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BRINE RIS

Electrochemical methods for Li extraction

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04/12/2024
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Lithium: The Driving Force Behind Energy Transition

Surging Demand

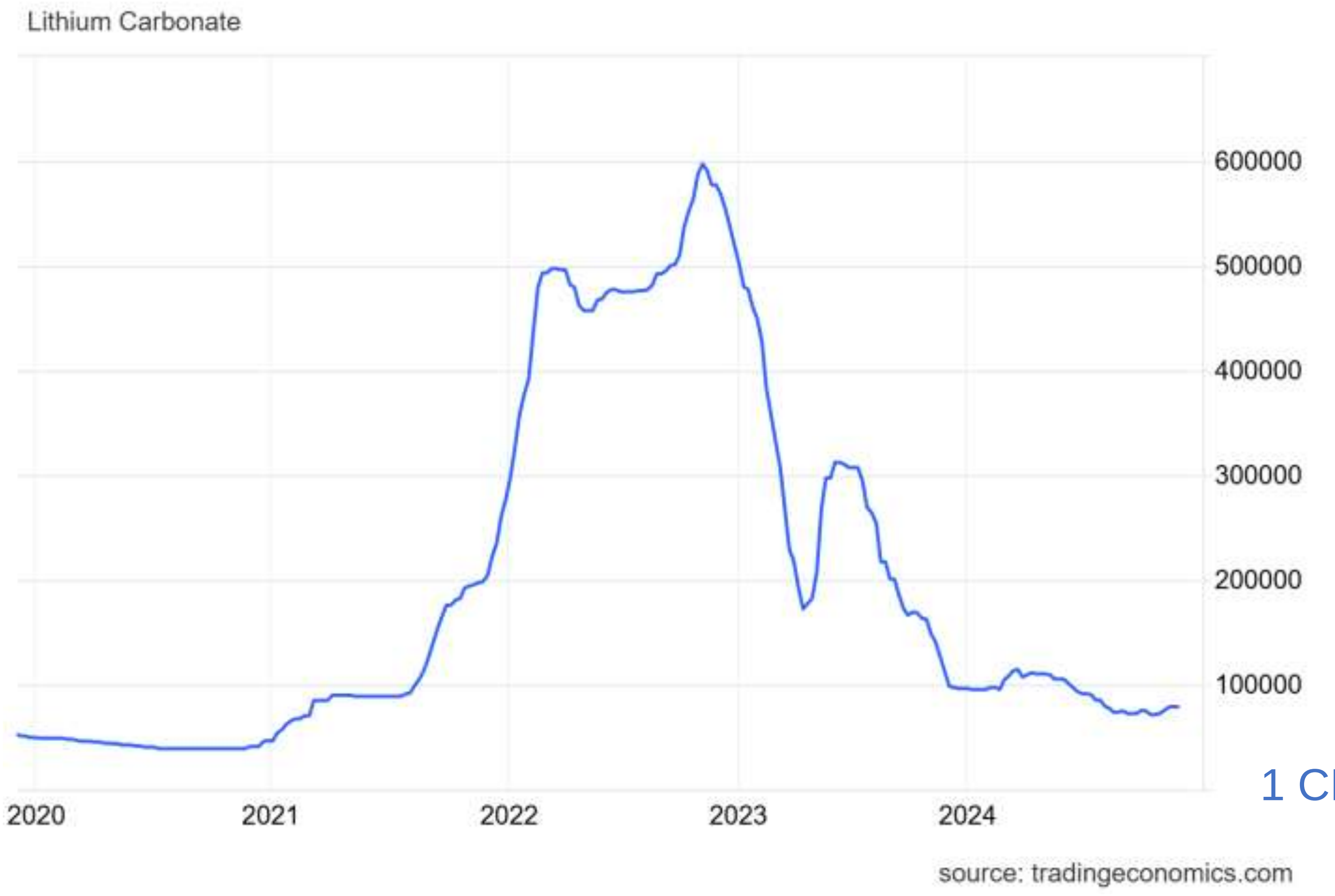
As electric vehicles and renewable energy storage become mainstream, lithium's role as a key enabler of the green energy transition is rapidly increasing.

Supply Challenges

Europe faces challenges in securing reliable, sustainable lithium supplies to meet its ambitious climate goals. Innovative extraction methods are needed.

Innovative extraction methods still a future

Lithium price



CNY/tonne

1 CNY= 0.13EUR

Supply Challenges

It relies on imports:

78% comes from Chile

8% from the US

4% from Russia

Addressing Europe's Lithium Supply Challenges

Domestic Production

Developing Europe's indigenous lithium resources is critical to reduce reliance on imports and ensure supply chain security.

Environmental Sustainability

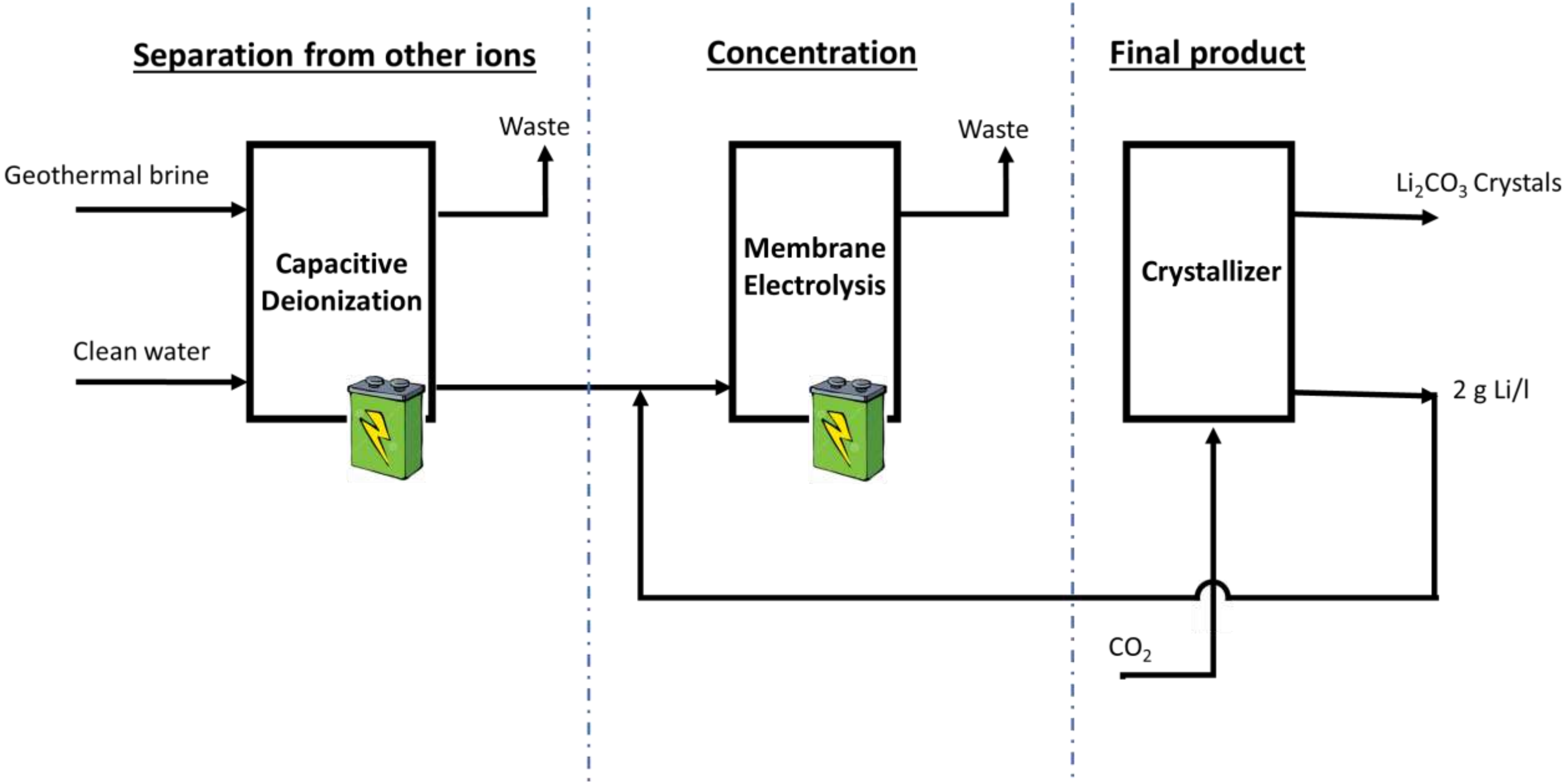
Extracting lithium using clean, energy-efficient electrochemical methods minimizes the environmental impact compared to traditional mining.

