Deutsches Biomasseforschungszentrum

IEA-AMF Technology Collaboration Programme on Advanced Motor Fuels

IEA Bioenergy

DBFZ

Perspective on renewable fuels for sustainable mobility

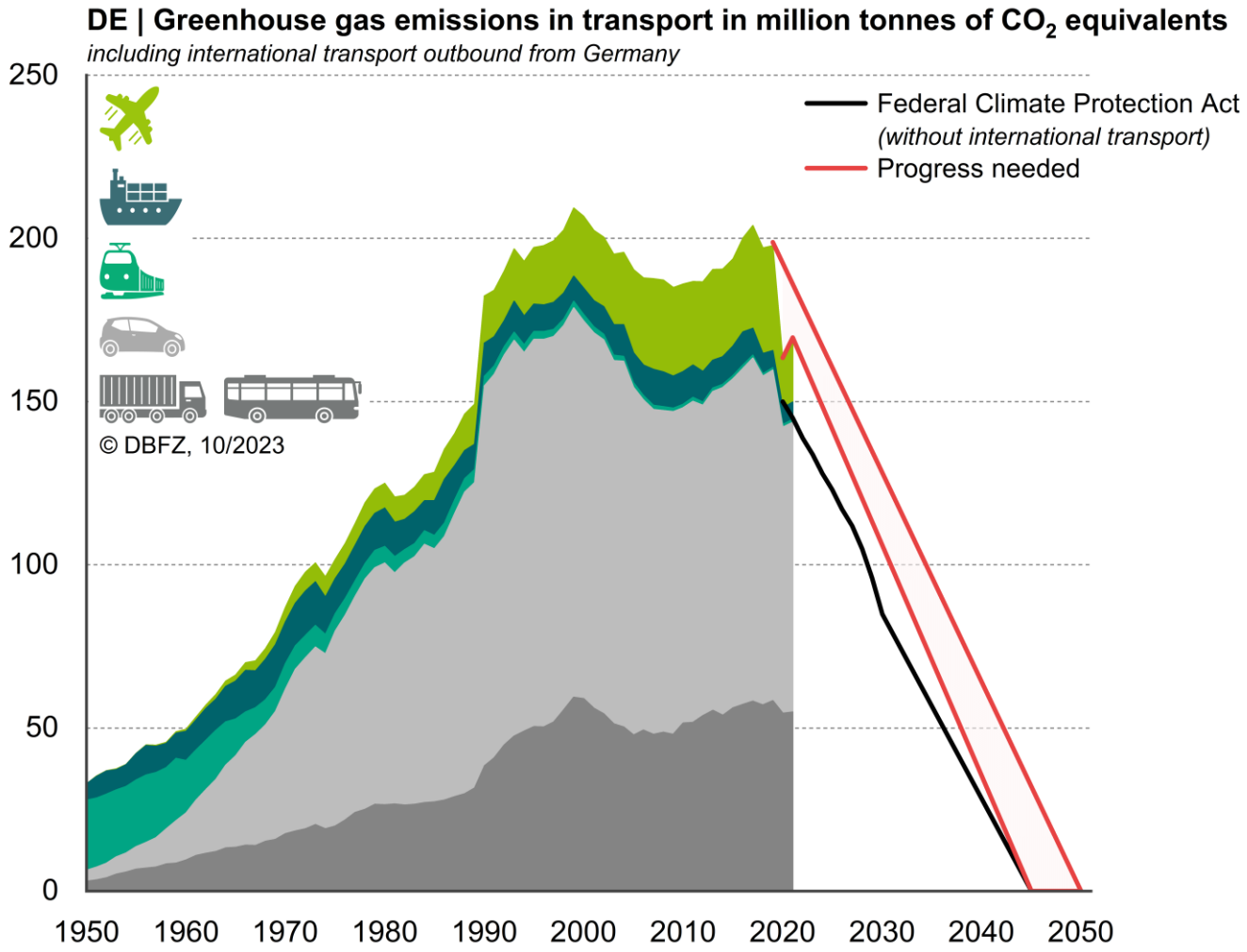
Insight on Germany

Franziska Müller-Langer, Jörg Schröder, Karin Naumann

International expert workshop "Ten times more renewable fuels"| Leipzig | Oct 24, 2023

Goal

Climate-neutral economy and society by 2045



Avoid - Shift - Improve

Strengthening public transport and rail freight, electrification of vehicle propulsion, intelligent traffic management systems

Currently most important option:

Renewable energies in transport

- GHG reduction of about 11 million tonnes of CO_2 equivalents per year
- Substitution of about 8% of energy consumption
  - 139 PJ biofuels (mainly in road transport)
  - 18 PJ renewable power (mainly in rail transport)

