ZERO BRINE

D10.4 Report on Field Visits to Pilot Projects

November 2021

FINAL

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Author(s)	Stuart Reigeluth, REVOLVE Joshua Franklin-Mann, REVOLVE Danielle Kutka, REVOLVE
Contact	vanessa@revolve.media danielle@revolve.media
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[1] **R**=Document, report; **DEM**=Demonstrator, pilot, prototype; **DEC**=website, patent fillings, videos, etc.; **OTHER**=other

[2] **PU**=Public, **CO**=Confidential, only for members of the consortium (including the Commission Services), **CI**=Classified

Executive Summary

As a subtask to capacity building (Task 10.6), field visits to the ZERO BRINE pilots are an essential part of the communication strategy to further disseminate and exploit the ZERO BRINE circular economy solutions for industrial wastewater to key stakeholders. The visits are an opportunity for knowledge sharing of the ZERO BRINE technologies and the resource potential and circular business opportunities of brine-intensive industries to industry and end-users. The site visits are also a great opportunity to invite policymakers to learn about these solutions and identify the policy gaps and key recommendations that will be specified in the policy briefs, helping advance circular solutions in the field of industrial wastewater. The field visits also build connections with media to foster wider interest in the project and disseminate its aims and results. As a key pillar of capacity building, the field visits raise the overall awareness of the pilot's objectives, contributions to the circular economy, and form interactive, educational activities that support the development of knowledge and skills-sharing in the circular economy.

In concurrence with the field visits, factsheets are developed to provide an in-depth overview of the respective pilots' aims, technologies employed, and resources recovered and are a core feature of the ZERO BRINE media kits.

This deliverable was first submitted in M24 as a draft. As the organisation of the field visits coincided with the development of the pilot operations, the decision was made by the ZERO BRINE Project Officer and Executive Project Coordinator to update this deliverable in six-month increments (M30, M36, M42, M48) with a final deliverable due by M54 at the end of the project.

Contents

1. Overview of Field Visits

The field visits target academic, corporate, and public partners and press. In order to optimise stakeholder engagement and attendance to the ZERO BRINE pilot site visits, organisation of these visits were coordinated with other key stakeholder events when possible.

To attract the interest of specialised press in the fields of water, water reuse, circular economy, technology and innovation and industrial processing, and to encourage the effective dissemination and exploitation of ZERO BRINE, REVOLVE has partnered with key print and digital media outlets. Through media partnerships, quality content is curated and interest in project news is secured, increasing the dissemination potential so that audiences follow ZERO BRINE's progress throughout the project's duration and increase the exploitation of the technology and results. For this reason, press relations are a key component of the ZERO BRINE communication strategy throughout the project.

The timeline of the ZERO BRINE field visits depends on the successful operations of the pilots. The timeline for the field visits is:

Field Visit NL –Demineralised Water Plant pilot at Plant One in Botlek area, Rotterdam Port (Site 1)
23 May 2019 (M24)
14:00-16:00 - EVIDES site excursion for press only
16:00-18:00 - Plant One test facility - EU Salt excursion + press

Field Visit PL – Coal mine water pilot at Bolesław Śmiały coal mine, Łaziska Górne
8 October 2019 (M29)
9:30 – 12:00 Visit coal mine + tour of pilot
12:15 - Visit to Silesian University Technology (SUT) presentations
15:00 - Brine Excellence Center (BEC) visit at SUT

Field Visit ES-IQE Silica site in Zaragoza, Spain
M28 September 2019
Due to confidentiality and safety concerns, a public site visit was replaced with an internal visit for a small group of consortium partners and supplementary informational communications were made about the pilot.

Field Visit TR: ZORLU Textile site in Lüleburgaz, Turkey (Online)
26 May 2021 (M48)
10:00 Press briefing + public livestream
Due to COVID-19 restrictions, an in-person field visit to the textile pilot was replaced with a digital journey that was organised as part of a press briefing within EU Green Week.

In parallel with the field visits, ZERO BRINE has developed 4 media kits per pilot including factsheets, interviews, photos and videos for each demonstration site.

a. Demineralised Water Plant Pilot (NL)

Based in the Botlek industrial area of Rotterdam port, the EVIDES Demineralised Water Plant (DWP) supplies water to 25 companies for use in industrial processing. Due to increasing quality standards, reliability expectations, and to deal with the increasing salinity of the feed water, sourced from the Brielse Meer, the pilot mimicked waste heat from nearby factories to eliminate brine effluent while recovering high purity calcium, magnesium, NaCl solution and sulphate salts. For practical concerns, an amendment (M36) has transferred the operational management of the pilot to TU Delft due to the pilot's operations on the premises of Plant One testing facility.

i. Visit Overview

The chloralkali sector has a high potential for the application of circular economy solutions for the recovery of salts from brine. To promote this potential and target key industry stakeholders in the salt industry, a broader collaboration was established in the context of the EU Salt Annual Meeting and General Assembly, organised by the European Salt Producers' Association (22-24 May 2019) in Rotterdam. On 23 May, the conference programme 'Circularity with a pinch of salt' included a session on material reutilisation where ZERO BRINE's Innovation Manager, Dimitris Xevgenos, presented the project and the application of circular economy approach to the chloralkali sector. To offer an example of circular processes in industrial applications, the presentation highlighted the pilot installation at the Evides Demineralised Water Plant (DWP) in Rotterdam, which provided the context for the site visit for EU Salt participants (salt and industry experts) in the afternoon that same day.

In addition to the EU salt participants, specialised press joined the ZERO BRINE pilot visit, located at Plant One Rotterdam, a sustainable tech and innovation test facility.

Lenntech representative explains the initial trial runs.

As the Plant One test facility is located a few hundred meters away from the Evides Demineralised Water Plant's operational facility, the visit included a stop at the Evides DWP to learn about the current technology and to contextualise the pilot plant at Plant One. At Evides, attendees were welcomed by

Jan Willem Mulder, Manager Process and Technology at Evides Industriewater. The visit included an overview of the industrial activities of the surrounding industrial cluster and an explanation of the current technology. Participants were then guided to see the technology and learn about the current purification process and had time for a Q&A. Other representatives from TU Delft were also present to answer questions and supplement the presentation by Evides.

EU Salt participants joined the press group at the pilot demonstration at Plant One, where all field visit participants were welcomed with an introduction by Roelof Moll and a representative from one of the technology partners, Lenntech. After viewing the pilot installation, participants were welcomed to a large conference room where short presentations on ZERO BRINE and the work being done at the pilot sites were presented by Dimitris Xevgenos (SEALEAU) and work package 2 (Sites 1 and II) Lead, Henri Spanjers (TU Delft), and Executive Project Coordinator Roelof Moll (TU Delft).

Following the presentations, questions were fielded from participants by project partners. These questions focused on the problems of releasing brine effluents into the Port, the energy use for the pilots in the context of the Life Cycle Analysis, and the value of the sources being recovered from the brine and what possibilities there are for their market use.

Coordination of the site visit was conducted by TU Delft and REVOLVE.

ii. Outreach and Results

A total of 45 participants took part in the field visit to the Plant One test facility, with most participants salt and industry experts.

The Demineralised Water Plant pilot factsheet was developed in M24 by REVOLVE with the guidance of TU Delft and Evides, to disseminate to the attendees (see Annex). This factsheet is included in the online media kit, and was promoted in the press release on the pilot and visit. The final factsheet was updated in M54 to include the pilot results and were also included in the technology video developed in M54.

During the visit, REVOLVE took photos, short video clips, and promoted the activities on social media, tagging the relevant media and attending partner companies. The top tweet during the visit made a total of >1700 impressions and had 34 engagements.

The top tweet from ZERO BRINE during the site visit.

The photos were integrated into the online media kit and in the ZERO BRINE photo galleries on the project website.

The attending media included technology and water-focused, Dutch-speaking print and digital media (De Ingenieur / WaterForum), digital, European water outlets (Water News Europe), and international, water-focused print and digital media (Global Water Intelligence / World Water).

The breakdown of the audience and subscribers of the attending media:

- De Ingenieur
    - >4,770 Twitter followers
    - Online: 56,000 monthly users
    - Print/Digital Subscribers: 22,000
    - Online Newsletter: 25,000
    - Audience: Educated following, interested in engineering
- WaterForum
    - >4,020 Twitter followers
    - Online: 12,000 monthly users
    - Online Newsletter: 9,000
    - Audience: Drinking, wastewater management, knowledge centers, universities, national/local governments, industrial/sewage treatment, water tech/engineering companies.
- Water News Europe
    - >1,200 Twitter followers
    - Online: 1,500 monthly users
    - Online Newsletter: >300
    - Audience: Water professionals, policy makers and water companies

- Global Water Intelligence
    - >15,200 Twitter followers
    - Online: 187,000 annual users in over 200 countries, 938,000 page views/year
    - Publication: Over 10,000 subscribers
    - Audience: EPC contractors, utilities, equipment/tech suppliers, engineers, and researchers

- World Water (Water Environment Federation)
    - >27,600 Twitter followers (WEF)
    - Online: 13,000 users/month, 116,000 page views/month (WEF)
    - Print Publication: 4,967 subscribers
    - Digital Publication: 21,649 subscribers
    - Audience: Engineers, government/municipal offices, consultants, contractors, planners, executives in water industry

As follow-up to the site visit, a dedicated press release was sent to all stakeholder segments in the ZERO BRINE mailing lists with a link to the online media kit. Overall, the Dutch demi water pilot was featured in 14 press articles from a variety of international and national presses and in four languages: French, Dutch, Korean, and English. Below is a comprehensive list of the various articles produced and their outreach, provided by Meltwater analytics:

Bouw proefinstallatie ZERO BRINE-project start in januari in Plant One, 27 Sep 2018, WaterForum; Reach: >1,085

Unieke kringloop in de Rotterdamse haven, 11 Jan 2019, Rijksdienst voor Ondernemend Nederland; Reach: >245,000

Industriële kringloop in de Rotterdamse haven, 14 Jan 2019, Engineers Online; Reach >17,800

Demin Water Pilot Advances Industrial Circularity & Critical Raw Material Recovery, 23 May 2019, Water Online; Reach: >77,400

ZERO BRINE – From industrial saline waste water to clean water and minerals, 24 May 2019, Holland Circular Hotspot; Reach >439

Zero Brine: Kick-off innovative brine treatment in Port of Rotterdam, 30 May 2019, Water News Europe; Reach: >2,225 (webpage analytics)

