The role of biodiesel in EU climate action

Input for EBB roadmap to 2030 and 2050

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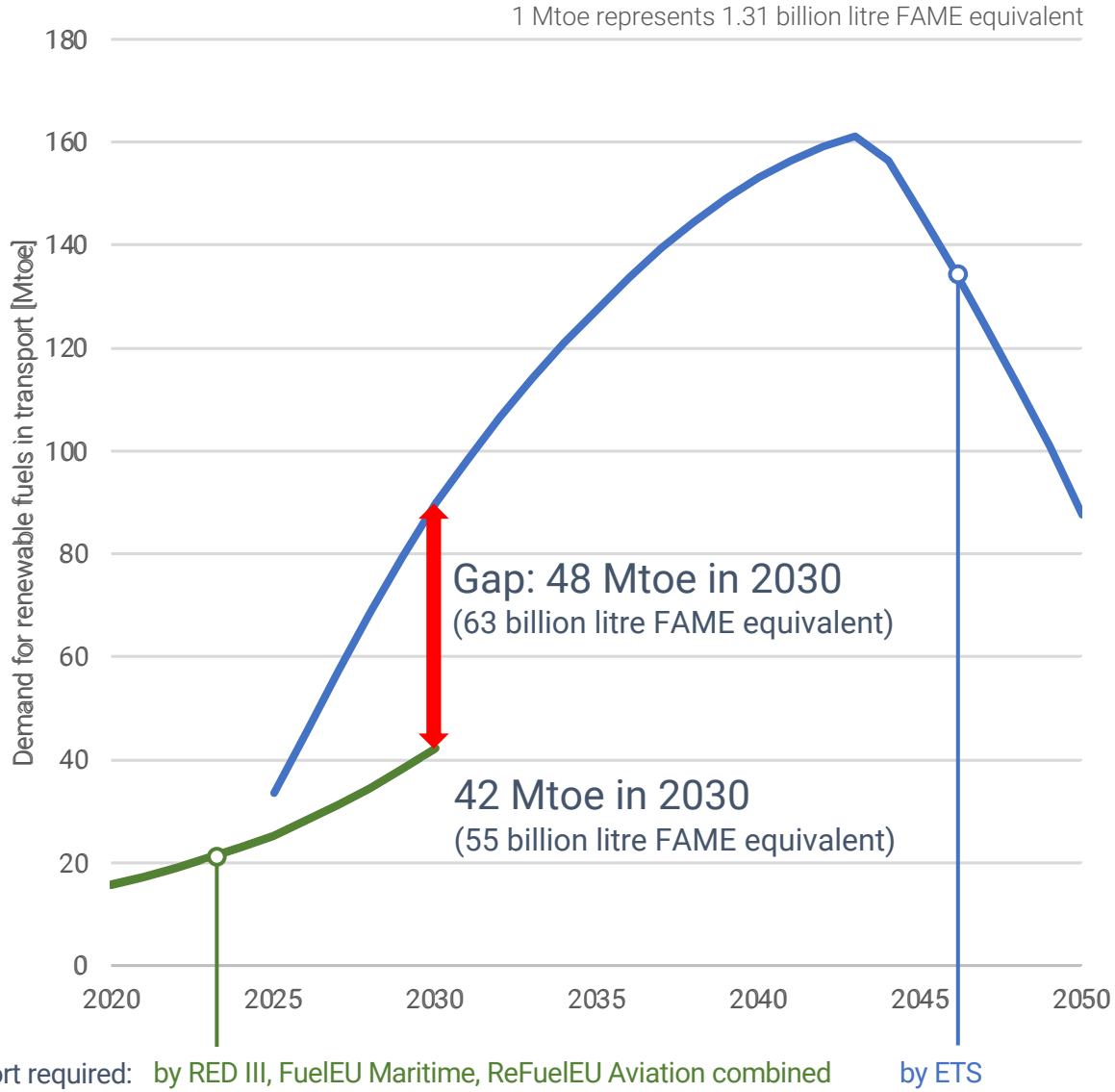
Demand for renewable fuels increasing sharply – peak demand in 2043

Mind the 2030 ETS gap

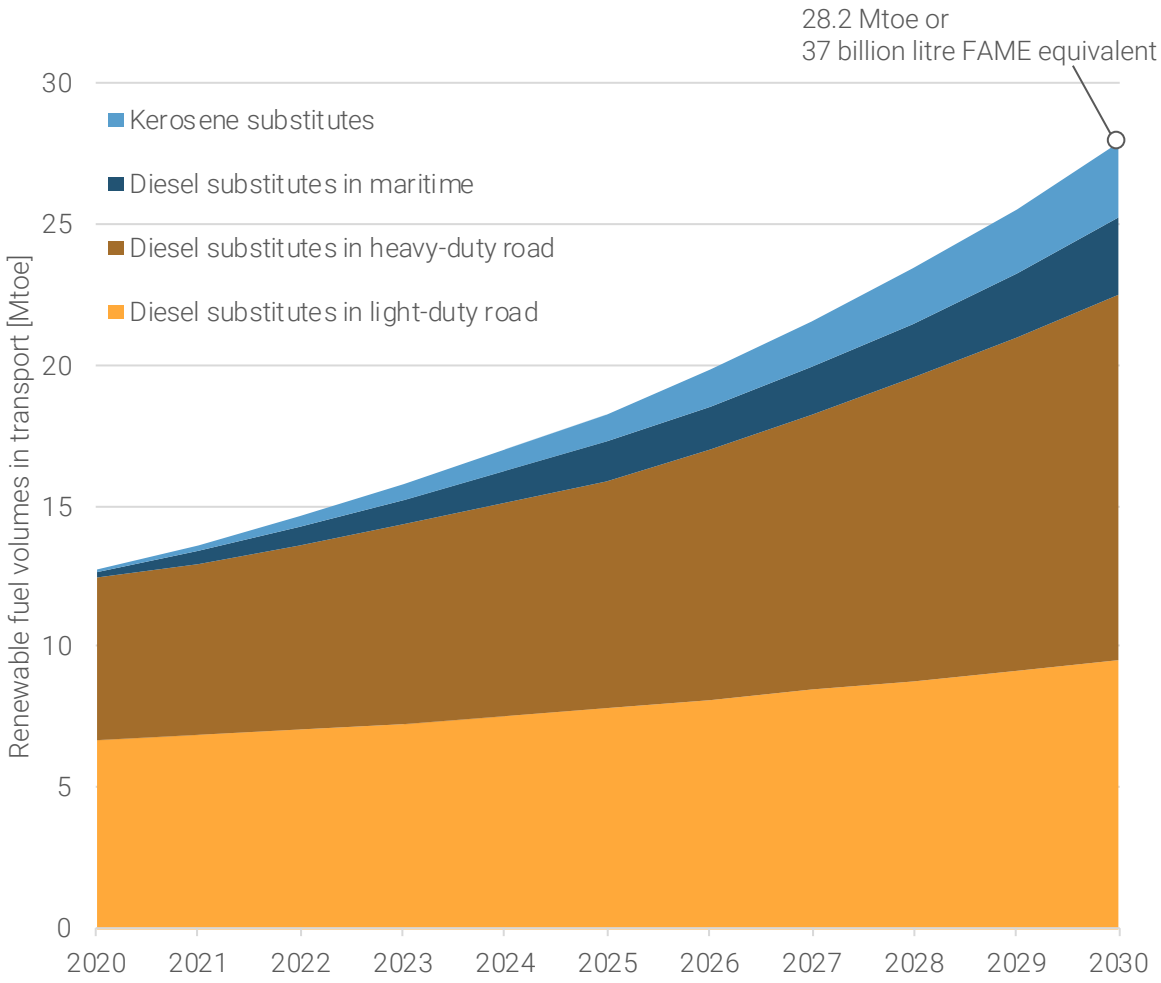
- The combined RED III, FuelEU Maritime and ReFuelEU Aviation mandates require up to 42 Mtoe of renewable fuels by 2030 (55 billion litre FAME equivalent)
- This is more than double current renewable fuel use
- ETS requires a sharply increasing amount of renewable fuels
- In 2030 ETS needs more than double the Fit-for-55 mandates
- Renewable fuels demand will peak at ~ 161 Mtoe in 2043 (212 billion litre FAME equivalent)
- This is almost 4 times the 2030 demand, > 8 times today
- During 2030-2050, most renewable fuel demand comes from heavy road, marine and aviation, which currently use mainly diesel and kerosene
- All solutions will be needed to close the gap, including biodiesel (FAME, HVO, HEFA)



Volume mandated by Fit-for-55

Demand for renewable fuel in diesel will double by 2030

- Mandated volume by Fit-for-55:
  RED III, FuelEU Maritime & ReFuelEU Aviation combined
- Demand for renewable fuels grows in all diesel segments
- From 13 Mtoe in 2020 to 28 Mtoe in 2030
  (17 billion litre in 2020, 37 billion litre in 2030)
- Road transport represents 80% of the demand for renewable fuels in diesel, fuel oil and kerosene segments in 2030
- By 2030 fraction of renewable fuels in road diesel ~18%
  → Could be combination of FAME and HVO
- Strong growth in demand for renewable fuels in maritime and aviation



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Volume mandated by Fit-for-55

Growth largely takes place in IX A and RFNBO

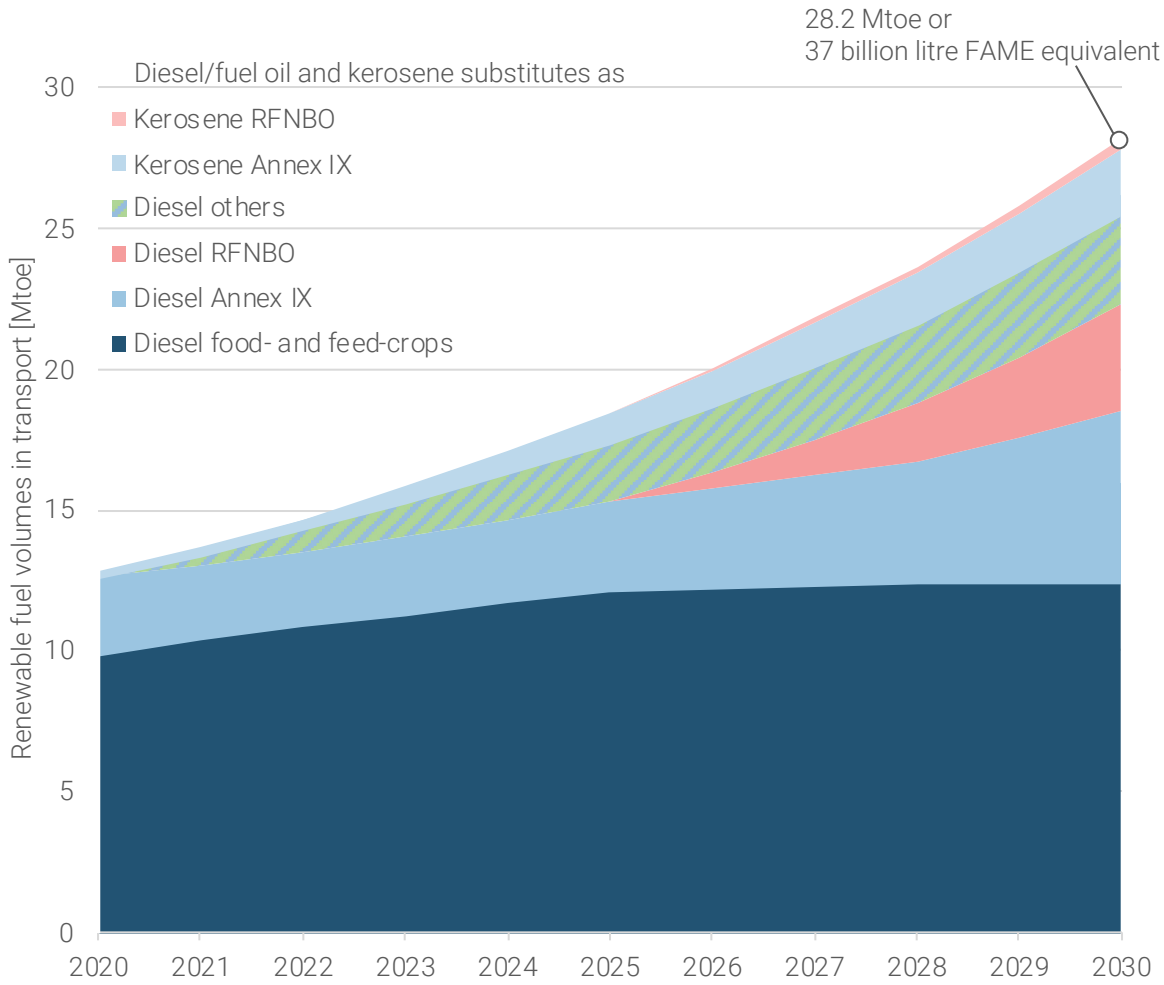
- In 2030, food-feed crop based biodiesel represents almost half of renewable fuels in diesel/kerosene segment
  … but growth is restricted by volume cap 5.5% (2020 +1%)

