

The background of the advertisement is a vibrant green and teal gradient. It features a large, faint dragonfly illustration in the lower right corner, with its wings spread. The background is also filled with numerous small, translucent water droplets and bubbles, creating a fresh and clean aesthetic. Faint, glowing green lightning bolts are scattered across the scene, adding a sense of energy and power.

DRAGONFLY[®]

Alkaline Water Electrolyzer

 DE NORA



Founded in **1923**, **De Nora** is an Italian multinational company listed on the Euronext Milan stock exchange, specializing in electrochemistry, leader in **sustainable technologies**, and has a vital role in the **industrial green hydrogen production chain**. The Company has a portfolio of products and systems to optimize the energy efficiency of critical industrial electrochemical processes and a range of products and solutions for water treatment.

De Nora has 25 operating companies in 10 countries and 5 R&D centers in Italy, the United States, and Japan, which ensure the **continuous improvement** and enlargement of its proprietary technologies covered by several patent families with more than 2.800 territorial extensions. With its widespread presence and broad product portfolio, the Company can effectively serve customers in 100 countries.

De Nora everywhere

Globally, **De Nora** is the **world's largest supplier of activated electrodes**, serving a broad portfolio of customers operating in chlorine & caustic soda production, components for electronics, and non-ferrous metal refining. De Nora is among the world's leading suppliers of **water filtration and disinfection** technologies (for the industrial, municipal, and marine sectors) and swimming pool disinfection components. Leveraging its well-established electrochemical knowledge, proven manufacturing capability, and a supply chain established over the years, the Company has developed and qualified a portfolio of electrodes and components to **produce hydrogen** through the electrolysis of water, which is **critical for the energy transition**.

Energy Transition

Energy transition applications are the natural extension of the Electrode Technologies business. De Nora's solutions are used to **generate green hydrogen** through water splitting and convert hydrogen into electricity. Hydrogen is crucial for **decarbonizing** many industrial processes; green hydrogen is key to achieving **"carbon neutrality"** and **"net-zero emissions"**.

Sustainability in DNA

De Nora aims to provide new solutions that can contribute to achieving the **United Nations 2030 Agenda** and the **Sustainable Development Goals (SDGs)**.

Boosted Alkaline Water Electrolysis

De Nora has a solid **Alkaline Water Electrolysis (AWE)** background. More than 100 years of expertise in electrochemistry and significant efforts applied in new R&D projects allowed De Nora to develop a new, boosted, alkaline water electrolysis technology. This is today the state-of-the-art technology for green hydrogen generation, ready to contribute to reducing the global carbon footprint in several industrial sectors.



“ We are not just surfing the transition, but creating the wave ”