Evides demonstrates circular economy, 18 June 2019, Filtration+Separation; Reach: >6,330

[네덜란드] Evides, 산업폐수 정화로 순환경제 실현, 20 June 2019, Korean Water Journal; Reach: >4,250

Kickstarting industrial circularity in the Port of Rotterdam, 19 Nov 2019, PR Pro; Reach: >1,022

Kickstarting Industrial Circularity In The Port Of Rotterdam, 19 Nov 2019, Water Online; Reach: >54,800

NIEUWE INDUSTRIËLE WATERZUIVERING IN BOTLEKGEBIED, 19 Nov 2019, De Ingenieur; Reach: 49,400

Waste brine aids circular economy, 20 Nov 2019, Filtration+Separation; Reach: >4,035

Zero Brine launches first pilot in Rotterdam, 5 Dec 2019, Filtration+Separation; Reach: >7,370

Kickstart circularité industrielle dans le port de Rotterdam, 7 Dec 2019, BTP News; Reach: >3,580

Based on the Meltwater data, above press articles is estimated to have reached 474,736 people.

b. Coal Mine Pilot (PL)

The pilot at Bolesław Śmiały Coal Mine in Łaziska Górne, Poland, demonstrates that coal mine water, considered a waste by the current mining industry, can be the source of valuable raw materials, such as concentrated brine, magnesium hydroxide, and high-quality RO permeate while halving the energy consumption compared to the current treatment method. Currently, coal mining largely contributes to the nearly 400 million tonnes of salt discharged into Poland's freshwater rivers, causing significant environmental strains and estimated to cause industry, agriculture, and water losses of up to $250 million per year. The pilot at the PGG Bolesław Śmiały Coal Mine can treat up 400 L/hr of wastewater with 82.8% salt recovery as well as calcium and magnesium rich retentate that allows for the recovery of magnesium hydroxide.

i. Visit Overview

On 8 October, participants from industry and media were welcomed to the Bolesław Śmiały Coal Mine by the general director of PGG – the owner and operator of the mine. Attendees were offered bottled drinking water recovered from mining wastewater produced from of the current technology's on-site desalination plant. Additional context was provided on the history of the mine and its activities as one of the oldest and deepest mines in Poland. A description of the pilot and its significance for the industry was given by Professor Marian Turek and Dr. Krzysztof Mitko of the Silesian University of Technology (SUT).

To disseminate the ZERO BRINE project and details on the local pilot to industry and experts within the field of circular economy, the field visit was organised a day before the International Brokerage Event Horizon 2020 for Circular Economy and Transforming Industry, which took place on 9 October in Warsaw, which was attended by REVOLVE.

Panoramic view of Bolesław Śmiały.

Due to the size of the pilot demonstration, participants were split into two groups. The groups had the opportunity to tour the mine's facilities and see a panoramic view of the operations, the town of Łaziska Górne and nearby power plant, as well as visit the ZERO BRINE pilot installation for an explanation of the processes and technologies from the researchers from SUT.

Researcher and participants during pilot visit.

Following the coal mine pilot visit, a short trip to the Silesian University of Technology allowed for presentations to further contextualize the impact of the ZERO BRINE technologies. Presentations were given from Grzegorz Gzyl from the Central Mining Institute on the impact of water discharges on surface water in the Upper Silesian Coal Basin, as well as an overview of ZERO BRINE by the project's Executive Coordinator Roelof Moll, the problems of brine and the ZERO BRINE solutions by Marian Turek, and the Technological innovation of ZERO BRINE by Luuk Rietveld, ZERO BRINE's Scientific Coordinator. The series of presentations were followed by a Q&A, addressing questions such as the likely impact of the evaluation of the Water Framework Directive on putting pressure on the coal mining industry to address its brine discharge.

ii. Outreach and Results

Around 40 participants joined the full-day field excursion including industry experts from The Central Mining Institute (GIG), The Institute of Mining Technology (KOMAG), and SUEZ.

The Coal Mine Pilot factsheet (developed in M28) was given to participants in English and Polish on the key aims of the pilot, its context and business opportunities (see Annex). This factsheet is also included in the online media kit. The pilot will be operational until M35; after the data is analysed, the factsheet was updated with the final results in M54 (see Annex). In M29 photos were also added to the media kit in the lead-up for the press release and a promotional Twitter video was also released showing highlights of the visit.

Footage from the pilot visit and additional interviews were held with consortium partners and industry experts for use in the technology videos and additional communication outputs. The pilot's technology video was completed to communicate the final results in M50.

During the visit, photos, short video clips, were taken and activities were communicated on social media to the ZERO BRINE followers, tagging the relevant media and attending partner companies. The top media tweet on the visit made a total of >3300 impressions and had 19 engagements.

The top media tweet from ZERO BRINE on the site visit.

The attending media included technology and water-focused, Dutch-speaking print and digital media De Ingenieur, European water outlet Water News Europe, and Reuters Television Poland, and Turkish press Daily Sabah.

Below is an overview of the attending media, the articles published as a follow-up to the field visit, and where possible, information on the subscribers/sectors for a clearer indication on the readership:

- REUTERS
    - Poland In article 'Coal mine treats its wastewater protecting environment' reached 34.1k people (Meltwater)
    - TVN24 article 'Coal mine in Poland desalinates wastewater to protect environment' reached 9.13 M people (Meltwater)

- De Ingenieur
    - Article 'Proef in Polen met zuiveren zout mijnwater' reached 49.4k people (Meltwater)
    - >4,770 Twitter followers
    - Online: 56,000 monthly users
    - Print/Digital Subscribers: 22,000
    - Online Newsletter: 25,000
    - Audience: Educated following, interested in engineering

- Water News Europe
    - Article 'Poland: Pilot recovers salt and clean water from coal mine wastewater' reached 3.1k people (online)
    - >1,200 Twitter followers
    - Online: 1,500 monthly users
    - Online Newsletter: >300
    - Audience: Water professionals, policy makers and water companies

- Daily Sabah
    - Print circulation: 7,000 subscribers
    - Article 'Circular economy: A path to eco-friendly business' reached 1.05 million people (Meltwater)

As follow-up to the site visit, a dedicated press release was sent to ZERO BRINE mailing lists with a link to the online media kit. Overall, the Polish coal mine pilot was

featured in 16 press articles from a variety of international and national presses and in five languages: French, Polish, Spanish, Dutch, and English. Below is a comprehensive list of the various articles produced and their outreach, provided by Meltwater analytics:

Przemysł cyrkularny w praktyce? Zgłoszenia na wyjazd studyjny do kopalni węgla Bolesław Śmiały, 26 Sep 2019, Teraz Srodowisko; Reach: >46,200

Coal mine in Poland desalinates wastewater to protect environment, 9 Oct 2019, TVN24; Reach: >9.13M

La nouvelle exploitation minière.. Une mine de charbon polonaise récupère des ressources précieuses à partir d'eaux usées, 11 Oct 2019, BTP News: Reach: >3,580

The new mining - Polish coal mine recovers valuable resources from wastewater, 11 Oct 2019, Smart Water Magazine; Reach: >6,240

Coal mine treats its wastewater protecting environment, 11 Oct 2019, PolandIn; Reach: >34,100

Polish coal mine recovers valuable resources from wastewater, 15 Oct 2019, FutureENVIRO; Reach: >164

Una mina de carbón polaca recupera valiosos recursos de las aguas residuales, 15 Oct 2019, FutureENVIRO; Reach: >744

Prezes PGG w Komisji Europejskiej: łańcuchy wartości spółek górniczych potrzebują ochrony, 21 Oct 2019, SLASKIBIZNES; Reach: >51,000

On coal and water in Poland, 22 Oct 2019, REVOLVE; Reach: >563

Polish Coal Mine Recovers Valuable Resources from Wastewater, 28 Oct 2019, Water Active; Reach: >489

Poland: Pilot recovers salt and clean water from coal mine wastewater, 29 Oct 2019, Water News Europe; Reach: >3,605 (webpage analytics)

Kombinacja kilku technik zapewni wydajny odzysk surowców z Solanki, 6 Nov 2019 Teraz Srodowisko; Reach: >28,000

Proef in Polen met zuiveren zout mijnwater, 11 Nov 2019, De Ingenieur; Reach: >49,400

PGG zamierza przestać zrzucać solankę do rzek. Obiecujący pilotaż w kopalni Bolesław Śmiały, 14 Nov 2019, SLASKIBIZNES; Reach: >42,200

Circular economy: A path to eco-friendly business, 19 Nov 2019, Daily Sabah; Reach: >1.05M

Circular economy: A path to eco-friendly business, 19 Nov 2019, World News Monitor; Reach: >35,400

Based on the Meltwater data, the total outreach of the press articles is estimated to have reached 1,256,905 people.

c. Silica Plant (ES)

The pilot plant at IQE in Zaragoza, Spain, in operation until M39, demonstrates the technical and economic feasibility of implementing a circular economy scheme in the silica industry to recover water, sodium sulphate, waste heat, acids and alkalis. Nanofiltration and crystallisation and electrodialysis with bipolar membranes (EDBP) were evaluated, yielding 75% water recovery suitable for on-site reuse. The pilot also used regenerated membranes, allowing higher water recovery and reducing energy compared to commercial RO membranes.

i. Overview

Due to confidentiality reasons, a public field visit was not permitted to the site. In lieu of a full coordinated visit, IQE produced an informational video explaining the pilot and the technologies employed. Additionally, REVOLVE worked with IQE and Eurecat to send a dedicated press release in M46 (Annex) following the final completion of WP4 deliverables and the results of the silica pilot, offering an opportunity for engagement with industry and media stakeholders.

To share insights into the operation of the ZERO BRINE technology within the silica factory, a factsheet was developed in M35 and updated with the final results in M54. REVOLVE produced the pilot technology video recapping the results in M54.

Photos of the pilot are available on the project website (here).

ii. Outreach and Results

By M54, the IQE textile pilot video had 341 views on YouTube and 444 impressions on the ZERO BRINE LinkedIn page.