- Further important contribution of IX B biodiesel
  … but growth is restricted by volume cap 1.7%

- Strong growth in subtarget Annex IX A to 2.2%
- Diesel replacements are not just diesel per se
  - Can be biomethanol in shipping
  - Can be bioLNG above expected in ships, trucks
  - Can be Alcohol-to-Jet (ATJ) in aviation

- Strong growth in subtarget RFNBO
  - Can be hydrogen via traditional refineries
  - Can be methanol in maritime
  - Can be other PtL

- More “other” fuels are needed to meet RED III GHG target
  - Can be IX A, RFNBO, RCF, or non-capped crops



Scenario assumes that the targets of FuelEU Maritime and ReFuelEU Aviation are exactly met (no overcompliance) and contribute to RED III. The achievement of RED III targets then further relies on renewable fuels in road transport. ReFuelEU Aviation (beyond 0.7% RFNBO subtarget) is met by Annex IX, without distinction between IX A and B. The combined total of IX A is assumed at the 2.2% subtarget in 2030, while the total of IX B is assumed at the 1.7% cap.

ETS requires accelerated renewable fuels deployment

- From 2025 onwards, ETS will require a strong reduction towards zero emissions around 2045
- Maritime and Aviation become part of wider ETS
- Road transport with buildings in a separate ETS

Road transport

- If buildings reduce emissions fast, transport will have leeway
- but only in early years, until building solutions are exhausted
- → The path may differ, but the end-point is fixed

Maritime and Aviation

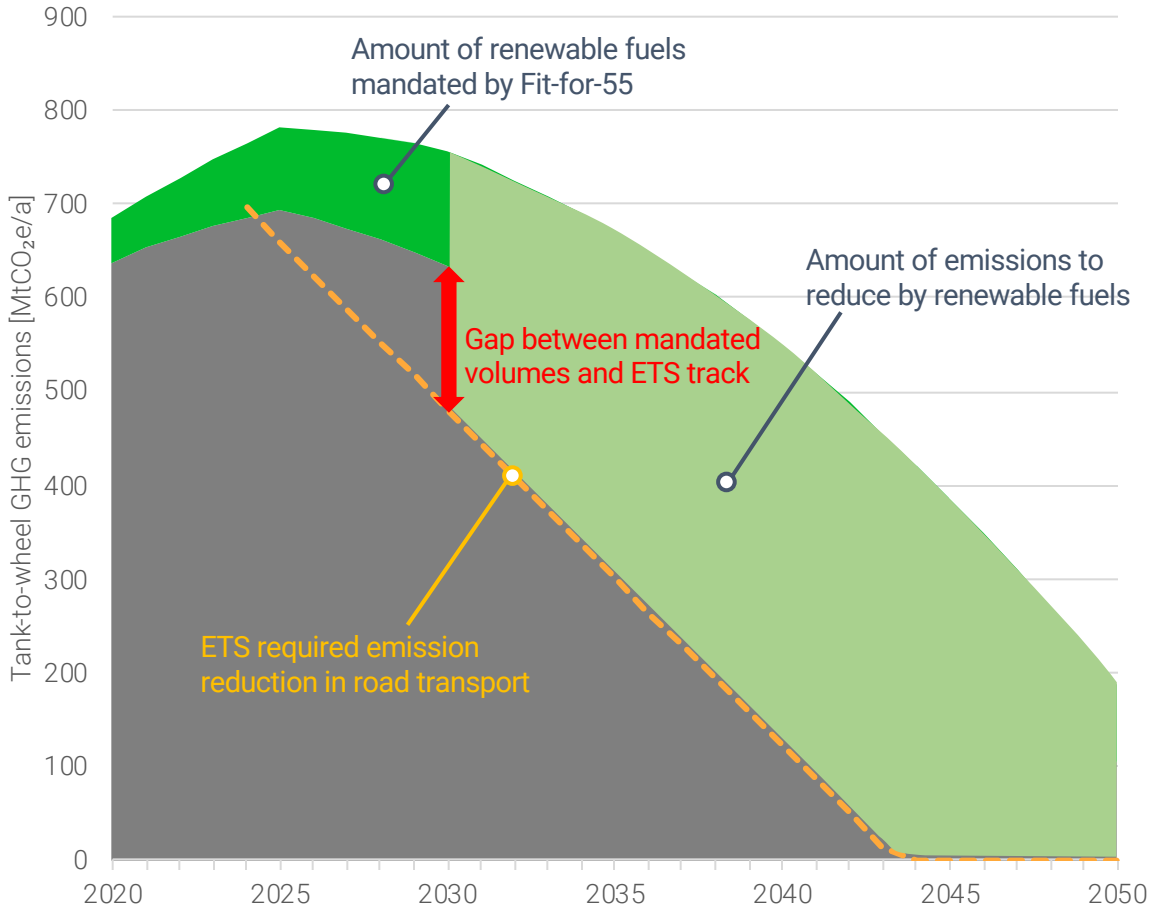
- These sectors combined are 8x smaller than road transport
- Mandates formulated in FuelEU Maritime and ReFuelEU Aviation are specified until 2050 and closer to ETS track

Combined transport sectors

- Combined ETS gap is ~48 Mtoe of renewable fuels by 2030 (63 billion litre FAME equivalent)

- Total peak demand for renewable fuels expected to be ~161 Mtoe in 2043 (211 billion litre FAME equivalent)

Development of emissions from **road transport**



Linear path assumes a pro rata reduction in road transport and buildings. In reality the dashed line may have to reduce faster, or stay horizontal for a while. With the proposed linear reduction rate, the end-point for both sectors combined, points towards zero end-use emissions in 2045.

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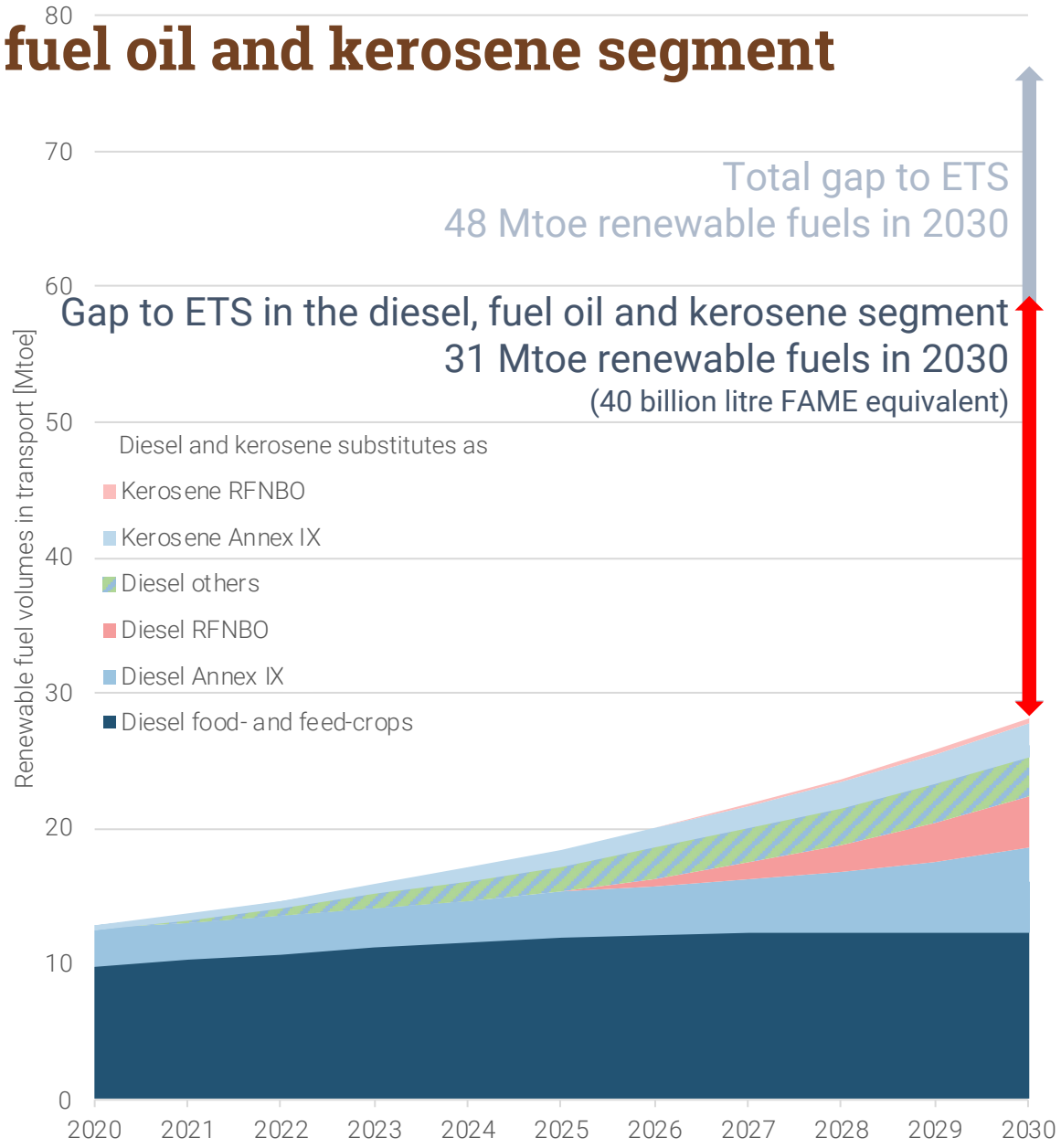
The 48 Mtoe gap is mainly in the diesel, fuel oil and kerosene segment

