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XXXVII Cycle

Energy harvesting from CO_2 through an IL based capacitor

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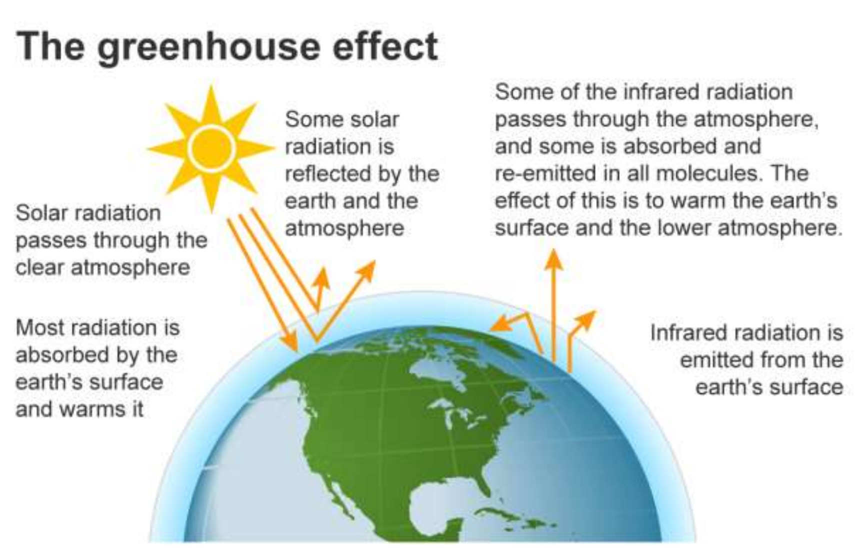
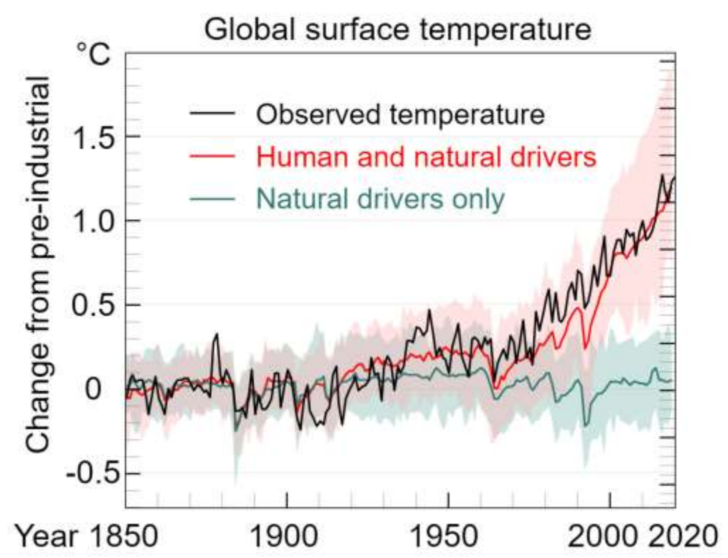
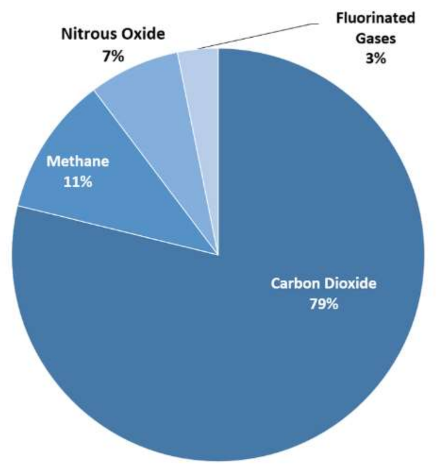
Research context and motivation

- Starting from 1900 **global temperature started to increase**, mainly because of human influence: emission of greenhouse gases (g.h.g.) and deforestation





- Greenhouse gas composition: the most abundant gas among g.h.g. is **Carbon dioxide (CO_2)**, coming mainly from oil and coal.
- CO_2 is **responsible for 60% of global warming** due to human activity



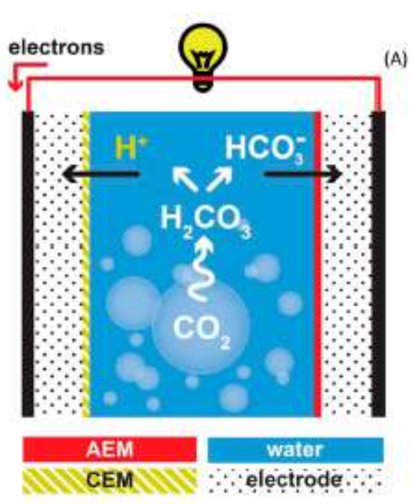
Addressed research questions/problems

- The goal is to **harvest energy from CO_2 capture**
- Adapt **Capmix** technique (nowadays exploited to harvest energy from salinity gradients) making it able to work with **mixing energy** coming from gases