The dedicated press release sent to all stakeholder segments in the ZERO BRINE mailing lists with a link to the online media kit and had a 22% opening rate with media and press. The Spanish silica pilot results press release was featured in 3 press articles from international and national presses and in Spanish, and English., provided by Meltwater analytics:

Advancing circular economy in silica production, 23 March 2021, Smart Water Magazine; Reach: >23,800

Advancing circular economy in silica production, 20 March 2021, MENAFN; Reach: >443,000

ZERO BRINE: Advancing Circular Economy in Silica Production, 19 March 2021, Press Club; Reach: 63

Based on the Meltwater data, the total outreach of the press articles is estimated to have reached 465,000 people.

d. Textile Factory (TR)

The pilot by TUBITAK at the ZORLU textile factory in Lüleburgaz – Kırklareli, Turkey focuses on the development of the innovative brine treatment system for textile industry to recover concentrated salt solution for using in textile dyeing process baths. Alternatively, salt recovery for other sectors such as the leather industry through salting processes is also considered.

i. Overview

Due to the 'force majeure' of COVID-19 restrictions on travel - coinciding with a national lockdown in Turkey in May 2021, the physical field visit planned to the Zorlu textile factory was replaced with a digital journey to the Turkish pilot site. The digital journey was developed by REVOLVE with the support of TUBITAK to contextualise the issue of brine releases in the textile industry, the technology employed, and the economic and environmental benefits. Additionally, the factsheet on the Turkish pilot was developed and translated into Turkish for local usage as well. All materials were made available for the presentation of the digital journey, which was held within a media briefing during EU Green Week.

The media briefing included a presentation from DG RTD on Research and Innovation for Circular Economy and a presentation on Circular economy and industrial wastewater which introduced ZERO BRINE. The digital journey was then presented by a representative of TUBITAK, and the session ended in a Q&A. The digital journey was also developed both in English and Turkish.

Figure 1 Digital journey

REVOLVE produced the pilot technology video covering the textile pilot's key results in M54. Photos of the pilot are available on the project website (here).

i. Outreach and Results

A total of 44 participants attended the media briefing and presentation of the textile pilot digital journey. The attending media included editors from Energy Monitor, Daily Sabah, and OOSKA News.

The digital journey has received 56 page views and the recorded session has 171 views on YouTube as of M54. Press release coverage of the Turkish pilot was featured in the following articles gathered via Meltwater media analytics:

ZERO BRINE: Extracting Value From Europe's Industrial Wastewater, 26 May 2021; OOSKA News; Reach: 2,088

Zorluteks TÜBİTAK MAM'ın Yürüttüğü Proje İle Çevresel Etkiyi Azaltıyor, 11 May, 34 Volt; Reach: 19,500

Zorluteks TÜBİTAK MAM'ın yürüttüğü proje ile çevresel etkiyi azaltıyor, 11 May 2020, Gundemde Ne Var; Reach: 206

Zorluteks TÜBİTAK MAM'ın yürüttüğü proje ile çevresel etkiyi azaltıyor, 11 May 2020, Bulten At; Reach: 253

Zorluteks TÜBİTAK MAM'ın yürüttüğü proje ile çevresel etkiyi azaltıyor, 11 May 2020, Ilk Duyan Sen Ol; Reach: 119

Zorluteks TÜBİTAK MAM'ın yürüttüğü proje ile çevresel etkiyi azaltıyor, 11 May 2020; Hibya Reach: 7,054

Zorluteks TÜBİTAK MAM'ın yürüttüğü proje ile çevresel etkiyi azaltıyor, 11 May 2020, Tüketici TV; Reach: 493

Zorluteks TÜBİTAK MAM'ın Yürüttüğü Proje İle Çevresel Etkiyi Azaltıyor, 11 May 2020, Samsunsondakika; Reach: 945

BASIN BÜLTENİ-Zorluteks, kazanım yönetimi ile çevresel etkileri en aza indirecek projeler geliştirmeyi hedefliyor, 11 May 2020, Yapı Kredi; Reach: 2.63 M

ZERO BRİNE PROJESİ İLE SU KAYNAKLARININ KULLANIMI AZALACAK, 12 May 2020, Temiz Mekan; Reach: 500

Based on the Meltwater data, the total outreach of the press articles is estimated to have reached 2,700,000 people.

CONCLUSIONS

The organisation of the in-person field visits, as well as the digital communication materials to educate stakeholders on the pilots in the form of press releases, videos, and the digital journey, were critical components to WP10 and the dissemination of ZERO BRINE's work. The field visits, videos, and digital journey thoroughly contextualised the complexity of brine releases and presented the economic and environmental benefits of the ZERO BRINE technologies, having tangible impacts in terms of the stakeholders reached. It proved particularly beneficial to coincide the field visits or pilot activities with other events as well, such as EU Green Week, which helps to reach a larger audience.

REFERENCES

NA

ANNEX

a. Media kits

Demineralised Water Plant Pilot Factsheet (NL) PDF

Coal Mine Pilot Factsheet (PL) PDF

Silica Factory Pilot Factsheet (ES) PDF

Textile Factory Pilot Factsheet (TR) PDF

b. Mailings

Invite Polish Site Visit (link)

Press release: Coal mine pilot site (link)

Press release: Demi water pilot site I launch (link)

Press release: Demi water pilot site I visit (link)

Press release: Demi water pilot site II launch (link)

Press release: Silica pilot (link)

Invite Press Briefing/Turkish Digital Journey (link)

a. Videos

Industrias Quimicas del Ebro presents the pilot in Spain (link)

The technology behind our coal mine pilot in Poland (link)

The technology behind our textile pilot in Turkey (link)

The technology behind our demi water pilot in the Netherlands (link)

The technology behind our silica pilot in Spain (link)

Press briefing & Digital Journey: Reducing pollution from industrial wastewater (link)

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ZERO BRINE PILOT DEMONSTRATION

DEMINERALIZED WATER PLANT IN BOTLEK, ROTTERDAM, THE NETHERLANDS

1. Context

At the Botlek industrial district of the Port of Rotterdam, demineralized water is an essential commodity required for the many production processes of surrounding enterprises. To produce demineralized water, reverse osmosis (RO) has become one of the main demineralization processes; however, RO alone is not sufficient to produce water of the required purity from the available water resources (fresh surface water), requiring several pre- and post-treatment processes to reach the desired purity for industrial use.

At the Evides demineralized water plant (DWP), one of the largest demineralized water production facilities in Europe, surface water is treated by RO combined with ion-exchange softening (IEX) and other technologies that results in the generation of brine as spent regenerant of IEX and RO concentrate (see Fig. 2).

2. Impact

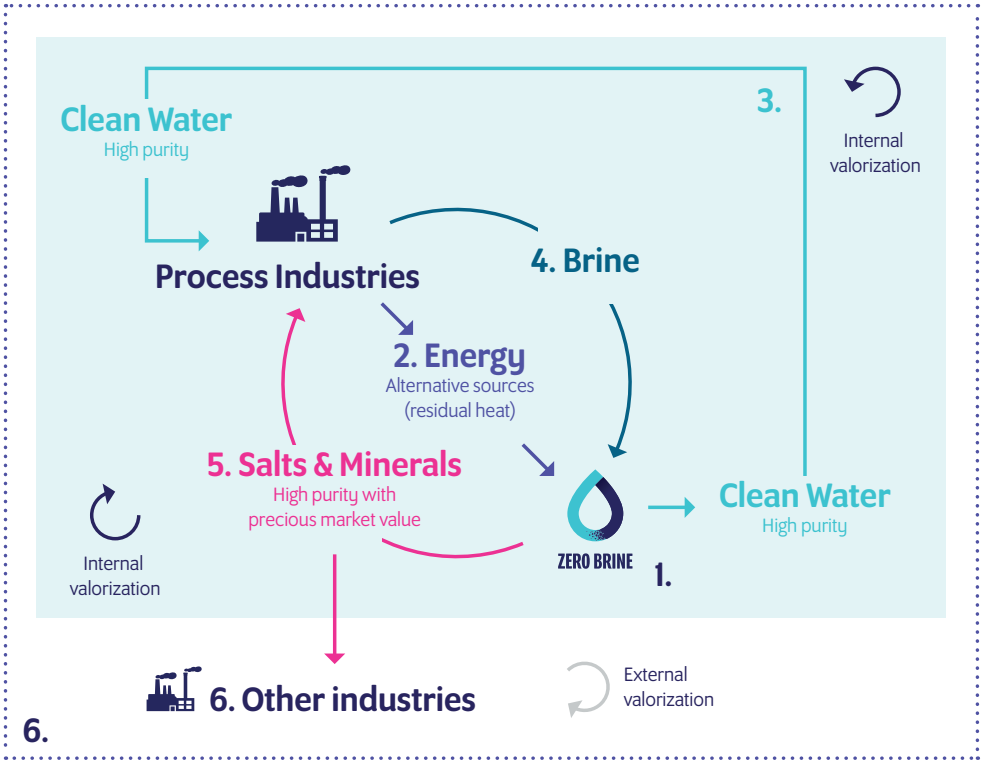
Industrial saline effluents (brines) are an environmental challenge and an economic opportunity.

ZERO BRINE demonstrated the circular economy approach to treat brine through redesigning the current scheme of discharging the generated brine – from linear to a circular model – to recover minerals, salts, and demi water from the discharges of the DWP. To achieve this, two large-scale demonstration pilots were tested at Plant One Rotterdam, a test facility focused on sustainable technology and innovation in the Energy Port and Petrochemical cluster of Rotterdam Port.

The demonstration plant comprised two sites combining residual heat (mimicked by low-pressure steam) and wastewater streams with the aim to eliminate the brine effluent at DWP (zero brine discharge). At Site 1, the aim was to treat the spent regenerant of the IEX unit and to recover valuable minerals and salts as well as water from the brine stream. This was done by nanofiltration, crystallization, and evaporation of IEX brine (see Fig. 3). Site 2 was an innovative design that aimed to treat the reverse osmosis concentrate of DWP by electro-oxidation followed by activated carbon adsorption, nanofiltration, reverse osmosis filtration, crystallization, and evaporation to remove the organic matter and to recover salts as well as water from the brine stream (see Fig. 4).

The ZERO BRINE project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730390.

Fig. 1 – Circularity concept of Zero Brine



1. ZERO BRINE technology
- High CAPEX / Low OPEX
- Required lower energy compared to current treatment practices

2. Energy
- Alternative and cheaper energy source to reduce CAPEX

3. Clean Water
- Lower water consumption by reusing the recovered water

4. Brine
- No water required for dilution
- No brine discharge
- No environmental levies

5. Salts & Minerals
- Internal use of salts and minerals
- Trading salts and minerals as a new source of revenues

6. Other Industries
- New supply chain of water and minerals lead to lower water pollution and potentially would lead to lower carbon emission on global scale

Within the demonstrations, materials with commercial values were recovered on the two sites for potential internal and external valorisation.

