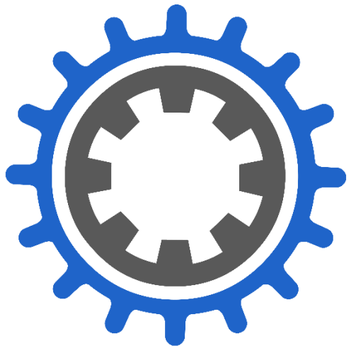

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BRINE RIS

Webinar Ghent University:

Electrochemical methods for metal recovery.

Selective Capacitive Deionization (CDI): An innovative method for metal recovery.

21/03/2024
Adrián Delgado Béjar

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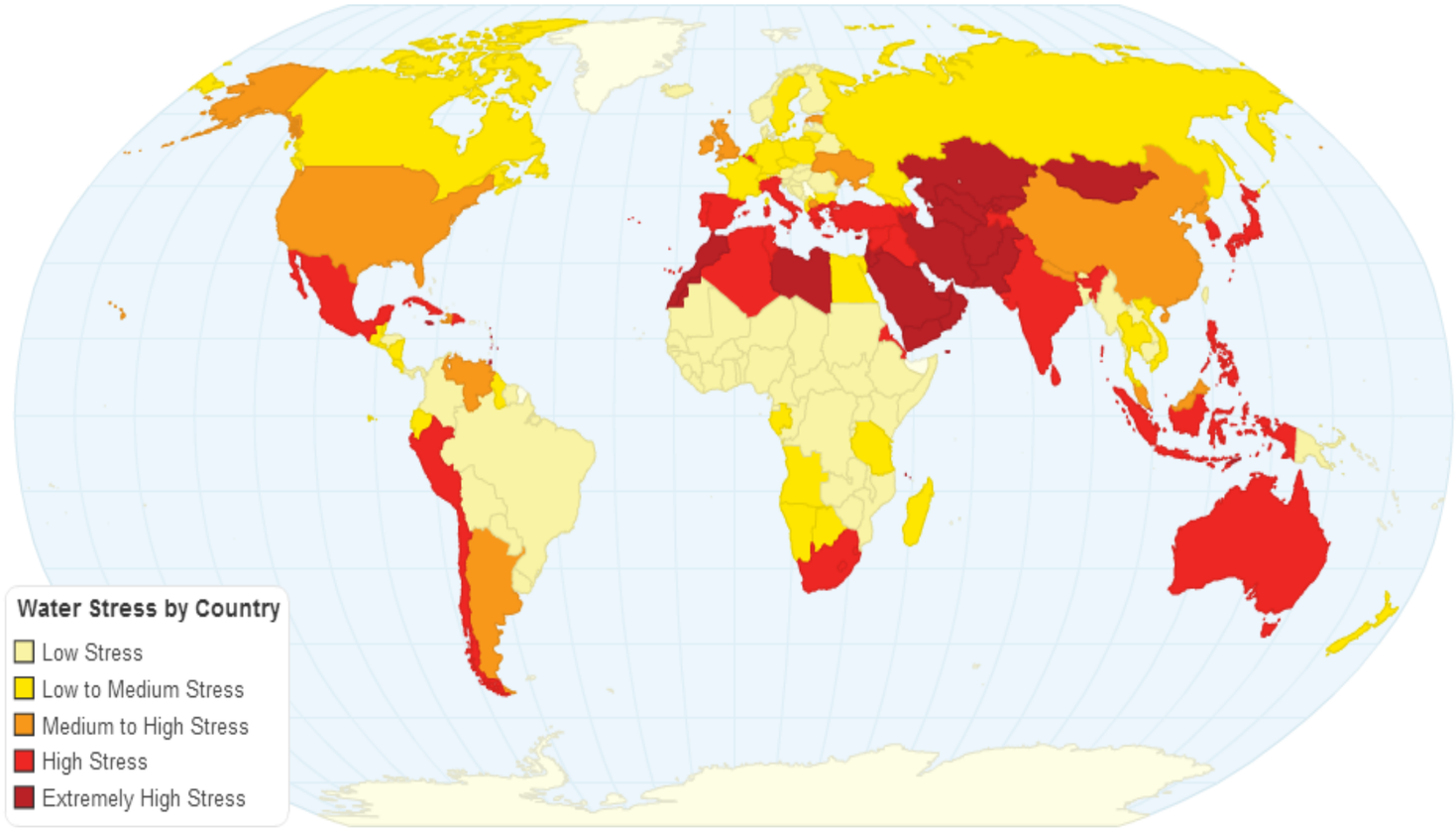
Origin of Capacitive Deionization

Water stress is been always a **concern** for researchers, leading to **new methods** that explore all possible ways to meet this water demand.