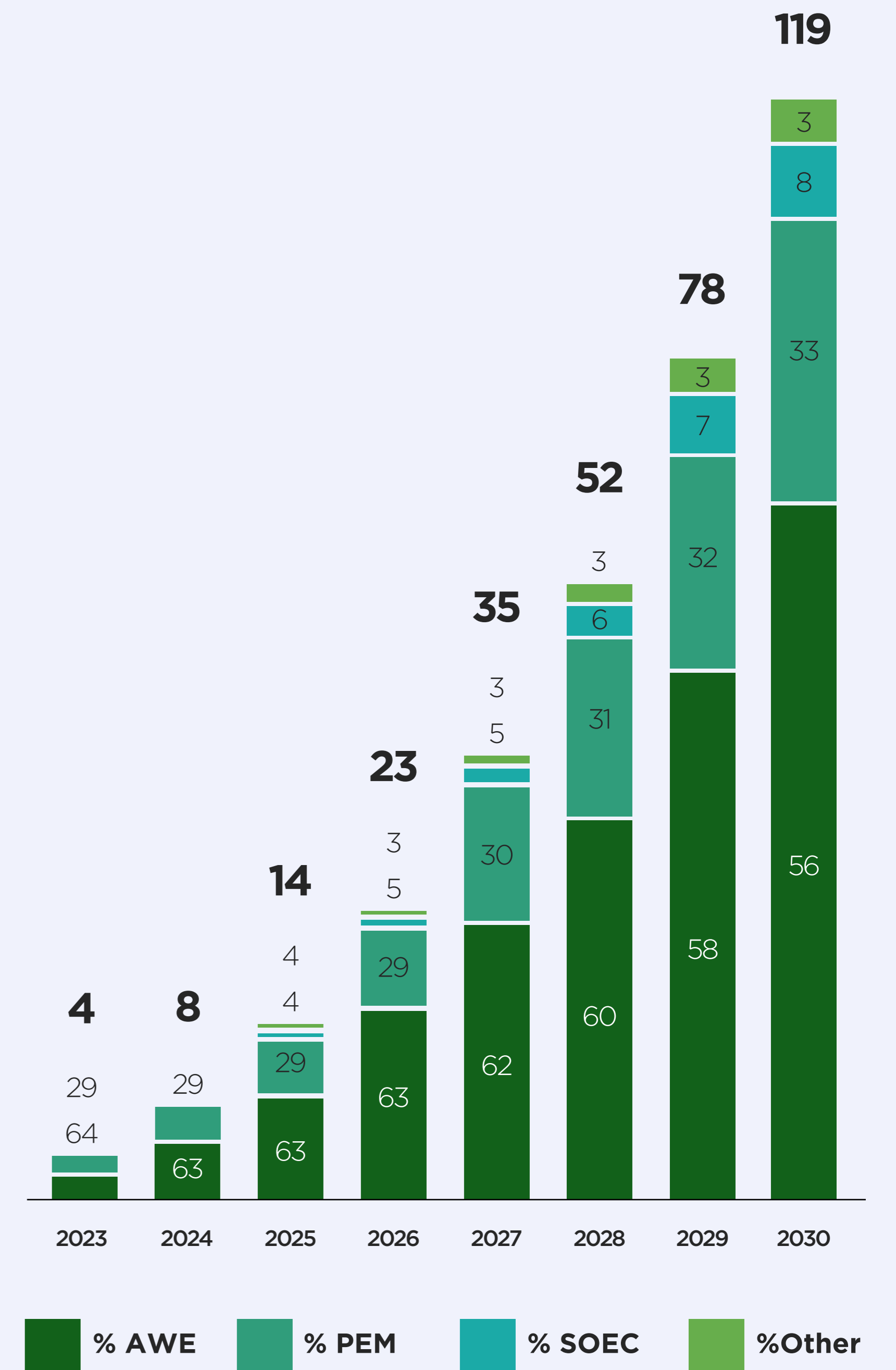
Hydrogen & Electrolysis

To reach the ambitious goal of net zero carbon emission by 2050 (NZE), the penetration of renewable energy sources will dramatically increase to reach the largest share in the next decades. The intermittency of these energy sources (such as Photovoltaic and Wind Turbines) highlights the necessity to integrate storage systems to balance the energy grid.

In the Energy transition process, **Green hydrogen** is widely recognized not only as a promising option for storing large quantities of renewable electricity over long periods of Power to Power (**P2P**) and as an energy vector for more sustainable **Mobility** (through Fuel Cell Electric Vehicle), but also as a renewable feedstock for a variety of **Chemical Production Power to Chemical (P2C)** (ammonia, methanol, green fuels, ...) and as unique alternative **energy source** for those sectors defined as **“Hard to Abate”** where electrification cannot substitute carbon-based power sources.

Today, the most established technology option for producing Green Hydrogen from electrical power sources is water electrolysis.

De Nora, in recent years, spent substantial R&D efforts in developing what we call boosted AWE, a solution that to maximize its operating current density (CD) and reduce the overall power consumption, pushing this technology toward PEMWE performances but guaranteeing the lower CAPEX investment. Furthermore De Nora enlarged its usual scope of supply (Electrodes and Electrode Package) to a full containerized electrolyzer suitable for small and medium scale. The result of this effort is the De Nora Alkaline Water Electrolyzer **“Dragonfly[®]”**.