3. Business opportunities

The concept of circularity proposed by the ZERO BRINE technology presents potential circular benefits for the companies at the Botlek industrial area. This is shown with the possible internal valorisation of salt and minerals that can be reused in the production of demi water at the Evides DWP, by recovering an NaCl rich solution that can be reused in the regeneration of IEX resins, as well as pure water that can be used internally in mixed bed polishing at Evides to produce ultra-pure water.

Additionally, the external valorisation of salts and minerals is also possible. The recovered resources from Site 1, magnesium hydroxide crystals ($Mg(OH)_2$) can be used in the pharmaceutical industry, food industry (added directly to human food and wastewater treatments (neutralized acidic wastewater). Calcium hydroxide crystals ($Ca(OH)_2$) can be used in industrial settings, such as sewage treatment, paper production, construction, and food processing, as well as medical and dental uses.

Recovered resources from Site 2, sulphate salts (Na_2SO_4), can be used in the manufacturing of kraft paper, paperboard, glass, and detergents and as a raw material for the production of various chemicals, while the ice recovered by EFC can be used for cooling and cleaning purposes.

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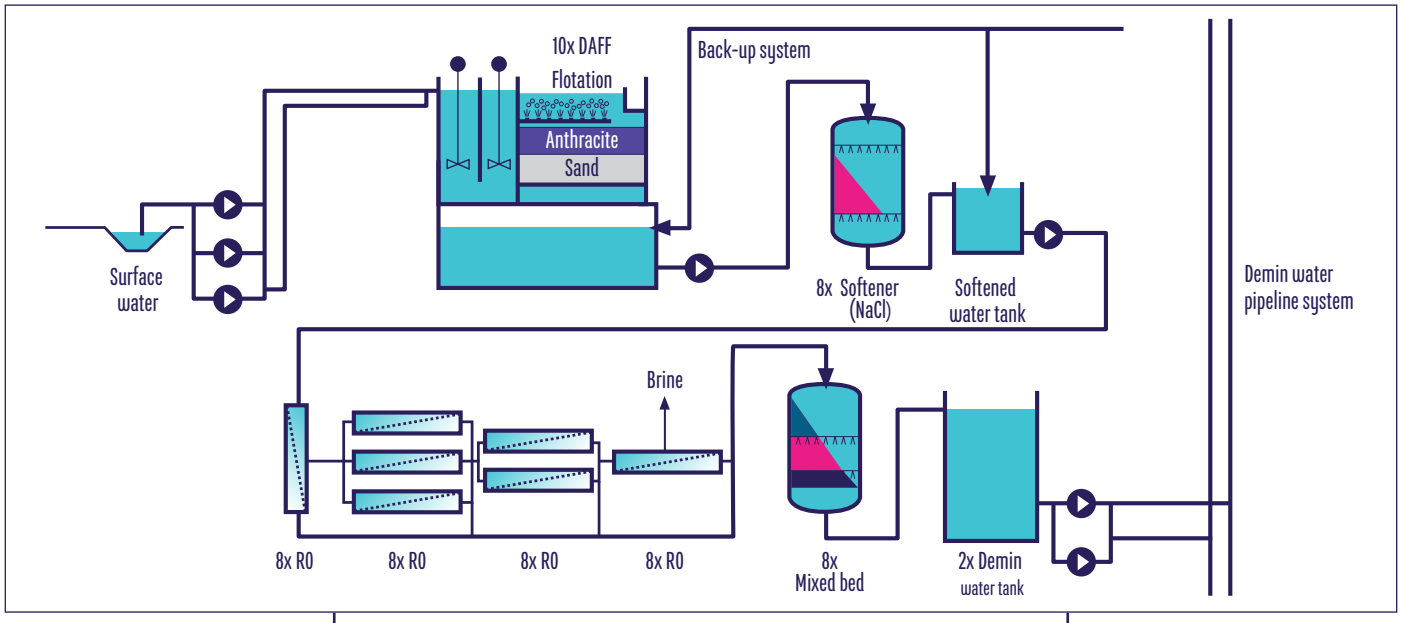
4. Key results

	Reductions in:			
	Water	**Emissions**	**Energy**	**Recovered resources**
Water plant	• 15%-20% reduction in water withdrawal at Evides DWP	• >98% brine discharge into the environment eliminated (>2.5 million m^3/year) • Reduction in CO_2 emissions by 1,012 tons/year or 14% by recovering minerals, salts, and clean water	• Thermal energy required for the evaporation process can be supplied by waste heat/residual heat of neighbouring industries • 44% less energy used by MED evaporator when compared to conventional methods	• 92% water recovery for intenal use (demi water) • 6.2% IEX regeneration solution recovery for internal use (purity > 3.1%) • 94.7% Calcium recovery ($Ca(OH)_2$) for external valorization (purity > 95.6%) • 87.8% Magnesium recovery ($Mg(OH)_2$) for external valorization (purity > 88.9%) • 93% Sulfate recovery (Na_2SO_4) for external valorization (unwashed: 94.6% purity)

For more information, see D2.6 Report on the operation and optimization process of the pilot plants at Botlek

Fig. 2 – Schematic view of the current processes at the DWP plant at Botlek



1 Site 1: Technologies

Nanofiltration (NF) – Multi Feed-Plug Flow Reactor Crystallizer (MF-PFR) – Multi Effect Distillation Evaporation (MED) for the treatment of Ion Exchange (IEX) spent regenerates

2 Site 2: Technologies

Electro-Oxidation Reactor (EOR) coupled with Granular Activated Carbon (GAC) commercially called NYEX – Nanofiltration (NF) – Reverse Osmosis (RO) – Multi Effect Distillation Evaporation (MED) – Eutectic Freeze Crystallizer (EFC) for the treatment of RO Concentrates

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Fig. 3 – Site 1 Technology scheme

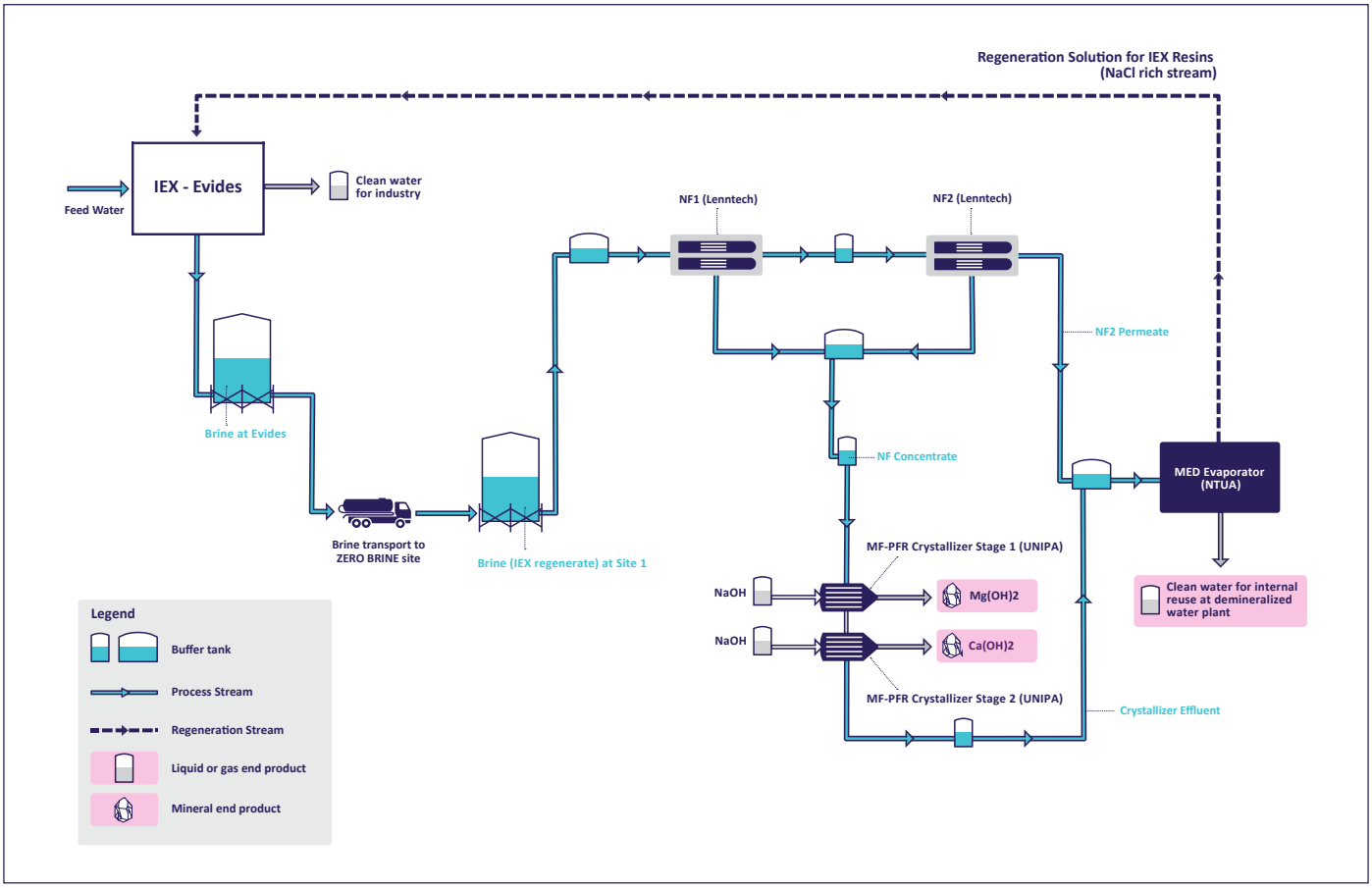
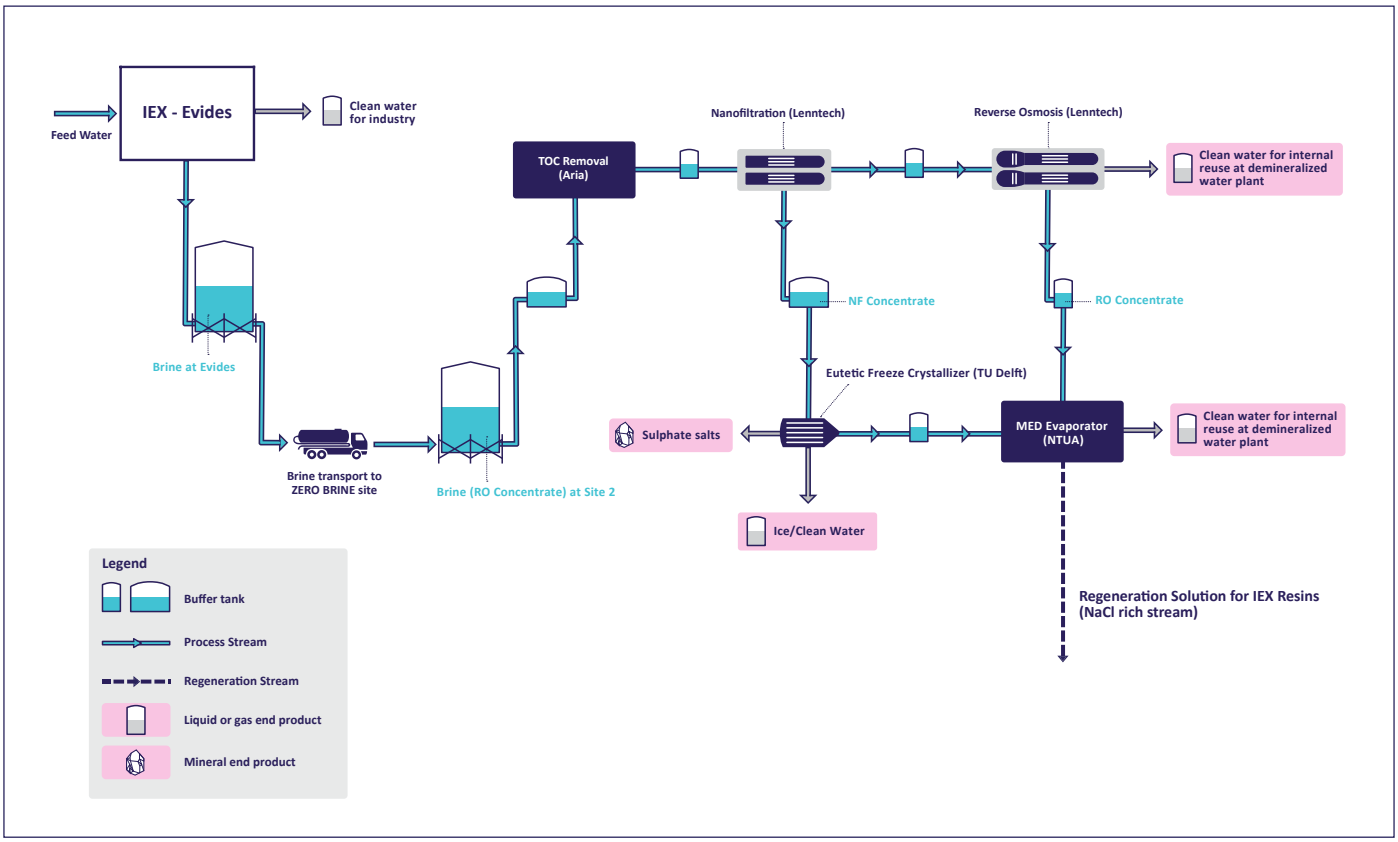


