Der reFuels-Ansatz von der Forschung zur industriellen Praxis

The reFuels approach: from research to industrial practice

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20.01.2026

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1. reFuels as an academic-industrial cooperation project
2. reFuels on the way to a demonstration plant
3. reFuels in implementation

reFuels as an academic-industrial cooperation project

Names of synthetic Fuels: Definition reFuels

reFuels fuels produced from non-fossil carbon and CO_2 sources, including advanced biofuels, in particular hydrocarbons produced using renewable hydrogen.

reFuels comprise all eFuels and biofuels and must be produced from renewable sources and be usable in existing vehicles.

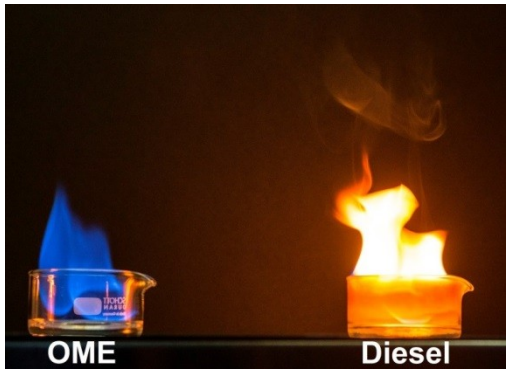
Reducing greenhouse gas levels in the atmosphere requires circular processes!

reFuels as an academic-industrial cooperation project

Classification of reFuels by Source and Process

Drop-in, blend components and feedstock for

- **Pressurized and liquefied gases:**
- **Liquid hydrocarbon fuels (Drop-in-Fuels)**
  - Fischer-Tropsch Diesel, Jet Fuel and gasoline
  - Methanol-to-Gasoline
  - Oligomeric gasoline (alkylate based petrol)
  - Synthetic aromatics (blend components)
- **Oxygenates (blend components):**
  - Methanol
  - Ethanol, Butanol
  - Octanol
  - Oxymethylenether (OME)
  - Methyl-tert.-butylether (MTBE)
- **Bio-oil and waste-oil co-processing feedstock**



reFuels as an academic-industrial cooperation project

Key question:

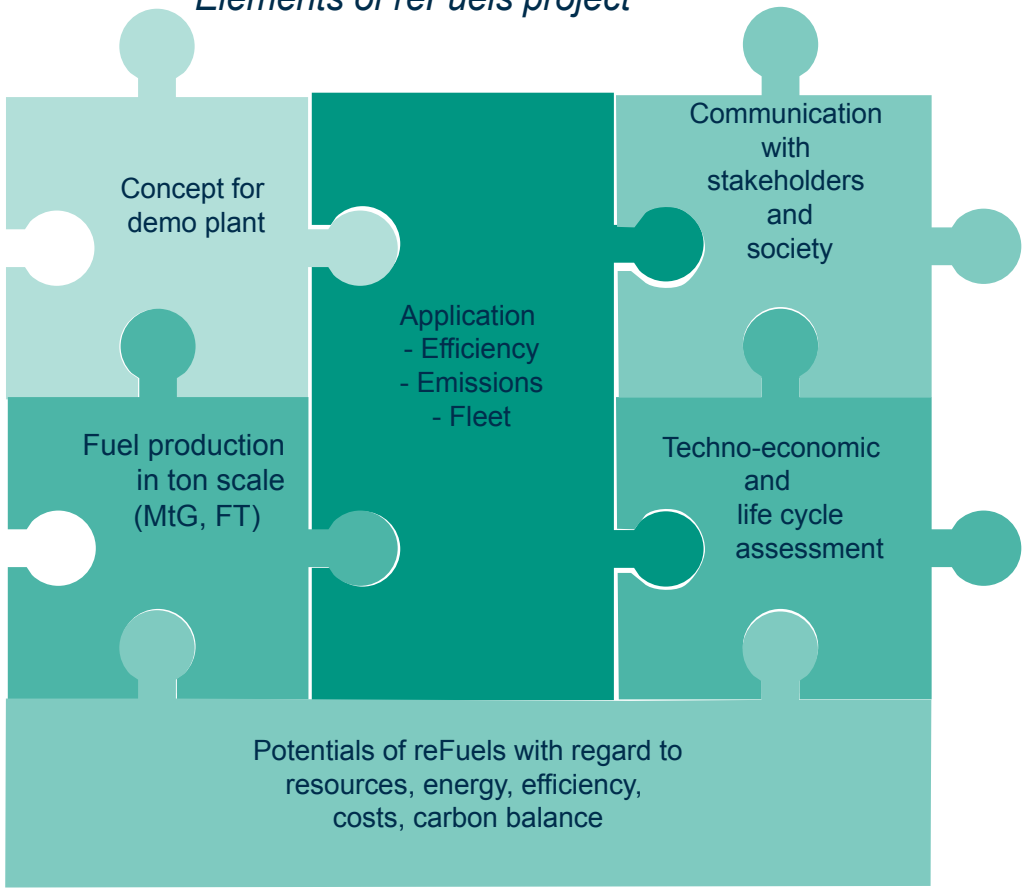
We produce fuels and demonstrate that they comply with standards.

- Project starting point: interdisciplinary „Strategiedialog Automobilwirtschaft“ vom the state of Baden-Württemberg, industry and science
- Industrial-scientific workshop at KIT showed urgent necessarity to speed up the introduction of reFuels

→ **Joint application** for state support,

coordinated by KIT

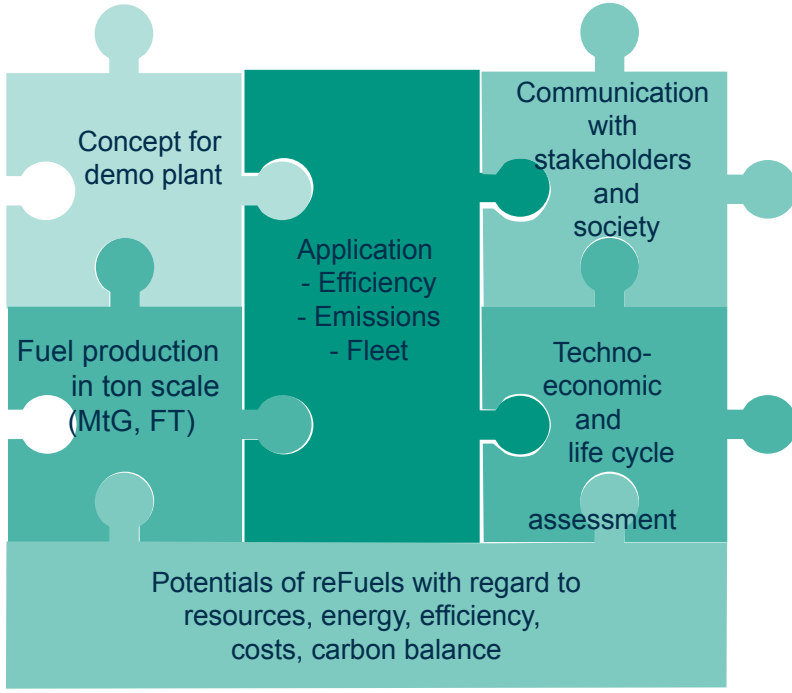
Elements of reFuels project

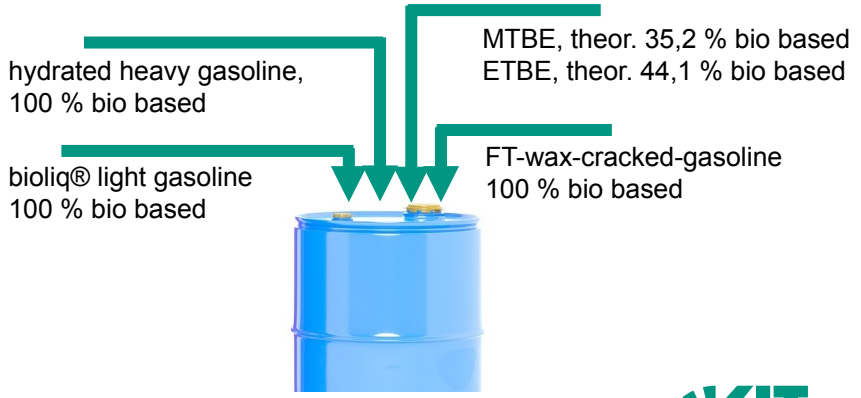


reFuels as an academic-industrial cooperation project

Major results:

