

Verfügbarkeit und Bezahlbarkeit von Importenergieträgern: Dimethylether DME – Multitalent für nachhaltige Mobilität, Industrie & Energiewirtschaft

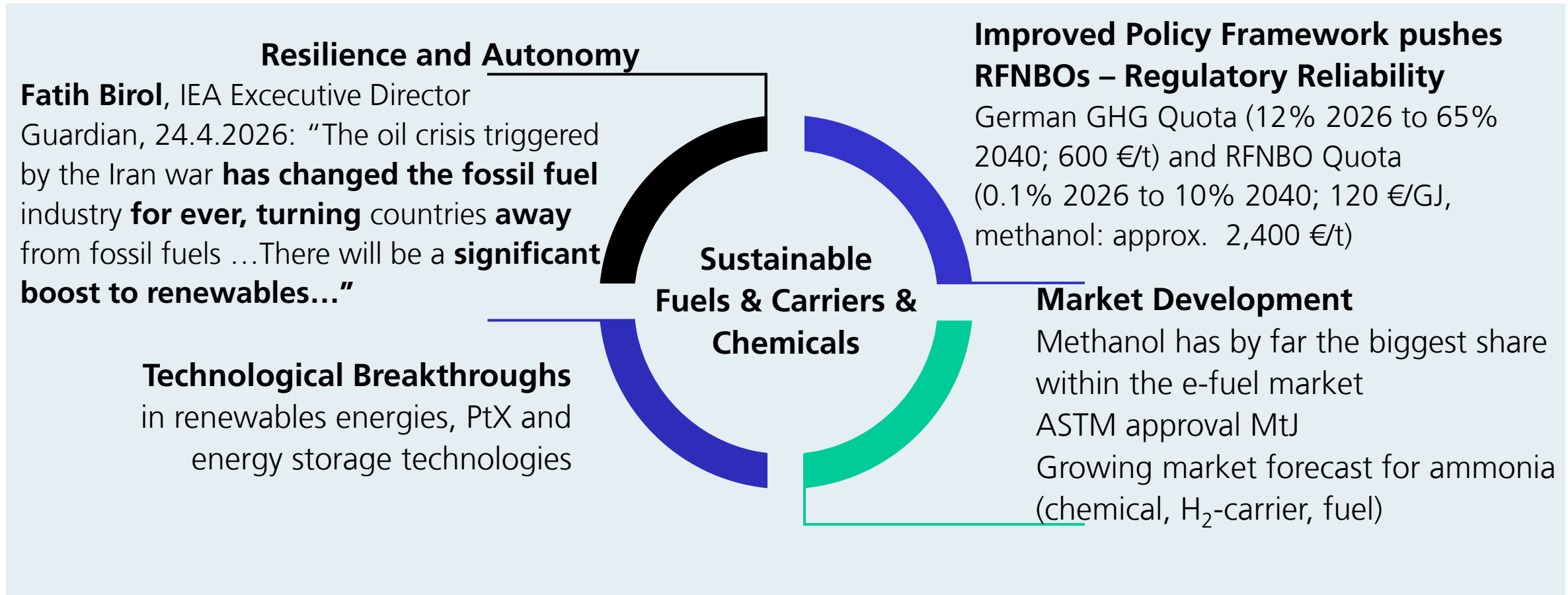
DME ist ein ungiftiges Gas mit ähnlichen Eigenschaften wie Propan und Butan, den Hauptbestandteilen von LPG (Liquified Petroleum Gas, auch bekannt als Campinggas bzw. Autogas).

DME besitzt eine hohe Energiedichte und könnte für den für Deutschland nötigen großskaligen Import nachhaltiger Energieträger und Grundstoffe für die Industrie eine wichtige Rolle spielen.

DME wird industriell aus Methanol mit mehr als 5 Mio t/a hergestellt. Innovationen bieten die Chance, die Kosten weiter zu reduzieren sowie durch Diversifizierung und Nutzung der vorhandenen Infrastruktur die Resilienz zu erhöhen.



Powerful Drivers for Sustainable Energy Fuels, Carrier & Chemicals



Global Hydrogen Flows

170 MT of hydrogen derivatives are transported over long distances by 2050 [1]

→ Energy density is key

→ H₂ derivatives are relevant: NH₃, MeOH, DME

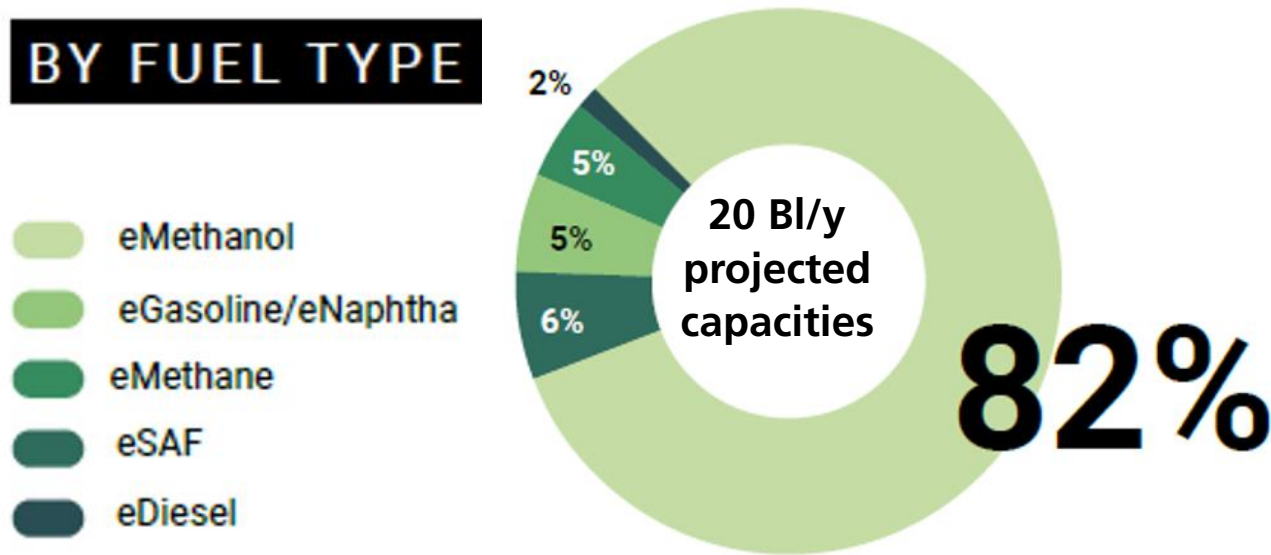
Category	Unit	LH2	NH ₃	DME
H ₂ storage density	kg _{H2} m ⁻³	70.9	121.1	172.2* (86.1)
Lower heating value	kWh kg ⁻³	33.3	5.2	8.0
Vol. energy density	kWh L ⁻¹	2.3	3.5	5.3