Fig. 4 – Site 2 Technology scheme



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ZERO BRINE

ZERO BRINE PILOT DEMONSTRATION
BOLESŁAW ŚMIAŁY COAL MINE IN ŁAZISKA GÓRNE, SILESIA, POLAND

Context

Saline wastewaters are a concern of many industries. The coal mining industry is particularly affected: every year Poland discharges around 4 million tonnes of sodium chloride (salt) into rivers, coming mainly from coal mines. This causes environmental damage and economic strains due to pollution fees. ZERO BRINE is turning this problematic issue into a source of income by recovering valuable resources such as water, salts, and minerals for reuse in other industries, creating potential jobs and societal improvements. The pilot plant is operated and overseen by the Silesian University of Technology (SUT) that is located nearby in the small city of Gliwice.

Coal mines are an important sector in the EU. Overall, coal is produced in 11 EU countries, having a major contribution to the energy security in nearly half of the Member States. In addition, coking coal is identified by the European Commission (EC) as one of the 27 critical raw materials since its supply risk is high. Coking coal also has a high economic importance due to its use in the metallurgy sector. As such, coal production will remain a very important sector in the future.

The coal mining industry is deeply affected by the environmental and economic problems with saline wastewater disposal. Every year, the mining sector discharges around 4 million tonnes of salt into the rivers in Poland. Poland's two longest rivers (Vistula and Odra) are under significant pressures from mining activities. For many years, excessive salt concentration has been found in the Vistula River, with 94% of the chlorides originating from hard coal mining activity. The Vistula River contains about 55% of the total fresh water resources in Poland and covers about 60% of the water needs in the country (including the river basin). The rising salination of the Vistula River is the cause of losses in industry, agriculture and water transport, which are estimated to be $100-250 million per year.

One possible solution is to use coal mining wastewater as the source of raw materials, thus turning the problem into a business opportunity. Poland only has one industrial-scale desalination plant in Czerwionka-Leszczyny, owned by PGWiR, which produces around 70,000 t/year of salt from coal mine water. The plant operates on coal mine water originating from operational "Budryk" mine and from an inactive mine, "Dębieńsko". The plant does not use chemical treatment. The low salinity coal mine water is pre-concentrated by reverse osmosis (RO). Then, after mixing with more saline coal mine water, it is subjected to further concentration by vapour compression (VC), and salt is obtained in a VC crystallizer. Unfortunately, this technology exhibits high energy consumption as well as limited salt recovery due to the presence of bivalent contaminants such as magnesium and calcium, which are not removed from the feed stream. The existing technology also does not allow the recovery of valuable raw materials, such as magnesium hydroxide.

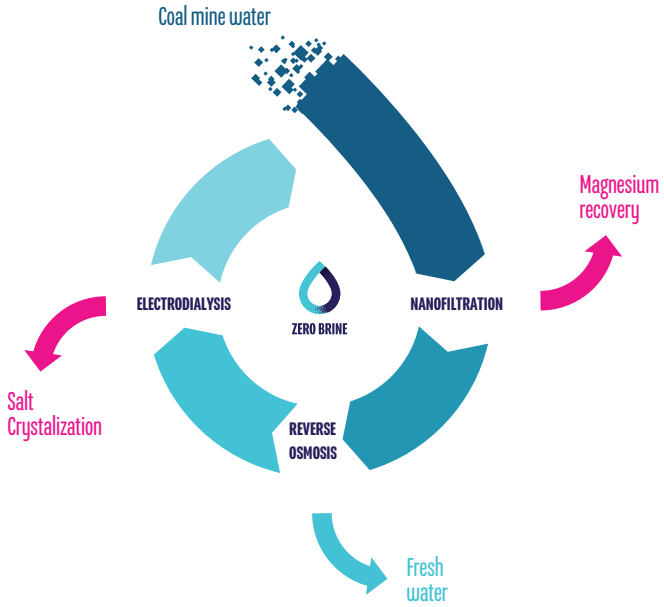
Decrease energy consumption by **33%**

Faster processing time than existing technologies

Recover materials such as **salt or concentrated brine, magnesium hydroxide**

Impact

ZERO BRINE aims at providing a technological solution of the saline wastewater problem for the coal mining industry. The ZERO BRINE technology is expected to decrease the energy consumption in the production of concentrated brine by 50% (target: 22 kWh/m3 of brine treated), compared to the vapour compression technology already used in Czerwionka-Leszczyny. The technology will also allow the recovery of raw materials: evaporated salt or concentrated brine, which both have multiple applications in the chemical industry, as well as magnesium hydroxide, which is a valuable commodity in the refractory materials industry. The ZERO BRINE team has already confirmed the interest of Poland's refractory materials manufacturer in new sources of high-purity magnesium hydroxide. Moreover, the same technology can be applied to other branches of industry which generate saline discharges.



Business opportunities

The problem of saline wastewaters is not unique to only one mine or one company – it has been a systemic issue throughout the whole industry for years. At the moment, 18 hard coal mines are still operational in Poland, provided below by coal mine industry: Jastrzębska Spółka Węglowa JSW Group (4 coal mines), Polska Grupa Górnicza (8 coal mines), Tauron Wydobycie (3 coal mines), Przedsiębiorstwo Górnicze Silesia (1 coal mine), Węglokoks (1 coal mine), Lubelski Węgiel Bogdanka S.A. (1 coal mine). All of those companies might be interested in turning their big environmental problem into a potential source of income.

An important business opportunity is the production of salt. The average production in Poland is around 4.3Mt/y, with salt-in-brine accounting for around two-thirds of production. Some 63% of salt-in-brine produced domestically is consumed in two synthetic soda ash plants (operated by Soda Polska Ciech). Around 21% of salt-in-brine is used in the production of evaporated salt and 16% in chlor-alkali production (by Anwil Nitrogen Plant, PCC Rokita and Organika-Zachem Chemical Works).

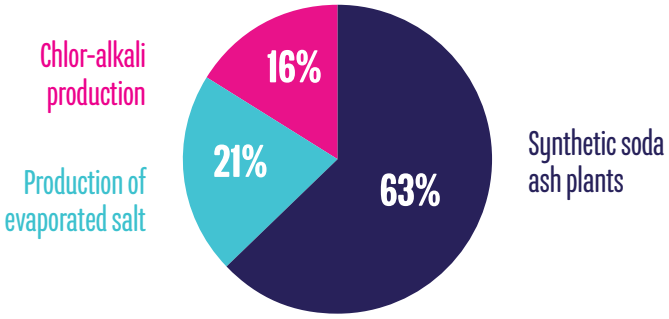
The magnesium hydroxide is of interest for the refractory materials industry. In 2006, the production of refractories in Poland reached nearly 300,000 tonnes, around 28% of which were unshaped materials. The main manufacturers in Poland include ZM Ropczyce S.A., PMO Komex (part of Alcerol-Mittal), PCO Z˙arów S.A., Vesuvius Skawina.

The business opportunities of ZERO BRINE are not limited to Poland. Because of how similar in composition the coal mine waters are to the sea water, the proposed technology could also be applied in the desalination industry – a sector which will become increasingly important due to the increasing water stress.