- Provision and validation of reFuels product samples (standard-compliant diesel and gasoline product samples) on a ton scale
- Increasing the technology maturity levels for methanol and Fischer-Tropsch-based processes
- Increasing carbon and energy efficiency through the efficient use and processing of co-products and through the use of energy and material flows from coupled plants in the integration of processes
- Stakeholder discourse and communication of results to society
- Increase in blending ratios up to "reFuels pure fuel"





Source:Ergebnisbericht reFuels https://doi.org/10.5445/IR/1000159935

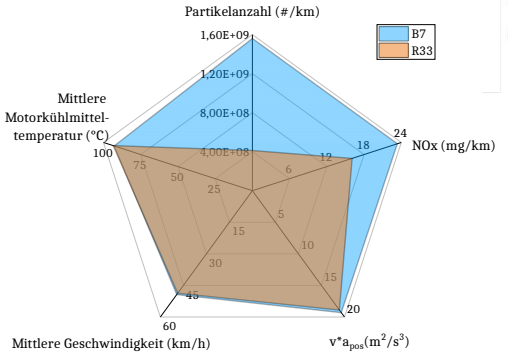
reFuels as an academic-industrial cooperation project

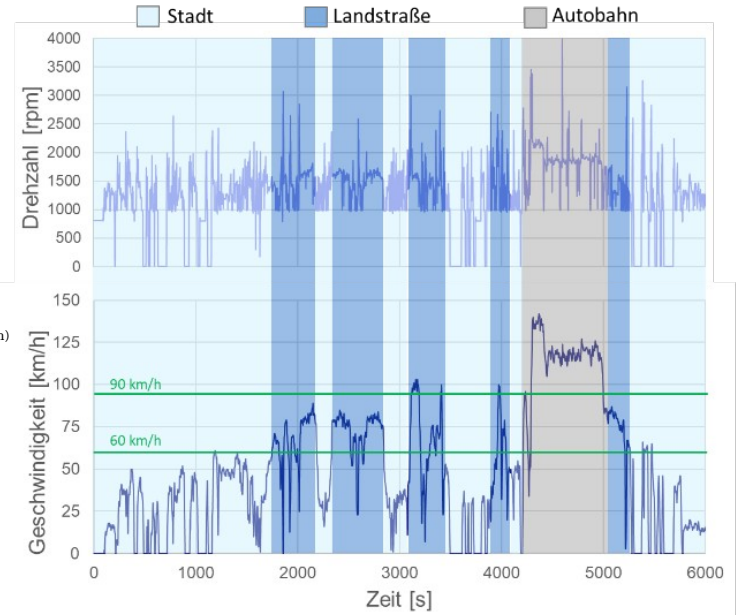
Key question:

What would it look like if this technology were integrated into the existing fuel production infrastructure?

- source_: Müller – die LILA Logistik

- Analysis of the boundary conditions for implementing reFuels in existing refinery infrastructures
- Holistic assessment – manufacturing processes, manufacturing costs (techno-economic assessment), product properties, environmental impacts (life cycle analysis), and application in existing vehicles.
- Detailled engine emission testing showed significant emission reduction potential
- Endurance run in cooperation with a haulage company covering approx. 1.6 million kilometers





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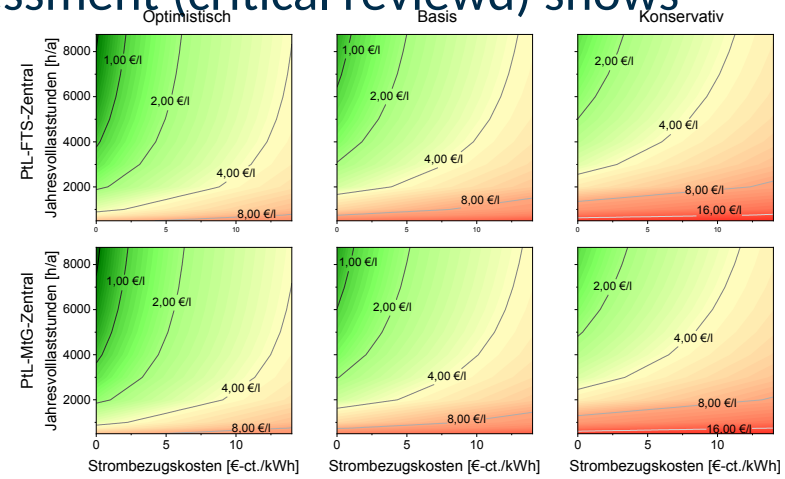
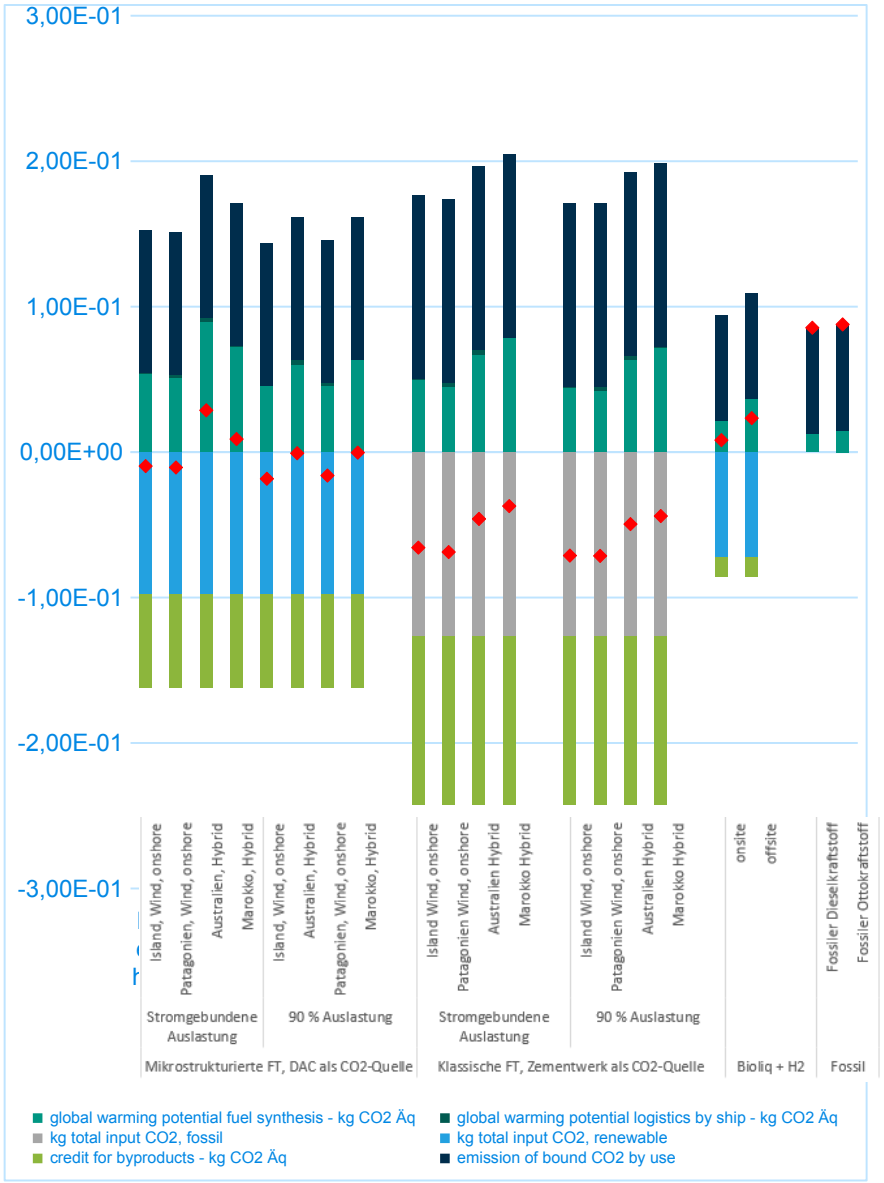
reFuels as an academic-industrial cooperation project

- reFuels in stakeholder discourse: A position analysis by associations from business, environmental, and civil society (https://doi.org/10.5445/IR/1000128394)
- Social implications of renewable fuels in expert discourse (https://doi.org/10.5445/IR/1000128396)
- Regenerative fuels viewed within the system: on the role of reFuels in energy system analyses (https://doi.org/10.5445/IR/1000128395)
- Techno-economic analysis incl. senstivities
- Ecological life cycle acessment (critical reviewd) shows reFuels as **GHG-negative**!!!