***technical H₂ storage density including steam reforming**
 LH2 (-253°C, atm) / NH₃ (-33°C, atm) / DME (25°C, 5.9 bar)



E-Fuels Market Share by 2030

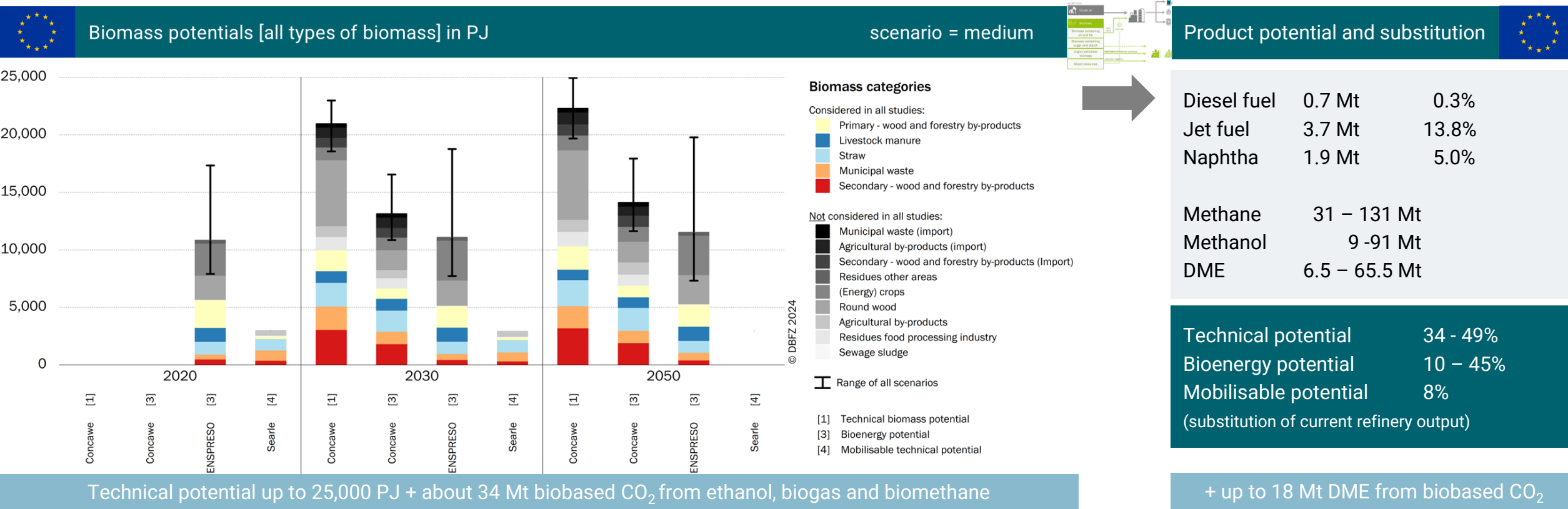
Methanol is the Frontrunner and Dimethyl Ether (DME) – Made from Methanol – Could Follow



- Methanol has by far the biggest share within the e-fuel market (European Energy/Kassø, etc.)
- Be aware: IEA Oil Market Report: Fossil Fuel demand: ca. 100 Mio barrel per day [2]

E-Fuel Alliance [1]

Biomass as Carbon Source | Limited Biobased Substitution Potential



- Biomass mobilization of importance >> high bandwidths and uncertainties in data for future potentials
- Increasing demand for biomass by 2030 with already high utilisation rates
- Example here: biomass type specific HEFA, methane via biogas, methanol / DME via gasification plus CO₂ via direct synthesis

Reference: [Naumann, K.; Cyffka, K.-F., Karras, T. (2024): https://www.dbfz.de/fileadmin/user_upload/Referenzen/Statements/Hintergrundpapier_Bio2x_Okt_2024.pdf]; [Naumann, K.; et al. (2025): Ressourcen und ihre Mobilisierung. DOI: 10.48480/w11j-9w27], Notes: Fuel-specific values: reference to mean values and mean scenarios of the studies (quantities in Mt oil equivalent, 1 kg oil equivalent = 42 MJ) | Total potential bandwidths also include min/max scenarios, resources not considered here: starchy crops, sugar from sugar beet (ethanol) | rape seed, sunflower, soya seed (diesel fuel, kerosine, naphtha) | lignocellulosic crops, stemwood, forest wood (methanol) | Mt = million metric tons

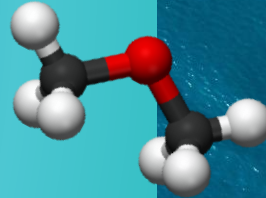
Dimethyl Ether (DME) as Hydrogen Vector and Base Chemical

DME is a commodity, made from methanol

- > 5 Mtpa global market
- Non-toxic, low environmental impact (GWP₁₀₀: 0.3), high energy density
- Stored as liquefied gas under pressure
→ Usage of LPG infrastructure (up to 20% blending)