Turning waste into a potential source of income for operational coal mines

Salt production: **4.3 MT/y**

Usage of salt-in-brine:



Magnesium hydroxide is used in refractory materials industry - which reached **300,000 tonnes** in 2006

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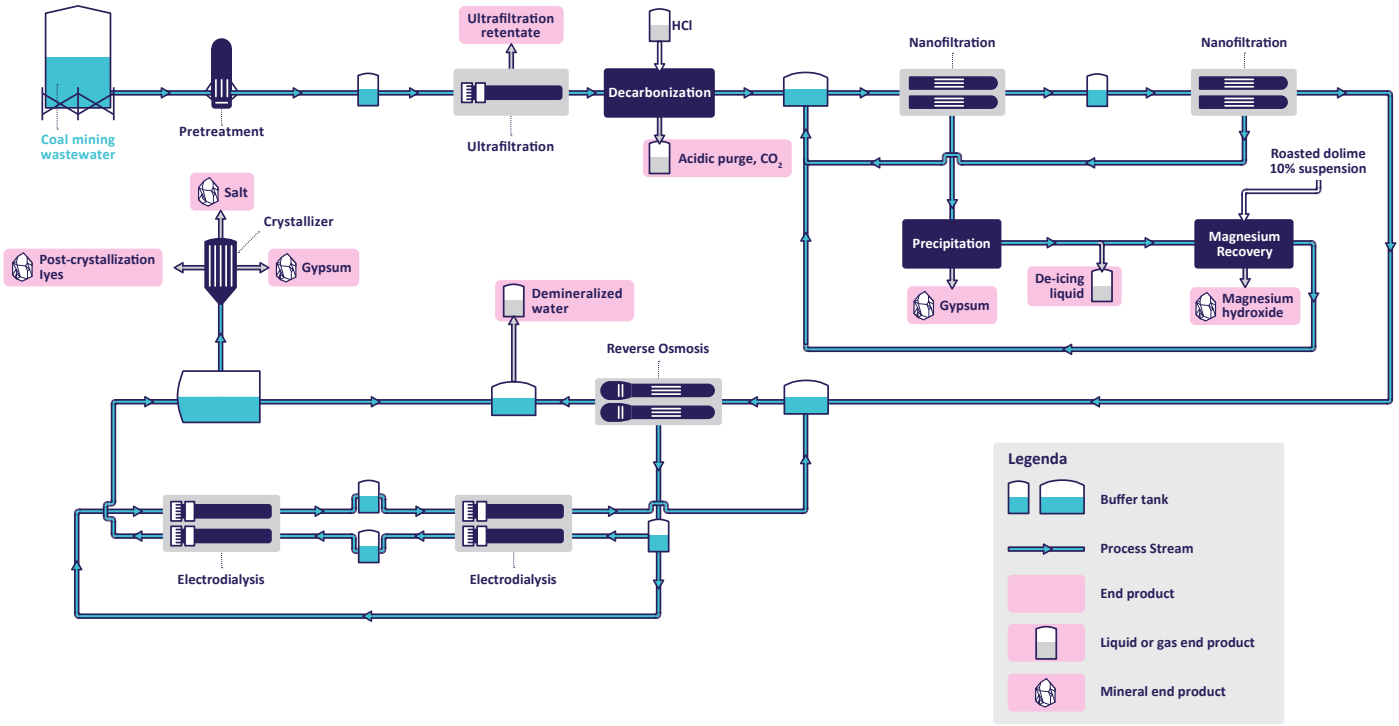
Technology

The feed – coal mine water – after being pre-treated with decarbonization and ultrafiltration, is subjected to a two-pass nanofiltration. Nanofiltration is a membrane method, which allows separation of univalent ions – such as sodium and chlorides – from bivalent ions – calcium, magnesium, sulphates. The nanofiltration unit thus splits the coal mine water into two streams: salt-rich permeate and calcium and magnesium-rich retentate. The retentate can be used n the recovery of magnesium hydroxide. Magnesium is a critical raw material officially listed by the European Commission as having high commercial value. (Currently, Europe imports over 95% of its magnesium from China.) The remaining calcium-rich solution could be used as a de-icing liquid. The nanofiltration permeate is concentrated in a hybrid reverse osmosis-electrodialysis system, which produces demineralized water of quality close to distilled water, highly saline concentrate, and the diluate, an essential commodity that can be used at the site. The highly saline concentrate could then be sold directly or used as a source for salt crystallization.

The pilot plant operating in the "Bolesław Śmiały" coal mine tests the nanofiltration-reverse osmosis-electrodialysis part of the proposed technology.

General scheme of the proposed technology



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Key results and conclusions

The pilot plant aimed at testing the proposed technology has been constructed in the "Bolesław S´miały" coal mine in Łaziska Górne, Poland. The pilot plant consists of pretreatment system, ultrafiltration, decarbonization, two-pass nanofiltration, r everse o smosis and electrodialysis, and is capable of treating 400 L/h of coal mine wastewater. The desalination experiments have been run in the pi-lot plant since July 2019 and it was confirmed that nanofiltration can split the coal mine wastewater into sodium-chloride rich stream suitable for further concentration and the magnesium-rich stream suitable for magnesium hydroxide recovery.

	Expected reduction in:			
	Water	**Emissions**	**Energy**	**Recovered resources**
Coal mine	NA	• 92.8% reduction of sodium chloride (NaCl) discharged to freshwater resources • 347 kg CO_2 /ton NaCl or 32.5% CO_2 reduction	• 33% energy reduction	• 90.6% water recovery (demi water) • 92.8% salt recovery (99% purity) • 94.9% magnesium hydroxide recovery $Mg(OH)_2$) for external valorisation (97% purity) • 0.84 kg/m^3 gypsum for external valorisation

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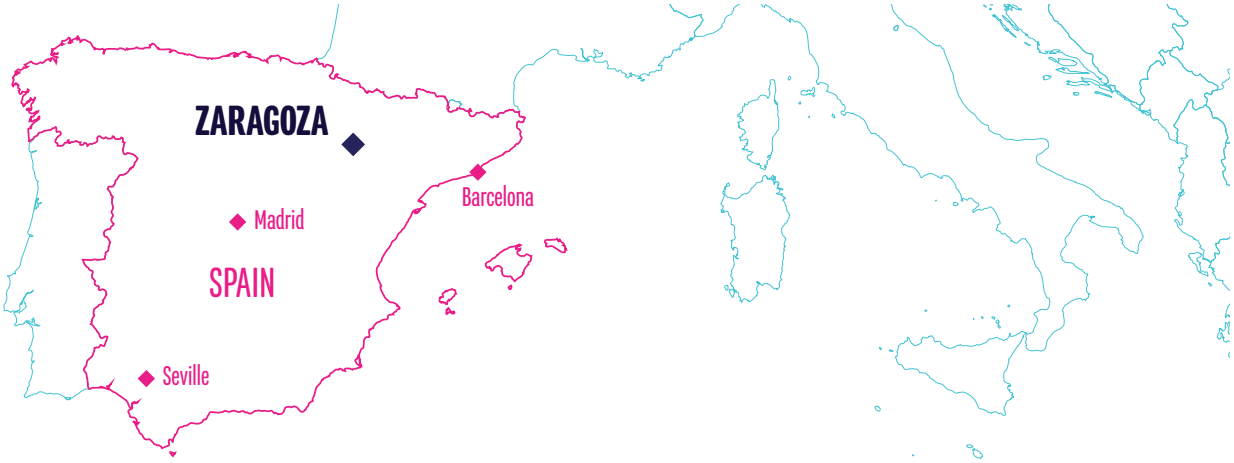
ZERO BRINE

ZERO BRINE PILOT DEMONSTRATION

INDUSTRIAS QUIMICAS DEL EBRO (IQE) IN ZARAGOZA, SPAIN



1. Industry context

Synthetic amorphous silica are used in a wide range of industrial applications. Due to their physico-chemical properties, they are used in synthetic resins, plastics, rubbers, cosmetics, nutritional products and drugs, for example, as fillers or anti-caking agents. Synthetic amorphous silica are produced either by a wet process – precipitation of a water glass solution with acids (precipitated silicas, silica gels, silicates) – or by high temperature hydrolysis of chlorosilanes (pyrogenic silicas).

In the production of silica by a wet process, high amounts of water (≈40m^3 per each tonne of silica) are consumed, as well as sulfuric acid (H_2SO_4) and sand. As a result, around 35m^3 of wastewater containing a high concentration (20 g/L) of sodium sulphate (Na_2SO_4) are produced. This wastewater is normally discharged to natural water sources such as rivers and seawater after passing through wastewater treatment plants.

It is estimated that 620,000 tonnes of precipitated silica is produced per year in the EU and 21,700,000 m^3 of wastewater is discharged.

Industrias Quimicas del Ebro (IQE) is seeking novel methods to recover resources (water and sodium sulphate) and minimize the wastewater generated, while reducing the cost of water supply and wastewater treatment. Even so, as it is stated in the BREF for the inorganic chemical industry sector, the concentration of sodium sulphate in wastewaters from the production of precipitated silica is too low for its recovery to be economically viable through available methods (spray drying, precipitation of gypsum or membrane dialysis, etc.).

2. Impact of the ZERO BRINE technology

ZERO BRINE aims at providing a technological solution for the saline wastewater problem for the silica industry. The technology applied in the ZERO BRINE project would enable IQE to recover up to 80% of wastewater generated, producing water suitable for its reuse in the same company, thus reducing freshwater consumption. In addition, the technology allows the recovery of raw materials: sodium sulphate, which is a valuable product for various industrial sectors, like the powered detergent or the glass industry.

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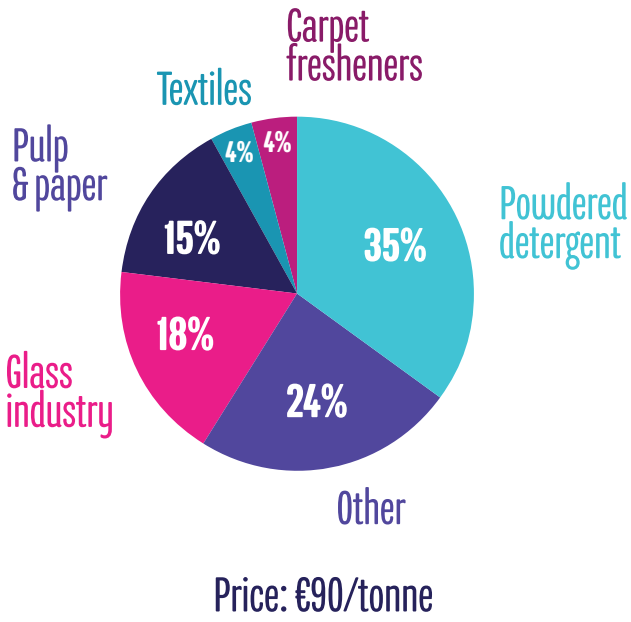
3. Business opportunities

The ZERO BRINE solution can be applied not only to the silica industry, but also to other industries which generate saline discharges containing high concentrations of sodium sulphate. This is the case for the pulp and paper industry, where sodium sulphate is one of the main reagents and also by-products of the pulping processes, especially the kraft process.

