IEA Bioenergy

European Commission

ADVANCED MOTOR FUELS
IEA-AMF
Technology Collaboration Programme on
Advanced Motor Fuels

The Contribution of Advanced Renewable Transport Fuels to **Transport Decarbonisation** in 2030 and beyond

Country report for Germany

Franziska Müller-Langer, Jörg Schröder, Kathleen Meisel, Markus Millinger (UFZ)

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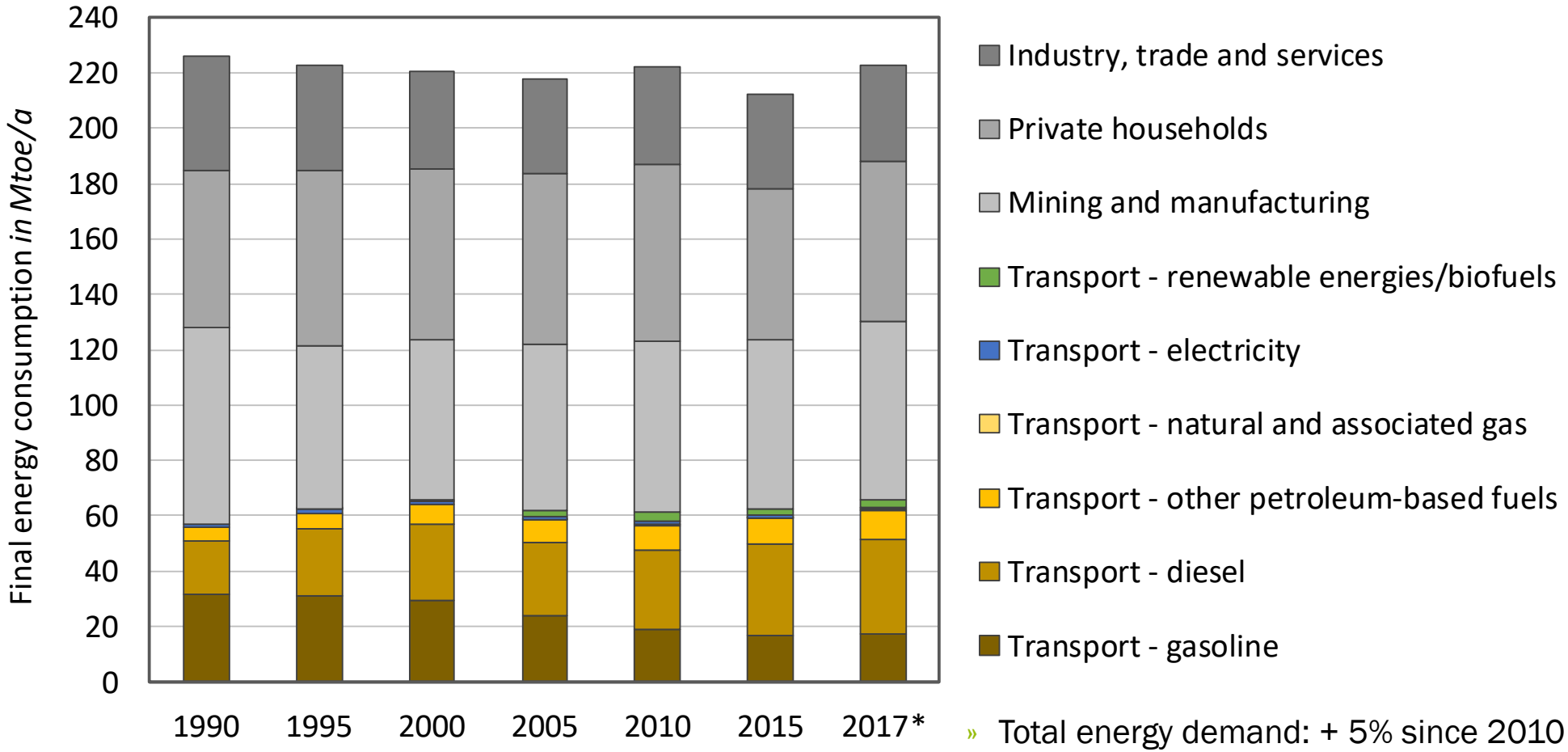
Agenda

1. Present situation of energy supply and vehicle stock in Germany
2. Targets and policy measures for the transport sector
3. Overall scenarios for German transport sector 2050
4. Scenarios for biofuels and other renewable fuels until 2030

