

Energy Harvesting from Carbon Dioxide Capture through an Ionic Liquid Based Supercapacitor

*Original*

Energy Harvesting from Carbon Dioxide Capture through an Ionic Liquid Based Supercapacitor / Molino, D., Zaccagnini, P., Martellone, S., Pedico, A., Ferraro, G., Bocchini, S., Lamberti, A.. - (2023). (244th ECS Meeting Gothenburg (SE) October 8-12, 2023) [10.1149/MA2023-02482444mtgabs].

*Availability:*

This version is available at: 11583/2989083 since: 2024-05-29T08:41:21Z

*Publisher:*

IOP Publishing

*Published*

DOI:10.1149/MA2023-02482444mtgabs

*Terms of use:*

This article is made available under terms and conditions as specified in the corresponding bibliographic description in the repository

*Publisher copyright*

(Article begins on next page)



# Energy harvesting from carbon dioxide capture through an ionic liquid based supercapacitor

Davide Molino,<sup>a</sup> Pietro Zaccagnini,<sup>a,b</sup> Simone Martellone,<sup>a</sup> Alessandro Pedico,<sup>a,b</sup> Giuseppe Ferraro,<sup>b</sup> Sergio Bocchini,<sup>a,b</sup> Andrea Lamberti,<sup>a,b</sup>

<sup>a</sup> DISAT Dipartimento di Scienza Applicata e Tecnologia, Politecnico di Torino, corso Duca degli Abruzzi 24, 10129, Torino, Italy

<sup>b</sup> Istituto Italiano di Tecnologia, Center for Sustainable Future Technologies, Via Livorno 60, 10144, Torino, Italy