Current/future applications: Huge market potential

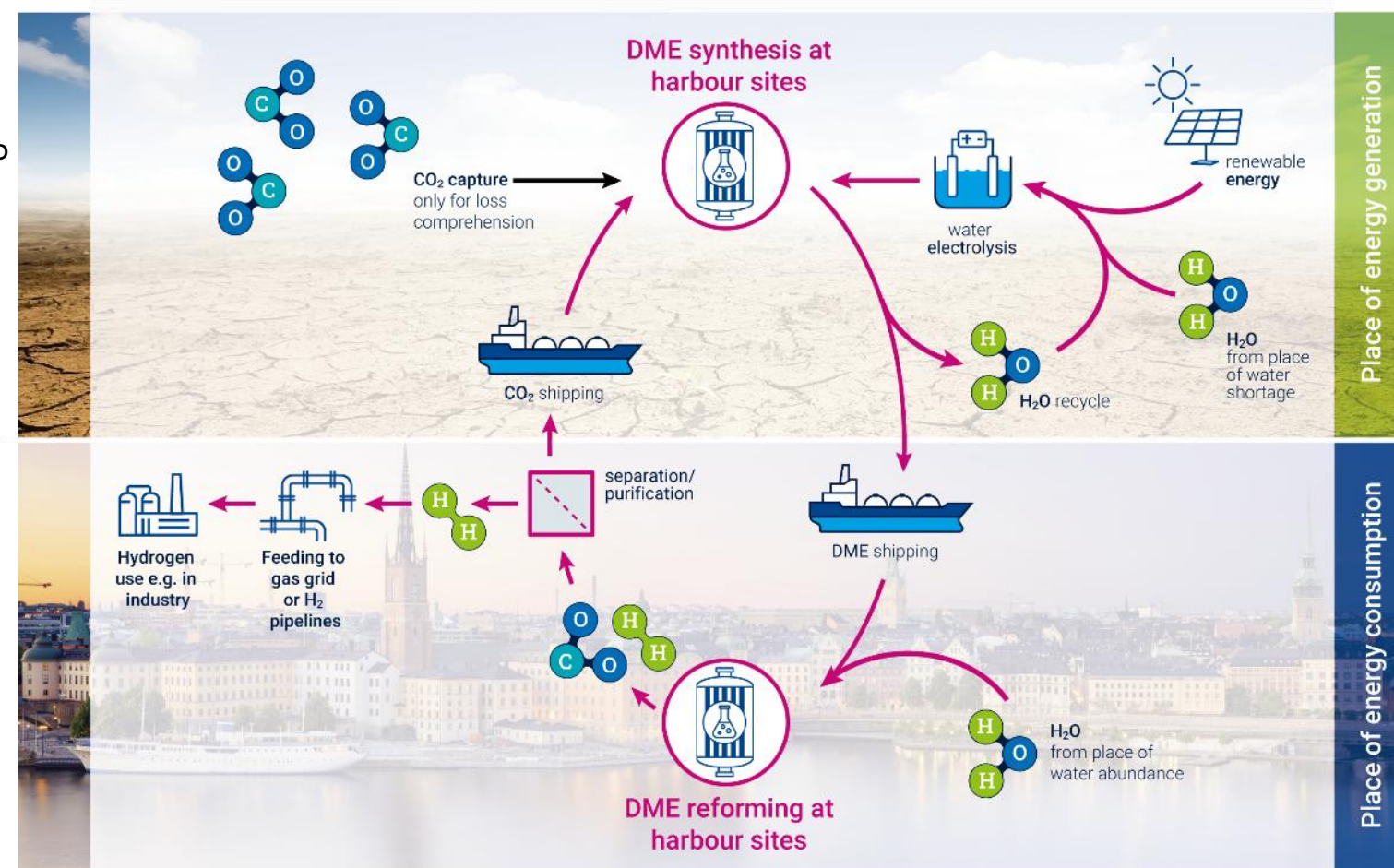
- Propellant, refrigerant, solvent
- LPG substitute & blend → global market 40 Mtpa
- 1) DME for global point-to-point hydrogen transport
- 2) Intermediate for fuels & chemicals
→ global SAF market 2050: ca. 400 Mtpa



1) Dimethyl Ether (DME) – A Global Point-to-Point H₂ Carrier

Advantages of the DME/CO₂ cycle

- DME has **48% higher theoretical hydrogen capacity** than NH₃ and is **non-toxic**, low GWP
- **Reduction of water consumption** in hydrogen production by ca. 45% compared to ammonia
- **Closed Carbon Cycle strongly reduces CO₂ demand**
- CO₂-separation after reforming process (concentrated CO₂-source)
- DME synthesis via intermediate, **highly dynamic methanol production** reduces need for H₂ storage
- **DME offers potential for cost-efficient H₂ delivery**



Schühle, P.; Stöber, R.; Semmel, M.; Schaadt, A.; Szolak, R.; Thill, S.; Alders, M.; Hebling, C.; Wasserscheid, P.; Salem, O. (2023) Dimethyl ether/CO₂ - a hitherto underestimated H₂ storage cycle; Energy & Environmental Science. [Link](#)

1) Dimethyl Ether (DME) – A Global Point-to-Point H₂ Carrier

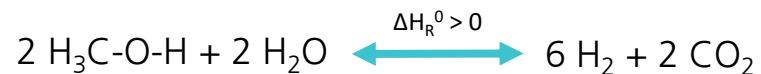
- DME reforming:
 - High temperature reforming using state of the art catalyst from industrial SMR process
 - Low- and medium temperature reforming @TRL 2

