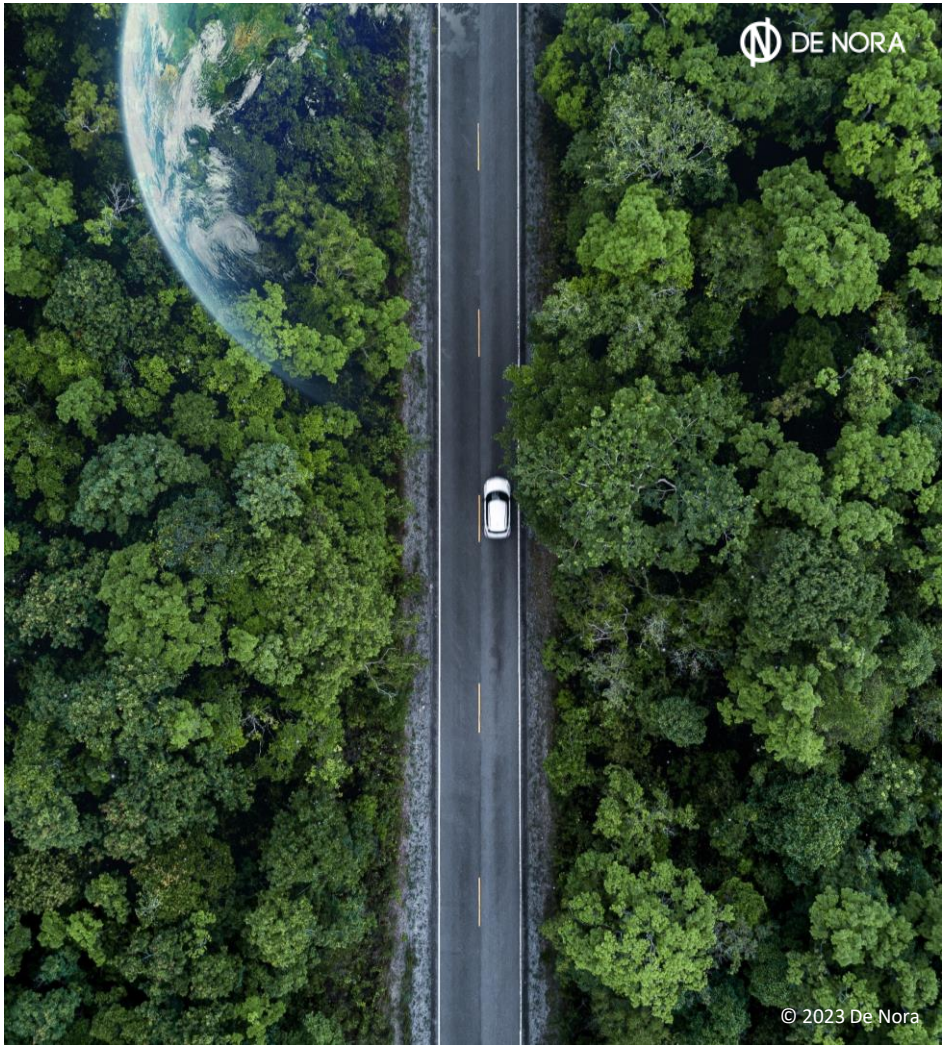
© 2023 De Nora

ABOUT US

Since 1923, we have been providing the most effective, efficient, reliable, and technologically advanced **solutions for the electrochemical, energy and water industries**.

To achieve our goals, we carefully listen to the needs of our customers and the global society by improving and delivering innovative products to solve today's problems for a better tomorrow.



DE NORA TODAY

The world's largest supplier of high-performing coatings and **electrodes** for industrial applications.

Leader in emerging sustainable technologies, and with a key role in **energy** transition.

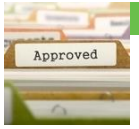
Recognized provider of disinfection and filtration solutions for **water** and wastewater treatment.