davide.molino@polito.it

106-2444

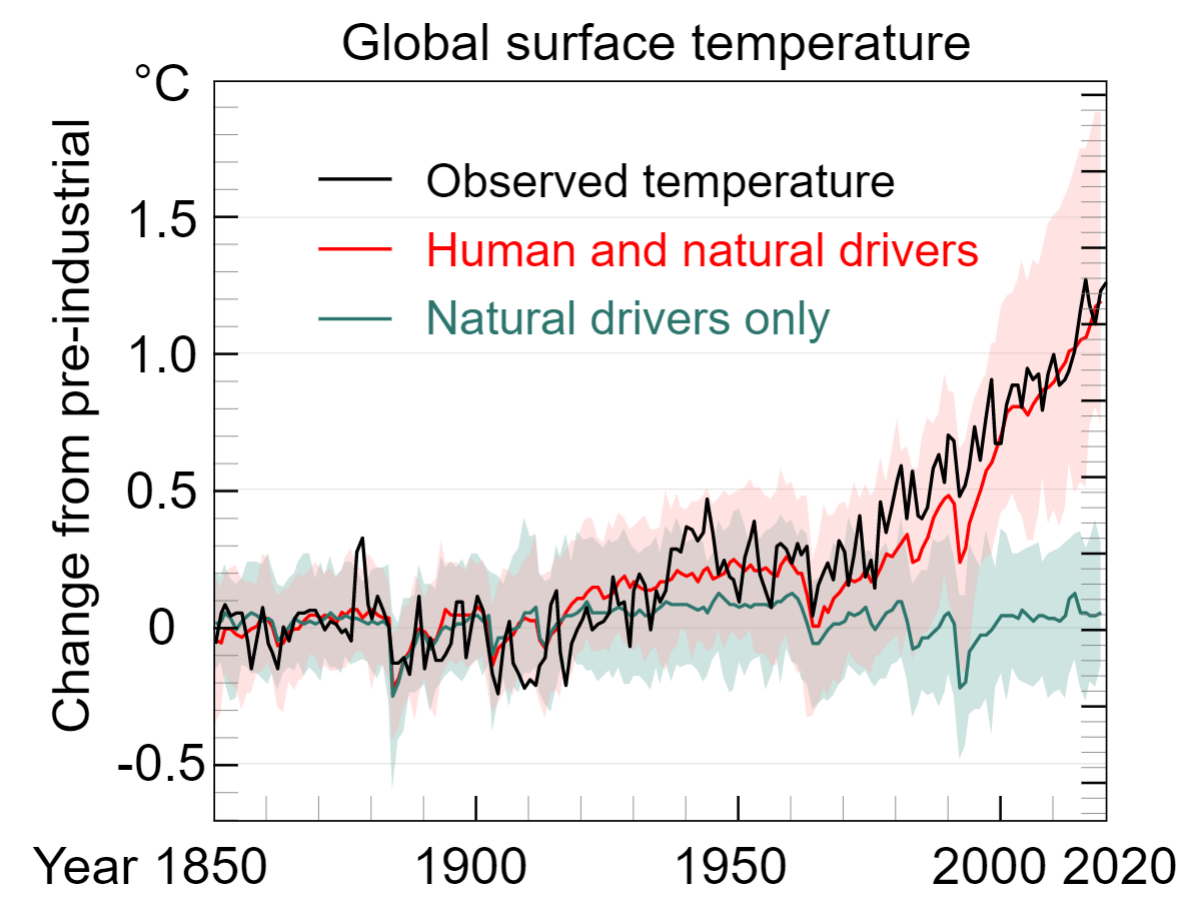
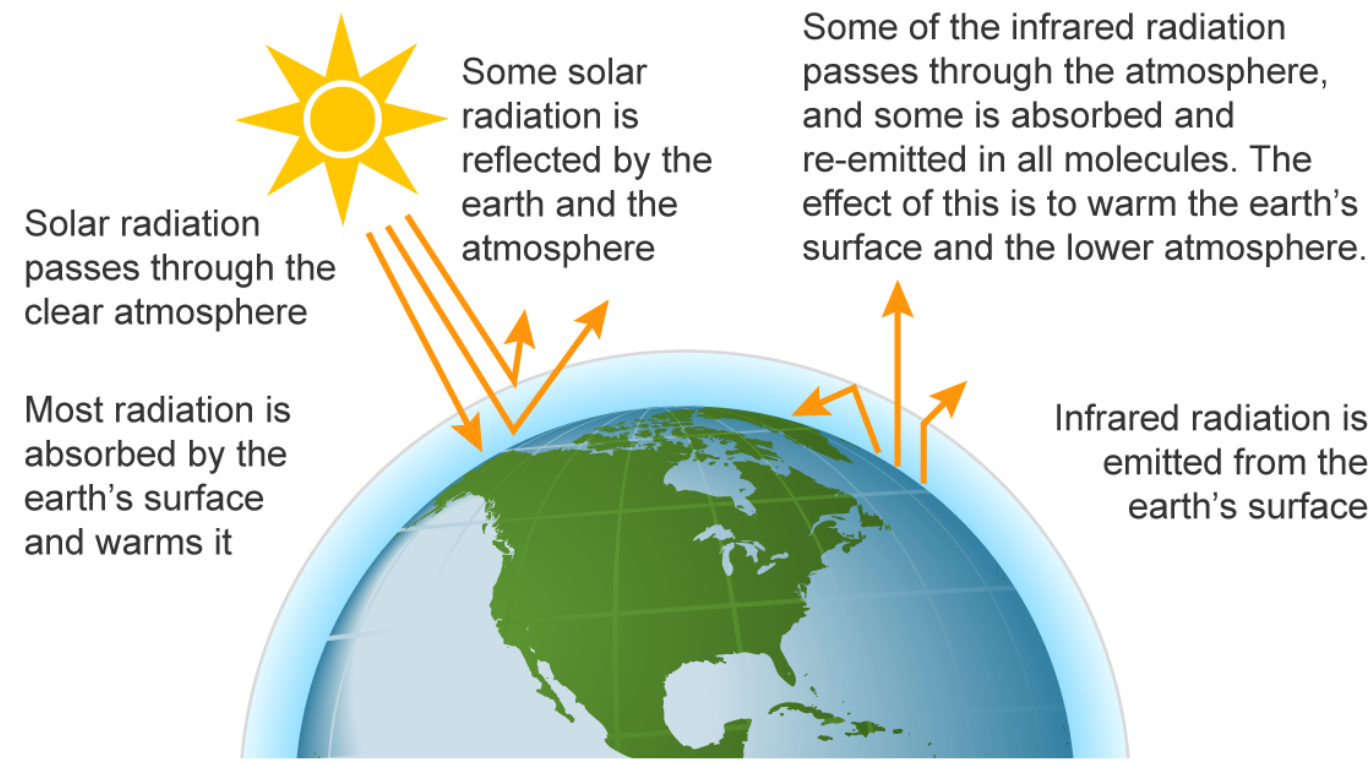
11 October, 2023