State of the art

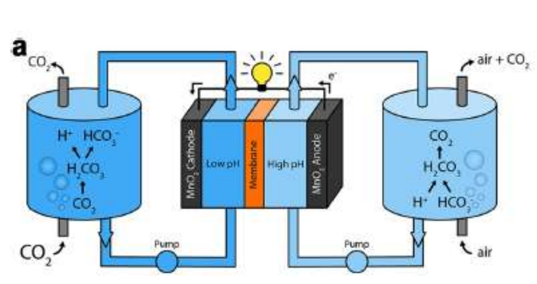
Membrane assisted capmix:

$CO_2 + H_2O \longrightarrow H_2CO_3 \leftrightarrow H^+ + HCO_3^-$



Ionic exchange membrane produce a voltage drop across the device.

CO2 induced pH gradient

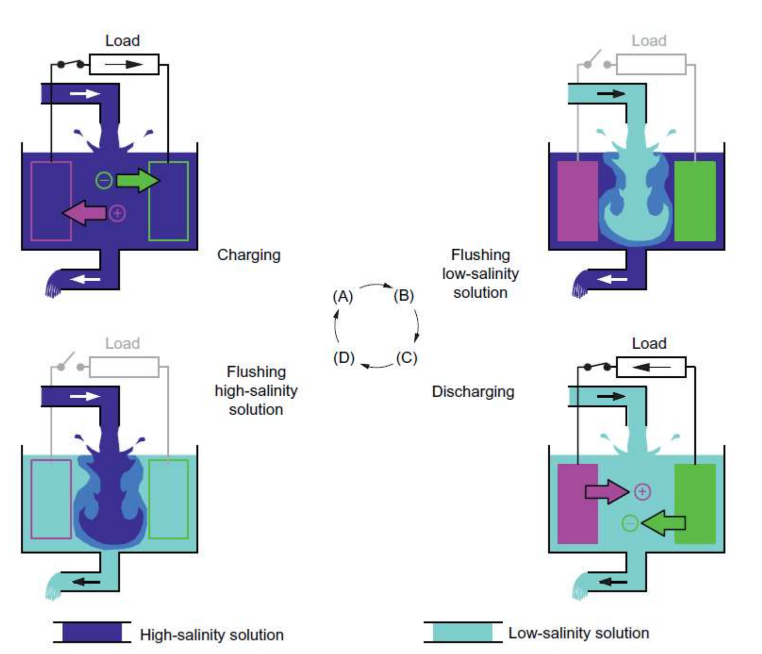


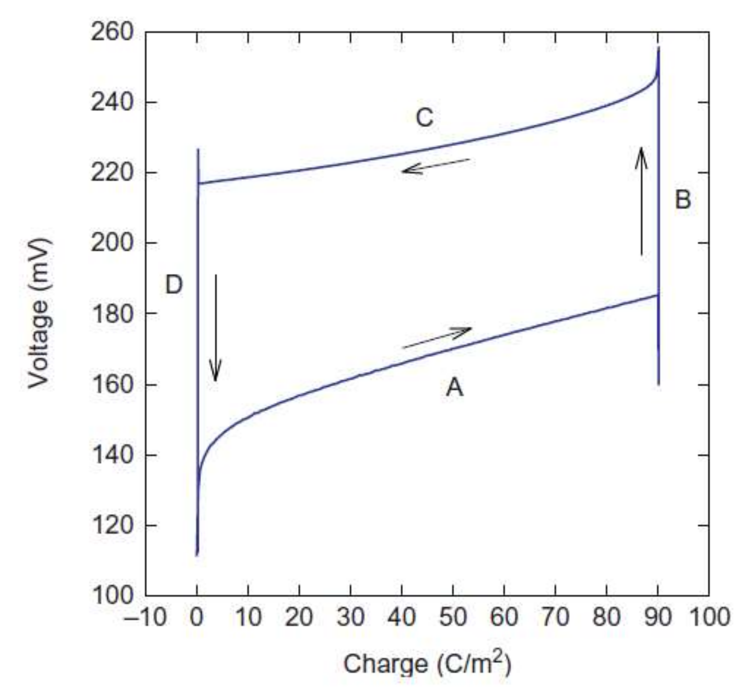
Different amount of CO_2 in 2 different tanks of water produces a pH difference. Exploiting a semipermeable membrane, it is possible to generate a pH gradient, resulting in a voltage drop across the device.

