

Turning salt into **strategic value**

Electrochemical solutions for lithium refining, recycling, and sodium sulfate valorization.

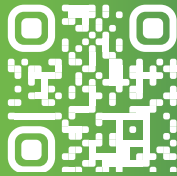
About De Nora

Founded in 1923 and listed on the Euronext Milan stock exchange, Industrie De Nora S.p.A. is an Italian multinational at the forefront of the **global electrochemical industries and water treatment solutions**.

De Nora is a **recognized leader** in electrochemical processes and technologies for water management. The company provides electrodes, equipment, services, and integrated solutions that enable industrial processes across the chlor-alkali, electronics, batteries' supply chain, water treatment (municipal and industrial), energy transition, decarbonization and circularity sectors.

With an extensive operational footprint spanning the Americas, Europe, the Middle

East, Asia and five R&D centers, De Nora leverages its **international expertise** to deliver customized, reliable solutions that address evolving market demands worldwide. The company is **deeply committed to Environmental, Social, and Governance (ESG) principles**, integrating environmental stewardship, innovation, and social responsibility into its business strategy and daily operations.



Scan the QR code
to discover how De Nora's
expertise enables industrial
transformation worldwide.

Turning salt into strategic value

Across industries, salt, brines and effluents are shifting from waste to valuable resources for recovery, circularity, and electrification. De Nora's electrochemical expertise helps customers to move from conventional processes to integrated electrochemical systems that recover value, reduce waste, and promote sustainability.



Powering the future through cleaner, resilient critical materials loops

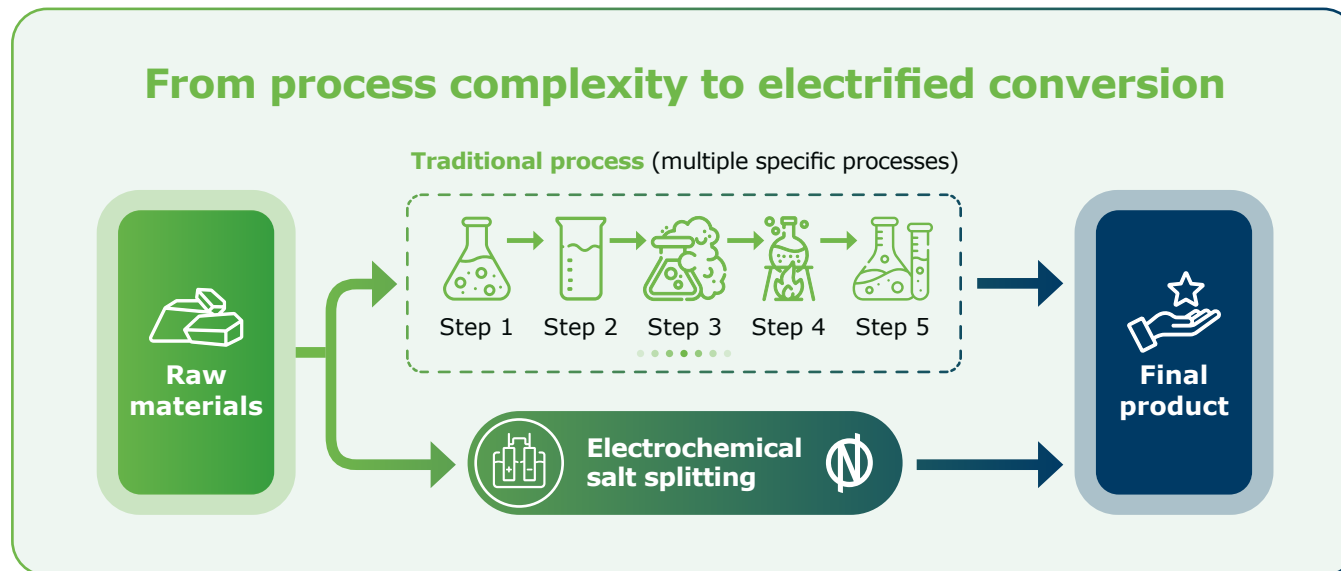
Industrial customers are under pressure to cut **waste, water, chemicals, logistics, costs and carbon footprint**. Meanwhile, critical materials like lithium are vital for electrification and energy storage. Chemical production processes require complex flowsheets—precipitation, washing, re-dissolution—that increase chemicals and energy use, by-products generation, raising costs and CO₂ emissions. Disposal costs also rise to meet wastewater regulations. **Electrochemical processes offer alternatives**, recovering salts from waste streams and brines—like solar, geothermal, or reverse osmosis eluates—for reuse, reagent regeneration, and chemical recycling, significantly improving economics while reducing CO₂ emissions.

