seawater – Fresh Water	50	1	220
Brine – Brackish Water	1	18	0.21
Seawater – Fresh Water	500,000 (Projected)	--	--

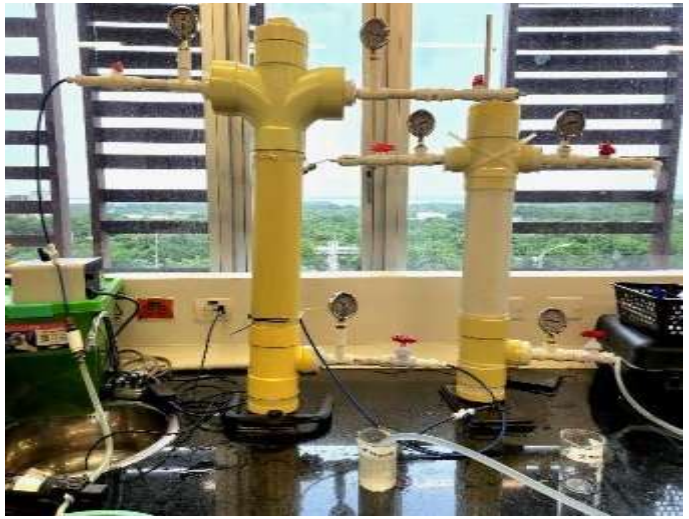
- **Credits:** REDStack BV webpage, Internet screenshots "Osmotic plant SWEETCH".