* Roland Berger - Project Demetra Report. April 2024



From traditional Alkaline Water Electrolysis (AWE)

A proven mature technology

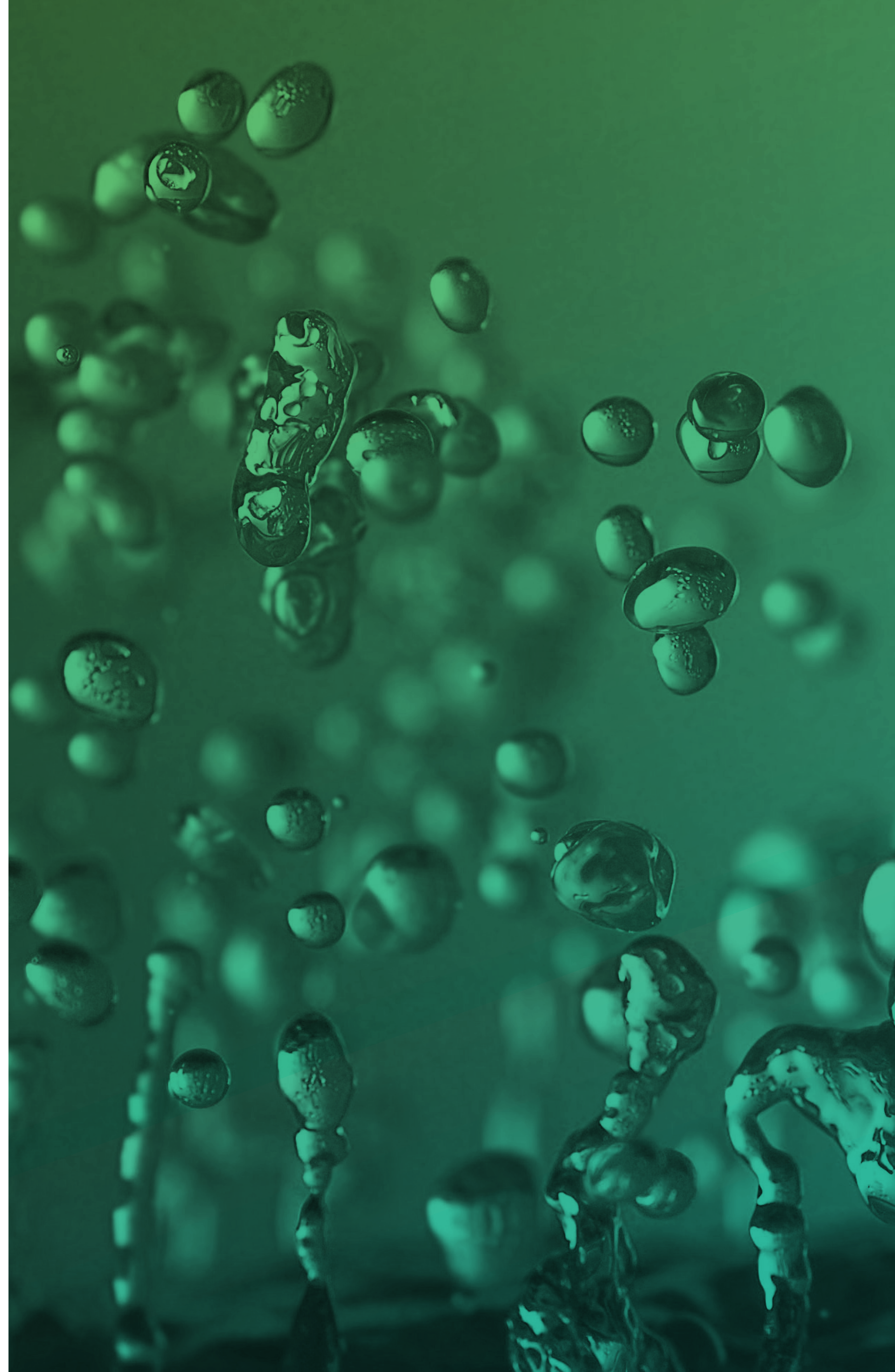
The alkaline water electrolyzer is an electrochemical reactor that decomposes water into hydrogen and oxygen gases using electric energy. The reaction takes place in the electrolytic cell, it is composed of two electrodes (anode and cathode) separated by a diaphragm immersed into a liquid alkaline electrolyte (solution of demi water and potassium hydroxide). Hydrogen is produced on the cathode side, while oxygen is produced on the anode surface. During the reaction, the separation of the two gases is guaranteed by the diaphragm that simultaneously allows the hydroxide ions (OH⁻) transport from the cathode to the anode.

