# Steel case

r3volution

reuse · resource · recovery

The EU-funded R3VOLUTION project is redefining industrial water management in Europe, aiming to enable more than 90% water reuse in water-intensive sectors.

Industries such as petrochemical, biochemical, pulp & paper, and steel produce highly complex wastewaters and lose thermal energy, leading to greenhouse gas emissions and costly treatment demands.

R3VOLUTION transforms these challenges into opportunities by recovering water, solutes, and up to 50% of thermal energy, while removing hazardous substances. The innovative project solutions are being validated at four demonstration sites across key industrial sectors. This brochure introduces the steel demo site.

## The steel industry demonstration case

The area around Barcelona (where the demo site is run by project partner CELSA) faces water availability constraints, with seasonal consumption limits set by authorities. This affects plant production capacity. A total discharge of 400 $km^3$/year is treated in the site's wastewater treatment plant (WWTP), using a simple physical-chemical process to meet discharge limits. While the WWTP complies with these limits, removing oil and grease and managing salinity levels remains challenging.

Future regulations are also expected to be stricter, and the authorized water concession may decrease. Currently, only 20—25% of treated wastewater is reused in specific production steps. CELSA aims to increase the water reuse to over 90%, focusing on producing high-quality water suitable for more demanding production processes, thereby reducing freshwater intake.

## Our solutions

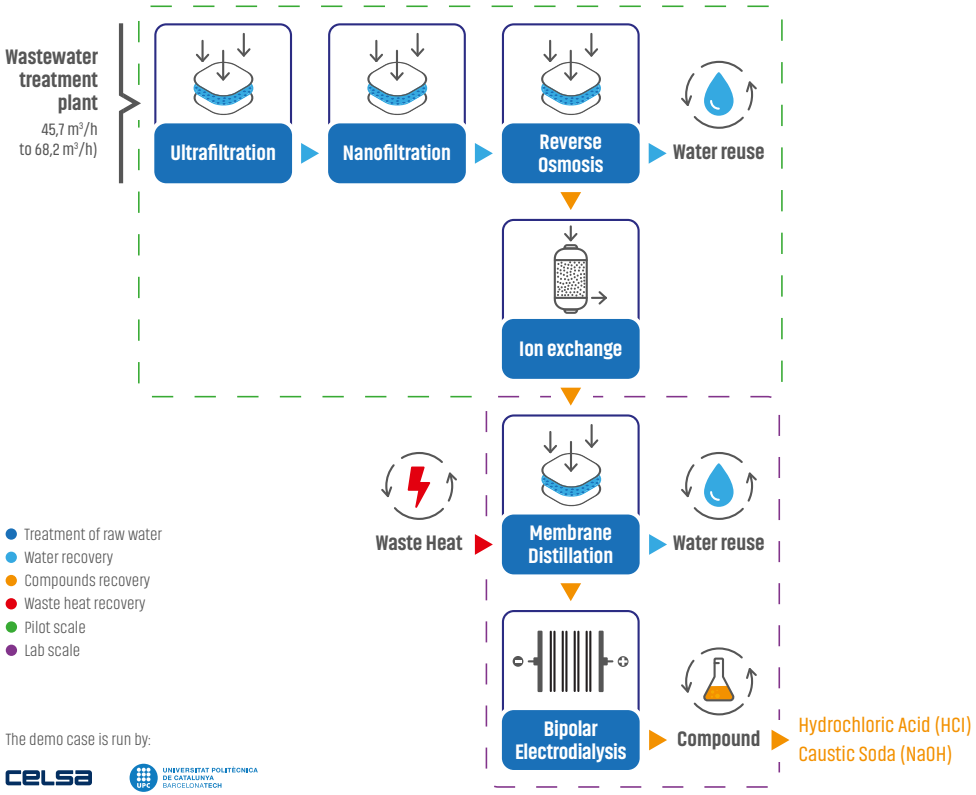
The proposed treatment process for the WWTP effluent uses a two-stage membrane system to maximise water reuse and meet strict discharge limits. An additional two-stage configuration is proposed to maximize water recovery (approaching ZLD) and enable solute valorization.

**Stage 1:** Ultrafiltration (UF) using polymeric membranes will remove oil, grease and suspended solids. Nanofiltration (NF) will be then used to remove hardness, avoid scaling and allowing maximum water recovery in the next step. Finally, a Reserve Osmosis (RO) step will reach the required water quality suitable for reuse in the cooling cascade system for steel production.

**Stage 2:** The RO brine, rich in NaCl is first subjected to ion exchange to remove any residual jardness and then further concentrated via membrane distillation (MD) using CELSA's waste heat, thereby increasing overall water recovery. The resulting concentrate is subsequently treated by bipolar electrodialysis (BPED) to recover HCl and NaOH for on-site cleaning operations.

This integrated **zero liquid discharge (ZLD) approach** enables higher water recovery while turning waste streams into valuable resources.

## Treatment train




The demo case is run by:

CELSA

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

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