Na_2SO_4 – Uses & Market Shares



Price: €90/tonne

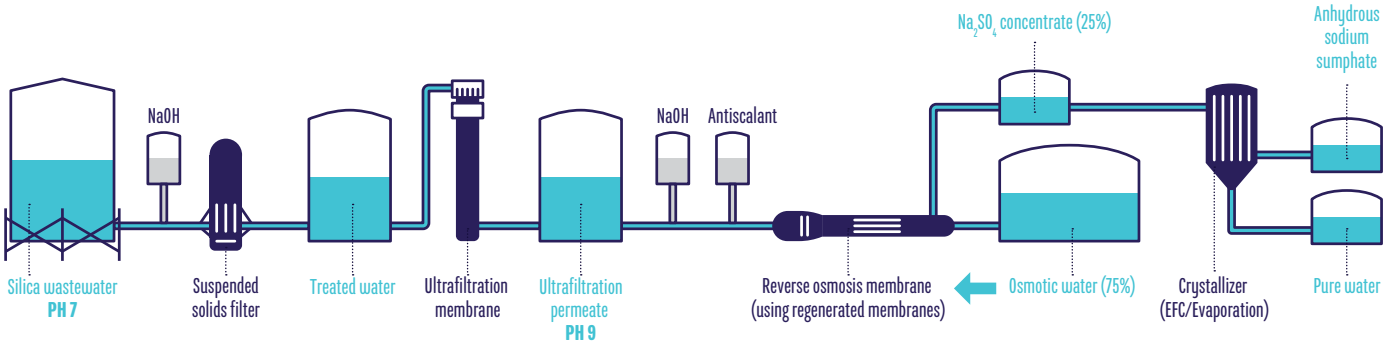
An important business opportunity is the production of sodium sulphate that is a valued product for various industrial sectors, like the powdered detergent or the glass industry.Business opportunities of ZERO BRINE are not limited to saline wastewater containing sodium sulphate. The technology developed and tested in ZERO BRINE can also be applied to recover valuable inorganic compounds other than sodium sulphate. The potential users are all industries with a high concentration of inorganic compounds in their effluents that could be recovered instead of discharged into the environment, such as desalination plants, salt mining, and chemical industries.

4. Technology + proposed scheme

The ZERO BRINE process is based on: a) a first membrane-based process using tailor-made membranes produced by regenerating end-of-life reverse osmosis (RO) elements from desalination plants otherwise destined for a landfill; b) treatment of the concentrate stream produced in the first stage by crystallization to achieve Zero Liquid Discharge. In order to avoid scaling problems during treatment with membranes, a pre-treatment to remove aluminium and iron is applied.

Regenerated membranes are able to achieve a suitable quality of water, equivalent to the current quality in the industry that could also be reused in the production process. In addition, a high saline concentrate is obtained to be treated by crystallization, either Eutectic Freeze Crystallization (EFC) or Evaporation. The concentration of wastewater using membranes reduces the energy consumption of the crystallization stage.

The ZERO BRINE process has been demonstrated at IQE at pilot plant scale.



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5. Key results and conclusions

The technology applied in the ZERO BRINE project would enable IQE to recover 20,000 tonnes per year of sodium sulfate and 80% of the wastewater generated (1,000,000 m^3 per year).

The concentration of saline wastewater using regenerated membranes before the crystallization process allows the reduction of treatment costs up to 70% when compared with the direct evaporation of wastewater.

The preliminary business plan elaborated for the development of the ZERO BRINE proposal foresees savings in the cost of water supply and wastewater treatment of around €460,000 per year and turnover of €1,800,000 per year from the sodium sulphate recovered.

Table 1 - Impacts of the ZERO BRINE technology on water, emissions, energy, and resource recovery in industry

	Expected reduction in:			
	Water	**Emissions**	**Energy**	**Recovered resources**
Silica factory	• 30% reduction in overall annual water consumption at IQE	• 100% reduction of brine discharged to the environment • 60% reduction of sodium sulphate (Na2SO4) releases into the Ebro River 6,000 tons/year CO2 reduction or 5 kg CO2/ m^3 of wastewater	• 72% reduction by waste heat (EFC technology compared to direct evaporation)	• 75-90% water recovery suitable for internal use • 90% recovery of sodium sulphate (Na2SO4) or 20,000 tons/year for external valorisation (>99% purity) • Sodium hydroxide (NaOH) (94% purity) and sulphuric acid (H2SO4) (72% purity) for external valorisation

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ZERO BRINE

ZERO BRINE PILOT DEMONSTRATION
ZORLU TEXTILE FACTORY IN LÜLEBURGAZ, TURKEY

1. Context

The management of industrial wastewater to comply with Zero Liquid Discharge (ZLD) has been receiving significant attention. The textile industry is one of the largest sectors in Turkey and makes up 10% of the country's GDP and employs around 750,000 people. However, the industry is also responsible for numerous environmental effects due to wastewater discharges which contain various chemicals, dyes, salts and other auxilary materials from unit processes. The industry covers 1-3% GNP of the countries worldwide. Turkey ranks 5th and 6th in production of woolen and cotton products worldwide which makes up close to 40% of total export income and 10% of the industrial work force. Therefore, the implementation of a well-designed solution to prevent pollution along with the ZLD concept is highly favorable for both environmental concerns and economically.

The textile industry is a highly water intensive sector. Water consumption ranges between 60 to 120 L/kg for cotton products and 110-650 L/kg for wool. Water is utilized at various steps of the unit processes such as pre-treatment, dyeing or finishing. Processes require extensive water use for dyeing, rinsing, conditioning and finishing operations. The crucial parameters of discharges from textile enterprises include mainly organic constituents, dissolved solids, inorganic salts, color, sulfate and pH.

Salt usage is also significant in the textile industry. Salt is consumed for dyeing cotton or linen fabrics and acts as a raw and auxiliary material.

Physicochemical and biological treatment techniques are widely employed to treat textile industry wastewater to comply with local discharge criteria. Moreover, membrane processes such as Nanofiltration (NF) and Reverse Osmosis (RO) are also utilized following conventional treatment methods as a tertiary treatment step to obtain a reusable stream. Membrane treatment for reuse is a very effective method for removal of ions and other pollutants. Reusable, high quality water is obtained using RO membrane processes.

RO on the other hand, results in the formation of highly polluted concentrate (brine) along with the high-quality, treated water stream. The impurities and pollutants in brine have serious adverse impacts on the environment. Principally, the brine discharges may cause environmental and ecological impacts on especially inland receiving water bodies such as lakes and rivers and may cause salinization of the soil which is one of the most severe environmental problems in agriculture.

The concept of circular economy and ZLD options are investigated for Zorlu Textile's integrated polyester yarn and cotton home textile manufacturing industry within the context of ZERO BRINE project. In this manner, treatment and recovery of the concentrated salt solution (brine) which can be reused in the dyeing baths of the textile plant and/or utilized as feed for salt production is targeted.

The demo project is primarily focused on the management of brine generated from the RO unit and developing an innovative brine treatment and recovery system. Brine from the RO treatment unit presents an important environmental concern due to the high concentration of impurities including various chemicals, salts, colors, hardness, alkalinity and nutrients. The primary difficulty to be overcome by this approach is the separation of hardness and color from brine while concentrating the salt solution which can, in turn, be used in textile dyeing processes. The recovered salt solution should also comply the criteria for textile dyeing process requirements.

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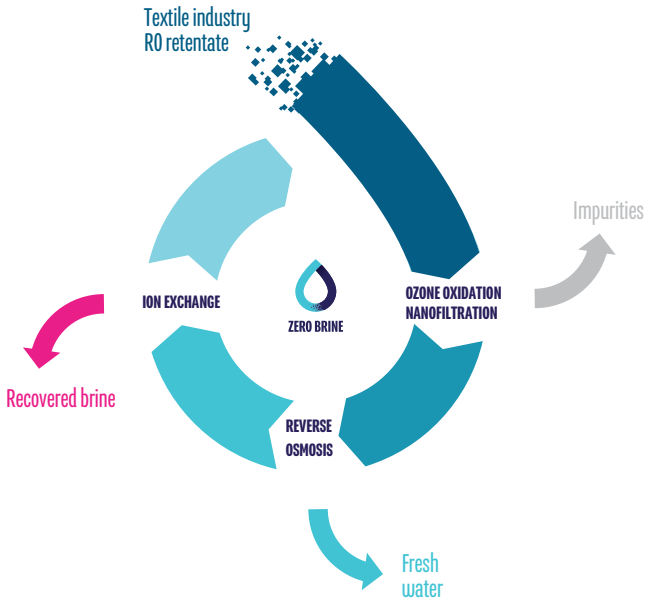
2. Impacts

The ZERO BRINE project intends to reduce saline wastewater streams generated by industry by recovering and reusing minerals, water and metals from wastewater. ZERO BRINE aims at the development of innovative technological solutions of the highly saline wastewater problem for several industrial sectors including the textile sector. In this context, concentrate (brine) recovery of approximately 400 tons/year as NaCl is targeted for Zorlu Textile. Depending on the brine impurity, recovered concentrate is utilized for in-plant processes. The conditions for recovery is appraised, and off-site use may also be made possible. Moreover, production 80 Km^3/year high quality water is also among the goals.

The results would have great impacts on the textile industry in achieving resource efficiency and improving sustainability due to the reduced consumption of process inputs, as well as the mitigation of greenhouse gasses accordingly. In this way, it is estimated that the reduction of 200 tons of CO_2 on an annual basis could be achieved.

Moreover, the similar technology and approach can be applied to other sectors of industry which generate saline discharges.

