



DECARBONIZING - VISION AND TECHNOLOGIES

TOPSOE

TOPSOE AT A GLANCE: OVER 80 YEARS OF INNOVATION AND LEADERSHIP

For more than 80 years, we have been guided by our purpose, 'Perfecting chemistry for a better world'. We work to deliver solutions that will leave the world in better shape for future generations.

Today, it is our ambition to lead the global transition of hard-to-abate sectors to a net zero future.

Thanks to decades of exceptional R&D, Topsoe is in a **unique position** to accelerate the transition to sustainable technologies.

#1

In renewable fuels

#1

In low carbon hydrogen

+2,500

Employees

\$1B

In revenue
(USD)

9%

Of revenues
invested in R&D

+500

Patent families

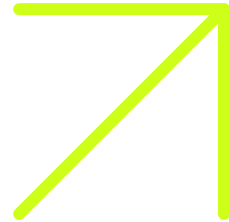


OUR VISION

**TO BE RECOGNIZED
AS THE GLOBAL LEADER
IN CARBON EMISSION
REDUCTION TECHNOLOGIES
BY 2024**



TOPSOE, WHAT WE DO



TOPSOE, WHAT WE DO

PRODUCTION AND SUPPLY OF CATALYSTS TO THE REFINERY AND PETROCHEMICAL INDUSTRY

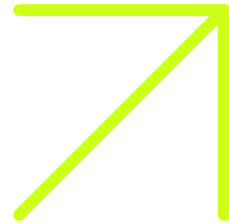
BASIC DESIGN AND LICENSING OF CHEMICAL PROCESSES BASED ON CATALYSIS

SUPPLY OF PROPRIETARY EQUIPMENT

IDENTIFY TECHNICAL SOLUTIONS

TECHNOLOGY COMPANY

TOPSOE, HOW WE DO IT



COMBINATION OF FUNDAMENTAL KNOWLEDGE,
MODELING FROM R&D, PILOT PLANTS AND
INDUSTRIAL PLANTS

TOPSOE, HOW WE DO IT

TOPSOE KNOWLEDGE IS APPLIED TO DEFINE
ENGINEERING SOLUTIONS

GOVERNING MTG REACTOR EQUATIONS

System of 16 coupled nonlinear PDEs:

$$\varepsilon \frac{\partial C_i}{\partial t} = -v_z \frac{\partial C_i}{\partial z} + D_{zi} \frac{\partial^2 C_i}{\partial z^2} + (1 - \varepsilon)R_i, i = 1, \dots, \text{NCOMP}$$

$$(\varepsilon \rho_f C_{pf} + (1 - \varepsilon) \rho_s C_{ps}) \frac{\partial T}{\partial t} = -v_z \rho_f C_{pf} \frac{\partial T}{\partial z} + K_{zi} \frac{\partial^2 T_i}{\partial z^2} + \sum_{i=1}^{\text{NREAC}} (-\Delta H_i) r_i (1 - \varepsilon) r_i a_{nr}^{y_i} a_r^{\delta_i}$$

$$-\frac{\partial a_r}{\partial t} = \frac{k_{Oxy}(T) \cdot y_{Oxy} \cdot y_A + k_O(T) \cdot y_O \cdot y_A + k_A(T) \cdot y_A^2}{1 + K_{H_2O} \cdot y_{H_2O}} \cdot a_r^{n1} \cdot a_{nr}^{n2}$$

$$-\frac{\partial a_{nr}}{\partial t} = \frac{k_{nr}(T) \cdot y_{H_2O}}{1 + K_{Oxy} \cdot y_{Oxy} + K_O \cdot y_O + K_A \cdot y_A} \cdot a_r^{n3} \cdot a_{nr}^{n4}$$

Numerical solution:



Carl Gustav Jacob **Jacobi**, 1804-1851

$$p_{NT}(z) = z^{N_0} p_N^{(\alpha, \beta)}(z-1)^{N_1}, NT = N + N_0 + N_1$$

$$y_N(z, \tau) = \sum_{i=1}^{NT} l_i(z) y_i(\tau)$$

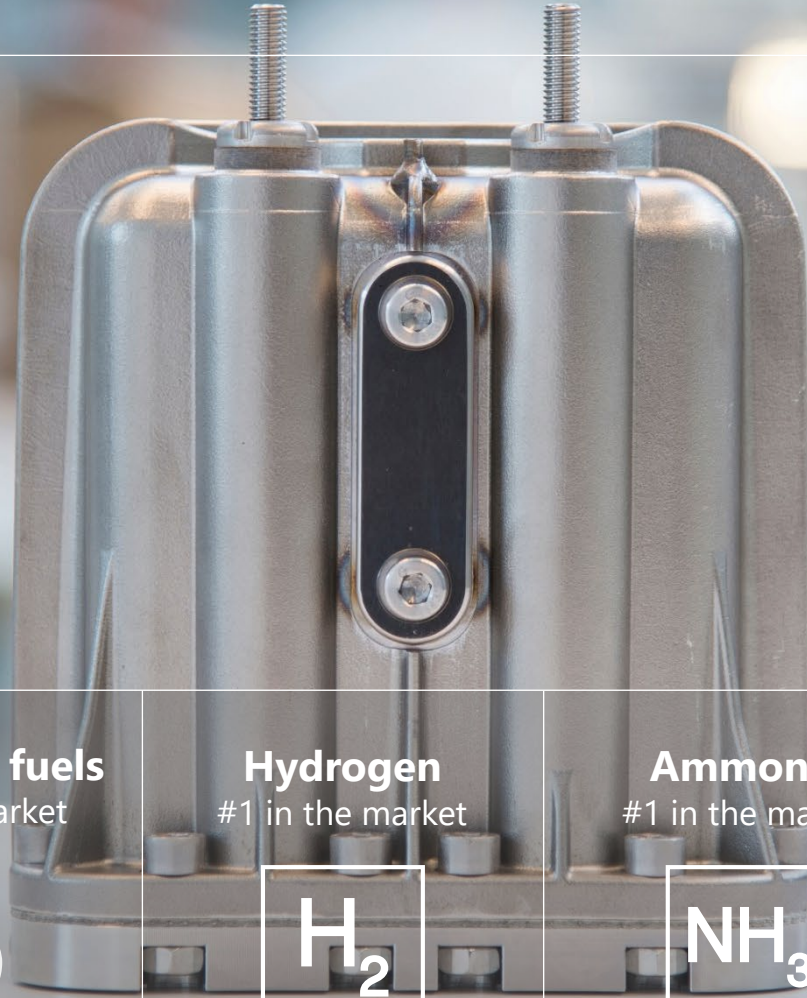
$$\left(\frac{\partial y_N}{\partial z} \right)_{z=z_k} = \sum_{i=1}^{NT} l'_i(z_k) y_i(\tau) = \sum_{i=1}^{NT} A_{ki} y_i(\tau)$$

$$\left(\frac{\partial^2 y_N}{\partial z^2} \right)_{z=z_k} = \sum_{i=1}^{NT} l''_i(z_k) y_i(\tau) = \sum_{i=1}^{NT} B_{ki} y_i(\tau)$$

WE USE OUR KNOWLEDGE FROM CATALYSTS, R&D, ENGINEERING AND OPERATING PLANTS



WE HAVE THE KNOWLEDGE AND ALL OF THE BUILDING BLOCKS TO DECARBONIZE HARD-TO-ABATE SECTORS



Topsoe possesses both the expertise and the technologies needed to transform renewable electricity, biomass, and waste into green hydrogen and green ammonia, eMethanol, eFuels, and biofuels that will power a sustainable future.