Source:Ergebnisbericht reFuels https://doi.org/10.5445/IR/1000159935

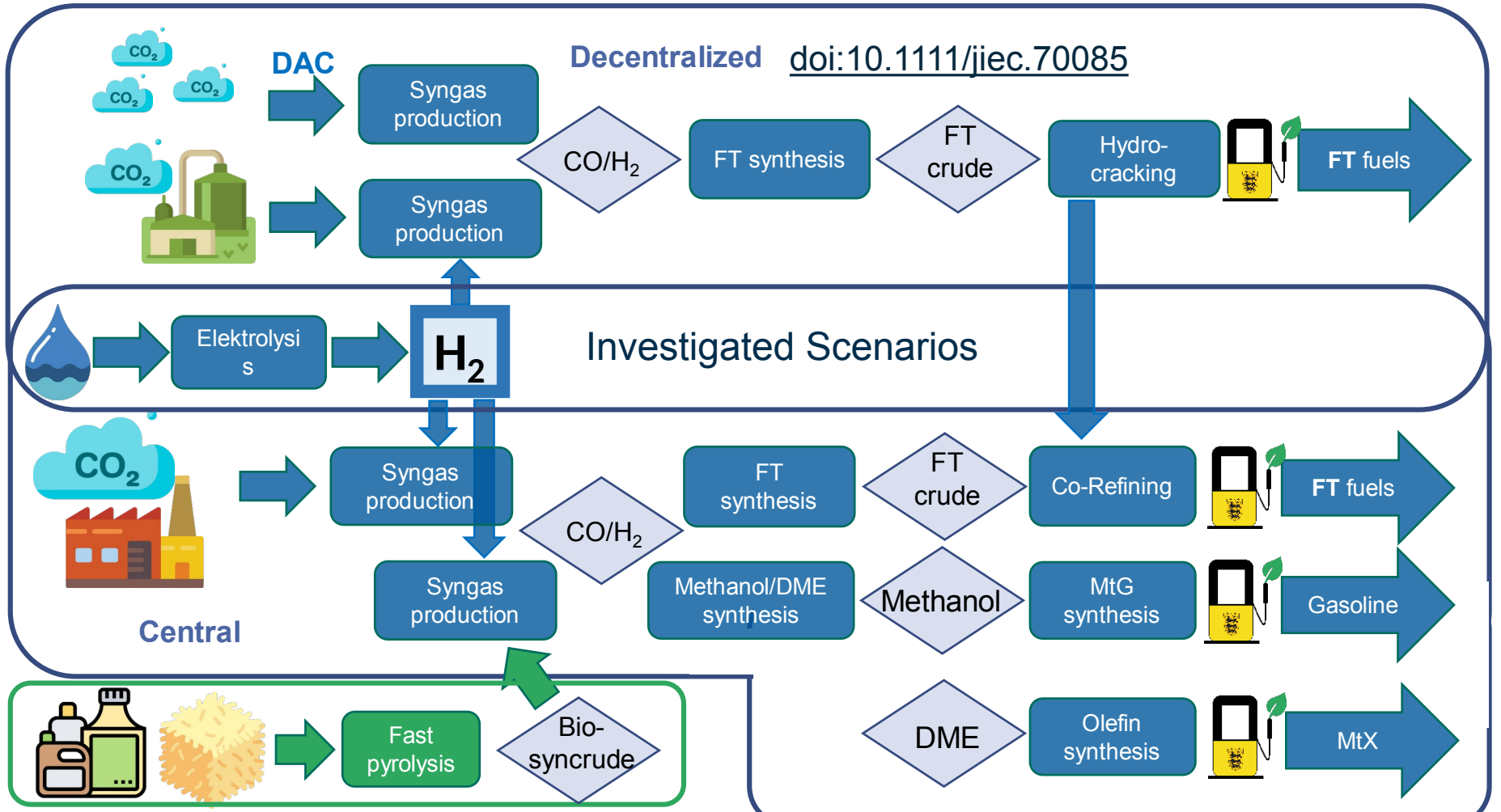
reFuels as an academic-industrial cooperation project

Key questions:

- centralized or decentral production?
- Fischer-Tropsch or Methanol or Pyrolysis path?

Technology	Decentralized	Central	Extended central	Central with biomass + H_2	International large scale plant
Fischer-Tropsch micro-reactor	Biogas as CO_2 source	Modular plant			
Fischer-Tropsch „classical" synthesis		Refinery or cement plant with CO_2 separation & H_2O electrolysis	Industrial complex with several CO_2 sources or pipeline	Biomass to liquid with renewable H_2-addition	World scale FT with DAC + desalination of sea water
Methanol-to-gasoline	Bioliq BtL concept			MtG BtL as above	