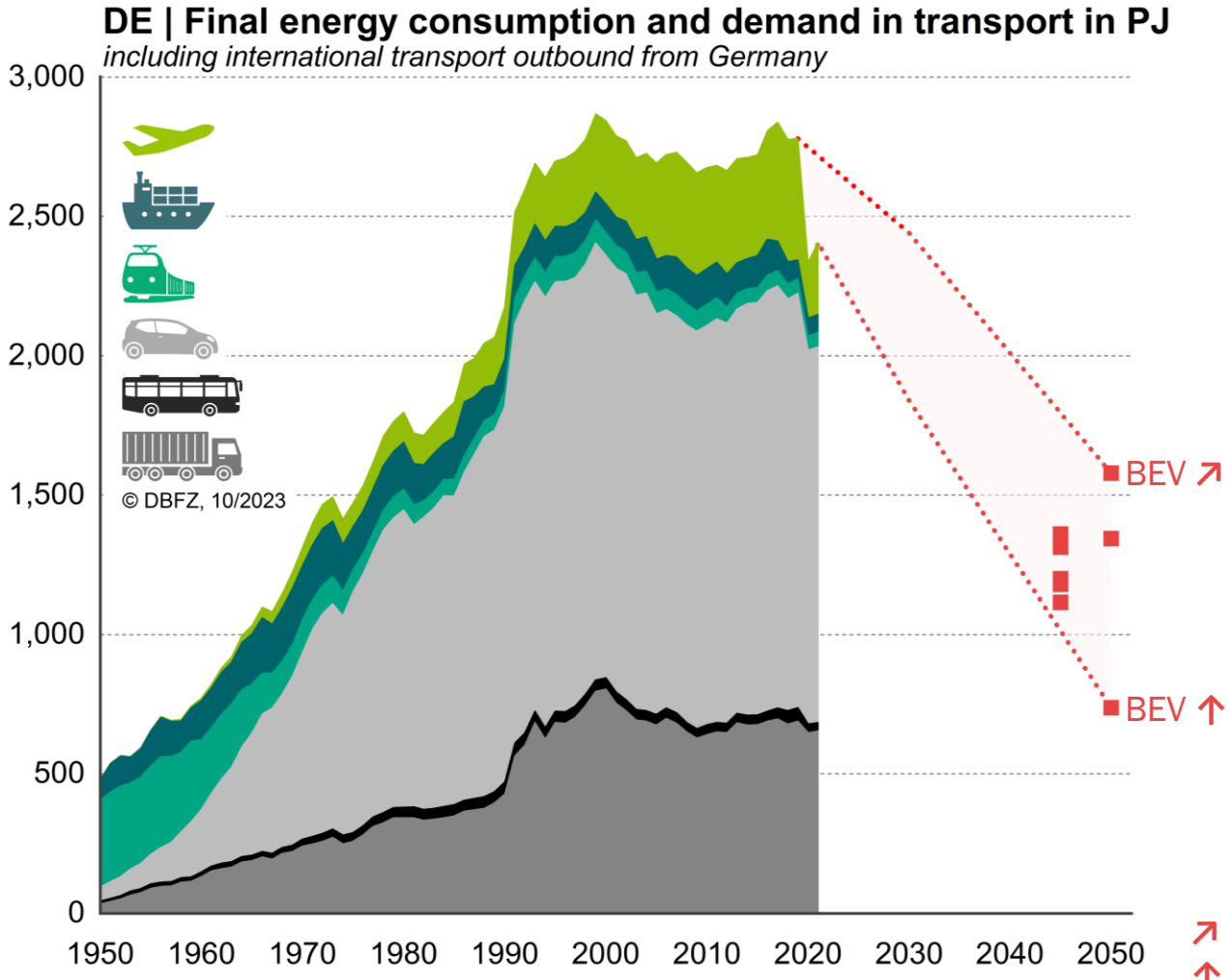
International transport

Not addressed in the Climate Protection Act

Reference: DBFZ-Report No. 44 [Schröder, Naumann 2023], adapted

Forecast

The more transport, the higher the final energy consumption



Overview of key studies on climate targets in Germany

Renewable energy demand in transport in 2045/2050

	UBA	Agora	BDI
Power	365 – 415 PJ	615 PJ	585 PJ
Hydrogen		145 PJ	75 PJ
Fuels	370 – 1,135 PJ	390 PJ	702 PJ
Total	735 – 1,550 PJ	1,150 PJ	1,362 PJ

↗ moderate share of electromobility
↑ high share of electromobility and traffic avoidance

Conversion: 1 Petajoule [PJ] = 278 Gigawatt hour [GWh] = 24 thousand tonnes oil unit [ktoe]

References: DBFZ-Report No. 44 [Schröder, Naumann 2023], [Eurostat 2023a], [Eurostat 2023b], [BMDV, Intraplan 2023], [UBA 2019, Agora 2021, BDI 2021, BMWK 2021, dena 2021]

Forecast

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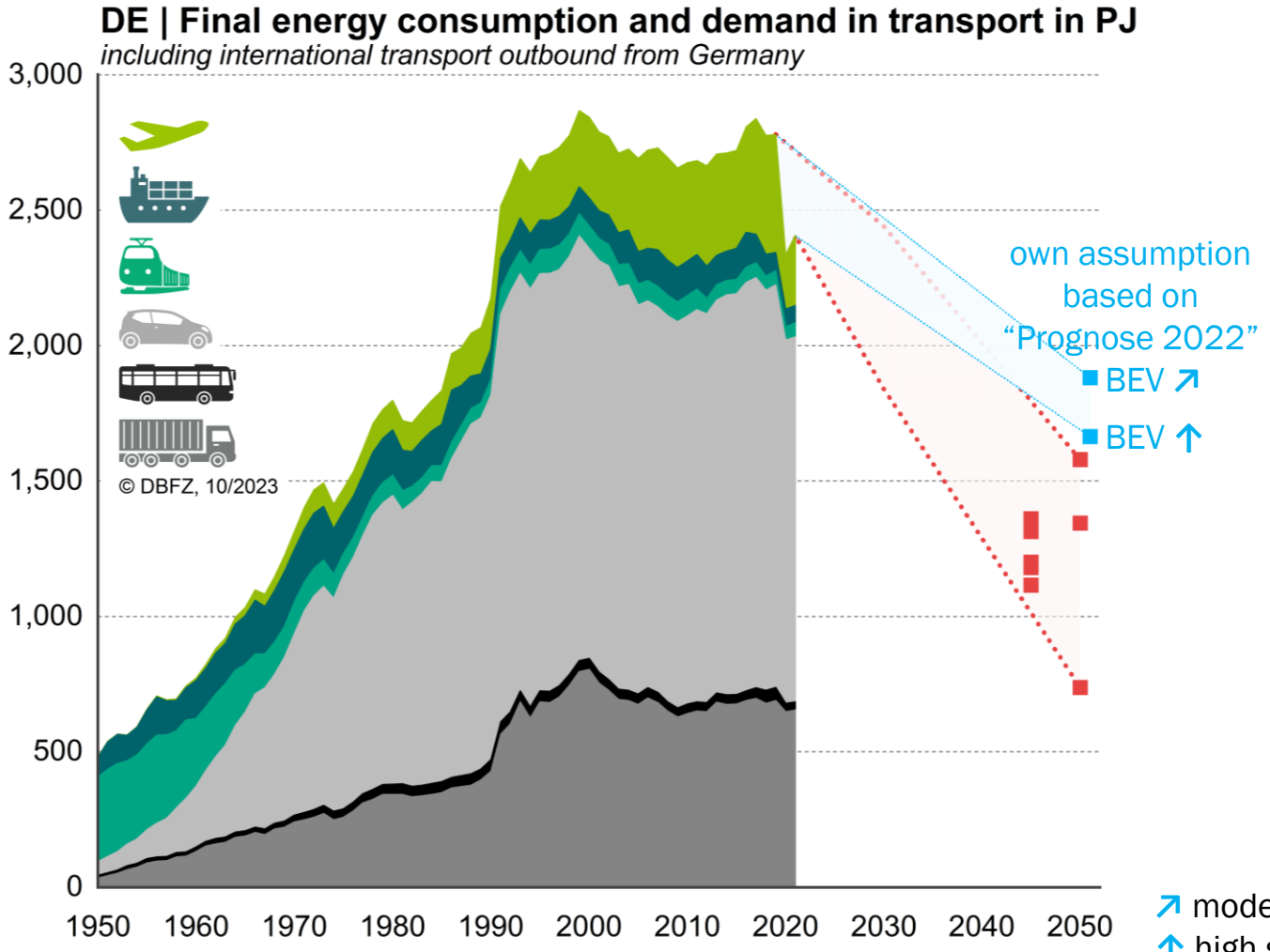


Long-term transport forecast „Prognose 2022“

Change in transport performance from 2019 to 2051

	Passenger transport	Freight transport
✈	+68 %	+?? %
🚌	+25 %	+0 %
🚗	+4 %	+54 %
🚆	+52 %	+33 %
Σ with 🚶 🚲	**+13 %**	**Σ +46 %**

The demand for renewable fuels will grow more strongly than the key studies forecast.