Fig. 1 – Conceptual scheme for textile pilot



3. Business opportunities

Brine is a valuable resource for the recovery of salt and water. In this way, the purpose is to close the loop between the saline wastewater generated by process industries and to contribute the circular economy. The goal is achieved by means of innovative existing and new technologies to recover and reuse high quality end-products. By taking into account the demo system results, other various enterprises actively operating in the textile sectors will likely be encouraged. The solutions developed may sustain;

I. compliance with the relevant regulations likely to be in force in the near future,

II. economic benefits for the enterprise implemented ZLD approach due to the reduction in consumption of salt and water,

III. improvements in visibility of the enterprise due to the increased concerns for environmental issues, and also relevant growth in export potential with good market value,

IV. business opportunities foreseen for the companies involved wastewater treatment and reuse/recovery options,

V. creation of new job alternatives for technical personnel in both textile or other relevant enterprises for various sectors including environmental fields (wastewater treatment and reuse companies).

4. Technology

Zorlu Textile industry wastewater is treated with physicochemical, biological methods and advanced treatment processes (activated carbon adsorption, ultrafiltration and RO) to obtain a reusable stream which is utilized for an energy company's cooling systems located near the Zorlu Textile. RO treatment consequently results in the generation of a highly polluted concentrate retantate (brine).

The proposed configuration of the brine treatment and recovery pilot system was developed based on the comprehensive characterization in bench scale tests, as well as the relevant assessments.

In this perspective, ozone oxidation and (NF) membrane processes are applied as the pre-treatment phase essentially to remove or mitigate impurities such as color, hardness, organic constituents and sulfate. NF provides 50-60% rejection of impurities whilst allowing 10-20% salt passage. Whereas, after NF membrane systems, RO is utilized as the concentration step for the NF permeate stream. At this stage, the concentrate stream of the RO unit is the recovered salt solution while the permeate of the RO unit is the reusable water – close to demineralized water quality – that can be reused for textile processing purposes.

The ion exchange softening process is also applied as the final step to acquire extra hardness removal of the recovered salt solution prior to the dyeing applications. This step would provide additional assurance as hardness is considered to be the critical parameter for textile dyeing processes. An activated carbon adsorption column and an UV oxidation unit are also provided within the pilot system to remove excess ozone remaining in the concentrate stream to provide protection for the membranes.

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Fig. 2 – General outline of the proposed system at Zorlu Textile

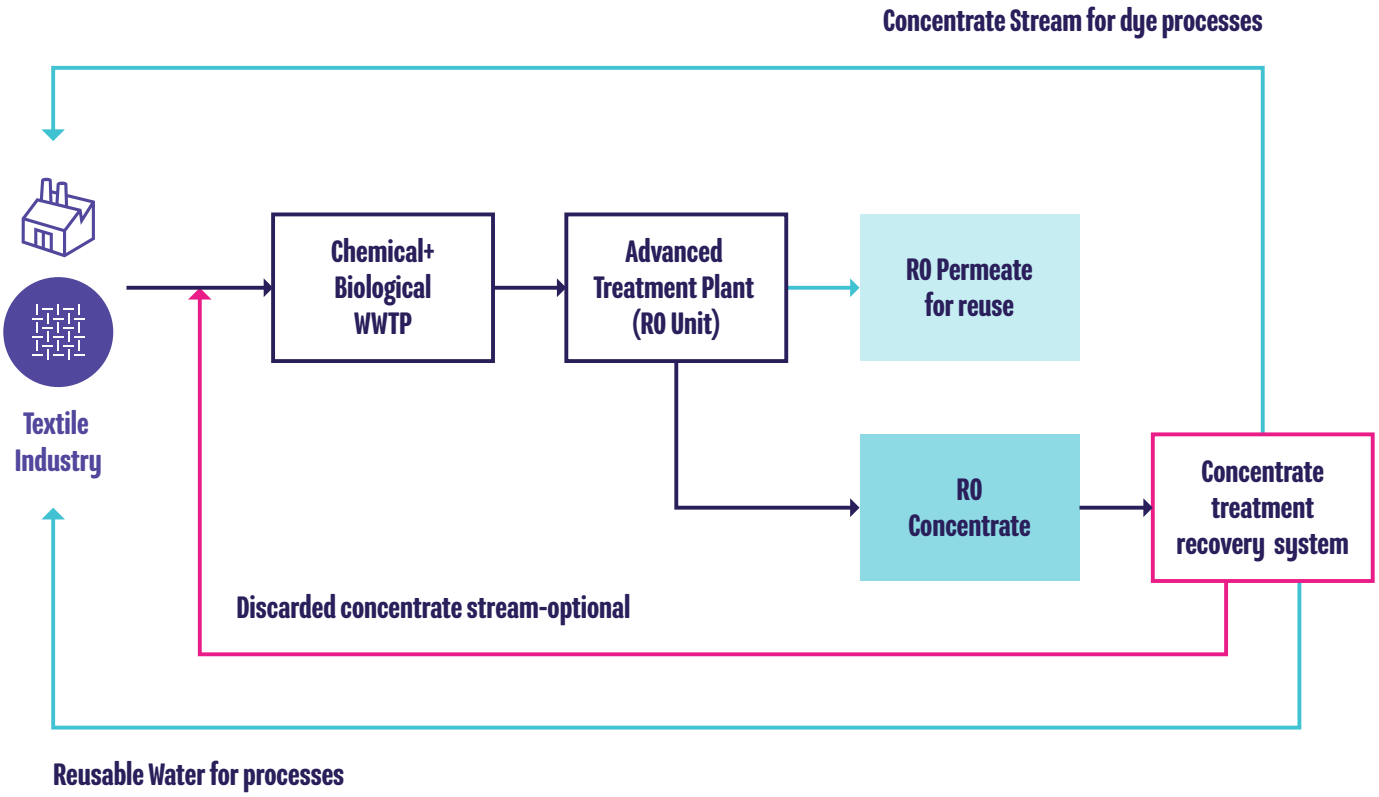
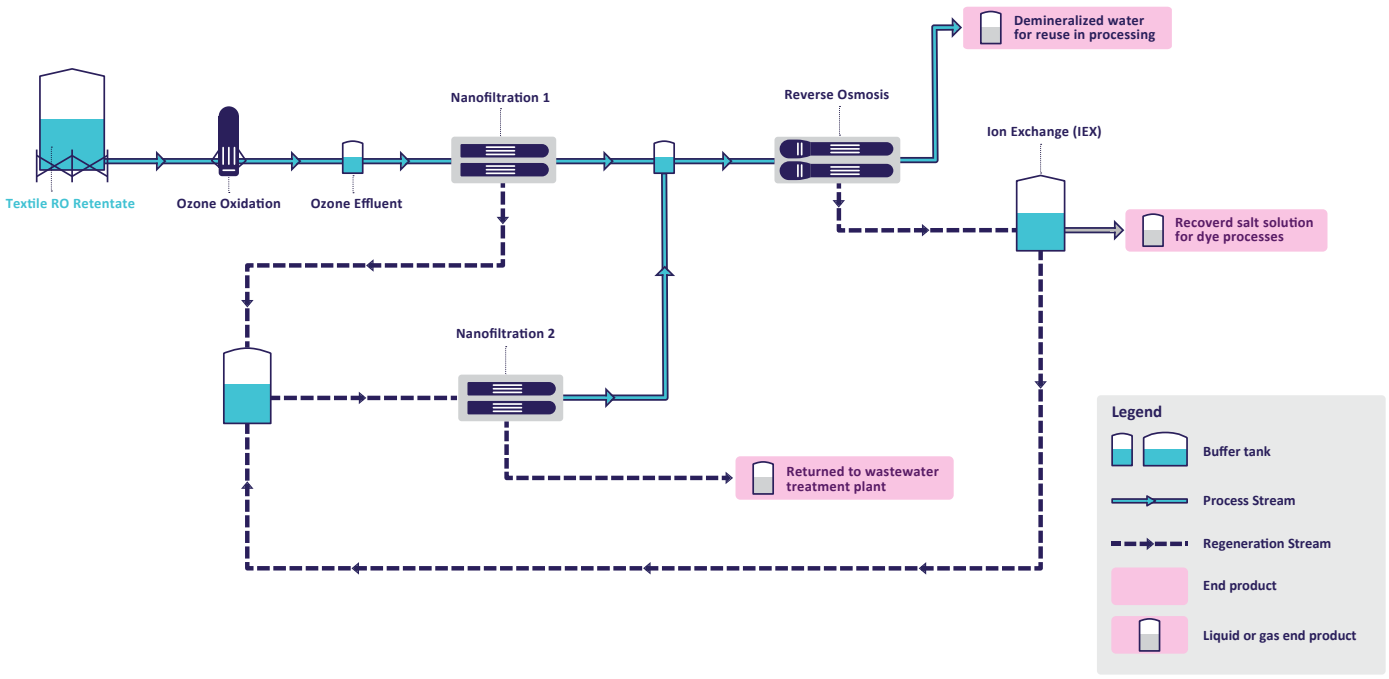


Fig. 3 – Process scheme of the applied technology for the pilot system



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5. Key results and conclusions

The textile brine recovery pilot plant is intended for testing and verifying the proposed technology. It has been constructed and is being operated at the Zorlu Textile premises at Lüleburgaz, Kırklareli.

The pilot system involves a pretreatment stage with ozone oxidation, nanofiltration, concentration stage with reverse osmosis and, as a precaution, a softening unit by an ion exchange column. The pilot plant is capable of treating 300 L/hr of RO retentate discharged from advanced wastewater treatment facilities of Zorlu Textile. The developed process scheme results in 50-60% of recovery of NaCl for the dyeing processes. Whereas, the clean water recovery as permeate of the RO treatment unit would be 70-80%. Alternatively, this stream will be reused within the enterprise for various purposes. The process design system allows the flexibility to be operated at relevant variable flow intervals. Moreover, the arrangement of the proposed treatment units and the piping connections could be varied to a certain extent depending on the operational conditions and the requirements throughout the operation period. Hence, by this approach it is anticipated to accomplish efficient recovery of salt solution for dyeing processes.

	Expected reduction in:			
	Water	**Emissions**	**Energy**	**Recovered resources**
Textile factory	• 7% reduction in total freshwater consumption of Zorlu Textile or freshwater abstraction by 123,000 tons/year	• 90-95% reduction of brine discharged to the environment • 150-200 tons/year CO_2 reduction	NA	• 70-80% water recovery from brine treatment system for onsite use • 600-700 tons salt/year for onsite dyeing of textiles

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