Supplementary information

In order to clarify what is the net energy extracted in a CDP cycle we will illustrate the different steps of this Carnot-like cycle.

During step 1 (Fig. 1A), the cell is charged in sea water. During this step, all the area bellow 0 V can be achieved in an "auto-generated cycle" and represent a net gain without energy input. Once the x axis is crossed energy needs to be invested to elevate the potential further.

During step 2 the change in salinity induces a change in the Donnan potential that lead to a potential increase (this potential increase is dependant on the salinity difference between the solutions and the permselectivity of the membranes, it is typically of around 145 mV with a 30 g/L and a 1 g/L solution in the experiments presented in this article).

During step 3 (Fig. 1B), the cell is discharged in the diluted solution. The charges are released with a higher energy level (i.e. potential) than during the charging step (step 1). All the area below the discharging line and above 0 V represents an energy gain. Discharging below 0 V is going against the equilibrium state and as such represent invested energy.

The difference between the gains and the energy invested represented the net energy extracted. It is important to note that in practice the discharge should not be "pushed" below 0 V as this is ultimately lost energy. The plain blue area in Fig. 1C presents the net energy extracted per cycle.

A potential drop over time ($\Delta E_{leakage}$) was observed in the experiment. It is particularly visible at the end of the discharging step where a lower potential can be measured, as the illustration in Fig. 1D. The complete energy cycle, therefore, would shrink, which leads to a lower net energy extraction.

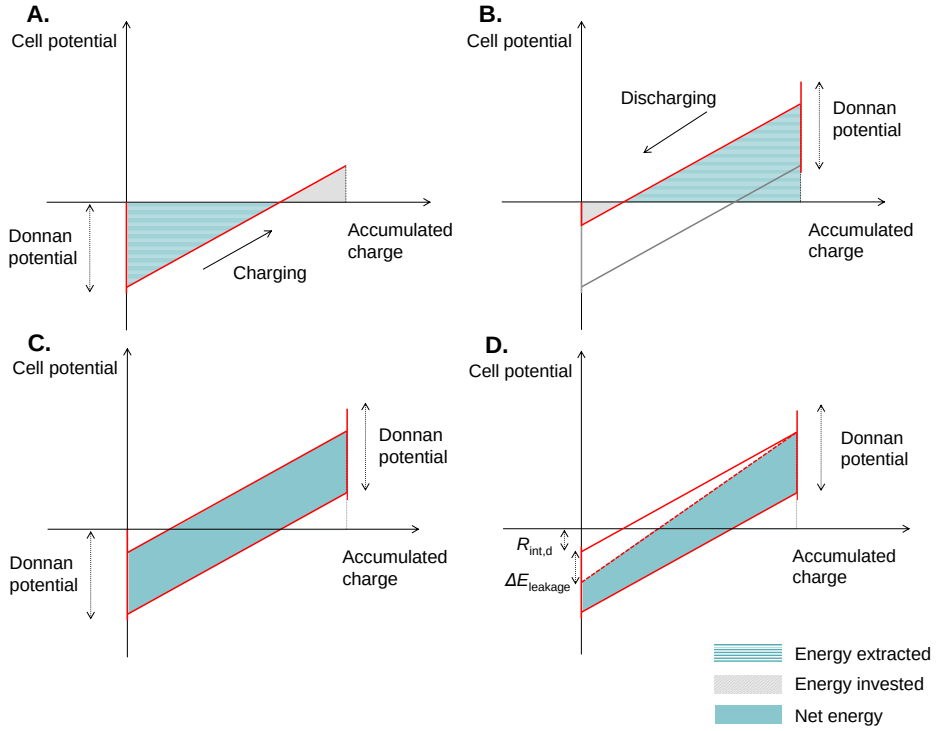

Fig. 1 Explanation on the energy cycle. A: charging step; B: discharging step, C: complete cycle. D: complete cycle with $\Delta E_{leakage}$

Figure 2 is presenting a triplicate experiment of a 4 C cycle. The average energy extraction is 0.34±0.02 J/cycle. This figure assesses the good reproducibility of the system.

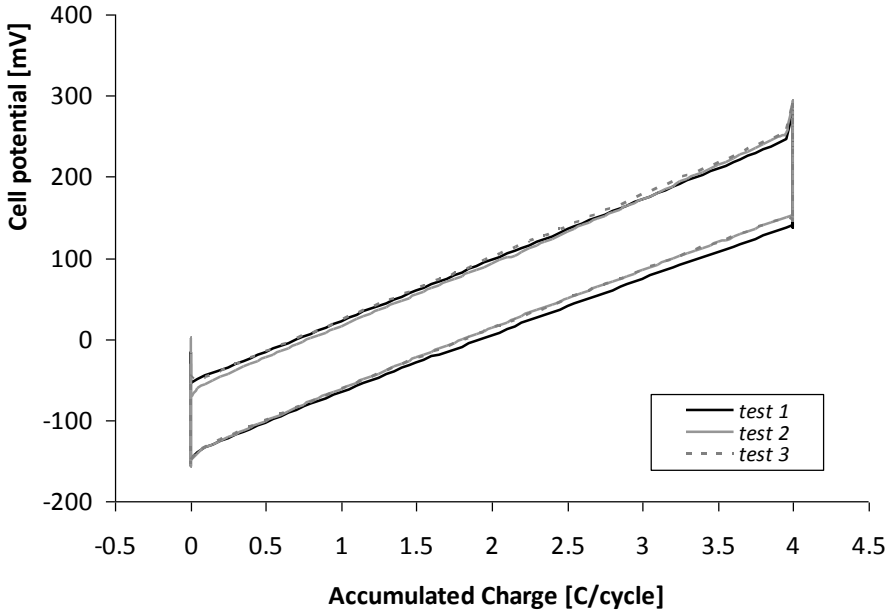

Fig. 2 Triplicate experiments assessing the reproducibility of the cycles. In this case are presented 4 C cycles obtained by charging and discharging at 50 mA.