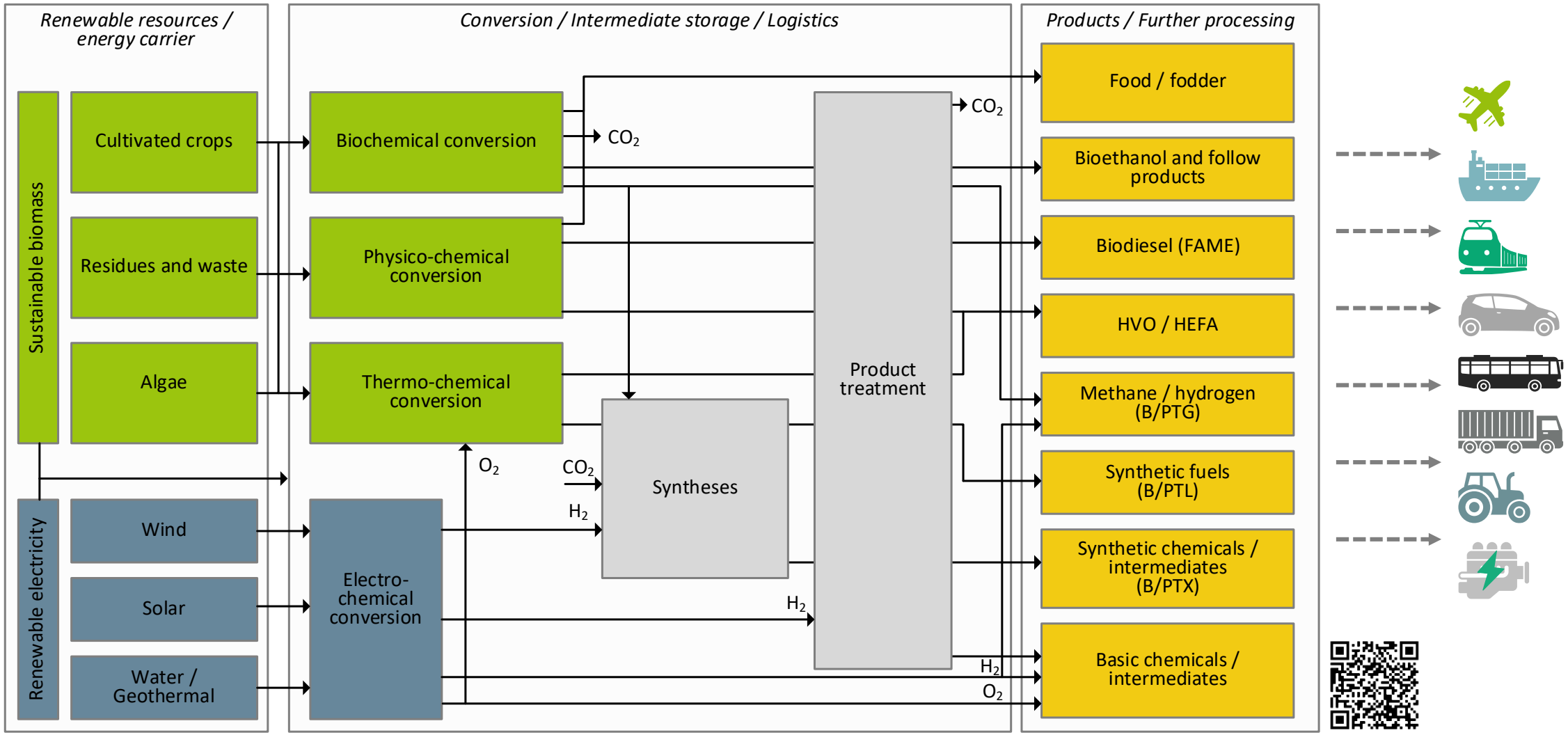
↗ moderate share of electromobility
↑ high share of electromobility and traffic avoidance

Conversion: 1 Petajoule [PJ] = 278 Gigawatt hour [GWh] = 24 thousand tonnes oil unit [ktoe]

References: DBFZ-Report No. 44 [Schröder, Naumann 2023], [Eurostat 2023a], [Eurostat 2023b], [BMDV, Intraplan 2023], [UBA 2019, Agora 2021, BDI 2021, BMWK 2021, dena 2021]

Fuel options

Diverse technology routes, synergies and value networks



SynBioPTX ©DBFZ 11/2021 (w/o entitlement of completeness)
B/PTG – Biomass-/Power-to-Gas, B/PTL – Biomass-/Power-to-Liquids, B/PTX – Biomass-/Power-to-products X; FAME – Fatty acid methyl ester; HEFA – hydrotreated esters and fatty acids; HVO – hydrotreated vegetable oils;

Fuel options

Technical readiness level of renewable fuels

Fuel Readiness Level

Reference year 2021	Technology Readiness Level TRL	Refuelling infrastructure	Long-term scope
Strom	**11**	✓ ↗	
Ethanol	**Bio:** 8 – **11**	✓ Blending	
Biodiesel (FAME)	**Bio:** 4 – **11**	↗ ✓ Blending	
Paraffinischer Diesel	**Bio:** 3 – **11** PTx: 3 – 7	✓	
Paraffinisches Kerosin	**Bio:** 3 – **10** PTx: 3 – 7	↗	
Methan	**Bio:** 6 – **11** PTx: 6	↗	
Wasserstoff	Bio: 4 – 8 **PTx:** 6 – **11**	↗	
Methanol	Bio: 3 – 8 PTx: 3 – 7	↗	
Methanol-to-gasoline	Bio: 3 – 8 PTx: 4 – 5	✓ Blending	
Alcohol-to-jet	Bio: 3 – 8 PTx: 4 – 5	↗	

