TECNOLOGIE DI DISSALAZIONE, SPERIMENTAZIONI ED INNOVAZIONE IN CORSO: TRATTAMENTO E VALORIZZAZIONE SALAMOIE

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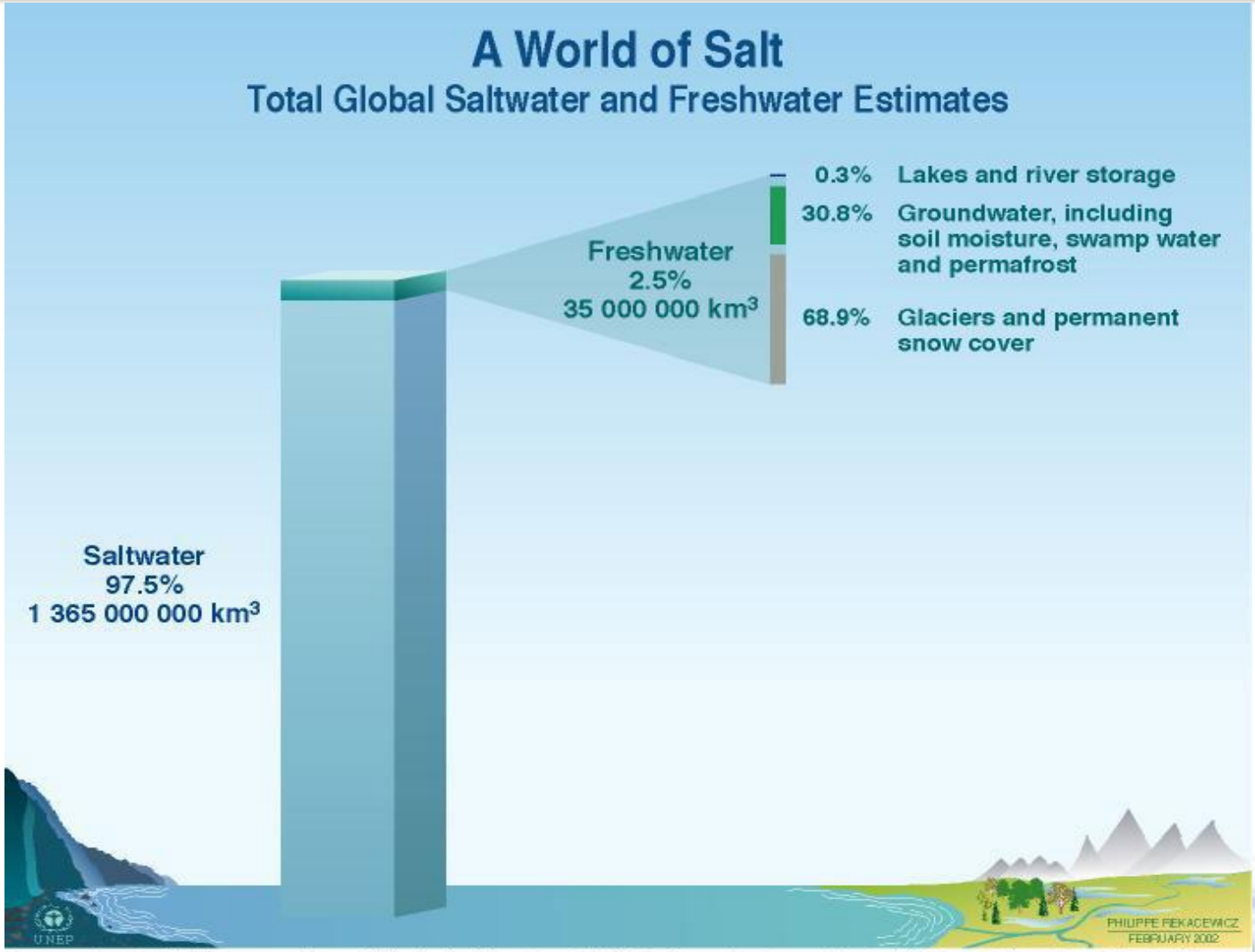
RESOURSEAS

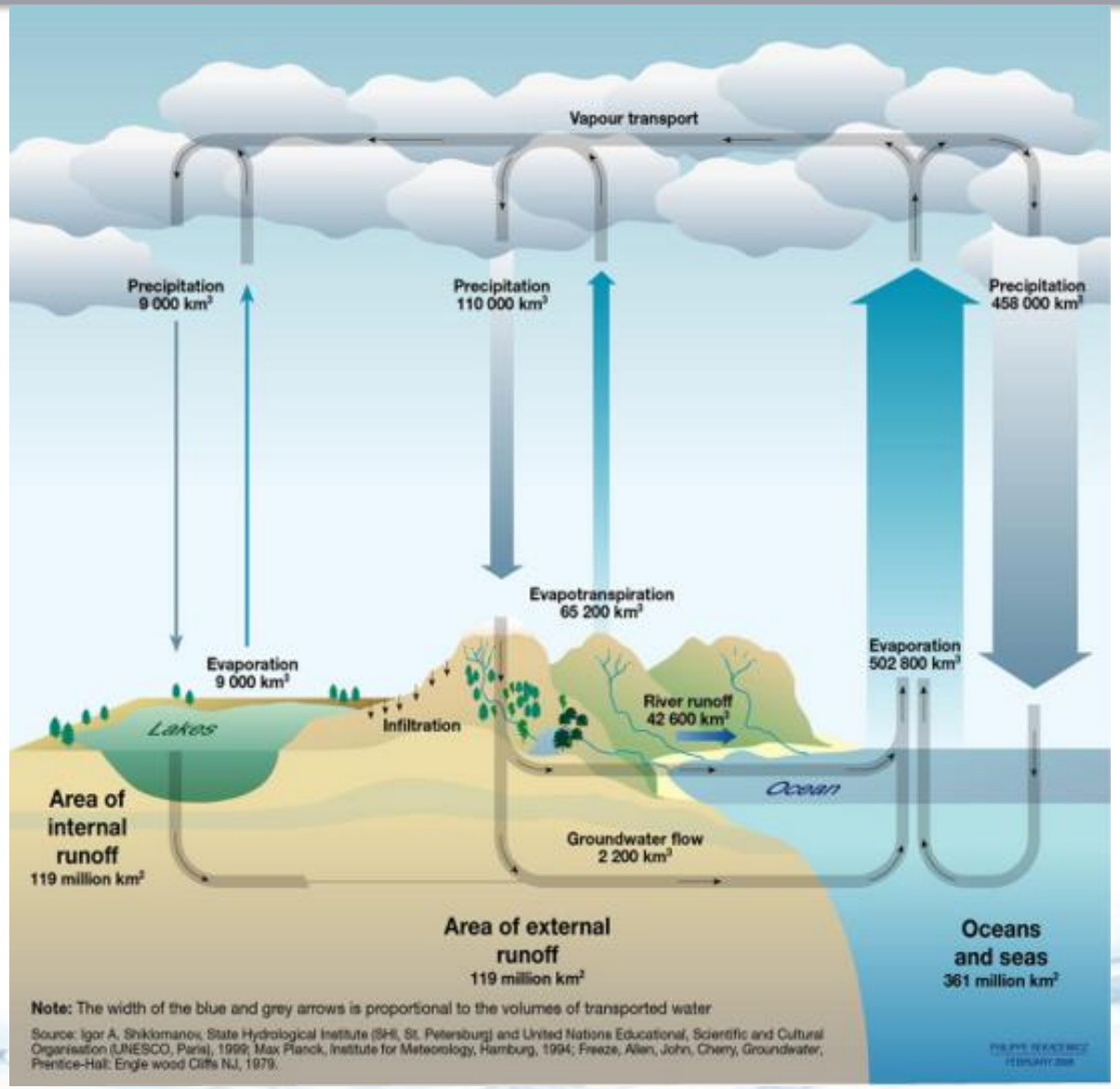
Workshop Nazionale
sul tema Dissalazione e Riuso delle Acque Depurate
Napoli, 24 giugno 2024
Sala Polifunzionale Museo Darwin Dohrn (DaDoM)

Total Saltwater and Freshwater



Source: Igor A. Shiklomanov, State Hydrological Institute (SHI, St. Petersburg) and United Nations Educational, Scientific and Cultural Organisation (UNESCO, Paris), 1999.

Hydrological Cycle



Water Scarcity

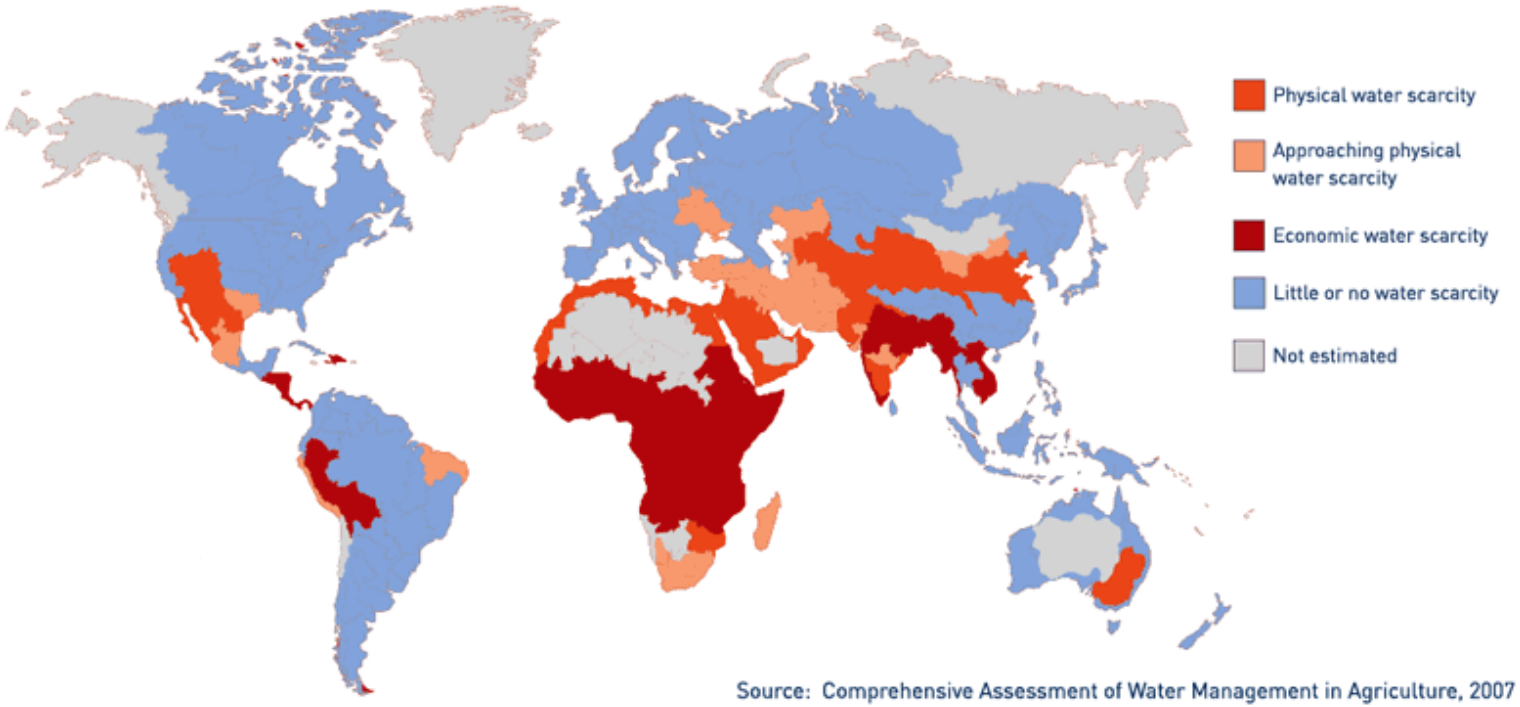
AREAS OF PHYSICAL AND ECONOMIC WATER SCARCITY