Present situation of energy supply and vehicle stock in Germany

Energy supply in general

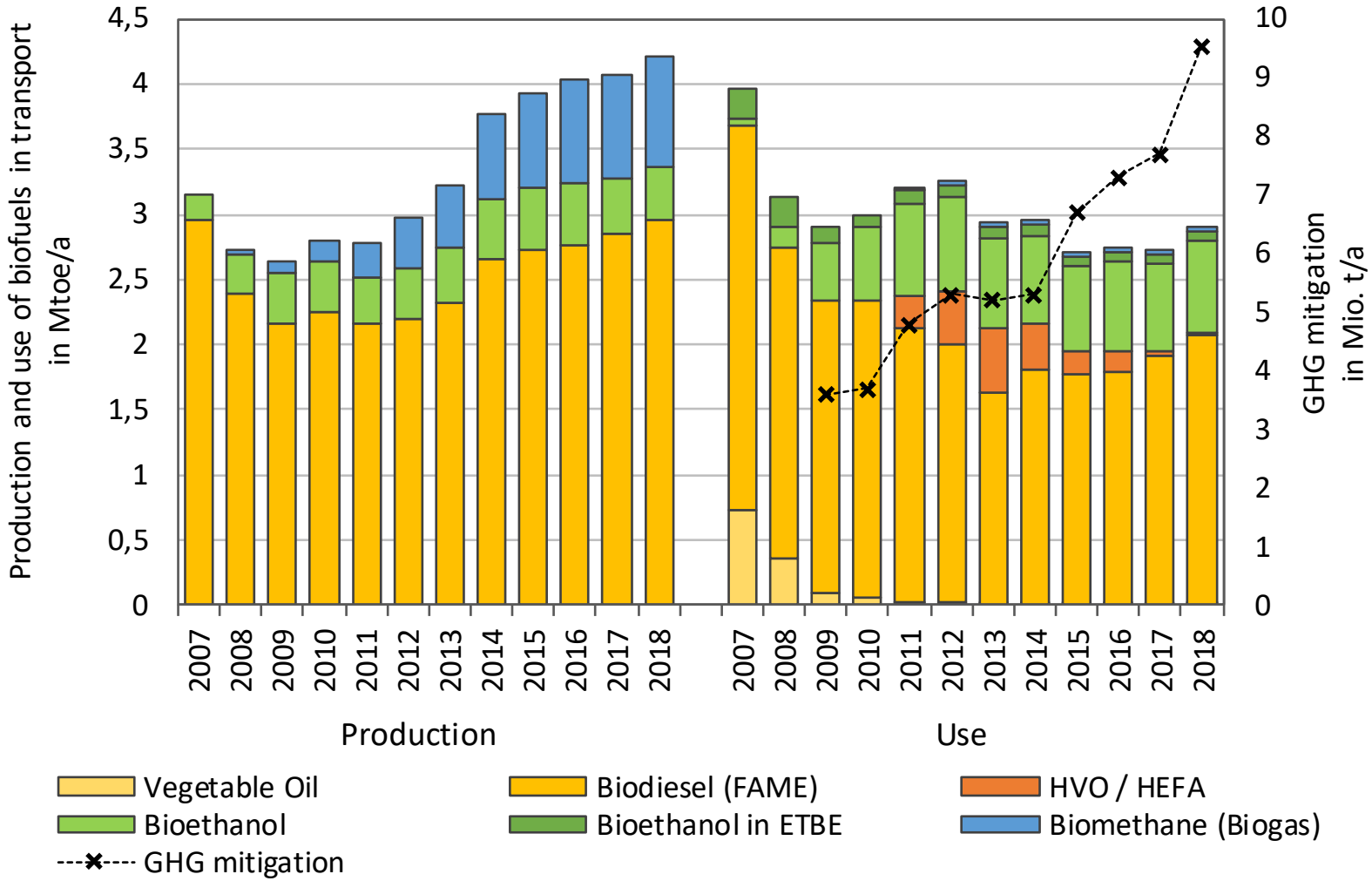


*data base: AGEB 2019; * priliminary data*

- Total energy demand: + 5% since 2010
  (of which 4% renewable fuels, 1.5% electricity)
- CO_2-eq. emissions: + 8% since 2010
  (incl. 4% reduction from renewable fuels)

Present situation of energy supply and vehicle stock in Germany

Development of biofuel production and use



German biofuel market in 2018

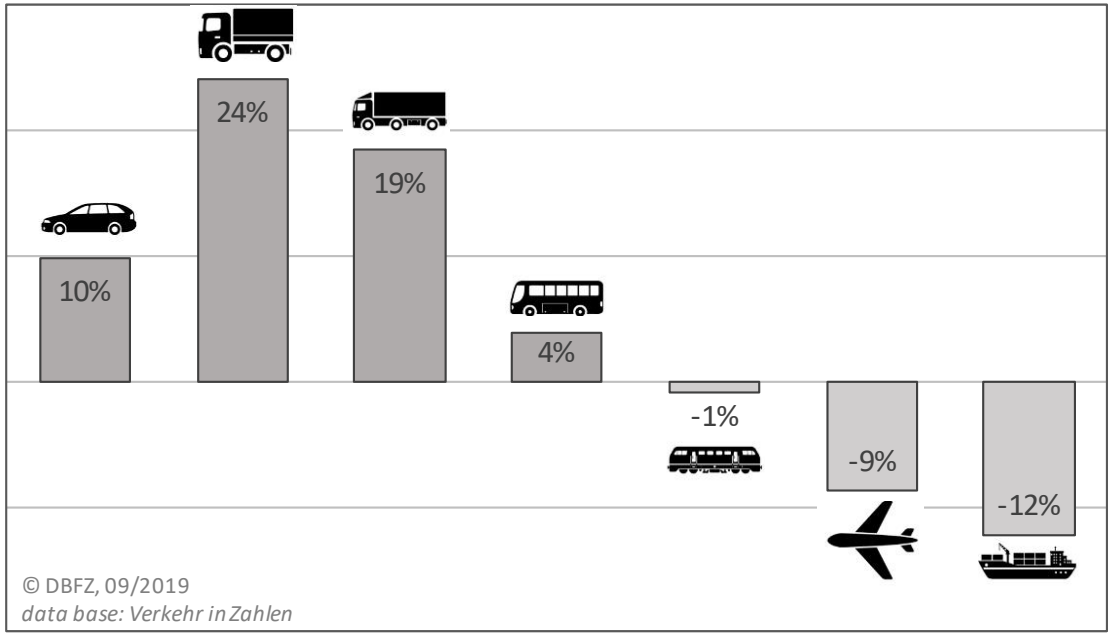
- GHG quota of 4 %
- 36% based on residues, 64% on cultivated biomass
- Biofuels avoid 9,5 millions tons of CO_2-eq. (new reference values from 2018)
- Fuel specific GHG mitigation (main fuel options)