✓ Refuelling infrastructure established

↗ Refuelling infrastructure under development

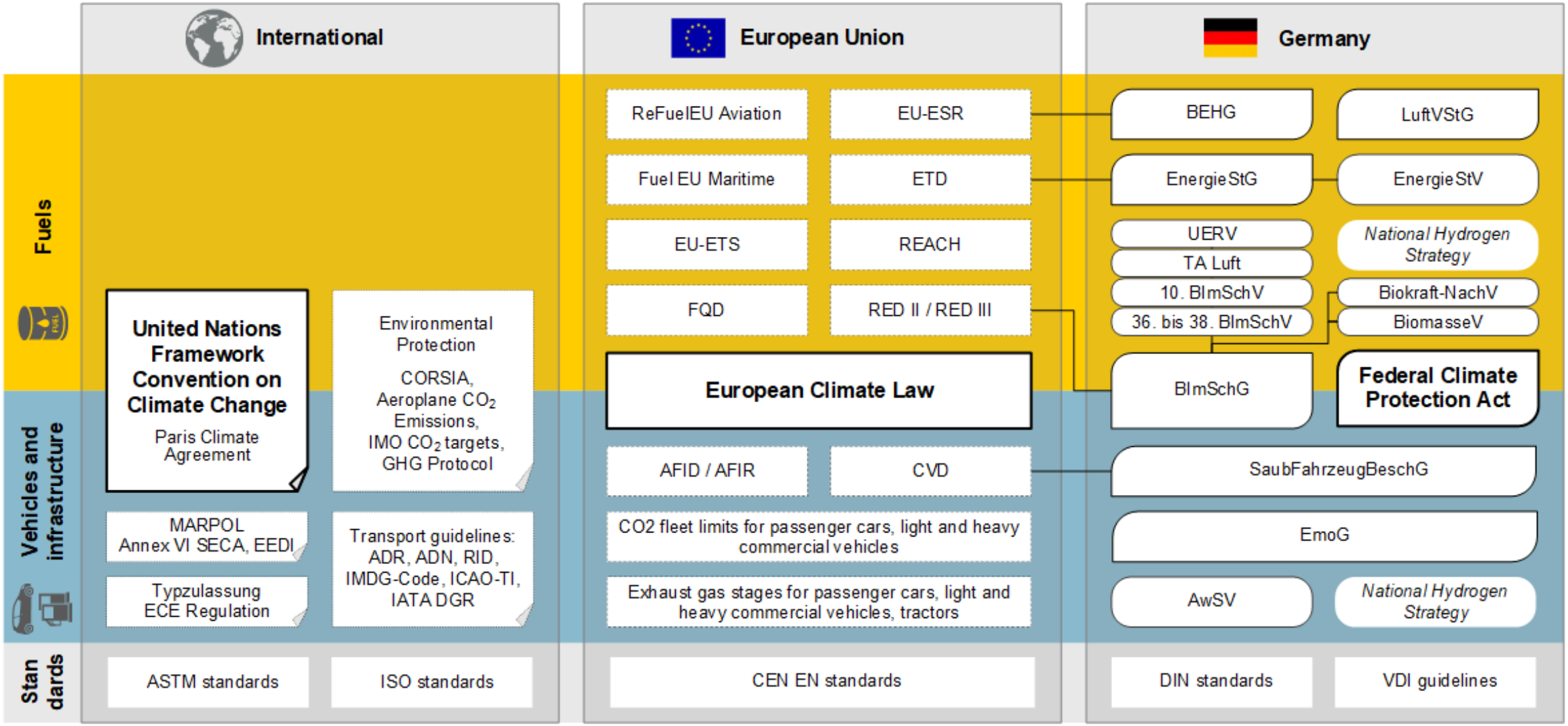
High energy demand for vehicle segment

Low energy demand for vehicle segment (residual stock)

Reference: [Schröder, Naumann 2023], TRL – Technology Readiness Level (TRL 1: Basic principles observed, TRL 8: System complete and qualified, TRL 10: Market integration, TRL 11: Market stability);

Dependencies

Framework policy influences market and competition

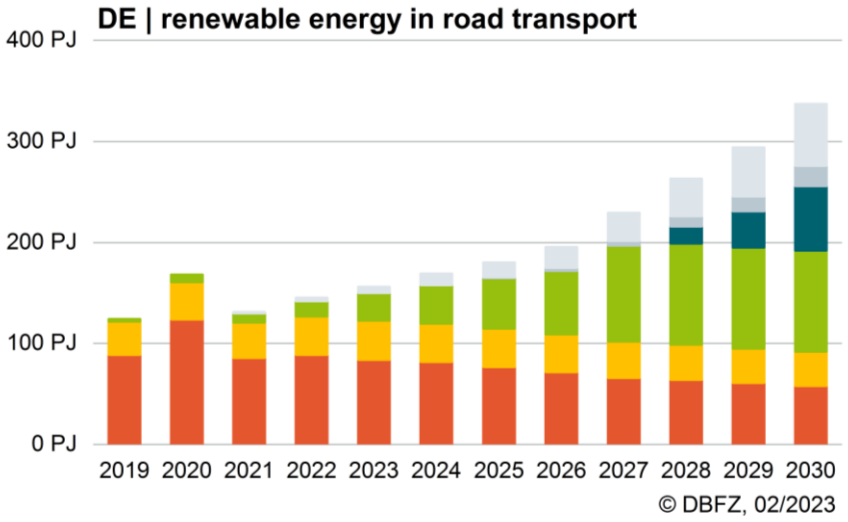


further information:

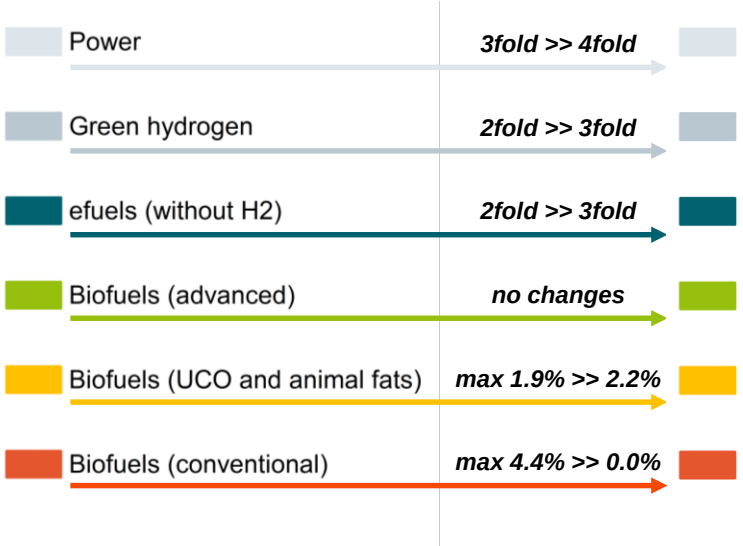
Referenz: DBFZ-Report No. 44 [Schröder, Naumann 2022], adapted

