Biofuels role in the oil industry as a potential alternative to conventional petroleum-based fuels

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Introduction

- Contributing around 5% to the GDP
- Employing more than 10 million people

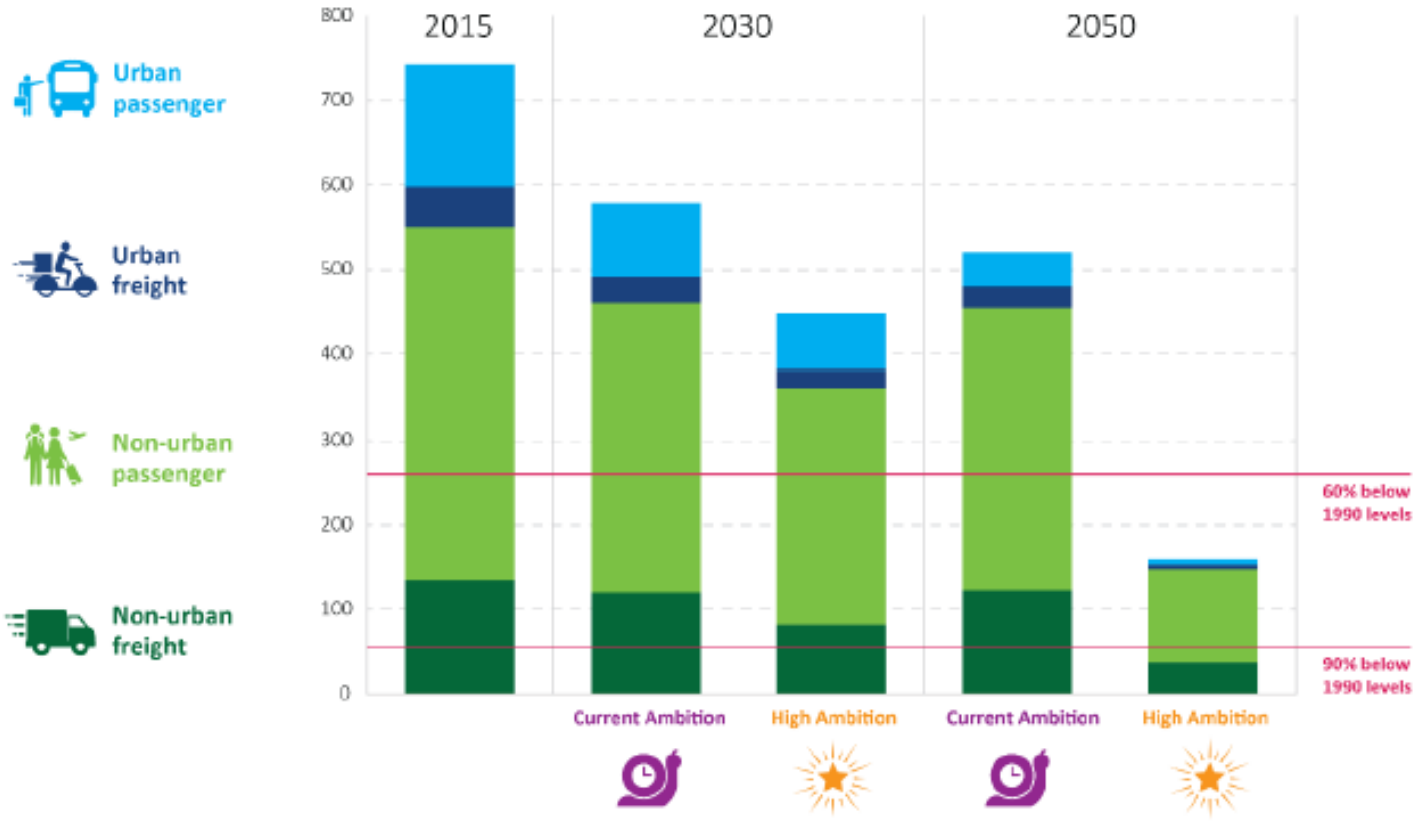
TRANSPORT IN EUROPE

25% of the EU's total GHG emissions

Goal:

- The first climate-neutral continent by 2050 requires ambitious changes in transport.
- A clear path is needed to achieve a 90% reduction in transport-related greenhouse gas emissions by 2050.