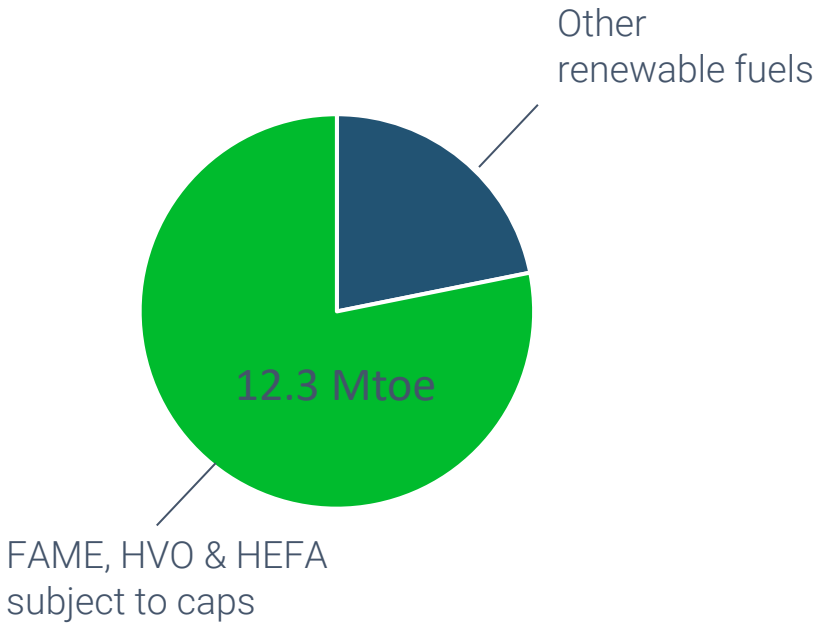
- In 2030, about 62% of all energy consumed in transport is in the diesel or kerosene segment
- Beyond 2035 the relative share of diesel and kerosene in liquid fuels increases due to decreasing petrol use
- To get on track for ETS in transport the 48 Mtoe gap will mainly have to be bridged in the diesel and kerosene segment
- If the 48 Mtoe is achieved equally in all modalities, then the additional demand for diesel + kerosene substitutes would be about ~31 Mtoe (40 billion litre FAME equivalent)
- This is almost 5 times the volume of renewable substitutes for diesel today
- All solutions are needed to close the gap



Development of food- and feed crop and Annex IX B fuels

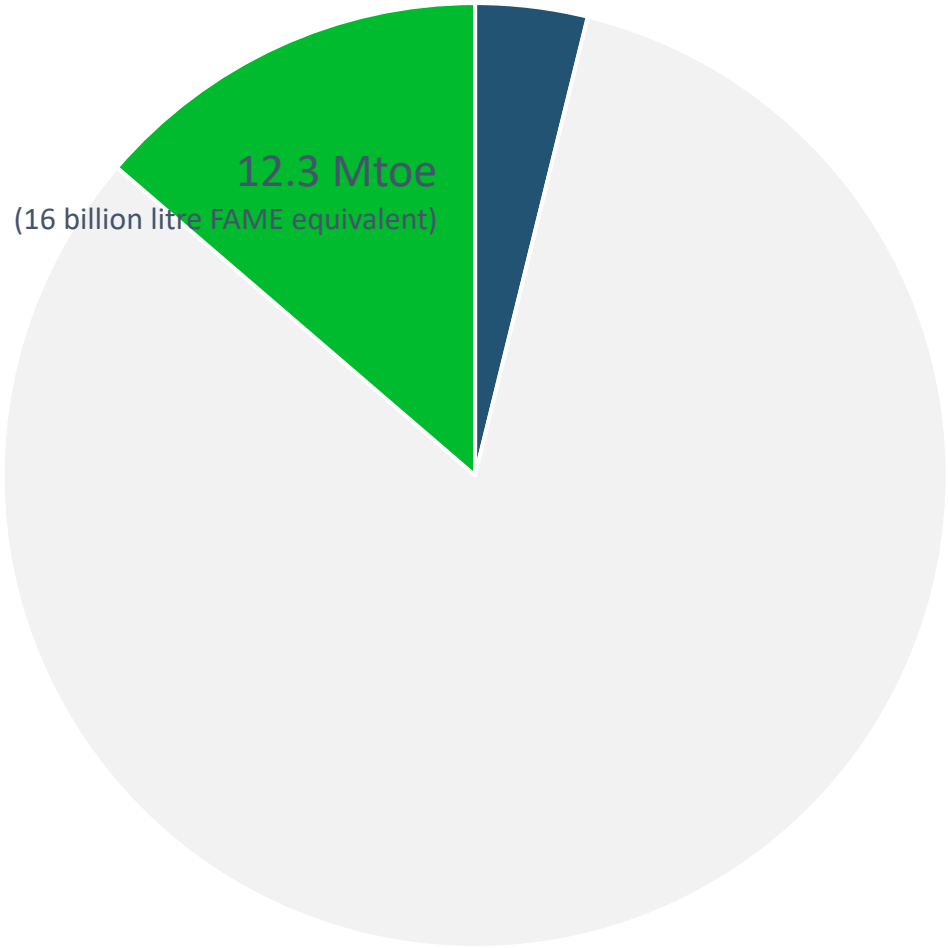
Scale-up is necessary for climate action

2020



2030

2020 volume compared to 2030 demand by ETS



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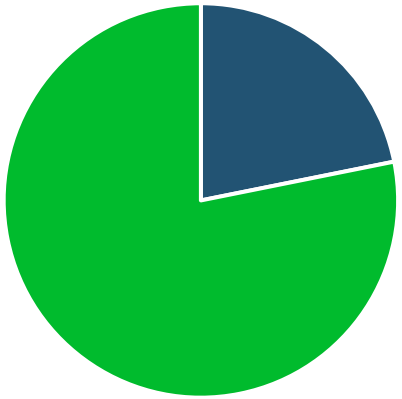
Development of food- and feed-crop and Annex IX B fuels

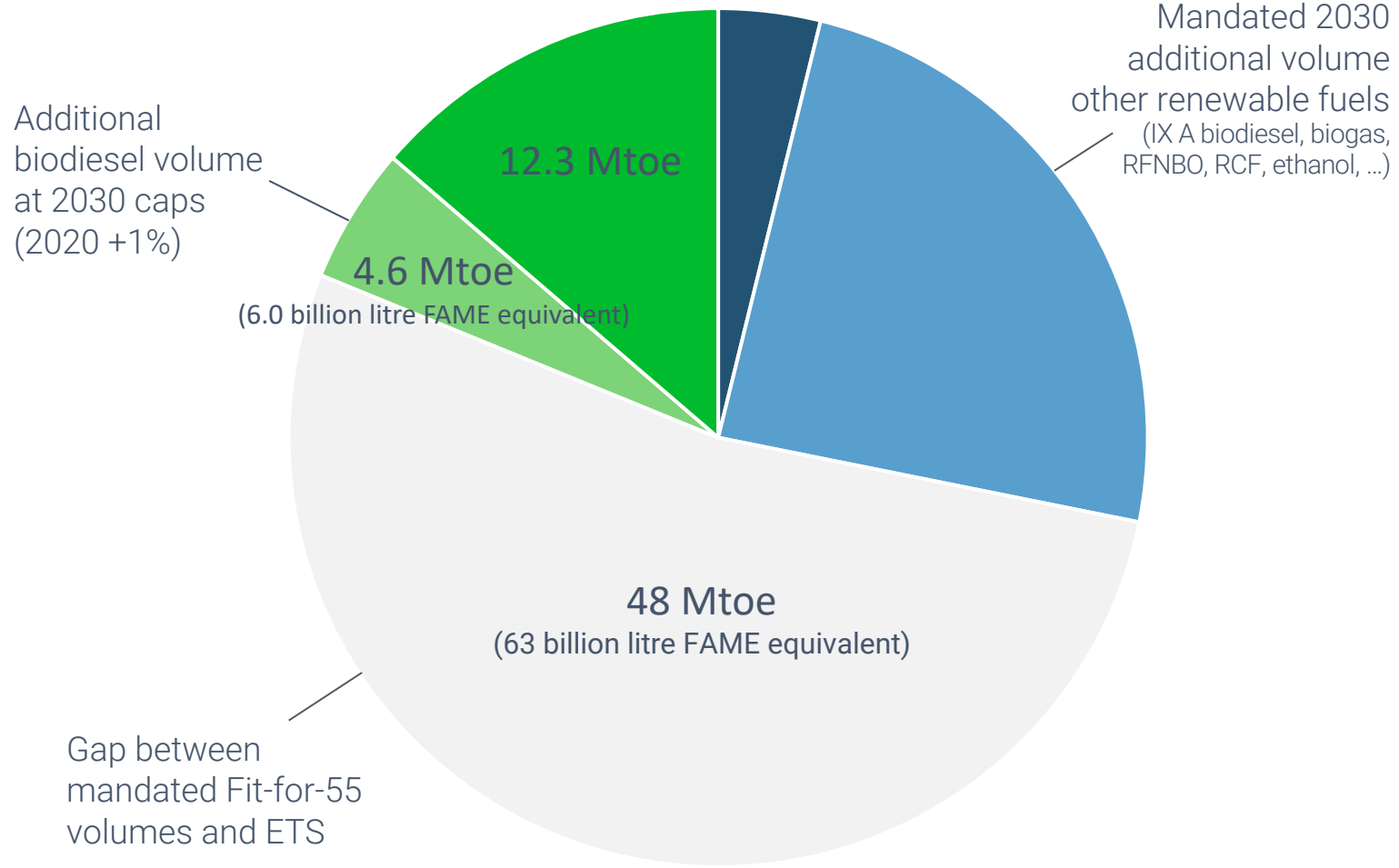
RED II caps severely limit the role diesel replacements can play

2020



2030

Contribution of food crops and Annex IX B at the 2030 caps



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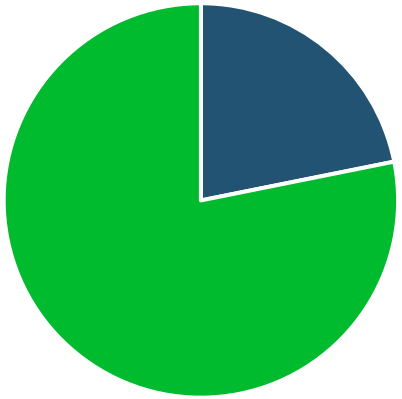

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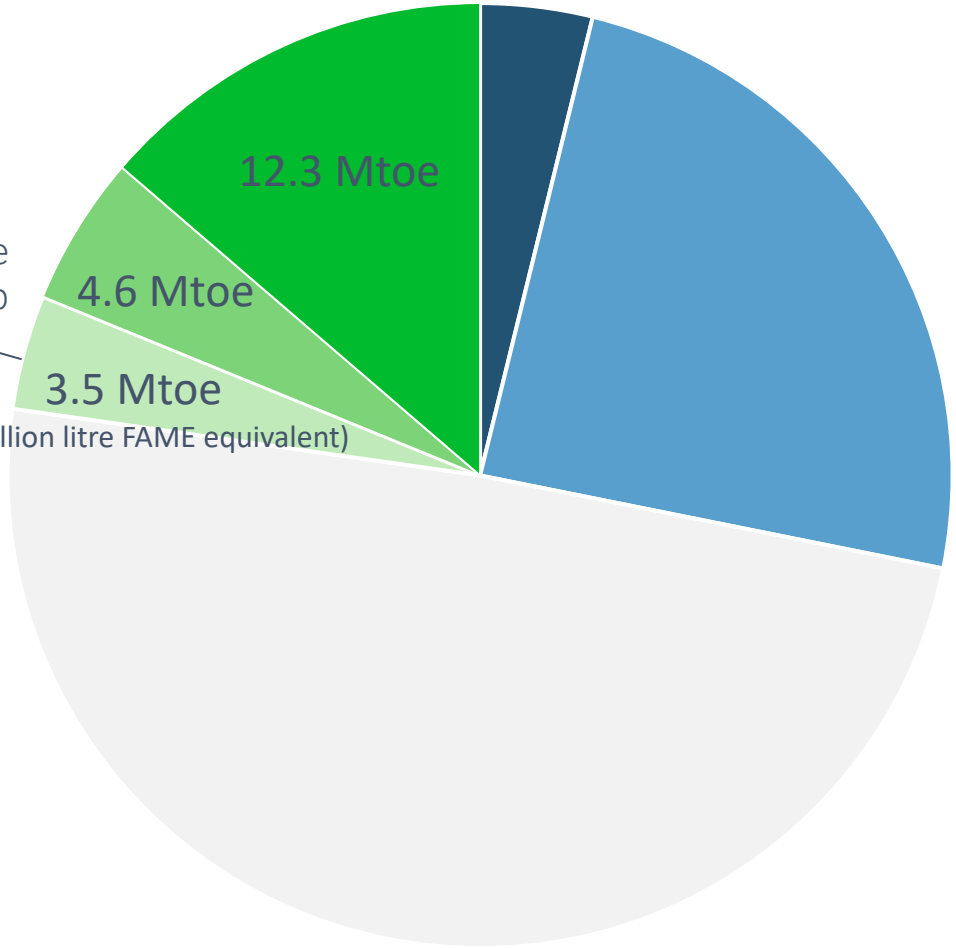
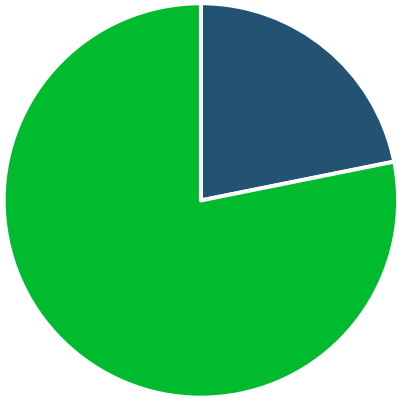