Biodiesel (FAME):	83%
Bioethanol:	86%
HVO/HEFA:	77%
Biomethane:	90%

Data base: BDBe 2019, 2019; BLE 2015a, 2018; BNetzA und BKartA 2018; Destatis 2018, 2019; FNR 2019; IFRI 2019; OVID 2019a, 2019b; VDB 2015; HVO / HEFA: no production in DE; Biomethane: production also for electricity and heat sector; GHG mitigation: 2019+ 2010 35% based on RED, 2011-2017 based on BLE data

Development vehicle stock

Vehicle stock change 2010 to 2017



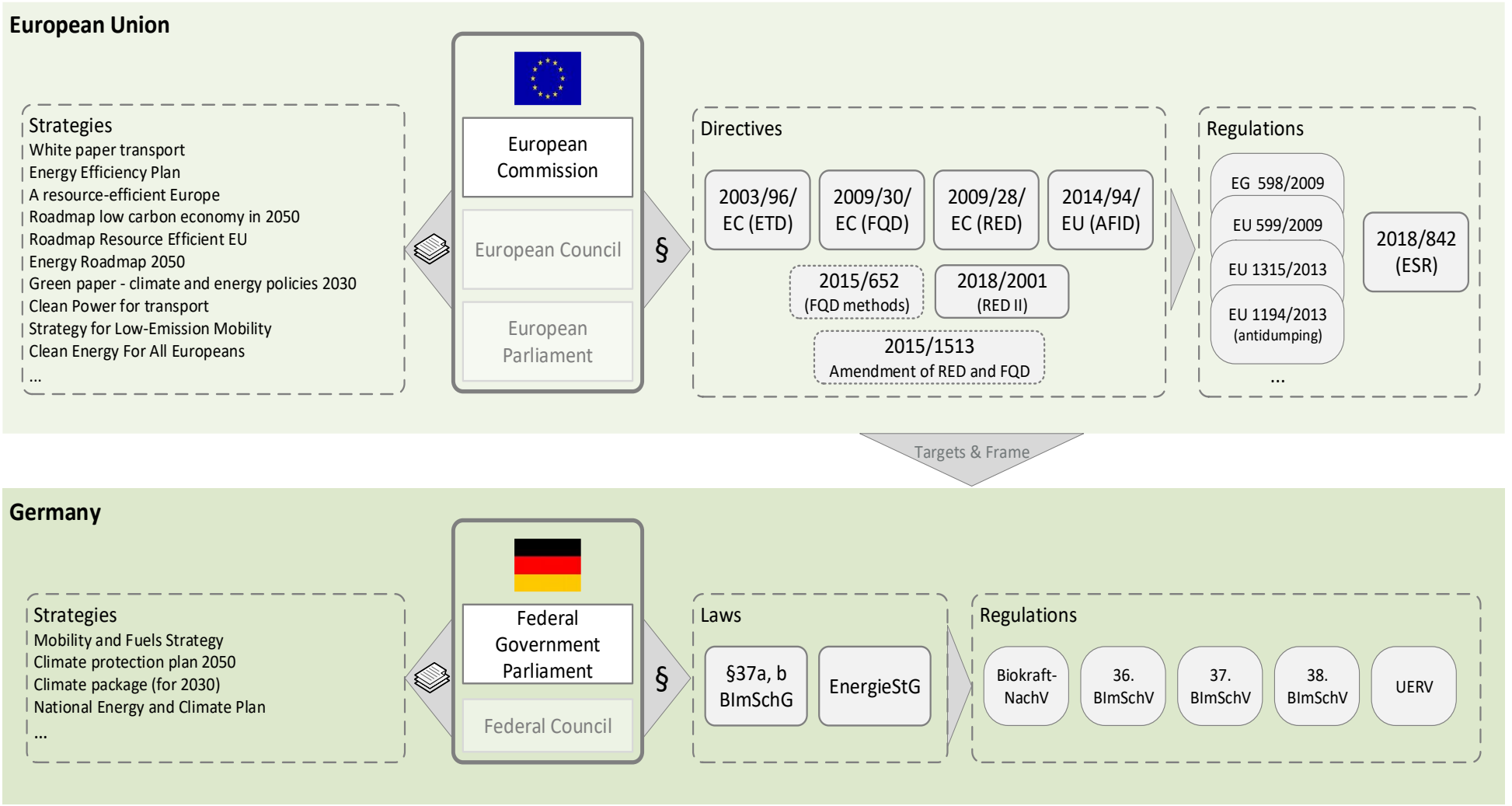
	Status 2017
Passenger Cars	**46.5 million**
Gasoline	30.5 million
Diesel	15.2 million
Autogas (LPG)	421 thousand
Natural gas (CNG)	75 thousand
HEV (incl. PHEV)	237 thousand
BEV	54 thousand
LDV & HDV	**3.0 million**
Semi-trailer trucks	211 thousand
Busses & coaches	79 thousand
Rail vehicles[1]	10 thousand
Air planes	1 thousand
Vessels	4 thousand