Technological Innovation

Pioneering electrochemical extraction techniques unlock new lithium sources and improve production efficiency.

Li extraction from geothermal brines

The process developed at Ghent University to extract lithium from geothermal brines has three main steps.
Each part of the process is tested in the laboratory until lithium carbonate crystals are obtained as a final product.



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Step 1: Capacitive Deionization (Separation Step)

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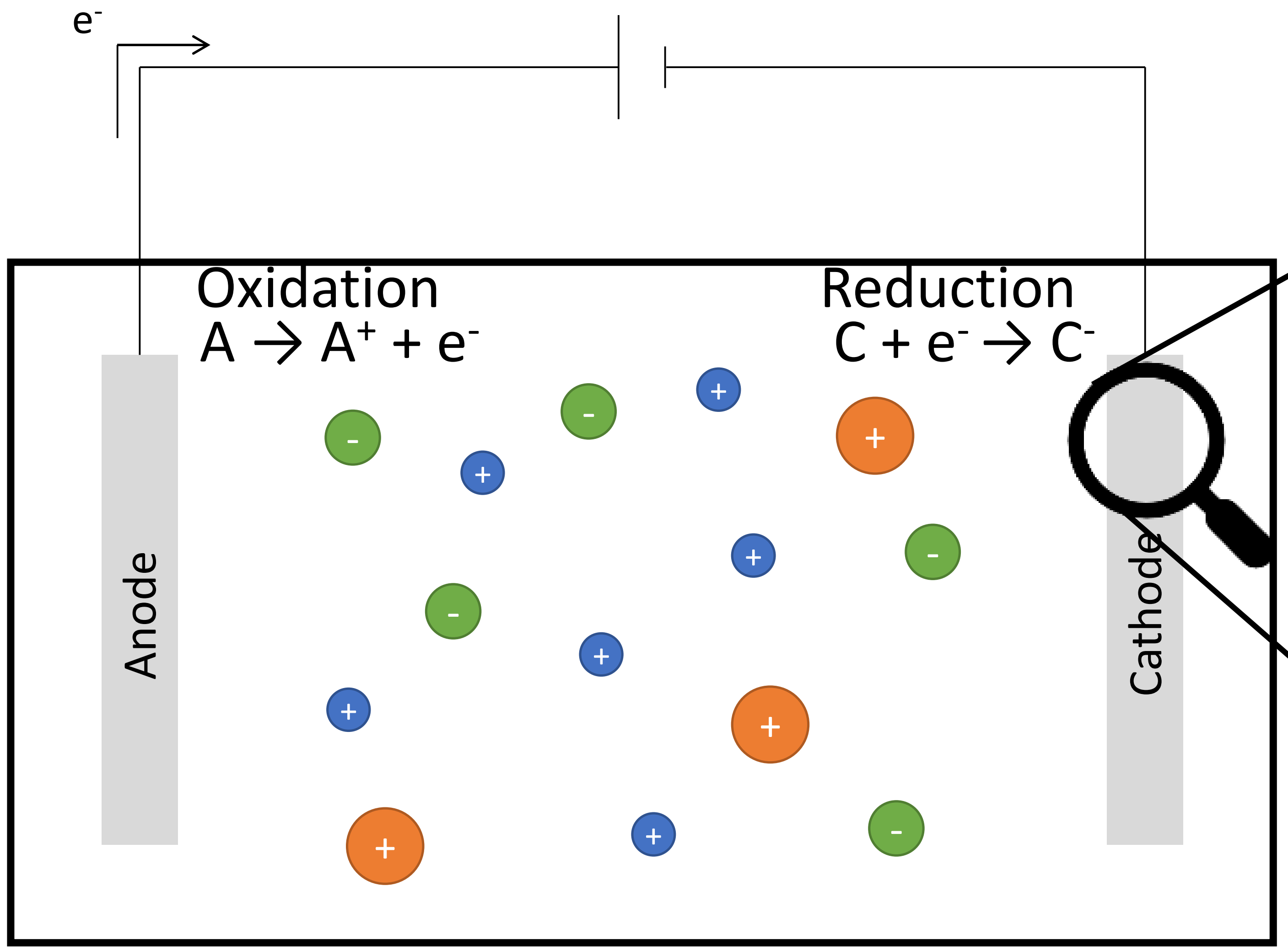
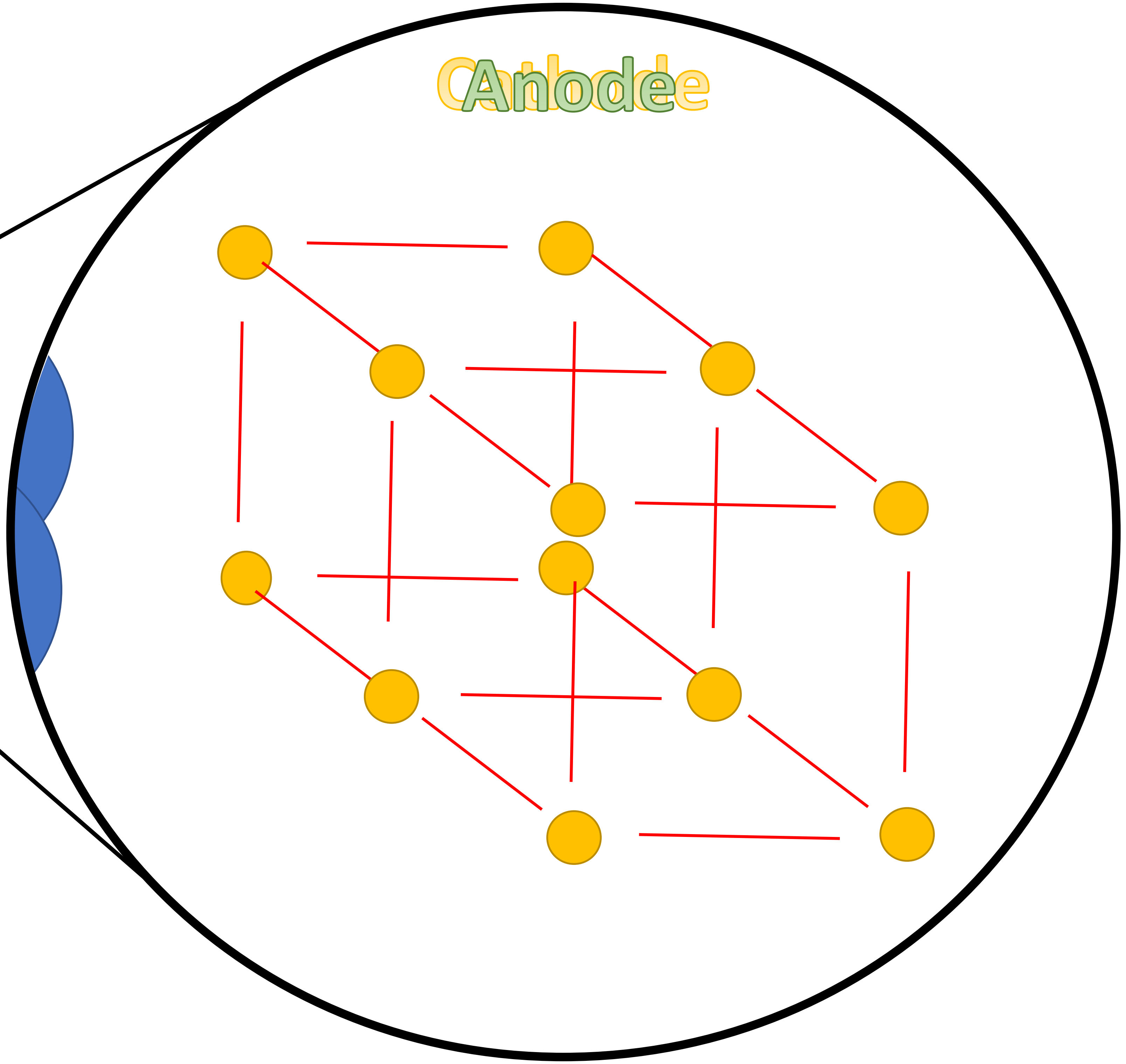
ELECTROCHEMISTRY + ABSORPTION





