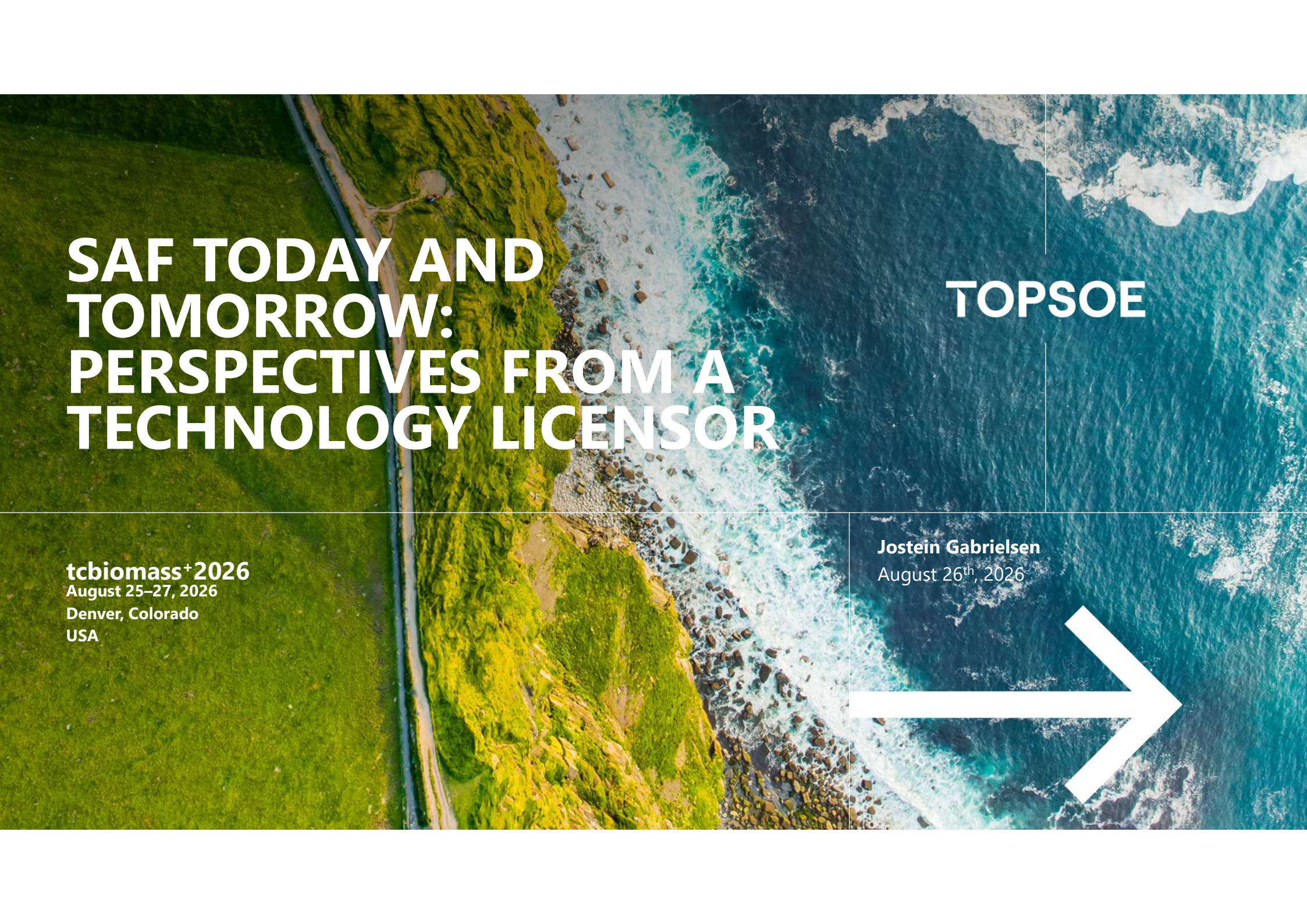




SAF TODAY AND TOMORROW: PERSPECTIVES FROM A TECHNOLOGY LICENSOR

TOPSOE

tcbiomass+2026
August 25–27, 2026
Denver, Colorado
USA

Jostein Gabrielsen
August 26th, 2026

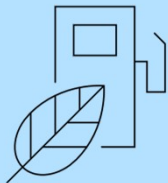
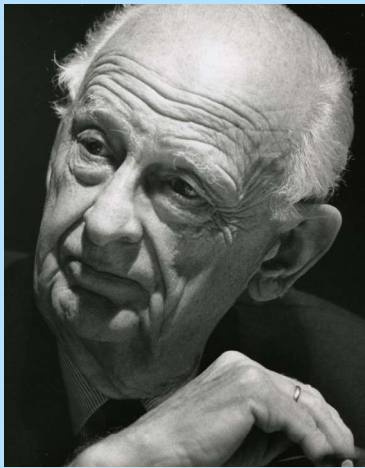


A FEW WORDS ABOUT TOPSOE

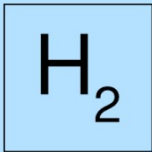
TOPSOE AT A GLANCE: OVER 85 YEARS OF INNOVATION AND LEADERSHIP

For more than 85 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.



Conventional and renewable fuels



Hydrogen

2,400

Employees

\$1B

In revenue
(USD)