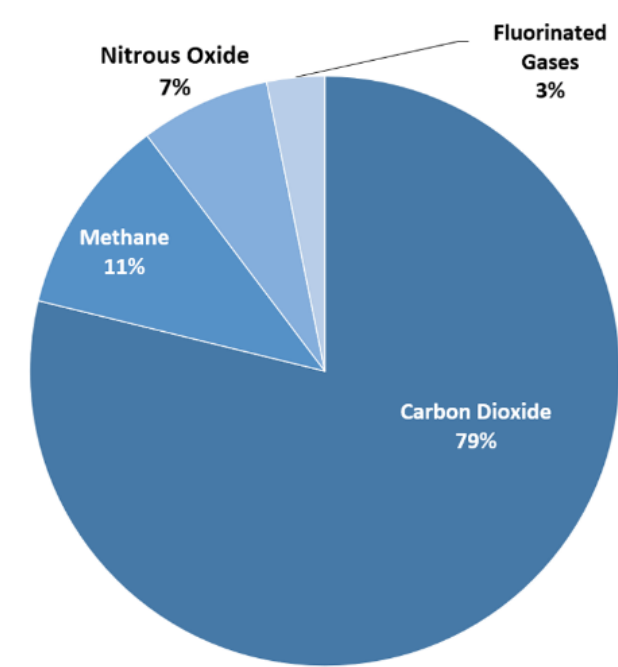
## Research context and motivation

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

### The greenhouse effect

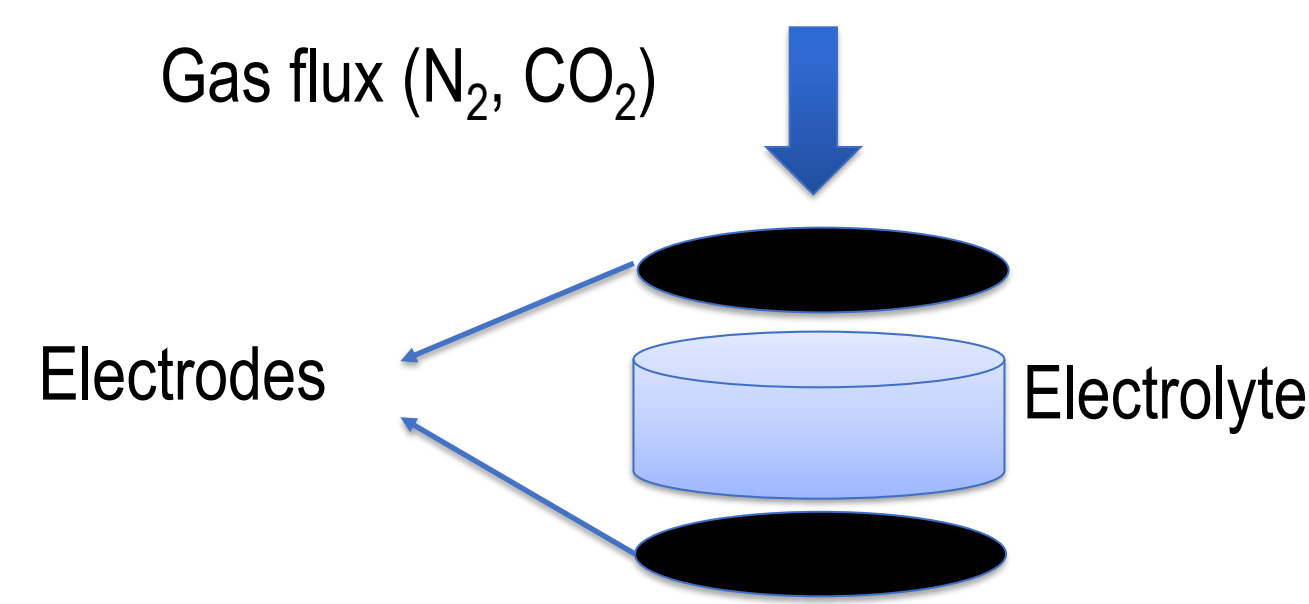


- Greenhouse gas composition: the most abundant gas among g.h.g. is **Carbon dioxide (CO<sub>2</sub>)**, coming mainly from oil and coal.
- CO<sub>2</sub> is **responsible for 60% of global warming** due to human activity