Physical water scarcity water resources development is approaching or has exceeded sustainable limits). More than 75% of the river flows are withdrawn for agriculture, industry, and domestic purposes (accounting for recycling of return flows). This definition—relating water availability to water demand—implies that dry areas are not necessarily water scarce.

Approaching physical water scarcity. More than 60% of river flows are withdrawn. These basins will experience physical water scarcity in the near future.

Economic water scarcity (human, institutional, and financial capital limit access to water even though water in nature is available locally to meet human demands). Water resources are abundant relative to water use, with less than 25% of water from rivers withdrawn for human purposes, but malnutrition exists.

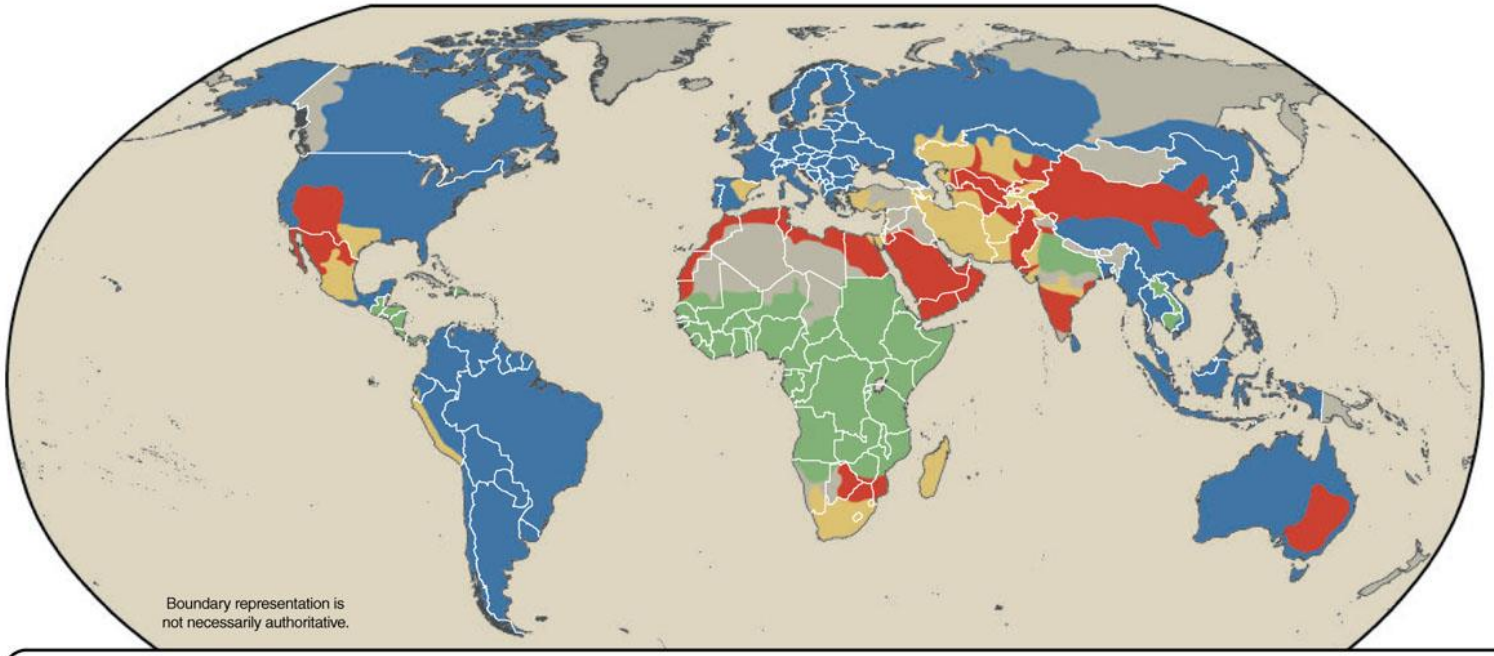
Little or no water scarcity. Abundant water resources relative to use, with less than 25% of water from rivers withdrawn for human purposes.



Source: Comprehensive Assessment of Water Management in Agriculture, 2007

Water Scarcity

Projected Global Water Scarcity, 2025



Physical water scarcity: More than 75% of river flows are allocated to agriculture, industries, or domestic purposes. This definition of scarcity — relating water availability to water demand — implies that dry areas are not necessarily water-scarce.

Approaching physical water scarcity: More than 60% of river flows are allocated. These basins will experience physical water scarcity in the near future.

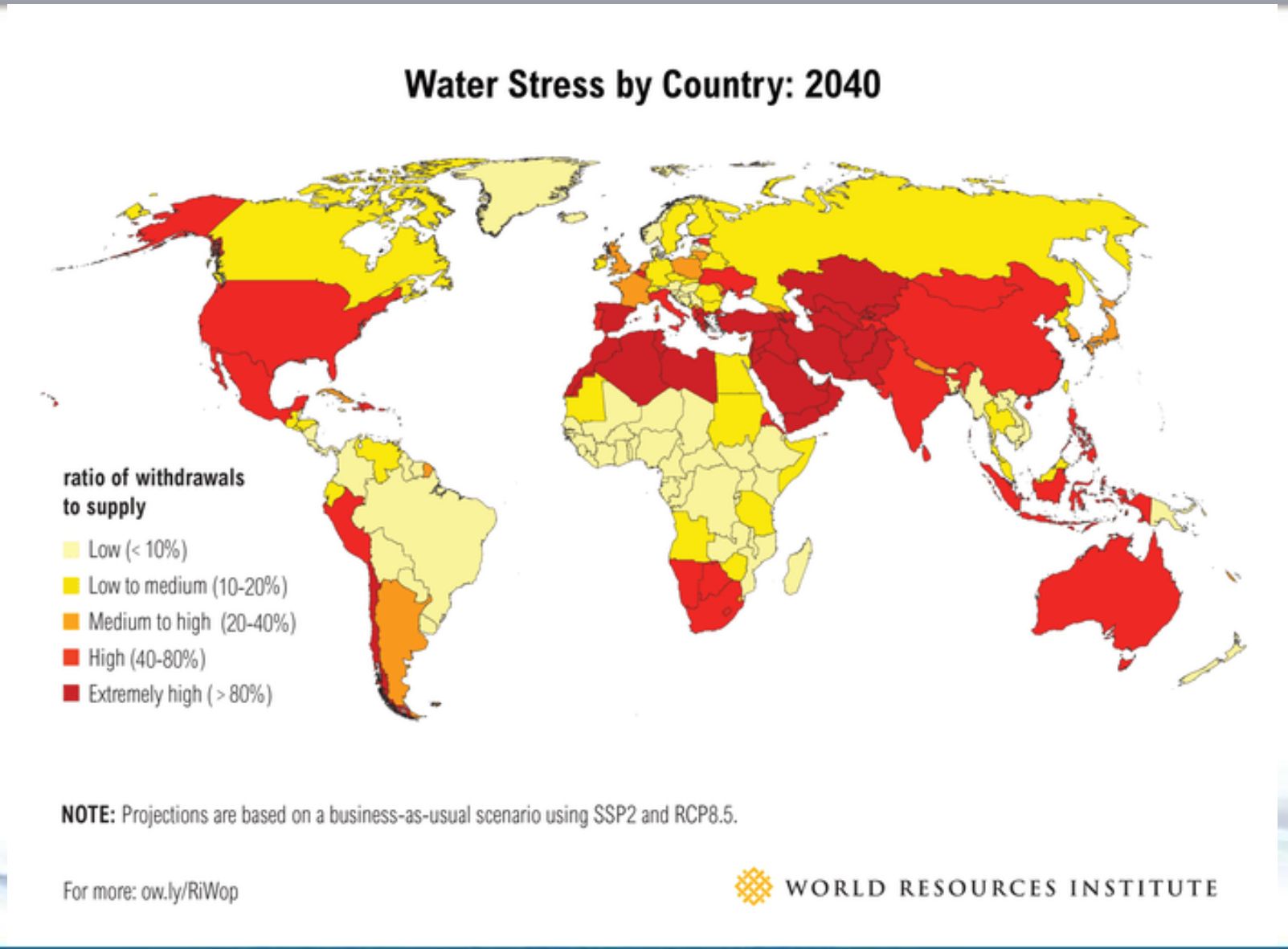
Economic water scarcity: Water resources are abundant relative to water use, with less than 25% of water from rivers withdrawn for human purposes, but malnutrition exists.

Little or no water scarcity: Abundant water resources relative to use. Less than 25% of water from rivers is withdrawn for human purposes.

Not estimated

Source: International Water Management Institute.