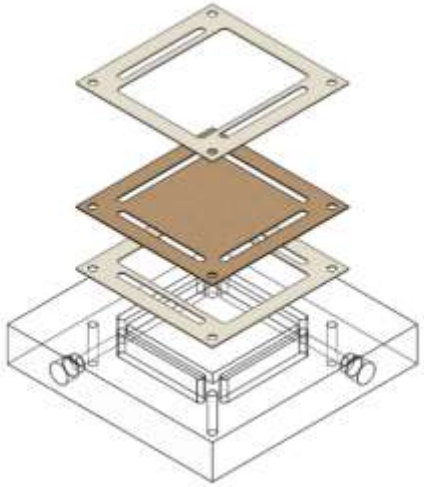
Our work in Colombia

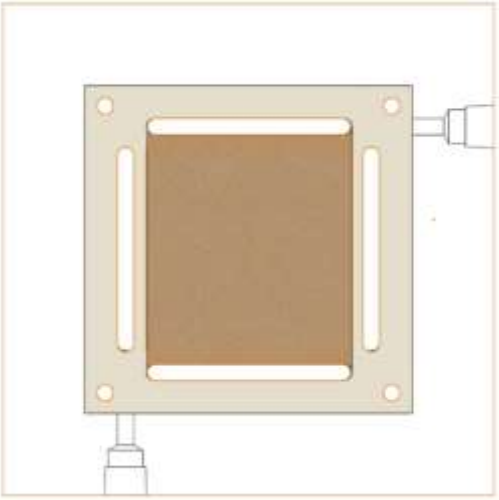
The Magdalena River Mouth

15 GW → **0.8 GW**

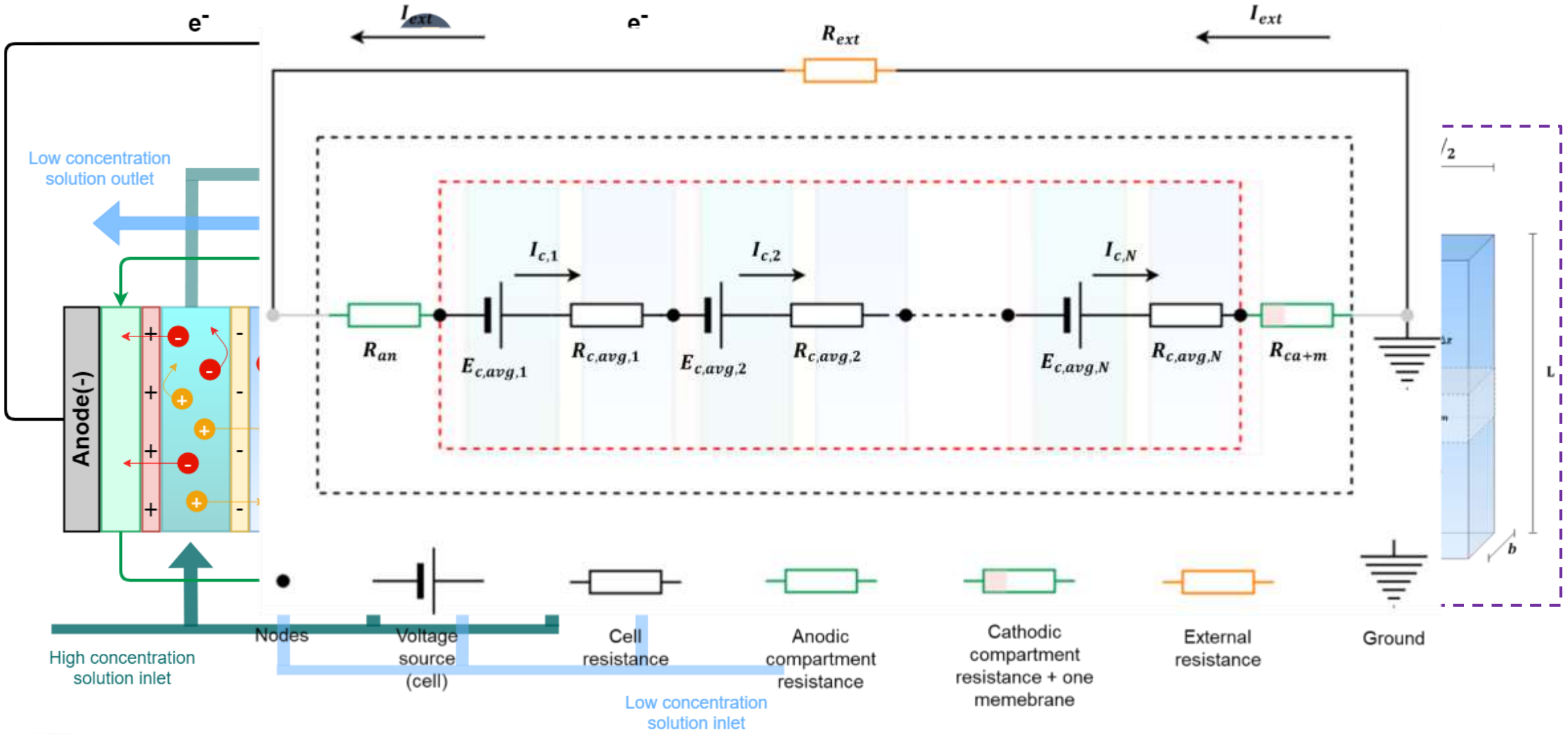
Theoretical Potential — *Technical Potential*