8.6%

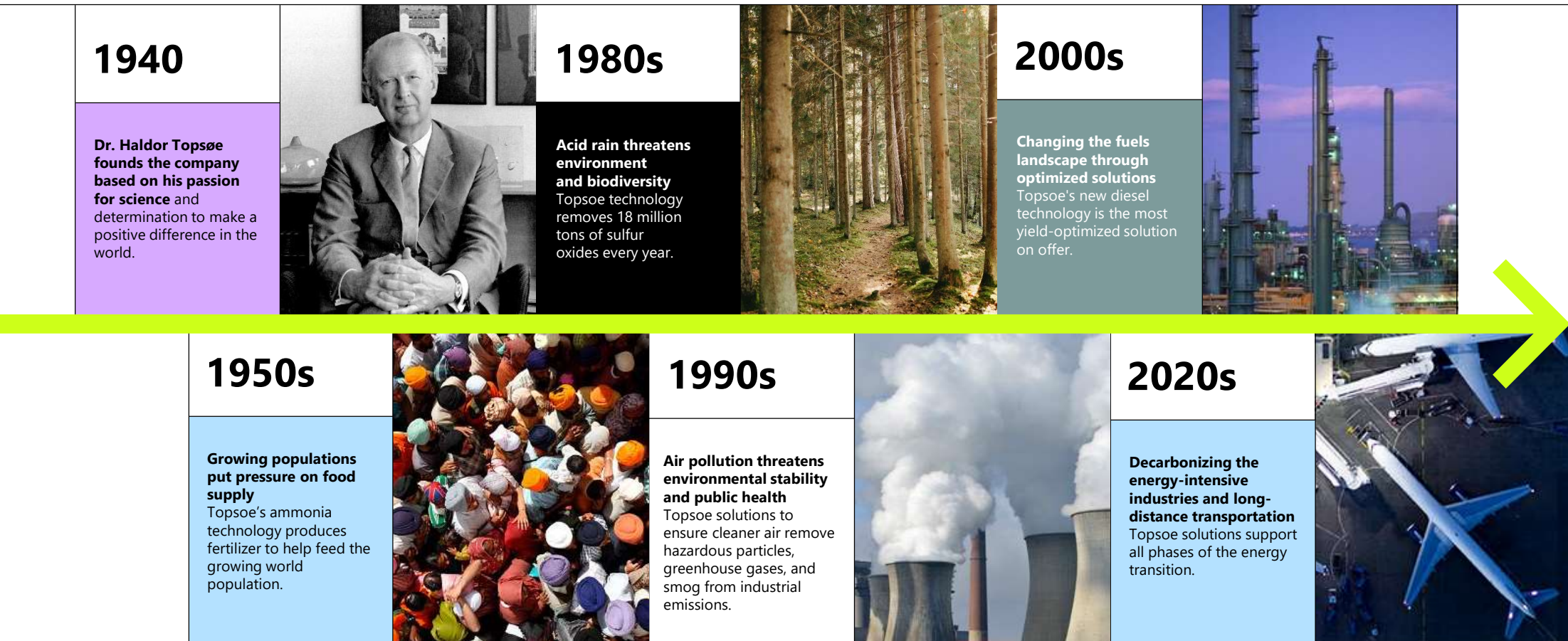
Of revenues
invested in R&D

+500

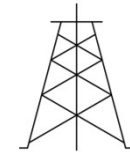
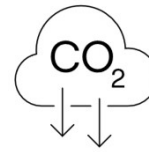
Patent families



A HISTORY OF TAKING ON SOME OF THE WORLD'S TOUGHEST CHALLENGES



TOPSOE OFFERS A WIDE RANGE OF TECHNICAL SOLUTIONS TO PRODUCE FOSSIL AND LOW GHG FUELS AND CHEMICALS



Solutions that displace fossil-based solutions		Solutions that drive significant GHG emission reduction			Solutions that minimize air pollution	Conventional solutions
Renewable energy	Biomass (stand alone or co-processing)	Carbon capture	Materials	GHG emissions	Other air emissions	Fossil-based
• Green H₂ • Green NH₃ • Green methanol • E-Naphtha • E-Jet/SAF • E-Diesel	• Diesel • Jet fuel/SAF • Gasoline • Naphtha • Marine fuel • Methanol	• Blue hydrogen • Blue ammonia	• Battery materials (Cathode) • Plastic recycling (hydro-processing)	• Nitrous oxide removal (N₂O) • Methane removal	• SO_x removal • Catalytic filters • NO_x removal	• Hydrogen • Ammonia • Methanol • Gasoline • Diesel • Jet fuel • Naphtha • Bunker fuel/Marine fuel • Synthetic fuels

GLOBAL LEADER IN TECHNOLOGIES, CATALYSTS AND SERVICES

**PROCESS DESIGN,
ENGINEERING AND
LICENSING**



**HIGH-PERFORMANCE
CATALYSTS**



**PROPRIETARY
EQUIPMENT**



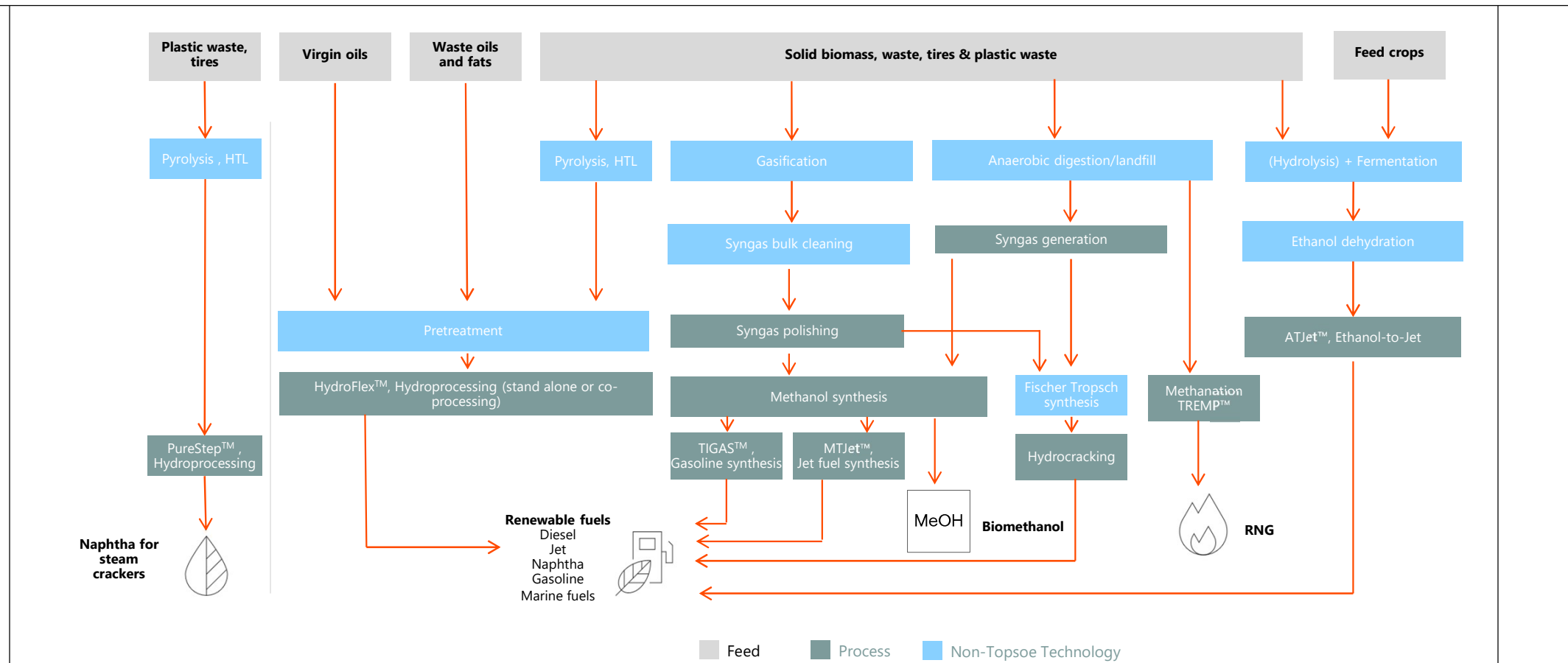
**SERVICE, SPARE PARTS,
CONSUMABLES AND DIGITAL
SERVICE SOLUTIONS**