- **Drawbacks of literature**: use of membranes (fragile), water as electrolyte (poor selectivity respect to carbon dioxide), low energetic yield, toxicity of amine (used to improve capture)

Adopted methodologies

- **Capmix** is a technology exploited in blue energy field, requiring an EDL capacitor and 2 water solutions with a different salinity. It is a 4 step process:



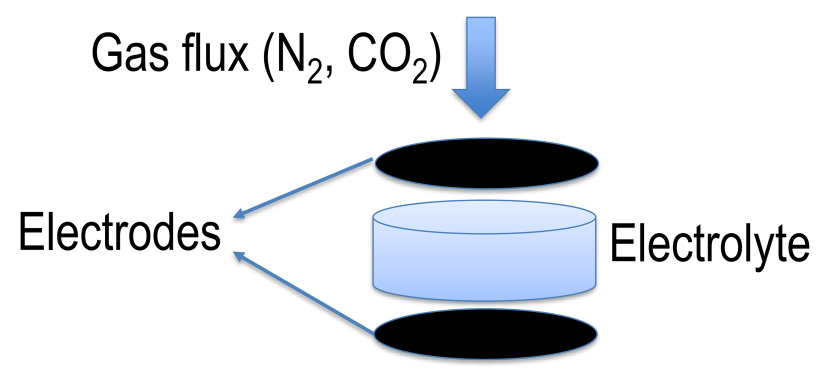


Area of charge-voltage plot is proportional to the harvested energy. In charged state, the change of the electrolyte (in OCV conditions) produces a voltage rise in order to satisfy **Q=CV**

Submitted and published works

Novel contributions

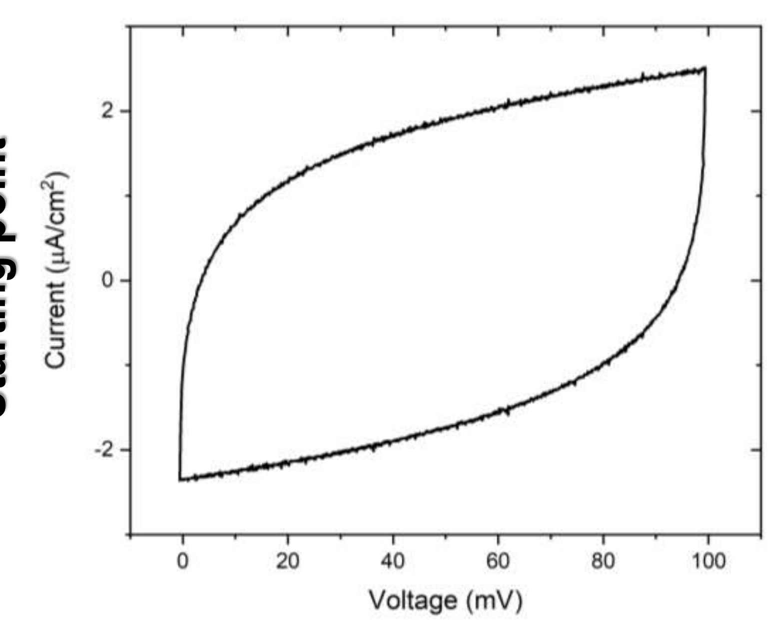
- Idea to **improve Capmix performances** is to exploit **Ionic liquids** as electrolyte inside the harvesting device. As in Capmix technology, we substitute high and low concentration solutions with fluxes of CO_2 and N_2.