- Massive changes in recent years, mainly LDV
- Stock of road vehicle steadily rising, other segments declines

[1] in 2015

Targets and policy measures for the transport sector

GHG quota in Germany



- **Conventional** biofuels **6,5% cap**
- **Advanced** fuels with **0,05% from 2020**
- **REDII** & **ESR**
- GHG mitigation of **40 to 42% until 2030** (to 98-95 million tons CO_2-eq.) and 80 to 95% until 2050 in transport (c.t. 1990)
- **Climate protection law** and **climate protection program** (focus e-mobility, PTx fuels, advanced biofuels)
- **GHG quota** as instrument likely also from 2021 onwards

2009/30/EG (98/70/EC) – FQD Fuel Quality Directive | 2009/28/EC – RED Renewable Energy Directive | 2003/96/EC – ETD Energy Tax Directive | 2014/94/EU – AFID Directive on the deployment of alternative fuels infrastructure | 2018/842 (ESR) – Effort sharing regulation 2021-2030 | BImSchG: Federal Immission Control Act (§37a – Minimum shares of biofuels related to the total fuel amount in transport) | EnergieStG: Energy Tax Law | Biokraft-NachV – Biofuels sustainability regulation | 36. BImSchV – Regulation for implementation of biofuels quota | 37. BImSchV – Regulation for counting of electricity based fuels and coprocessing of biooils on the GHG quota | 38. BImSchV – Regulation for the determination of further terms regarding the GHG mitigation of fuels

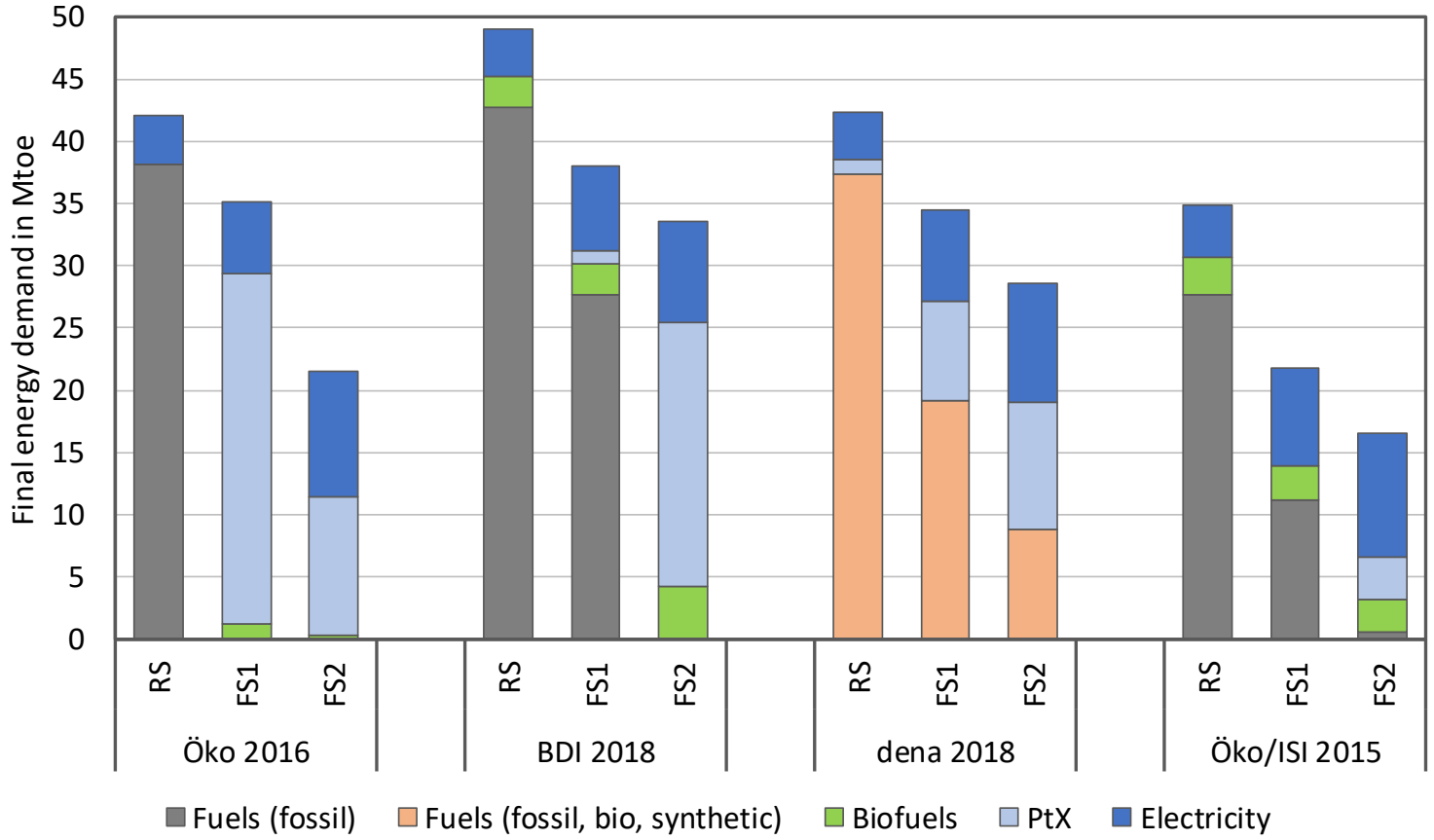
Scenarios for German transport sector 2050