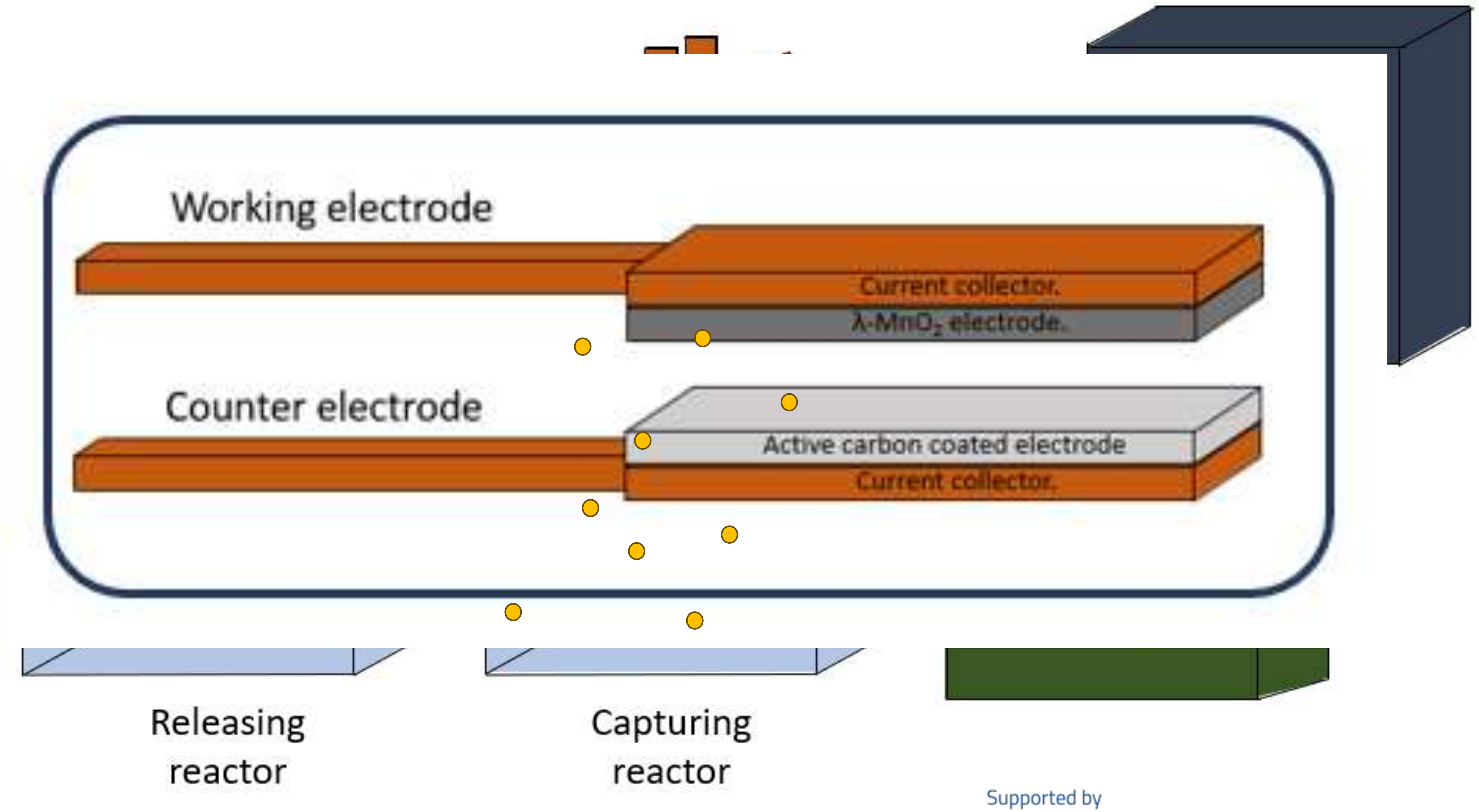
To balance the electron transfer, ions in the solution migrate towards the electrodes.

BUT: it is not a selective process.

Also called: Selective sieves = f (atomic radius)

Step 1: Capacitive Deionization (Separation Step)

- Working electrode as **CATHODE**
- Lithium is **absorbed** in the working electrode



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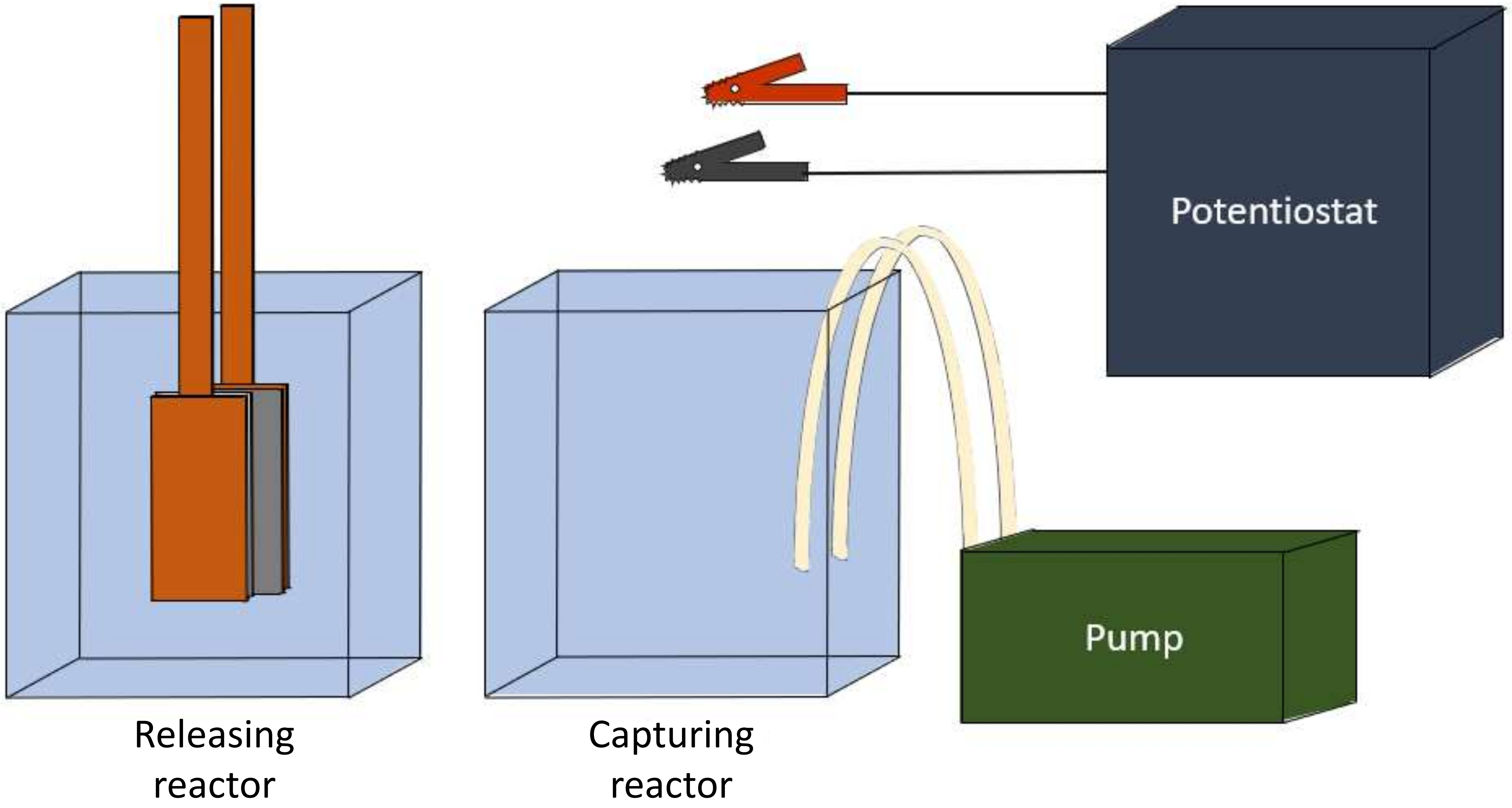
Step 1: Capacitive Deionization (Separation Step)