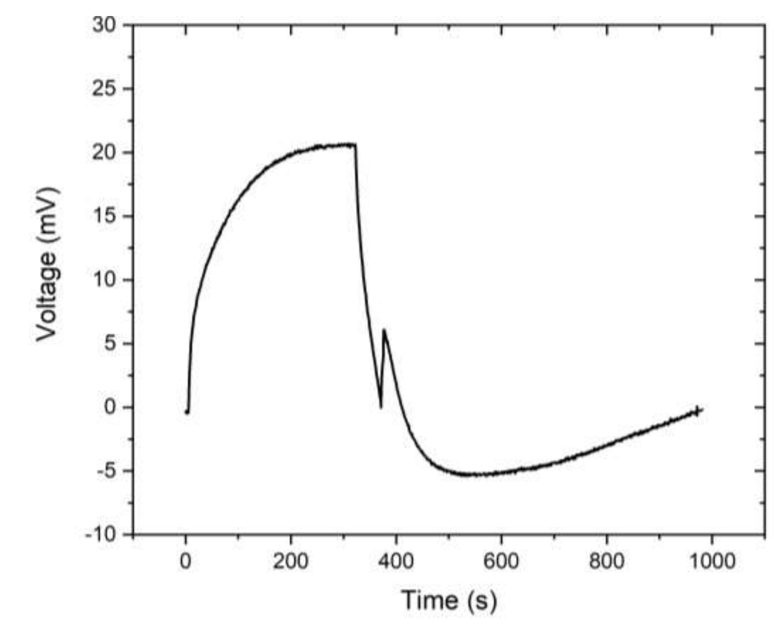
3 tested configurations		
Electrodes: GDL **Electrolyte:** Dabco Imidazolide	**Electrodes:** GDL **Electrolyte:** 20% Dabco Im 80% Emim AC	**Electrodes:** Act. Carbons **Electrolyte:** 20% Dabco Im 80% Emim AC