➔ Several selected synthesis paths to be investigated

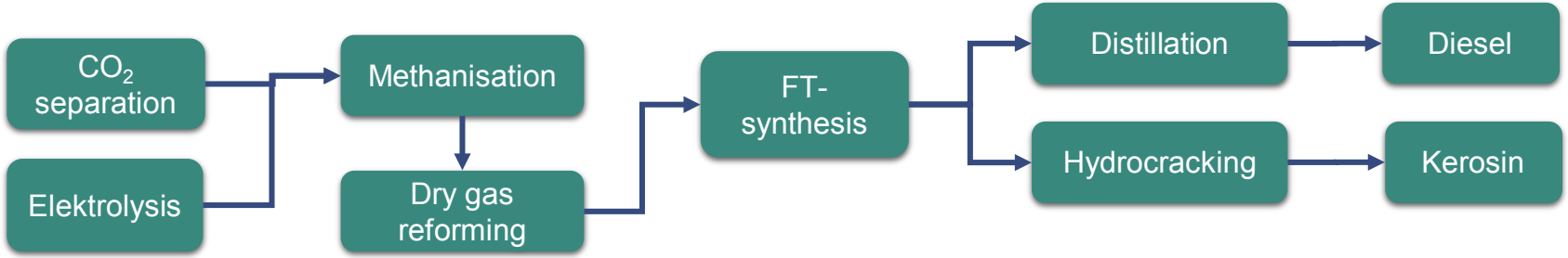


https://doi.org/10.1021/acs.energyfuels.3c04524

reFuels auf dem Weg zur Demoanlage

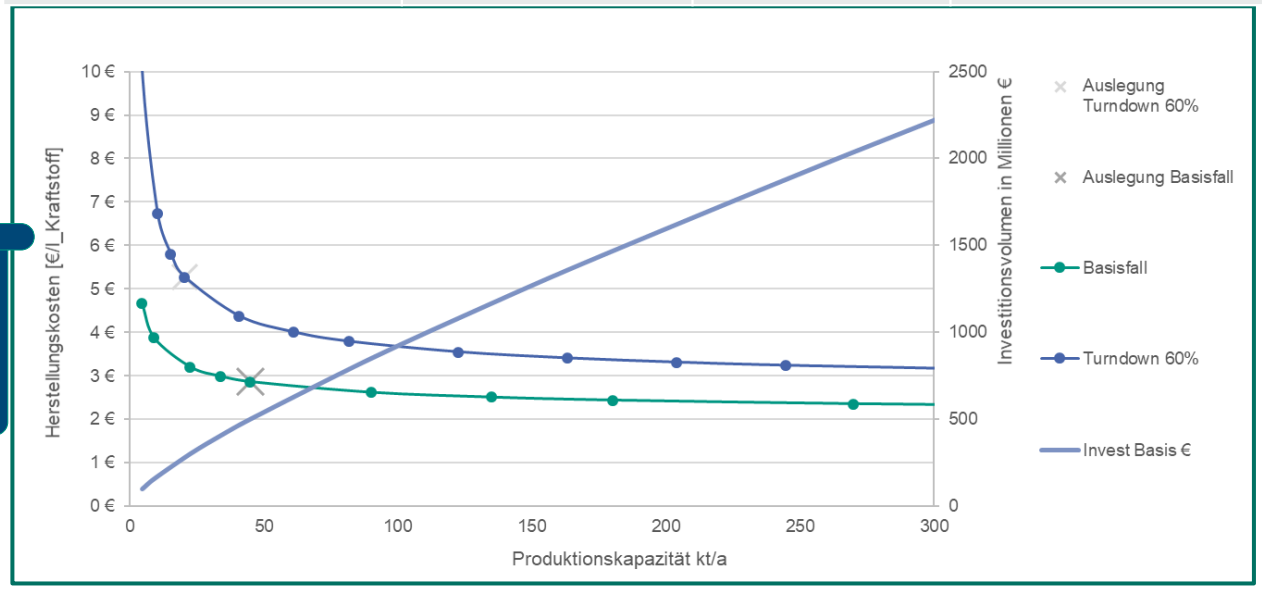
Key question:
In which way reFuels can be produced in existing infrastructure?

- Refinery integrated FT-synthesis using FCC-cracker off-gas via dry gas reforming, RWGS and SOEC
-
-
-



	DGR base	RWGS	Co-SOEC
C-utilization	61 %	85 %	100 %
CO_2-reduction	7,3 t/h	12,5 t/h	14,2 t/h
Product capacity	20.400 t/a	27750 t/a	38500 t/a
Energy recovery	42 %	50 %	52 -55 %

EU RED II Delegated Acts

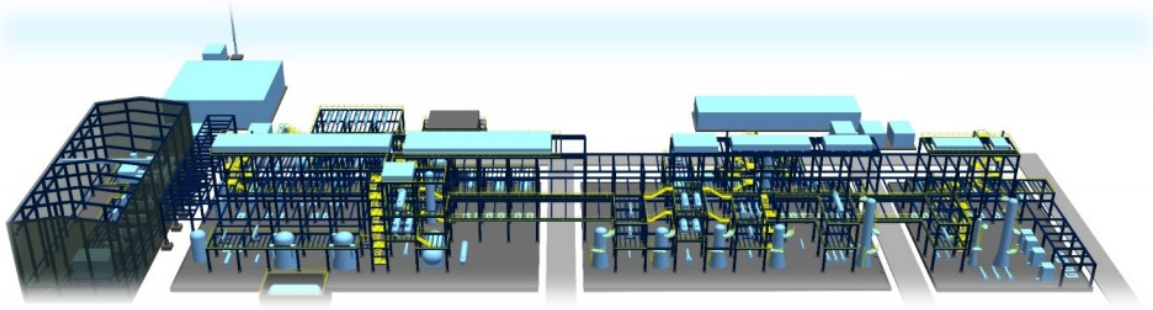


Source: Ergebnisbericht reFuels – Kraftstoffe neu denken DOI: 10.5445/IR/1000159935

reFuels on the way to a demonstration plant

Key question:
What do you need to do to get involved in a larger project?

- Projects in southern Germany must be adapted to intermediate products (MeOH and FT crude) as educts, as delegated acts require electrolysis and CO_2 processing to be relocated to preferred regions.



Source: Ergebnisbericht Forschungsunterstützte Maßnahmen zur Transformation von Anlagen für klimaneutrale Kraftstoffe (reFuels) in den industriellen Maßstab; DOI : 10.5445/IR/1000189548

- Methanol-to gasoline (MtG) and Methanol-to-Jet via olefines (MtO – OtX) as preferred pathway
- Analysis of Fischer-Tropsch as „supplying path“ for additional blending components

Source: Mineralöraffinerie Oberrhein MiRO

Political focus on synthetic jetfuel

- Detailed analysis MtO – OtJ with higher yields on kerosene after pricipal feasability was shown in seperate study

Source: DOI : 10.5445/IR/1000189548

reFuels on the way to a demonstration plant

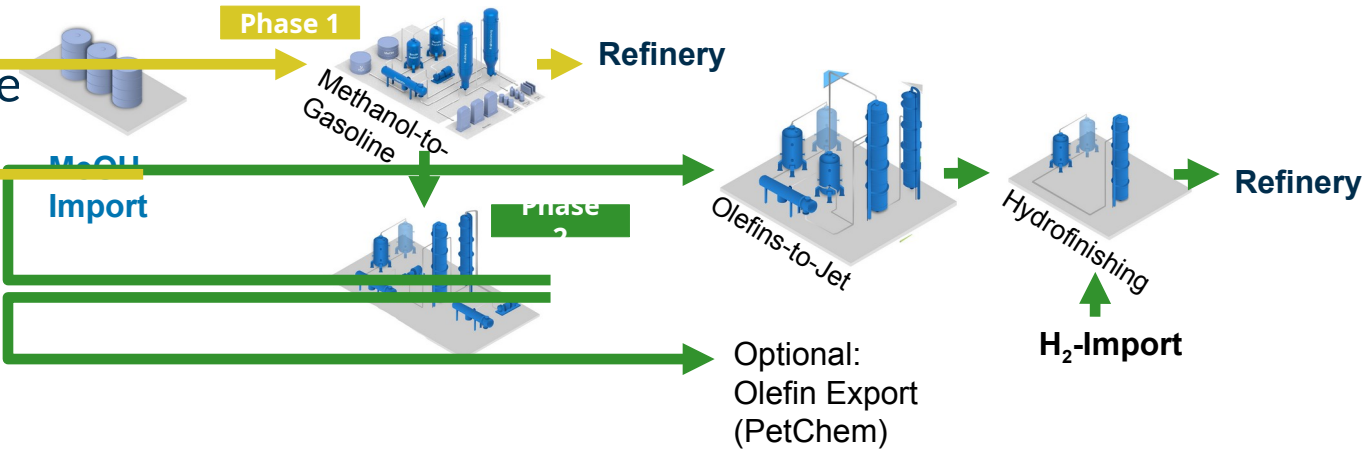
Key question: How can we mitigate the risk of the balancing act between technical maturity and market readiness?

How advantageous is a modular concept (first gasoline, then jet fuel)?

- Premium factor for kerosine is generally higher
- DME shows advantages related to MeOH

→ separate research activities (reFuels for the Länd)

- Life cycle and techno-ecological ass.