Brief summary on overall scenarios

Premise	(Öko 2016)	(BDI 2018)	(dena 2018)	(Öko/ISI 2015)
Base assumption				
Popul. (million) in 2030 / 2050	78 / 74	81 / 77	81 / 76	78 / 74
GDP CAGR until 2050	0. % p.a.	+5 %	1.1% p.a.	0. % p.a.
Oil (USD/bbl) in 2030 / 2050	120 / 195	111[a], 80[b] / 115[a], 50[b]	77 / 65	128 / 195
CO_2 (EUR/t_{CO2}) in 2030 / 2050	–	26 / 45	–	30 / 50
Scenario target				
Reference scenario (RS)	Current measures continued	Current measures continued	Current measures continued	Current measures continued
Future scenario 1 (FS1)	Decarbonisation of transport and max. vehicle efficiency	80% GHG reduction in 2050	Strong variation of technologies used	80% GHG reduction in 2050
Future scenario 2 (FS2)	FS1 + Quality of life in inner cities and shifting of freight traffic to the rails	95% GHG reduction in 2050	Strong electrification in all sectors	95% GHG reduction in 2050
Biomass assumption	RS: until 2020 7% cap and after 2020 phase-out for fuels from cultivated biomass. FS: Blending quota for Bioethanol (lignocellulose) of 5%, biodiesel (BTL, HVO palm oil, UCOME) of 10% and biomethane of 4%; total potential biofuels of maximum 90 PJ	RS: maximum sustainable amount available for energy use is 1 200 – 1 300 PJ in Germany. FS: available sustainable amount increase from 1 076 PJ (2015) to 1 200 PJ (2050); therefrom 9% for transport sector	Domestic potential for bioenergy is 950 PJ/a; imported potential for bioenergy is 173 PJ/a; the assumed potential limit of 1023 PJ/a is achieved for all scenarios	Domestic biomass potential is 1 211 PJ (RS), 1 223 PJ (FS1) and 1 131 PJ (FS2); raw materials mainly waste and residues; imported biomass necessary
PTX assumption (Power to X, PTG – to gas, PTL – to liquids)	FS: 5% in 2030; 95% in 2050; 100% imported	FS2: demand for PTX fuels is 1 224 PJ for all sectors (878 PJ for transport sector); significant import demand for Germany	Domestic PTX is 468 to 590 PJ/a in 2050. FS2: PTG hydrogen mainly produced in Germany and PTG methane imported from EU	FS2: PTL after 2030; 2040: 25% PTL of total liquid fuels; 2050: 50% PTL of total liquid fuels; domestic or imported PTL is used.