De Nora's commitment

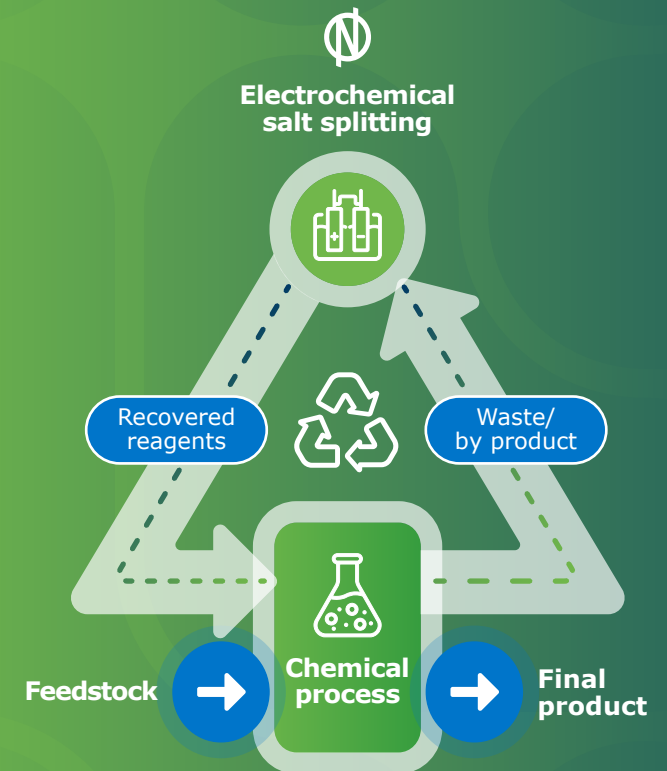
Dare - Simplify lithium refining and turn salt-rich wastewater into valuable chemicals with future-proof solutions, challenging conventional routes.

Develop - Fit-for-purpose electrochemical solutions for real chloride or sulfate matrices, using scalable platforms tailored to customer needs.

Deliver - Proven, future-proof industrial assets backed by De Nora's electrochemical heritage, proprietary electrode and cell expertise, manufacturing strength, providing efficient operations, competitive performances and lifecycle services.



From waste management to resource recovery



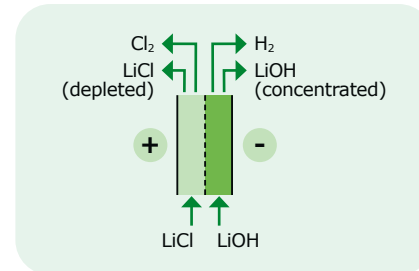
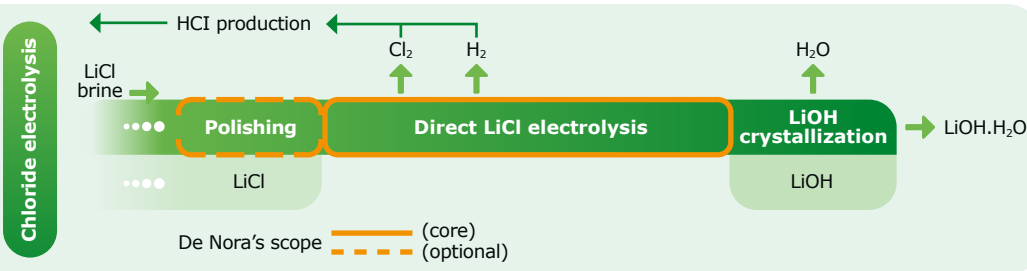
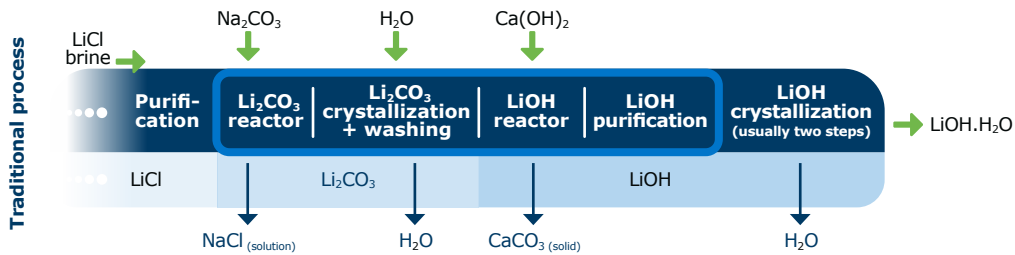
Lithium refining and recycling