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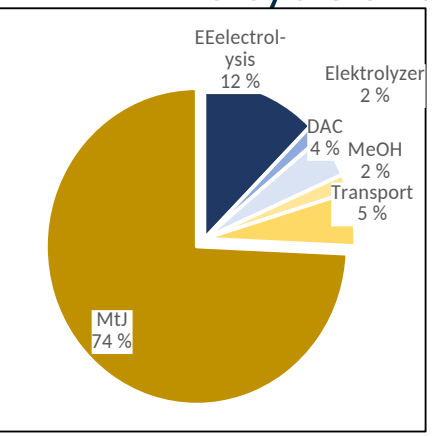
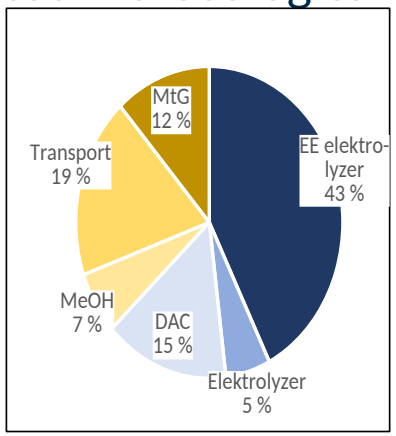
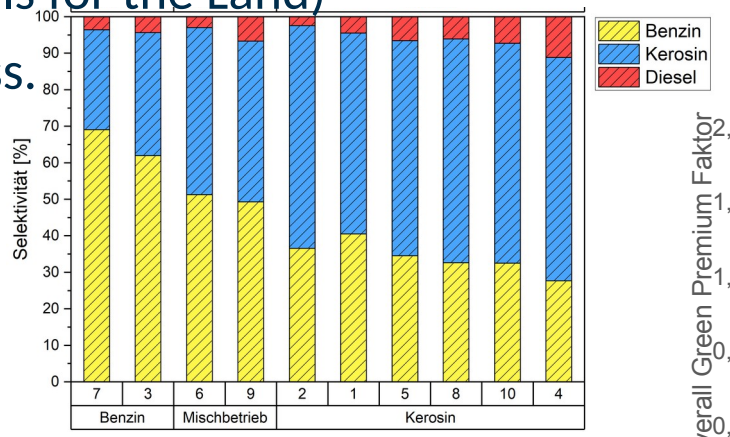
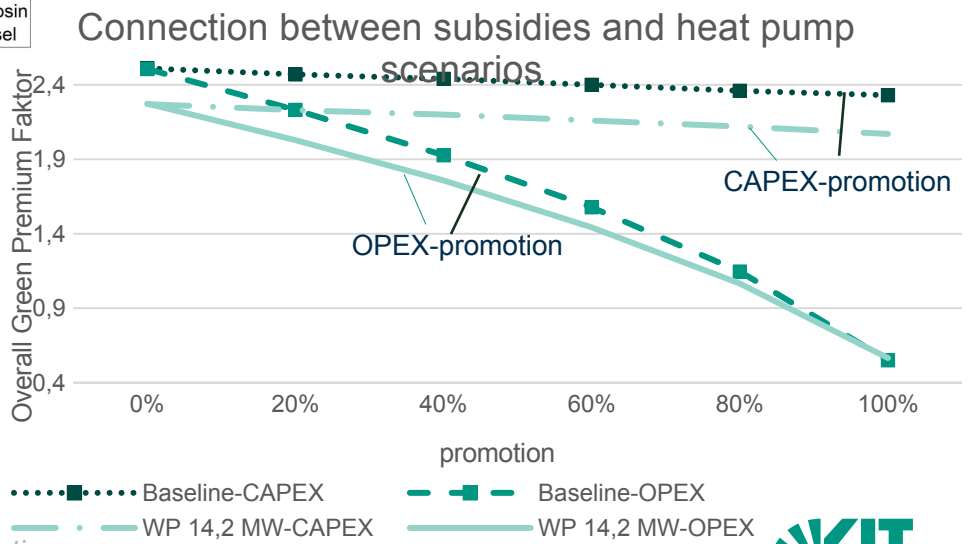








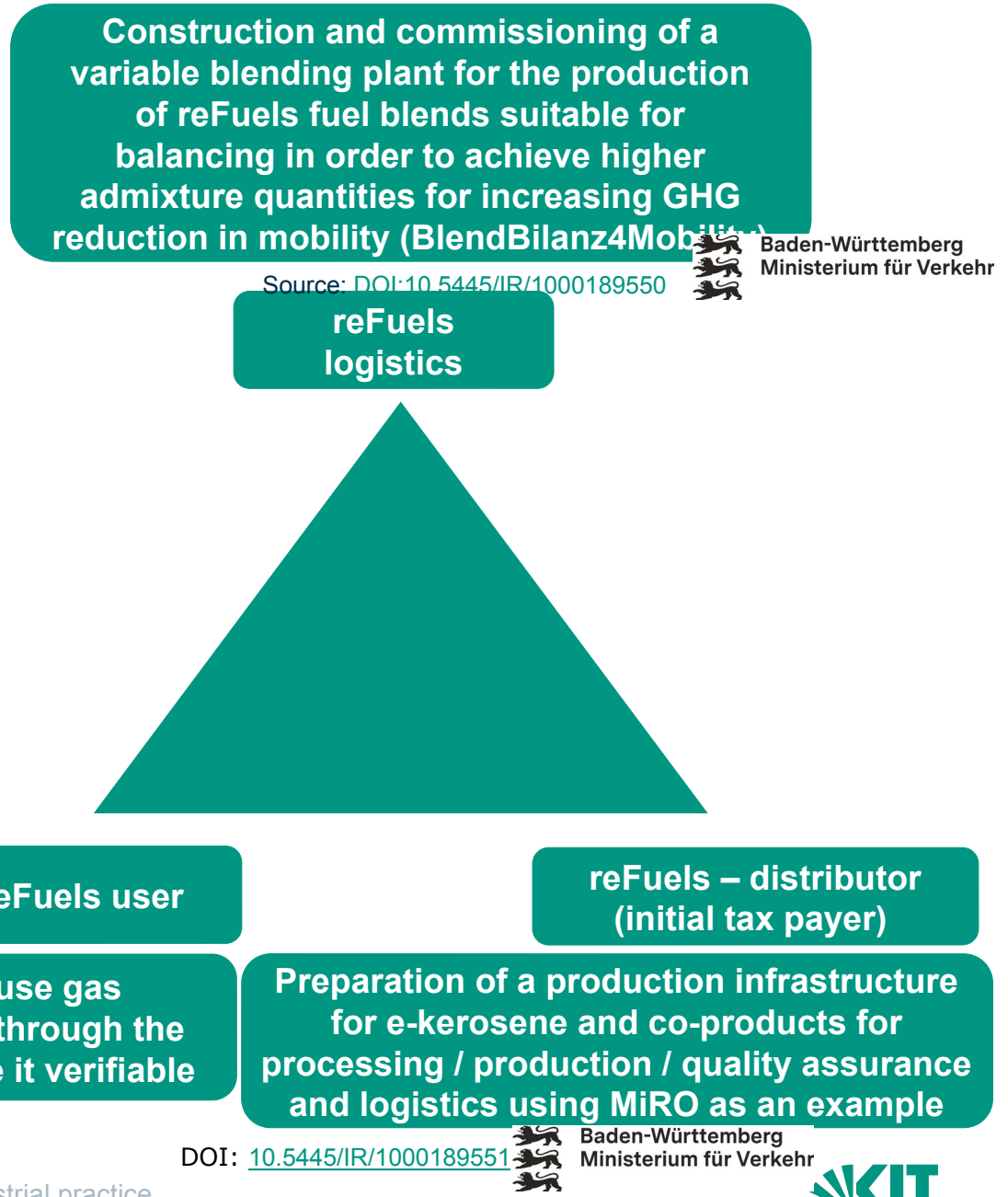
reFuels in implementation

Key question:

How can I best put the fuels to use?