Main reactions

- DME hydrolysis

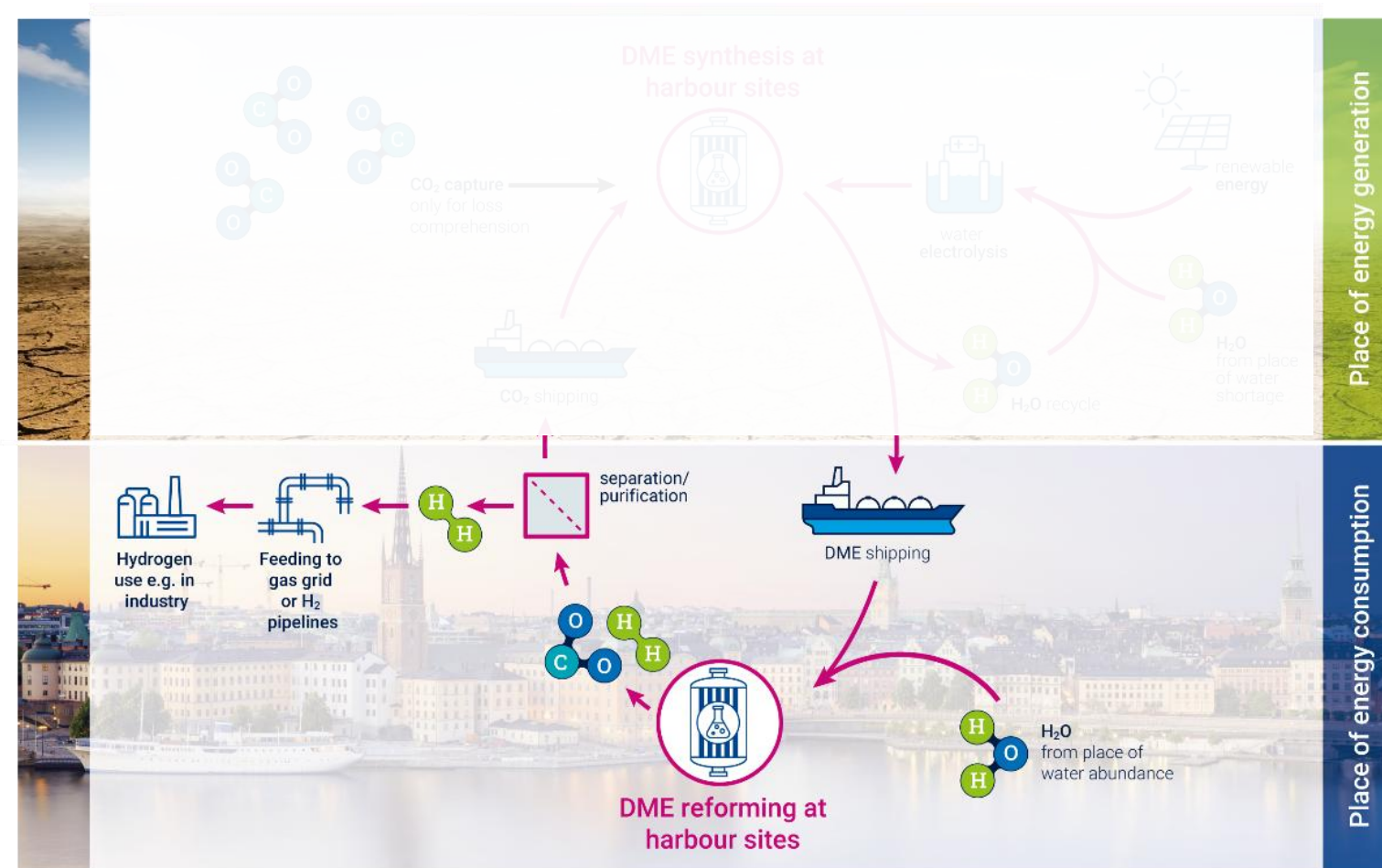


- MeOH steam reforming



Side reactions

- DME decomposition, MeOH decomposition, MeOH-to-Gasoline, methanation, Water-Gas-Shift