De Nora technology is DLE Agnostic.

Rising demand for electric vehicles (EVs), renewable energy storage systems (EES), and advanced battery technologies will drive lithium demand over the next decades. Lithium hydroxide (LiOH) and lithium carbonate (Li₂CO₃) demand is expected to grow at double digits through 2035.

LiOH from LiCl - Traditional process vs. electrochemical route

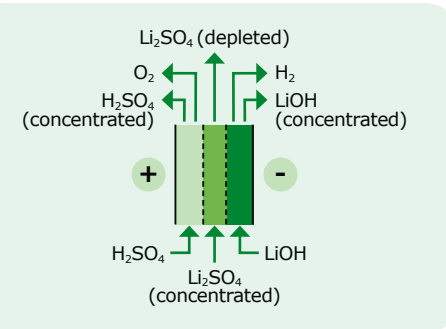
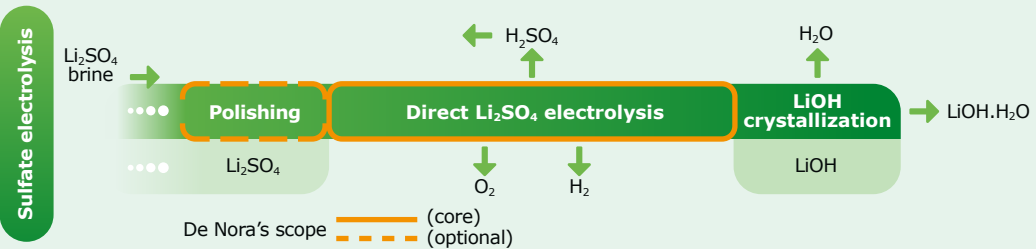
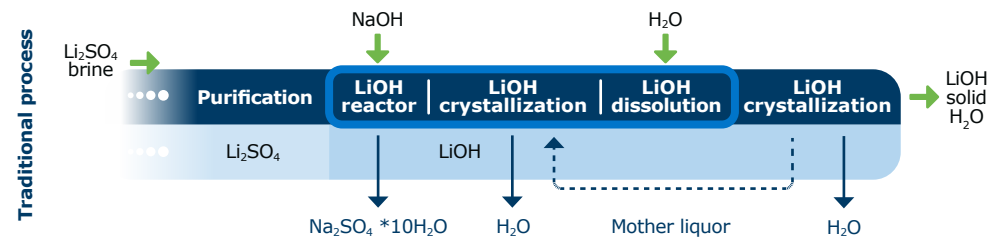
In the traditional process, lithium chloride (LiCl)-rich streams can pass through carbonate formation, crystallization and washing, hydroxide conversion, purification, and (two steps) crystallization. The electrochemical route introduces direct LiCl electrolysis as a conversion step toward LiOH, thereby reducing the number of intermediate steps. This solution leads to a reduction in plant CAPEX (due to overall process simplification) and OPEX (no need for reagents or waste disposal) after the DLE step.