Closing the gaps between the stakeholders

- How can I enable smaller blend quantities during ramp-up? (blending as enabling supporter)
- How and where do I blend SAF jet fuels and ensure the required fuel quality?
- How do I convert refueling options? (example implementation in a closed private boating environment)



reFuels in implementation

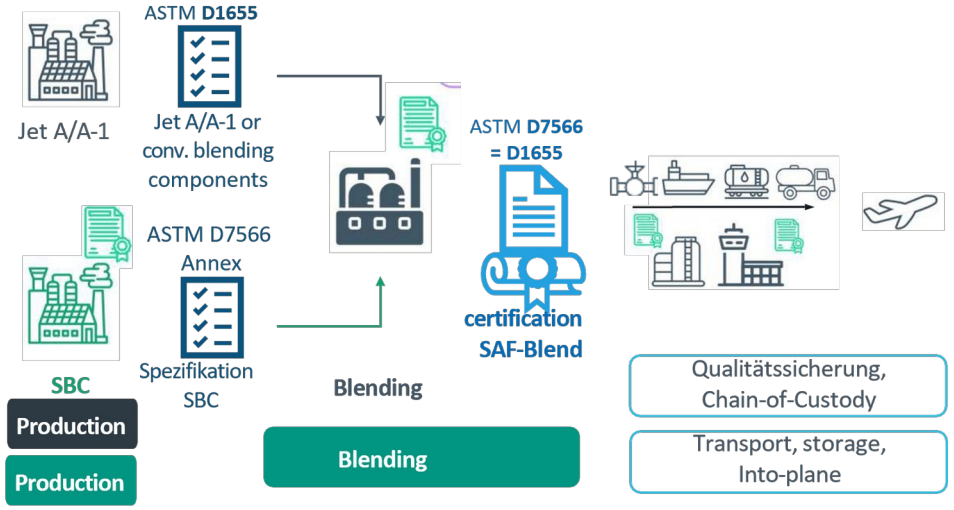
Key questions:

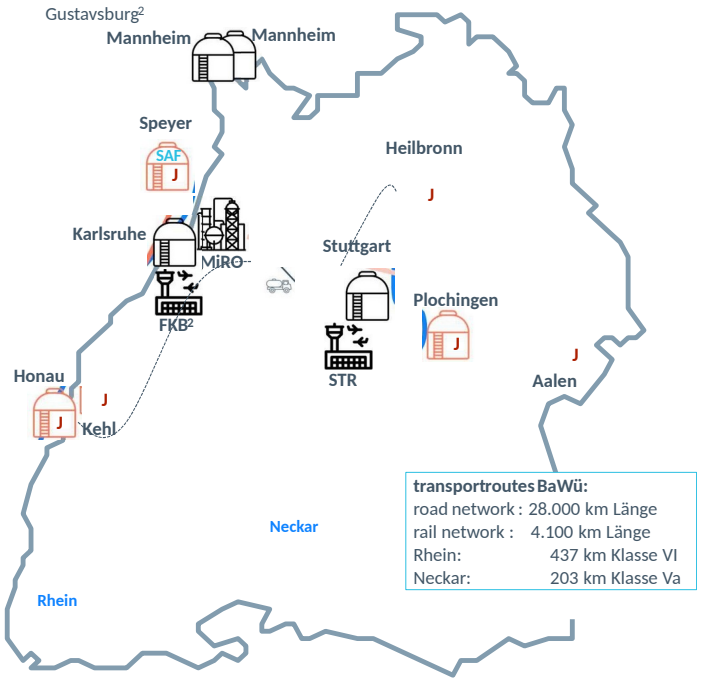
How can I best put the fuels to use?

How and where can I blend jet fuels and ensure the required fuel quality for the Stuttgart and Karlsruhe applications?

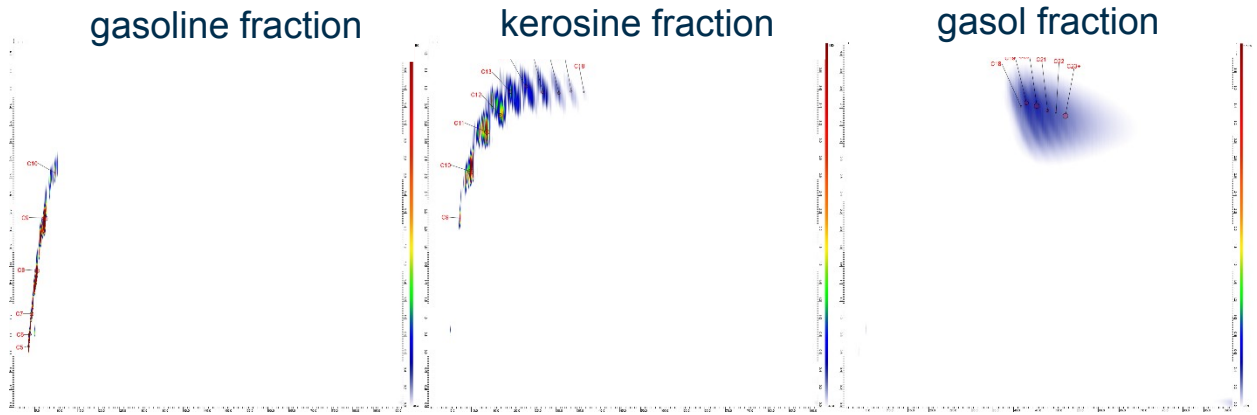
Results:

- Development of a prediction model for the distribution of partial products in the synthesis of re-kerosene
- Optimization of the yield of re-kerosene from the quantity of partial products
- Concept study on the development of a scalable infrastructure for kerosene fractions, taking into account geographical and technical conditions





Source: Ergebnisbericht Vorbereitung einer Produktionsinfrastruktur für e-Kerosin und Koppelprodukte für Verarbeit Produktion/ Qualitätssicherung und Logistik am Beispiel der MiRO, DOI: 10.5445/IR/1000189551



reFuels in implementation

Implement greenhouse gas reduction at Bodensee through the use of reFuels and make it verifiable

Key question: How can I best put the fuels to use?

What obstacles arise?

- due to the potential unsuitability of old boats
- The conversion of marine fuel stations? (organizational obstacles)
- Availability, prices, boat owners' concerns about incompatibilities, and how can these be addressed?
- How high is the respective fuel-dependent greenhouse gas footprint per tank filling?
- How can other neighboring countries be involved and motivated?

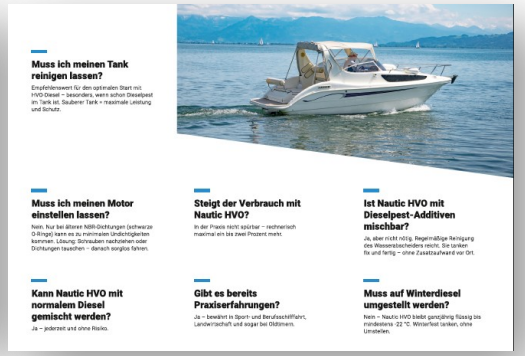
Source: Ergebnisbericht reFuels Bodensee

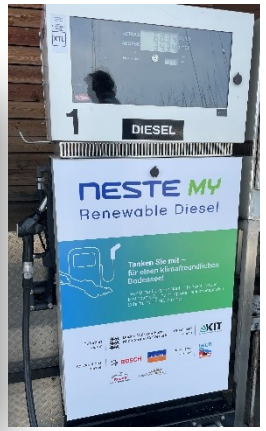
reFuels in implementation

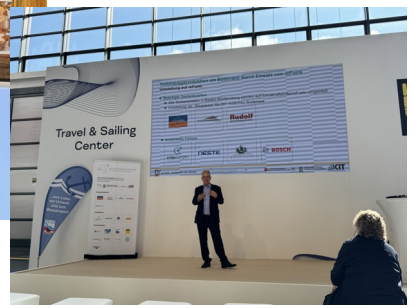
Implement greenhouse gas reduction at Bodensee through the use of reFuels and make it verifiable

Results:

- Fuel quality as a deciding factor for implementation (Nautic E10 + Nautic HVO)
- Workshops with boat workshops incl. customer flyers
- Accounting of GHG-reduction as the key (linking Nabisy data with gas stations)
- Public visibility (political attention)