EC characterization | **Capmix performances**

Starting point

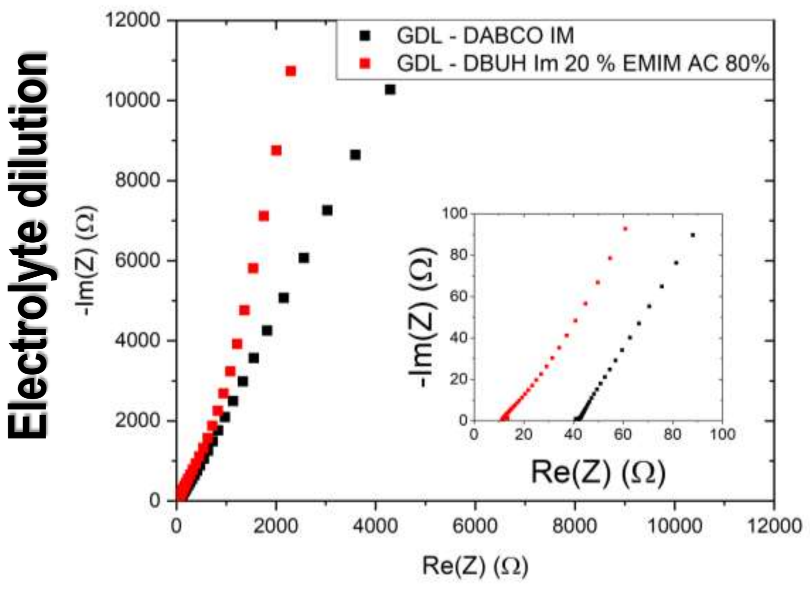


C= 0.3 mF/cm² η= 91.3% ESR= 40 Ω

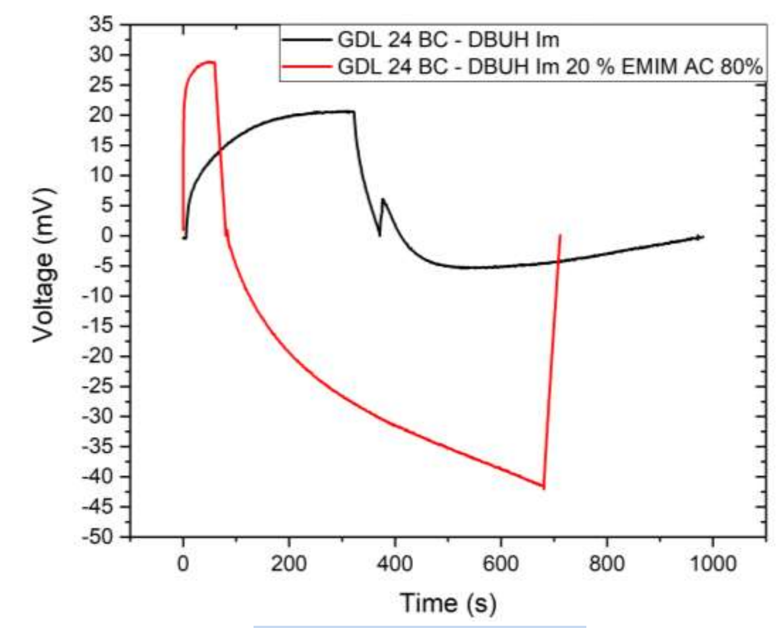


E=0.1 μWh/m²

Electrolyte dilution

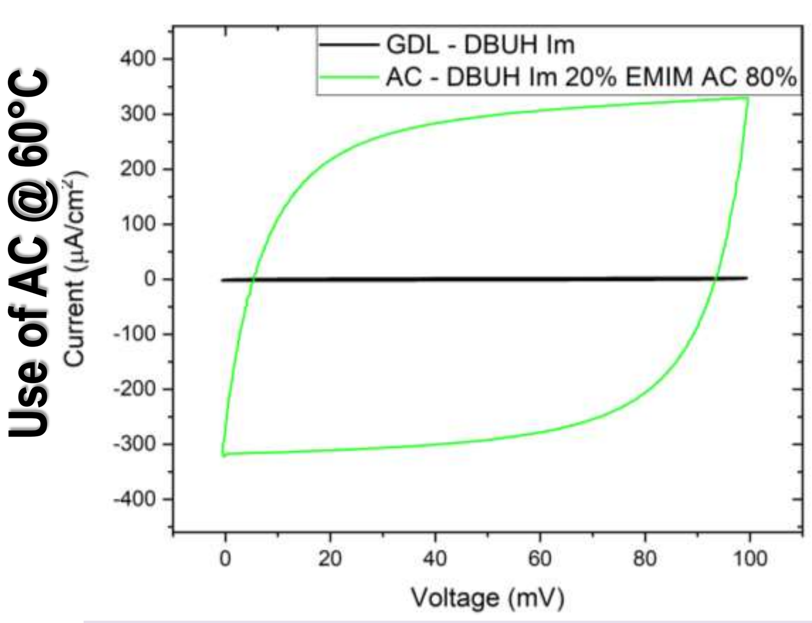


C= 0.4 mF/cm² **η= 96% ESR= 12 Ω**

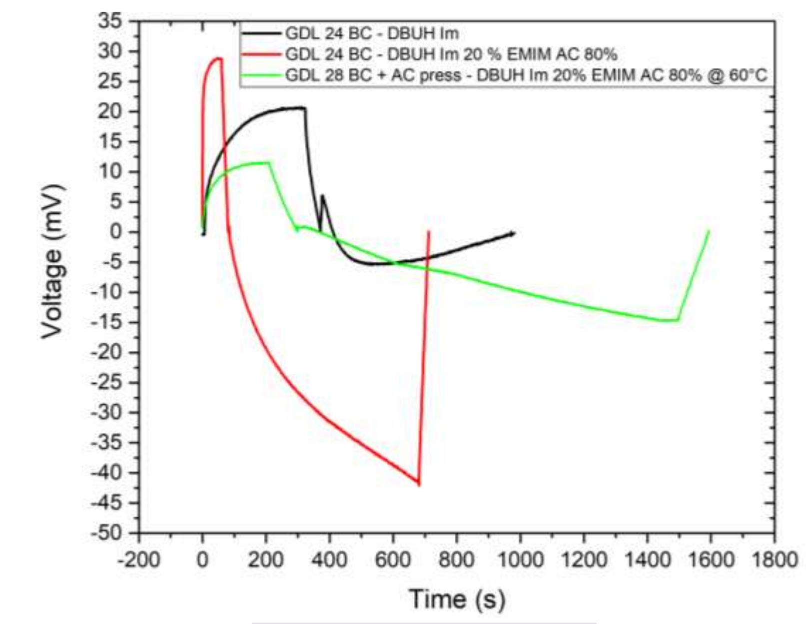


E= 2.4 μWh/m²

Use of AC @ 60°C



C= 50 mF/cm² η= 98% ESR= 3 Ω



E=30.4 μWh/m²

Future work

- **Use of new ionic liquids** more selective for CO_2 capture
- Improve ionic mobility, reducing ion pairing by **polar aprotic solvent**, such as Propylene carbonate
- Enhance conducibility of the electrolyte by inserting a **supporting salt**
- Increase the voltage rise due to the adsorption of CO_2 by exploiting **functionalized electrodes**, able to autonomously accumulate specific charges at their surface

List of attended classes

- 02UKHKI - Applied spectroscopic methods (13/06/2022, 6)
- 01DMLKG - Introduzione alla microscopia ottica (24/03/2022, 4)
- 01LEXRP – Strumenti e tecnologie per lo sviluppo del prodotto (28/06/2022, 5)
- 01UNXRV – Thinking out of the box (2/12/2022, 1)
- 01SWPRV – Time management (23/12/2022, 1)
- 01QORRV – Writing scientific papers in English (24/03/2022, 3)