TOPSOE'S LOW CARBON FUEL AND CHEMICAL TECHNOLOGIES

THE PATH TO DECARBONIZATION

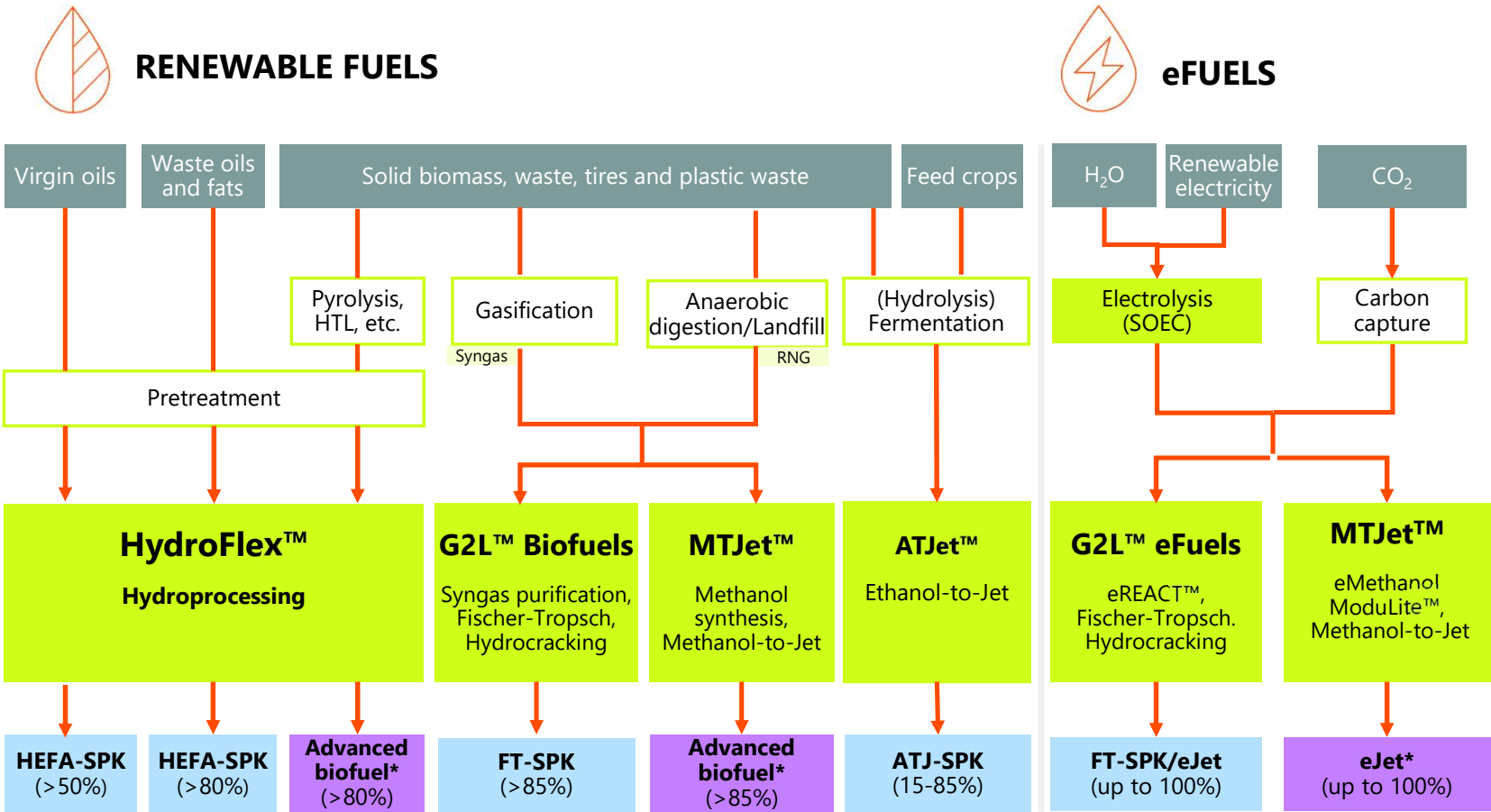
RENEWABLE FUELS AND RENEWABLE CHEMICALS



TOPSOE AND SAF

SAF PATHWAYS - TOPSOE PORTFOLIO

- Feed
- Process
- Process (Topsoe & Partners)
- Product (GHG Emissions savings)



*Not approved ASTM pathways yet

Source: CORSIA, ICCT paper 2021-11, WEF+McKinsey 2020-11

TOPSOE RENEWABLE FUEL REFERENCES AROUND THE WORLD

OVER 80 RENEWABLE FUEL PROJECTS.

- **HydroFlex™** – Operating (25)
- **G2L™ fuels** – Construction/Engineering (4)
- **HydroFlex™** – Construction/Engineering (52)

