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

Country report for Germany

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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

- Total energy demand: + 5% since 2010 (of which 4% renewable fuels, 1.5% electricity)
- CO₂-emissions: + 8% since 2010 (incl. 4% reduction from renewable fuels)

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data base: AGEB 2019; * preliminary data
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 CO₂‐eq. (new reference values from 2018)

» Fuel specific GHG mitigation (main fuel options)
  Biodiesel (FAME): 83%
  Bioethanol: 86%
  HVO/HEFA: 77%
  Biomethane: 90%

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Data base: BBDe 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
Present situation of energy supply and vehicle stock in Germany

Development vehicle stock

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

Vehicle stock change 2010 to 2017

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<thead>
<tr>
<th>Type</th>
<th>Status 2017</th>
<th>Details</th>
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<tr>
<td>Passenger Cars</td>
<td>46.5 million</td>
<td>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</td>
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<td>LDV &amp; HDV</td>
<td>3.0 million</td>
<td>Semi-trailer trucks: 211 thousand, Busses &amp; coaches: 79 thousand, Rail vehicles: 10 thousand, Air planes: 1 thousand, Vessels: 4 thousand</td>
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1 in 2015
Targets and policy measures for the transport sector

**GHG quota in Germany**

**European Union**
- Strategies
  - White paper transport
  - Energy Efficiency Plan
  - A resource-efficient Europe
  - Roadmap low carbon economy in 2050
  - Roadmap Resource Efficient EU
  - Energy Roadmap 2050
  - Green paper - climate and energy policies 2030
  - Clean Power for transport
  - Strategy for Low-Emission Mobility
  - Clean Energy For All Europeans

- Directives
  - 2003/96/EC (ETD)
  - 2003/96/EC (FQD)
  - 2009/28/EC (RED)
  - 2009/30/EC (FQD)
  - 2014/94/EU (AFID)

- Regulations
  - EG 598/2009
  - EU 599/2009
  - EU 1315/2013
  - EU 1194/2013 (antidumping)
  - 2018/842 (ESR)

- Amendment of RED and FQD
  - 2015/1513

**Germany**
- Strategies
  - Mobility and Fuels Strategy
  - Climate protection plan 2050
  - Climate package (for 2030)
  - National Energy and Climate Plan

- Laws
  - §37a, b BImSchG
  - EnergieStG

- Regulations
  - Biokraft-NachV
  - 36. BImSchV
  - 37. BImSchV
  - 38. BImSchV
  - UERV

- GHG quota as instrument likely also from 2021 onwards

- 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 CO₂ 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)
## Scenarios for German transport sector 2050

### Brief summary on overall scenarios

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<td><strong>Base assumption</strong>&lt;br&gt;Popul. (million) in 2030 / 2050 GDP CAGR until 2050 Oil (USD/bbl) in 2030 / 2050 CO₂ (EUR/tCO₂) in 2030 / 2050</td>
<td>78 / 74&lt;br&gt;0. % p.a.&lt;br&gt;120 / 195&lt;br&gt;—</td>
<td>81 / 77&lt;br&gt;1.1% p.a.&lt;br&gt;111a, 80b / 115a, 50b&lt;br&gt;26 / 45</td>
<td>81 / 76&lt;br&gt;77 / 65&lt;br&gt;—</td>
<td>78 / 74&lt;br&gt;0. % p.a.&lt;br&gt;128 / 195&lt;br&gt;30 / 50</td>
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<td><strong>Scenario target</strong>&lt;br&gt;Reference scenario (RS)&lt;br&gt;Future scenario 1 (FS1)&lt;br&gt;Future scenario 2 (FS2)</td>
<td>Current measures continued Decarbonisation of transport and max. vehicle efficiency FS1 + Quality of life in inner cities and shifting of freight traffic to the rails</td>
<td>Current measures continued 80% GHG reduction in 2050</td>
<td>Current measures continued Strong variation of technologies used Strong electrification in all sectors</td>
<td>Current measures continued 80% GHG reduction in 2050</td>
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<td><strong>Biomass assumption</strong>&lt;br&gt;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</td>
<td>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</td>
<td>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</td>
<td>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</td>
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<td><strong>PTX assumption</strong>&lt;br&gt;(Power to X, PTG – to gas, PTL – to liquids)</td>
<td>FS: 5% in 2030; 95% in 2050; 100% imported</td>
<td>FS2: demand for PTX fuels is 1 224 PJ for all sectors (878 PJ for transport sector); significant import demand for Germany</td>
<td>Domestic PTX is 468 to 590 PJ/a in 2050. FS2: PTG hydrogen mainly produced in Germany and PTG methane imported from EU</td>
<td>FS2: PTL after 2030; 2040: 25% PTL of total liquid fuels; 2050: 50% PTL of total liquid fuels; domestic or imported PTL is used.</td>
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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)
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

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

Fuel qualities within the GHG quota in Mtoe

2016 2017 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030

Biomethane (biowaste) 0
PTG hydrogen 2
Bio-LNG (biowaste) 4
Ethanol (sugar beet) 6
Ethanol (sugar cane) 8
Ethanol (biowaste) 10
Ethanol (straw) 12
Biohydrogen 14
FAME (palm) 16
FAME (rape seed) 18
Bio-LNG (biowaste) 20
HVO/HEFA (palm) 22
HVO/HEFA (UCO) 24
HVO/HEFA (rape seed) 26
Bio-LNG (biowaste) 28
PTL 30
Electro mobility (BEV) 32

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

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