Additional biodiesel volume
at 7% food-crop cap

Development of food- and feed-crop and Annex IX B fuels

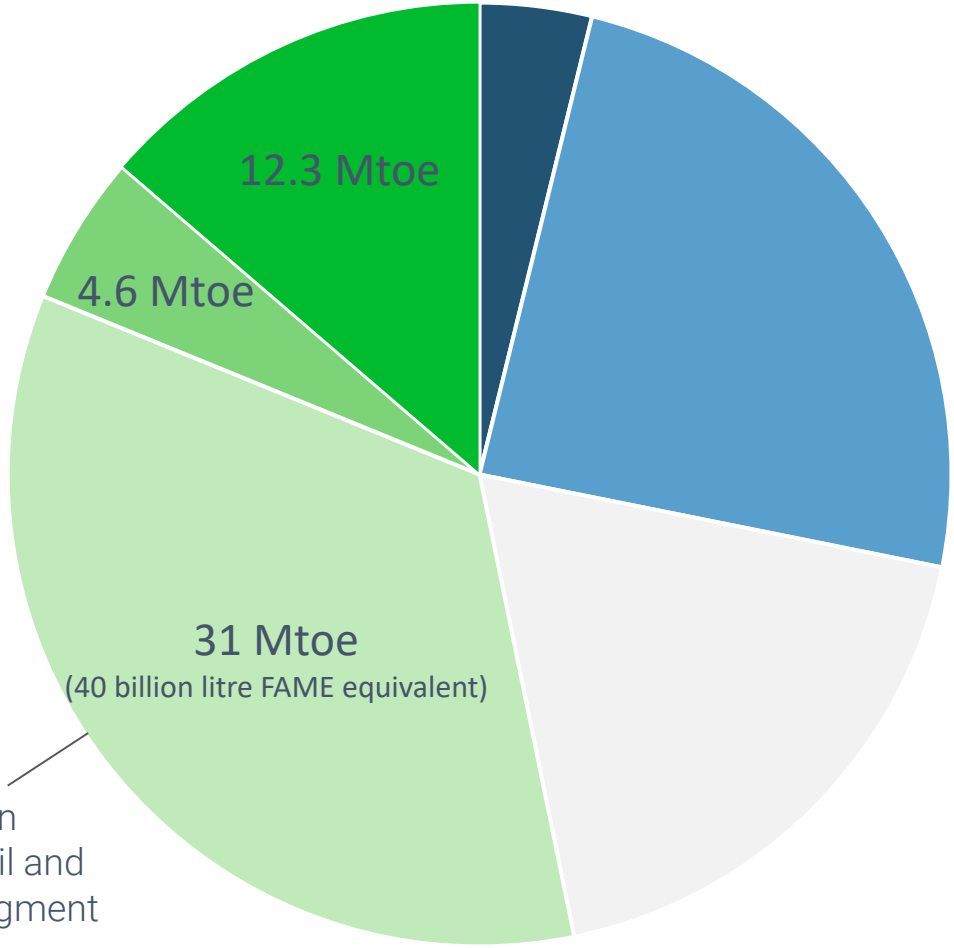
Larger role of diesel replacements necessary

2020



2030

challenging the limits
and/or expanding to Annex IX A



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Food and feed crop cap

- Cap had the objective to minimise ILUC (Indirect Land Use Change) emissions [1]
- Alternative options, like increased GHG thresholds & specific sustainability requirements, were considered
- NGO suggested crop cap – which was eventually adopted – because it had the least administrative costs

However:

- Newest GLOBIOM research shows that ILUC from rapeseed is low
- Increase with low ILUC risk is possible, if well managed

Annex IX B 1.7% cap

- Official argument to limit Annex IX B was to give more room for Annex IX A [2]
- The limited availability of waste oils was also mentioned
- While not explicitly mentioned the cap was also intended to address fraud concerns

However:

- Annex IX A has subtarget and its development is not limited by Annex IX B
- Limited availability of waste oils is for the market to solve
- Supply chain traceability will be ensured by EU database, UCO fraud can be limited by more testing and policing

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[1] *SWD(2012) 343 final pg 32-67*
[2] *SWD(2016) 418 final Part 1 pg 51 & 122*

The demand for renewable diesel and kerosene replacements will increase
Mobilising sustainable feedstocks crucial to enable a larger role biodiesel

Expand into Annex IX A feedstock and fuels

Sustainably increase crop production and Annex IX B feedstock mobilisation

- Sustainably increase yields on existing land
- Apply sequential cropping, catch, and cover crops
- Innovations in and expansion of waste collection
- New types of Annex IX B waste streams

Improve confidence in diesel replacements and its feedstocks as a sustainable solution

- Monitor and regularly publish insights on the volumes, performance, impact and benefits of biodiesel and on feedstock origin
- Increase supply chain influence: support and incentivise farmers to improve practices, promote farmer assistance programs
- Improve transparency and reduce fraud by testing and policing, through schemes or sector initiatives

Recognise co-benefits of biodiesel beyond transport

- Strengthens EU protein self-sufficiency
- Contributes to the circular economy and is a building block of the bioeconomy
- Can improve nutrient recycling
- Supports rural development

Recommendations

Unlocking the role of diesel and kerosene replacements

Diesel replacements have a large role in EU climate action

- Role needs to increase towards 2030
- Beyond 2030 a large additional volume of renewable fuels is needed in the diesel, fuel oil and kerosene segments
- Diesel replacement producers should actively make themselves future-proof to play a role in addressing the gap
- Current regulation hinders the contribution of biodiesel to climate action

Sector action to open policy dialogue

1. Improve performance to increase contribution to sustainable and circular economy
2. Address concerns of the societal debate
3. Suggest effective policy instruments: set strict criteria so that the limits can be lifted
4. Leverage biodiesel to assist the sustainable development in agriculture, and the EU protein strategy

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Annex

Model and scenario specifications

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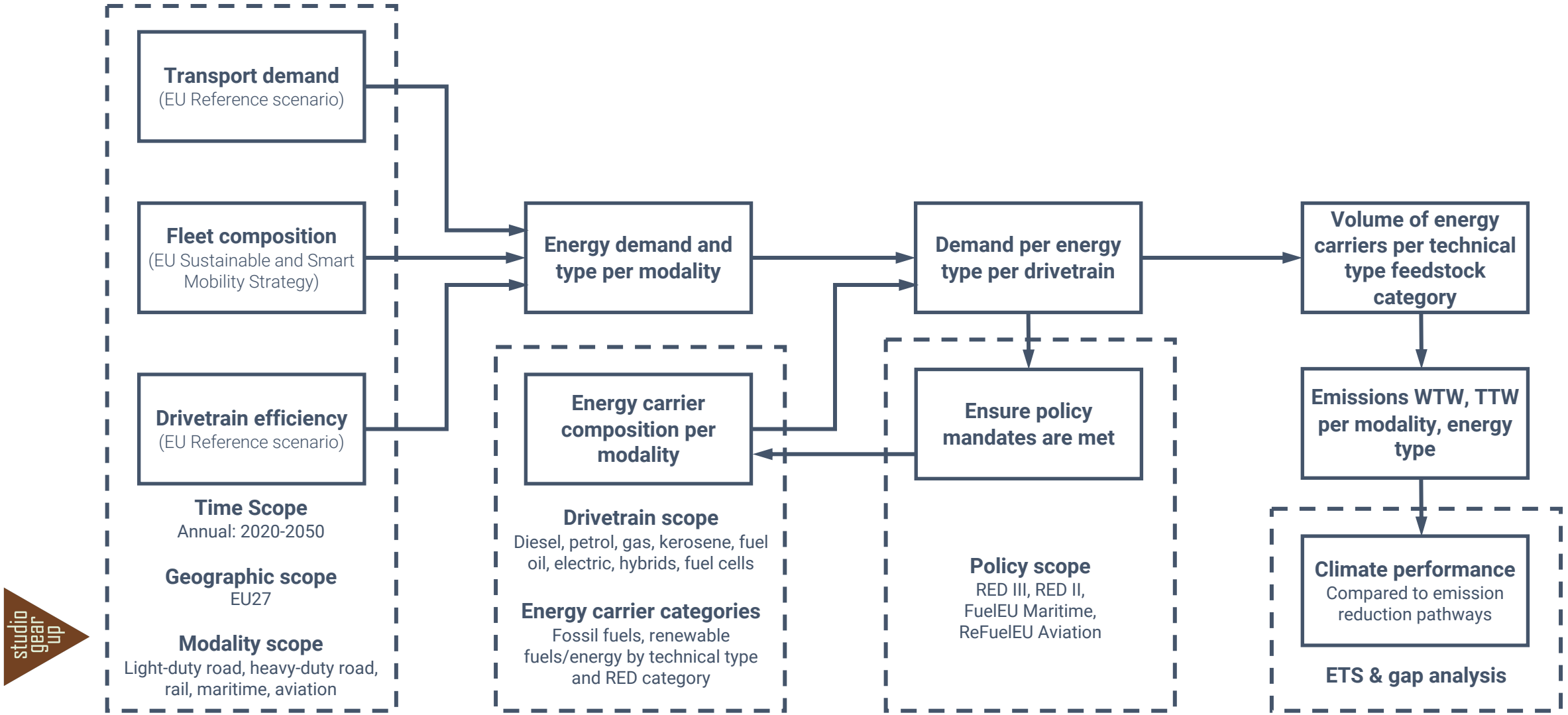
sGU Energy in Transport Model

Overview



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sGU Energy in Transport Model
Main data sources

Main data sources

- Demand for transport in passenger-km and tonne-km per modality for 2020-2050:
  EU Reference Scenario 2020, which is also the foundation of the Fit-for-55 package
- Fleet composition in terms of drivetrains per modality:
  MIX scenario in the Sustainable and Smart Mobility Strategy, which is also the underlying scenario of the Fit-for-55 package
- Vehicle powertrain efficiencies:
  Adopted from the technology assumptions of the EU Reference Scenario 2020
- Efficiency development in maritime shipping:
  International Energy Agency – Energy intensity of international shipping under EEDI and Sustainable Development Scenario 2005-30
- Where data was given per 5 or 10 year interval, intermediate years were interpolated (linear or parabola where appropriate)
- Share of renewable electricity in electricity, at EU level:
  European Environment Agency – EU renewable electricity has reduced environmental pressures; targeted actions help further reduce impacts (2021)
- 2020 calibration:
  Overall energy consumption: Eurostat, Renewable fuels: Eurostat SHARES, biodiesel and ethanol: Eurobserver, fleet: ACEA
- Policy targets:
  Fit-for-55 proposals, such as Amended ETS (2021/0211 (COD)) and Amended RED II (2021/0218 (COD))

sGU Energy in Transport Model
Further assumptions

Passenger vehicles fleet development

- 30 million electric passenger vehicles in 2030 [1]
- No more sales of passenger vehicles with internal combustion engine from 2035 onwards – only BEV and FCEV according to MIX scenario in the Sustainable and Smart Mobility Strategy
- Only about 1% of FCEVs in light-duty and 2% in heavy-duty transport in 2030

- Within a modality, all vehicle types are assumed to drive the same distance per year
- In reality the annual mileage per drivetrain can vary greatly. This is mainly caused by total-cost-of-ownership and fuel/energy prices, which are both impacted by tax and support measures. Therefore typical mileage per vehicle type cannot be predicted.