To improve the overall efficiency of the reaction, catalyst layers are deposited on both electrodes.

Alkaline Water Electrolysis is known as the principal process for the water splitting reaction; due to its wide applications, also in large-scale plants, it has proven to be the **most mature** technology that can guarantee **reliable performances** upfront **low initial investment and maintenance cost**.

Nevertheless, AWE technology shows few limitations such as: low current density, slow dynamic response to load variation, limited flexibility and large overall footprint.

De Nora changed the rules, enhancing a consolidated technology. AWE technology evolve into a boosted AWE, allowing a new perspective for the most mature electrolysis process, boosted without renouce to reliability, low maintenance and intitial investment effort.



to... De Nora boosted AWE

*A boost to technology,
a new evolution*

De Nora loves to break the rules, and the new, empowered technology, is a perfect example of our approach. Our target is to facilitate the energy transition through green hydrogen, is to ensure competitive prices too. Initial investment could be a barrier for companies that are thinking to decarbonize part/or all their processes, so a mature technology, just like the classical AWE, is the starting point to smash its limitation and push the technological level more than a step forward. The De Nora's technology is the evolution of Alkaline Water Electrolysis.

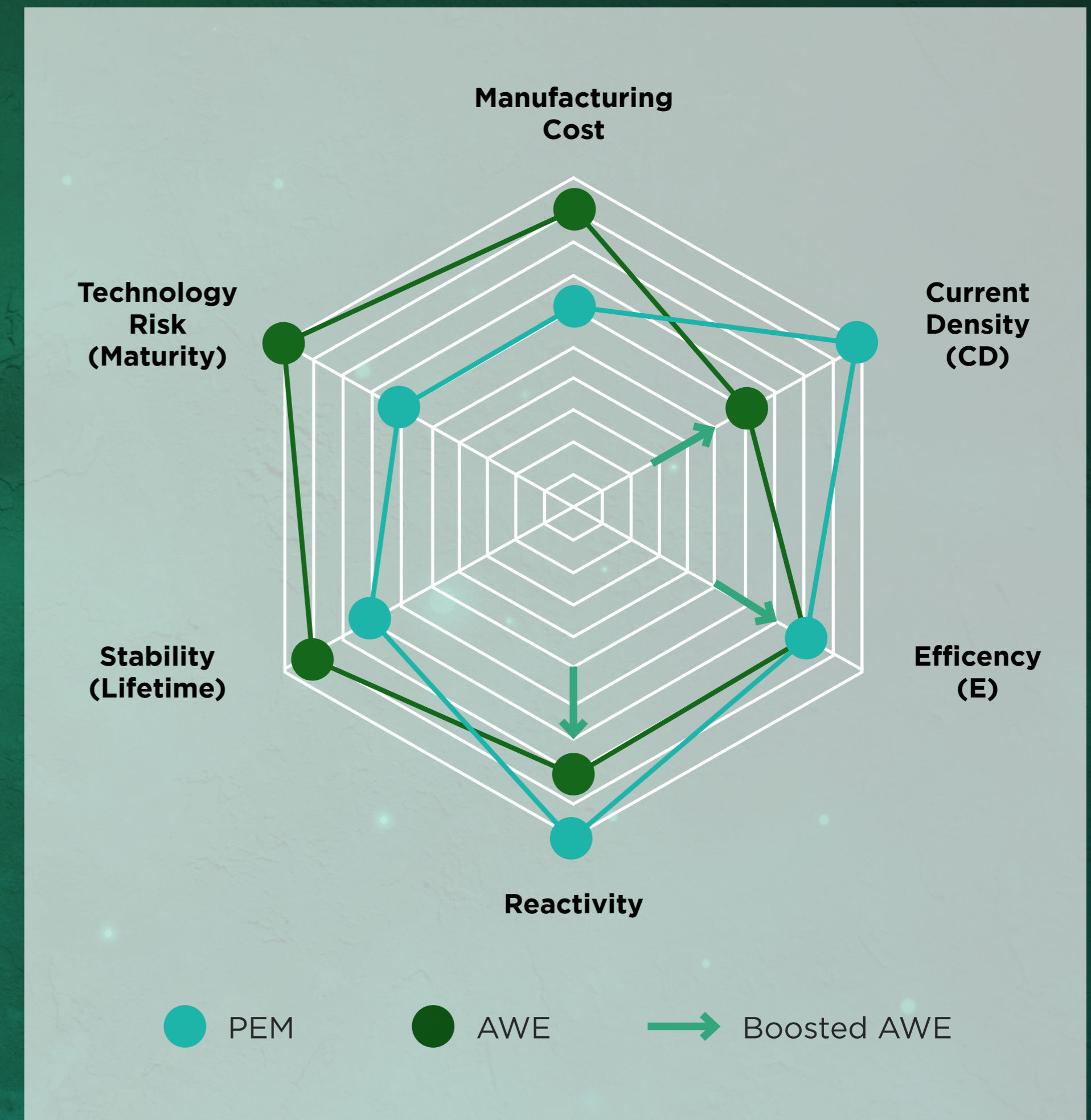
Starting from the alkaline technology strengths such as:

- **Reliability**
- **Efficiency**
- **Moderate initial cost**
- **Low operative costs**

The De Nora's boosted AWE offers other improvements:

- **High efficiency**
High-performing electrode coatings combined with new cell design increase the reaction efficiency allowing a reduction of the operational cost (energy saving).
- **Augmented Current Density**
It can be translated into a substantial reduction of the stack footprint and of the initial investment.
- **High flexibility**
A wider operational range.
- **Rapid Dynamic**
High capability to respond to load variation, for the coupling with RES.

De Nora's high-performing electrode coating technology is completely Noble Metals-free and this allows a reduction of the initial investment cost and of the further refurbishment costs.





Dragonfly[®] System

Ready to Evolve

PROCESS SHELTER

ELECTRO-INSTRUMENTAL SHELTER

Innovative Cooling System

ALL ON BOARD
All ancillaries included

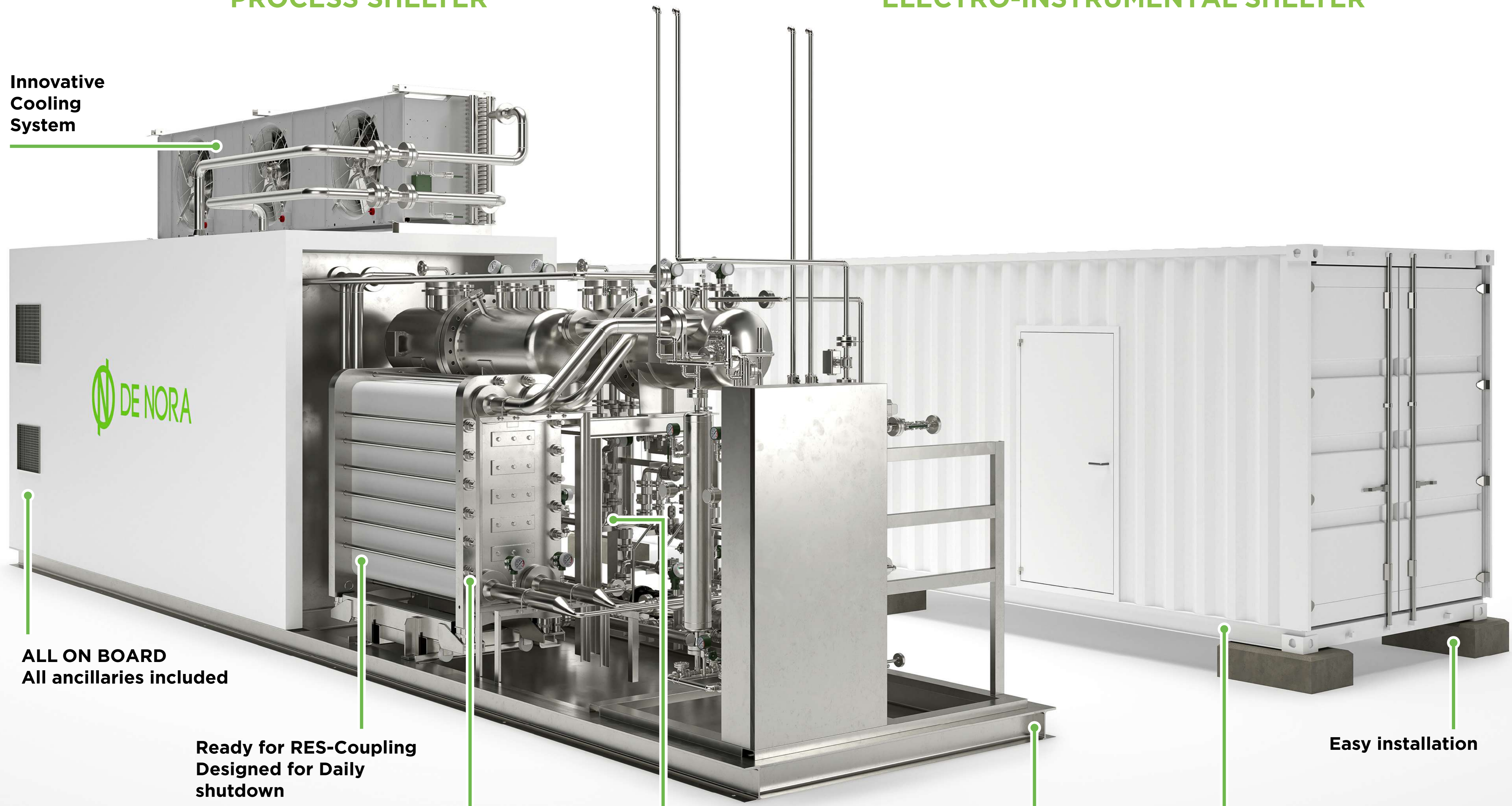
Ready for RES-Coupling
Designed for Daily shutdown