- Electrodes change to **Releasing Reactor**
- **Polarity** reversed



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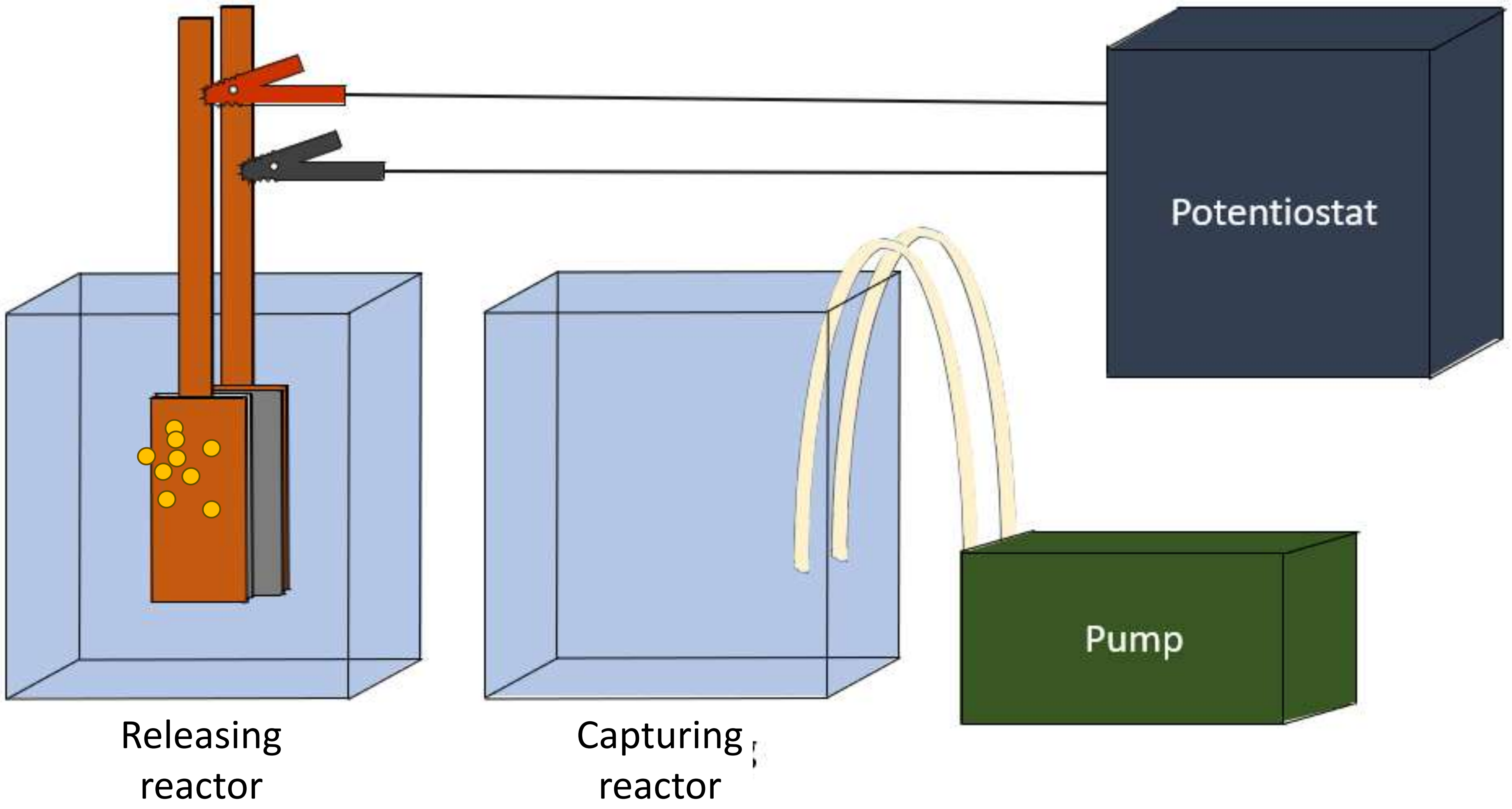
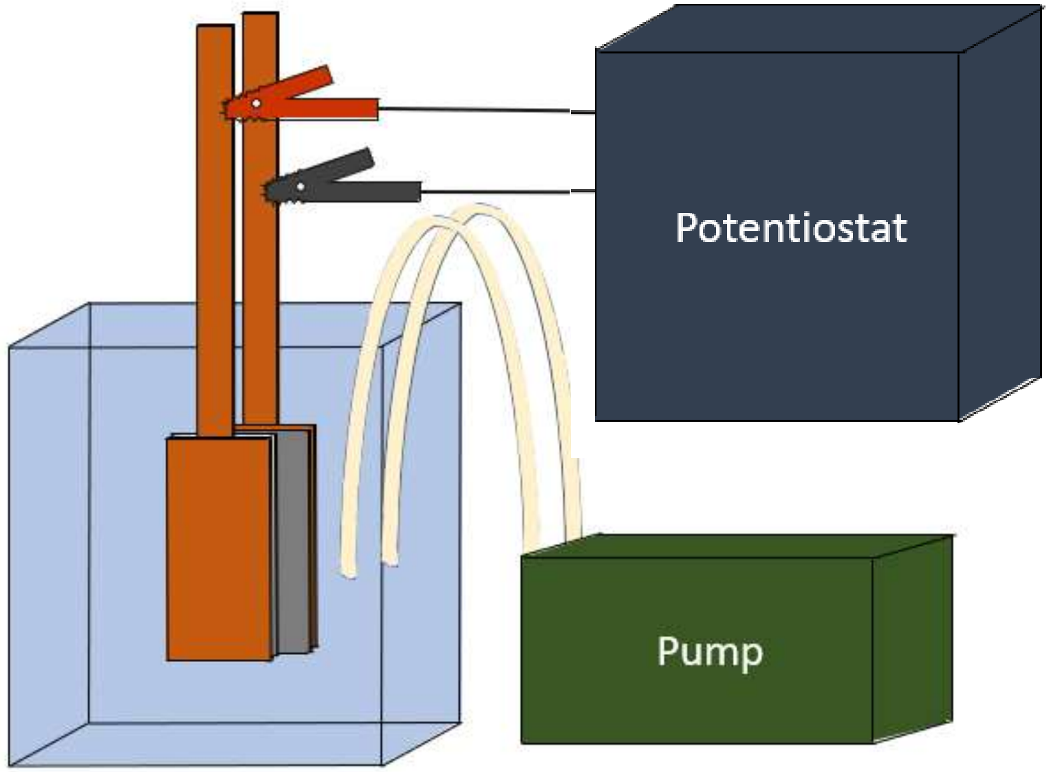
Step 1: Capacitive Deionization (Separation Step)