Technical type of fuels is not defined

- Diesel and petrol substitutes can be any type that is compatible with the diesel or otto engine respectively

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[1] *EC COM(2020)789 Final, Sustainable and Smart Mobility Strategy*

sGU Energy in Transport Model
Further model specification

Specification of renewable fuel types

- Demand for energy carrier is calculated per drivetrain per modality
- Fuels can be specified within the following categories, in line with RED II/III definitions
  - Fossil
  - Renewable: Food- and feed-crops
  - Renewable: Annex IX A feedstocks
  - Renewable: Annex IX B feedstocks
  - Renewable: RFNBOs
  - Renewable: Others (to indicate further required volumes of renewable fuels not being capped, could be RCF, additional Annex IX A, RFNBO, or fuels from non-capped crop feedstocks)

Approach to fuel specification per modality and drivetrain

- Iteratively, the correct percentages were determined per feedstock category, fuel type and modality, while respecting constraints (targets, subtargets, caps) as specified by RED III, FuelEU Maritime and RefuelEU Aviation for milestone years

- The volumes of renewable fuels mandated by these policies can be achieved via different distributions of fuels over modalities
- Therefore, several scenarios were assessed – in the main text, an average scenario is presented

sGU Energy in Transport Model
Comparison to the ETS linear emission reduction path

Proposed ETS best portrays the emission reduction required to achieve climate neutrality by 2050

- The amount of remaining fossil fuels is calculated, and translated to remaining tank-to-wheel greenhouse gas emissions
- These emissions are compared with linear emission reduction pathways proposed for ETS by the Fit-for-55 package
  - Maritime and aviation are to be included in existing ETS – the linear reduction pathway of -4.2% annually from 2025 onwards points to zero emissions in 2050
  - Road transport is in a separate ETS with buildings – the linear reduciton pathway of -5.15% from 2024 onwards points to zero emissions in 2050

- In reality, the pathway for transport will not be exactly linear as there is leeway in other sectors
- For instance, early emission reduction could be more cost-attractive in buildings than in road transport
- However, (1) energy use in buildings is smaller than road transport and (2) the cost attractiveness of insulation differ per building and heat-pumps are not always a realistic option
- Still, the end-point will need to be near zero by 2045-2050 to achieve economy wide climate neutrality
- This is best portrayed by the current ETS pathways

Distance to ETS indicates the need for additional emission reduction

- Could be achieved by curbing demand and modality change
- Could be achieved by further electrification and efficiency improvement
- Could be achieved by increasing volumes of renewable fuels

Scenario definitions

2020 starting point for all scenarios

- All scenarios are calibrated to the observed RES-T volumes around 2020
- Categories not mentioned are assumed to be zero/negligible in 2020

Fuel	2020 volume (Mtoe)	Main source	Comments / further assumptions
FC biodiesel in road transport	9.9	Eurostat, ePure, Eurobserver	Apply same blend% in light and heavy road transport
FC ethanol in road transport	2.6	Eurostat, ePure, Eurobserver	
FC biogas to road transport	0.1	Eurostat	All via heavy road transport, nothing in light
IX A biodiesel in road transport	0.4	Eurobserver	Apply same blend% in light and heavy road transport
IX A ethanol in road transport	0.4	ePure, Eurobserver	All via light road transport, nothing in heavy
IX A biogas in road transport	0.1	Eurostat	All via heavy road transport, nothing in light
IX B biodiesel in road transport	2.1	Eurobserver	Apply same blend% in light and heavy road transport
IX B biodiesel in shipping	0.2	Eurobserver, sGU 2020	
IX B biodiesel in aviation (HEFA)	0.1	USDA	

Scenario definitions

Fit-for-55 scenarios

In all scenarios, during 2020-2030, RED III, FuelEU Maritime and ReFuelEU Aviation are met:

- RED III: GHG target –12.25%, FC 6%, subtarget IXA 2.2%, subtarget RFNBO 2.6%, cap IXB 1.7%
- FuelEU Maritime: GHG target -6%, no food crop based fuels, no subtargets
- ReFuelEU Aviation: Renewable fuels target 5% (volume), no food crop based fuels, subtarget RFNBO 0.7%

Three scenarios have been explored in this study
Main principles and assumptions that distinct the scenarios

Road first	Maritime and maritime first	Hybrid
• Most biodiesel is used in road transport	• Prioritise IXB to maritime and maritime until 1.7% cap in 2030	• Prioritise IXA HEFA to aviation
• All IXA (subtarget) and IXB (cap) to road • RFNBO subtarget for aviation is met • Targets for aviation and maritime are mainly met by other fuels	• Complement with IXA, RFNBOs if needed • Until FuelEU Maritime -6% GHG is achieved • Remaining IXA (subtarget) and IXB (cap) to road • Aviation is met by other other IXA fuels (ATJ, FT)	• But only after 0.7% RFNBO (subtarget) • Then complement with IXA HEFA • Until 5% (volume) renewable fuels is met • Maritime is mainly met by other IXA fuels (LNG, MeOH)

Other main assumptions

- BEVs and FCEVs are assumed to equally displace petrol and diesel vehicles. Note that currently, diesel cars are being replaced faster by EVs than petrol cars. This may shift as cheaper EVs are coming available for the non-business driver.
- The model applies fleet composition as proxy for distributing demand-km over vehicles. Note that currently, diesel cars drive further than petrol cars and EVs. However future drive patterns are difficult to predict.
- No FC to aviation or maritime (they could, but we assume that they will find priority in road transport)
- By 2030, petrol contains ~14% renewable fuels (by energy), consisting of 6% FFC, 2% IX B, 3% IX A, 3% RFNBOs, 1% others.
- No blend limit for biodiesel in road transport (can be high blend FAME, drop in HVO)
- RFNBO can be as a full RFNBO fuel, or as hydrogen used in a fossil oil refinery.

Annex
Detailed results

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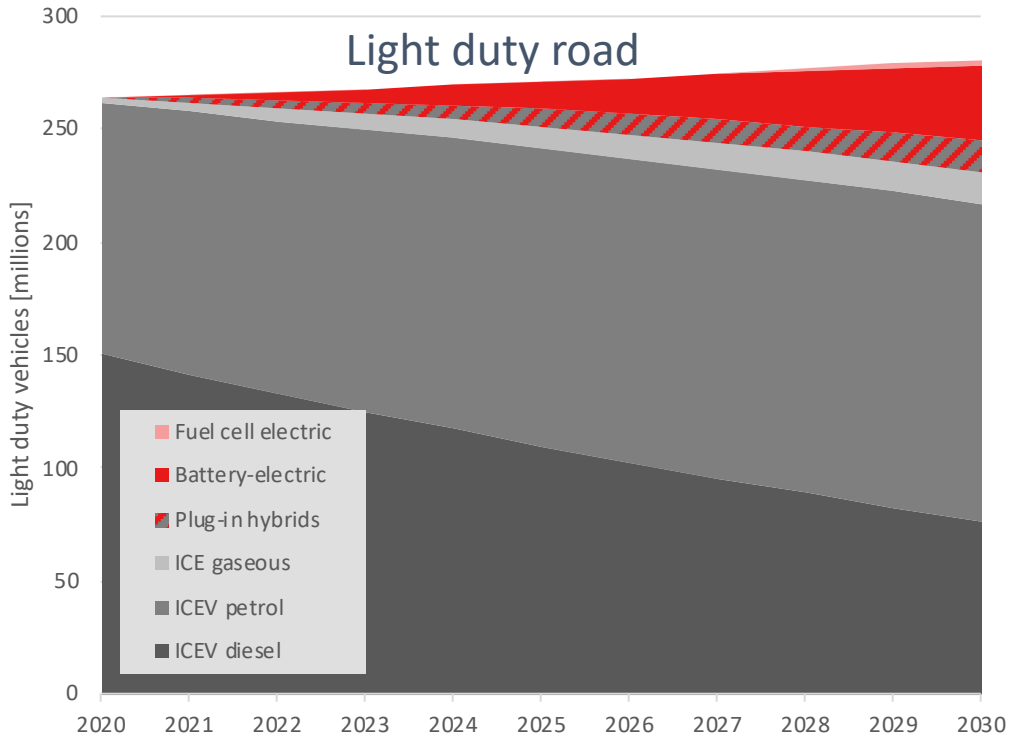
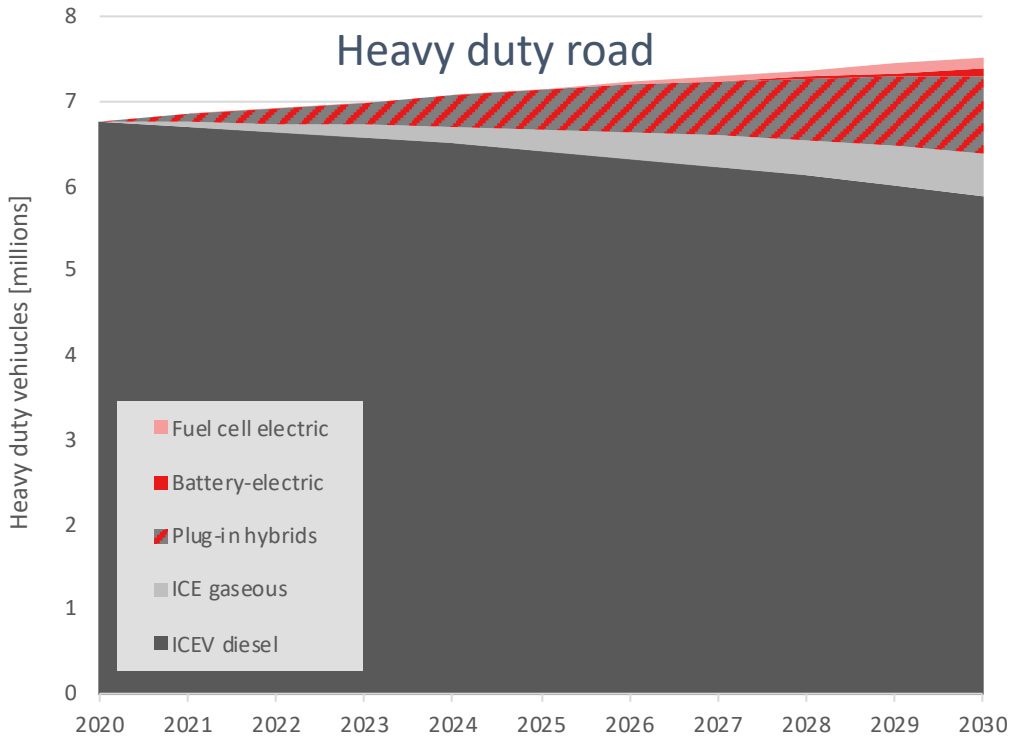
Development of road vehicle fleets until 2030