DE NORA TODAY

€852.8m
2022 Revenues

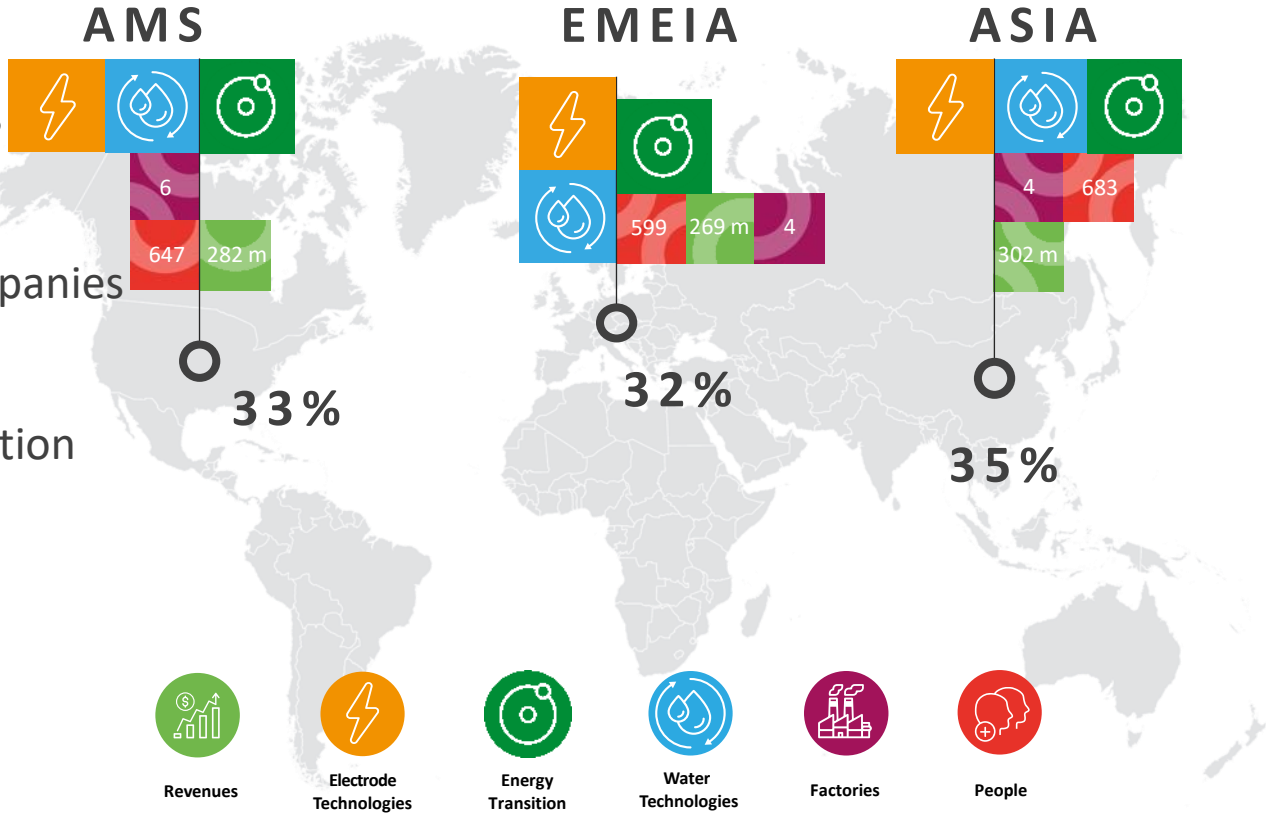
25
Operating companies

100
Years of innovation



260+
Patent families

1.900+
People



FY 2022

© 2023 De Nora

Purpose, Vision & Mission

PURPOSE

Empower collaboration and champion resilience

VISION

Leverage available talents as catalyst for a sustainable future

MISSION

Agility & green technologies for value creation

© 2023 De Nora

Sustainability is in our DNA

DE NORA

Environmental, Social, and Governance factors (ESG factors) at the core of De Nora's values and strategy.

Committed to contributing to achieving the Sustainable Development Goals (SDGs) defined in the United Nations 2030 Agenda.

© 2023 De Nora

Timeline

Outstanding track record of organic growth, supported by several innovative technological breakthroughs and successful transformational M&A activities

© 2023 De Nora

Businesses Overview

A comprehensive portfolio of mission-critical solutions and high-value-added aftermarket services.

- **Electrode Technologies**
- **Energy Transition**
- **Water Technologies**

© 2023 De Nora

DE NORA EVERYWHERE: END MARKETS & APPLICATIONS

Commercial & Institutional Buildings

Industry / Chemicals

Commercial & Institutional Buildings

Power and Energy

Communication & Smart Techonologies

Mobility

Consumer lifestyle

Energy Storage & Transportation

Infrastructure/Municipal Infrastructure

Mobility

Infrastructure/Municipal Infrastructure

Electrode Technologies

Energy Transition

Water Technologies

© 2023 De Nora

Energy Transition

Global leader in Technologies for Green Hydrogen production

Energy Transition applications are the natural extension of the Electrode Technologies business.

Products: DSA® electrodes for Alkaline Water Electrolysis (AWE), electrolysis cells, Gas Diffusion Electrodes (GDE) for fuel cells.

Services: electrodes manufacturing, recoating and repair, spare parts, supply and maintenance agreements, engineering design, joint development.

© 2023 De Nora

DE NORA

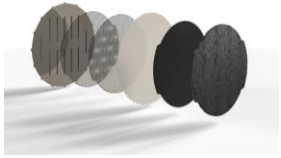
MAIN APPLICATIONS

Energy Storage

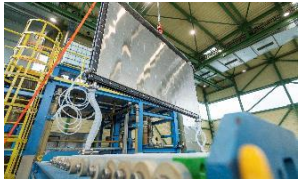
Green Chemicals

Mobility

PORTFOLIO



Electrodes for Alkaline Water Electrolysis (AWE)