Renewable fuels
#1 in the market



Hydrogen
#1 in the market



Ammonia
#1 in the market



Methanol
#1 in the market



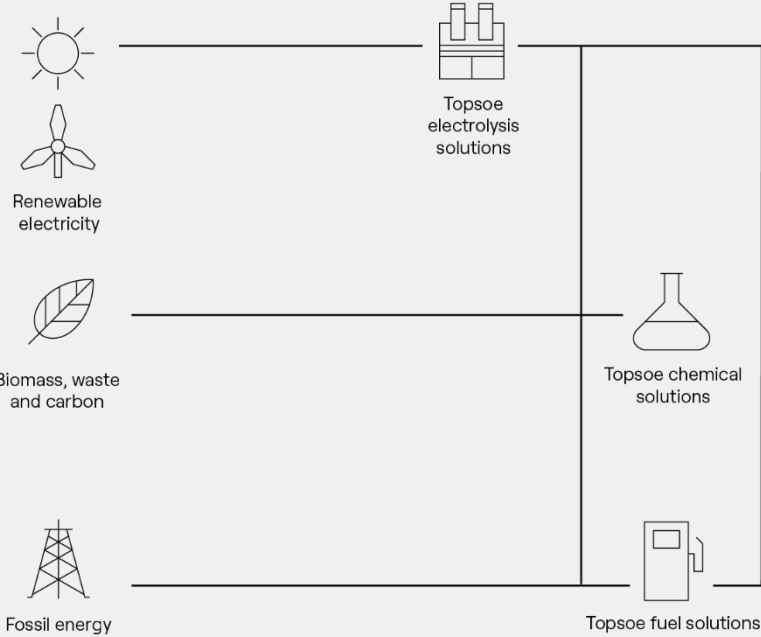
Electrofuels



OUR EXPERTISE AND TECHNOLOGIES POWER A SUSTAINABLE FUTURE

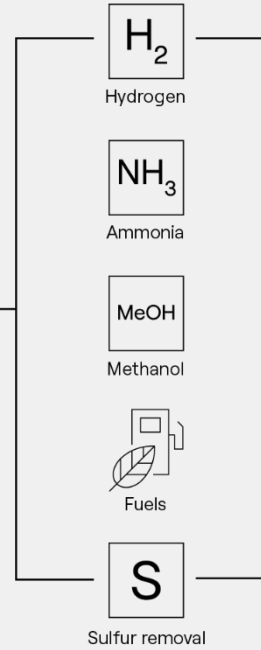
ENERGY SOURCES

Fuels and chemicals can be produced from various ways of both renewable and fossil feedstocks.



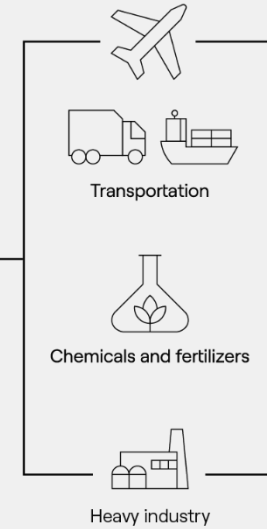
CHEMICALS AND FUELS

For our customers, the output is more efficient processes or renewable feedstocks, that significantly can lower the carbon footprint, and thereby supporting them in their energy transition.



UTILIZATION

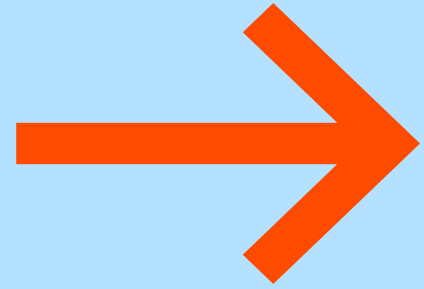
The societal benefits of these end-products come, among other things, in the shape of a cleaner transportation sector and hard-to-abate sectors such as steel, cement, and mining, who can reduce their carbon footprint.