Seawater has been targeted due to its extensive availability.

Countries are seeking for more cost - effective approaches for desalination of water:

⇨ Current technologies require big amount of energy.



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Origin of Capacitive Deionization

1960 Electrochemical demineralization was reported: ions removed by electrochemical reactions with chemical groups of carbon particles of the electrodes – Blair and Murphy.

1971 Johnson and Newman introduced theory for ion transport in porous carbon electrodes for ion storage according to a capacitor mechanism.

1990 The technology attracted more attention because of the development of new electrode materials.

1996 Farmer et al. introduced the term Capacitive Deionization and used the now commonly abbreviation CDI for the first time.

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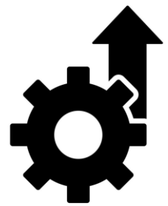
Origin of Capacitive Deionization

Capacitive Deionization as a **better alternative** for these existing technologies:

- energy efficiency.
- environmental friendliness.
- ion removal efficiency.





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What is Capacitive Deionization?

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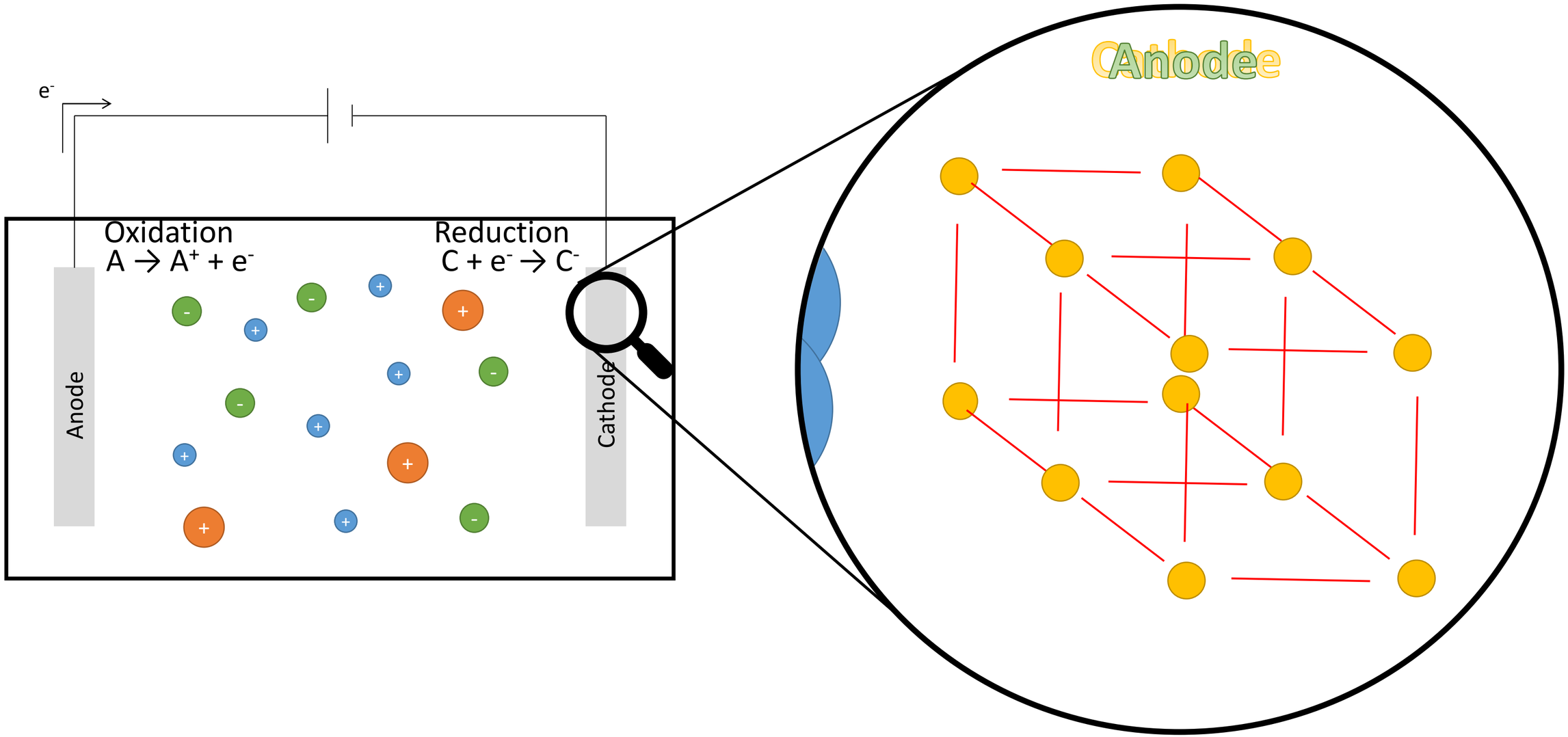
ELECTROCHEMISTRY + ABSORPTION