Scenarios for German transport sector 2050

Overview on overall scenarios | Final energy demand



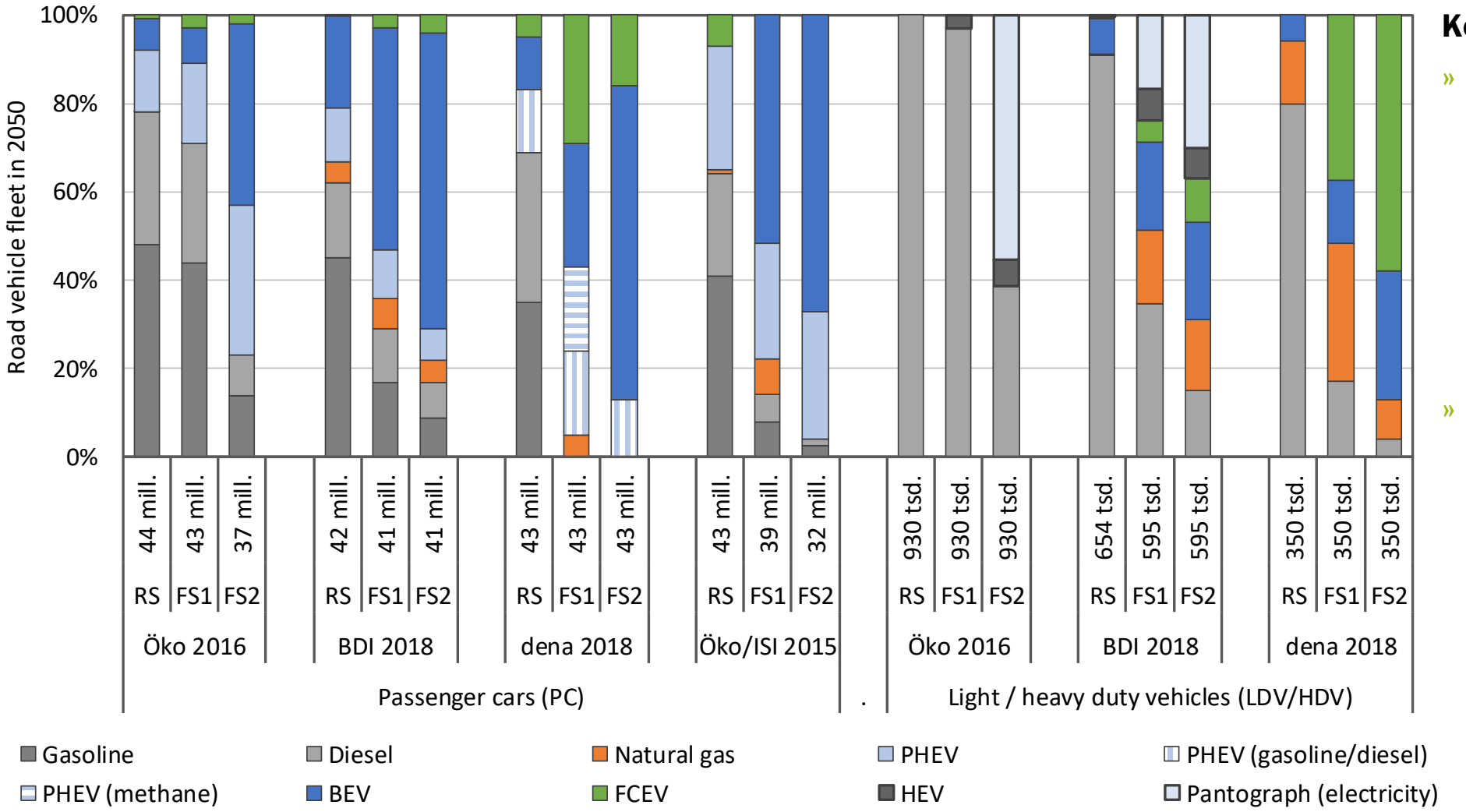
Key results

- National target in 2030 (40 to 42 % GHG mitigation) will not be reached in most of the studies
- Avoiding traffic or shifting traffic relevant in all scenarios
- Direct or indirect use of electricity dominant
- Demand on synthetic and biofuels
- Combustion engines with a relevant role, but with alternative fuels

Martin Wietschel, Philipp Kluschke, Stella Oberle (Fraunhofer ISI, Karlsruhe), Natalja Ashley-Belbin (IREES, Karlsruhe) Überblicksstudie: Auswertung von Studien und Szenarien der Energiesystemanalyse mit Schwerpunkt „Mobilität“ (online: https://um.baden-wuerttemberg.de/fileadmin/redaktion/m-um/intern/Dateien/Dokumente/5_Energie/SDA/Studie_Energiesystemanalyse_Mobilitaet.pdf)

Scenarios for German transport sector 2050

Overview on overall scenarios | Road vehicle fleet



Key results

- for PC: direct electrification (BEV market shares of 10-30% until 2030, 30-70% until 2050), other powertrains and related fuels (e.g. PHEV, fuel cell, synthetic fuels, CNG) and their shares with quite different assessments
- for LDV/HDV: increasingly more relevant, battery-based powertrains are seen for LDV up to 12 t and light-duty short-radius distribution, other solutions with different assessments (e.g. trolley HDV with hybrid-diesel and battery, hydrogen-HDV, and HDV with synthetic fuels

