

Anion exchange membrane (AEM) for cost-competitive water electrolysis by Evonik

Teaser presentation

Nov. 2021 | Patrick Borowski, Dr. Christian Däschlein, Dr. Franziska van Krüchten, Dr. Artjom Maljusch, Dr. Jeroen Ploegmakers



Disclaimer

To the best of our knowledge the information in this presentation was compiled from sources believed to be reliable for informational purposes only. All pieces of information in this presentation were summarized by Evonik Operations GmbH and should provide an actual overview of the status of our innovation technology and its business potential. All information is highly confidential. The partial reproduction or copy of it is only allowed after agreement with the Evonik Operations GmbH.

Evonik at a glance

Leading beyond chemistry to improve life, today and tomorrow



Source: Evonik Financial Report 2020

Green hydrogen will play a central role in a defossilized society achieving the climate targets of Germany and the EU

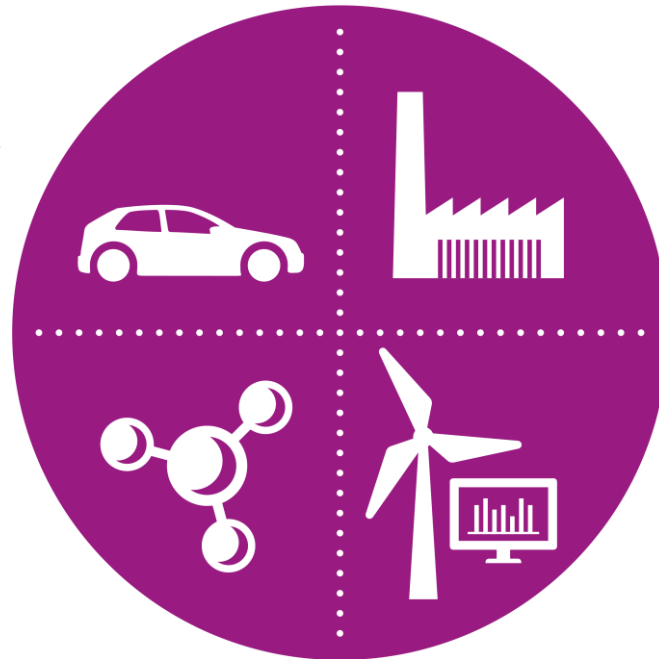
Current and future utilization of defossilized hydrogen

Mobility / Transportation

The use of green hydrogen or syn-fuels enables the defossilization of mobility and transportation.

Feedstock chem. Industry

Green hydrogen can reduce the carbon footprint of products from chem. industry.



Industry

Hydrogen as a reducing agent or as fuel in industrial processes can massively reduce CO₂ emissions.

Energy Management

Hydrogen can be used to store renewable energy and enable efficient energy management.

Our AEM technology with our DURAION[®] membrane will reduce the CAPEX and OPEX costs of electrolysis.