Water Scarcity



United Nation - SDG 6

Ensure availability and sustainable management of water and sanitation for all

Indicator 6.4.2 “Level of water stress: freshwater withdrawal as a proportion of available freshwater resources”

Target 6.4 seeks to ensure sustainable withdrawals and supply of freshwater to address water scarcity

Desalination process (conventional technology)


Seawater

Desalination Plant

Waste Brine

Energy input

Points of attention:

- Brine disposal
- Energy requirements

Saltwork process (traditional technology)


Seawater

Saltworks

Waste Brine

<u>Points of attention</u>:

- Brine disposal
- Low production rate
- Large coastal areas needed

$Mg(OH)_2$ production process

Mines

$Mg(OH)_2$ production facilities

Points of attention:

- low purity product

Seawater

$Mg(OH)_2$ production facilities

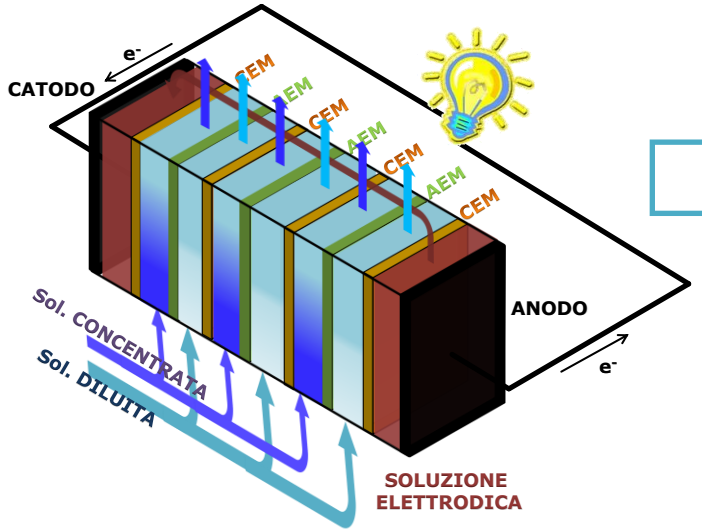
Points of attention:

- high production cost

Salinity Gradient Power (SGP)

River water

SGP plant

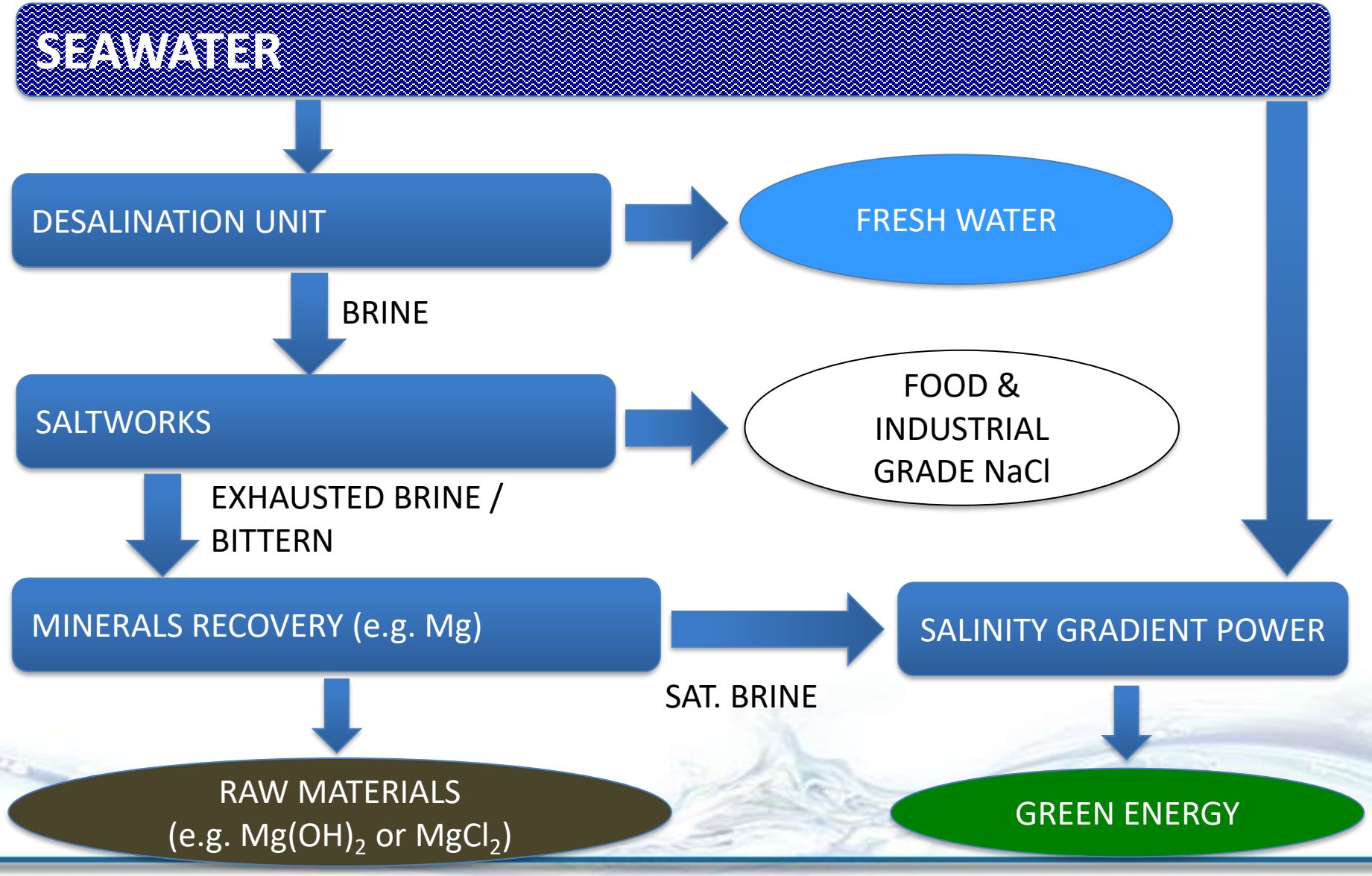


Seawater

<u>Points of attention</u>:

- Low power with RiverWater-SeaWater

The idea of the integrated cycle



Next generation water-smart management systems: large scale demonstrations for a circular economy and society – WATER-MINING

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement 869474.

Dr. Dimitris Xevgenos, Exec. Project Coordinator, TU Delft
Email: d.xevgenos@tudelft.nl

WATER-MINING: Overview

water mining
value for society

- **Partners:** **38** (from 12 countries)
- **Coordination:** **TU DELFT** (Applied Sciences faculty)
- **Project Budget:** **19,174,543.75 €**
- **EC Funding:** **16,876,959.63** (~88% of total budget)
- **Duration:** **48 months**
  - **Start date:** **01/09/2020**
  - **End date:** **31/08/2024**

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The Water Mining project

It is a **research** and **innovation** project that develops **energy-efficient technologies** for treating **alternative *WATER* resources**, whilst promoting the **extraction (*MINING*) of valuable products** from the residues generated during the process.

6 Case Studies

Desalination
Sea-mining

Urban wastewater
Urban-mining

Industrial used streams
Industrial-mining

Concept behind Water Mining Project

Water Value Chain

1

Water as a Resource

Water demands must be met by policymakers, and in the face of increasing water scarcity, alternative water resources must be integrated into the supply. Desalination is expected to play a key role, especially in water-stressed regions.

2

Water as a Consumable

Over the last century the global population tripled, and together with increasing levels of consumption and living standards, water demand increased substantially. Urban water consumption is an important fraction of the total human water use, but it presents a possible alternative source of water via wastewater recovery technology.

3

Water as a Durable

Durable goods are defined as goods used for final consumption regularly over a period of over one year. Development of innovative technologies to reuse industrial water is promising for reducing water demand from within this sector via advanced wastewater treatment and recovery technology.

Desalination
Sea-mining

Urban wastewater
Urban-mining

Industrial used streams
Industrial-mining

Case study 1

Data-mining

New water services

- Fit-for-purpose water
- Carbon neutral water services
- Safe water reuse
- Smart water management
- Recovery and supply of critical raw materials
- Supply of nutrients
- Supply of alginate-like polymers
- Rate setting mechanisms
- Demand management

Minimum Liquid Discharge desalination: a pilot study in Lampedusa island

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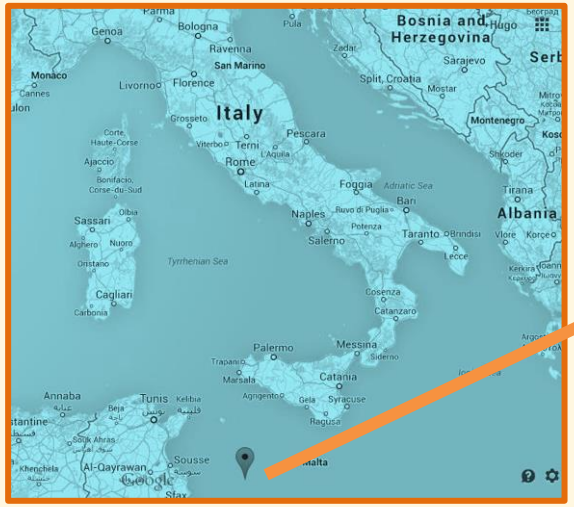
Lampedusa, a small Sicilian island affected by fresh water scarcity, presents a **SWRO** plant with an installed capacity of around **3,500 m^3/day** which:

- Covers **100% of the total drinking water needs of the island**;
- consuming **10% of the energy generated by the Power Station of the island**.