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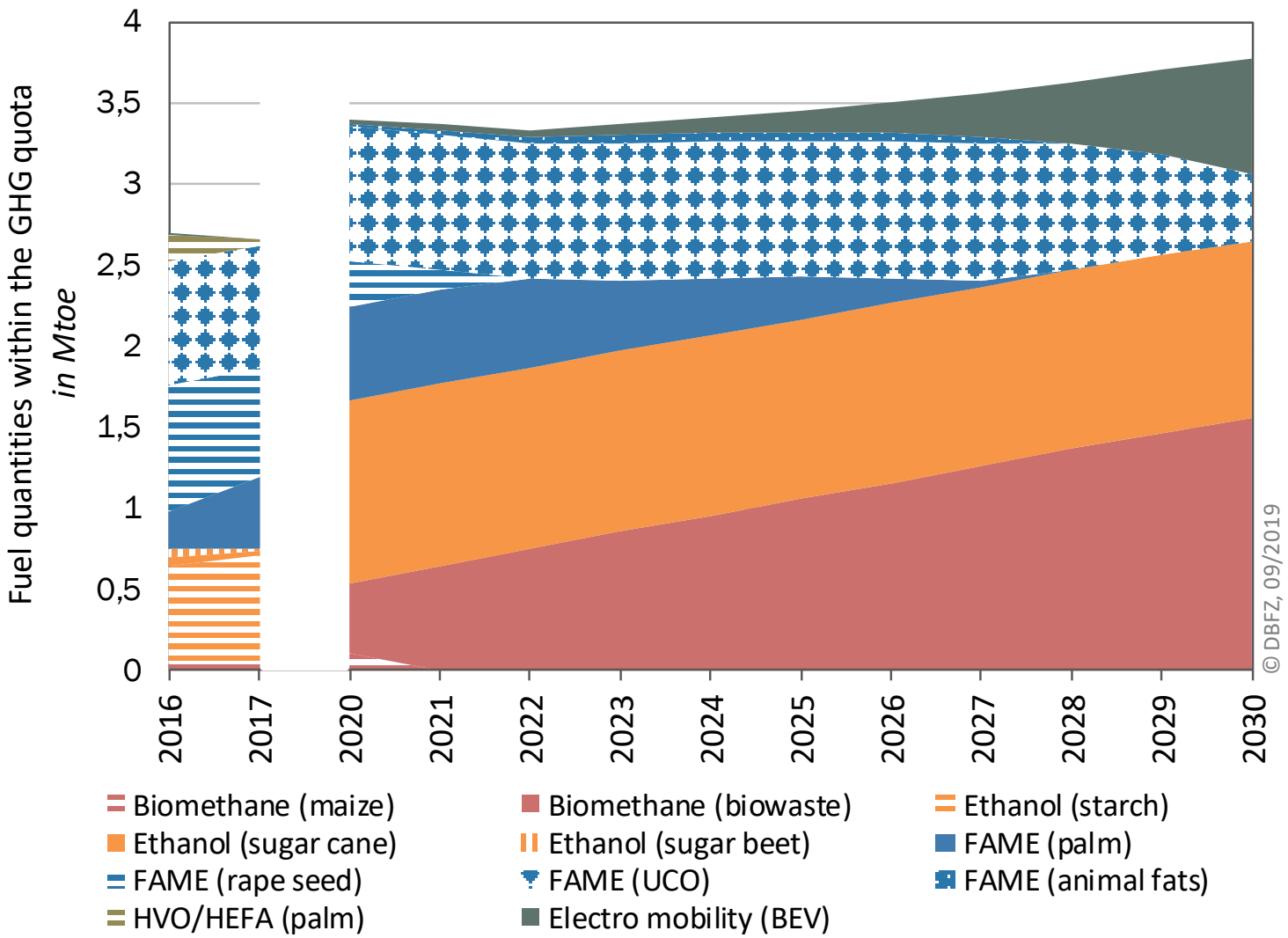
Scenarios for biofuels and other renewable fuels until 2030

DBFZ base case scenario | direct transposition of RED II



Frame

- RED II frame 14% renewables in transport
- 52 Mtoe final energy demand in 2030
- mainly based on GHG mitigation costs
- considering feedstock potentials, increasing renewable electricity shares, fuel blend walls, 6 million BEV and 3% gas share

Key results

- correspondent GHG quota just 5.7% (w/o UER and electricity in rail transport) >> 3 Mtoe
- advanced fuels share only covered by biomethane from biowaste >> requires strong increase of gas as fuel
  - domestic ethanol if no import increase of sugar cane ethanol
  - decreasing shares on UCOME and phase out of PME