Electrolysis Cells

Stacks for AWE

Gas Diffusion Electrodes for fuel cells

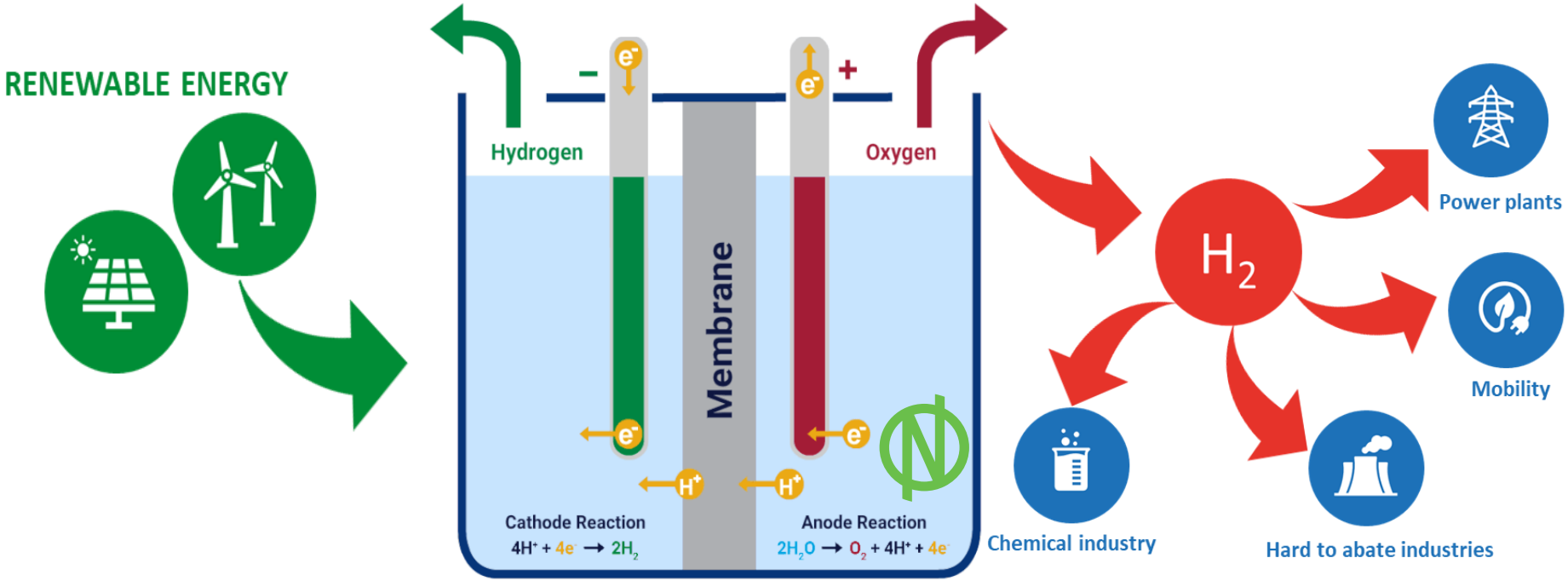
© 2023 De Nora

ENERGY TRANSITION

DE NORA

Green Hydrogen Value Chain

"Electrocatalysis at the heart of the Green Hydrogen Revolution"



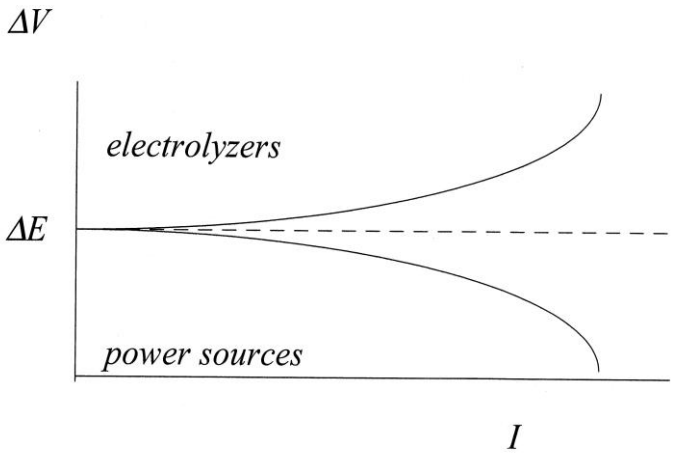
© 2023 De Nora

ENERGY TRANSITION

Hydrogen & Oxygen Evolution

Electrochemical Polarization

$\Delta V = \Delta E \pm$ overpotentials



Basic V-I curve

$$V_{cell} = C' + k'*j + k'' * \log(j)$$

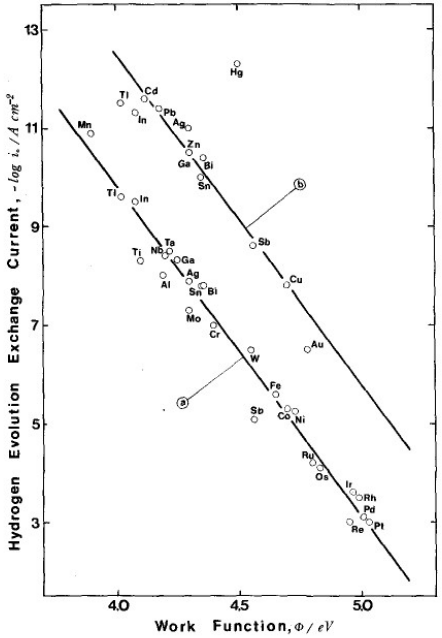
Sum of the cathodic and anodic equilibrium and over-potential

Sum of the anodic and cathodic "Tafel-Slopes"

Voltage drop of an electrochemical cell related to resistors following the Ohmic law (e.g., separator, electrolyte, contact losses)

© 2023 De Nora

Hydrogen Evolution



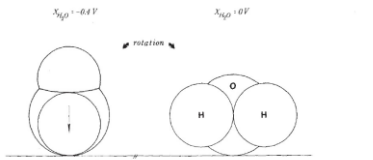


Fig. 2. Scale drawing of water molecule in position of (a) maximum, (b) minimum orientation suggested as occurring on positively and negatively charged metal surfaces, respectively. χ is surface potential resulting from the given orientation.