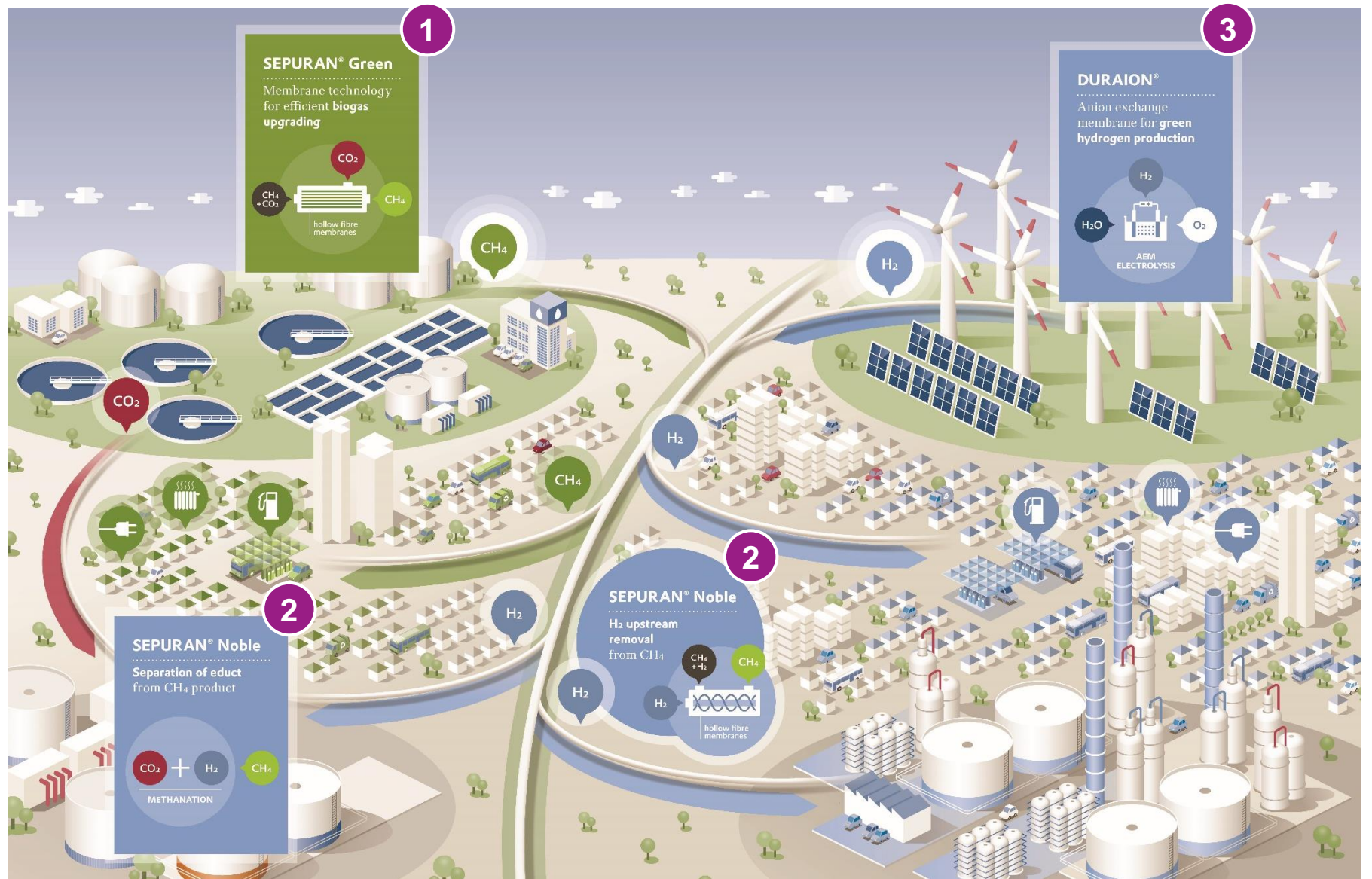
To meet the EU target to have 40 GW electrolysis capacity installed in land by 2030, the CAPEX and OPEX costs of electrolyzers must be reduced massively.

With our membrane technology, we significantly contribute to the transition to a sustainable gas economy

1. Raw biogas from organic waste is converted into **sustainable biomethane** and "green" CO₂
2. Our **hydrogen extraction membranes** enable to use **existing natural gas pipelines** to transport and extract green hydrogen




In the **production of synthetic biomethane** from CO₂ and green hydrogen, we ensure efficient product separation

3. With our anion exchange membrane DURAION®, we contribute to the **breakthrough of electrolytic production of green hydrogen** in the future



The anion exchange membrane (AEM) water electrolysis combines the benefits of PEM* & AEL* water electrolysis without their major drawbacks