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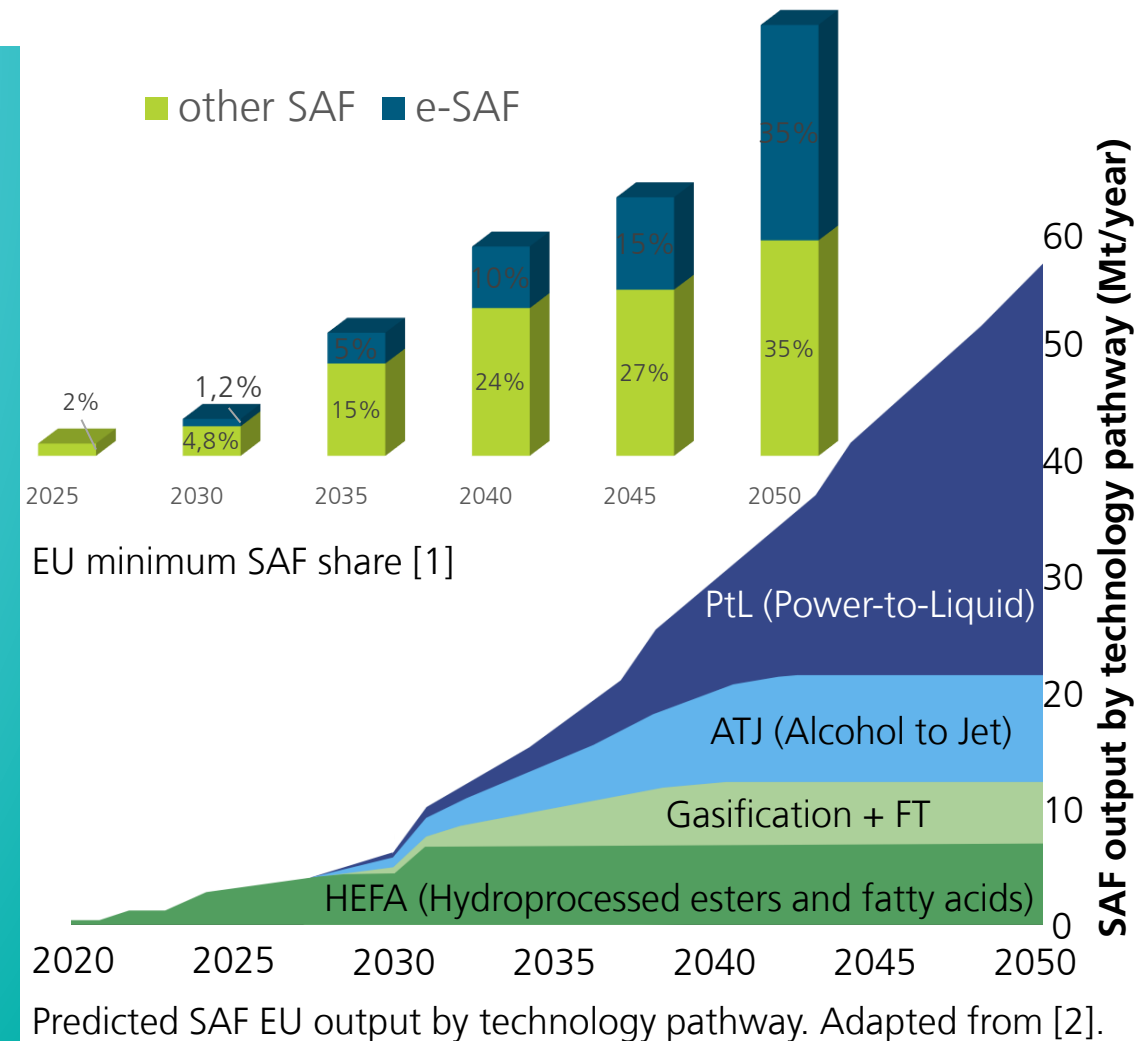
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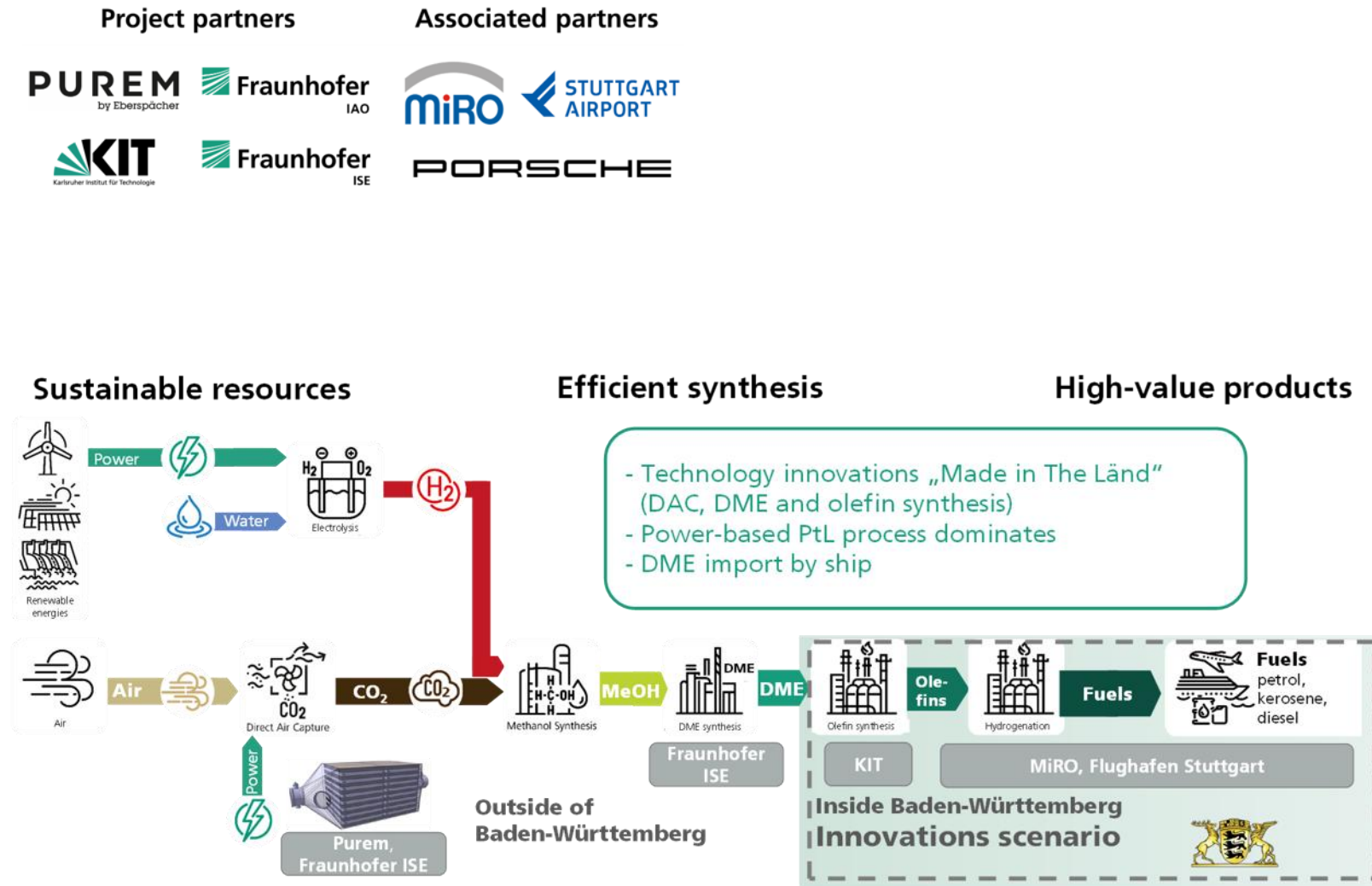


2) DME as a Platform Molecule for the Production of e-fuels

e-Fuels-fürs-Länd-Projekt

Project Goals

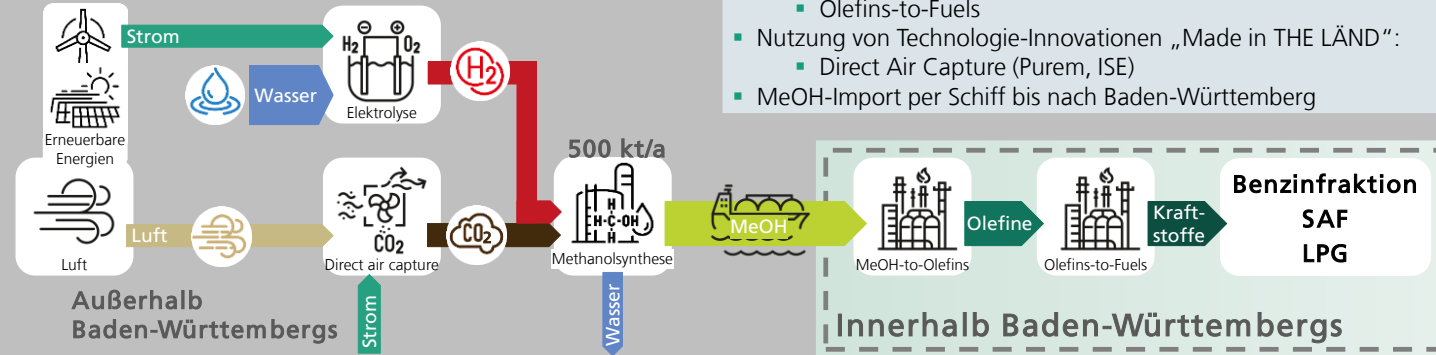
- Assessment of different scenarios for production of DME-based e-fuels regarding fuel production costs and value added in Baden-Württemberg
- Comparison of DME-based e-fuels with state-of-the-art technologies (e.g. e-methanol/reference scenario)
- Showcase a concept for an early business case for e-fuels in Baden-Württemberg based on DME