High Efficiency electrodes
for improved energy consumption and wide operational range

Simplified BoP
for rapid response to load variations

Shelter with Standard Container dimension
for an easier transportation

Easy installation





Dragonfly[®] System

Evolved turn-key solution

Dragonfly[®] System is a completely integrated hydrogen generation unit developed by De Nora as a natural evolution of the widespread expertise demonstrated in designing and producing electrodes for the major AWE OEMs. It was born from the need to have an electrolyzer that could fully exploit the potential of the De Nora electrodes and was born responding to the most special needs of customers.

It's a small-sized containerized alkaline water electrolysis unit designed to be easily installed at the user facility and operated even by those users who are not particularly familiar with this type of process. These characteristics make it applicable in all the sectors that require in situ hydrogen generation, such as: fine chemical, pharma, biogas upgrading, oleochemistry, refinery, mobility...

The unit, thanks to its **pressurized design**, can generate H₂ and O₂ at a design pressure of 30 bar, which is already suitable for most industrial applications without any additional compression step.

“Dragonfly[®] System” is a **turn-key solution** with all the utilities needed for its operation already included:

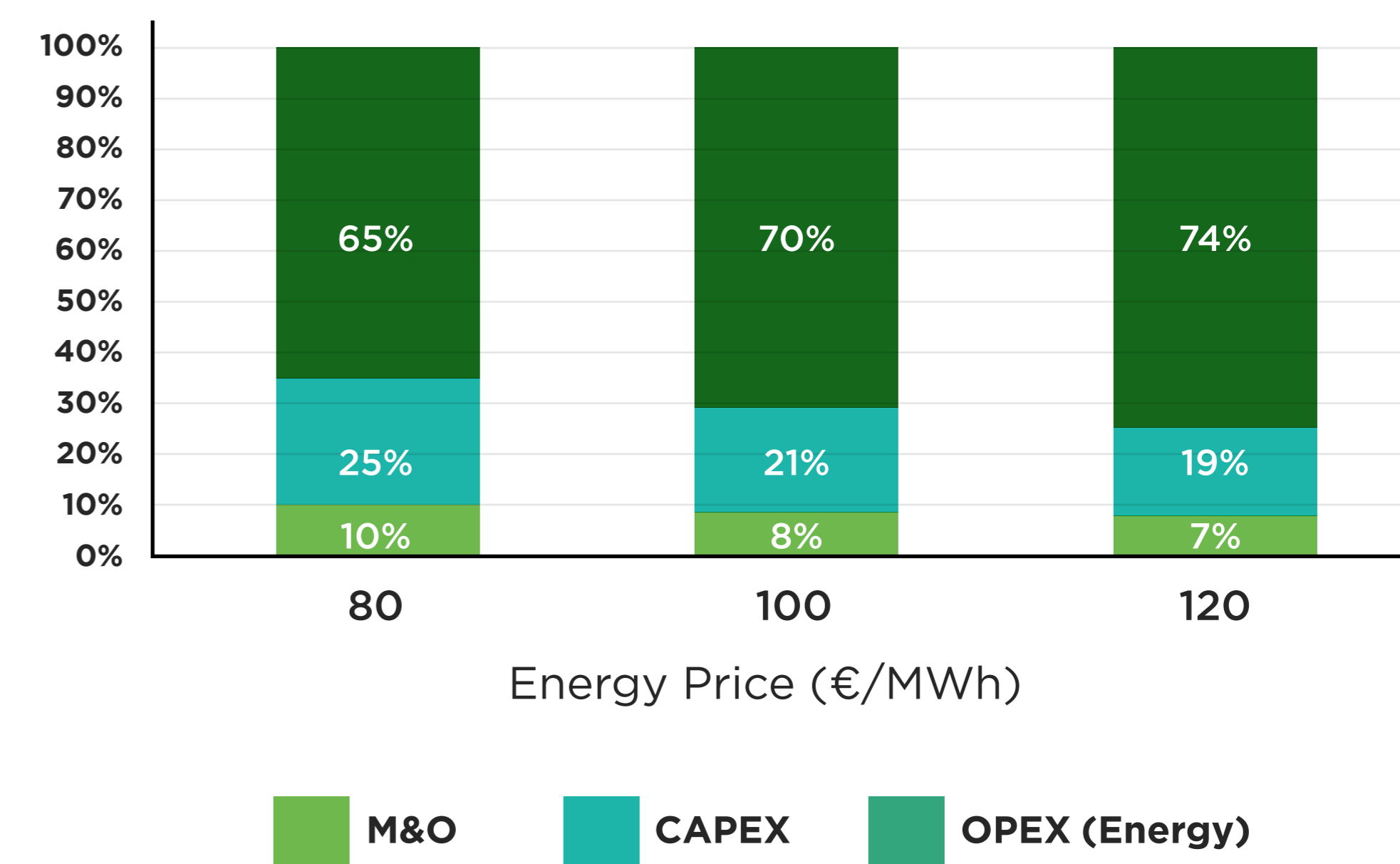
- Transformer/rectifier
- Water Treatment Unit
- Nitrogen generation Unit (for purging)
- Compressed air generation unit (for instruments)
- Dehumidifier
- H₂ secondary treatment system (DeOxO) optional
- Cooling system

Power and water: ready to generate hydrogen!
Nothing more than power and water supply is needed to operate the Dragonfly unit.

“Dragonfly[®] System” is an innovative hydrogen generation unit designed with the aim to reduce the TCO:

- **Initial investment:** Thanks to its high current density and footprint, material consumption can be sensitively reduced. In addition, all the De Nora solutions do not use Noble Metals as a catalyst.
- **Maintenance Cost:** The simplified BoP and EoL electrodes refurbishment reduces maintenance cost
- **Operational Cost:** the high efficiency which characterized the system can be translated into power consumption savings.