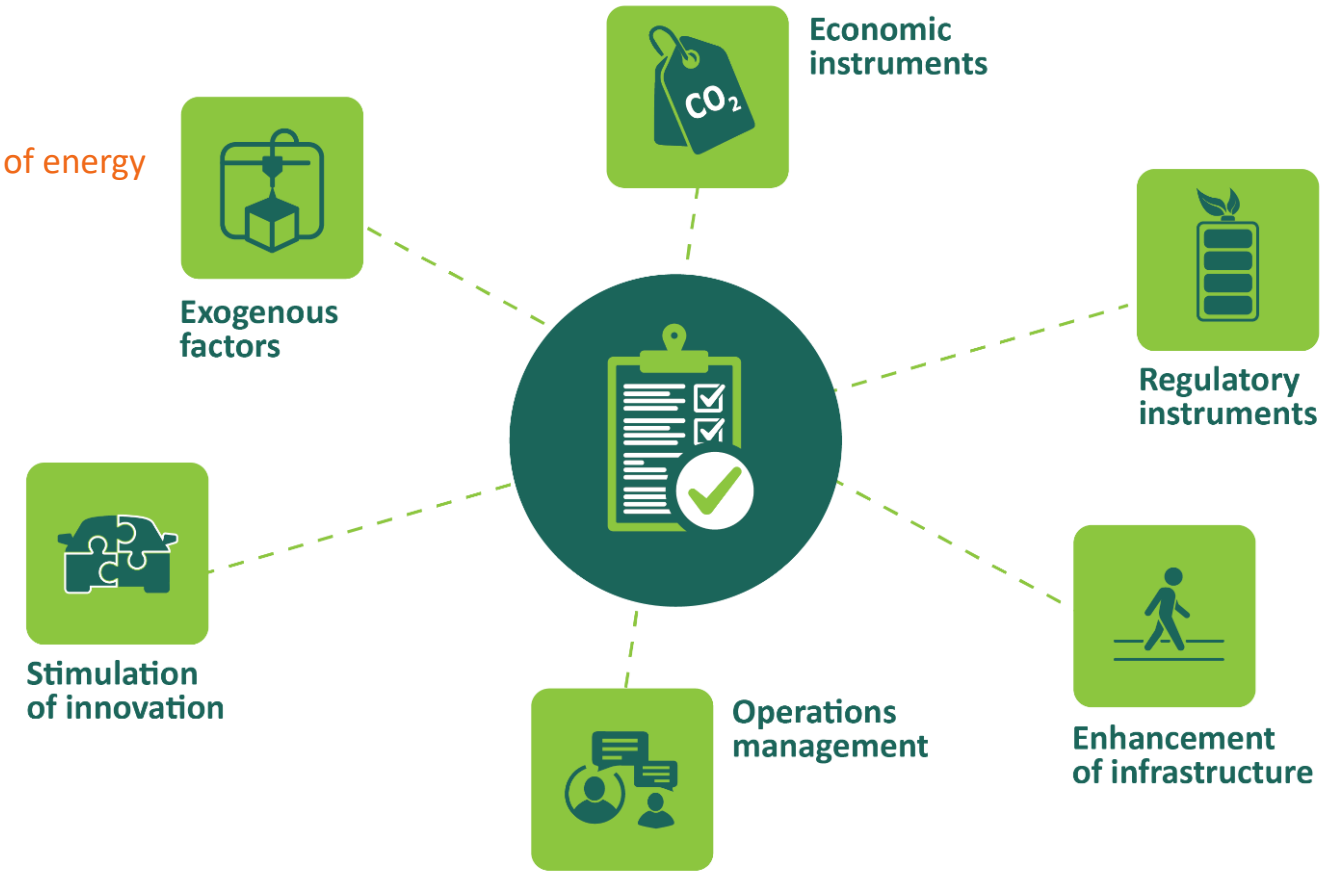
Introduction



Total emissions by transport sector and scenario in Europe
Million tonnes of CO_2

Source: ***: Decarbonising Transport in Europe (DTEU): Policy implications and scenario feasibility, SUMMARY OF THE FINAL PROJECT EVENT, International Transport Forum, 2020.