DME as a Platform Molecule for the Production of e-fuels

ii) Referenz-Szenario (2035)

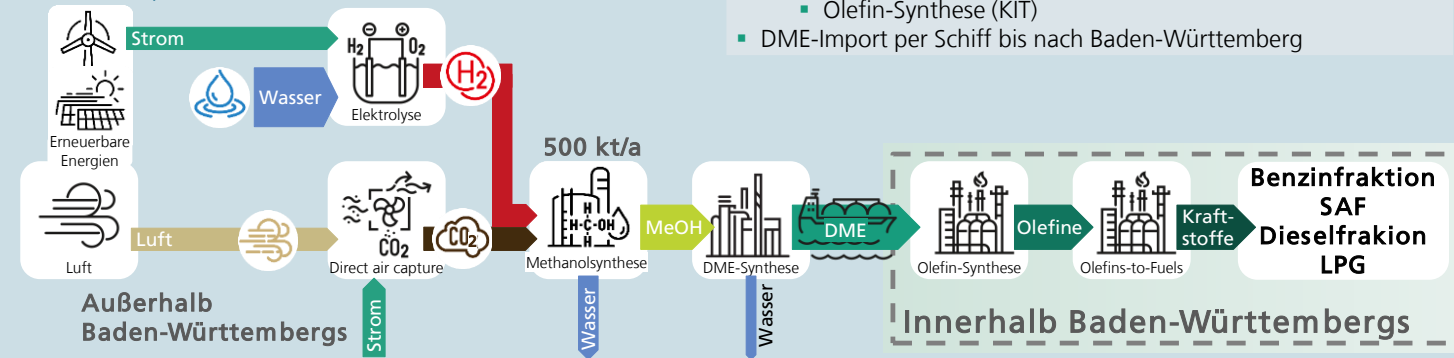
Exportregion: je ein Szenario für
Finnland, Spanien und Brasilien



e-Fuels-fürs-Länd-Projekt

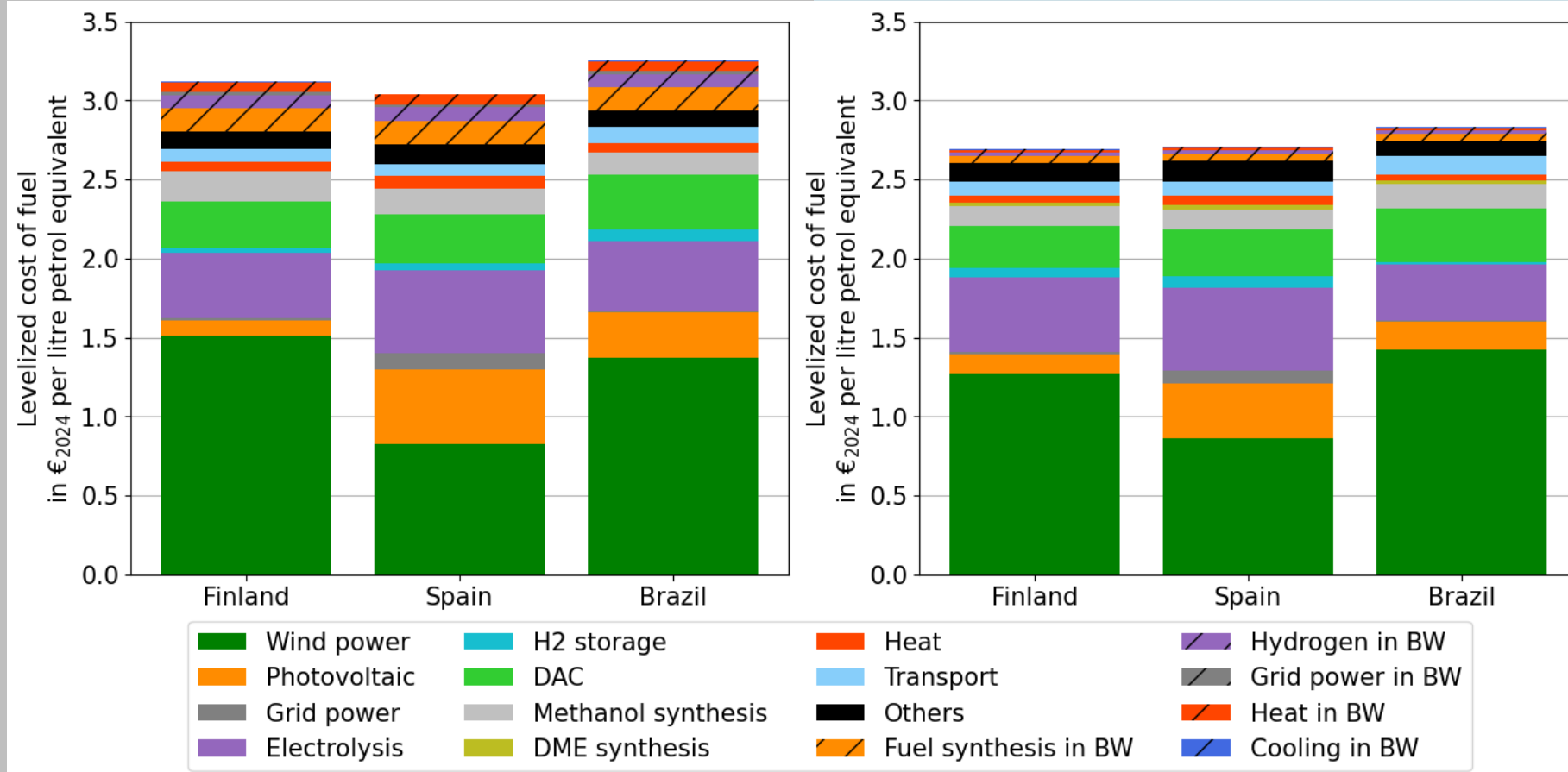
iii) Innovations-Szenario (2035)

Exportregion: je ein Szenario für
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DME as a Platform Molecule for the Production of e-fuels

e-Fuels-fürs-Länd-Projekt – Report [1]