LiOH from Li₂SO₄ - Traditional process vs. electrochemical route

Lithium sulfate-rich streams are relevant to hard-rock lithium rich (spodumene) processing and certain recycling routes. Traditional conversion generates sodium sulfate as by-product stream. The electrochemical route uses direct electrolysis of Li₂SO₄ to produce LiOH and recover the acid's value. The overall value resulting from savings in CAPEX and OPEX can, in this case, result higher than for the chloride route.



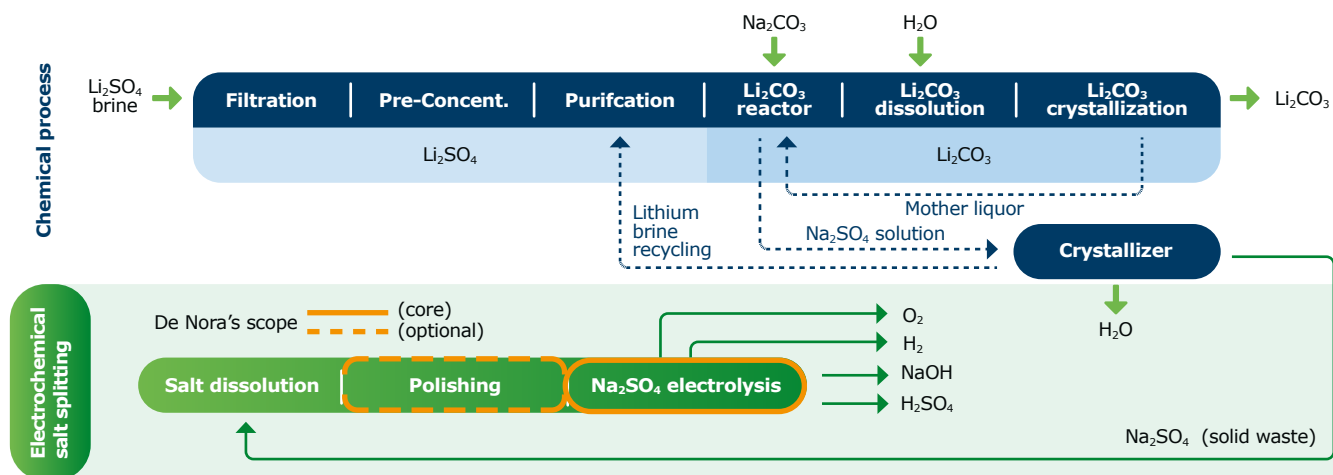
Sodium sulfate salt splitting

Sodium sulfate (Na_2SO_4) is a raw material used across several industrial sectors, as well as a byproduct of many processes. As a consequence, its large increased availability reduces its market value. Consequently, producing sodium sulfate as a byproduct creates a process issue that must be managed by either disposing of it or selling it at a very low price. A viable alternative to this anti-economic practice is the electrochemical splitting into valuable caustic soda (NaOH) and sulfuric acid (H_2SO_4).

Sodium sulfate valorization - Generation of NaOH and H_2SO_4

Wastewater streams rich in sodium sulfate are generated in processes such as amorphous silica production and pulp & paper operations. Rather than spending money to treat these streams as low-value waste to meet regulatory requirements, electrochemical salt splitting can convert sodium sulfate into sodium hydroxide and sulfuric acid for potential reuse or valorization.

Acid and base generated by electrolysis can be recycled on-site in the upstream process, eliminating logistics burden and reducing overall OPEX and the CO_2 footprint.



Electrochemical salt splitting produces valuable chemicals and hydrogen stream that can be used as fuel.

Industry	Salt to be split
Lithium processing	Li_2SO_4 , LiCl
Pulp & Paper industry, Lithium, Precipitated Amorphous Silica	Na_2SO_4
Melamine production, CO_2 capture	Na_2CO_3
Caprolactam Processing	$(\text{NH}_4)_2\text{SO}_4$
Electronics and glass industry	TMA-Cl, TMA ₂ -SO ₄
Chlor alkali for WT	NaCl

Other salt splitting opportunities

Electrolysis allows the valorization of waste streams as feedstock, turning them into valuable chemical products.