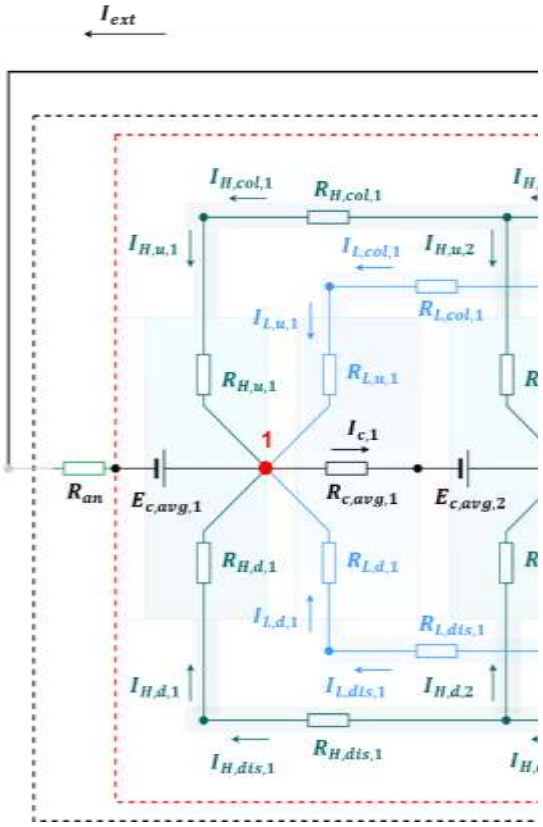


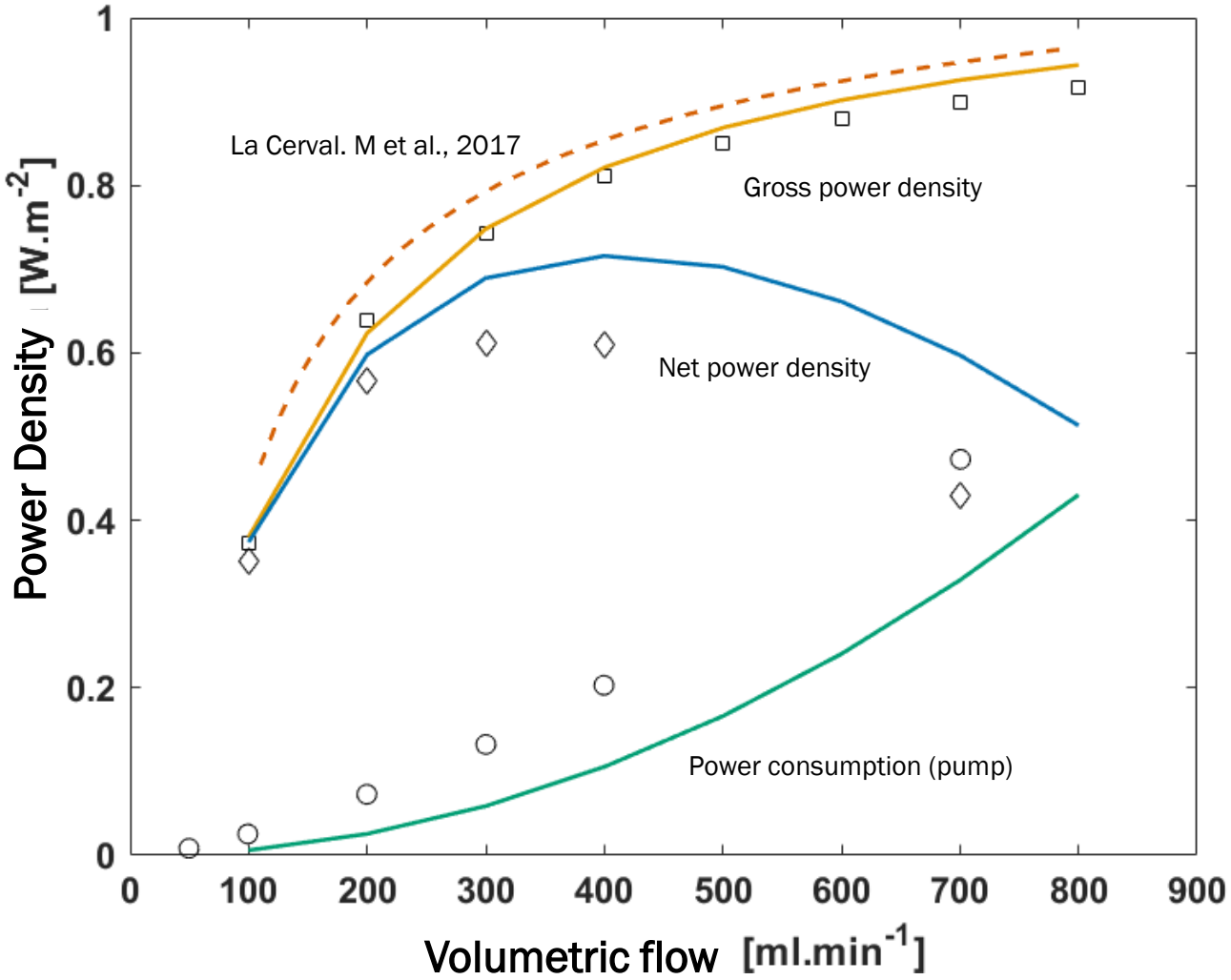


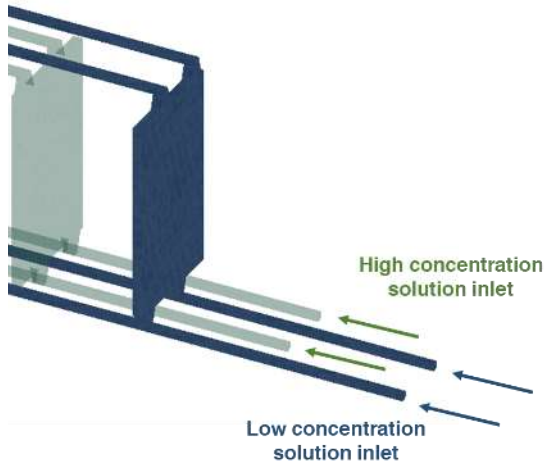
Our work in Colombia



Our work in Colombia







- Experimental from **Veerman, et.al. (2009)**

The demonstration unit

1,800 m

Some properties and key numbers

PROPERTY	MAGNITUDE	UNITS
SEAWATER TEMPERATURE (Avg)	30.5	°C
RIVER WATER TEMPERATURE (Avg)	28.0	°C