Lampedusa

Main objectives of Case Study:

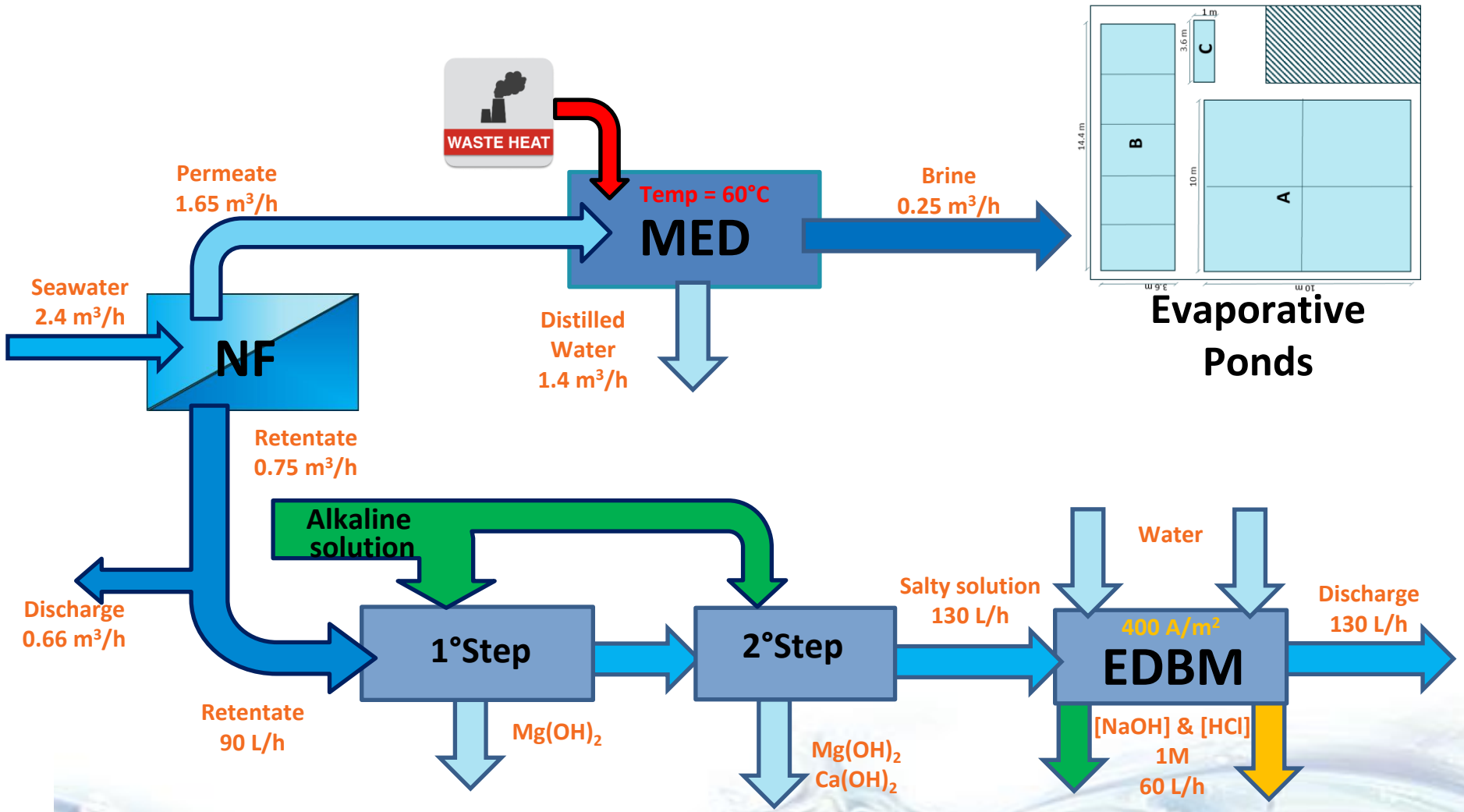
- Prove the advantages of advanced desalination combined with **waste heat recovery** (from the Power Station)
- Contribute to **energy saving**
- **Desalinate water** and **produce high quality salts** (such as NaCl, $Mg(OH)_2$) and **chemicals** (such as HCl, NaOH)

Installation and Demonstration of a seawater treatment chain at Cala Pisana, Lampedusa (Site of SWRO plant and Power station)

Cala Pisana, Lampedusa

Water Mining – Case Study 1 – General Scheme

Seawater Mining in Lampedusa, Italy



Outcomes of the pilot campaign

- **Nano Filtration**
  - **High NF rejection was obtained for Mg (higher than 98%), Ca (higher than 95%) and Sulphate (higher than 99%)**
  - **Stability of NF during the Long Run test (about 77 Hours)**

- **MF-PFR**
  - **High recovery was obtained for Mg, higher than 97%**
  - **High $Mg(OH)_2$ purity was obtained, higher than 95%**
  - **High Ca/Mg removal efficiency was achieved, higher than 95% (for both cations)**
  - **Stability of MF-PFR during the Long Run test (about 60 Hours)**

Outcomes of the pilot campaign

- **EDBM**
  - High stability along the test
  - Able to easily vary the target concentration to adapt to different treatment chain equipment requests
  - Low consumption and high Current efficiency

- **MED**
  - Low conductivity of distillate, below 25 µS/cm
  - High conductivity of brine, higher than 220 mS/cm
  - Concentration factor up to 8

- **Evaporative Ponds**
  - High purity of NaCl salts, higher than 99% (ionic), from permeate stream

Introduction to the Integrated SEArcularMINE Pilot Plant

Presenter: Fabrizio Vicari RES

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 869467 (SEArcularMINE). This output reflects only the author's view. The European Health and Digital Executive Agency (HaDEA) and the European Commission cannot be held responsible for any use that may be made of the information contained therein.

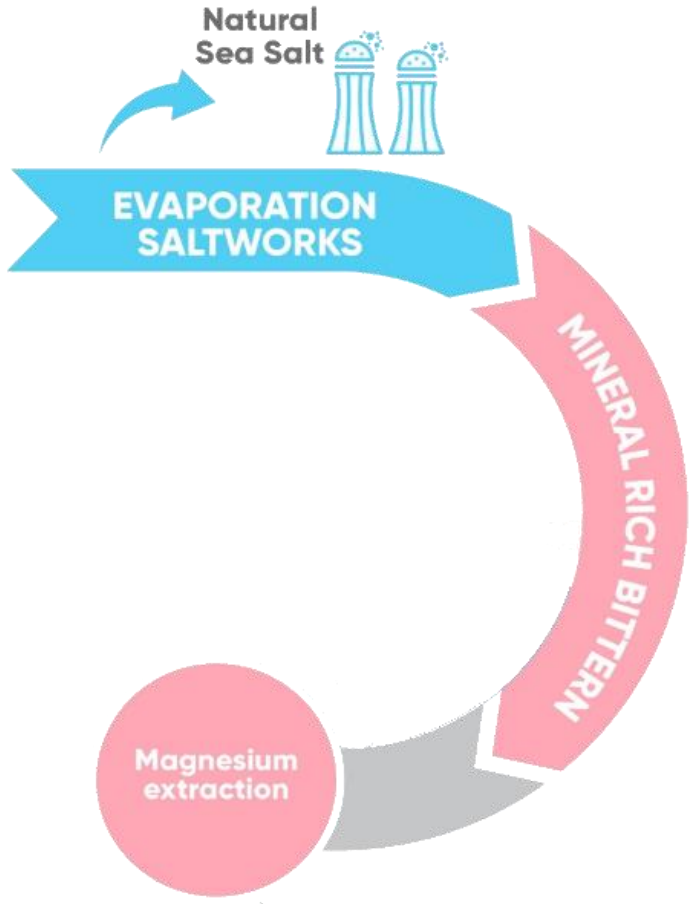
SEArcularMINE

From the original seawater circular mining concept to the integrated pilot plant

The city of Trapani and its saltworks (highlighted in yellow)

SEArcularMINE

From the original seawater circular mining concept to the integrated pilot plant



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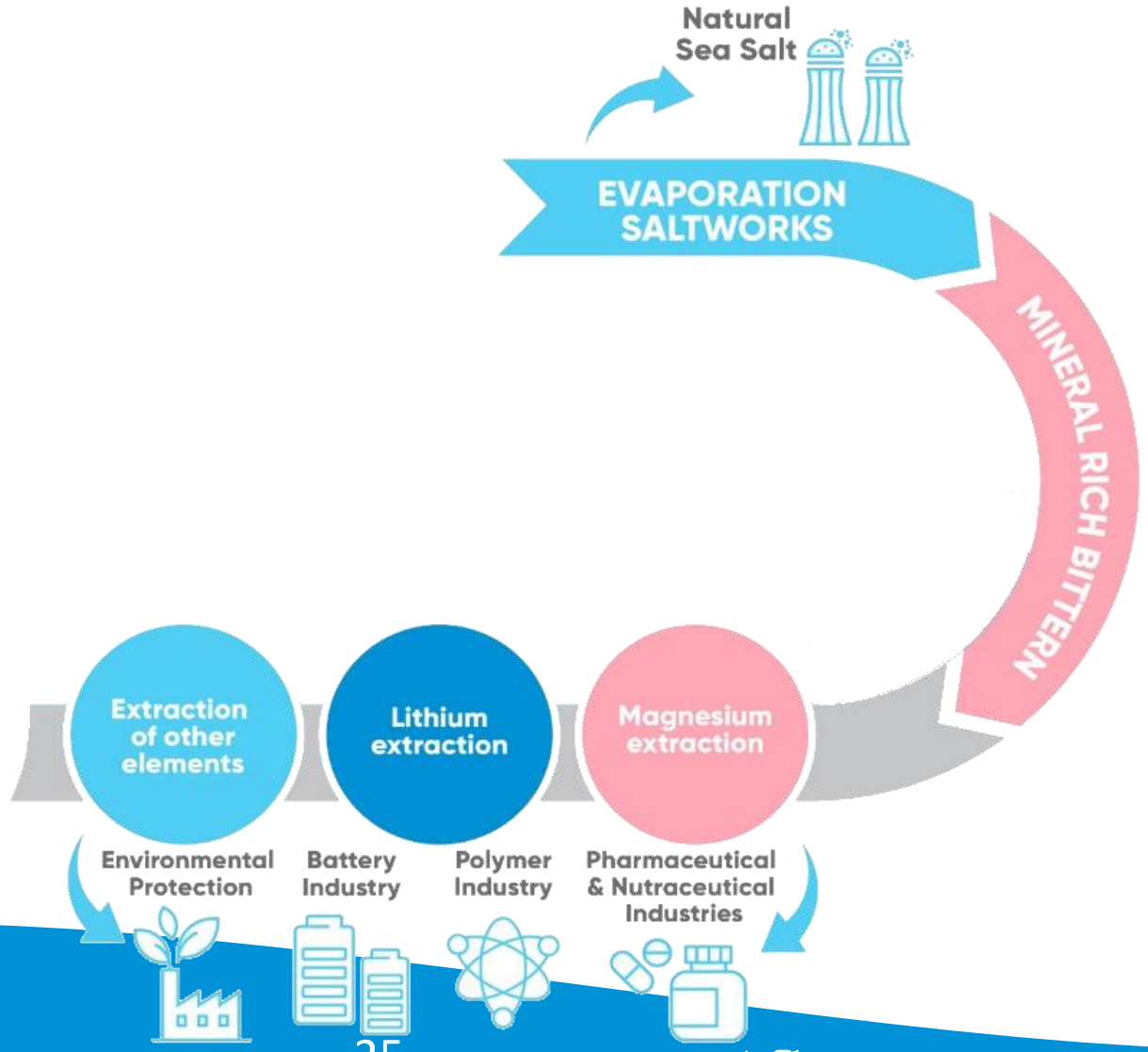