VALUE CREATION

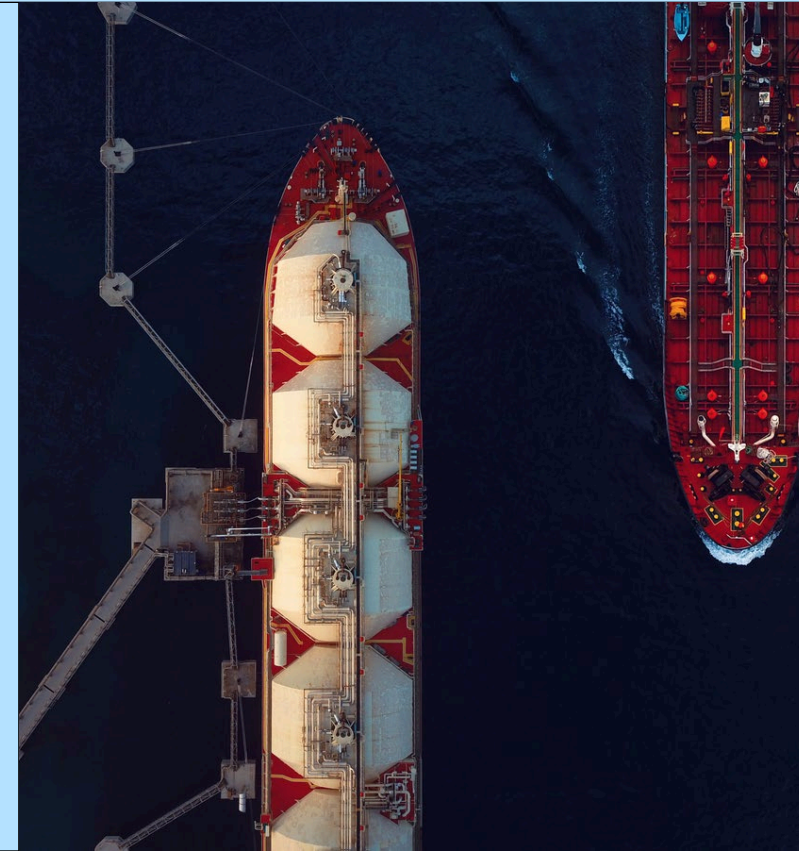
We create value for customers, employees, shareholders, and society. We contribute directly to the United Nation's Sustainable Development Goals (SDGs) nos. 13, 7, 3, 12, and 8.





PROJECTS DEFINING THE FUTURE OF DECARBONIZATION

with industry leading carbon emission
reduction technologies from Topsoe



Topsoe is part of the Acetate Consortium supported by the Bill & Melinda Gates Foundation. The aim is to provide technologies for sustainable food production.

First Ammonia will be using Topsoe's solid oxide electrolyzer cells (SOEC) technology to produce green ammonia in Germany and the US.

Topsoe is technology partner in **FlagshipONE**, Europe's largest production facility for green fuel for the shipping industry.

ExxonMobil is building the world's largest low carbon hydrogen facility in the US, running on Topsoe technology.

Topsoe will deliver technology to the first dynamic green ammonia plant in China, build by **Mintal Hydrogen Energy Technology**.

HIF, USA LLC have selected Topsoe to deliver technology for the world's largest e-fuels plant in Texas.






Topsoe and **Fidelis New Energy** have formed a carbon neutral hydrogen technology alliance, enabling the production of low carbon hydrogen.

An aerial photograph of a rugged coastline with numerous icebergs floating in the water. The scene is dominated by shades of blue and white, with the dark, rocky shore in the center-right. The text is overlaid on the image.

**REDUCING
CARBON
EMISSIONS**

**THE GREEN ENERGY TRANSITION
MUST BE JUST, LEAVING NO ONE
BEHIND, AND WITHOUT
COMPROMISING THE PROTECTION
OF PEOPLE AND NATURE**

OUR IMPACT ON SELECT UN SUSTAINABLE DEVELOPMENT GOALS

UN SDG	SOLUTIONS	OPERATIONS
<p>Climate action</p> 	<p>We have the technologies needed to transform renewable electricity, biomass, and waste into green hydrogen, green ammonia, and zero-emission fuels and chemicals.</p>	<p>We have a net-zero 2040 target in line with the SBTi net-zero standard. We seek to continuously strengthen our resilience to physical climate risks.</p>
<p>Good health and well-being</p> 	<p>Our catalysts reduce – and in some cases also eliminate – air emissions such as sulfur, SOx and NOx from industry, for the benefit of public health.</p>	<p>Our global operations involve potential safety risks for our employees, suppliers, customers, contractors and communities. We aspire to ‘Zero Harm’ and do not compromise on safety.</p>
<p>Responsible consumption and production</p> 	<p>Our carbon emission reduction technologies contribute to a more sustainable production of fuels and chemicals. We are also involved in converting used plastics to new plastics.</p>	<p>We work hard to ensure that our conduct is economically, environmentally, and socially sustainable.</p>
<p>Affordable and clean energy</p> 	<p>We have the technologies needed to transform renewable electricity into green hydrogen, green ammonia, and zero-emission fuels and chemicals.</p>	<p>We strive for net-zero operations within this decade, which includes transitioning to renewable energy.</p>
<p>Decent work and economic growth</p> 		<p>We contribute directly and indirectly to economic and community development through employment, taxes, working conditions, and donations. We respect human and labor rights and strive to uphold these in our global operations.</p>