Fig. 1. Exchange currents for electrolytic hydrogen evolution (column (3), Table 1) *vs.* values of the work function of metals (column (4), Table 1).

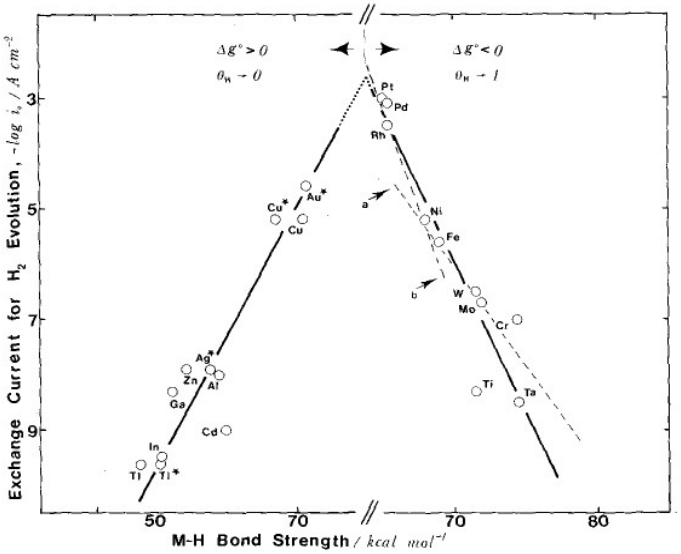


Fig. 4. Exchange currents for electrolytic hydrogen evolution *vs.* strength of metal–hydrogen bond derived from heat of hydride formation[124] in the case of *sp* metals, and from heat of adsorption from gas phase[123] in the case of transition metals. Starred values refer to spectroscopic dissociation heat[18]. Value of adsorption heat for W from Eley and Norton[151]. Δg^0 is standard free energy of hydrogen adsorption. θ_H is surface coverage with atomic hydrogen. Arrows indicate theoretical slopes[110] for (a) ion + atom, (b) combination reaction. As for the X-axis scale, see text.

[3] Trasatti S. *J. Electroanal. Chem.*, **1972**, Volume 39, Issue 1, 163-184

© 2023 De Nora

ENERGY TRANSITION

Hydrogen Evolution

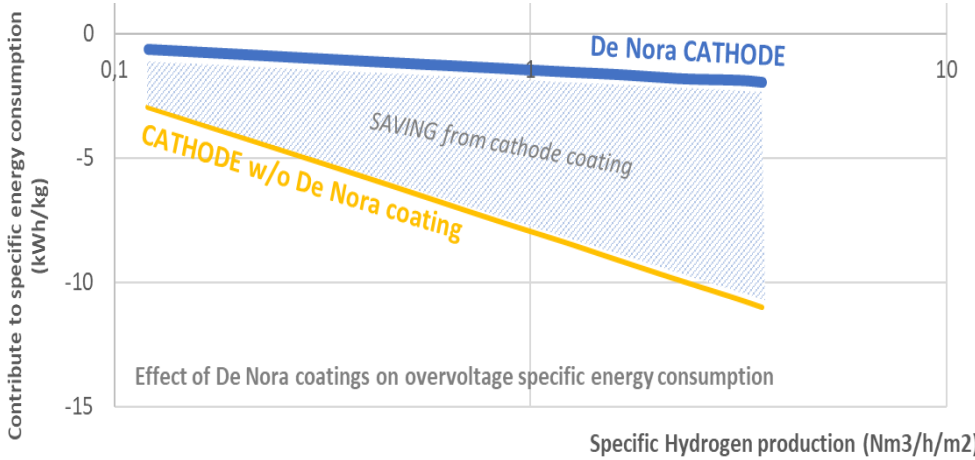
De Nora coating portfolio includes cathode for hydrogen evolution as the well known NRG® cathodes family:

examples of Mixed Metal Oxide coatings were the combination between **noble metals** and **rate earth** oxides enable the turnover of the catalytic site high performing and long lasting for both C/A and water electrolysis application

NRG®

cathodes for Hydrogen generation products

- Pt-Pr
- Ru-Ce
- Ru-Pr
- Ru-Pt-Pr



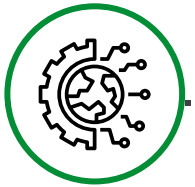
The best catalyst for hydrogen evolution is the one that best balance the adsorption of H atom with the desorption of the H_2 molecule onto the substrate