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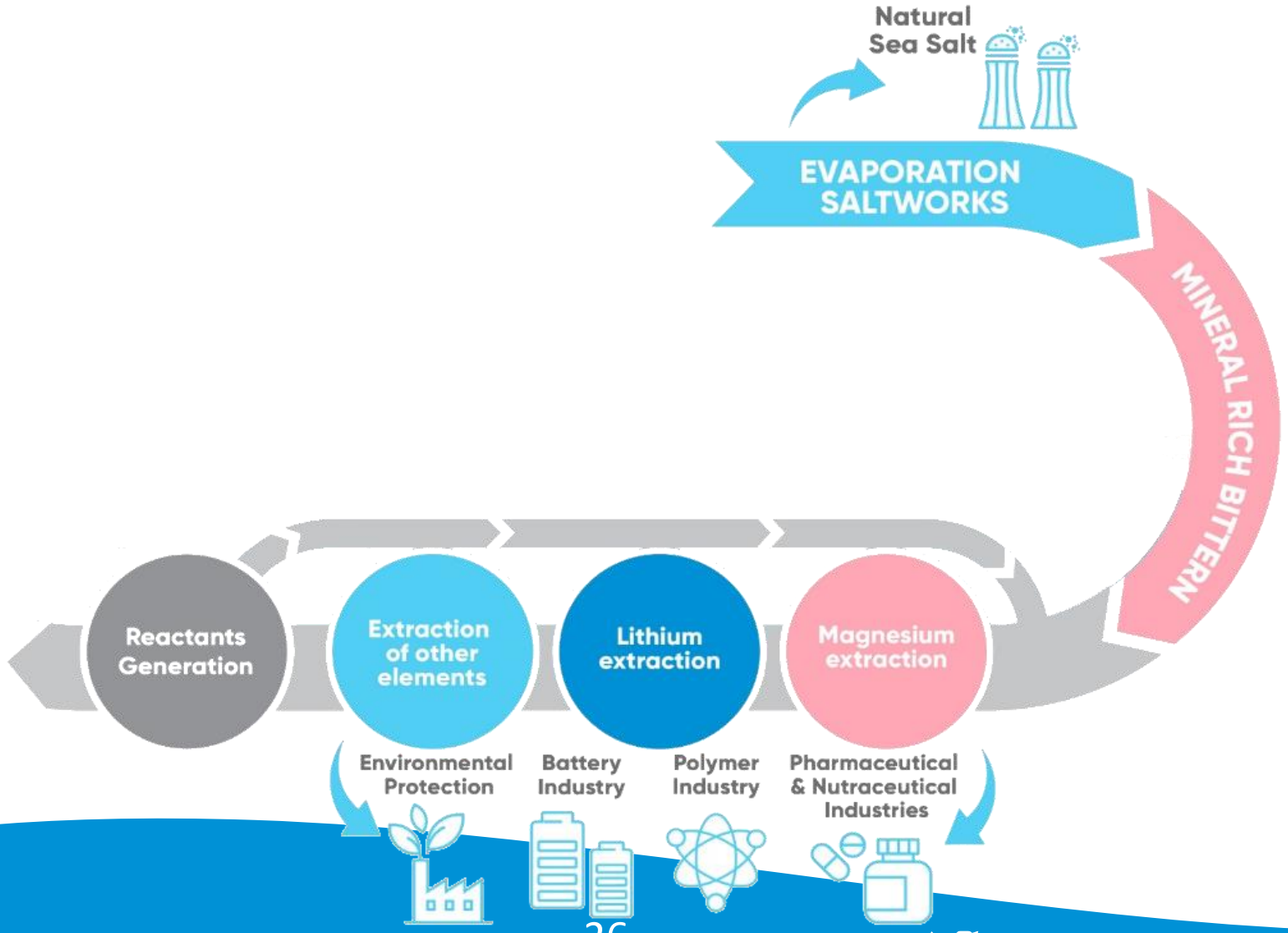

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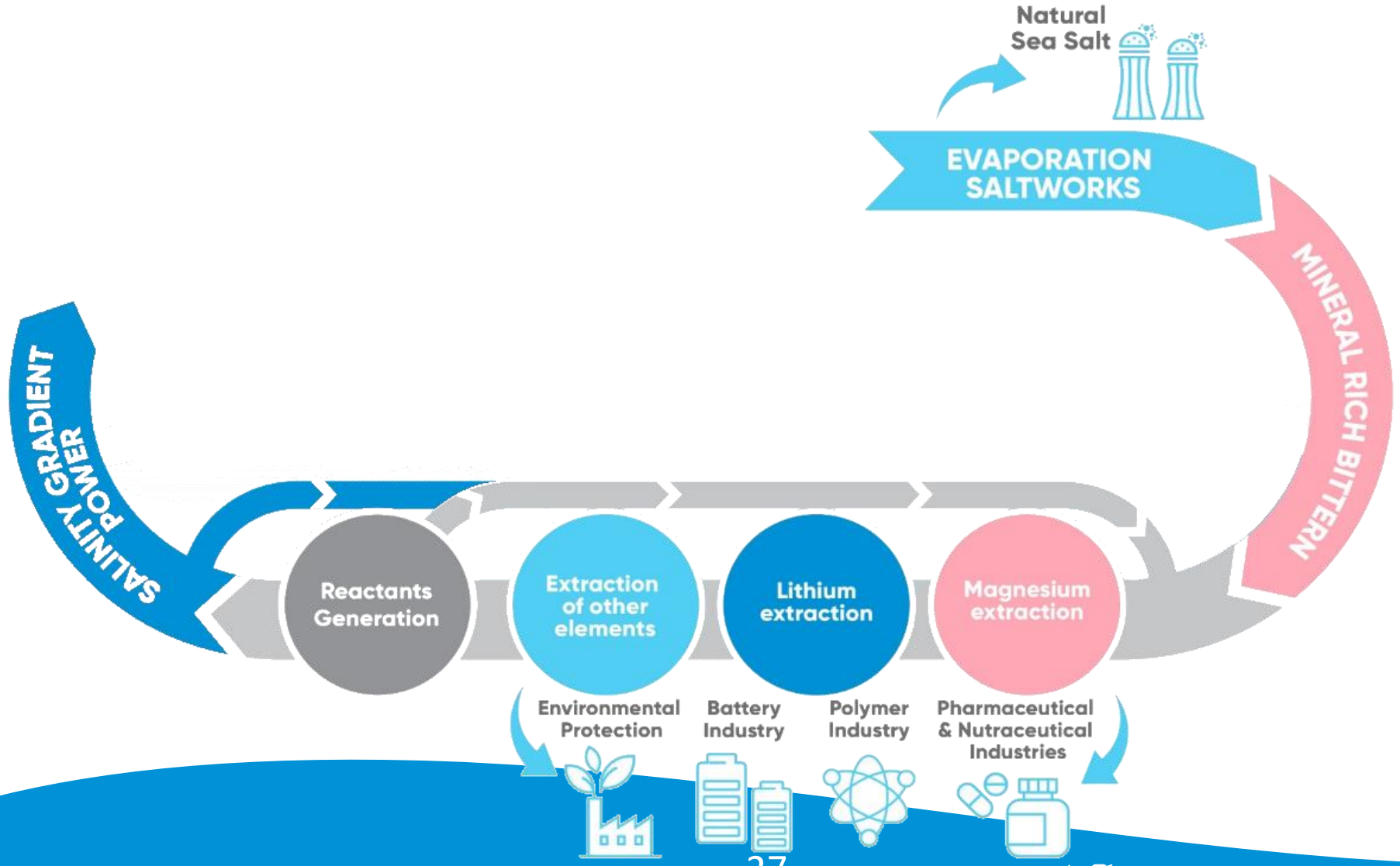

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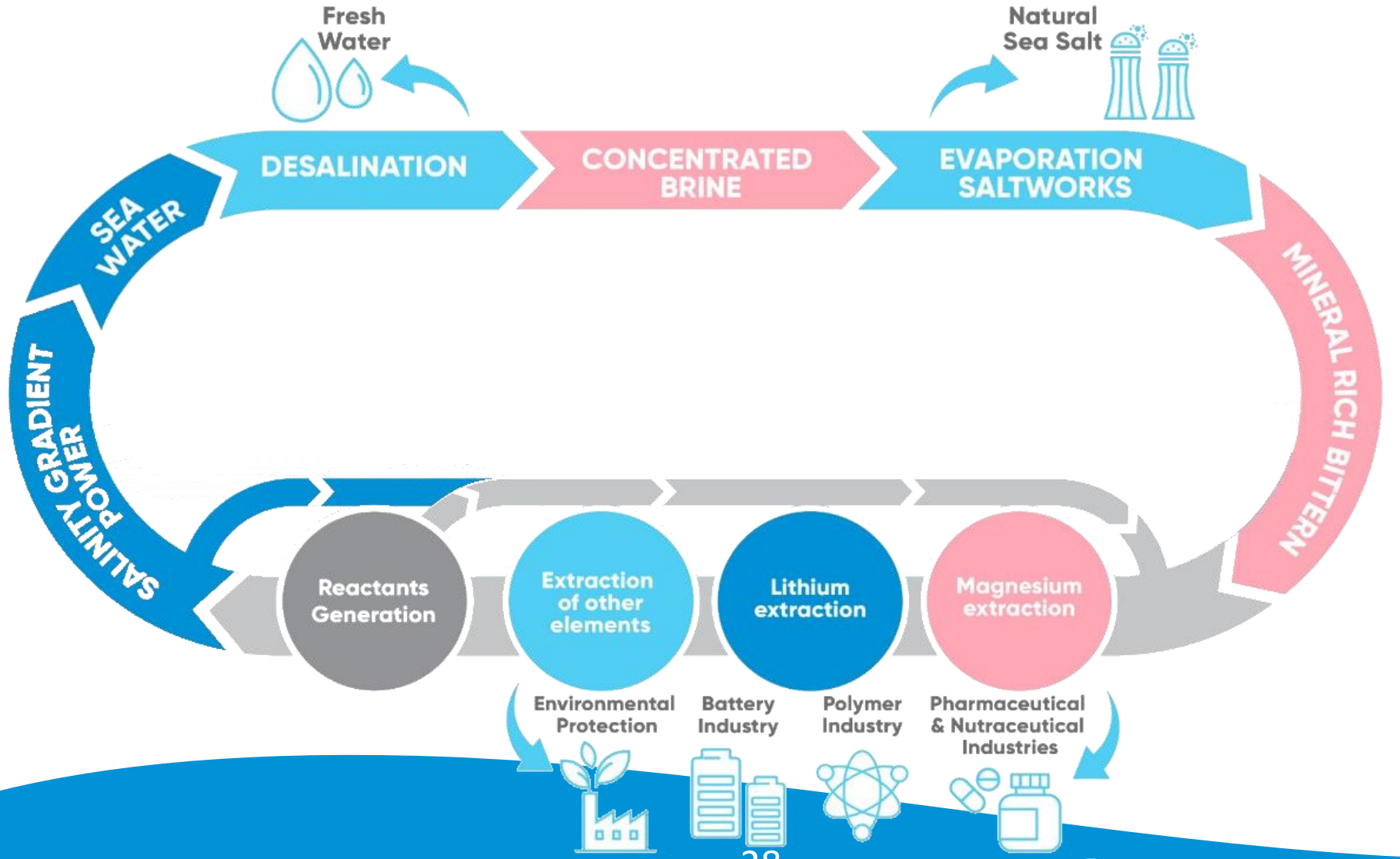