26

Operating plants*

>35%

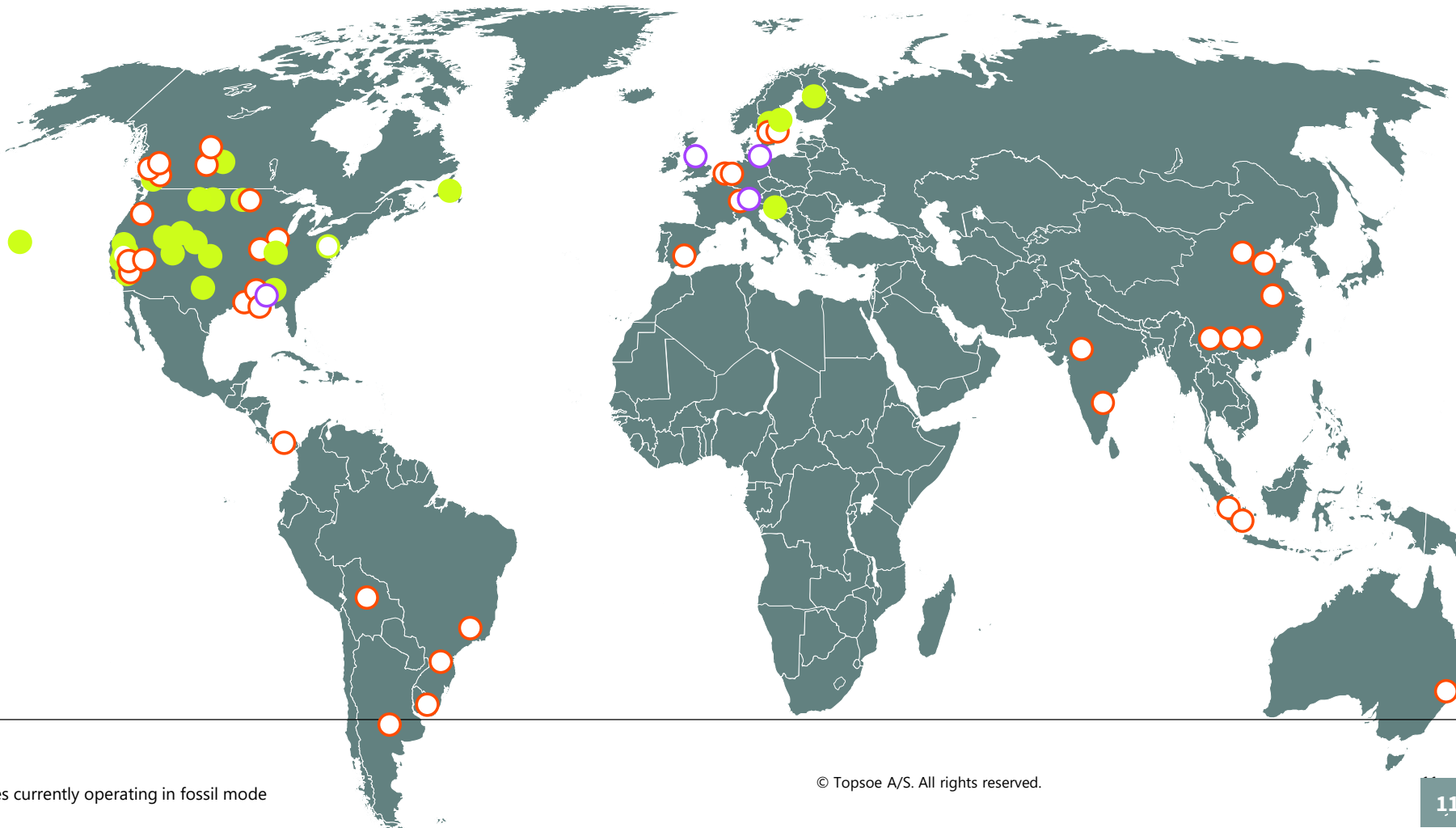
Of the renewable fuels operating capacity volume

2010

Start-up of first reference

>20

Revamps



TOPSOE

*Two references currently operating in fossil mode

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THE JOURNEY INTO HYDROFLEX™ TECHNOLOGY

> **100**

CATALYST REFERENCES

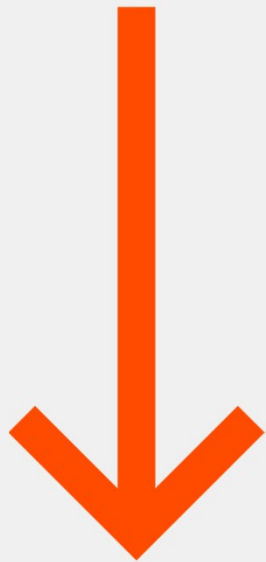
Industrial cycles co-processing renewable feedstocks in hydroprocessing units for HVO

7

CATALYST ORDERS

Placed for SAF

FOSSIL HDP UNIT



RENEWABLE HDP UNIT

HDP= hydroprocessing

< 5 VOL %
CO-PROCESSING



Catalyst system and operational adjustments.
Revamp typically not required

< 10 VOL %
CO-PROCESSING



Study recommended.
Revamp typically not necessary

> 10 VOL %
CO-PROCESSING



Some type of revamp is typically
required

100 VOL %
STAND-ALONE



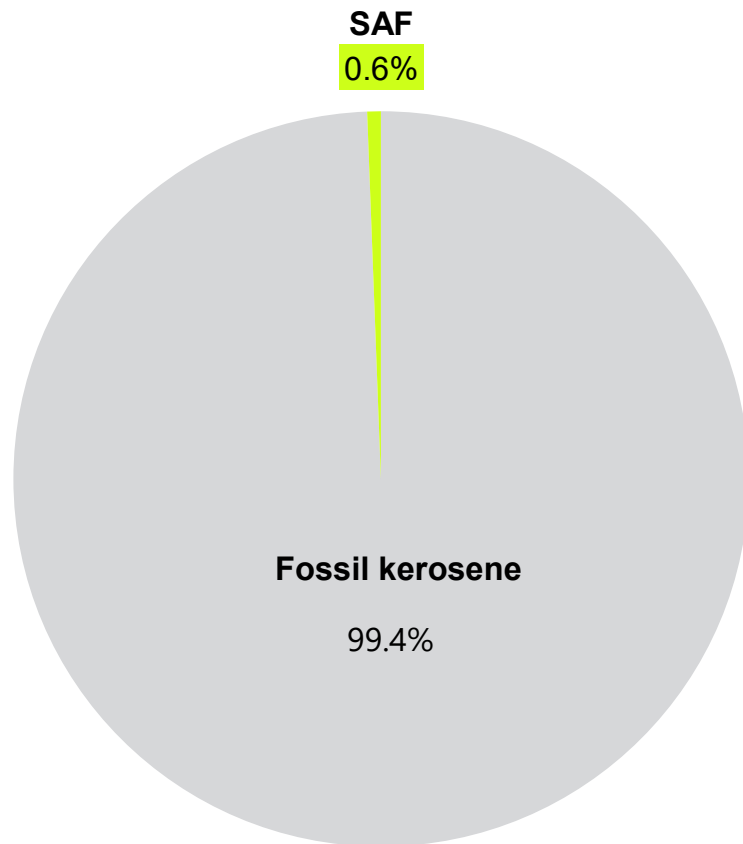
Grassroot unit or extensive
revamp required

HEFA NOW AND TOMORROW

HOW MUCH SAF CAN WE EXPECT IN 2050?