## Results

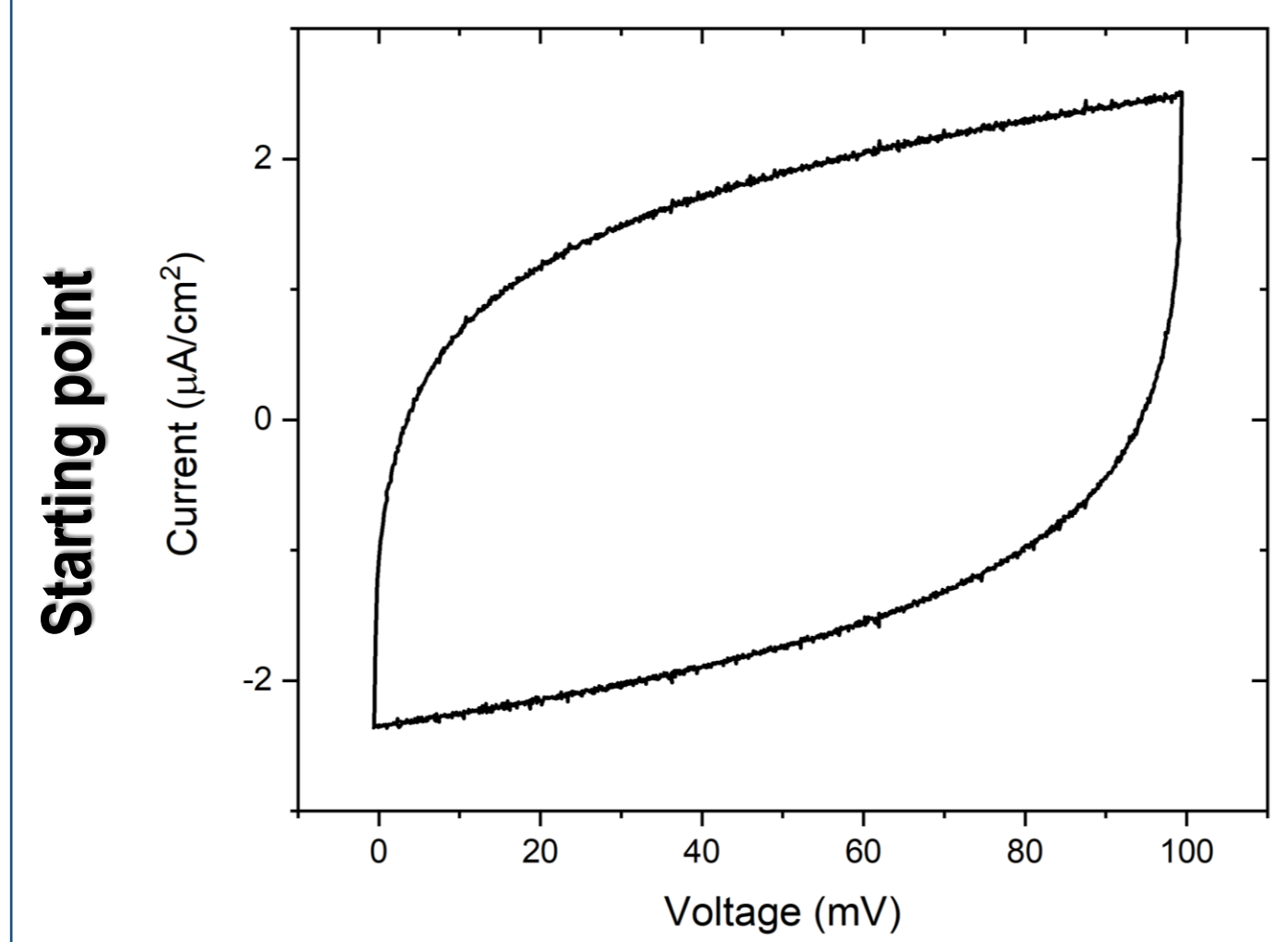
- Idea to **improve CO<sub>2</sub>Cap performances** is to exploit **ionic liquids** as electrolyte inside the harvesting device. As in Capmix technology, we substitute high and low concentration solutions with fluxes of CO<sub>2</sub> and N<sub>2</sub>.