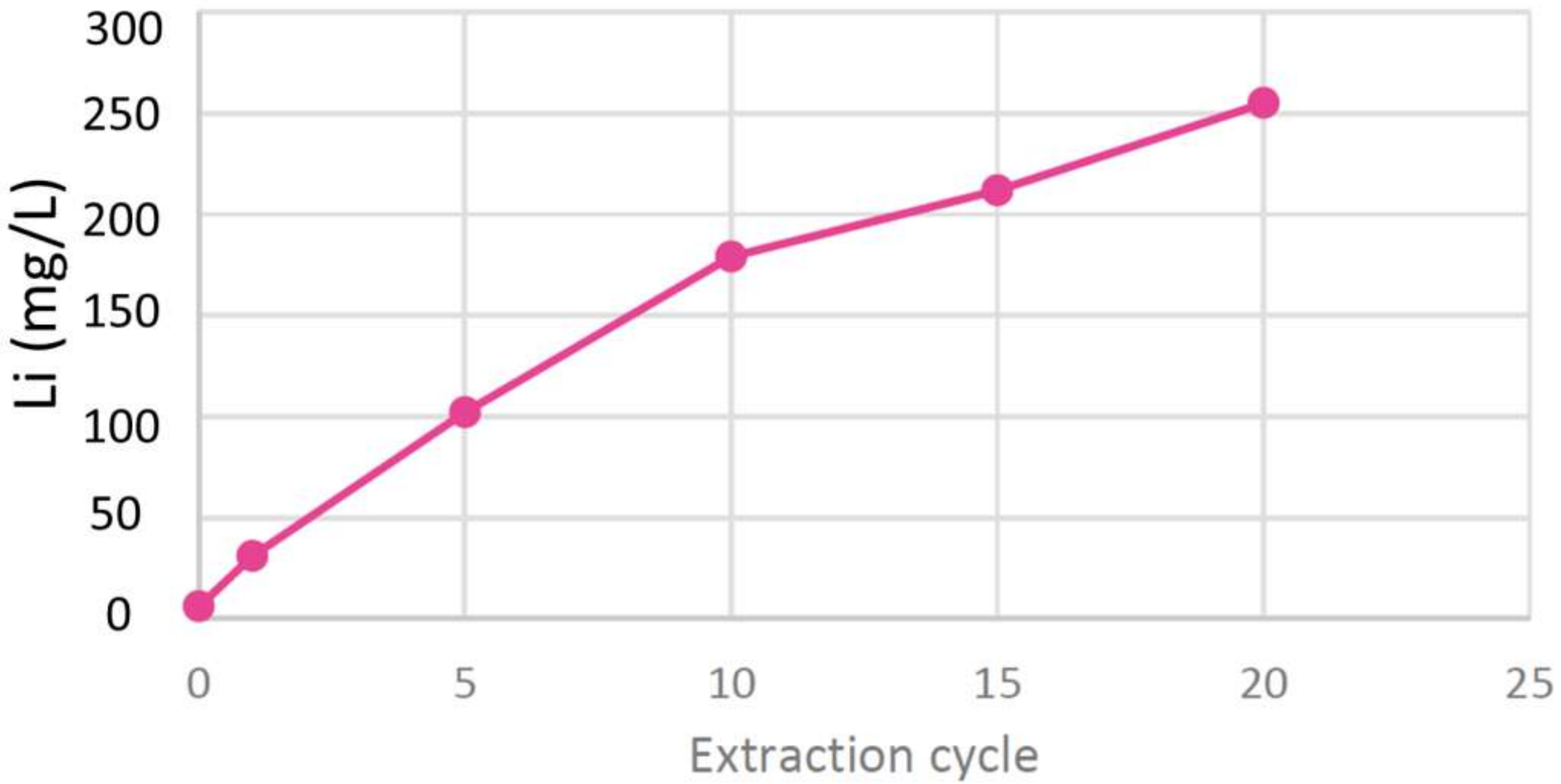
- Working electrode as **ANODE**
- Lithium is **desorbed** from the working electrode



Step 1: Capacitive Deionization (Separation Step)

After 30 cycles, lithium was extracted with a **concentration of 300 mg/l**

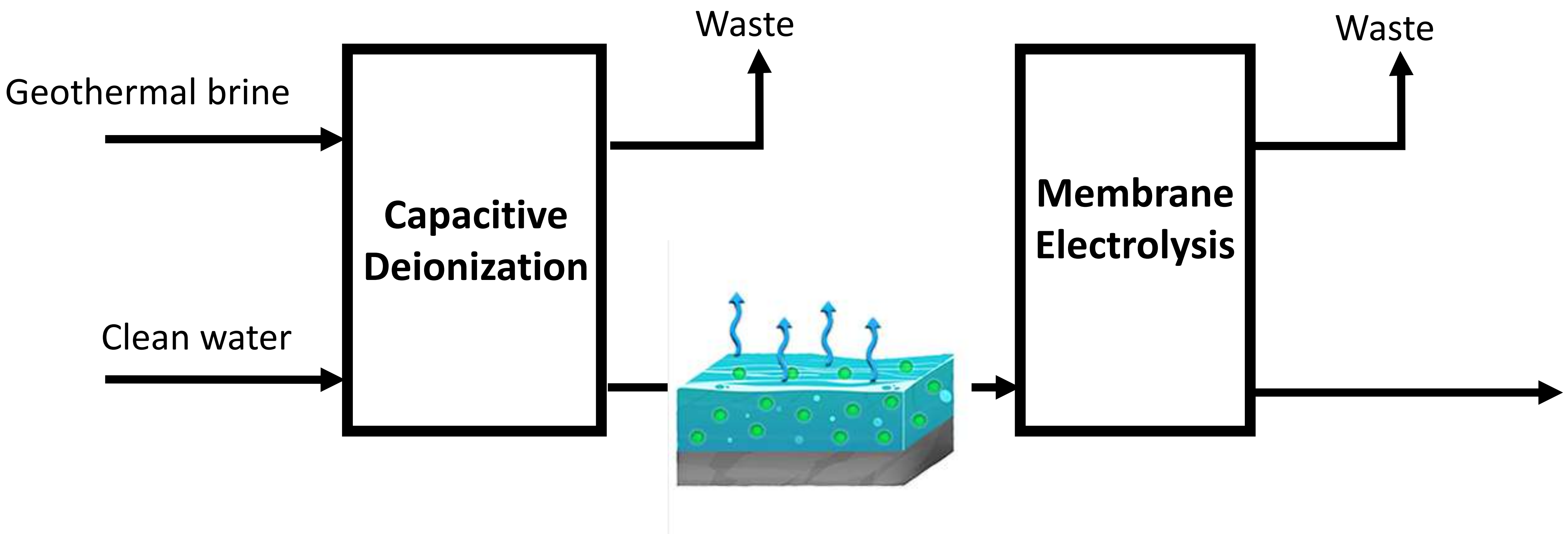




Graph 1- *Lithium concentration in the clean solution per cycle.*

Lithium Extraction Flowsheet

Separation from other ions **Concentration**



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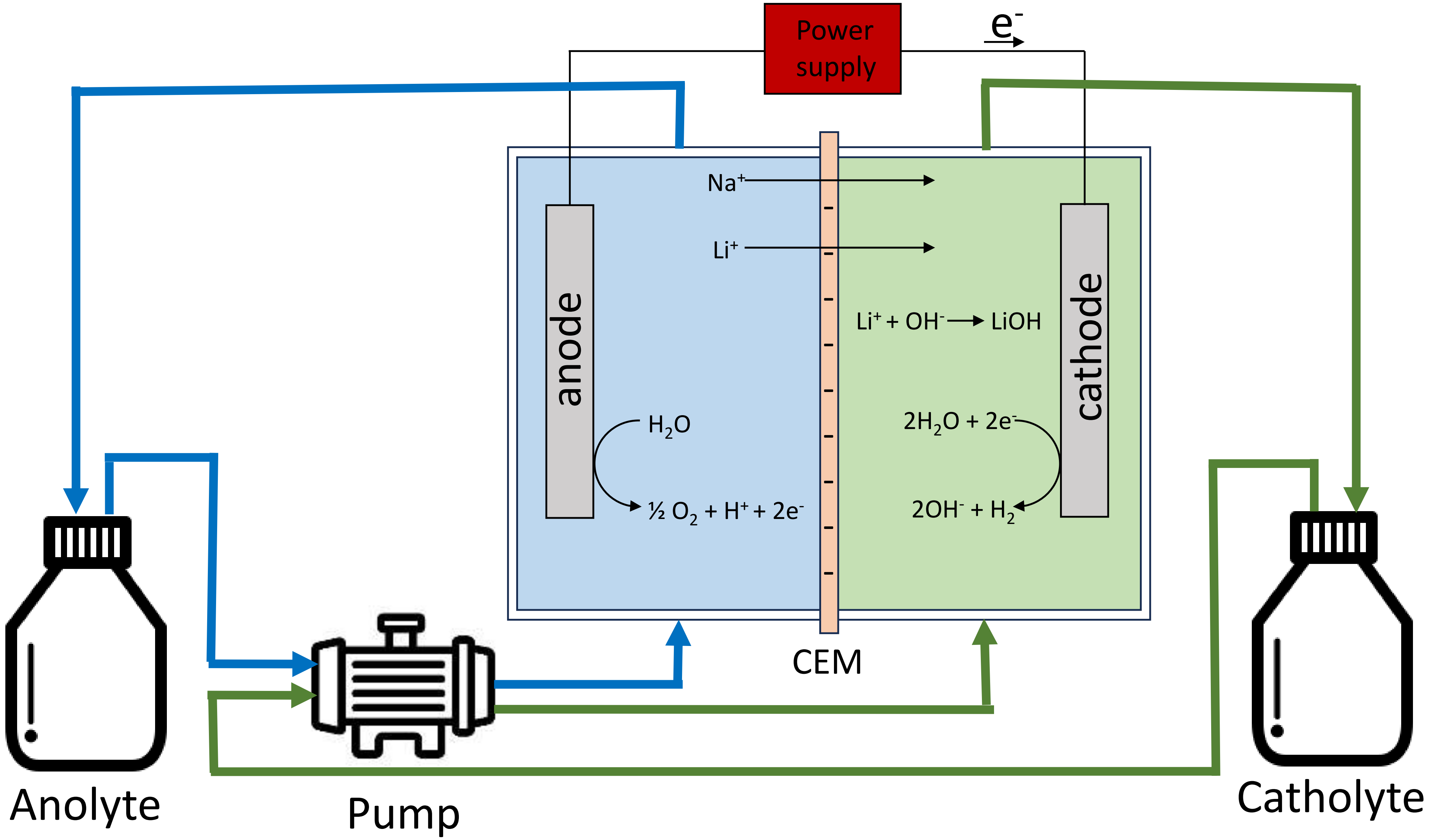
Step 2: Membrane Electrolysis (Concentration Step)