SEArcularMINE

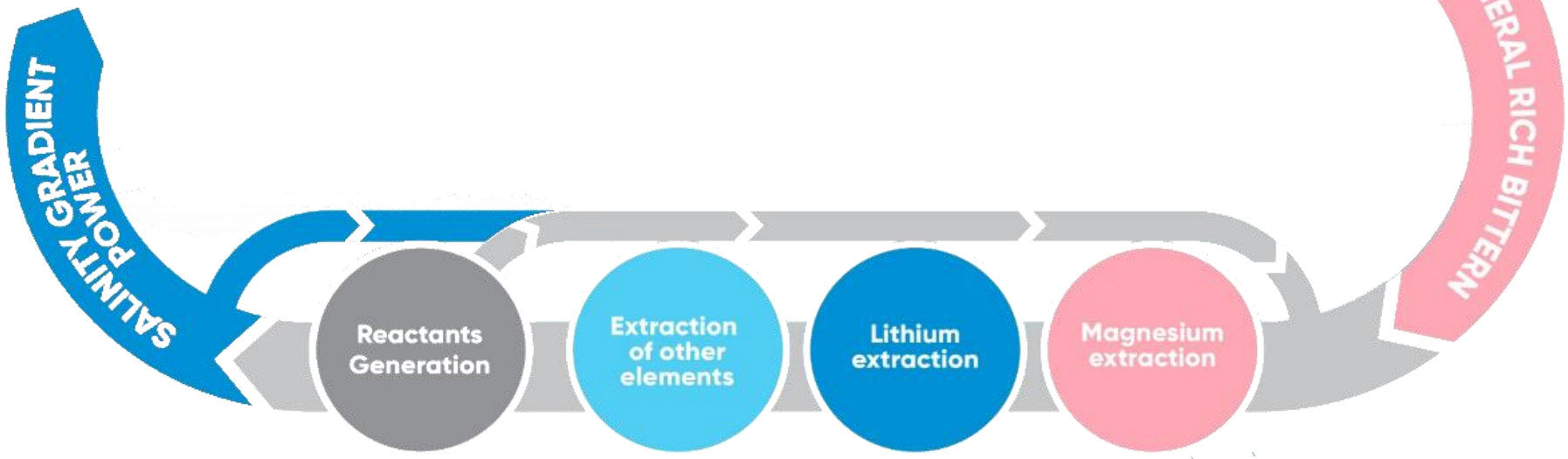
From the original seawater circular mining concept to the integrated pilot plant

IT Patent granted
EU Patent pending

Circular Processing of Seawater Brines from Saltworks for Recovery of Valuable Raw Materials

SEArcularMINE

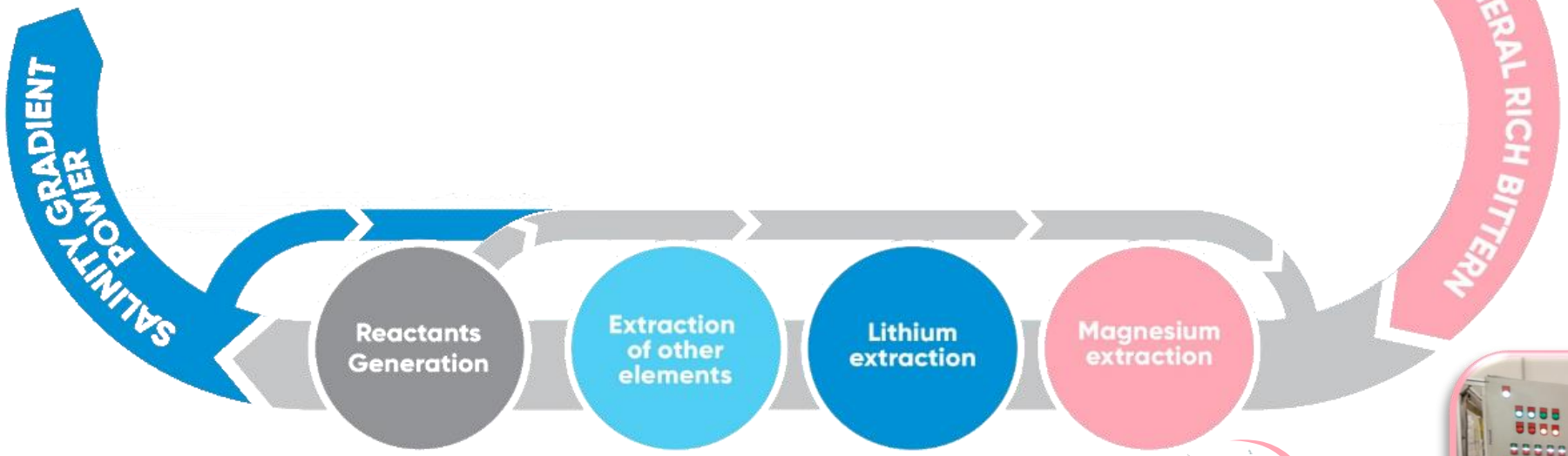
From the original seawater circular mining concept to the integrated pilot plant



Mg-CGCR

SEArcularMINE

From the original seawater circular mining concept to the integrated pilot plant

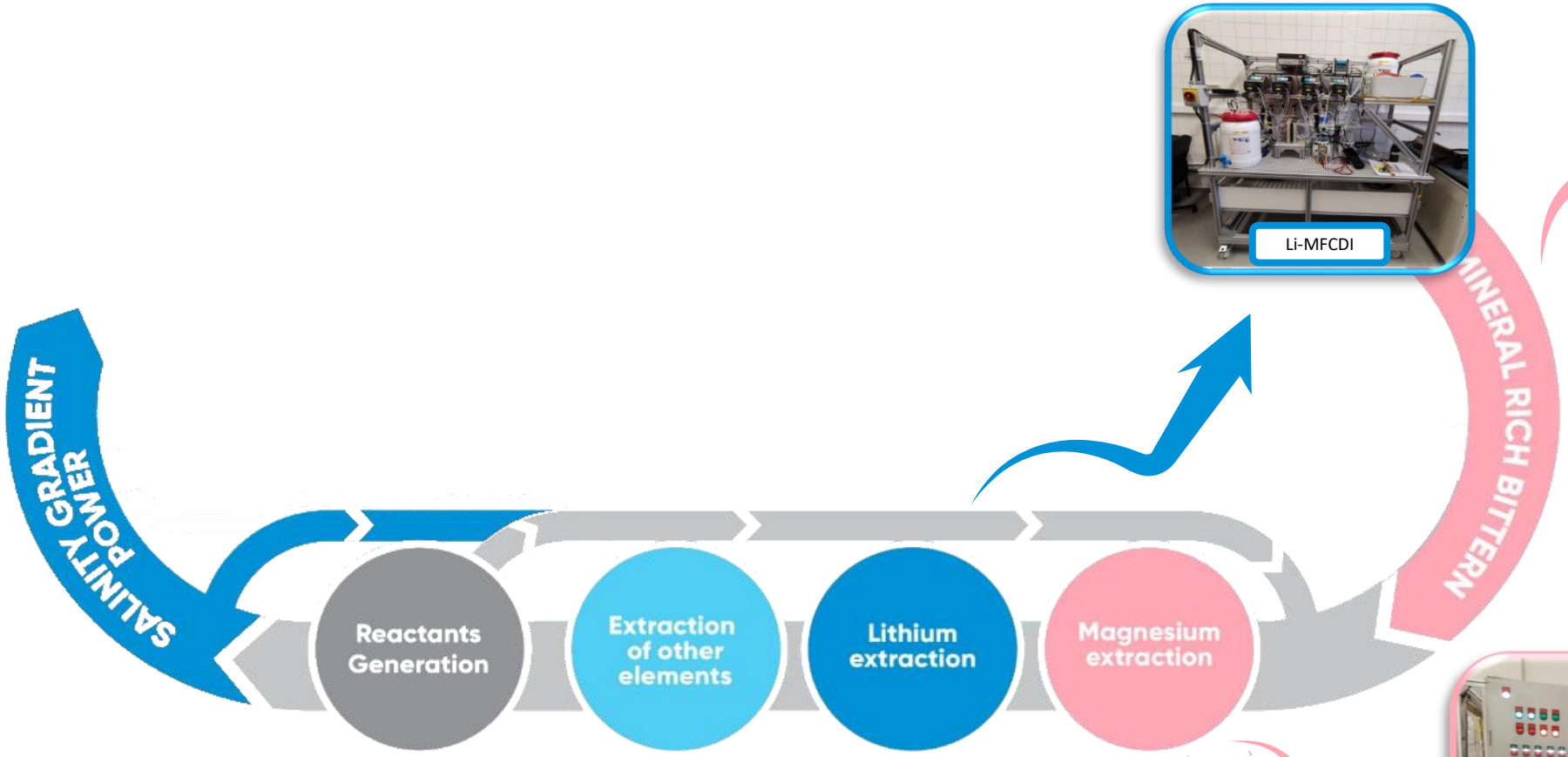



UF pre-treatment


Mg-CGCR

SEArcularMINE

From the original seawater circular mining concept to the integrated pilot plant



Li-MFCDI


UF pre-treatment


Mg-CGCR

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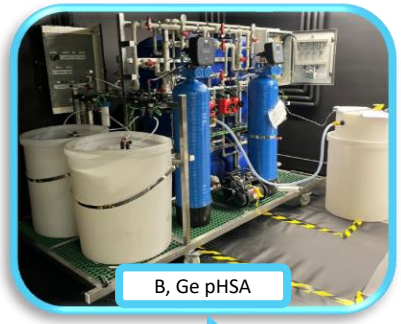

