

Research and Innovation through LIFE and HORIZON projects

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Need to change habits...



We have only one planet





Commerce balance in the EU-27





Climate change leads to economic loses

The financial losses caused by extreme weather and climate-related events exceeded €487 billion in the EU-27 over the last 40 years. The overall cost was the highest for Germany, Italy, France.



Green Deal Ambitions



Become climate-neutral by 2050



Protect human life, animals and plants by cutting pollution



Help companies become world leaders in clean products and technologies



Help ensure a just and inclusive transition



Climate change and water scarcity



Water scarcity cost

- \$260 billion is lost globally each year due to lack of fresh water and sanitation.
- The increase in freshwater consumption combined with the effects of climate change will lead to increase in social, economic, environmental and geopolitical risks. According to the 2019 Global Risks Report of the World Economic Forum (WEF), a crisis due to water scarcity will affect the global economy next 10 years.

Water scarcity effects on EU economy

- Water scarcity is an increasingly frequent and worrying phenomenon that affects at least 11% of the European population and 17% of EU territory
- Since 1980, the number of droughts in Europe has increased, and they have become more severe, costing an estimated €100 billion over the past 30 years. One of the worst droughts occurred in 2003, when one-third of EU territory and over 100 million people were affected. Between 1976 and 2006, the number of people and areas hit by drought rose by almost 20%, and the yearly average cost has quadrupled.

Desalination-an answer to water scarcity

- During seawater desalination tons of brine are rejected back to sea.
- Brines are also produced by many industrial processes such as (chemical, food, extractive etc.)
- Tons of salts end in surface water bodies and sewage systems

United Nations Environment Programme Environmental Challenge 'Brine discharges is the major threat to the aquatic environment.'

Industry accounts 22% of the global water demand

Innovative systems development to close the cycles of



Circular economy among companies = Industrial symbiosis



Policy review and assessment





Sol Brine-General Information

"Development of an advanced innovative energy autonomous system for the treatment of brine from seawater desalination plants"

Area of implementation: Tinos Island, Greece

Project	EC Funding (LIFE+):	
1,209,6	604,844.00 €	
Duration:	Start date:	End date:
39 months	01/10/2010	31/12/2013





Municipality of Tinos Island (Project Coordinator)



National Technical University of Athens



Culligan Hellas S.A.

Sol Brine Objectives





Process flow diagram







Results

- Total brine elimination: The system has been designed in line with the Zero Liquid Discharge principle
- Water Recovery: (> 90%)
- **Production of useful end-products.** (a) water of high quality and (b) dry salt. Products with market opportunities.
- Energy autonomous operation: Solar thermal collectors are used for delivering hot water and a PV for electricity. All energy requirements are covered exclusively through the use of solar energy.
- Use of state-of the art technology: Custom designed vacuum evaporation technology (evaporator and crystallizer) and solar dryer.

Sol Brine Pilot







Sol Brine Pilot











Sol Brine Pilot



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Sol Brine-EU Green Awards

The best Life Project of last 25 years



Zero Brine-General Information

"Re-designing the value and supply chain of water and minerals: a circular economy approach for the recovery of resources from saline impaired effluent (brine) generated by process industries"

Area of implementation: The Netherlands, Spain, Poland, Turkey







Zero Brine Objectives



Industrial sectors

HORIZ

2020

- Desalination •
- Extractive •
- Textile •
- Silica •

Pilot in EVIDES



"EVIDES produces tons of freshwater to the Rotterdam port and the surrounding industrial area. Tons of brine are rejected in the sea"

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2020

Process flow diagram



Pilot in EVIDES



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EVIDES Pilot results

- Ca and Mg removal of around 93%
- Purity of recovered Mg crystals is 84-90% and Ca crystals is 93-99%
- Water recovery of about 90%
- Quality improvement of end products □ a positive impact on annual revenues (3,000,000-8,000,000 €/year)

2020

- Avoiding environmental penalties due to brine discharge
- Internal valorization of NaCl solution

Industrial Symbiosis

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Online Brine Platform

Salts/Water End-User Waste heat owner Centre of Excellence **Technology Provider Brine Owner** Brine Analyses, Design of Brine Treatment Systems. Tools for the Estimation of CAPEX and OPEX **Industrial Symbiosis** Platform Consultancy about the recovered material and their market Matching 1 **Circular Economy** ZERO BRINI HORL 2020

Brine Mining-General Information

"Demonstration of an advanced technique for eliminating coal mine wastewater (brines) combined with resource recovery"



Area of implementation: Poland



Brine Mining Partners

Coordinating beneficiary



National Technical University of Athens

Beneficiaries



GLOWNY INSTYTUT GORNICTWA



LENNTECH

NEVIS

NEVIS-NOVEL Environmental Solutions S.A.