NET-ZERO BY 2040

TOPSOE



Operations



Eliminate process emissions by 30% in 2024 and by at least 95% in 2030



Invest in renewable energy solutions



Transition to 80% renewable electricity by 2025



Implement digital performance monitoring and analytics

Supply chain



Supplier engagement strategy launched in 2022



Decarbonization becomes a mandatory requirement in supplier selection, starting in 2023



Two-thirds of supply chain emissions to be covered by science-based reduction targets by 2027

Value chain

- Engage with suppliers on emission reduction progress
- Collaborate with customers and other business partners to reduce emissions
- Reduce emissions to at least 90% by 2040
- Neutralize residual emissions which cannot yet be eliminated by 2040 (off-sets)

Main sources of emissions

- 70% Supply chain (scope 3, upstream)
- 12% Chemical processes (scope 1)
- 9% Fossil fuel combustion (scope 1)
- 6% Electricity (scope 2)
- 4% Investments & products (scope 3, downstream)

— Path to net zero
--- Business as usual

Near-term target commitment:
Absolute scope 1 and 2 GHG reduction of 100% by 2030

Long-term target commitment:
Net-zero emissions across our value chain

2020

2022

2024

2030

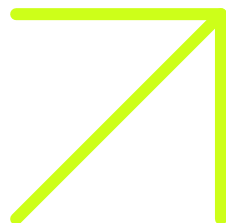
2040

**WE MAKE OUR
VOICE HEARD
IN THE
CONVERSATION
SHAPING THE
FUTURE OF OUR
INDUSTRY AND
THE ENERGY
TRANSITION**

SELECTED MEMBERSHIPS

UN Global Compact	Royal Society of Chemistry
World Economic Forum	Business Council for Sustainable Energy
Hydrogen Europe	Fuel Cell & Hydrogen Energy Association
Hydrogen Council	Axcel Future network for renewable energy and PtX
European Clean Hydrogen Alliance	A.P. Møller Mærsk Center for Zero Carbon Shipping
European Electrolyzer Partnership	Dansk Industri
CEFIC – European Chemical Industry Council	Green Power Denmark – Power-to-X network

HOW TO GET TO NET ZERO



HOW TO GET TO NET ZERO

TECHNOLOGY DEVELOPMENT BY PRIVATE COMPANIES
SUCH AS TOPSOE

CLOSE COOPERATION BETWEEN RESEARCH
INSTITUTIONS AND THE PRIVATE SECTOR

DEVELOPERS WHO ARE PREPARED TO TAKE FINANCIAL
AND TECHNICAL RISK

COOPERATION WITH MAJOR OIL COMPANIES WHO
HAVE THE RESOURCES

LEGISLATION BY INTER-GOVERNMENT AND
GOVERNMENT BODIES – INCENTIVES

SUMMARY

- TOPSOE has solutions for decarbonization
- TOPSOE will continue extensive R&D effort, engineering and build production facilities to enhance decarbonization
- TOPSOE will continue working with oil majors, developers and partners on decarbonization projects
- TOPSOE will continue working with inter-governmental and government bodies on decarbonization



An aerial photograph of a glacier system. The glacier is a light greyish-blue color with a textured surface. It flows from the top of the frame towards the bottom. In the center, the glacier narrows and then widens again. The water in the channels is a vibrant turquoise color. The background is a dark, deep blue, suggesting the ocean or a large body of water. The text "THANK YOU FOR LISTENING" is overlaid in white, bold, sans-serif font on the upper left portion of the glacier.

**THANK YOU FOR
LISTENING**

TOPSOE