TOTAL JET DEMAND IN 2026 IS 7 MBPD AND IS EXPECTED TO GROW SIGNIFICANTLY

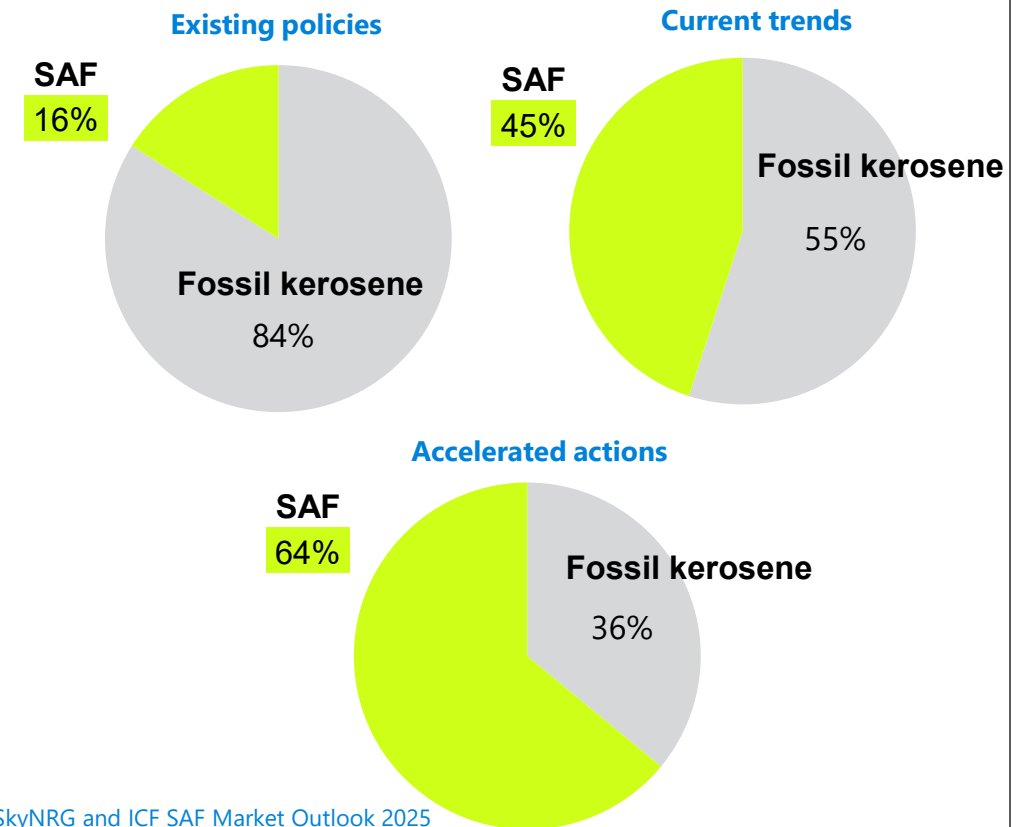
2025



[IATA](#)

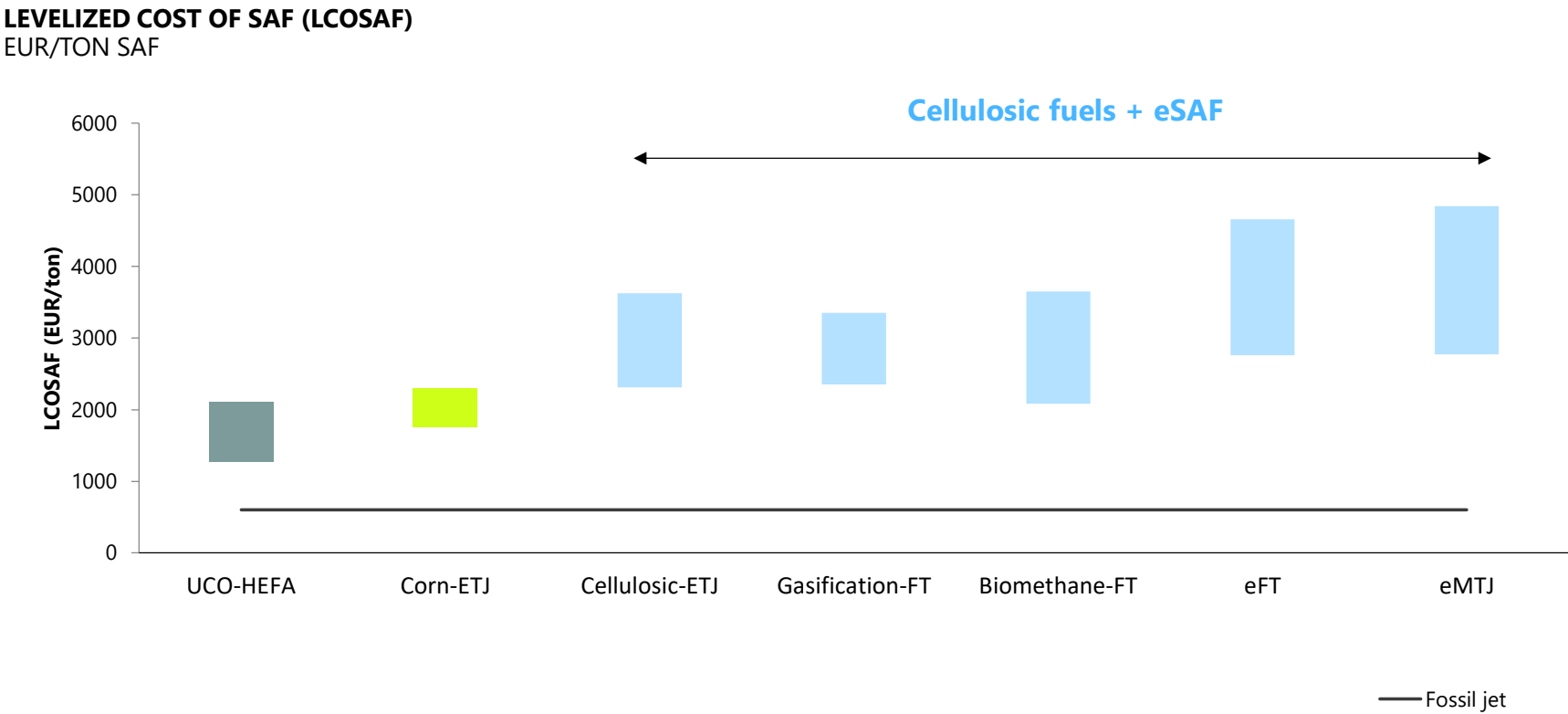
TOPSOE

2050



[SkyNRG and ICF SAF Market Outlook 2025](#)