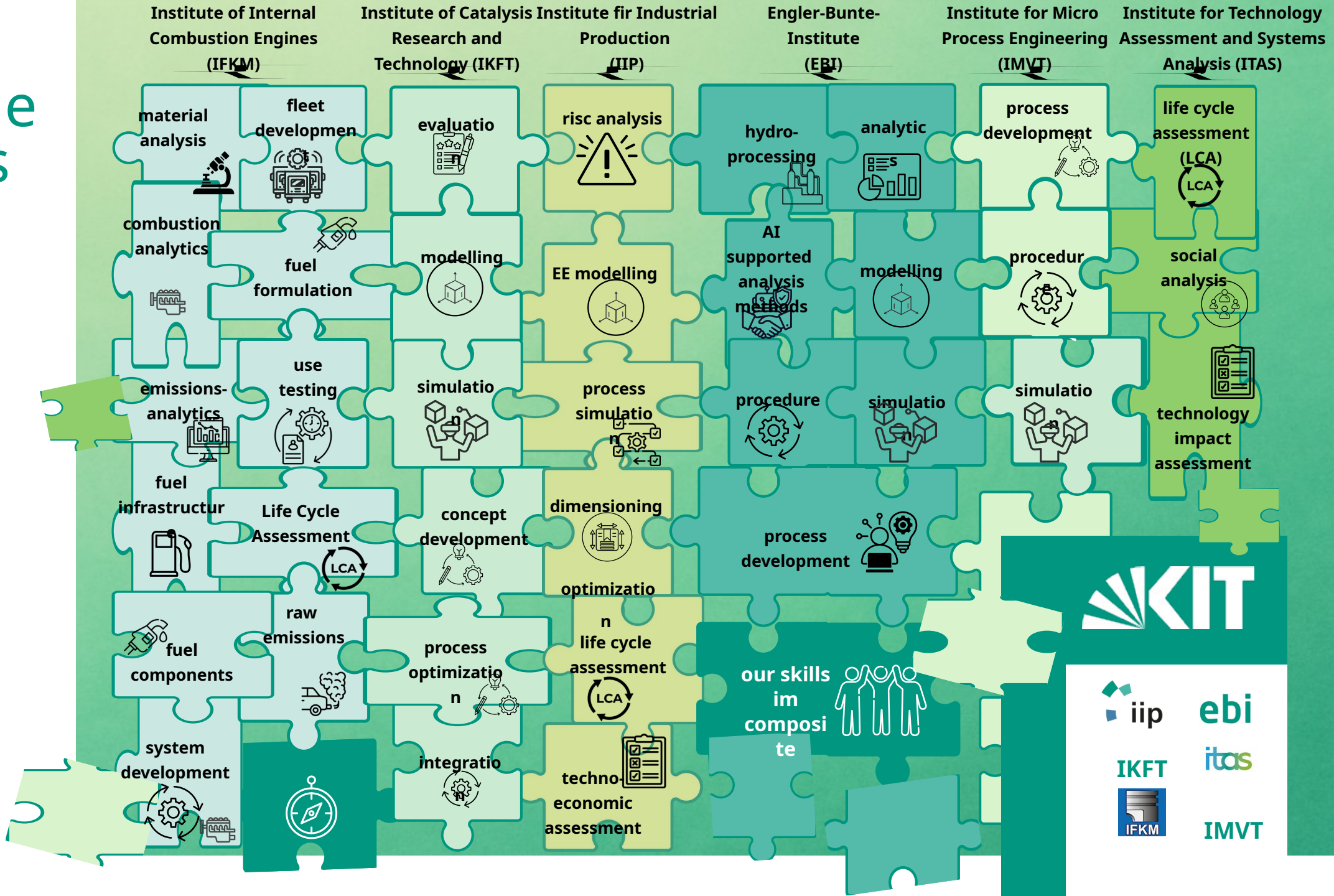






Source: Ergebnisbericht reFuels Bodensee

Our combined skills



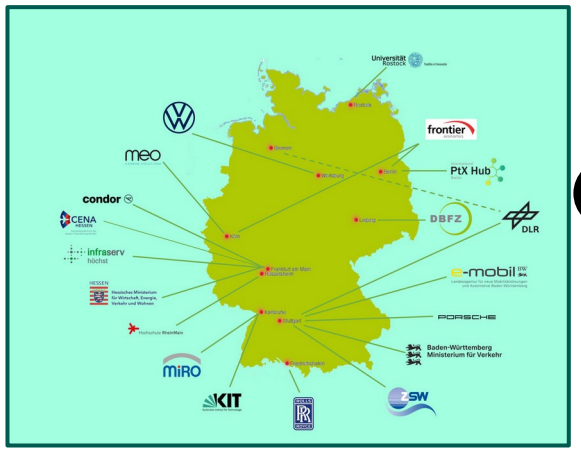
reFuels in implementation
Potential to be expanded by partner network

	2030	2035	2040
Rohstoffe Bioenergie Potenzial [Mtoe]	292 - 360	290 - 366	298 - 375
Verfügbare CNF* [Mtoe]	99 - 139	77 - 127	69-135
Kraftstoffbedarf Gesamtflotte Straße [Mtoe]	238 - 247	162 - 188	96 - 129
Anteil CNF an Bedarf Gesamtflotte	42 - 56%	48 - 68%	72 - 105%

* inkl. 1st Gen gem. RED und RFNBO gem. dt. Gesetzesentwurfs zur Umsetzung der RED III
>70% THG-Reduktion

INNO FUELS INNOVATIONSPLATTFORM

REFUELS



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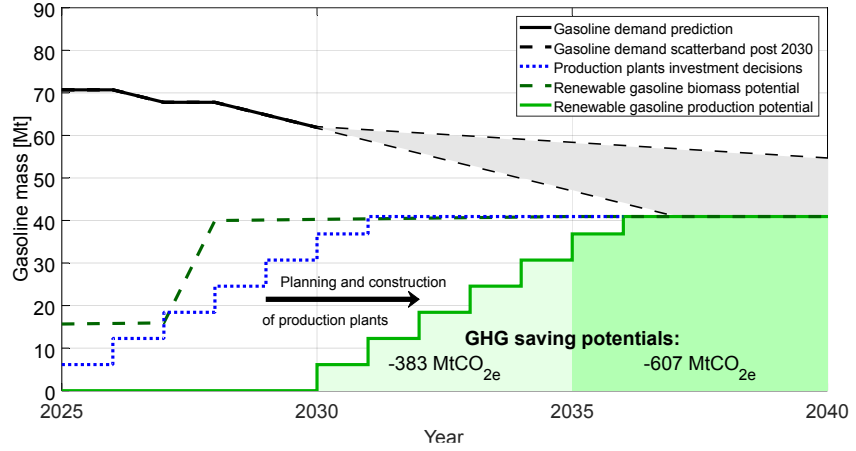
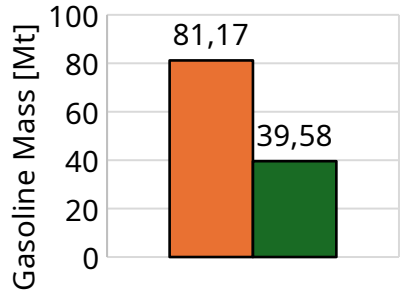
Aston University Birmingham UK · EBRI Energy & Bioproducts Research Institute · MATE Hungarian University of Agriculture and Life Sciences · vkm · KIT Karlsruhe Institute of Technology