SEAWATER SALINITY (Avg)	36.3	$g.kg^{-1}$
RIVER WATER SALINITY (Avg)	0.06	$g.kg^{-1}$
RIVER FLOW (Avg)	7,130	$m^3.s^{-1}$
RIVER FLOW (High Discharge)	~ 11,000	$m^3.s^{-1}$
RIVER FLOW (Low Discharge)	~ 4,000	$m^3.s^{-1}$
SEAWATER INTAKE (Distance to plant)	250	m
RIVER WATER INTAKE (Distance to plant)	50	m

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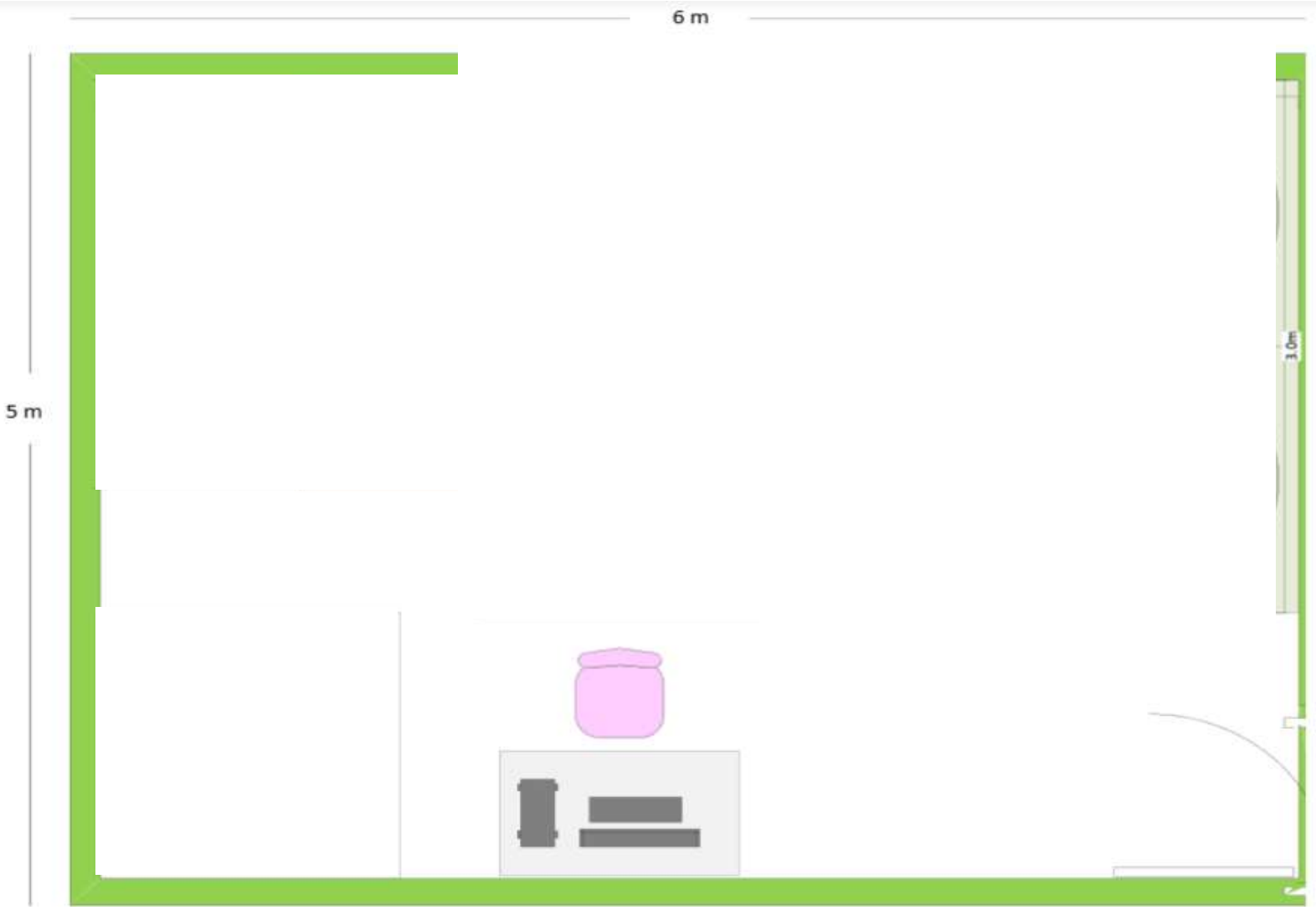
Roldan-Carvajal et.al (2021)