Greenhouse gas reduction quota determines use of renewables

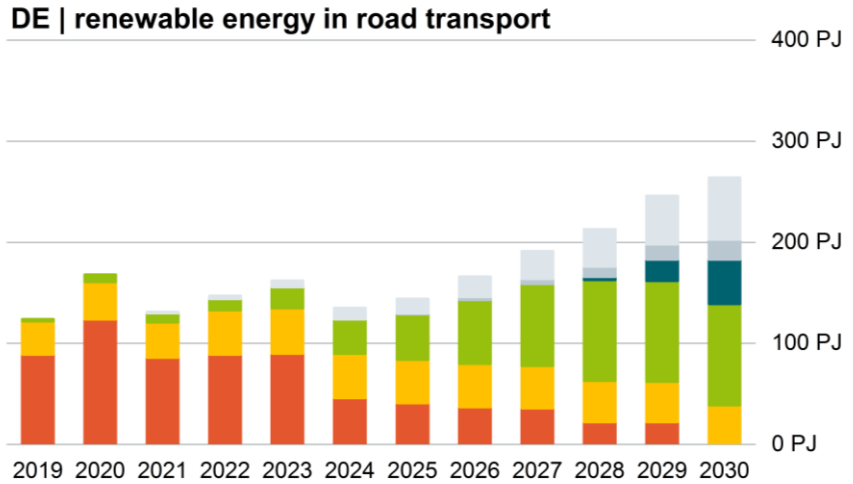
GHG quota – status quo



Discussed changes to the chargeability



GHG quota – adapted

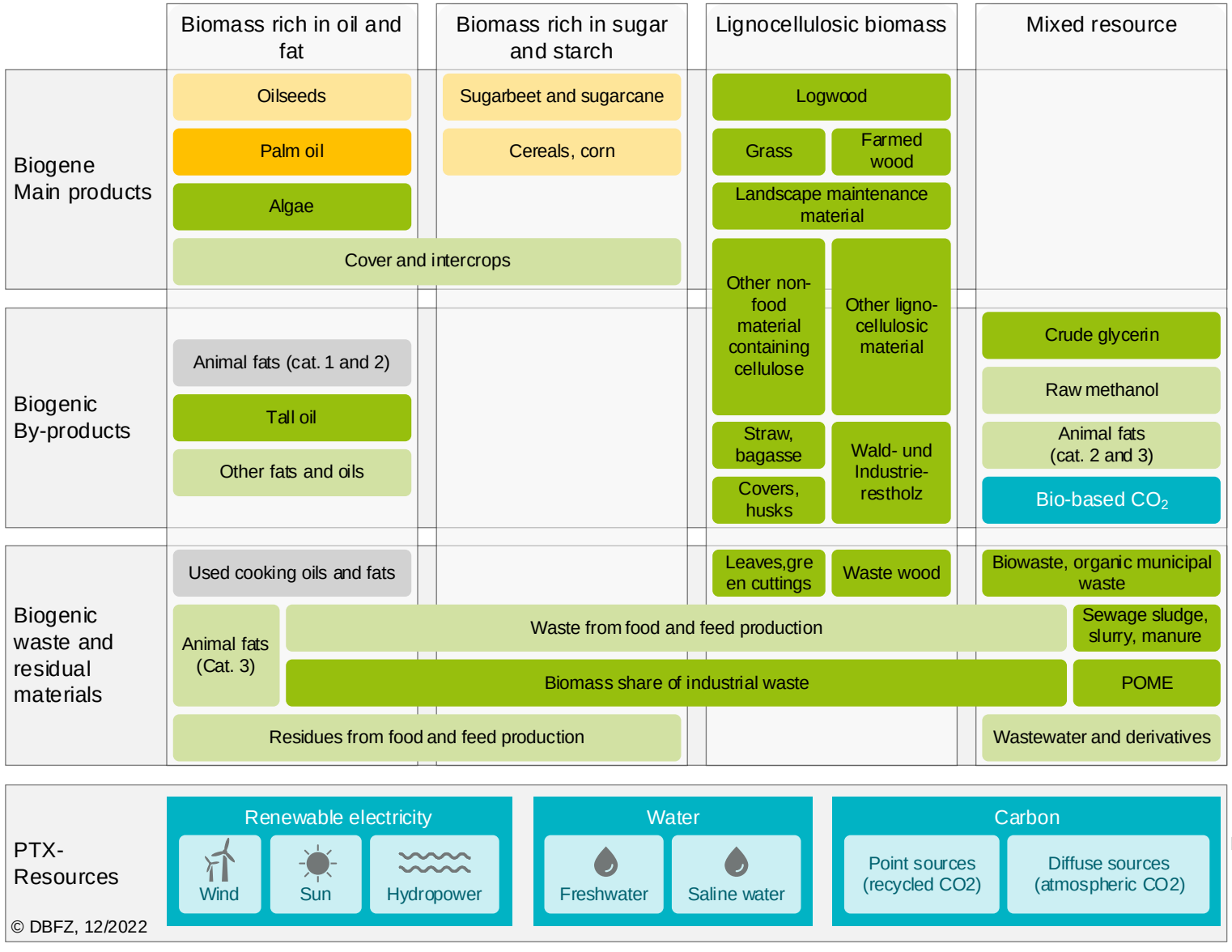


2022	2023	2024	2025	2026	2027	2028	2029	2030		2022	2023	2024	2025	2026	2027	2028	2029	2030
7%	8%	9.25%	10.5%	12%	14.5%	17.5%	21%	25%	GHG quota	7%	8%	8%	9.25%	11.5%	14.5%	17.5%	21%	25%
7%	7%	8%	9%	9%	11%	13%	15%	17%	Share of renewables [real]	7%	8%	6%	7%	8%	9%	10%	12%	13%
Emission budget according to the German Climate Protection Act (KSG) in million tonnes CO_2 eq. in transport																		
+6	+12	+14	+15	+17	+17	+19	+22	+28	KSG target path 2030	+5	+12	+16	+18	+19	+19	+22	+26	+33
+6	+18	+32	+47	+64	+81	+100	+122	+150	Cumulative exceedance until 2030	+5	+17	+33	+51	+70	+89	+111	+137	+170

References and further information in [Naumann 2022], advanced biofuels according to RED II Annex IX A, UCO and animal fat based biofuels according to RED II Annex IX B.

Dependencies

No renewable products without renewable resources



Carbon takes key role for renewable fuels

Identify mobilisable resources (regional, national and global)