- Light duty road mainly concerns passenger cars
- 30 million battery electric vehicles are introduced by 2030
- 60% of EVs displace petrol, 40% displace diesel vehicles [1]
- All hybrids are petrol-hybrid
- Small increase in gas vehicles
- Fuel cell electric small until 2030

- Heavy duty road concerns commercial vehicles and busses
- Electric until 2030 mainly via diesel-hybrids
- Further significant increase of LNG vehicles
- Battery electric and Fuel cell electric small until 2030

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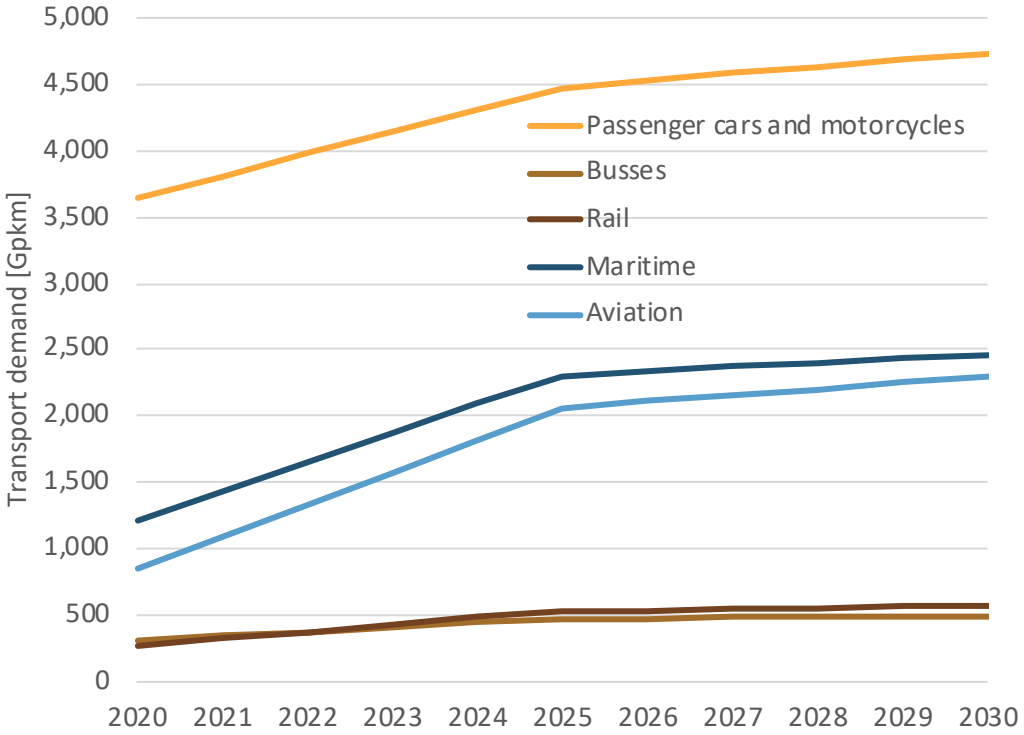
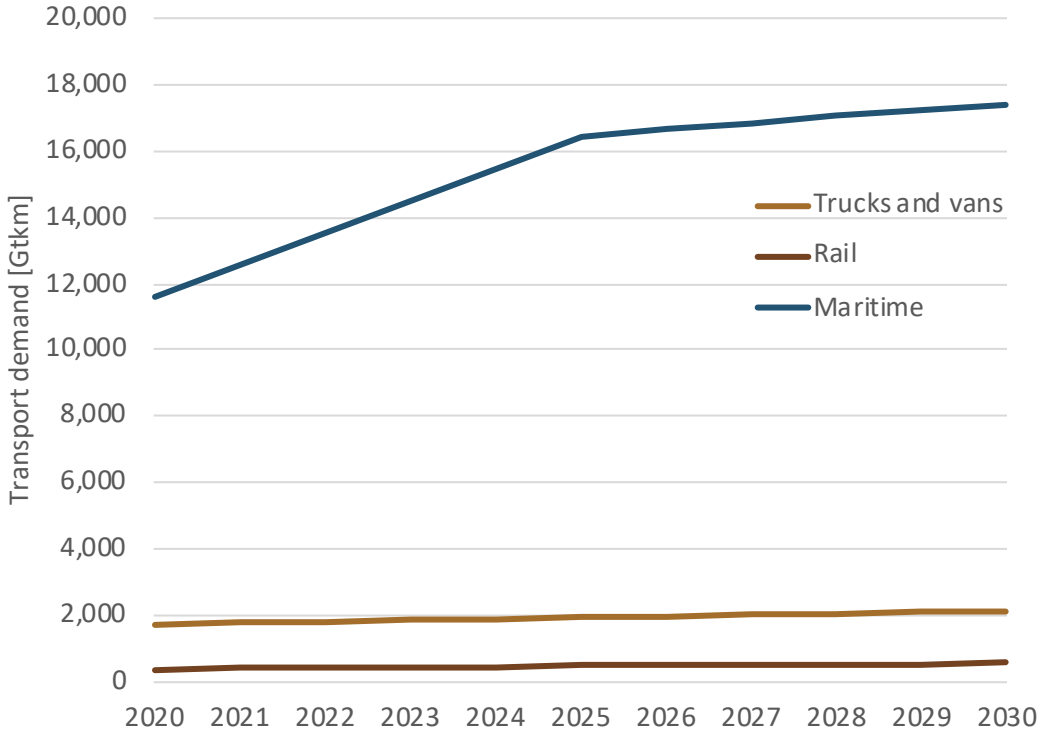
[1] *MIX scenario in the Sustainable and Smart Mobility Strategy, EU Reference Scenario 2021*

Demand for transport increases in all sectors until 2030 and beyond





- Passenger transport in all sectors increases
- Total growth of passenger-km (all sectors combined) is 68% in 2030 compared to 2020
- Especially maritime and aviation see strong growth until 2030, mainly due to post-Covid19 recovery (2020 dip)

- Freight transport in trucks and vans growths only slowly (had least impact from Covid dip in 2020)
- Strong increase in maritime goods transport
- Total growth in freight-km (all sectors combined) is 47% in 2030 compared to 2020

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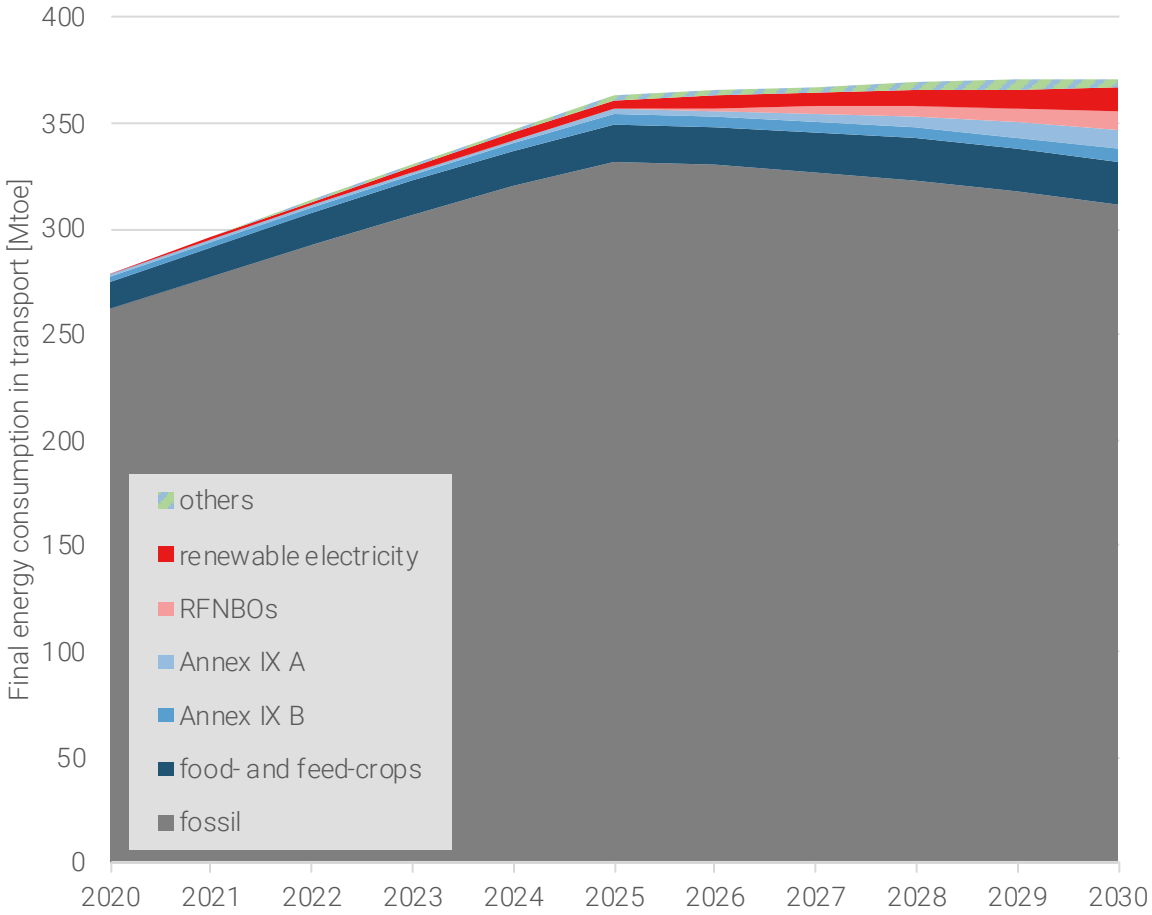
Demand for fossil fuels peaking around 2025

- The high increase in transport demand for passengers and freight, is only partially compensated by efficiency improvements
- Therefore, the total demand for energy in transport still increases with 33% in 2030 compared to 2020

- By 2030, the mandates from the Fit-for-55 package require a doubling of renewable energy (including renewable electricity) in transport:
  - 17 Mtoe in 2020
    (22 billion litre FAME equivalent)
  - 59 Mtoe in 2030
    (77 billion litre FAME equivalent)

- However, even with the Fit-for-55 mandates:
  - Still 84% of all energy consumed in transport is fossil based
  - The absolute volume of fossil fuels will be 19% larger in 2030 than in 2020: 312 vs 262 Mtoe
- Fossil fuel demand peaks ~332 Mtoe around 2025