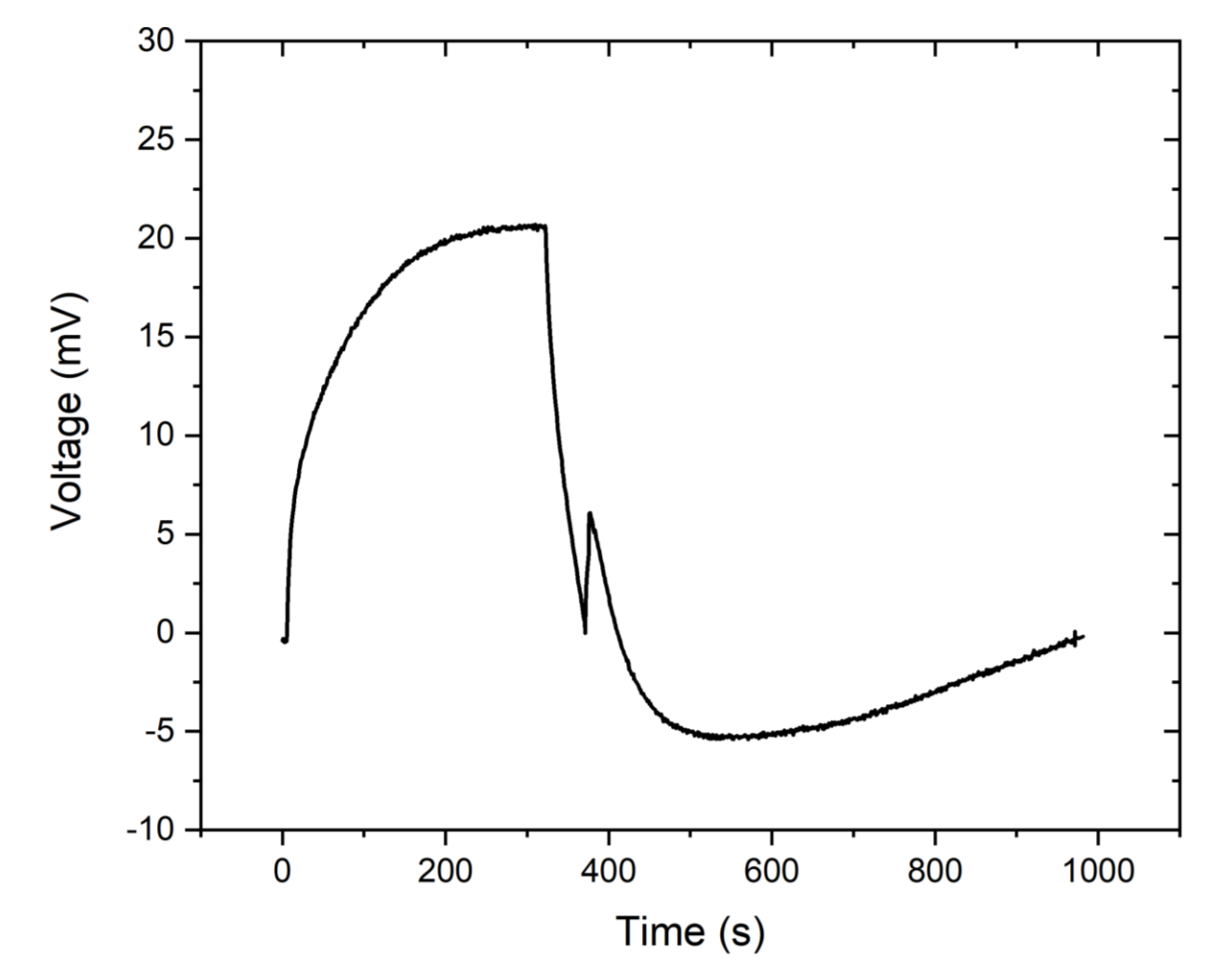
### 3 tested configurations

<b>Electrodes:</b> GDL	<b>Electrodes:</b> GDL	<b>Electrodes:</b> Act. Carbons
<b>Electrolyte:</b> Dabco Imidazolide	<b>Electrolyte:</b> 20% Dabco Im 80% Emim AC	<b>Electrolyte:</b> 20% Dabco Im 80% Emim AC