Cells' Room in R&D Laboratory - Milan (Italy)

ENSO

LOOP TO PERFECTION

Enso is a 2/3-compartment cell electrolyzer - De Nora's proprietary electrochemical reactor - that provides value to customers targeting salt-splitting processes. The electrolyzer leverages De Nora extensive experience in chlor-alkali, lithium, hydrogen generation splitting water and other heavy-duty electrochemical processes.

Lab

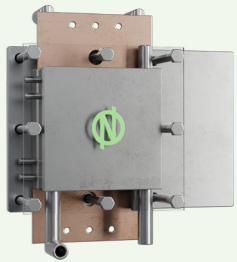
Pilot

Commercial scale

From lab to pilot-cell and industrial-scale production, our Salt Splitting solution grows with your needs—starting with early-stage testing, moving to plant validation, and scaling seamlessly into a robust industrial system capable of handling everything from small batches to several thousand tons size.

Proof of principle

- Data acquisition
- Brine pre-treatment
- Operative condition
- Product purity



Field test of real brine

- Process Optimization
- Analysis and development
- Final validation



Commercial scale production easily expandable

- Two commercial sizes
- Optimized coverage of the production needs
- Easy increase of the capacity in phases



Health
and Safety



High
performance



Simplified
maintenance



Scalability

The industrial enabler of future-proof assets

Enso electrochemical solutions **provide practical alternatives** to address critical raw material scarcity, wastewater treatment and reuse, and **brine valorization—turning waste into resources**. De Nora offers a phased pathway supported by **scalable systems**, from laboratory cells to pilot units and expandable commercial equipment, enabling a smooth transition from feasibility study to industrial-scale deployment. As demand grows, the solution can be scaled to large applications without requiring additional validation.

For lithium applications, **Enso** can be paired with the majority of the Direct Lithium Extraction technologies, enabling fast deployment and optimization of lithium hydroxide monohydrate production while reducing operating costs and environmental impact.

Enso solution lowers chemical procurement and handling costs, eliminates process-waste disposal expenses, and reduces exposure to reagent price volatility and tightening waste-treatment regulations.



Experience

Reliable solution



Modular

Scalable solution



No Risks

Proven and consolidated process and technology industrial execution



Chemical regeneration

Electrochemical industrial enabler



Process simplification

Water use reduction



The Power of Proprietary Electrode Expertise

Built on De Nora's more than 50-year legacy and undisputed leadership in electrode development, testing, and manufacturing, Enso integrates proprietary DSA® anodes, NRG® cathodes, and Gas Diffusion Electrodes (GDEs) for depolarized operations. Enso's electrodes are engineered in-house to maximize performance, extend asset life, and enhance the economics of salt splitting.



Customer Services

Service and maintenance agreements

Integrated service solutions focused on maintaining operational continuity, optimizing asset performance, and supporting long-term reliability throughout the entire equipment lifecycle.

Electrode repair and recoating services

Advanced repair and recoating solutions that restore electrode performance, extend service life, and ensure reliable operation while reducing downtime and supporting sustainable asset management.

Upgrade, refurbishment and retrofit services of existing installations

Tailored upgrade and retrofit solutions that enhance productivity, safety, and efficiency while extending the life of existing installations without full system replacement.

Global presence

An **international network** covering Europe, Middle East, North America, Latin America, and Asia-Pacific.



Site surveys and health check audits

Comprehensive on-site assessments and performance audits delivering actionable insights, optimization opportunities, and expert recommendations to optimize equipment reliability, efficiency, and asset longevity.

Spare and replacement parts

Reliable OEM spare parts, maintenance kits, and customized supply agreements designed to maximize equipment uptime, preserve performance, and support long-term operational efficiency.

Contact us

service.etr@denora.com



Get in touch

www.denora.com

Discover more



Circularity and Salt Splitting Brochure - CSS2606001

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