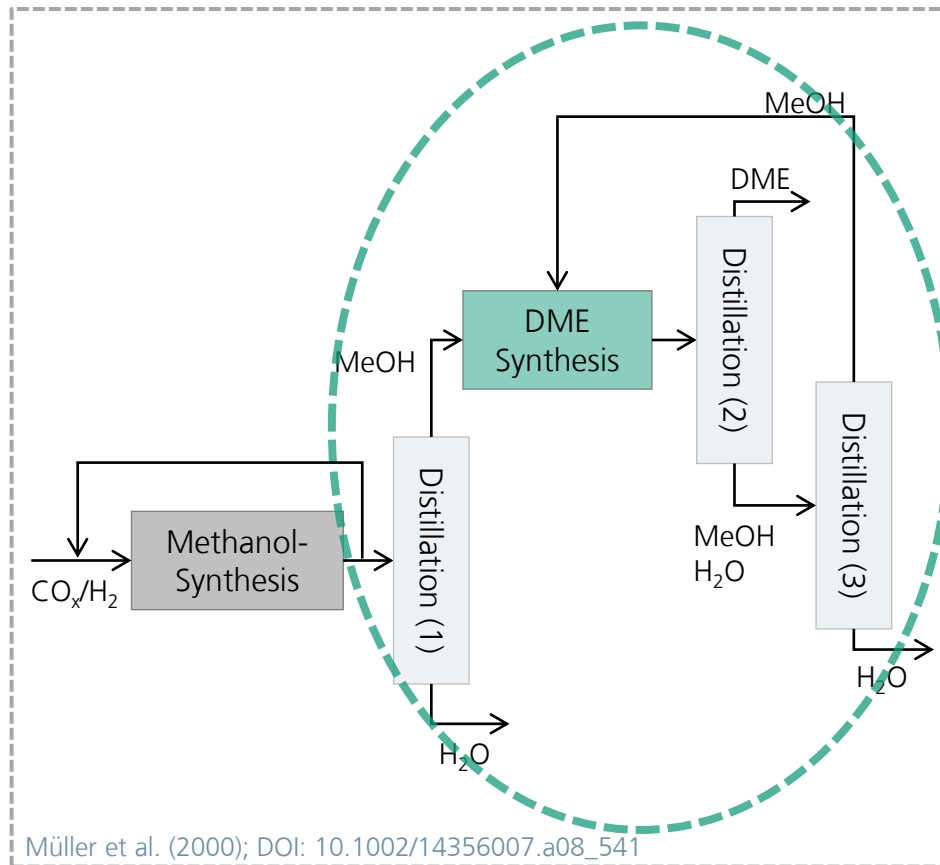
Reference scenario: Methanol transport & methanol to fuel

Innovation scenario: INDIGO & DME transport & DME to fuel

DME Synthesis: INDIGO Technology by Fraunhofer ISE

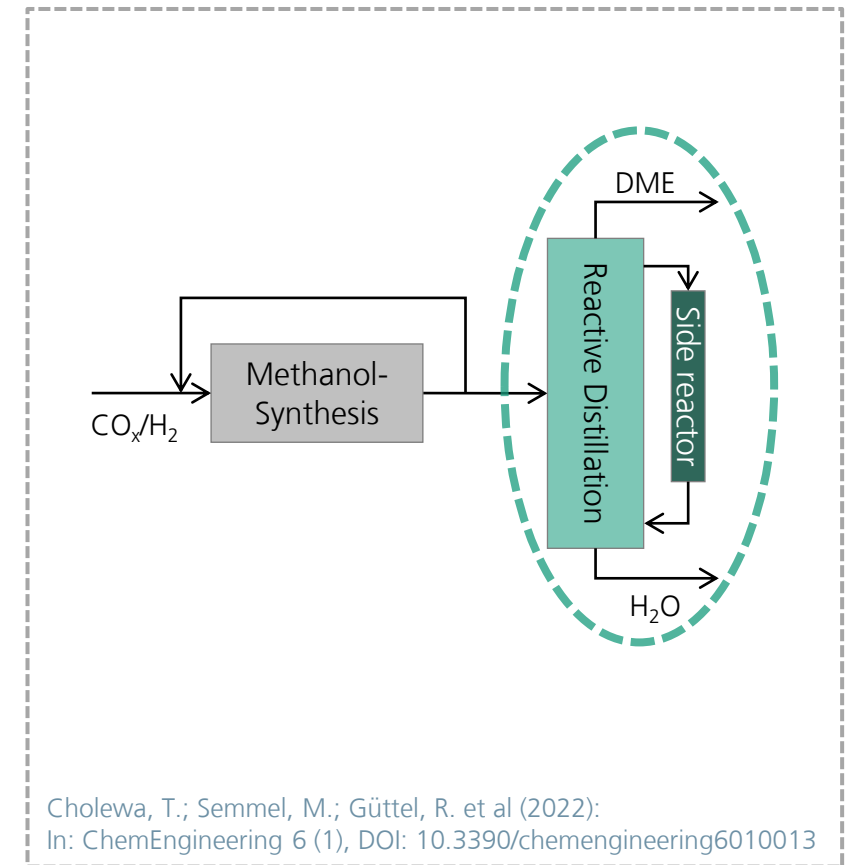
Patent Granted: DE102022114811B4

Conventional Process



Reactive distillation

INDIGO Technology



World's First DME Production Directly from Crude MeOH

Pilot Campaign with thyssenkrupp Uhde

- **Feedstock: Real crude MeOH including contaminants from side reactions** from CO₂-based methanol synthesis with commercial catalyst from Carbon2Chem Pilot plant ^[1].
- Stable day/night operation for more than **400 h** TOS with very low catalyst deactivation.
- **Fuel-grade DME product** was achieved in a single catalytic distillation unit without further purification steps.
- Successful validation of **Aspen Plus process simulation** based on piloting campaign.