What is Capacitive Deionization?

Typical CDI cell operation:

- Electrodes of porous carbon.
- Low voltage (about 1.2V).
- Saline water in the cell.

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Key factors in Capacitive Deionization

1. Sufficient surface area of activated carbon.

Ions are adsorbed in the crystalline structure of the electrode:

The more material in contact with the solution → The more vacancies to capture ions.

2. Appropriate pore size distribution.

The size of the vacancies will determine the captured ions, therefore, the chosen crystalline depends on the target ion in the solution.

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Developments of Capacitive Deionization

Applications such as desalination of brackish water and seawater, water softening, removal of weak acids and **CRM recovery**.

Focus on electrode material suitable for this technology:

- Conductive.
- Selective with the target ion.
- High surface area.
- Cheap.
- Stable.

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Developments of Capacitive Deionization

To enhance the selective capture of certain ions, membranes were introduced in the system:

- Membrane Capacitive Deionization (MCDI)
- Monovalent Selective Membrane CDI (MSMCDI)
- Flow Electrode-Based Capacitive Deionization (FCDI)

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Developments of Capacitive Deionization

To enhance the selective capture of certain ions, membranes were introduced in the system:

- **Membrane Capacitive Deionization (MCDI):** with Anion Exchange Membrane and Cation Exchange Membrane.

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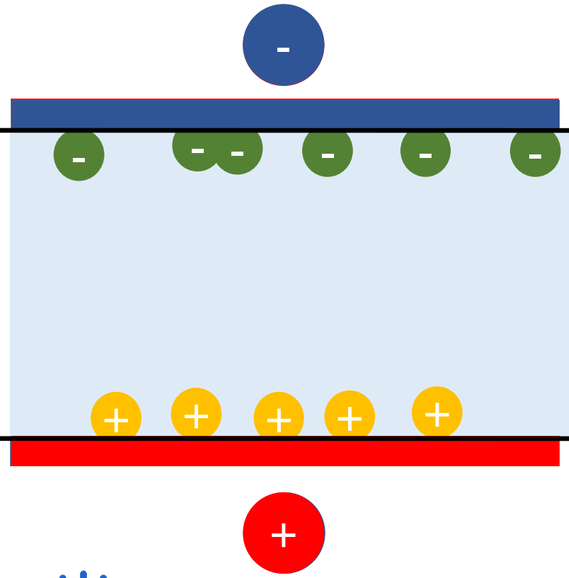
Developments of Capacitive Deionization

To enhance the selective capture of certain ions, membranes were introduced in the system:

- Normal **Capacitive Deionization (CDI)**.