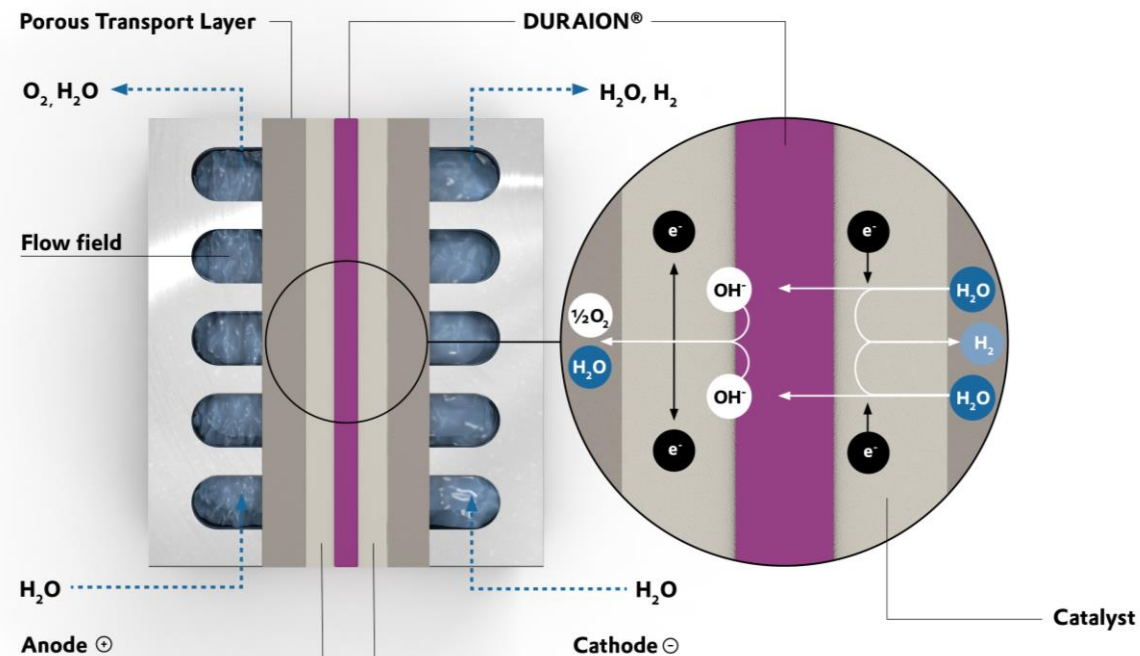
AEM electrolysis	PEM electrolysis	Alkaline electrolysis
<ul style="list-style-type: none"> High production rates Pressurized H₂ production Dynamic operation Inexpensive materials & electrodes 	<ul style="list-style-type: none"> High production rates Pressurized H₂ production Dynamic operation <i>Noble metal and titanium materials & electrodes</i> 	<ul style="list-style-type: none"> <i>Low production rates</i> <i>No pressurized H₂ production</i> <i>Unflexible operation</i> Inexpensive materials & electrodes
 <p>CAPEX Low OPEX Low</p>	 <p>CAPEX High OPEX Low</p>	 <p>CAPEX Low OPEX High</p>

AEM electrolysis – The best of two worlds!

*PEM: Proton exchange membrane | AEL: Alkaline electrolysis

The membrane is the heart of the electrolyzer: DURAION® pushing the performance of Evonik polymer and membrane competence