© 2023 De Nora

ENERGY TRANSITION

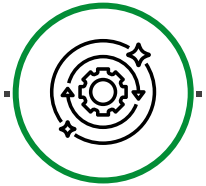
Anodes and Cathodes

De Nora proprietary electrodes enable **higher hydrogen & oxygen production rates** at any specific energy consumption



Higher current density

Reduced power consumption



More compact installations

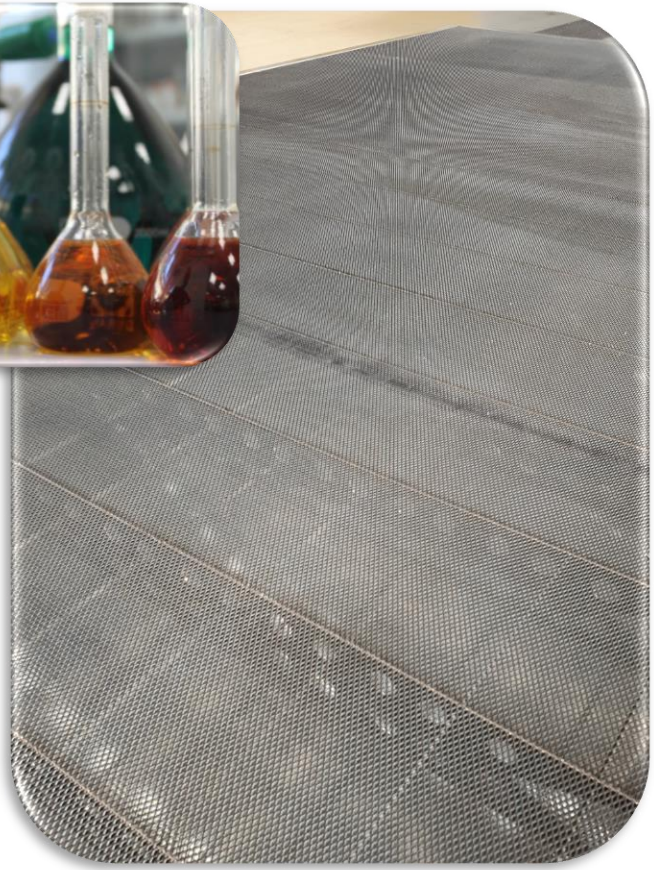
Improved lifetime and stability

© 2023 De Nora

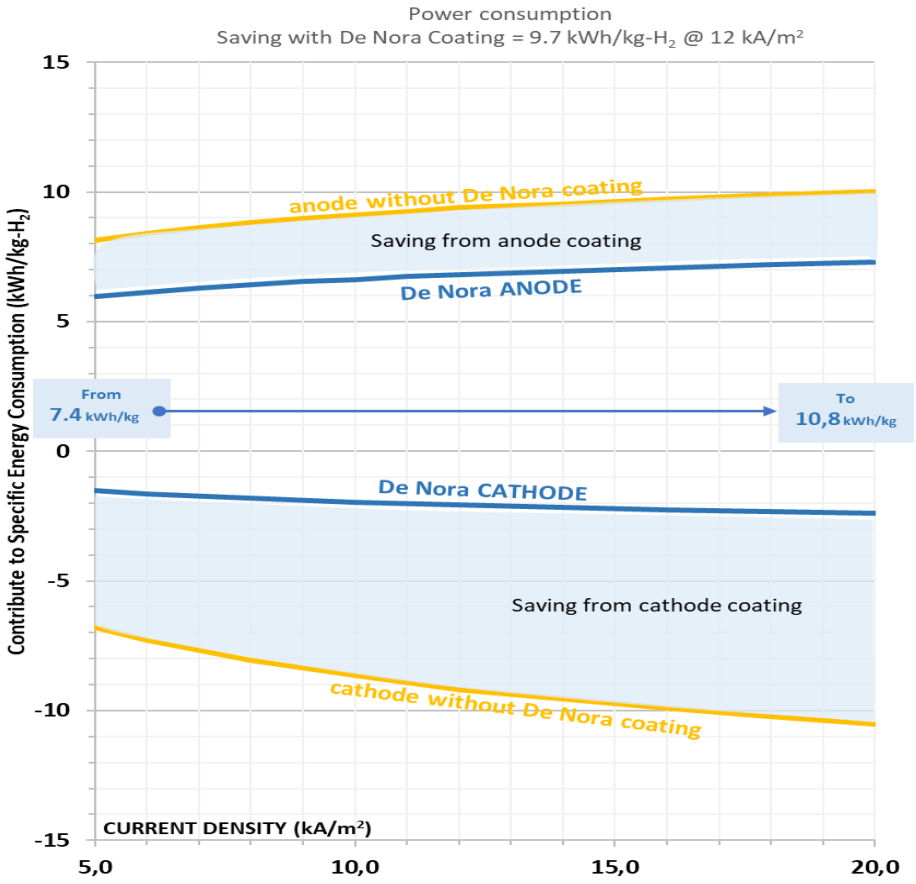
DE NORA

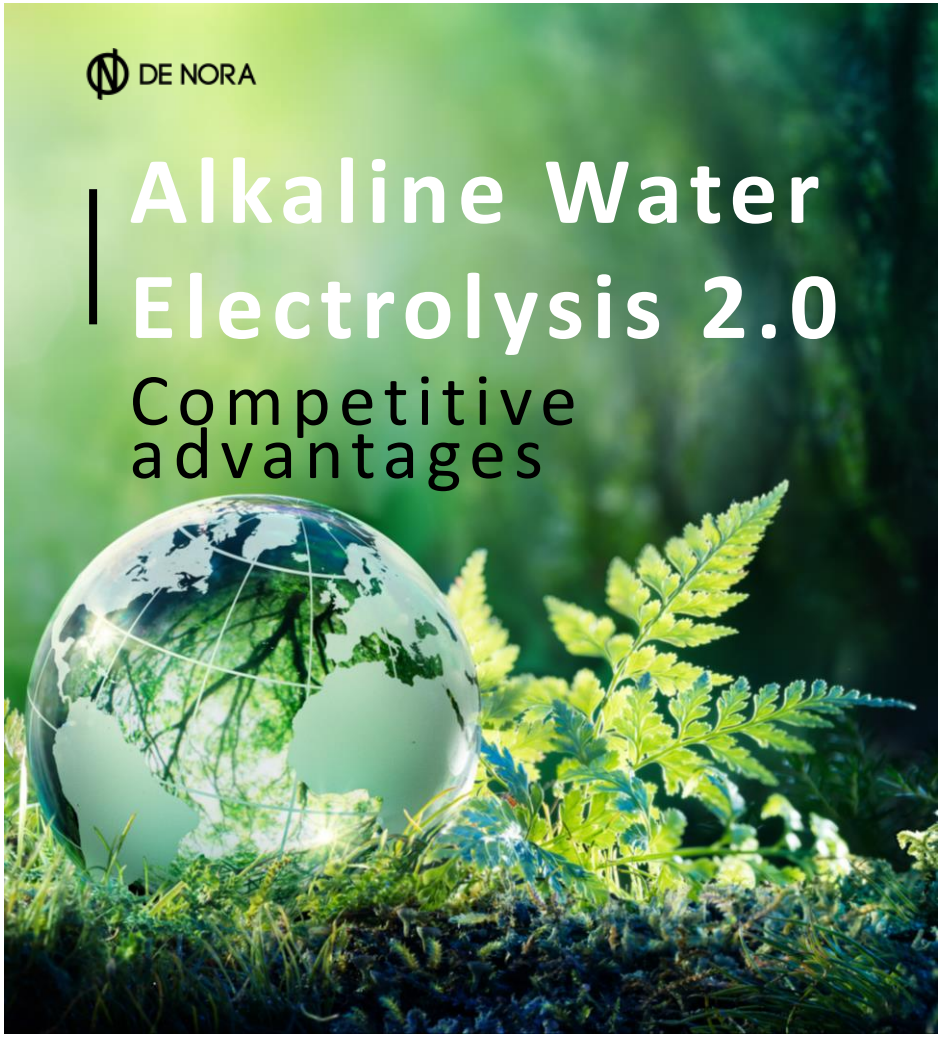
Alkaline Water Electrolysis vs. Alkaline Water Electrolysis 2.0