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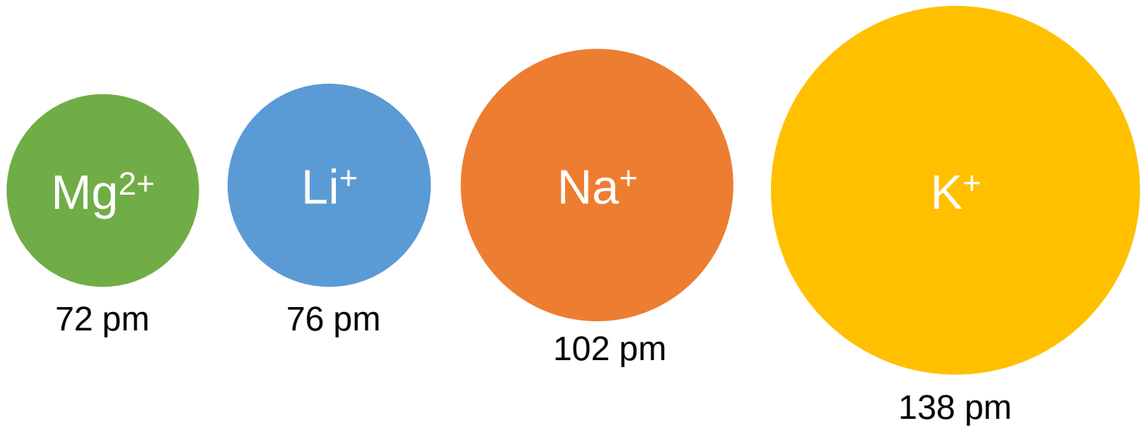

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Developments of Capacitive Deionization

To enhance the selective capture of certain ions, membranes were introduced in the system:

- Membrane Capacitive Deionization (MCDI): with Anion Exchange Membrane and Cation Exchange Membrane.
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- **Flow Electrode-Based Capacitive Deionization (FCDI):** with suspended electrode material.

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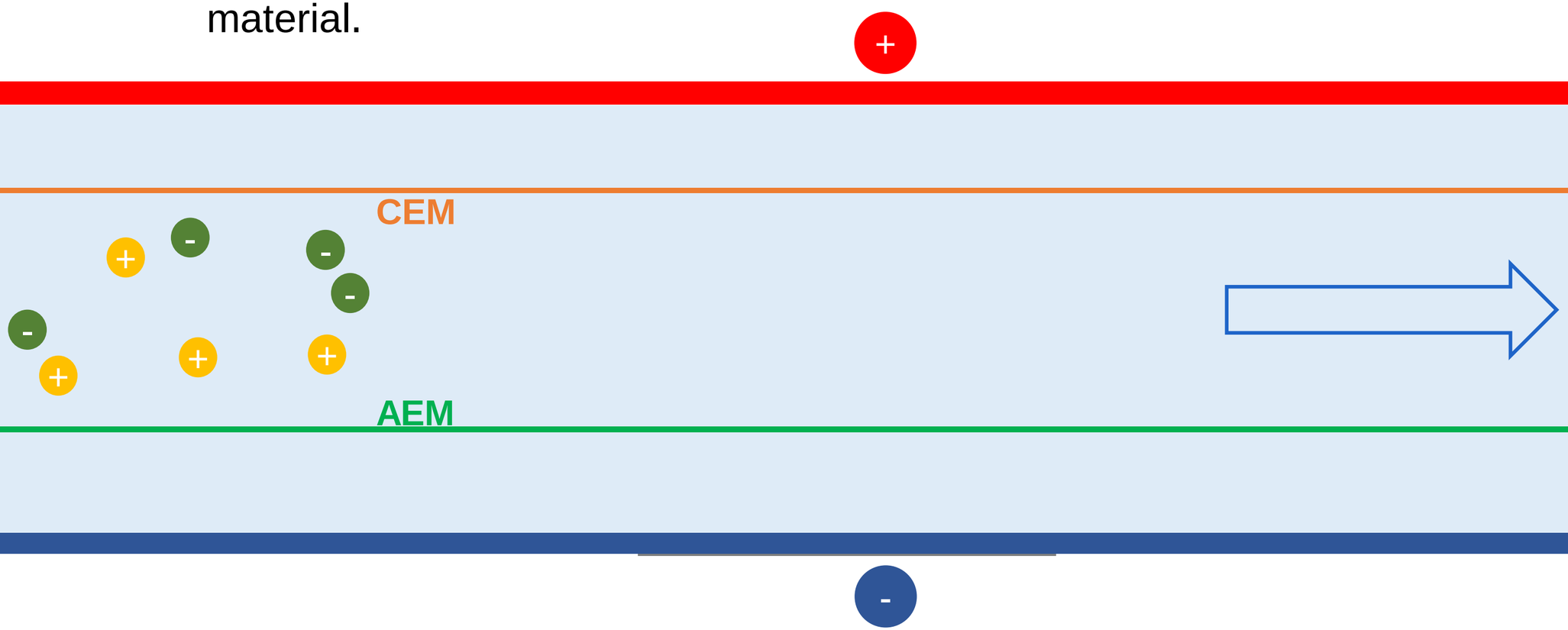
Developments of Capacitive Deionization

- **Flow Electrode-Based Capacitive Deionization (FCDI):** with suspended electrode material.