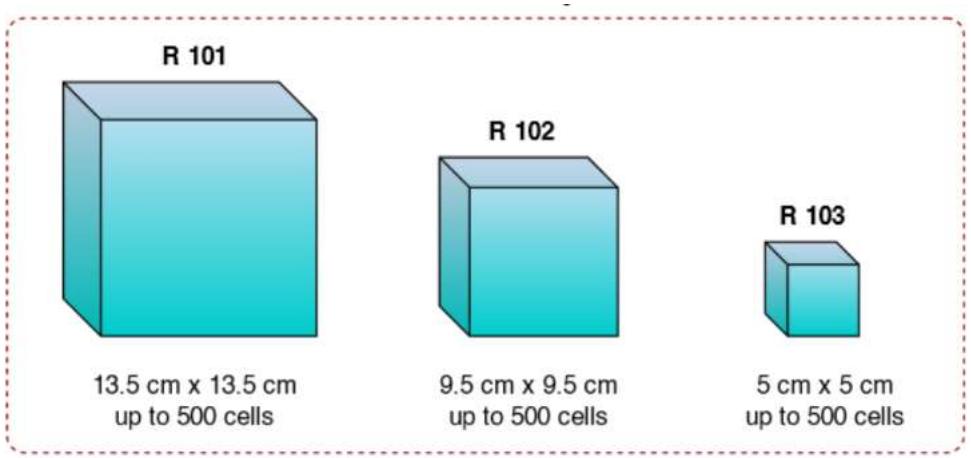
The demonstration unit

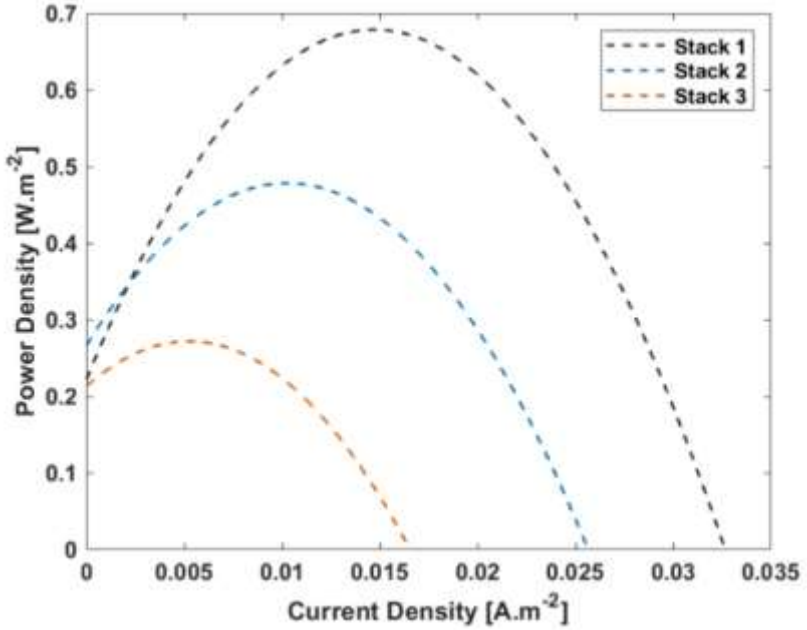


LABEL	DESCRIPTION

- Picture from report: **Perez-Grisales, M:S & Arias-Gonzalez (2022)**

The demonstration unit





PROPERTY	MAGNITUDE	UNITS
R 101 active area	~ 2.5	m^2
R 102 active área	~ 9	m^2
R 103 active area	~ 18	m^2
R 101 pressure drop	6,848	kPa
Seawater line pressure head (h_f)	6.30	$m^3.s^{-1}$
Riverwater line pressure head (h_f)	0.82	$m^3.s^{-1}$
(2) Seawater pump power	2.0	HP
(2) Riverwater pump power	1.5	HP

Upcoming work/Concluding remarks

When will it be ready? We depend on the progress of the construction of the tourist complex.

Expected outcomes:

“Test centers are magnets for other green alternatives.”

A laboratory operating at relevant conditions to research marine energy, water treatment, desalination, hydrogen production from rivers and seawater, grid integration, or aquaculture synergies.

The know-how and local capacity-building for eventual developments at a larger (industrial) scale.