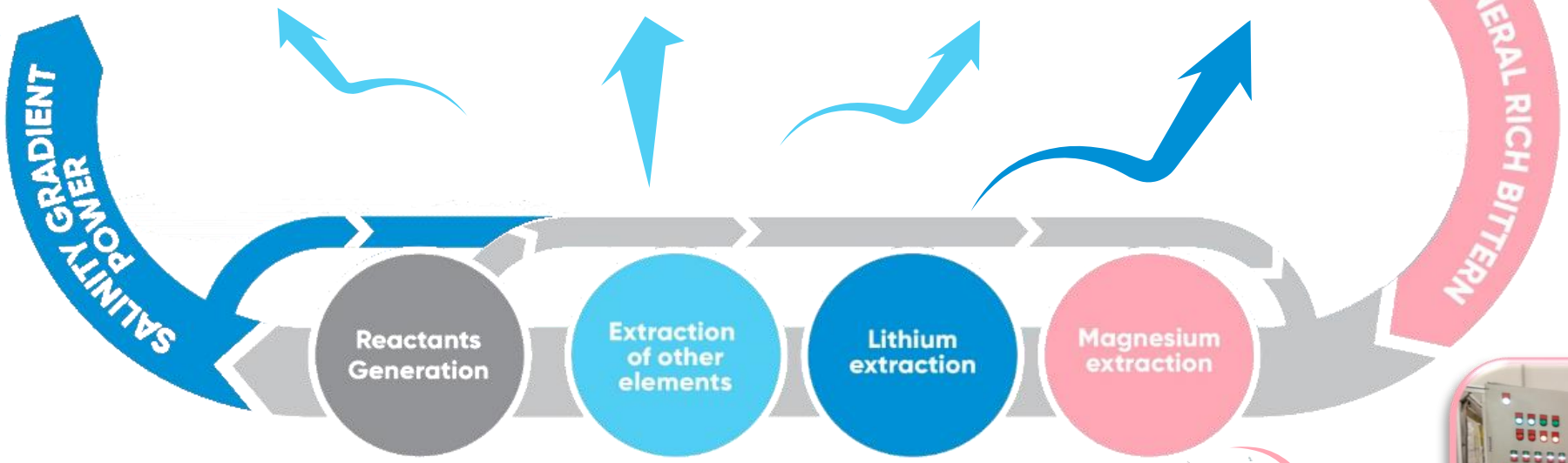

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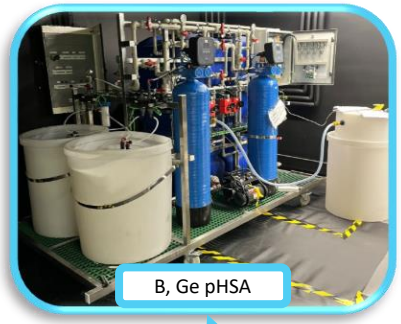

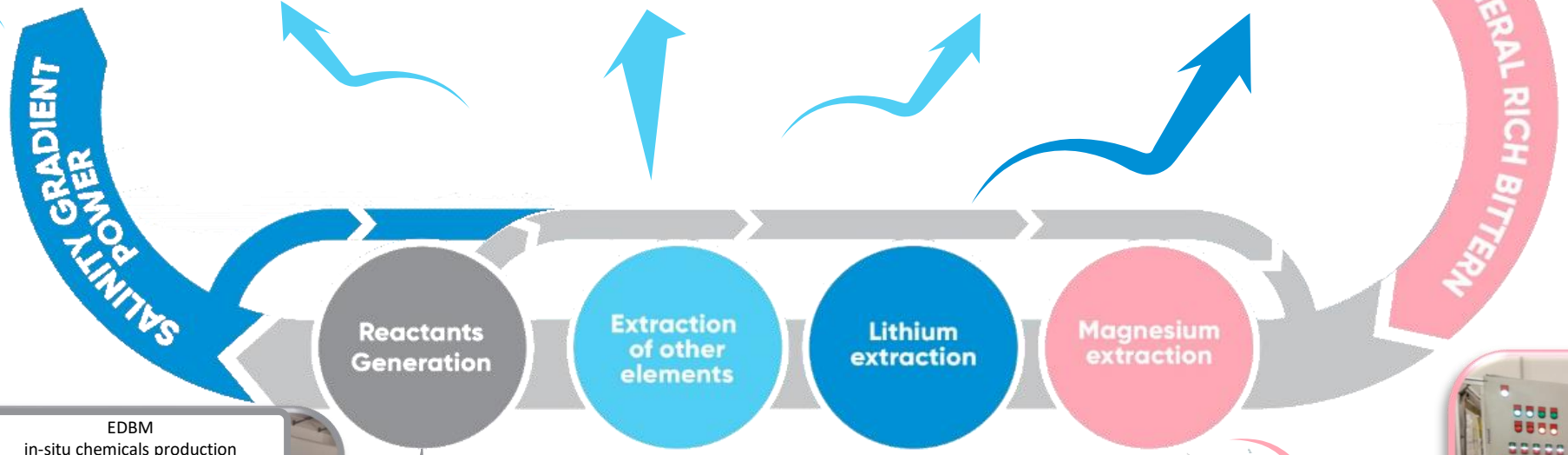

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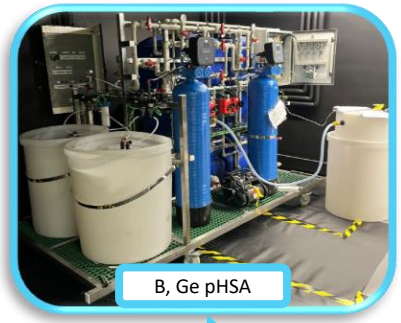

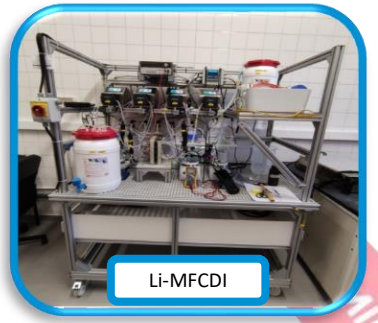

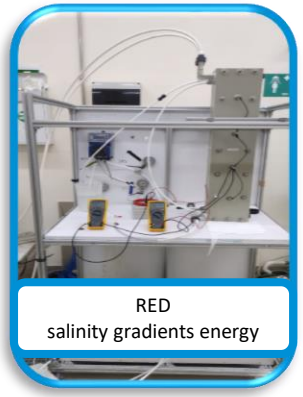

SALINITY GRADIENT POWER

MINERAL RICH BITTERN

Reactants Generation

Extraction of other elements

Lithium extraction

Magnesium extraction

SEArcularMINE

From the original seawater circular mining concept to the integrated pilot plant

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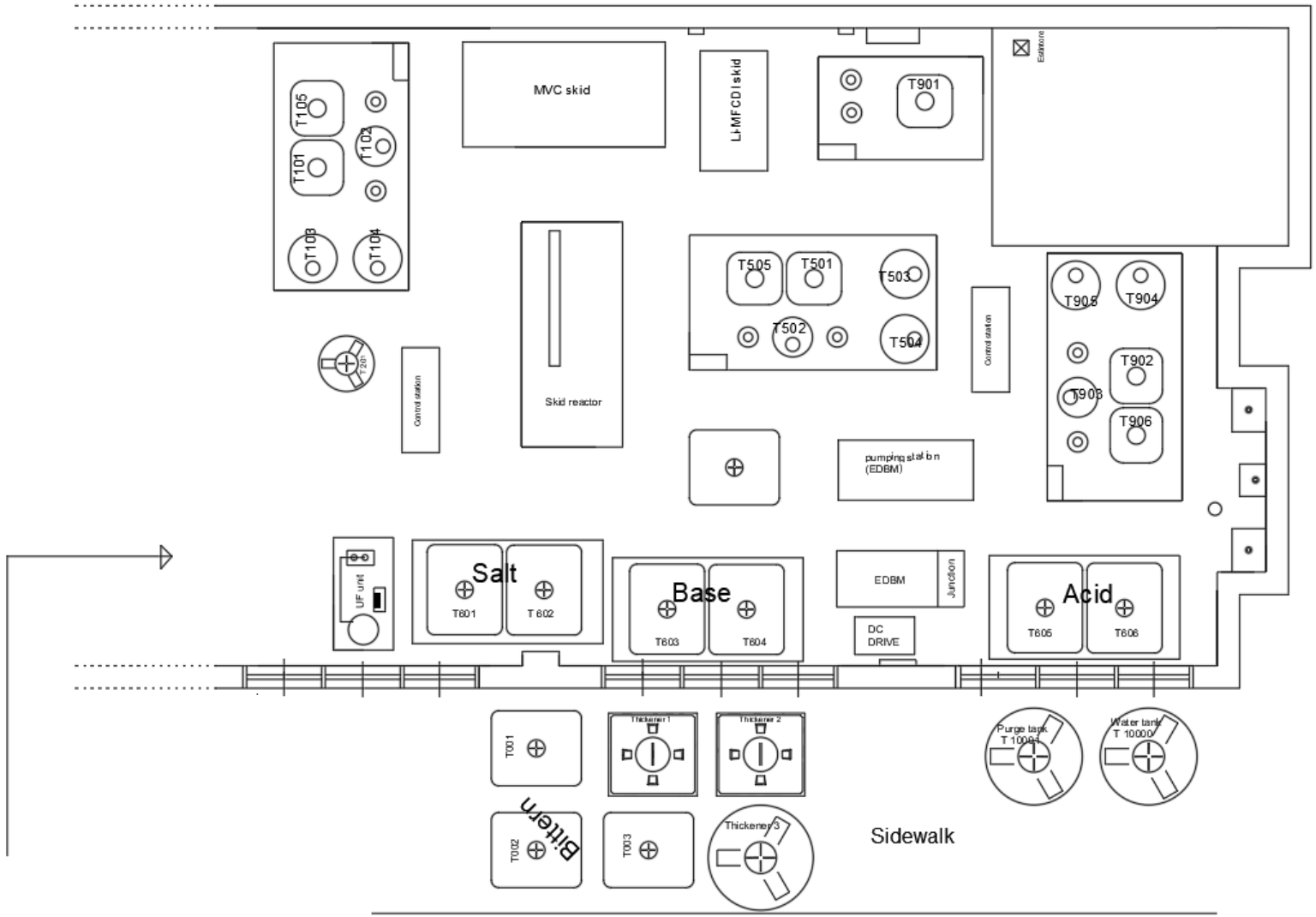
www.searcularmine.eu