Coating



DSA®
Electrodes



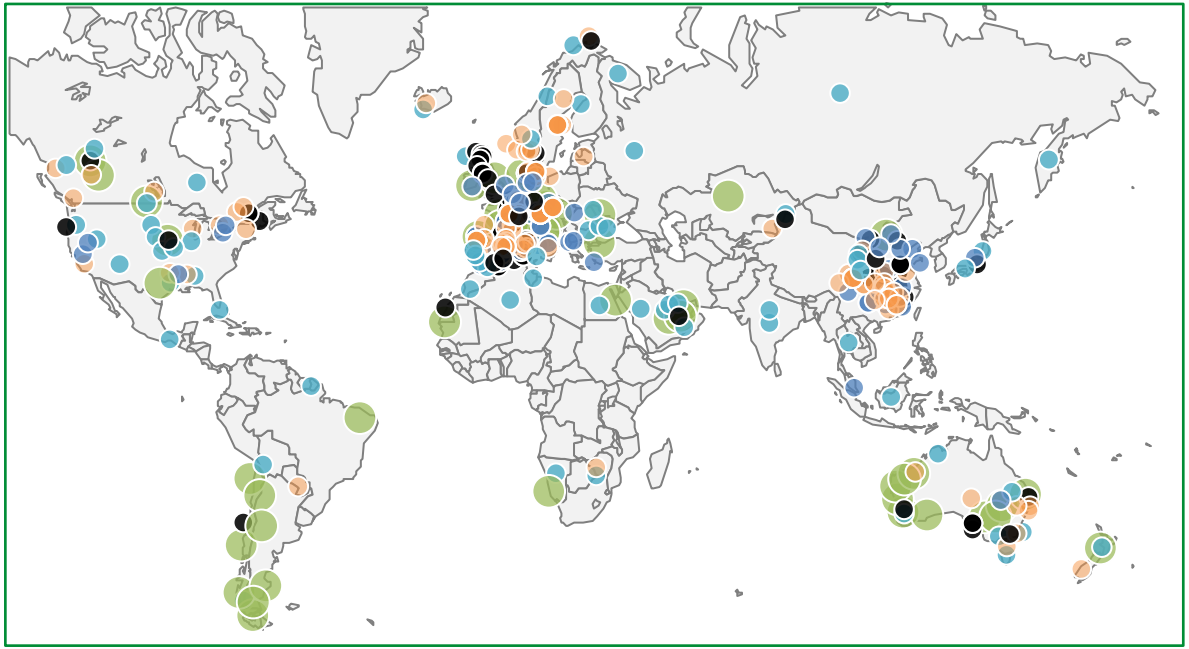

DE NORA
Alkaline Water Electrolysis 2.0
Competitive advantages

© 2023 De Nora

IN 2022 HYDROGEN PROJECTS PIPELINE GREW TO 680 PROJECTS BUT ONLY 10% HAVE TAKEN THE FINAL INVESTMENT DECISION (FID)

DE NORA

Hydrogen Projects Announced Worldwide (2022)



- 51 **Giga-scale production**
  Green hydrogen projects >1 GW
- 262 **Large-scale industrial usage**
  Refinery, ammonia, methanol, steel
- 128 **Transport**
  Trains, ships, trucks, cars, etc
- 40 **Infrastructure projects**
  Distribution, transportation, storage
- 53 **Integrated hydrogen economy**
  Cross-industry, various types of end-uses

Source: Hydrogen Council (November 2022). Focus on large-scale projects including commissioning after 2030, >1,000 small scale projects and project proposals not included.

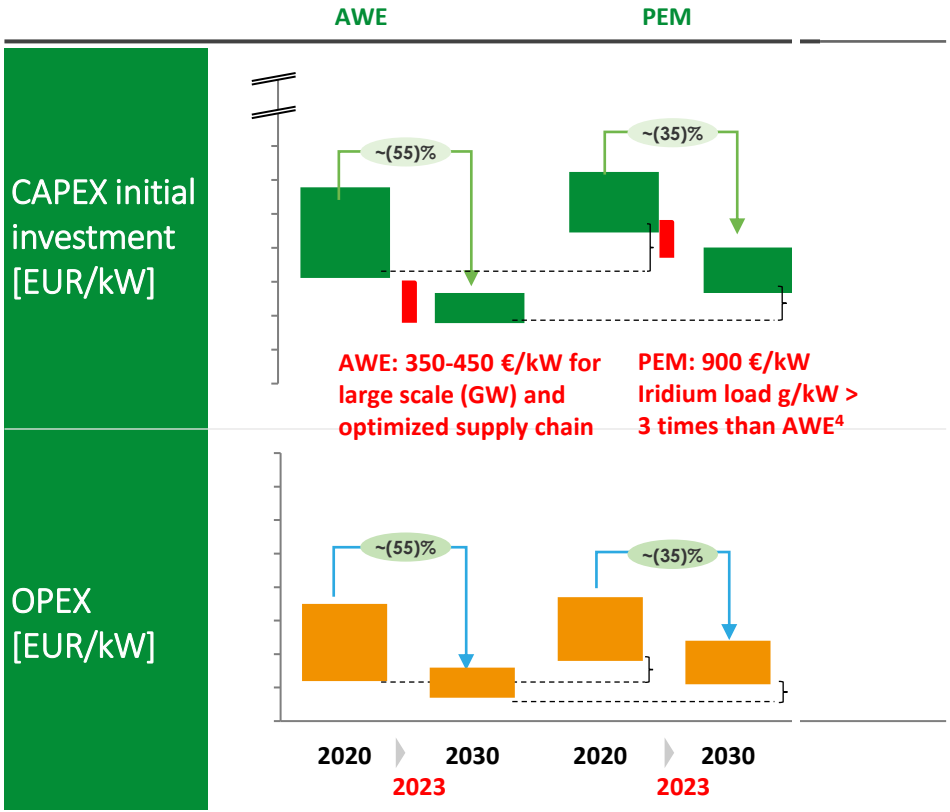
De Nora is making up a significant share of the 10% of post-FID projects, with its involvement in the largest projects in Europe and around the world

ADVANCED AWE HAS OVERALL ADVANTAGES AND IS THE PREFERRED CHOICE FOR LARGE-SCALE GREEN HYDROGEN

DE NORA

	Commercial Technologies	
	Advanced AWE Alkaline Water Electrolysis	PEM Polymer Electrolyte Membrane WE
Readiness Level	Commercial, high reliability	Commercial
Stack size	Largest capacity by tk nucera 20 MW Electrolyzer	Limitation in large scale due to smaller stack sizes (ITM 0,66MW; Plug Power 1MW; Cummins up to 2MW; Siemens 0,73MW)
Power Consumption	4.55 kWh/Normal m^3 H_2 i.e., tk nucera	5.2 kWh/Normal m^3 H_2 i.e., Plug Power
Pros	✓ **High efficiency** ✓ **Low capex cost** ✓ **Low cost of construction materials** ✓ **Highly synergetic with Renewable Energy**[1]	✓ Rapid response (stack) to variable loads ✓ High gas purity ✓ High flexible operations
Cons	× Lower gas purity × Use of 30% KOH	× High CAPEX cost × Noble Metal- based catalyst and protective coatings × Expensive construction materials × Lower durability × Lower efficiency × Membranes based on Perfluorinated compounds (PFAS)