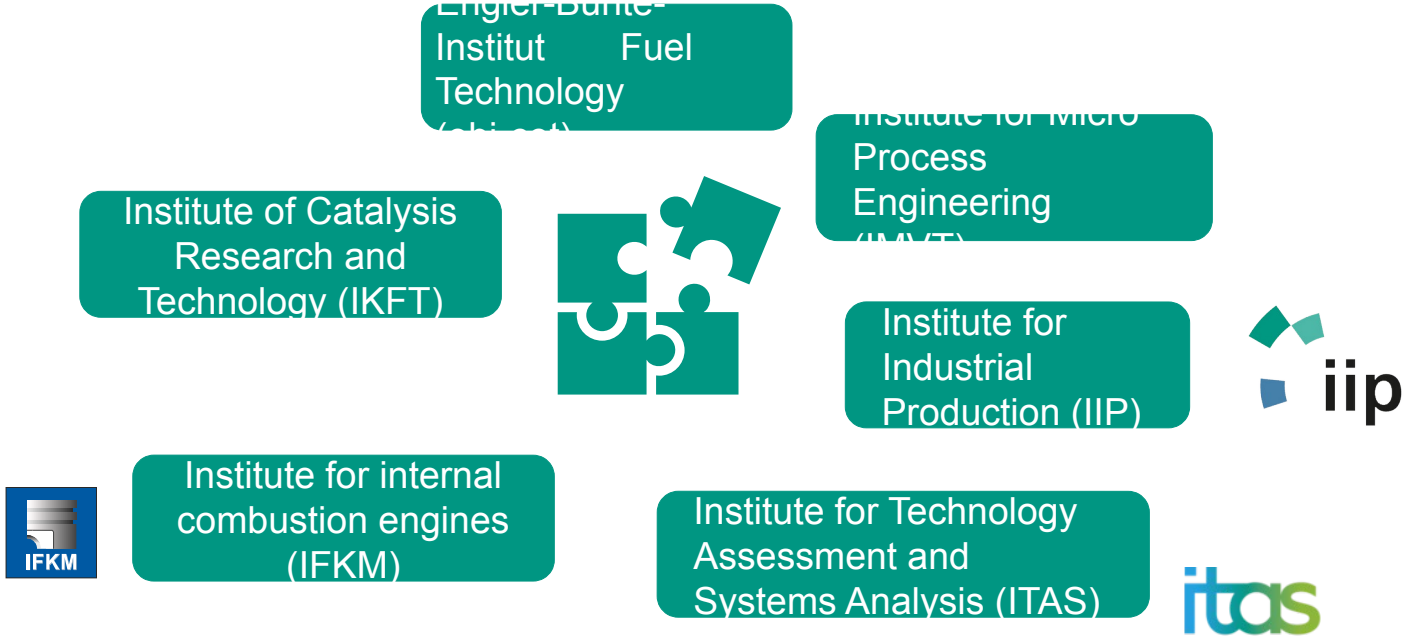




•Source: Analysis of the availability of sustainable, biogenic gasoline in Europe, DOI: 10.1007/978-3-658-49720-0_24

Leveraging synergies

Results achieved by leveraging existing synergies within the framework of our partner network.



We thank for the financial support and the constructive discussions and workshops of the projects by

Baden-Württemberg Ministerium für Verkehr

strategiedialog automobilwirtschaft BW

FUNDING PROGRAMME RENEWABLE FUELS

With funding from the Federal Ministry of Transport

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Project management agency VDI|VDE|IT FNR Fachagentur Nachwachsende Rohstoffe e.V.

Kontakt

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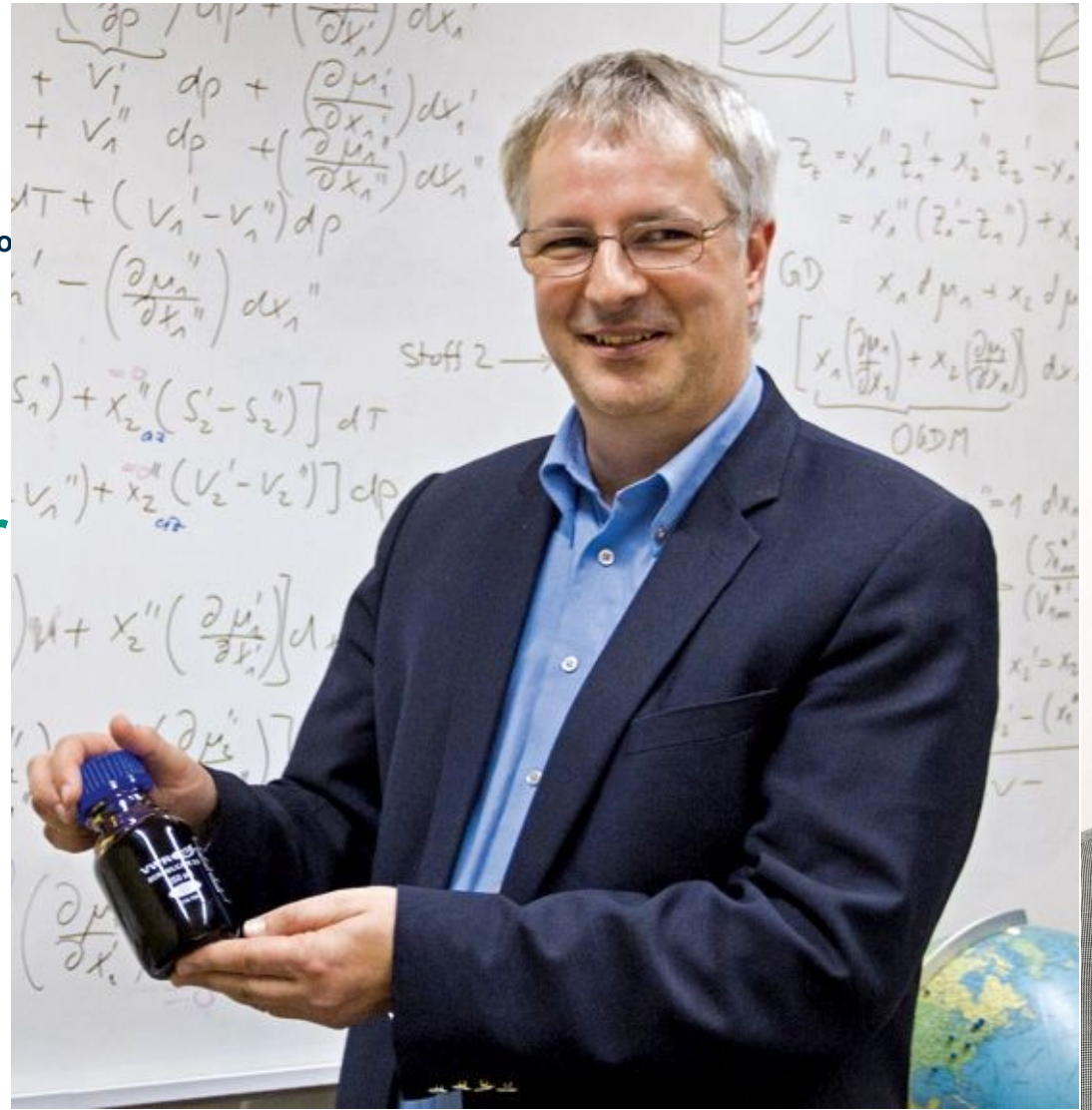

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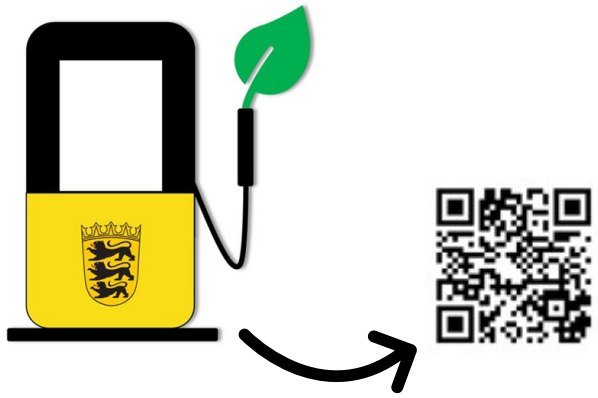

reFuels – Kraftstoffe neu denken

Baden-Württemberg
Ministerium für Verkehr

strategiedialog automobilwirtschaft BW

INNO FUELS
INNOVATIONSPLATTFORM

GESAMTKONZEPT ERNEUERBARE KRAFTSTOFFE

Gefördert durch: Bundesministerium für Verkehr

aufgrund eines Beschlusses des Deutschen Bundestages

Koordiniert durch: NOW GMBH

Projektträger: VDI VDE IT, FNR

REFUELINERTURE

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reINVENT - reFUELS

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