UNIPA installation site: The Great Experiences Lab

SEArcularMINE

From the original seawater circular mining concept to the integrated pilot plant

UNIPA installation site: The Great Experiences Lab



Continuous long-run operation

Magnesium produced from real bittern from Trapani

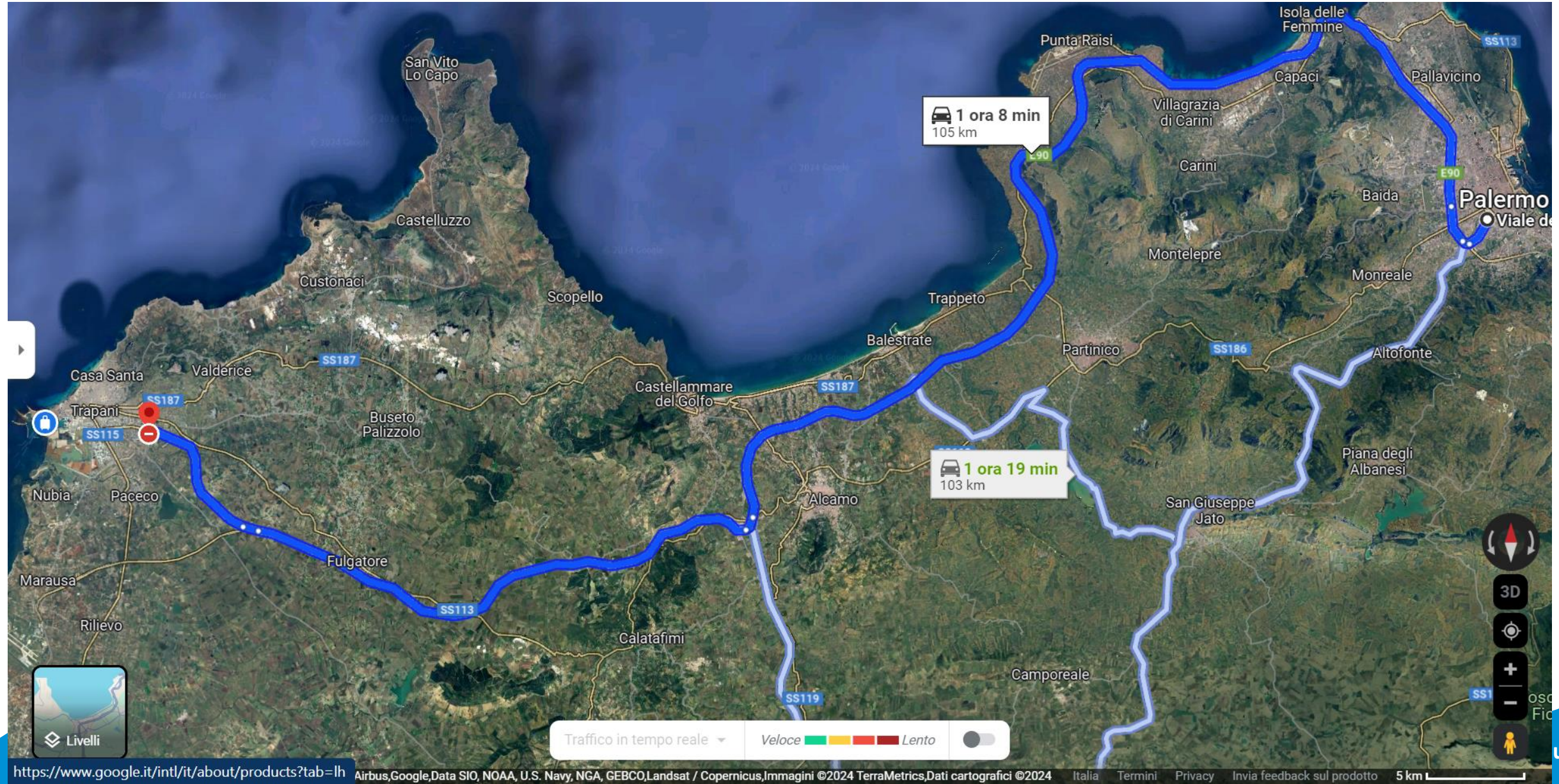
Continuous long-run operation

Relocation from UNIPA to ResourSEAs

From a relevant to an operational environment

Relocation from UNIPA to ResourSEAs

From a relevant to an operational environment

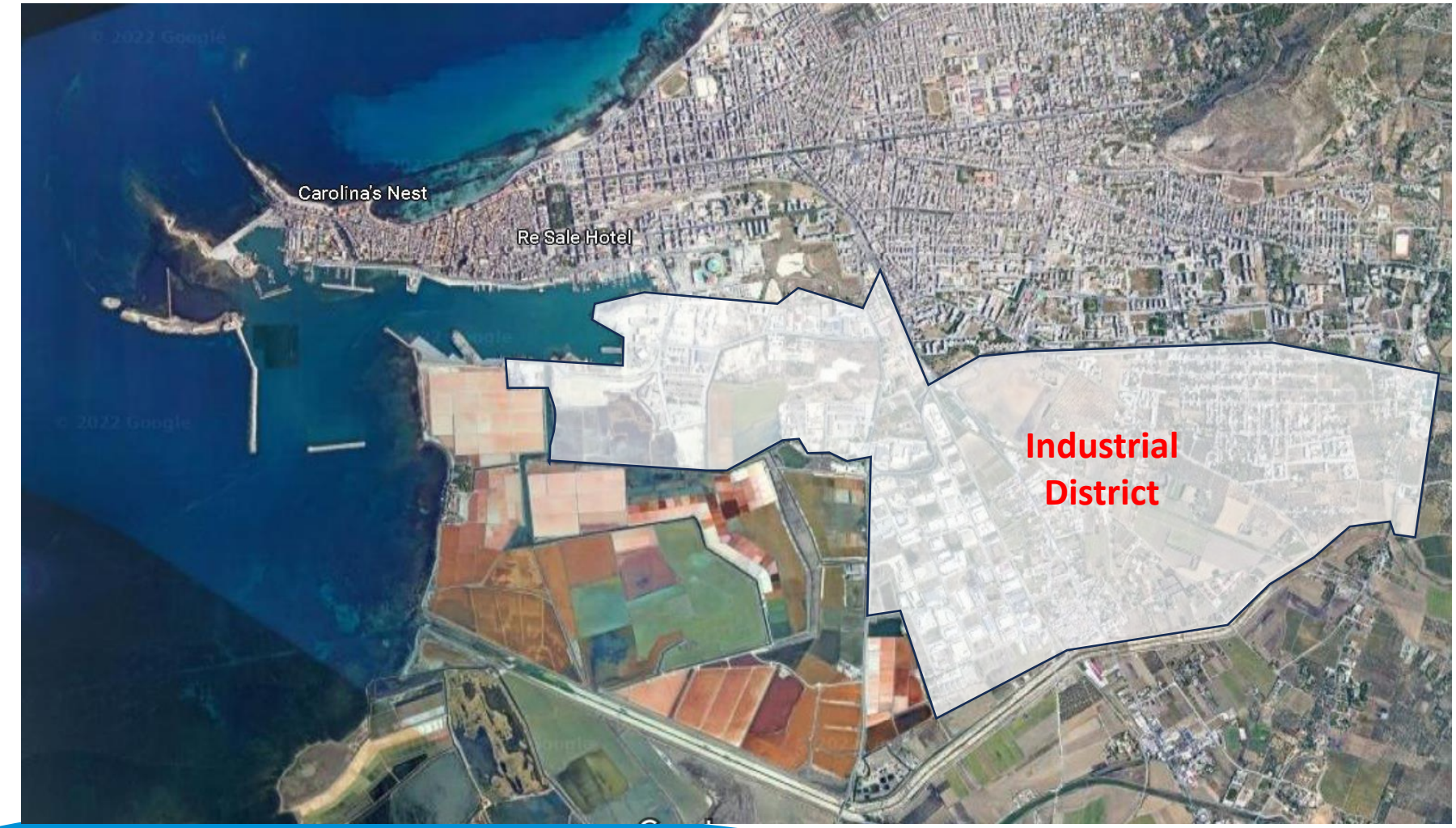


Relocation from UNIPA to ResourSEAs

From a relevant to an operational environment

Relocation from UNIPA to ResourSEAs

From a relevant to an operational environment



Relocation from UNIPA to ResourSEAs

From a relevant to an operational environment

Relocation from UNIPA to ResourSEAs

From a relevant to an operational environment

Conclusioni

1. **Le strategie di valorizzazione delle salamoie marine hanno raggiunto livelli tecnologici sufficienti allo scale-up industriale;**
2. **La produzione di composti del magnesio appare come la soluzione economicamente più vantaggiosa, se implementata in un approccio circolare con produzione in-situ dei reagenti necessari;**
3. **La produzione di soluzioni diluite di acidi e basi da salamoie con tecnologia EDBM è possibile e vantaggiosa se opportunamente implementata in una catena che rimuova i cationi bivalenti a monte e riutilizzi le soluzioni acide/basiche a valle;**
4. **L'integrazione tra la dissalazione e la produzione di sali e minerali può diventare un driver economico importante, ma non risolve a scala globale il problema dello smaltimento controllato delle salamoie esauste;**
5. **I numerosi esempi di implementazione di progetti sul «brine mining» lasciano intravedere un grande potenziale ed una promettente traiettoria di sviluppo di nuovi approcci per la «dissalazione sostenibile»**

THANKS!

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