Schematic cell design of AEM electrolysis



DURAION®

Our performance promise



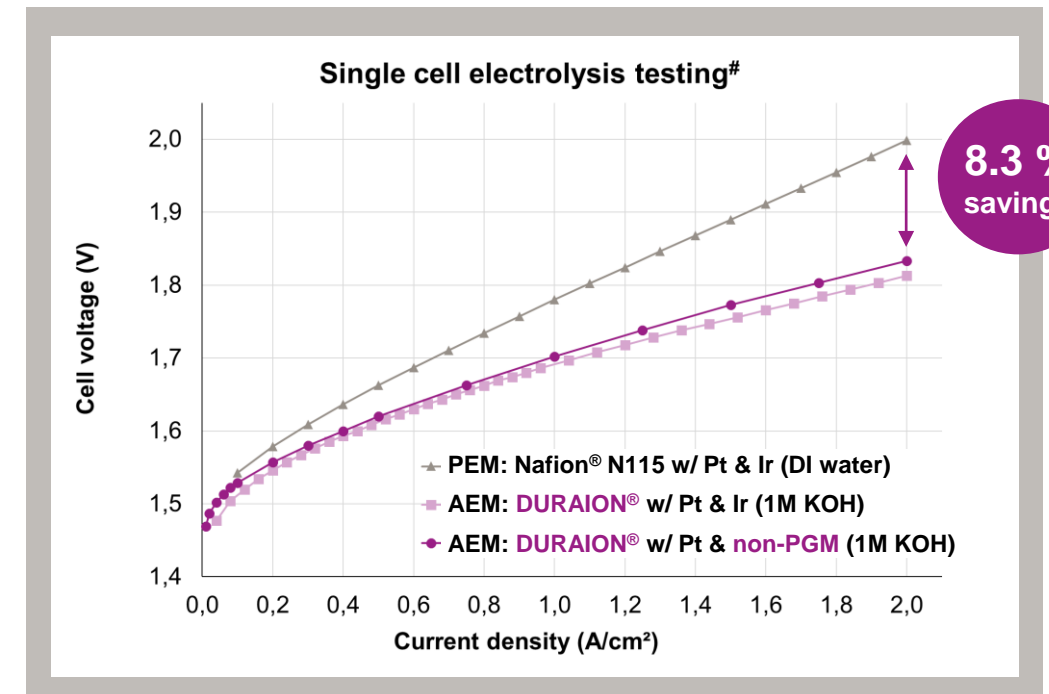
- Very high ionic conductivity
- Excellent chemical stability in aggressive media
- Distinguished mechanical integrity

The DURAION® membrane of Evonik meets the quality triangle of membrane-based water electrolysis

Experimental lab data indicates that DURAION® enables less operation costs compared to PEM electrolysis with a Nafion® membrane

Ex-situ and in-situ performance data of DURAION® in comparison to the PEM technology state-of-the-art Nafion® membrane

Property [Unit]	Nafion® N-115	DURAION®
Ionic conductivity# (mS/cm)	111*	108**
Water uptake# (wt. %)	14	13
Mechanical strength# (E-Modulus) (GPa)	0.08	0.4
Thickness (µm)	144	60
Hydrogen permeation*** (NmL*µm*min ⁻¹ cm ⁻²)	9.8	3.9



lab scale, single cell, 25 cm² active area, both electrodes fed by electrolyte, 60 °C, ambient pressure

* measured in H⁺ form, ** measured in OH⁻ form, *** hydrogen permeation at 35 bar H₂ pressure & at 40°C

DURAION® enables the cost-efficient production of green hydrogen via water electrolysis

Key Benefits of DURAION and the Evonik AEM technology



Best in class CAPEX ...



- ✓ No Ti, no Pt coated cell materials required
- ✓ No PMG electrodes required, especially Iridium

Best in class OPEX ...



- ✓ Highest current efficiencies compared to benchmark
- ✓ Possibility pressurized (30 bar), dynamic operation

Best in-class performance ...



- ✓ Very high ionic conductivity
- ✓ Excellent chemical stability in aggressive media
- ✓ Distinguished mechanical integrity

Best in class technology ...