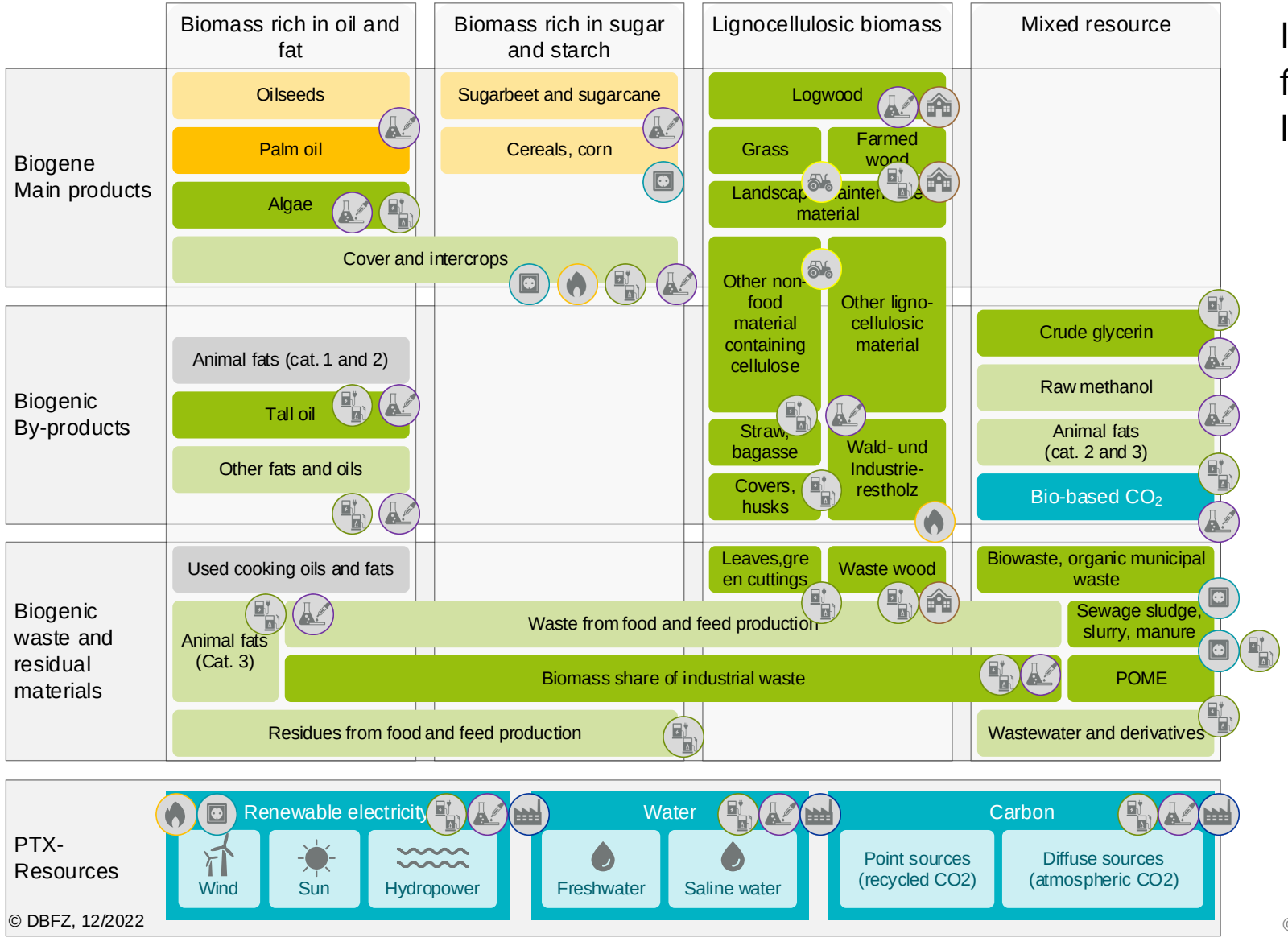
Identify levers for the economic mobilisation of sustainable resource potentials

Strategies required:

- Sustainable production
- Mobilisation
- Optimisation
- Distribution

Figure legend:

Increasing demand for resources with opportunities and risks

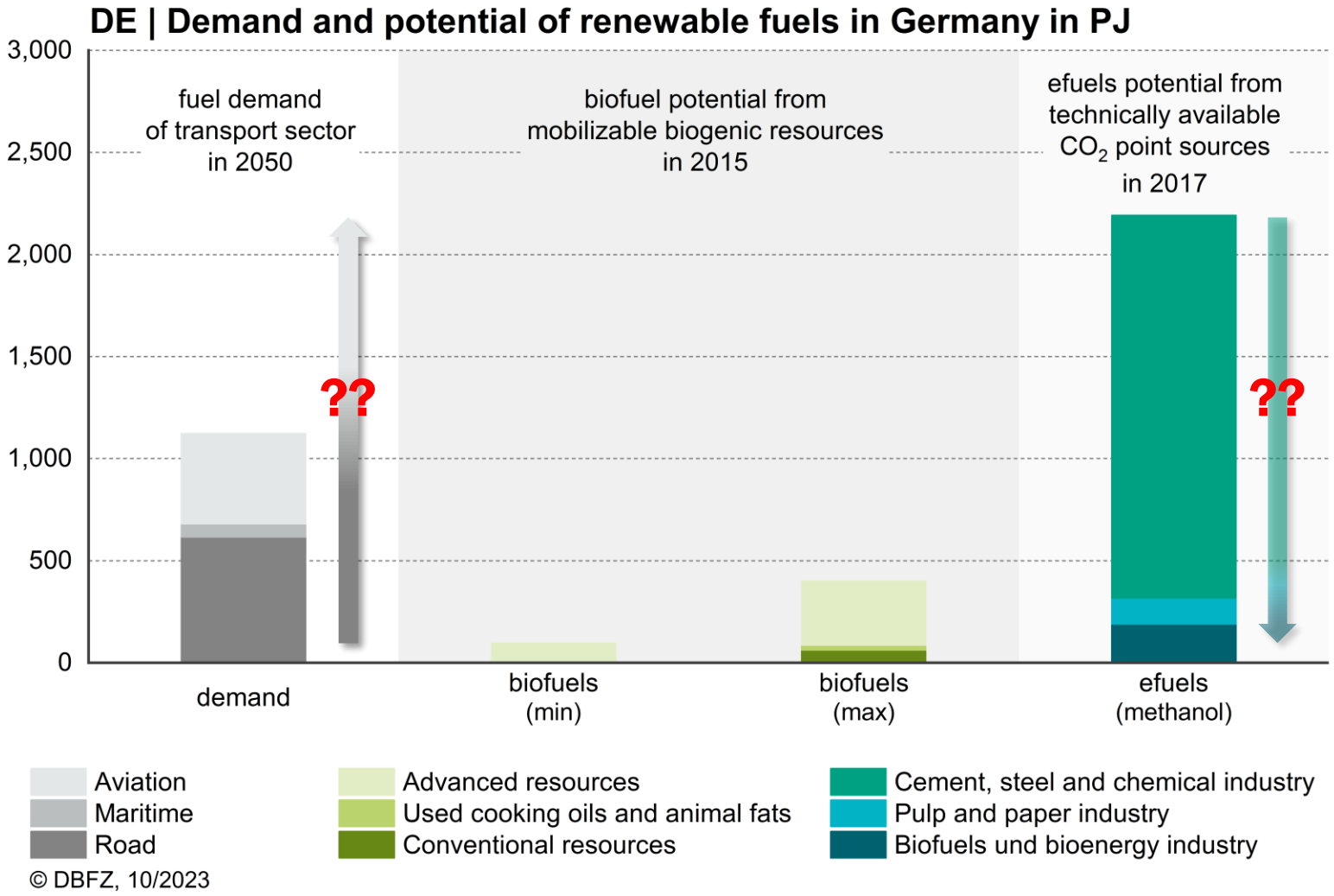


Increasing demand for renewable resources from all sectors with already high utilisation levels

- Heat
- Power
- Transport
- Chemicals
- Construction
- Industry
- Agriculture

SoBio
Scenarios of optimal biomass use in the German energy system
www.dbfz.de/sobio

Renewable fuels „Made in Germany“?