ACKNOWLEDGEMENTS

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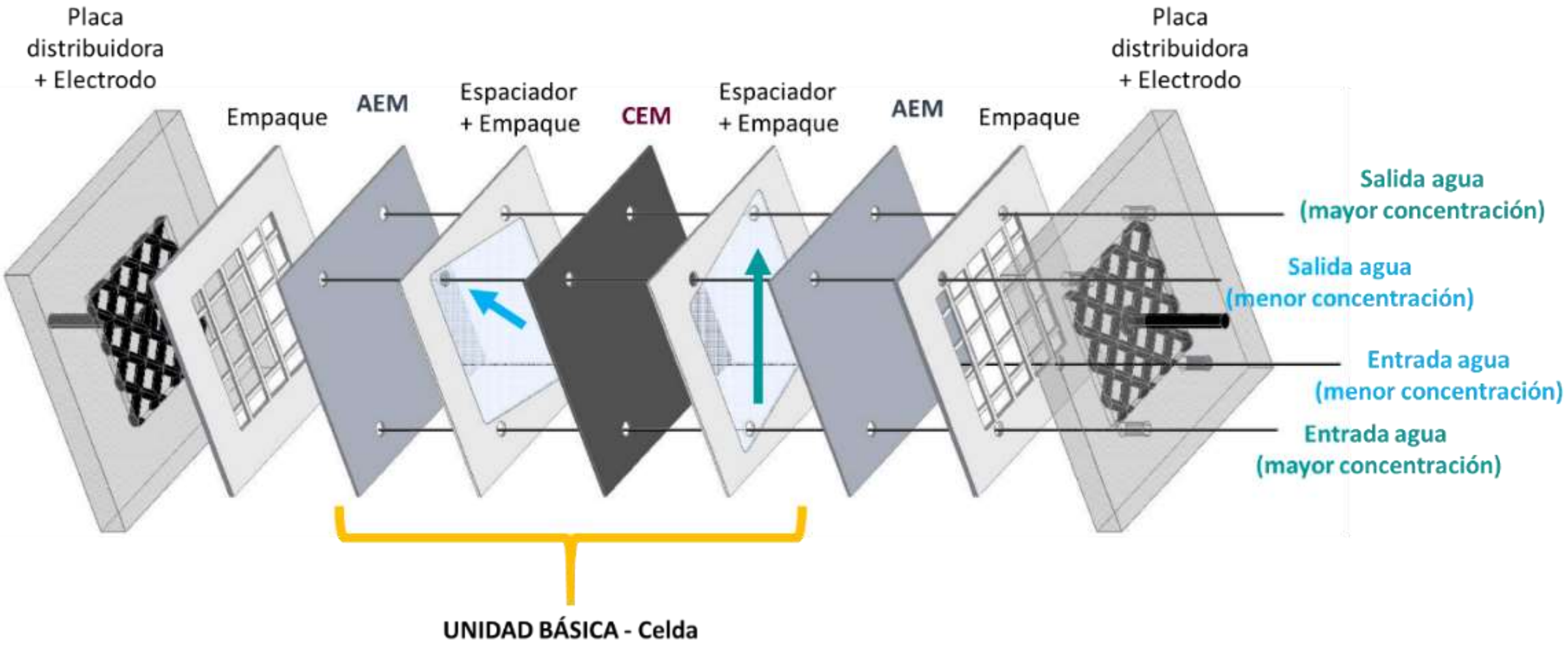
Placa distribuidora + Electrodo
Empaque
AEM
Espaciador + Empaque
CEM
Espaciador + Empaque
AEM
Empaque
Placa distribuidora + Electrodo
Salida agua (mayor concentración)
Salida agua (menor concentración)
Entrada agua (menor concentración)