SAF IS AND WILL REMAIN MORE EXPENSIVE THAN FOSSIL JET FUEL

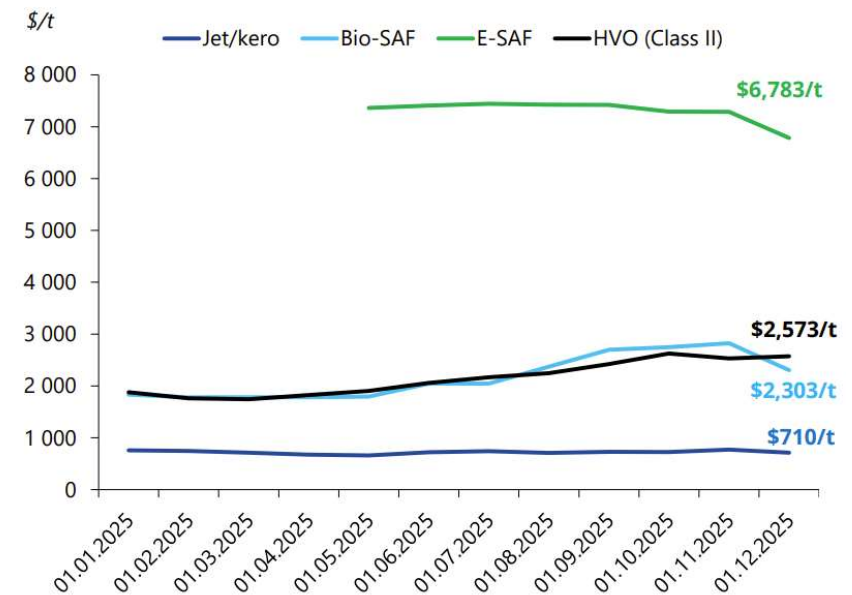


HEFA NOW

HEFA IS THE ENABLER OF SAF TAKE-OFF

- HEFA succeeded because it is bankable, fast, and compatible with existing assets and was a natural evolution of HVO production
- Its dominance is driven by risk minimization, not by unlimited scalability
- Feedstock availability and competition are now system-level constraints, not technical ones
- As mandates rise, HEFA becomes the anchor pathway, not the main growth engine
- HEFA unlocked SAF — now the market is testing its boundaries

Conventional Jet Fuel, SAF and HVO Prices in Europe, 2025



illuminating the markets®

Source: "SAF: Ready for take off", Valentin Kotlomin (Argus Media), Topsoe Technology Summit (Dubai, January 2026)

HEFA TOMORROW

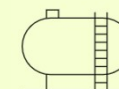
HEFA IS NOT THE LONG-TERM SCALING SOLUTION ON ITS OWN

- The future of HEFA is optimization, revamps, co-processing, product flexibility and addition of new feedstocks
- **How will HEFA be “tomorrow”?**
 - Global production (LATAM, APAC, Middle East)
 - More co-processing
 - Feedstock diversification
 - Integration with hydrogen unit to minimize emissions
- **Wild cards:**
 - Interplay with other fuel end markets (competition for feedstock and impact on prices)
 - Scaling of innovation within feedstocks (speed, price, volume)

What could the new HEFA feedstocks be?



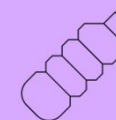
Oils from intermediate crops, nut shells, crude tall oil, rubber seed oil, etc.



Synthetic fatty acids or ketones made from biogas, food waste, etc.



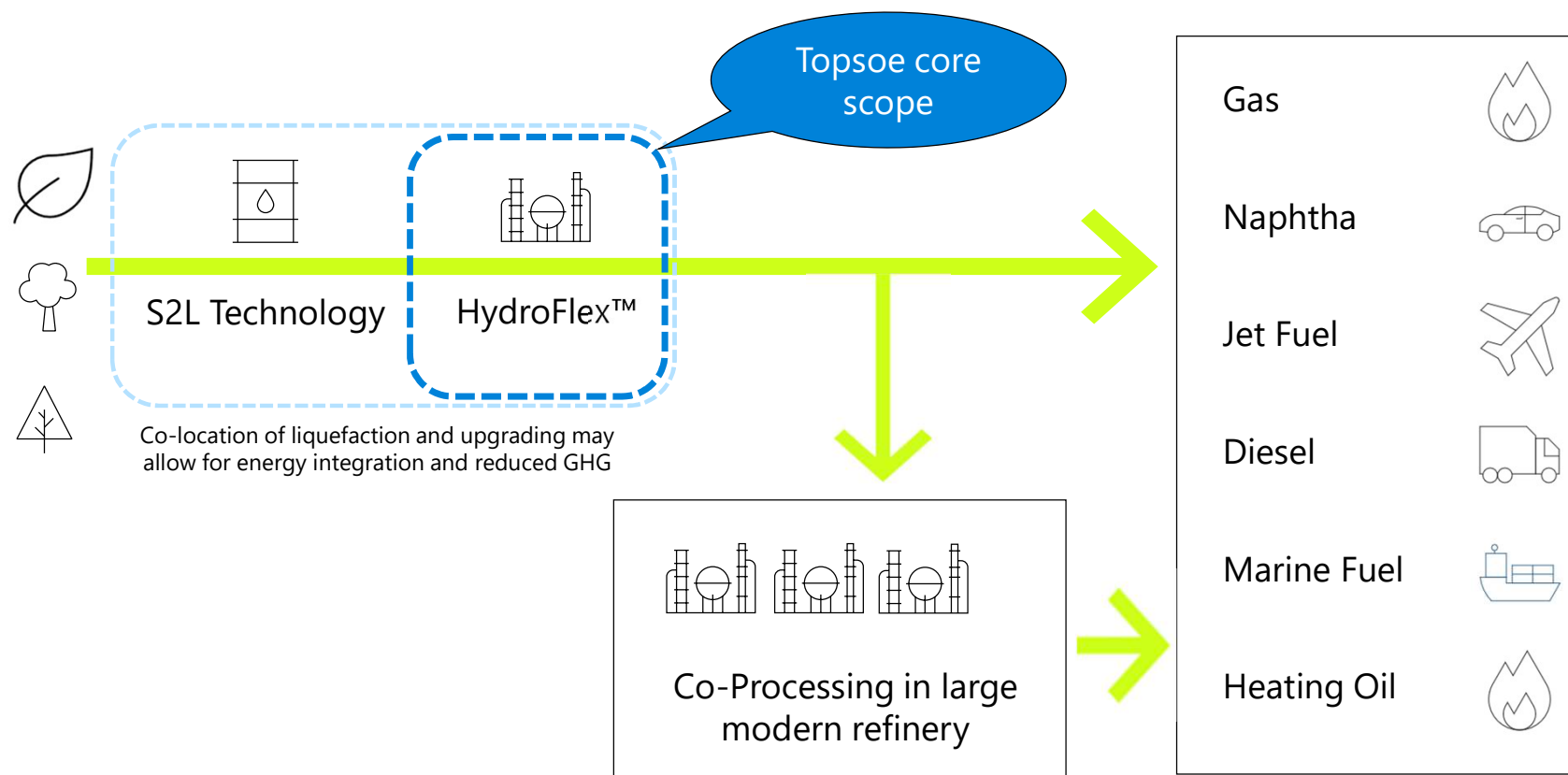
Biocrudes from biogenic waste, sewage sludge, etc. (through pyrolysis or solvolysis)