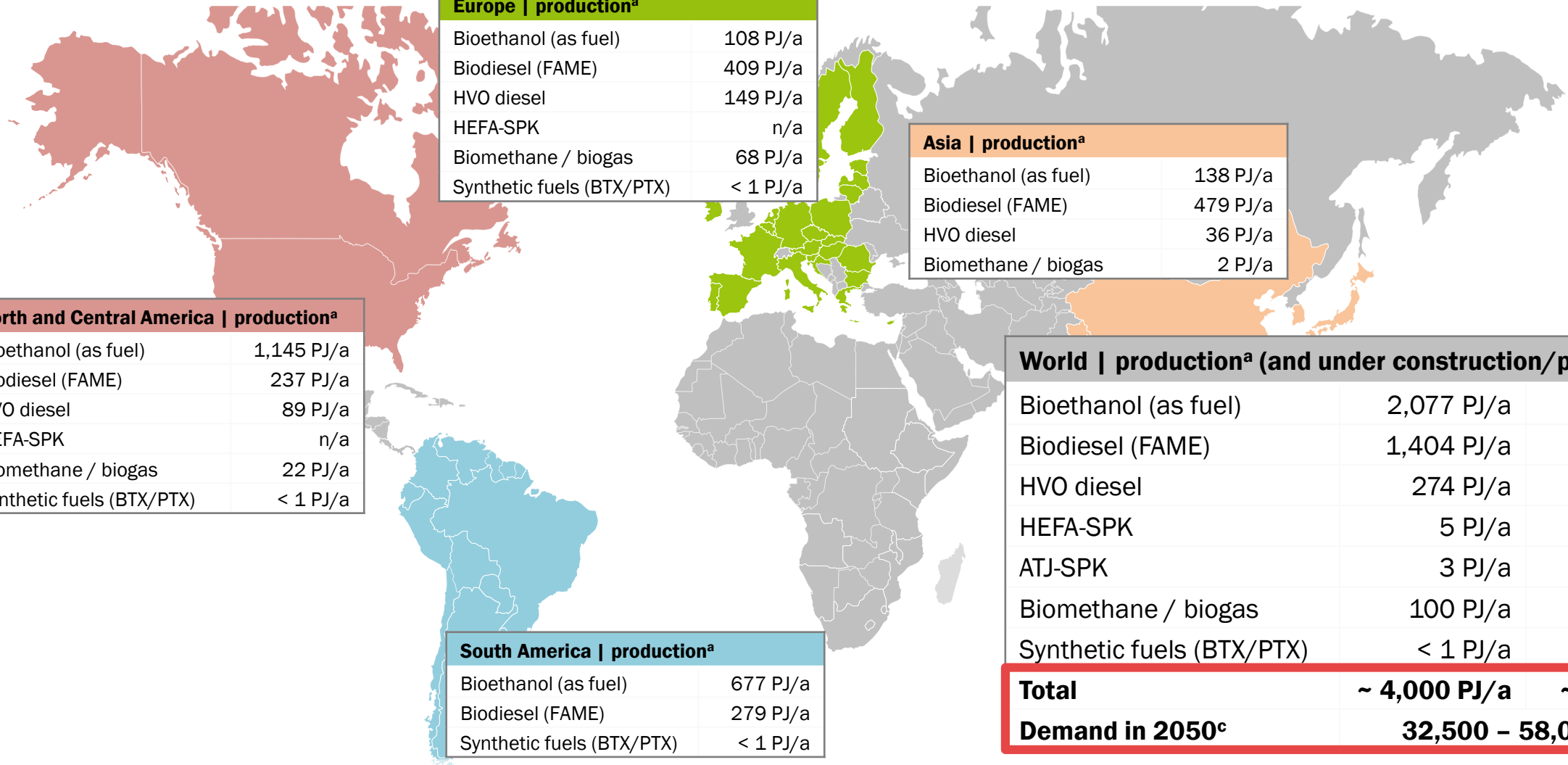


- Current traffic forecast massively increases the demand for renewable fuels
- Fuels from regional resources not sufficiently available
- Perspective limitation of available CO_2 sources
- Import of renewable fuels is essential
- Data stock for globally available resources very inconsistent

Note: Own calculation and presentation based on data: bandwidths for biofuels according to mobilizable potential; efuels potential according to CO_2 point sources; demand scenarios exemplary according to [UBA 2019] with Green Late scenario; Reference: [Schröder and Naumann 2023], adapted

World

Renewable fuels in the international market



Europe | production[a]	
Bioethanol (as fuel)	108 PJ/a
Biodiesel (FAME)	409 PJ/a
HVO diesel	149 PJ/a
HEFA-SPK	n/a
Biomethane / biogas	68 PJ/a
Synthetic fuels (BTX/PTX)	< 1 PJ/a

Asia | production[a]	
Bioethanol (as fuel)	138 PJ/a
Biodiesel (FAME)	479 PJ/a
HVO diesel	36 PJ/a
Biomethane / biogas	2 PJ/a

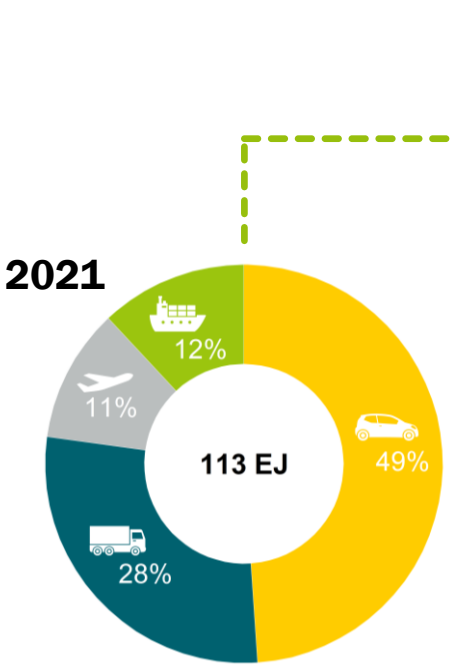
North and Central America | production[a]	
Bioethanol (as fuel)	1,145 PJ/a
Biodiesel (FAME)	237 PJ/a
HVO diesel	89 PJ/a
HEFA-SPK	n/a
Biomethane / biogas	22 PJ/a
Synthetic fuels (BTX/PTX)	< 1 PJ/a

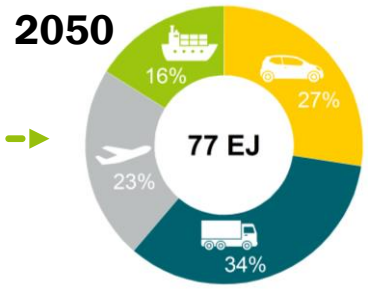
South America | production[a]	
Bioethanol (as fuel)	677 PJ/a
Biodiesel (FAME)	279 PJ/a
Synthetic fuels (BTX/PTX)	< 1 PJ/a

World | production[a] (and under construction/planned[b])		
Bioethanol (as fuel)	2,077 PJ/a	(792 PJ/a)
Biodiesel (FAME)	1,404 PJ/a	(485 PJ/a)
HVO diesel	274 PJ/a	(81 PJ/a)
HEFA-SPK	5 PJ/a	(33 PJ/a)
ATJ-SPK	3 PJ/a	(k.A.)
Biomethane / biogas	100 PJ/a	(k.A.)
Synthetic fuels (BTX/PTX)	< 1 PJ/a	(469 PJ/a)
Total	**~ 4,000 PJ/a**	**~ 2,000 PJ/a**
Demand in 2050[c]	**32,500 – 58,000 PJ/a**	