SEALEAU B.V.



Silesian University of Technology



POLSKA GRUPA GORNICZA

ΘΕΡΜΟΣΩΛ ΑΤΜΟΛΕΒΗΤΕΣ

THERMOSSOL STEAMBOILERS S.A.

TITAN SALT Titan Salt B.V.





Importance of coal in Europe

- In 2019, 44% 244 (tonnes) of EU's total lignite production was covered by Germany
- Europe's total hard coal production was 57 million tonnes. Poland has a leading role in hard coal production -95% of the EU hard coal is produced in Poland



Latest EURACOAL Statistics on lignite and hard coal production and imports of them in EU – 2020 report

The problem

- Poland is the dominant coal producer in Europe
- Coal mines produce huge amounts of brines
- Direct or indirect brine discharge to water bodies:
- Quality Degradation of river water
 - Vistula: 55% of fresh water in Poland (Ecological Status: Moderate)
 - Cost from Vistula salinization: \$150-200 million per year (transport services, industry, agriculture)



The project target area



The project's target area: The Goławiecki Stream and the Small Vistula River



Coal mine brine discharge in the project target area

Result of coal mine brine discharge in the Stream and the River

- □ National Monitoring Report (2019): Bad Water Condition
- ☐ High content of chlorides, sodium ions and sulfates
- The Goławiecki Stream's conductivity reaches the level of seawater
- High water hardness in the Goławiecki Stream's source

High level of K⁺, Br⁻, Sr, Mn⁺², B, HCO₃⁻ all these ions are associated with produced wastewater from coal mine operations



Brine Mining Objectives

WFD and Circular Economy Package Implementation

>95% salts purity

>90% recovery of salts and

Marketable
products (e.g.Decrease of energy consumptionMgOH)Debiensko system



Brine Mining process flow diagram



Brine Mining – Circular Economy Diagram





Brine Mining – Expected Results (1/2)

1. Prevention of brine discharge

Avoid discharge of 7,000 m³ brine per year into surface water

2. Recovery of clean water

Recovery of 5,782 t of clean water per year

3. Production of minerals/salts



432 t of minerals/salts will be produced per year



LIFE Brine-Mining Expected Results

4. Purity of the minerals/salts



Mg(OH)₂: 91% purity
CaCO₃: 98% purity
CaSO₄: 91% purity
NaCl: 98% purity

5. Prevention of CO₂ emissions



407 t of CO₂ emissions savings

The project is co-funded by the μηκαι κάνα κατηση Πρώτων Υλών Κυκλική Οικονομία

Brine Mining – Expected Results (2/2)

4. Purity of the minerals/salts



- ☐ Mg(OH)₂: 91% purity
- **CaCO**₃: 98% purity
- **CaSO**₄: 91% purity
- □ NaCl: 98% purity

5. Prevention of CO₂ emissions



407 t of CO₂ emissions savings



Water Mining – General Information



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



Larnaca WWTP with numbers



The problem

Element	Symbol	MW	Unit	Value
Sodium	Na	23	mg/L	490
Magnesium	Mg	24	mg/L	61
Calcium	Са	40	mg/L	149
Chloride	CI	35	mg/L	890
Tot. Phosphorous	Р	31	mg/L	1.52
Elec. conductivity	EC		mS/cm	4.2

High salinity \Box impacts to the soil (salinization-degradation), not appropriate for sensitive



Water Mining Objectives

Policy gaps/suggestions Social acceptance of products

products

Industrial sector

- Desalination
- Chemical Industry
- Urban Wastewater

>90% recovery of salts and

>95% salts purity,

marketable

products

Anaerobic digestion for biogas production

>50% of energy from renewable Energy Sources

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Larnaca pilot process flow diagram



Pilot in Larnaca WWTP



Water Mining Platform



Walnut-General Information

"Closing waste water cycles for nutrient recovery"



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Walnut Partners





Walnut-Objective

WalNUT aims to develop the necessary concepts and technological solutions to re-design the value and supply chains of nutrients from wastewater and brine.

- ✓ 15 partners
- ✓ 5 pilots
- Implementation in 4 countries
- Input: industrial, urban wastewater and sludge, brines

2020

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NTUA role in Walnut

Pilot

 System for the recovery of Mg and K to be used in Bio-Based Fertilizers

Platform

 To help matching among wastewater owners, technology providers/consultan ts and end-users of nutrients

Policy

- Review of European and National Policy
- Gaps and barriers definition
- Policy suggestions for the adoption of Bio-Based Fertilizers and the proposed by the project systems



NTUA pilot process flow diagram



Thank you for your attention!