Plastic pyrolysis oils or tire derived oils

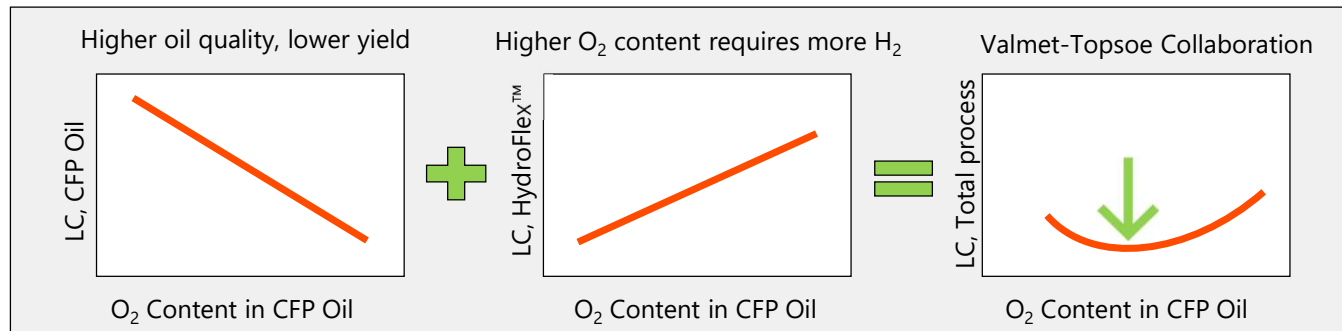
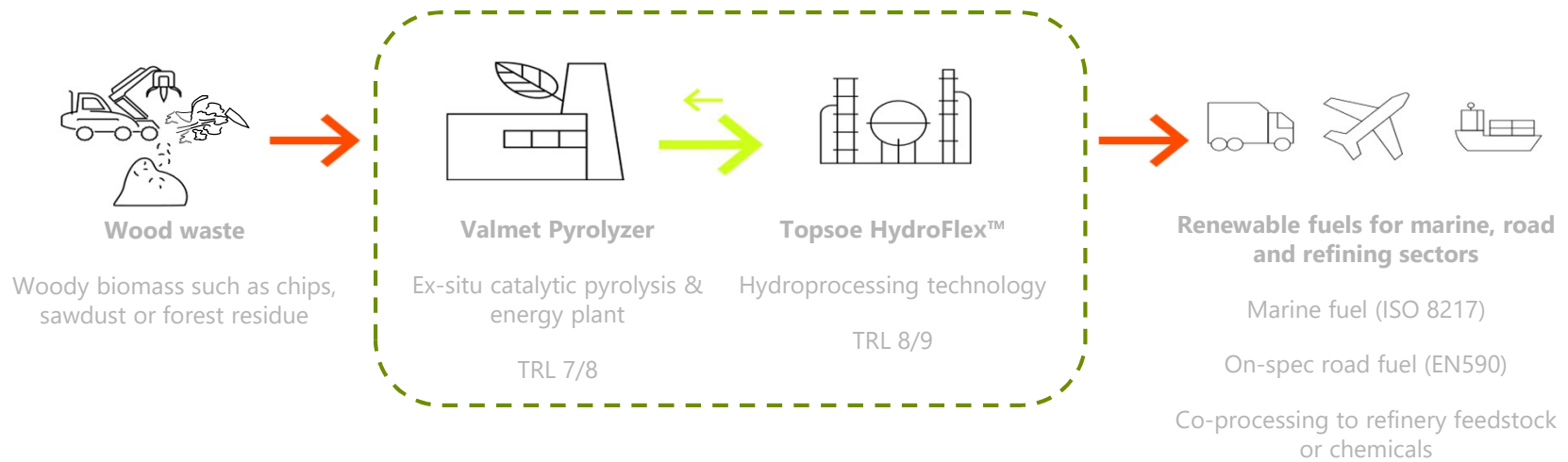
PATHWAYS TO MARKET

FROM SOLID BIOMASS TO HIGH QUALITY FUEL PRODUCTS



A UNIQUE COMBINATION TO PRODUCE RENEWABLE FUELS FROM WOOD WASTE

COLLABORATION ON INTEGRATED SOLID TO FUEL SOLUTION WITH HIGH TRL LEVEL



ETJ: THE NEXT SAF TO DEPLOY

ETJ IS THE NEXT DEPLOYABLE SAF PATHWAY

ETJ WILL BE THE MOST COST-EFFICIENT SOLUTION AFTER HEFA FOR SAF FOR MANY YEARS

- ETJ **adds feedstock** and geographic diversification
- It **reduces** exposure to **FOG price volatility**
- It **leverages existing ethanol** infrastructure and markets
- It is attractive because it balances:
 - Cost
 - Technology maturity
 - Time to FID

Why and when will ETJ deploy?

SAF demand will outpace HEFA feedstock availability in a few years resulting in higher feedstock prices

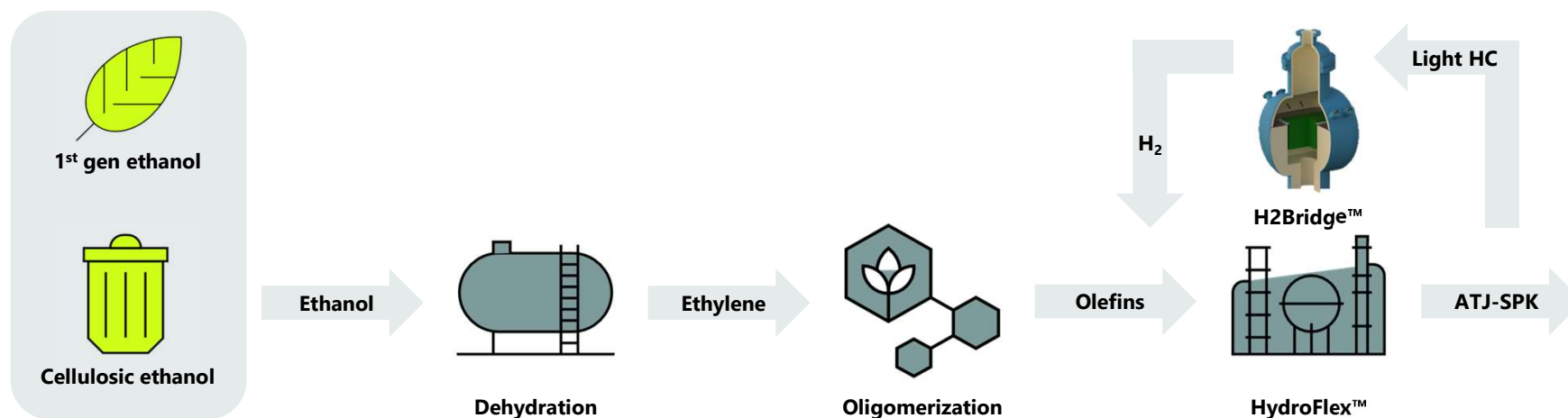
The growing SAF demand will be driven by regulation / incentives