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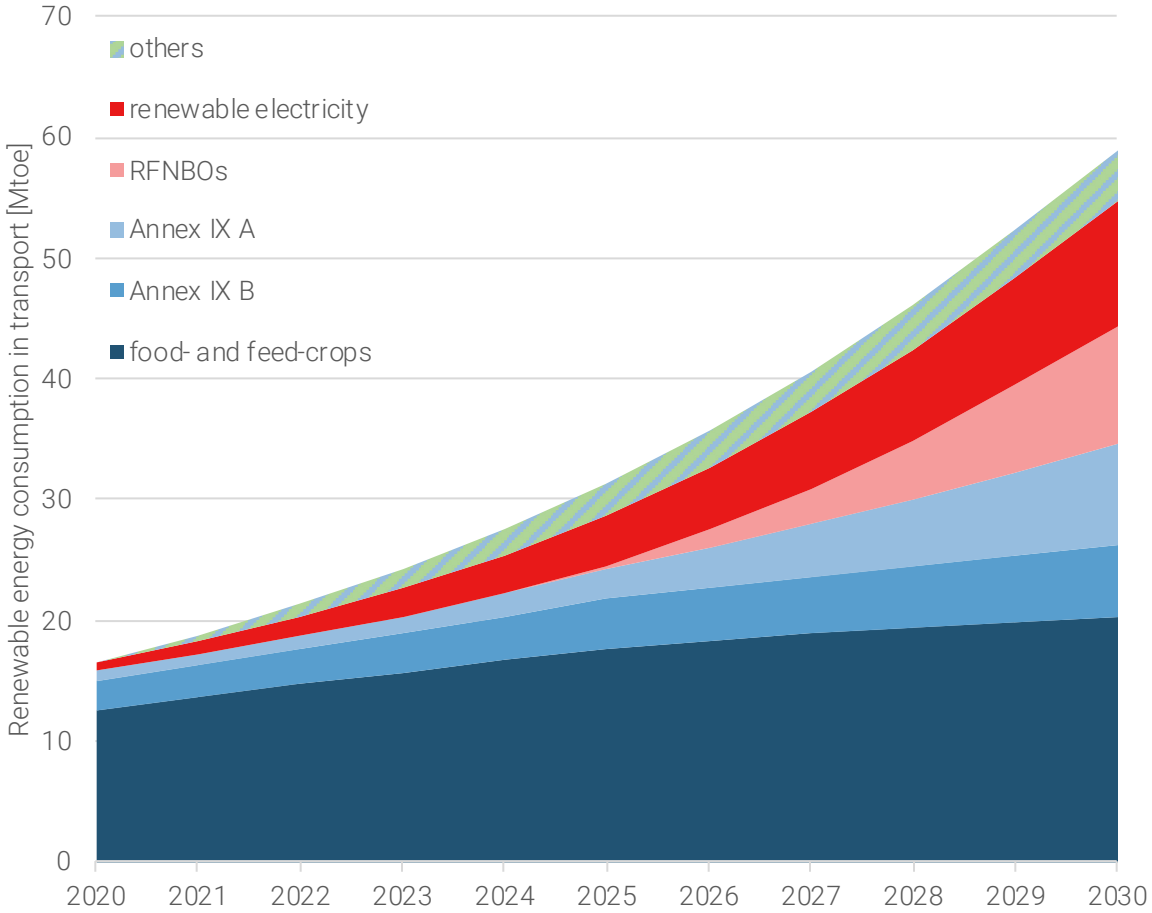
Renewable energy in transport in 2030 : mainly renewable fuels

- Renewable electricity expected to grow strongly in the light transport segment
- RFNBOs have a strong subtarget: 2.6% in 2030
  - Current demonstration is negligible
  - The production of RFNBOs will further increase the demand for renewable electricity

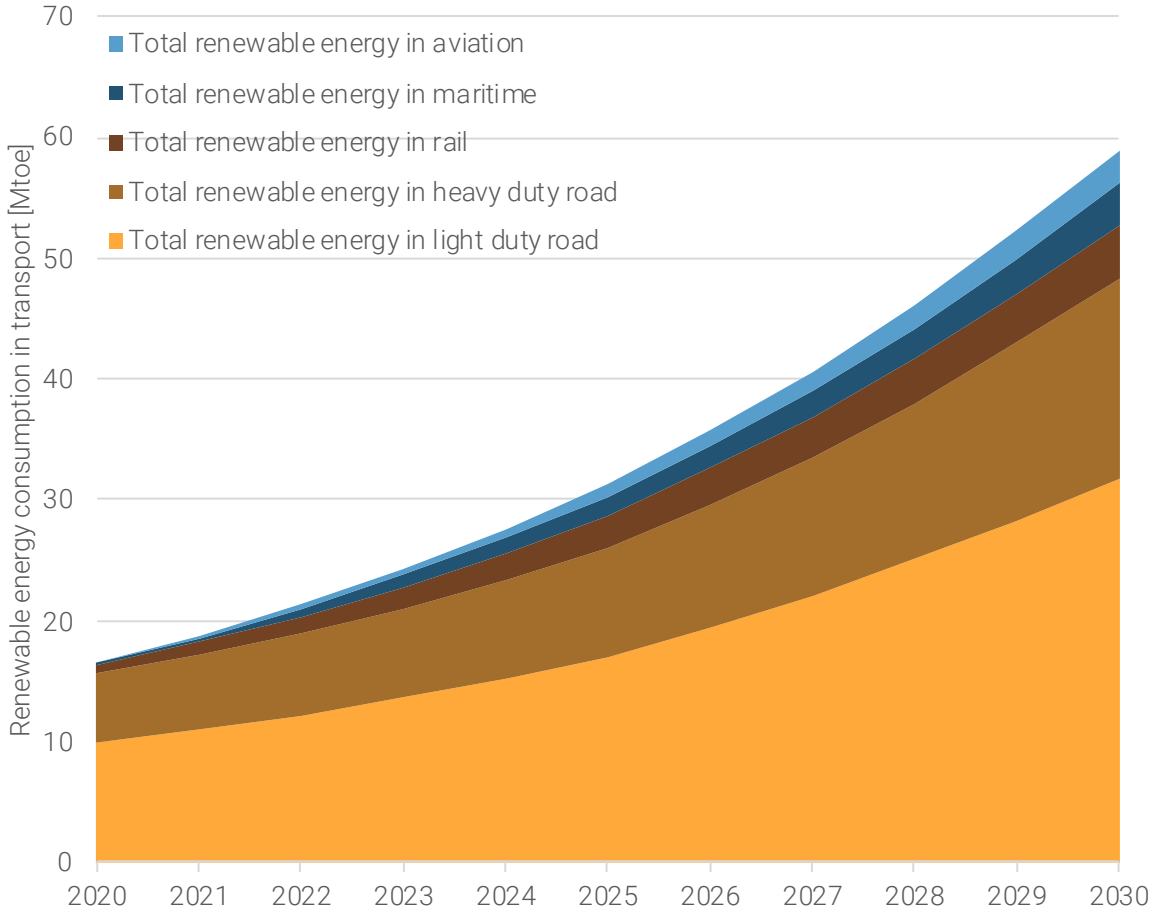
- Food crops and Annex IX both deliver about ⅓ of energy in transport
- Food crops at 5.5% = 1% above the 2020
- Annex IX A at 2.2% = almost 10x today



Most renewable energy is consumed in road transport

- In 2030, most renewable energy will still be consumed in road transport

- By 2030, maritime and aviation together represent 27% of all energy demand in transport
- Their role in renewable fuels is relatively small:
  - FF55 sector targets are modest
  - Food crops not allowed in maritime/aviation
  - All renewable electricity is placed in road



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Road first scenario

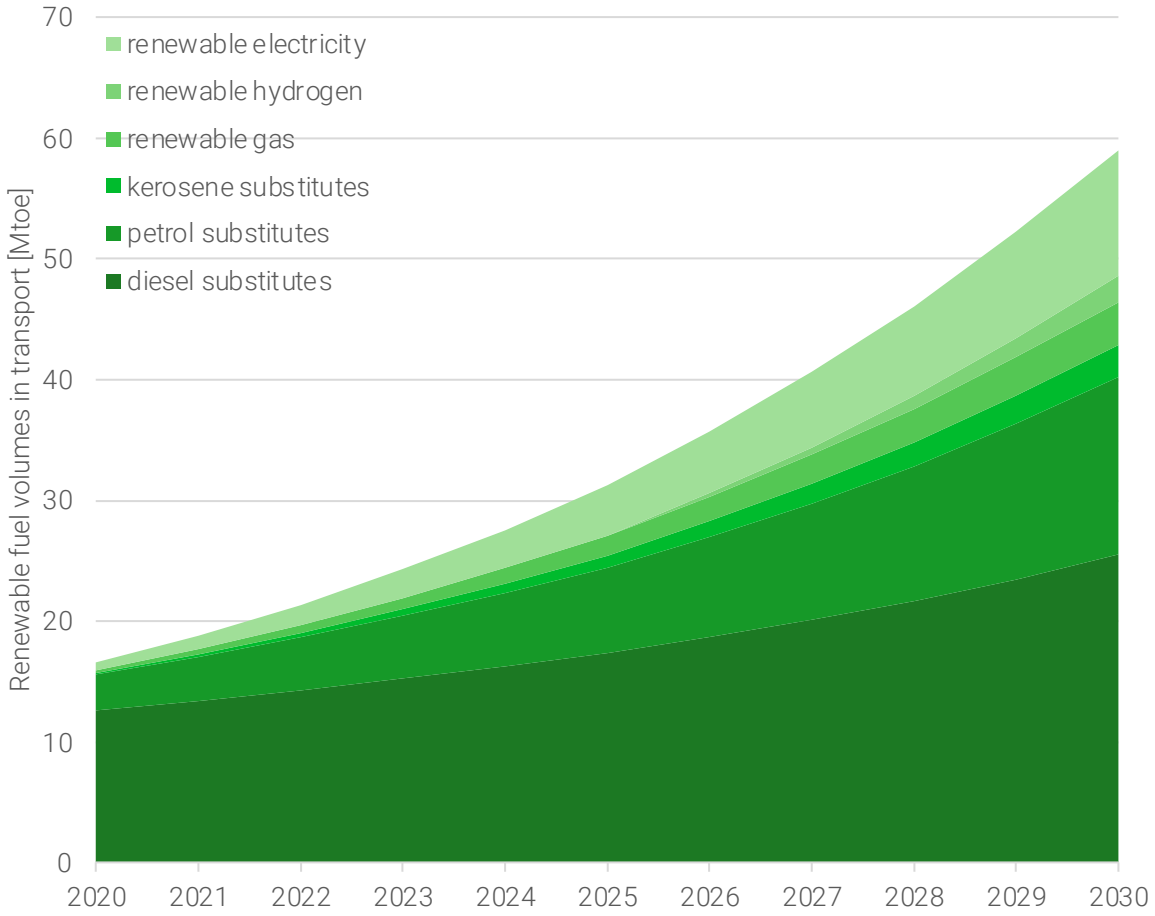
Diesel and kerosene represent 58% of the renewable energy in 2030

- In the Road first scenario, it is assumed that Annex IX diesel type renewable fuels are preferably placed in the road sector
- Only the volumes required by FuelEU Maritime and ReFuelEU Aviation are placed in the maritime and aviation sectors respectively

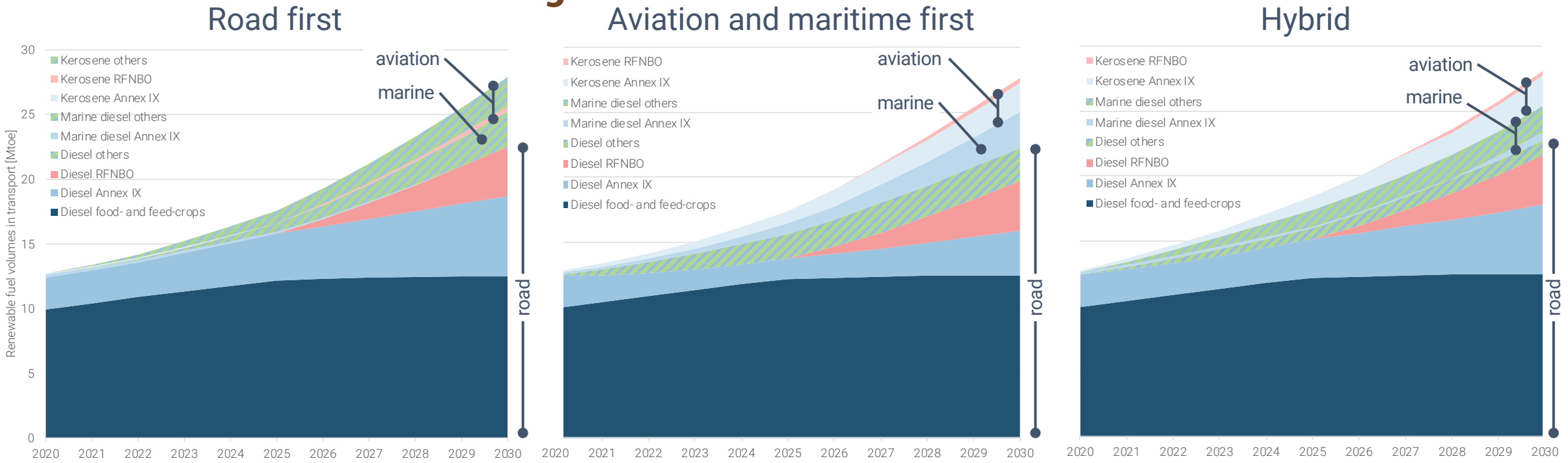
- All scenarios lead to a strongly increasing demand for renewable fuels in all segments

- In the Road first scenario, this means that the demand for renewable fuels in the diesel segment doubles from 12 Mtoe today to 27 Mtoe in 2030
- There is also a strong growth in demand for renewable petrol

- Demand for renewable fuels in diesel does not necessarily imply renewable diesel
  - Annex IX A and RFNBO in maritime can also concern bioLNG and biomethanol
  - Biofuels and RFNBO in heavy road transport can also concern bioLNG, ED95
- Note that renewable gas is already included (in line with the Sustainable and Smart Mobility Strategy SSMS. In our scenario, we do not expect additional renewable gas above the SSMS).