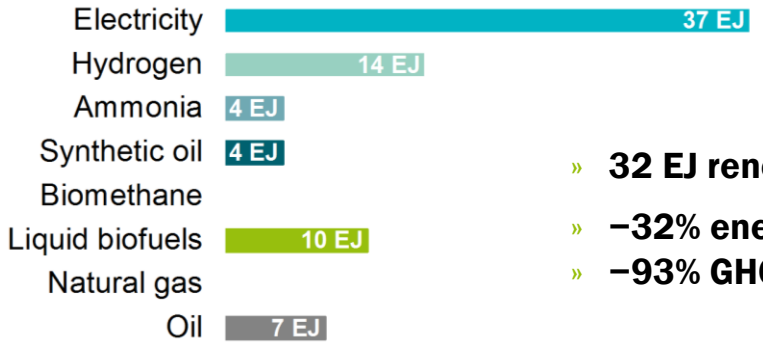
[a] production in 2021 and biomethane capacities in 2019; [b] planed capacity; [c] demand according to IEA World Energy Outlook 2022 und IRENA Global Energy Transformation 2018

World Energy Outlook 2050



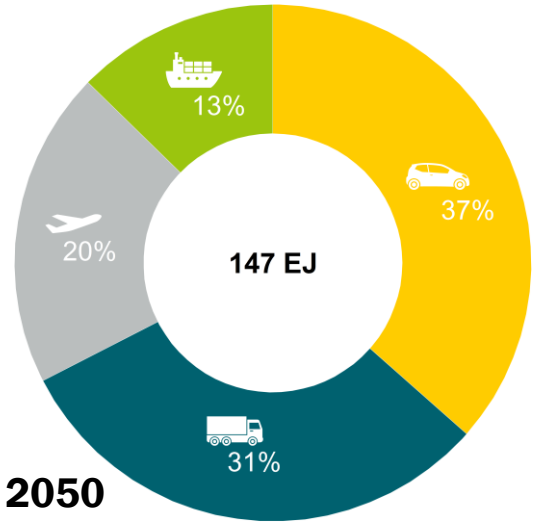


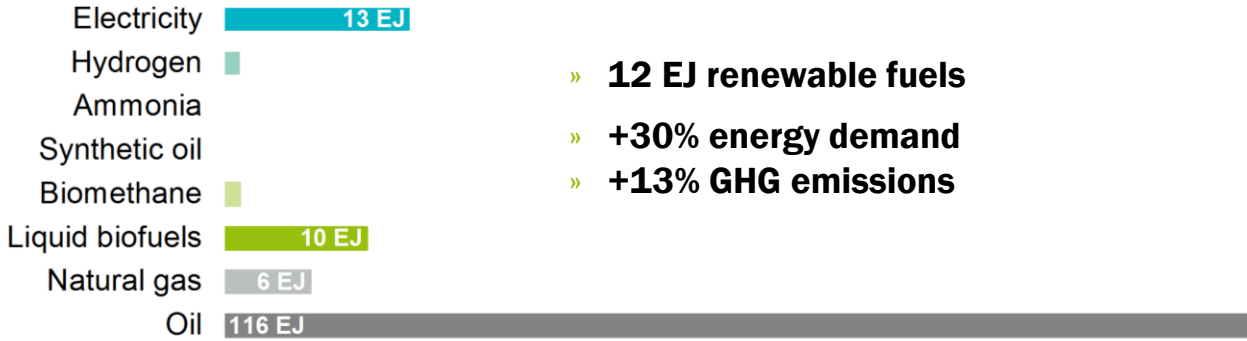
IEA Net Zero Scenario



- 32 EJ renewable fuels
- −32% energy demand
- −93% GHG emissions

IEA Stated Policies Scenario





- 12 EJ renewable fuels
- +30% energy demand
- +13% GHG emissions

Note: Synthetic oil produced through Fischer-Tropsch conversion or methanol synthesis. It includes oil products from CTL and GTL, and low-emissions liquid hydrogen-based fuels. Liquid fuels derived from biomass or waste feedstock, e.g. ethanol, biodiesel and biojet fuels.

Conclusion

GHG savings only with integrated transport and energy transition

- Transport sector under particularly high pressure to act >> to achieve the **climate targets**, it is crucial that
  - the **final energy demand** in road transport is **significantly reduced**
  - all existing and obvious **options for reducing emissions** are used
  - in addition to new vehicles, the potential for **GHG reduction in the existing vehicle stock** is exploited to a much greater extent
- Current **traffic forecast** for Germany massively **increases the need for renewable fuels** and the pressure to act
- Even ambitious measures to reduce the total energy demand in road transport require a **GHG quota of more than 25%** to achieve the climate target
- **Increasing resource and product diversification required** for renewable fuels and need to implement more complex technology options >> many influencing factors for successful technology development
  - Stable regulatory framework >> fair development for all options, e.g. binding GHG quota until 2045
  - Managing demand on resources >> renewable carbon as the key to renewable fuels
  - Establish greenhouse gas abatement costs as a competition driver
- Renewable fuels essential from an **international context** >> opportunities and risks for new value chains as well as knowledge and technology transfer

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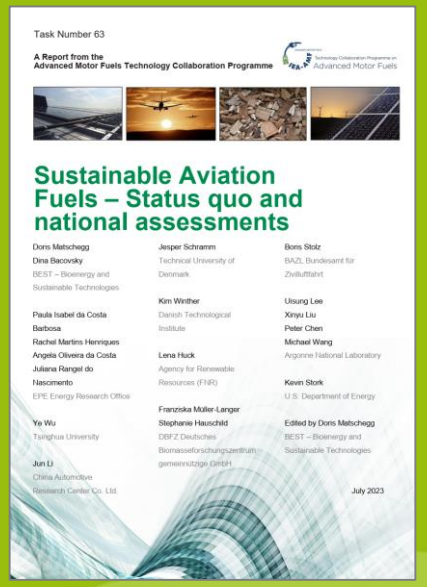
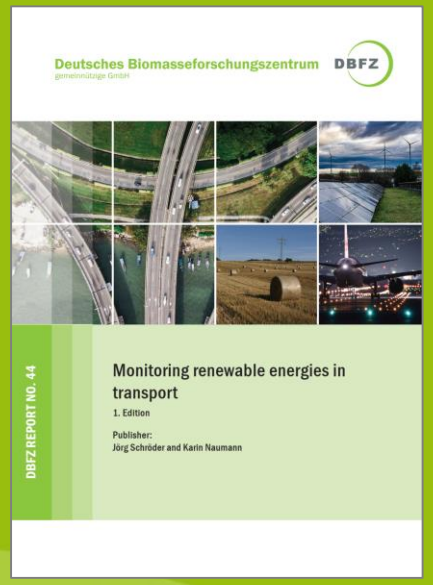
Interesting recent publications

https://www.ieabioenergy.com/blog/task/lessons-learned-biofuels/#



https://iea-amf.org/content/projects/map_projects/63



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