Advanced bio-SAF and eSAF pathways have many years to become cost competitive

Ethanol production will mature with CCS in many places

The price of 2G Ethanol will drop as the capacity and demand increase

TOPSOE ATJet™ TECHNOLOGY OFFERING HIGHER YIELD AT LOWER CAPEX



Solution features

- Highly selective oligomerization catalysts and proven hydrogenation catalysts
- High SAF yield to minimize feedstock contribution to the levelized cost of SAF
- Integration (including H₂ production) to minimize carbon intensity and maximize credit generation

Benefits

- Offering simplified design for lowest CAPEX in the market
- Fast-track program targeting commercial operation no later than 2030
- Relying on Topsoe's strong history in commercializing integrated fixed bed catalyst technology

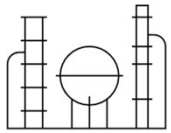
TAKE HOME MESSAGES

TAKE-HOME MESSAGES

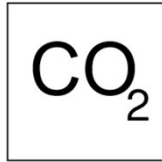
- **SAF scaling is a system challenge, not a technology challenge**
 - Offtake, feedstocks, certification, infrastructure and financing matter more than reactors
- **HEFA enabled SAF — other pathways will scale it**
 - HEFA remains essential and will grow, but significant growth requires complementary pathways
- **ETJ is about diversification**
 - It expands the SAF supply base beyond fats, oils and greases and will be the most cost-efficient solution after HEFA for many years



MAKING SAF PROJECTS BANKABLE: THE NEED FOR TOTAL VALUE CHAIN COLLABORATION



**SAF
Technology**



**Carbon
Intensity,
Sustainability,
Certification**



**Logistics and
Infrastructure**



**Project
financing,
Investment**



Regulations



**Offtake
agreement**



Feedstocks

STOP. SCAN. LISTEN.

A TOPSOE PODCAST FOCUSING ON RENEWABLE FUELS.

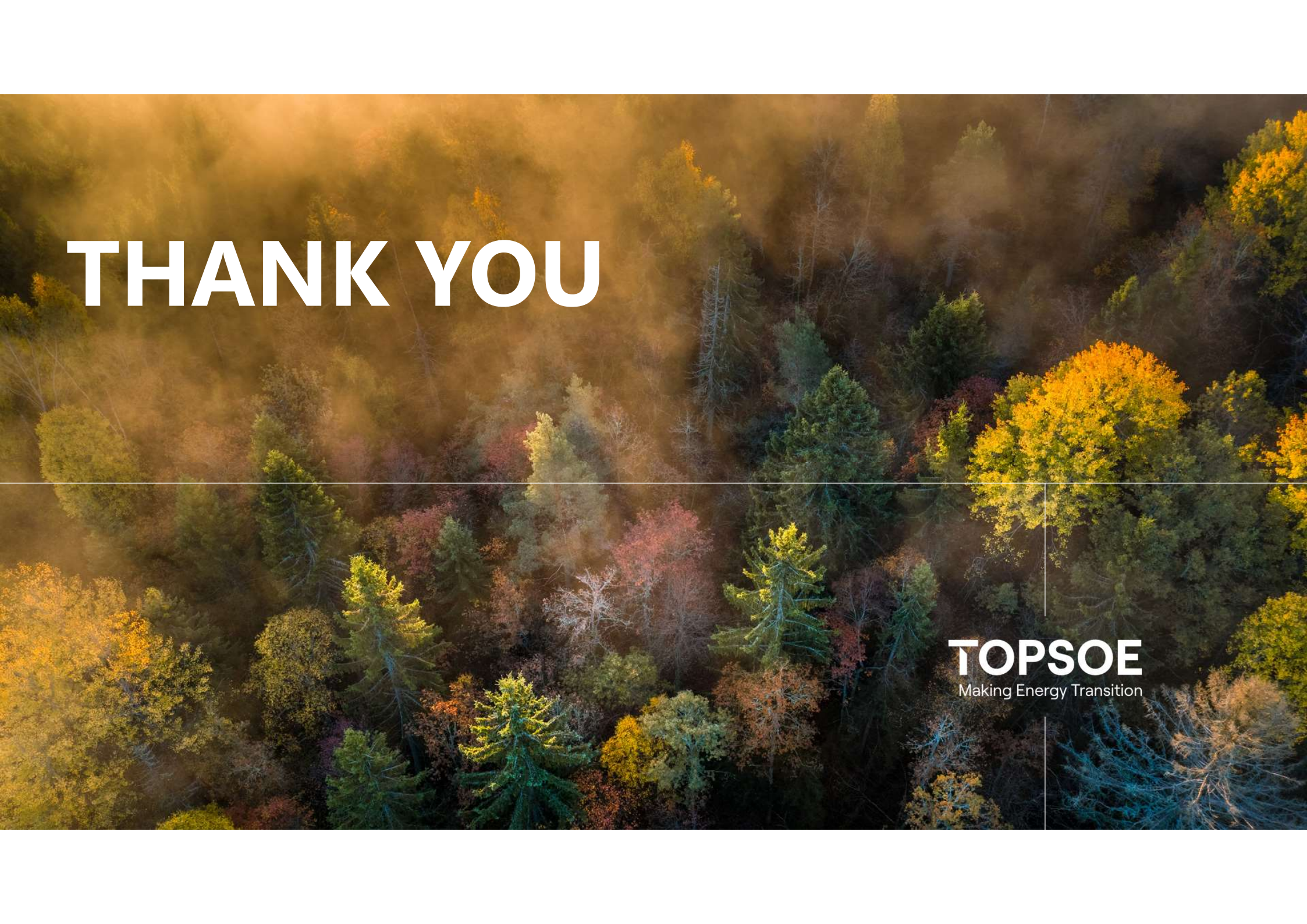
THE FUEL FOR THOUGHT PODCAST SERIES

- Key industry players, experts, and influencers discuss industry challenges.
- What is driving our industry and where is it heading?
- Get new perspectives, inspiration, and knowledge.



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THANK YOU

TOPSOE
Making Energy Transition