Biodiesel demand according to three scenarios



- Scenarios evaluate different preferences to place biodiesel in different modalities. The difference between scenario total volume results is small.
- Maritime and aviation have targets that can be achieved by Annex IX and other renewable fuels, but not by crop based biofuels. For the achievement of the RED III mandate, all fuels can be placed in all sectors, but the contribution of Annex IX biofuels in maritime and aviation is additionally stimulated by a 1.2x multiplier. Towards 2030 Annex IX fuels are cost attractive compared to other options in these sectors.
- The **Road first** scenario assumes that biofuels are preferably placed in the road sector, while the targets for maritime and aviation are mainly achieved via RFNBOs and "other" biofuels (may not be FAME, HVO, HEFA). The total demand for diesel and kerosene replacements is about 28 Mtoe in 2030.
- The **Aviation and maritime first** scenario assumes that the maritime and aviation targets are mainly achieved via Annex IX type biofuels. The demand for diesel replacements in road transport is only slightly reduced, but contains more "other" biofuels (may not be FAME, HVO). The total demand for diesel and kerosene replacements in 2030 is about 28 Mtoe.
- The **hybrid scenario** assumes, compared to road first, more Annex IX renewable diesel in aviation (and some in maritime), while the role of renewable diesel in road transport is slightly reduced. The role of "others" is smaller than in the aviation and maritime first. The total demand for diesel and kerosene replacements is again about 28 Mtoe.
- Note that the total demand in all scenarios also include about 4 Mtoe RFNBOs and 2.5-3.2 Mtoe other fuels (which can be all except the capped options). This means that the minimum demand for renewable diesel outside RFNBOs is probably about 20 Mtoe in all scenarios.

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Road transport and buildings in a separate ETS

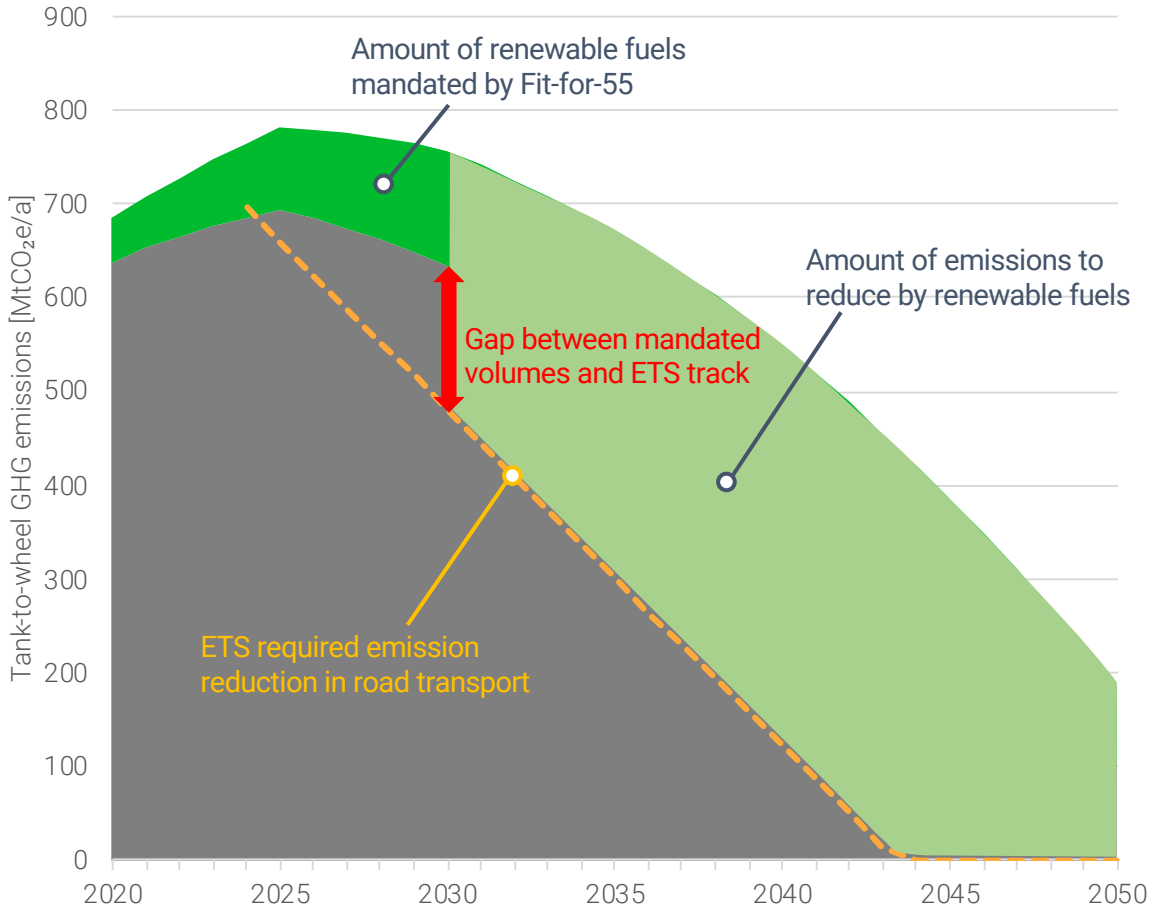
ETS will require to accelerate renewable fuels deployment

- Fit-for-55 package proposes to place road transport together with buildings in a separate ETS
- From 2025 onwards, ETS requires strong TTW emission reduction to zero in 2045, in both sectors combined
- Emission reduction is achieved via the fuel sellers
- They will have to buy allowances for the fossil fuels they sell, and allowances will become scarcer over time
- They will have to reduce their fuel sales or replace by renewables

- Graph assumes linear reduction path for road transport
  - ETS specifies linear path for both sectors combined
  - If both sectors achieves emission reduction in same tempo (pro rata), the path for road transport is straight
  - If buildings achieve emission reduction faster than road transport, the line for road transport will be higher
  - Fuel consumption in road transport is about 3 times larger than in buildings, so road transport cannot delay emission reduction for long period
- The path may differ, but zero emission end-point is fixed

- Under such pro rata assumption, the total gap is ~48 Mtoe of renewable fuels by 2030
- The peak demand for renewable fuels expected : about 90 Mtoe at the 2043 end-point – independent of path

Development of emissions from **road transport**



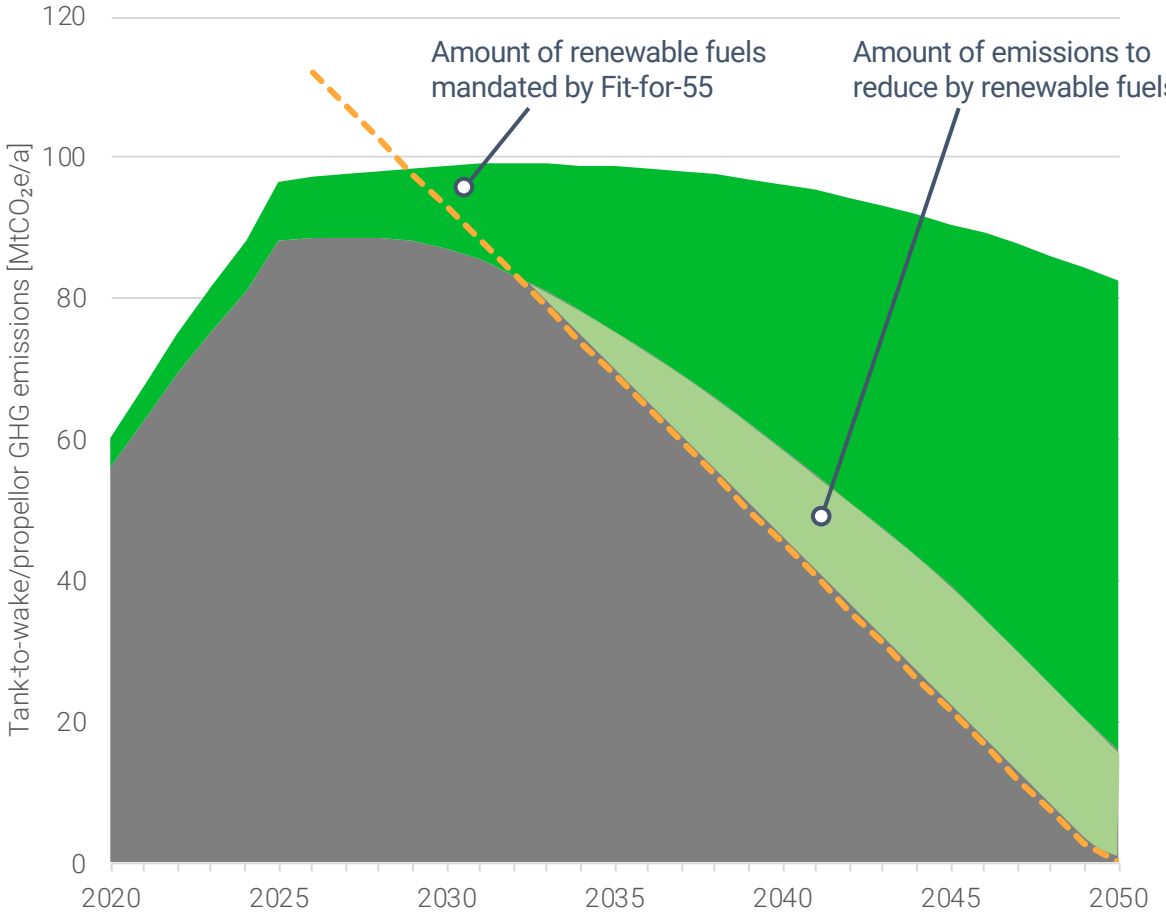
Linear path assumes a pro rata reduction in road transport and buildings. In reality the dashed line may have to reduce faster, or stay horizontal for a while. With the proposed linear reduction rate, the end-point for both sectors combined, points towards zero end-use emissions in 2045.

Maritime and aviation in the wider ETS

- Fit-for-55 includes renewable energy and emission reduction mandates for maritime and aviation until 2050
- Combined with energy efficiency trajectories this will achieve far reaching emission reduction by 2050

- Maritime and aviation become part of the wider ETS, which will see a linear reduction rate from 2025 onwards
- This implies that the sectors combined should achieve zero emissions around 2050 (end-use or TTW emissions)
- On top of mandates, some additional effort needed to respect ETS path and achieve zero emission in 2050

- Note that aviation and maritime combined represent 1/8 of energy consumption in road transport.



Linear path assumes a pro rata reduction in Maritime and Aviation compared to the rest of the wider ETS. In reality the dashed line may have to reduce faster, or stay horizontal for a while. With the proposed linear reduction rate, the end-point for all sectors combined in the wider ETS, points towards zero end-use emissions in 2050.

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