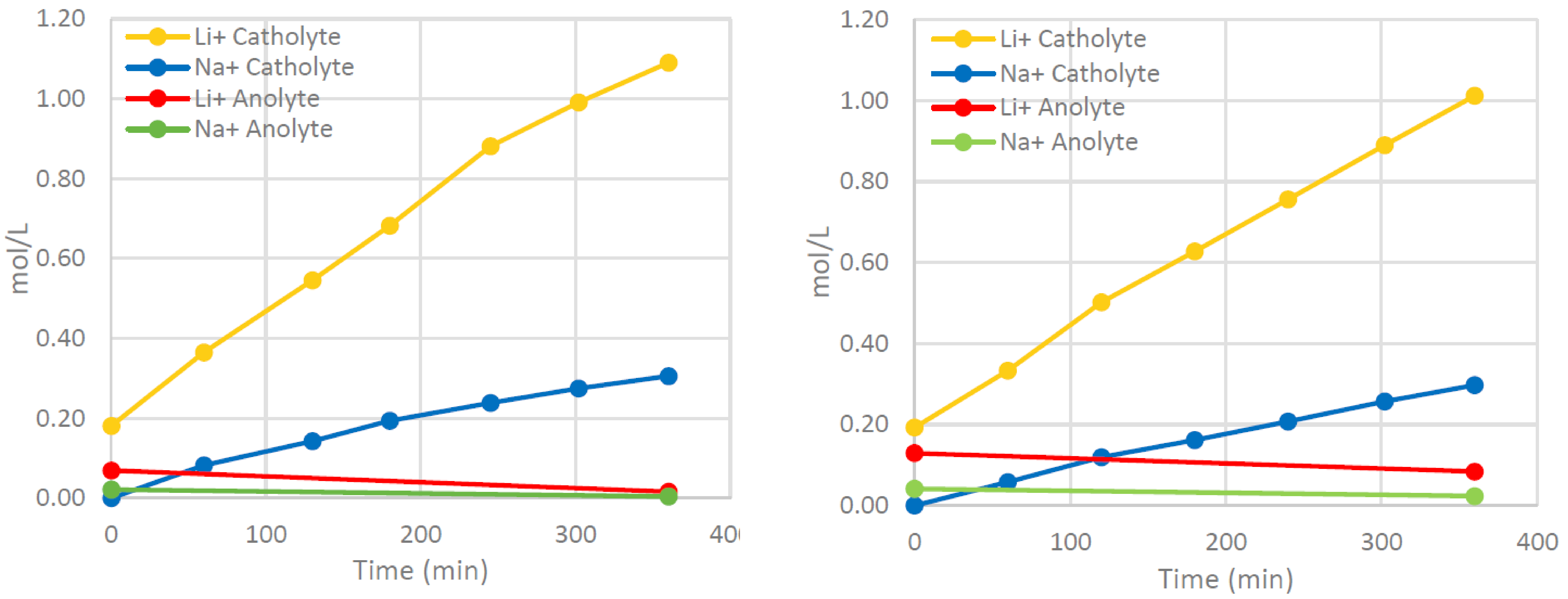


- **Water splitting** occurs: Cell is **polarized**.
- **Li+ migrates** to maintain neutrality in the cell.
- **Difference in volume** between anolyte and catholyte helps in the concentration process.

*CEM= Cathion Exchange Membrane

Step 2: Membrane Electrolysis (Concentration Step)

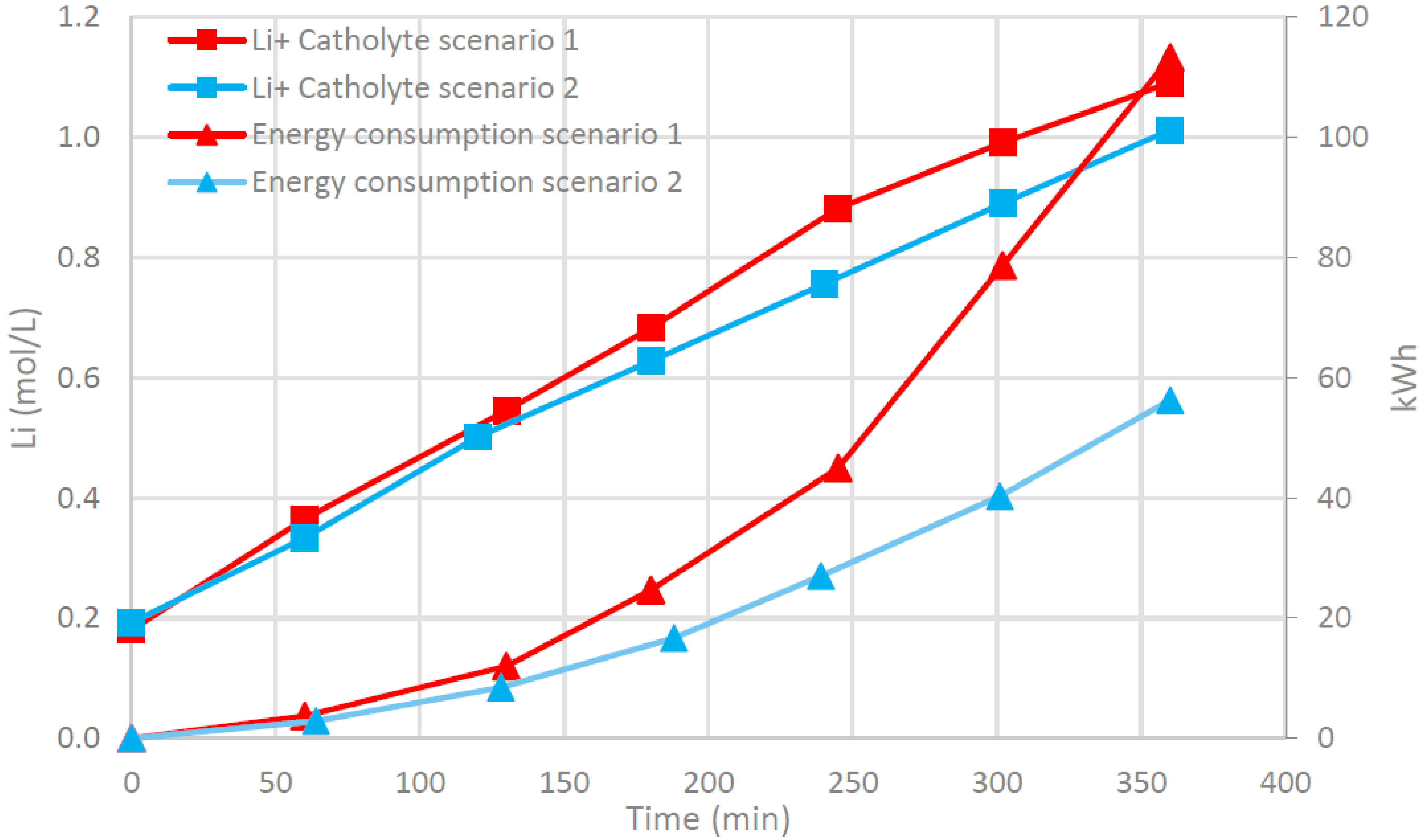
Scenario 1: **500 mg Li/L** after evaporation.
Scenario 2: **1000 mg Li/L** after evaporation.