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Developments of Capacitive Deionization

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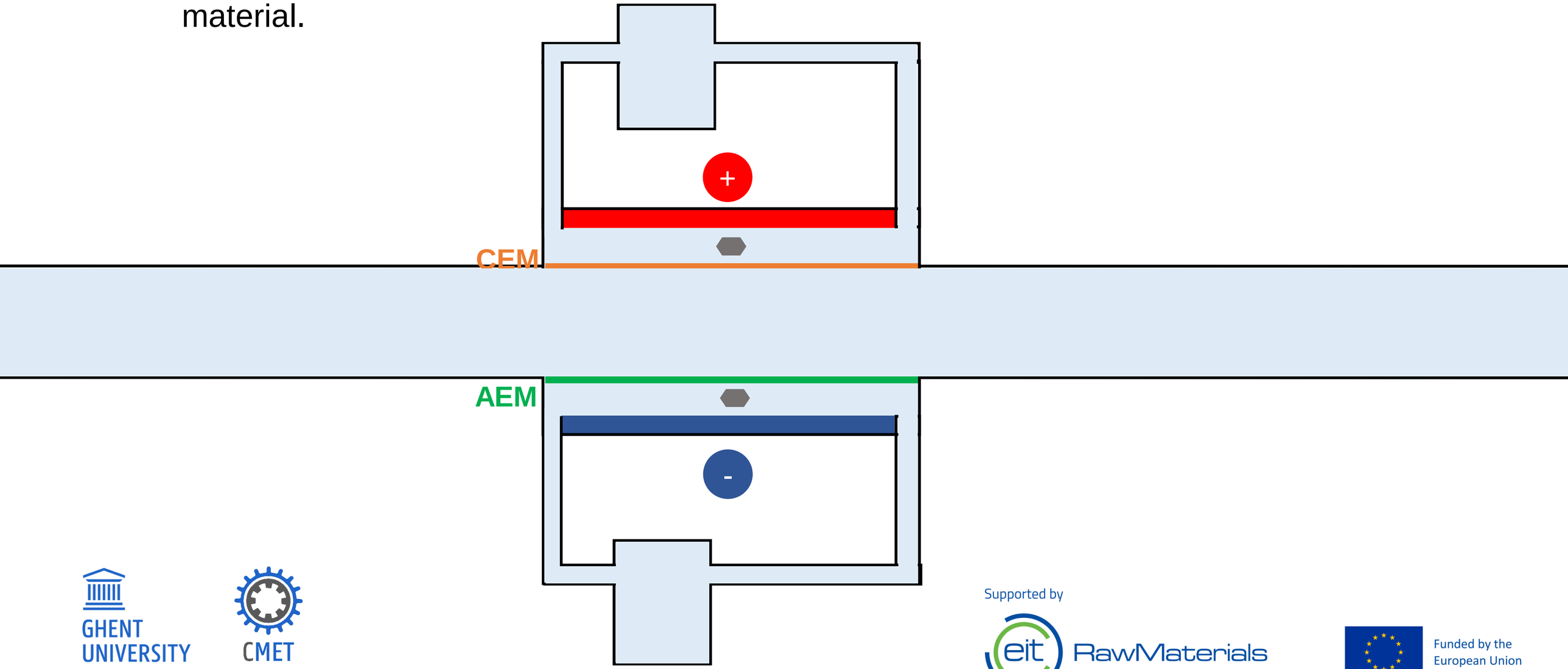

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Developments of Capacitive Deionization

- Arsenic
- Copper
- Vanadium
- Lead
- Chromium
- Nickel
- Cadmium
- Lithium
- Zinc
- …

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Take home messages

- Capacitive deionization is a technique to selectively remove ions from saline waters.
- The removed ions can be recovered, what makes this technique interesting for CRM.
- New electrode materials development is key for the selective capture of target ions.
- The configuration of the capacitive deionization can help in the effectiveness and feasibility of the process.

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Thanks for listening.

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