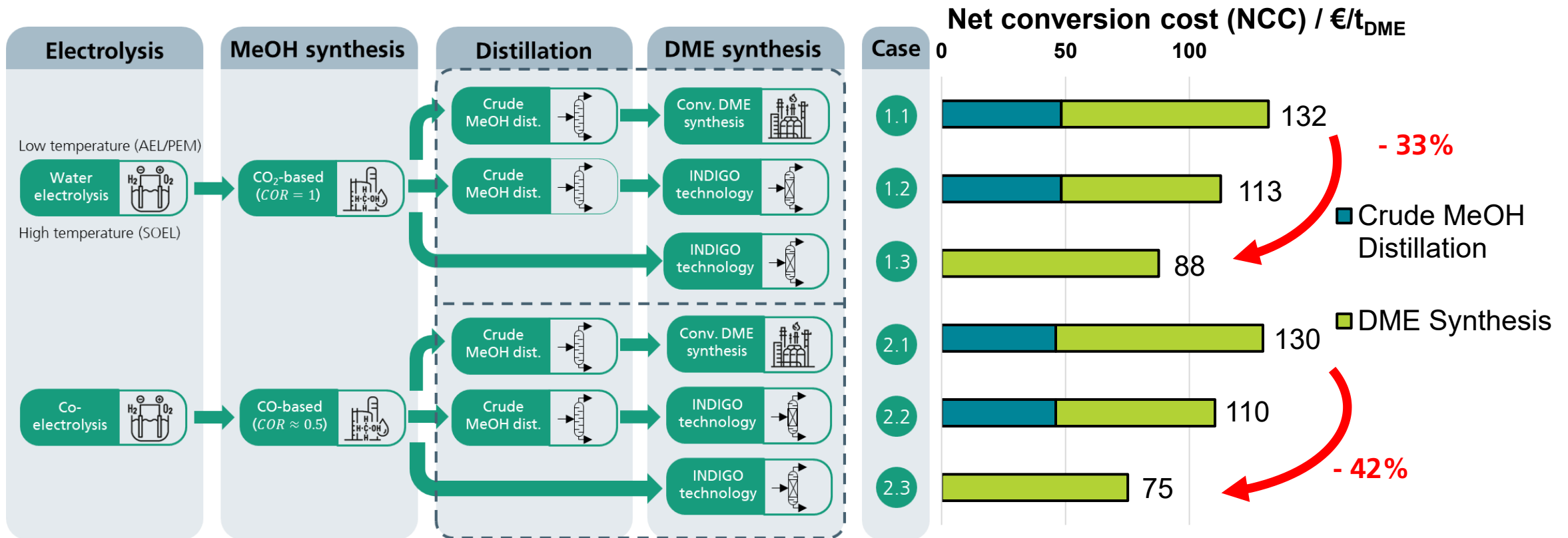
DN 50 distillation column,
commissioning & operation
since 2024



INDIGO Technology

Assumptions:
 Electricity price: 166.5 €/MWh
 Nat. gas price: 22.8 €/MWh
 Depreciation period: 20 years
 Interest rate: 5 %
 Labor cost: 54 €/h

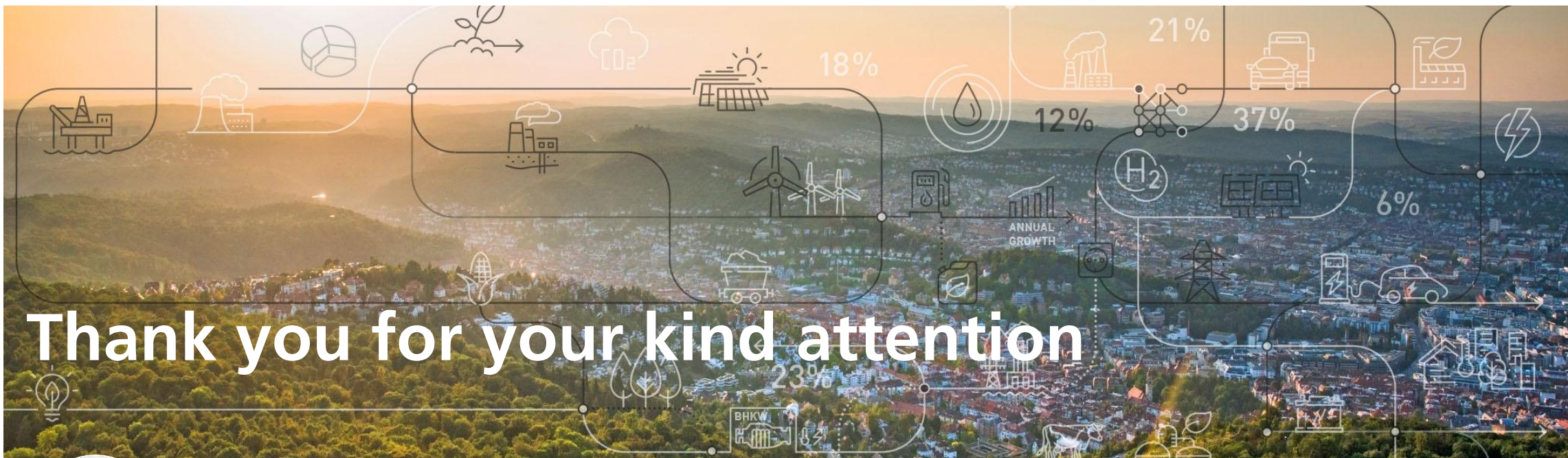
Techno-Economic Analysis [1]



Summary & Conclusions

- DME is already commodity chemical. Due to its advantageous properties, there is enormous market potential as a
 - **Global point-to-point energy carrier** and
 - **Platform molecule for fuels and chemicals.**
- **Many components of the DME value chain are already available. Biomass is an important feedstock.** This enables a **fast ramp-up and resilience.**
- **Future cost reduction** will be realized through **global scale-up** and **technological improvements** by optimization in syngas production and process intensification.
- **INDIGO technology from Fraunhofer ISE enables significant cost reductions.**





Achim Schaadt

achim.schaadt@ise.fraunhofer.de

Head of Department Sustainable Synthesis Products



Robert Szolak

robert.szolak@ise.fraunhofer.de

Head of Department Sustainable Synthesis Products



Elias Frei

elias.frei@ise.fraunhofer.de

Director Division Hydrogen Technologies
Deputy Director Institute

Fraunhofer Institute for Solar Energy Systems ISE, 79110 Freiburg, Germany, www.ise.fraunhofer.de