Entrada agua (mayor concentración)
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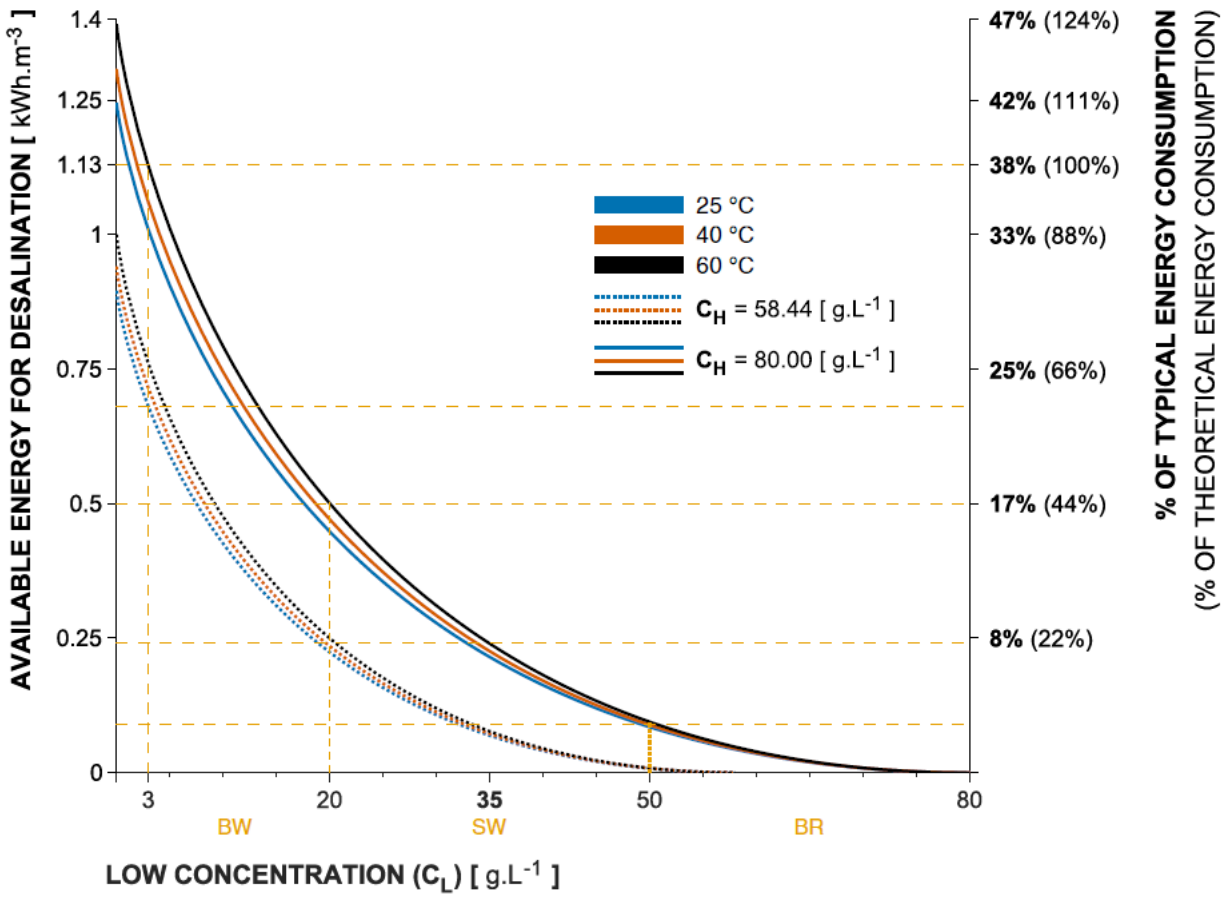
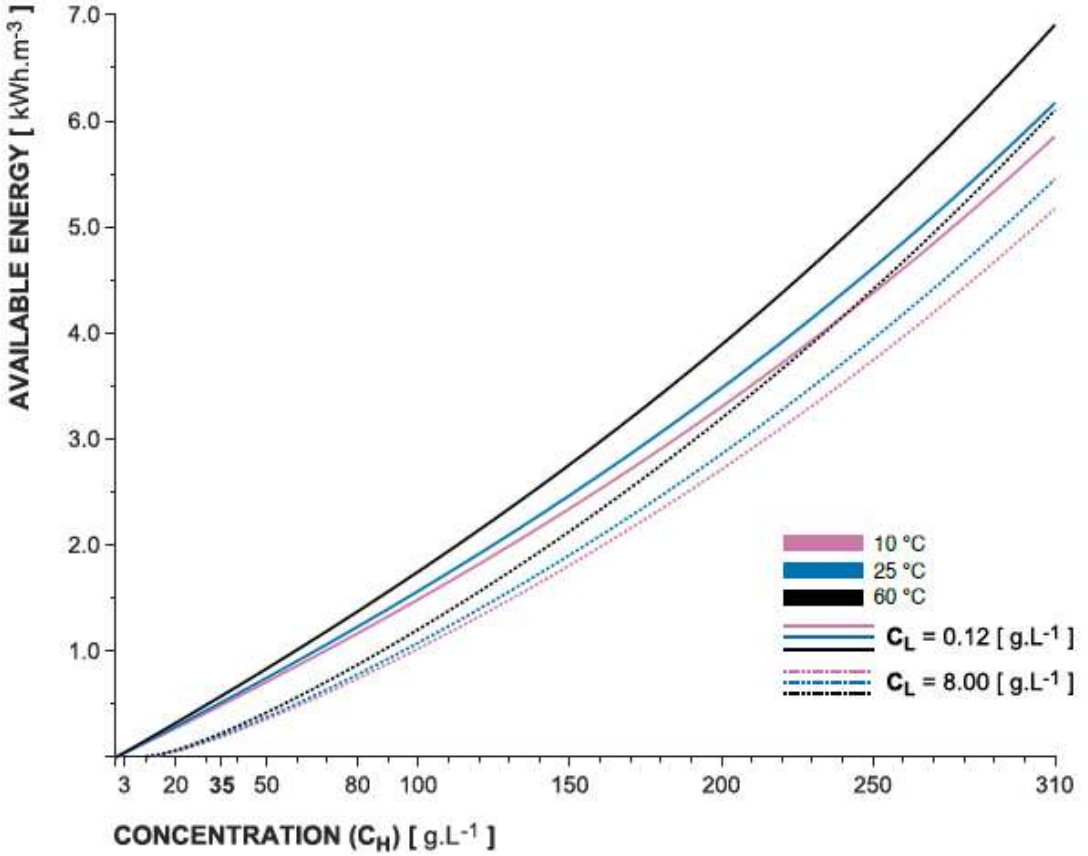

AVAILABLE ENERGY FOR DESALINATION [kWh.m-3]
1.4
1.25
1.13
1
0.75
0.5
0.25
0
47% (124%)
42% (111%)
38% (100%)
33% (88%)
25% (66%)
17% (44%)
8% (22%)
% OF TYPICAL ENERGY CONSUMPTION
(% OF THEORETICAL ENERGY CONSUMPTION)
25 °C
40 °C
60 °C
CH = 58.44 [g.L-1]
CH = 80.00 [g.L-1]
3
20
35
50
80
BW
SW
BR
LOW CONCENTRATION (CL) [g.L-1]


AVAILABLE ENERGY [kWh.m-3]
7.0
6.0
5.0
4.0
3.0
2.0
1.0
10 °C
25 °C
60 °C
CL = 0.12 [g.L-1]
CL = 8.00 [g.L-1]
3
20
35
50
80
100
150
200
250
310
CONCENTRATION (CH) [g.L-1]

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