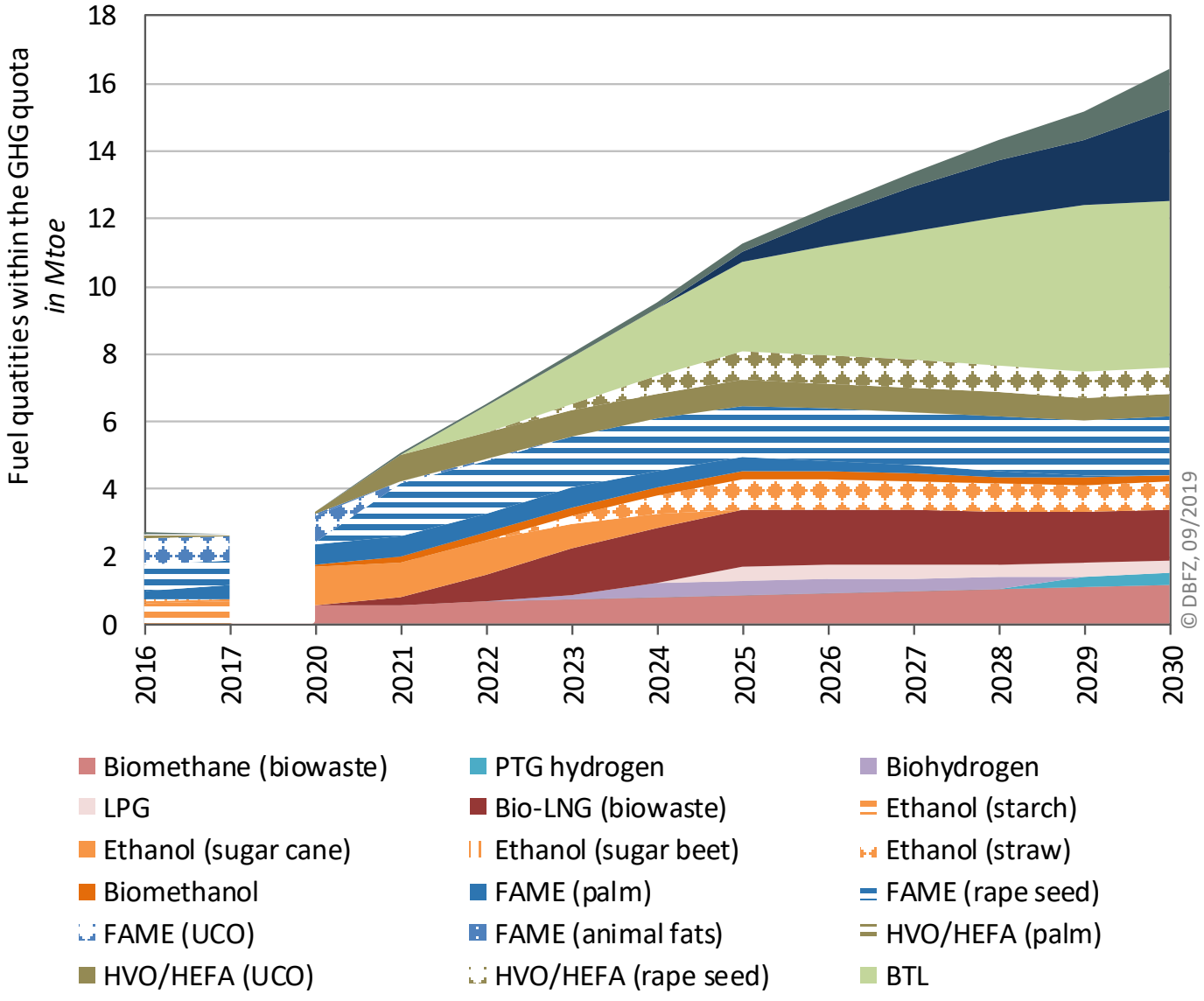
Untersuchungen zur Ausgestaltung der Biokraftstoffgesetzgebung
FKZ: 22401416
2016 - 2019

Gefördert durch:
Bundesministerium für Ernährung und Landwirtschaft
aufgrund eines Beschlusses des Deutschen Bundestages
FNR 10

Further assumptions: e.g. Emob with RE share of 55%; no increase in prices; limit of cultivation area of 2 million ha in DE, total technical potentials of feedstocks and imports considered; GHG values conventional according BLE 2018, RED II default values for other options >> decreasing GHG values until 2030, UER – upstream emission reduction

Scenarios for biofuels and other renewable fuels until 2030

Climate scenario | 40% GHG reduction



Frame

- Same as for RED II but 40% GHG mitigation in transport until 2030
- 39 Mtoe final energy demand in 2030
- 10 million BEV and increasing gas market shares are necessary

Key results

- Correspondent GHG quota of about 34.5% (w/o UER and electricity in rail transport) >> 16.5 Mtoe
- All fuel options, a significant decrease in energy consumption and a high GHG quota are required
- Capacities of advanced biofuels and PTx have to built up asap
- Share on renewable energy 41% in 2030

UER – upstream emission reduction
Further assumptions: reference 1990 based on reference value 94,1 g CO_2-eq./MJ e.g. Emob with RE share of 65%; no inflation considered; limit of cultivation area of
2 million ha in DE, total technical potentials of feedstocks and imports considered

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FNR 11

Conclusion

- Big gaps and thus challenges resulting from recent developments and binding targets until 2030
- For reaching future targets many different sustainable renewable fuels possible and potentially competitive
- RED II frame does not result in significant reductions of GHG emissions
- Climate target frame require all options and start-up of advanced biofuels and renewable PTx/e-fuels as soon as possible >> D&D until 2030, R&D&D&I for options relevant from 2030
- Challenge: advanced fuel availability, market competition of educts/products and related operability of control mechanism

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More information: https://iea-amf.org/content/news/TD-WS

Contact: dina.bacovsky@best-research.eu

Contact for Germany: franziska.mueller-langer@dbfz.de