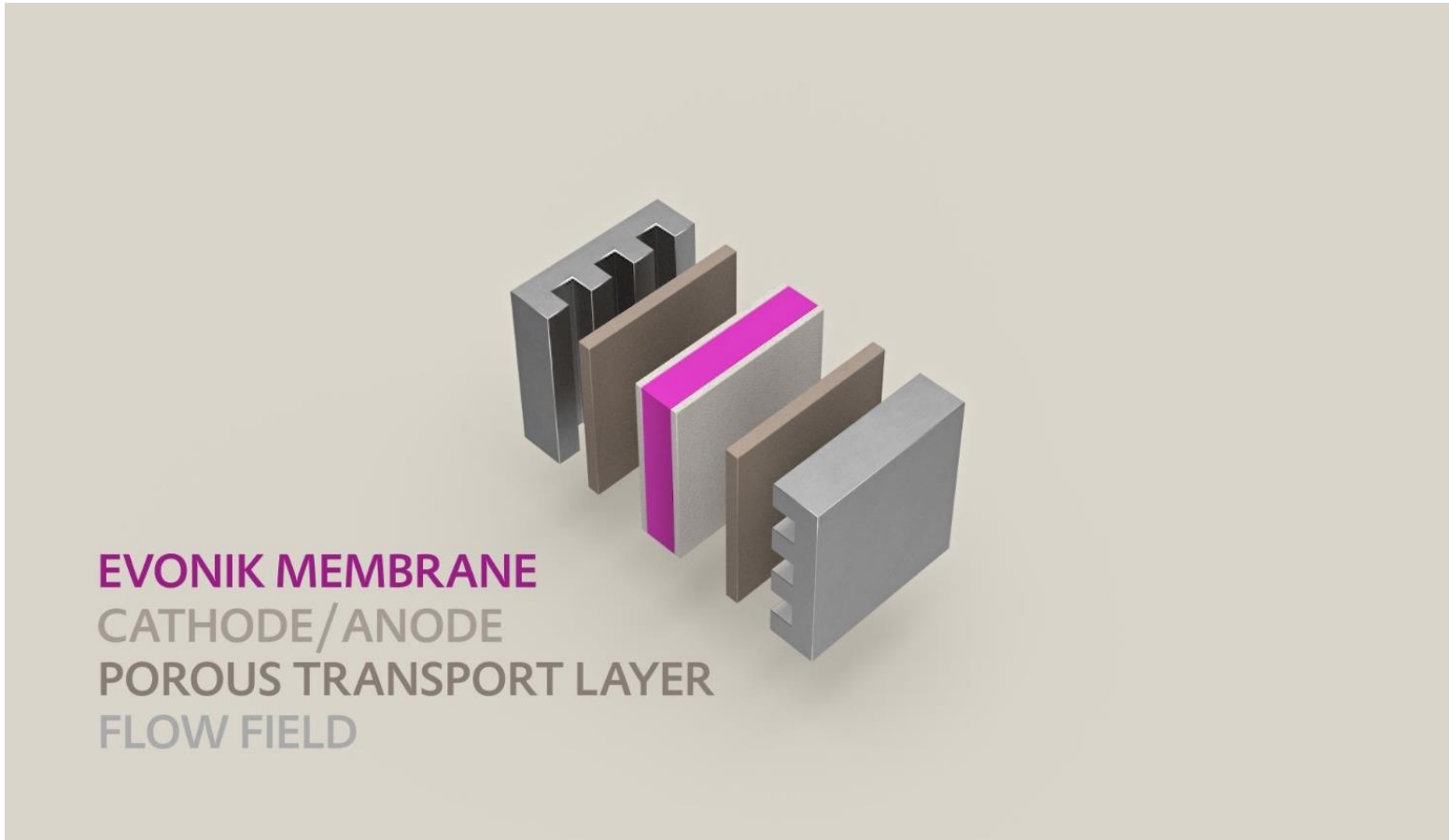
... to enable the cost-efficient production of green hydrogen!

Evonik guarantees scalable and customizable solutions based on our pronounced and backward-integrated monomer and polymer expertise.



Our polymer expertise makes us unique among the developers of anion exchange membranes.

Is there interest in further information?



Your contacts for further information

Dr. Artjom Maljusch

Technology Development AEM
artjom.maljusch@evonik.com

Dr. Christian Däschlein

Director Hydrogen Economy
christian.daeschlein@evonik.com



EVONIK

Leading Beyond Chemistry