### EC characterization



### Capmix performances

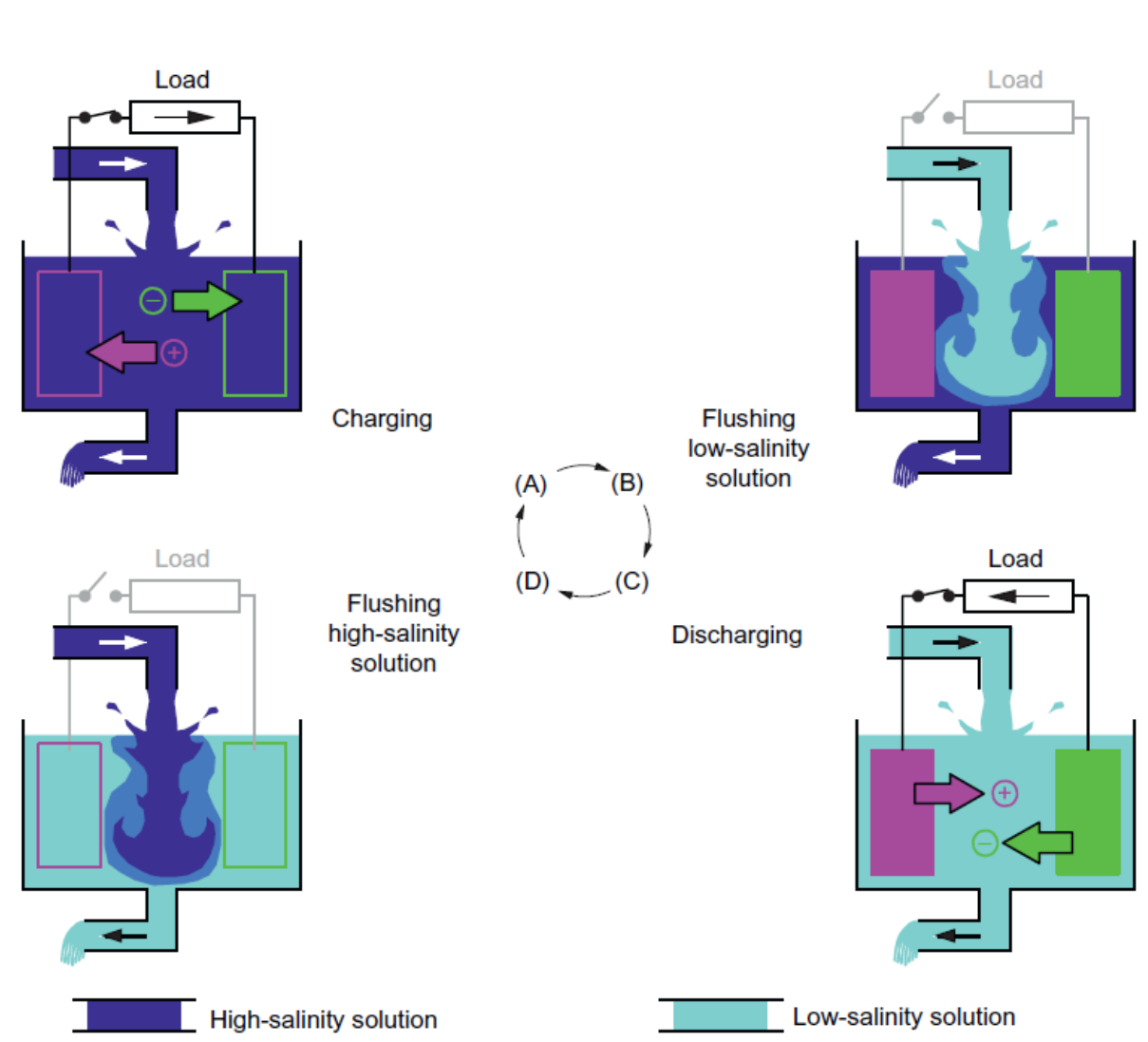


## Addressed research questions/problems

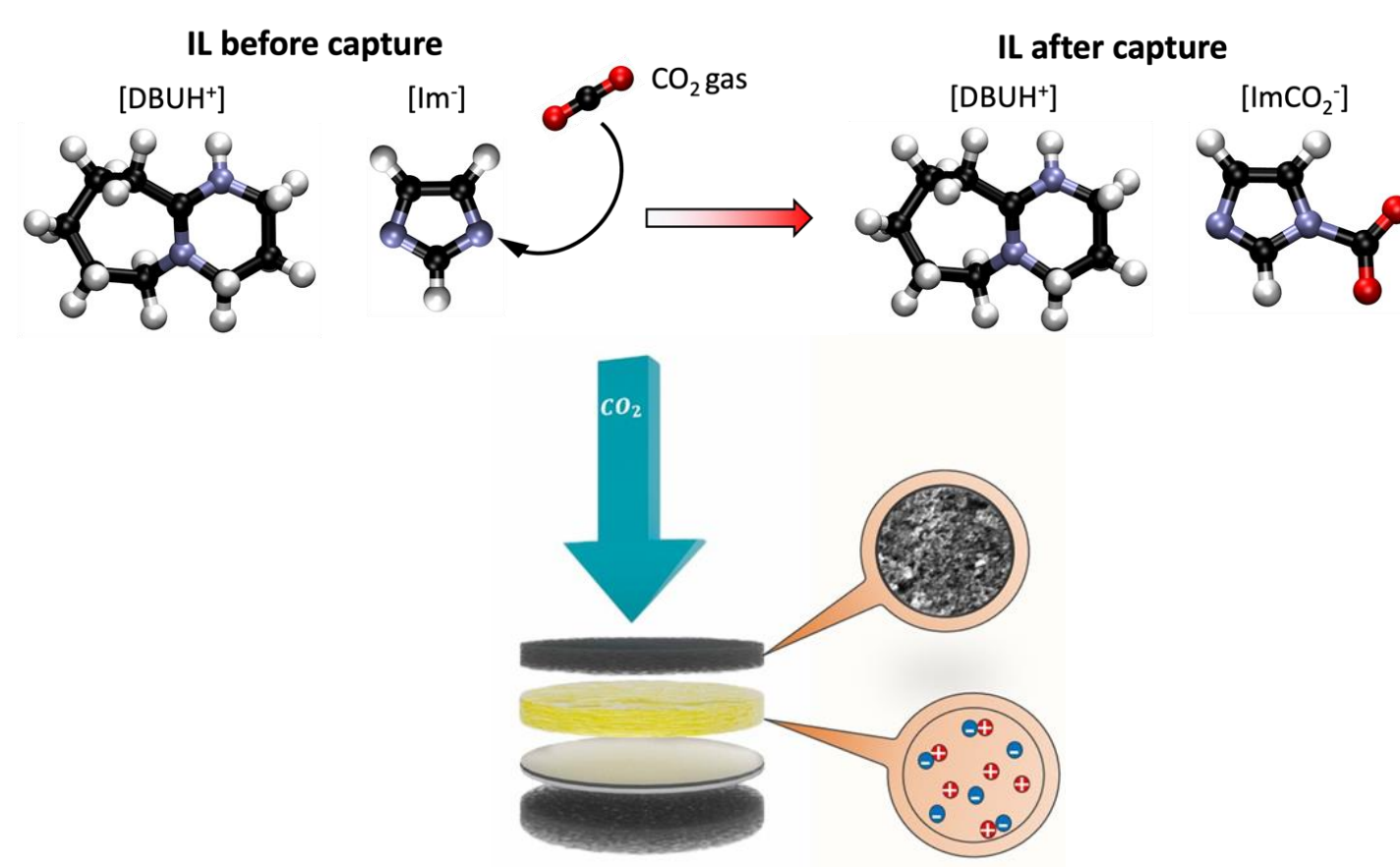
- The goal is to **harvest energy from CO<sub>2</sub> capture** adapting the Capmix technique, but the mechanism is totally different.