Introduction



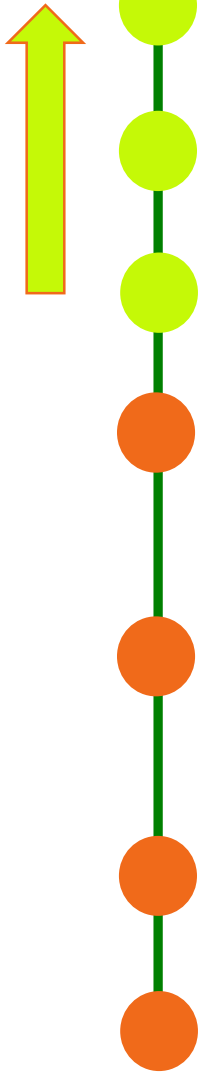
- Decarbonization of energy sources
- Support for hybrid and electric planes and synthetic fuels in aviation
- Mandates for sustainable aviation fuels
- Incentives for Low/Zero-emission fuels and related infrastructure
- Fuel Economy Standards

Increased low-carbon electricity generation and the spread of alternative fuels will cut demand for the transport of fossil fuels.

Decarbonizing Transport in Europe The Way Forward

Source: ***: Decarbonising Transport in Europe The Way Forward, International Transport Forum, © OECD/ITF 2021

Timeline for biofuel in the EU



2023 - Provisional agreement to raise 2030 target to at least 42.5%, aiming for 45%

2022 - REPowerEU Plan: EC proposal to raise target for 2030 to 45%

2021 - Renewable Energy Directive: EC proposal to raise target for 2030 to 40%

Directive 2018/2001/EU on the promotion of the use of energy from renewable sources (RED II)

Directive 2015/1513/EC amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources (iLUC)

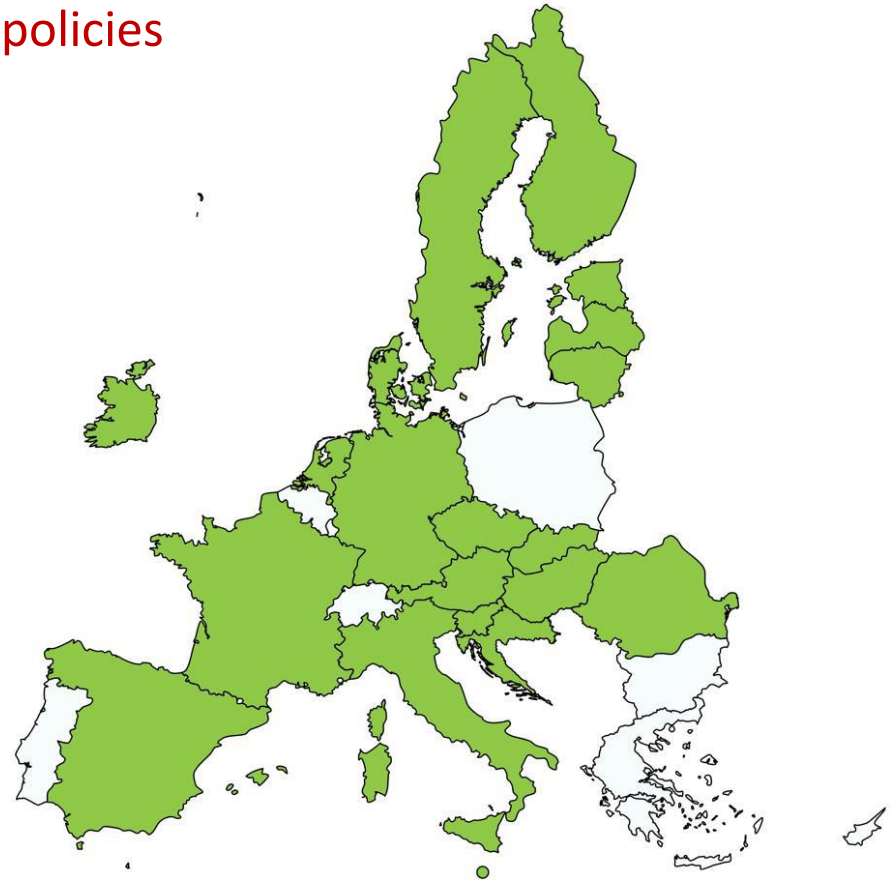
Directive 2009/28/EC on the promotion of the use of energy from renewable sources (RED I)

Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport

Policy transposition

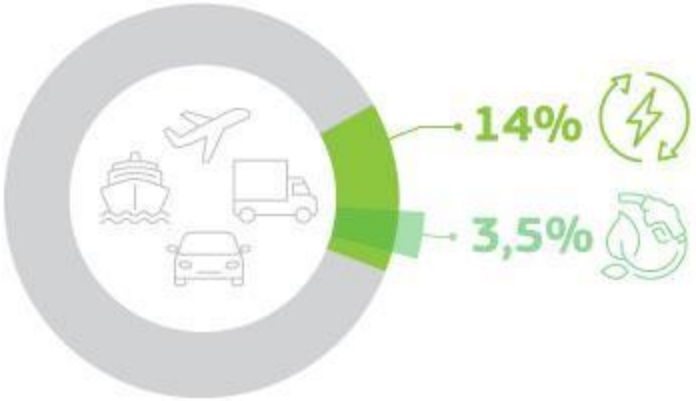
	Type	Minimum overall biofuel target (%)	Advanced biofuel target[1] (%)	Biofuel in petrol (%)	Biofuel in diesel (%)	Reduction of GHG intensity of fuels (%)
Austria	Energy	-	0.2	3.4	6.3	-6
Belgium	Energy	10.2	0.11[2]	6.5	6.5	-
Bulgaria	Volume	-	1 (in diesel)	9	6	-
	Energy	-	0.05	-	-	
Croatia	Energy	-	0.2	-	-	-6
Cyprus	Energy	-	0.2	-	-	-6
Czechia	Volume	-	0.22	-	-	-6
Denmark	Energy	-	-	-	-	-3.4
Estonia	Energy	7.5[3]	0.5	-	-	-
Finland	Energy	13.5[4]	2	-	-	-
France	Energy	-	1.2 (in petrol) 0.4 (in diesel)	9.5	8.6	-10
Germany	Energy	-	0.3	-	-	-8[5]
Greece	Energy	-	-	3.3	-	-
	Volume	-	0.2	-	7	
Hungary[6]	Energy	8.4	0.2	6.1 (RON 95)	0.2	-
Ireland[7]	Energy	16.985	0.3 (in energy)	-	-	-6
Italy[8]	Energy	-	3	0.5	-	-6
Latvia	Volume	-	0.2	9.5 (RON 95)	6.5[9]	-
Lithuania	Energy	7.2	0.4	6.6	6.2	-
Luxembourg	Energy	7.7[10]	-	-	-	-6
Malta	Energy	-	0.2	-	-	-
Netherlands[11]	Energy	18.9	2.4	-	-	-6
Poland	Energy	8.9	0.1	3.2	5.2	-
Portugal	Volume	11	0.5	-	-	-
Romania	Volume	-	-	8	6.5	-
Slovakia	Energy	8.6	0.5 (double counted)	-	-	-6
	Volume	-	-	9	6.9	
Slovenia	Energy	10.3[12]	0.2	-	-	-6
Spain	Energy	10.5[13]	0.3	-	-	-6
Sweden		-	-	-	-	-7.8 for petrol -30.5 for diesel

2023 national biofuels policies



Source: ***: Overview of biofuels policies and markets across the EU, PURE, European renewable ethanol, 2023.