Graph 2- *On the left, evolution through time of lithium and sodium in catholyte and anolyte of scenario 1; on the right, same parameters for scenario 2.*

Step 2: Membrane Electrolysis (Concentration Step)

Concentration reached of **7.5 g Li/L** after 6 hours.
Energy consumption dependent of initial concentration of lithium:



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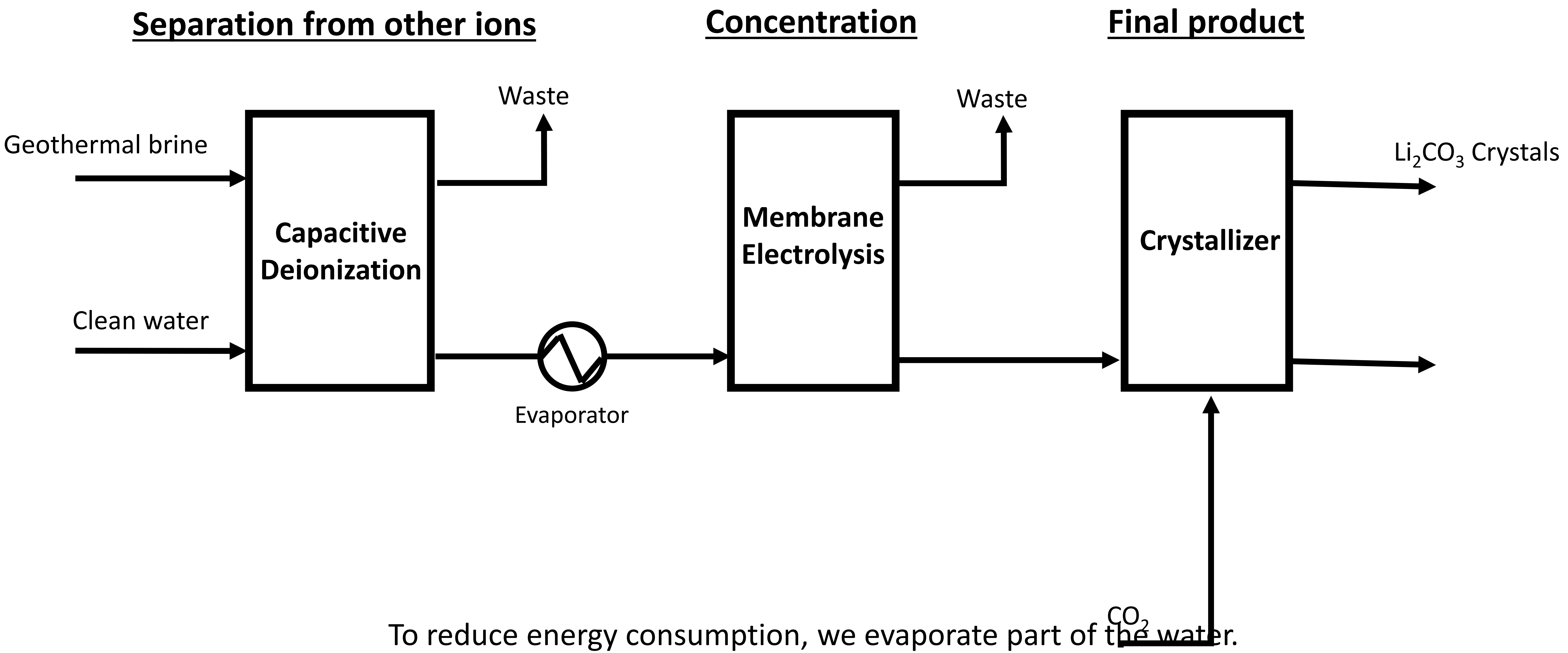
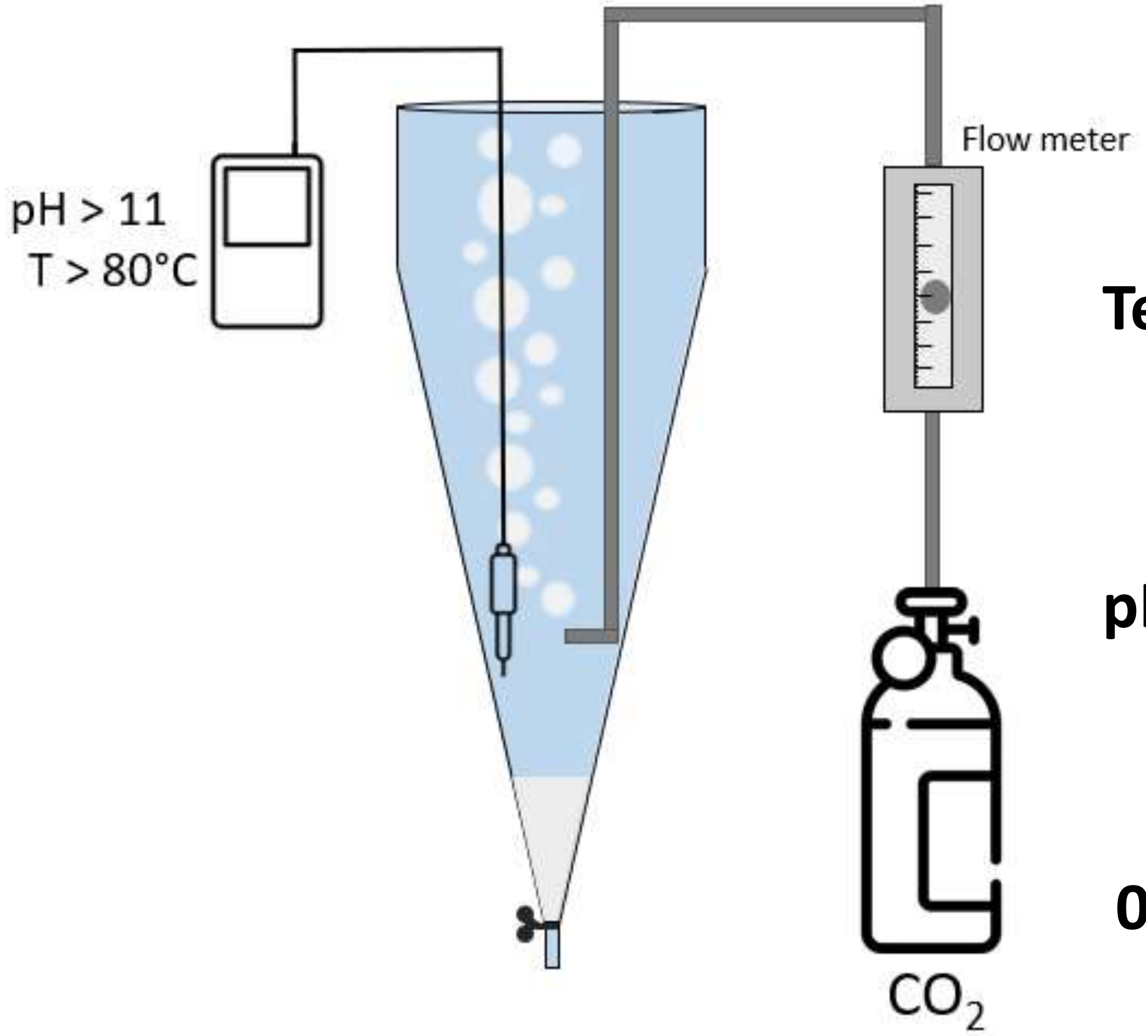
Lithium Extraction Flowsheet



To reduce energy consumption, we evaporate part of the water.