### Working principle

#### Capmix



#### CO<sub>2</sub>Cap



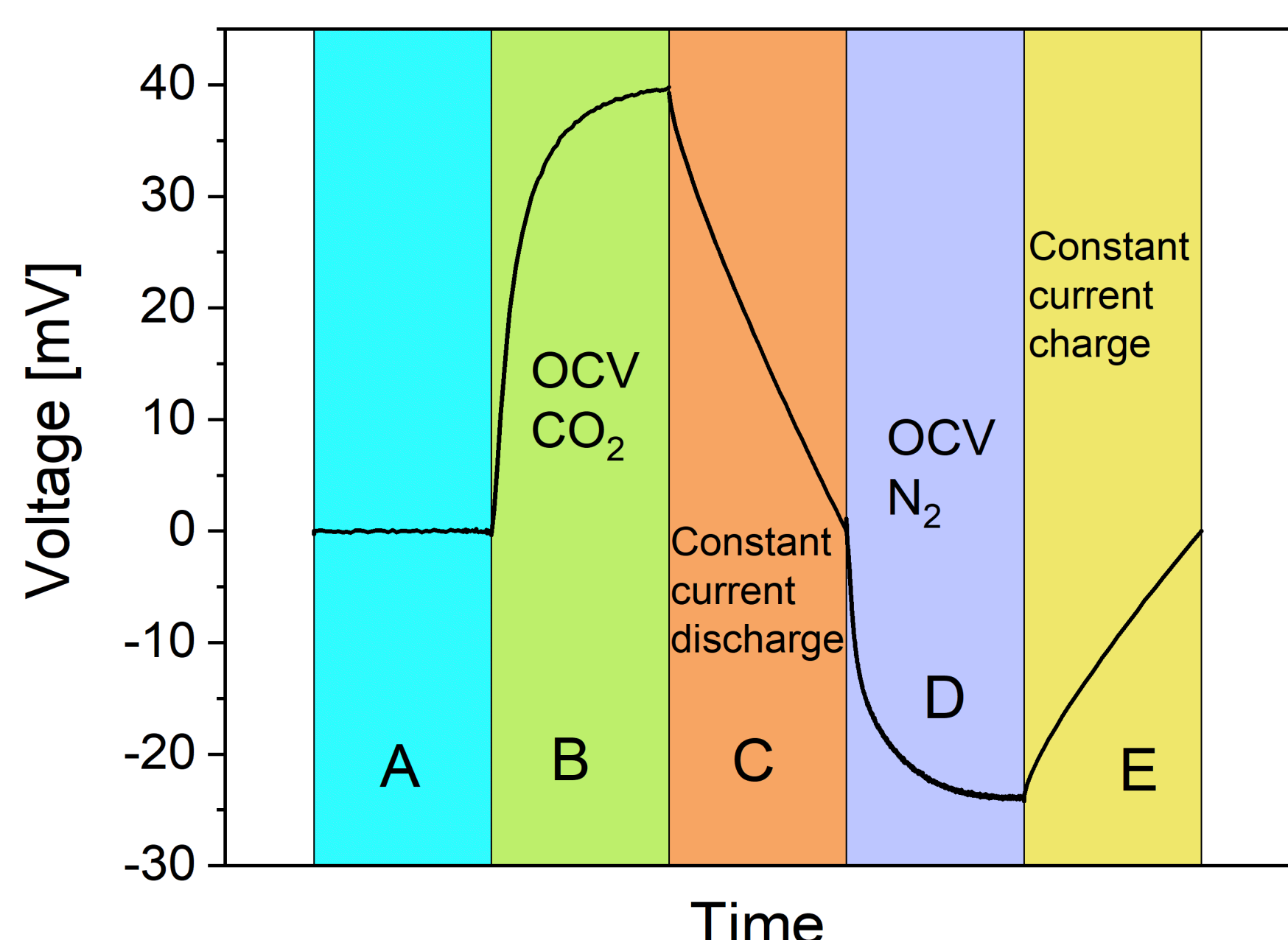
The reaction between the ionic liquid and CO<sub>2</sub> happens **only on one electrode**, producing a junction across which a voltage difference is created

Technology exploited in blue energy field, based on **EDL enlargement**

## Adopted methodology

**Procedure:** inspired from Capmix, but avoiding the polarization of the device used to store charges at the electrodes interfaces.

- A: 5' short circuit
- B: OCV + CO<sub>2</sub> flush (50 ml/min)
- C: Constant current discharge (energy recovery)
- D: 15' OCV + N<sub>2</sub> flush (50 ml/min) (regeneration of the electrolyte)
- E: Constant current charge (energy recovery)



## Future work

- Use of new ionic liquids** more selective for CO<sub>2</sub> capture
- Improve ionic mobility, reducing ion pairing by **polar aprotic solvent**, such as Propylene carbonate
- Enhance conductivity of the electrolyte by inserting a **supporting salt**
- Increase the voltage rise due to the adsorption of CO<sub>2</sub> by exploiting **functionalized electrodes**, able to autonomously accumulate specific charges at their surface

**ACKNOWLEDGEMENT:** This result is part of a project that has received funding from the European Research Council (ERC) under the European Union's ERC Starting Grant. Grant agreement "CO<sub>2</sub>CAP" No. 949916