ADVANCED AWE DELIVERS HYDROGEN AT THE LOWEST COST



Key highlights

- Technology development driving LCOH[1] reduction
- Advanced AWE technology most convenient (CAPEX and OPEX) even in the future: raw materials cost and maintenance costs as key drivers
- PEM current Iridium load g/kW > 3 times than AWE[2]

[1] Levelized Cost of Hydrogen

[2] Fraunhofer ISE November 2021

© 2023 De Nora

ADVANCED AWE HAS OVERALL ADVANTAGES AND IS THE PREFERRED CHOICE FOR LARGE-SCALE GREEN HYDROGEN

DE NORA

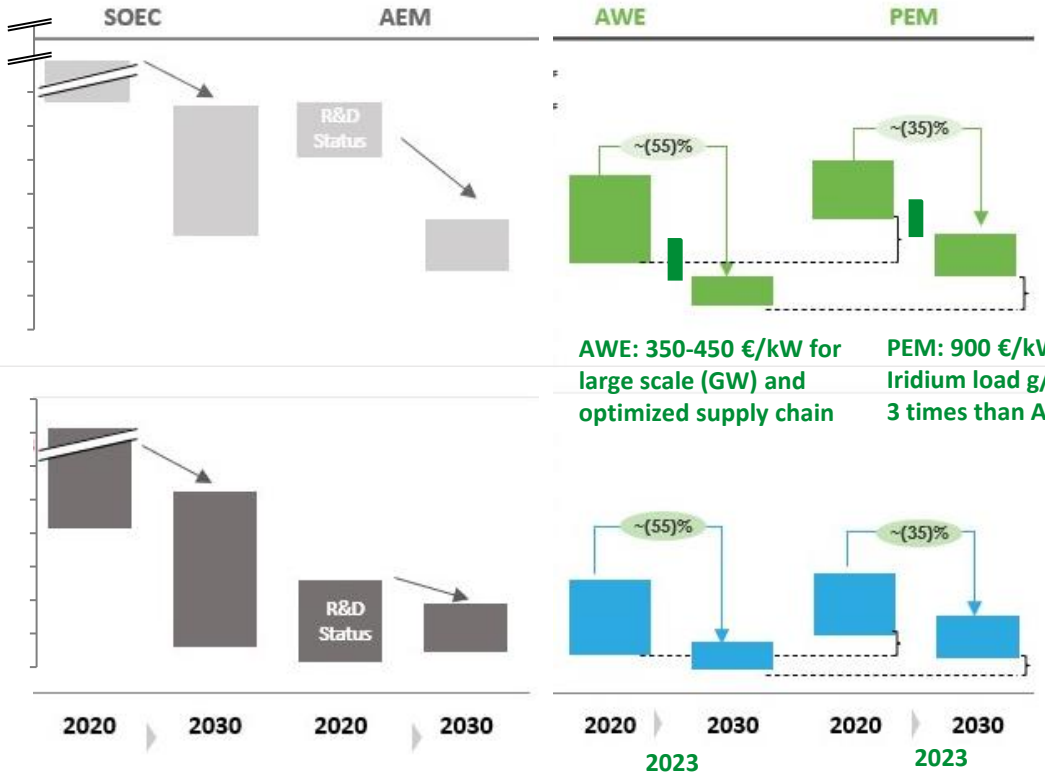
	R&D Phase	
	SOEC Solid Oxide Electrolyser Cells	AEM Anion Exchange Membrane
Pros	✓ Higher overall system efficiency ✓ Can recover waste heat / steam	✓ Highly flexible operations ✓ High gas purity ✓ Rapid response to variable loads ✓ Less corrosive electrolyte ✓ Non noble metals based coating ✓ Low cost of construction materials
Cons	✗ R&D phase ✗ Low dynamics ✗ Long start up and shut down times ✗ High temperature operations ✗ Materials corrosion	✗ R&D phase ✗ AEM durability ✗ Membrane conductivity

ADVANCED AWE DELIVERS HYDROGEN AT THE LOWEST COST

DE NORA

CAPEX initial investment [EUR/kW]

OPEX [EUR/kW]



Key highlights

- Cost development estimations on SOEC and AEM are illustrative since they are still in R&D status
- Advanced AWE confirmed to be the most convenient even in the future

[1] Levelized Cost of Hydrogen
[2] Fraunhofer ISE November 2021

© 2023 De Nora

FORECASTS SEE ALKALINE INCREASE TO 50% MARKET SHARE BY 2050, UP FROM ORIGINALLY EXPECTED 30%

DE NORA

	AWE	PEM
Market share	AWE market penetration increase: 1) larger scale projects 2) lots to offer for future innovation 3) can deal with fluctuations in renewable energy	Downgrade PEM to 30%: 1) expert calls favoring alkaline for large-scale projects 2) Iridium content that may limit PEM to 27% penetration

Market share of above 50% (installed base) for AWE in this decade (internal research based on IEA)

© 2023 De Nora

© 2023 De Nora