Step 3: Crystallization (Obtaining Final Product)



Temperature > 80 °C

- **Li_2CO_3 not soluble**
- **Na_2CO_3 soluble**

pH > 11

- **Li_2CO_3 not soluble**
- **$NaHCO_3$ soluble**

0.36 l CO2/min

$$2LiOH + CO_2 \rightarrow Li_2CO_3 + H_2O$$

2 g Li/l remaining in the solution

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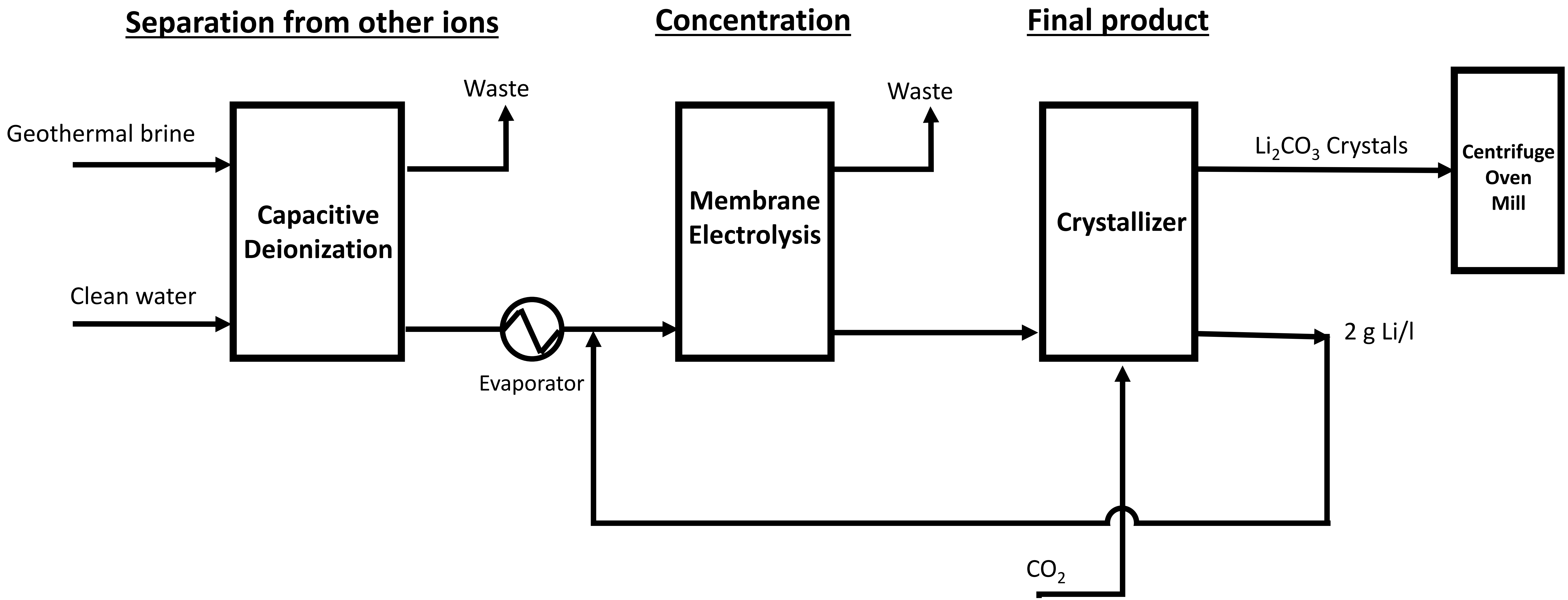
Lithium Extraction Flowsheet



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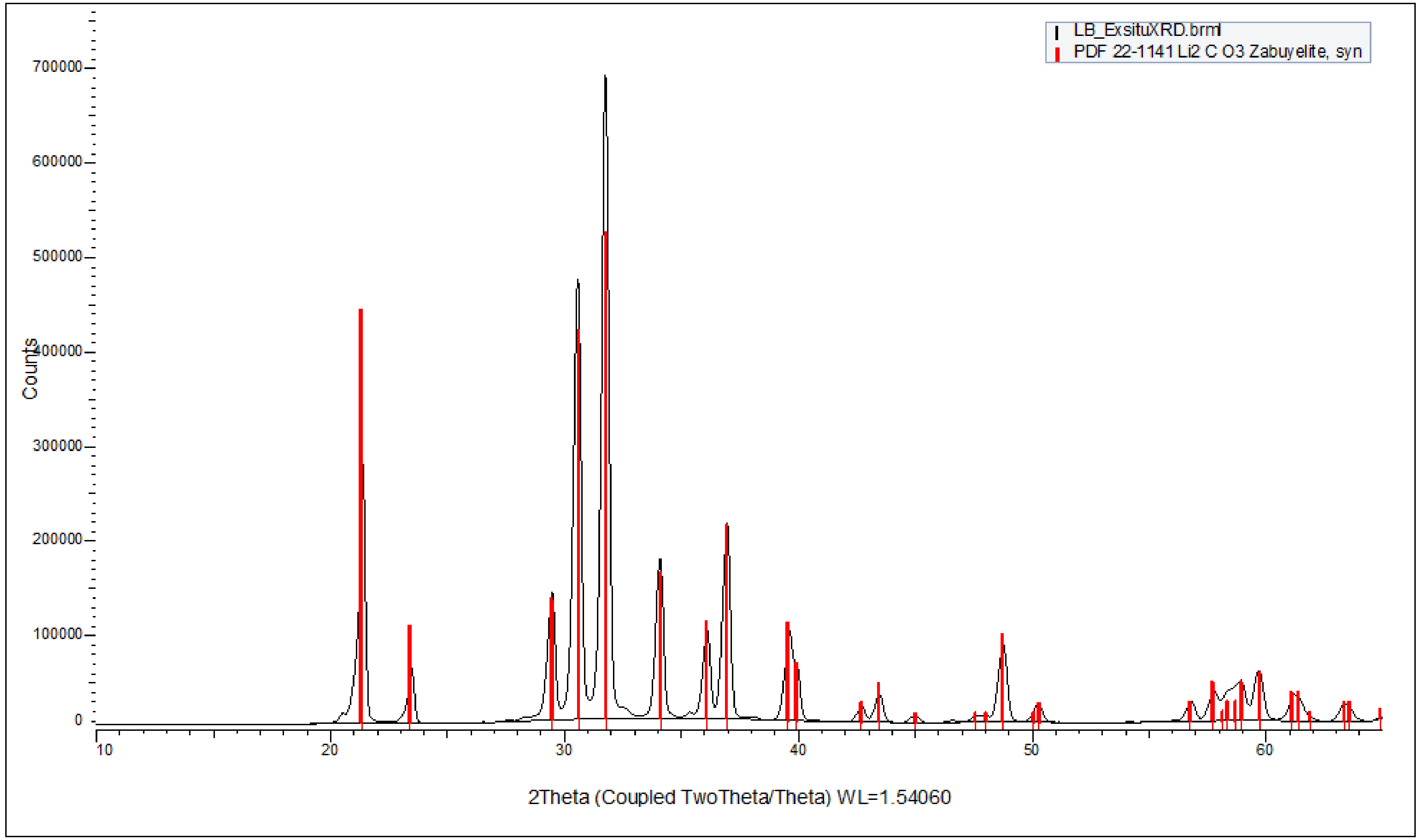
Final product

Sent to analyze with XRD and the profile matches perfectly with Li_2CO_3



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Conclusions

- We created a **full process** from a raw material (geothermal brine rich in lithium) to a high-added **value final product** (lithium carbonate crystal) with a **separation** from other ions present in the brine, **double concentration step** (partial evaporation and membrane electrolysis process) and **crystallization**.

- The optimal concentration of lithium in the starting point of each technique must be studied to analyse what is more **energetically profitable**.

- Challenge still the presence of certain elements like: As, U, Ba, Pb, Mg…

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Thanks for listening.

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