TCO main factors





Characteristics

Pressurized

- Design pressure: 30 bar

High current density

- Up to 12 kA/m²

High reliability

High flexibility

- Wider operational range
- Coupling with RES
- Rapid response to load variations

High-efficiency electrodes

- Reduced specific power consumption

Simplified BoP

- Reduced KOH loop
- Dedicated cooling circuit

Fully containerized

- For outdoor applications

Optimized transportation costs

- STD containers

Minimized installation costs

- Turnkey solution
- Low impact civil works

Ease of maintenance

- Minimized maintenance cost
- Electrodes refurbishment service

Customizable

- A bespoke project to satisfy customer needs





Dragonfly[®] System

*High performance
containerized Electrolyzer*

All Utilities onboard:

- Transformer/Rectifier Unit
- Water Treatment Unit
- Nitrogen Generation Unit
- Instrumental Air Generation Unit
- H₂ Treatment Unit (DeOxO) optional
- Cooling System

All Pertaining Safety Systems:

- In line gas analyzers (hydrogen/oxygen)
- Gas leakage detection system
- Forced ventilation unit
- UPS unit for safety system autonomy





Design and performance data

Unit size	1 MW	7,5 MW
Nominal Power for electrolysis (kW)	1000	4000 - 7500
Hydrogen Production (Nm ³ /h) @ Nominal load	190 - 210*	840 - 1500*
Oxygen Production (Nm ³ /h) @ Nominal load	95 - 105*	420 - 750*
Hydrogen purity (dry gas basis @ Nominal load)	> 99,8%*	> 99,8%*
Oxygen purity (dry gas basis @ Nominal load)	> 99,5%*	> 99,5%*
Load Range**	20 -120%*	20 - 120%*
Specific Power Consumption (kWh/kg) @ Nominal load	*53,3 - 54,2*	*53,6 - 55,2*
Operating Pressure (barg)	30*	30*
Operating Temperature (°C)	< 90	< 90
Power Supply	MV/LV	MV/LV
Ancillaries Power Consumption (kW)	50 MAX	350 MAX
Operating Current density (kA/m ²)	Up to 12.0, depending on specific needs and characteristics of the downstream sections	Up to 12.0, depending on specific needs and characteristics of the downstream sections

* Depending on System configuration

** Based on hydrogen production rate @ Nominal load



Services

Our expertise enhances the user experience of high-performance products. De Nora supports your business in all product life cycle.

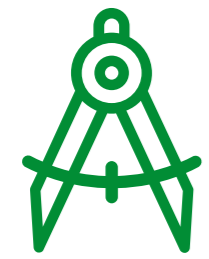
BUSINESS CONTINUITY



Remote monitoring & online support

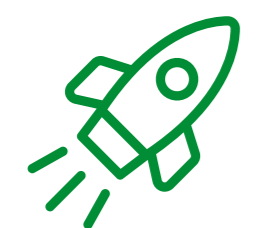


Longterm supply & maintenance agreements

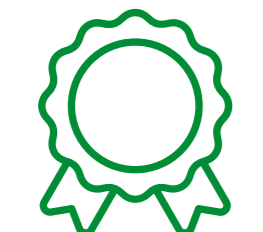


Tailored solutions & engineering design

ADDED VALUE



Performance enhancement



Product quality improvement



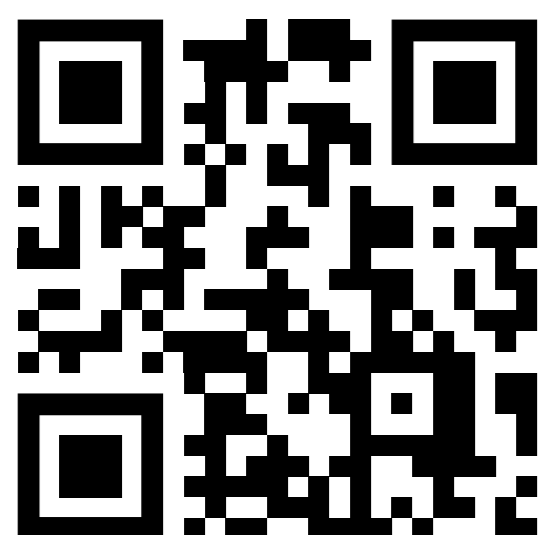
Environmental sustainable solution

Contact Us

service.etr@denora.com



Discover more



Get in touch
with us

www.denora.com

**Dragonfly® System Brochure
ETR-DF2402001**

De Nora reserves the right to modify the data in this document at any time and without notice.
Any reproduction, even partial, is prohibited.