Renewable Energy Directive

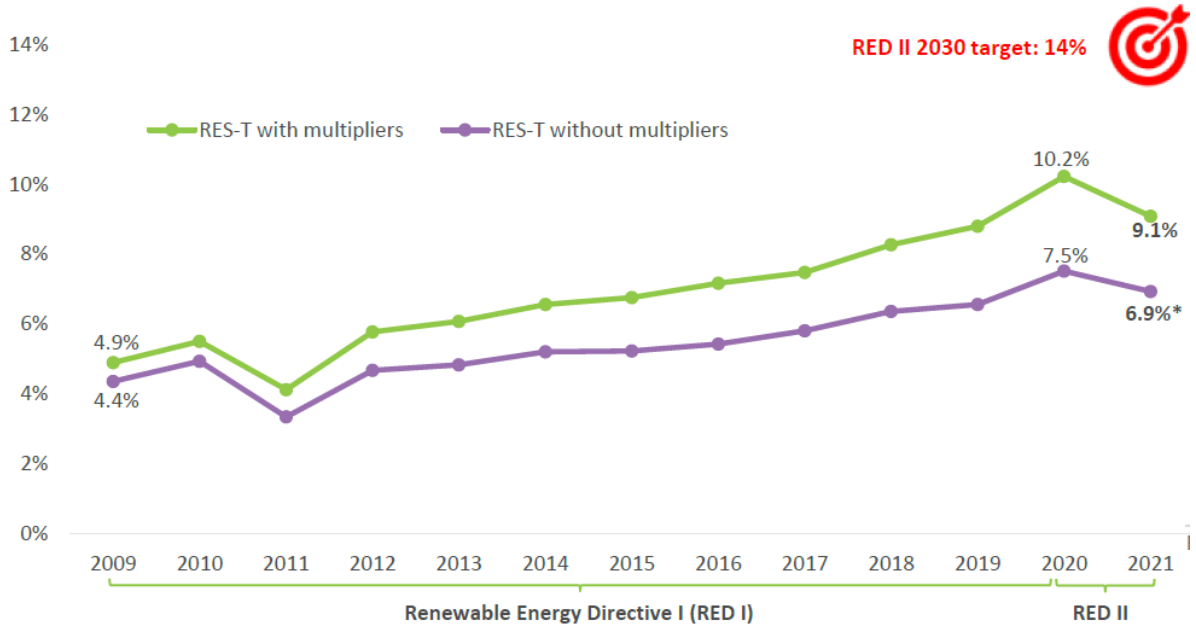


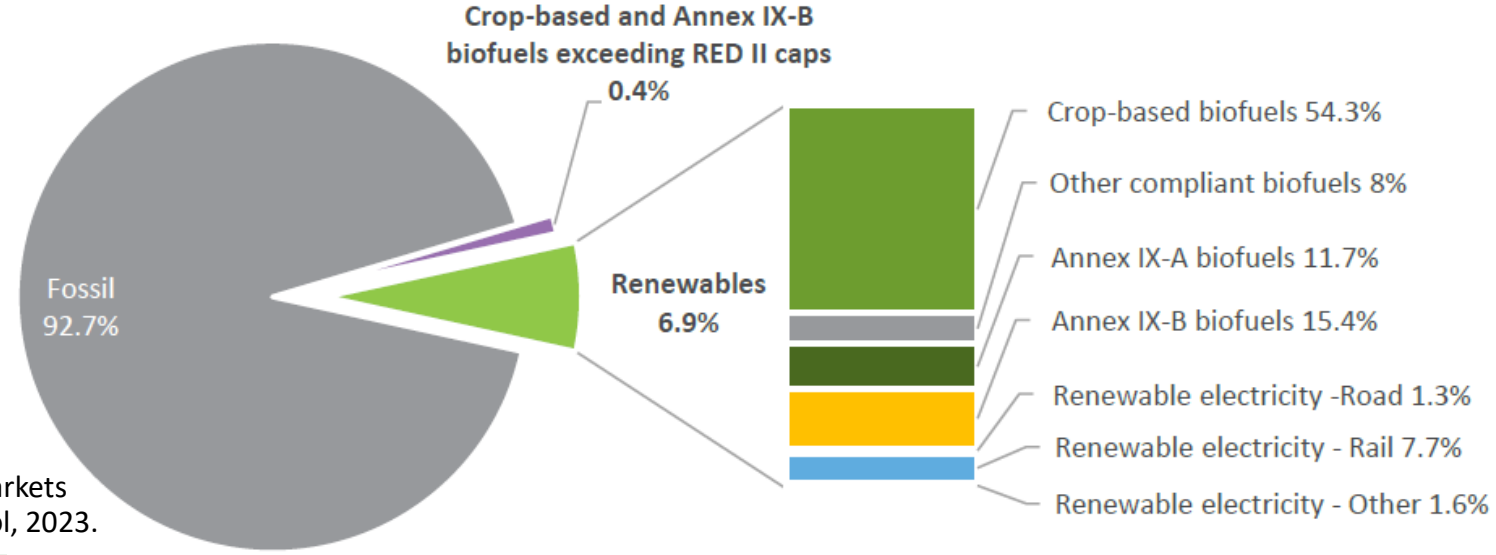
Under the Renewable Energy Directive, EU countries are obliged to ensure:

- the share of renewable energy in the final consumption of energy in transport is at least 14% by 2030
- a minimum share of 3.5% of advanced biofuels
- an obligation on fuel suppliers to fulfill the achievement of this target.

- The Commission adopted on June 2023 new rules establishing the share of biofuels and biogas in mixed fuels, co-processed using bio-based and fossil-based raw materials, and that can count towards the Renewable Energy Directive target for renewables in transport.
- The Delegated Regulation EU/2023/1640 (the methodology to determine the share of biofuel and biogas for transport, produced from biomass being processed with fossil fuels in a common process) was published in the Official Journal of the EU on 18 August 2023 and has been subject to public feedback, several consultations and scrutiny from the European Parliament and the Council.

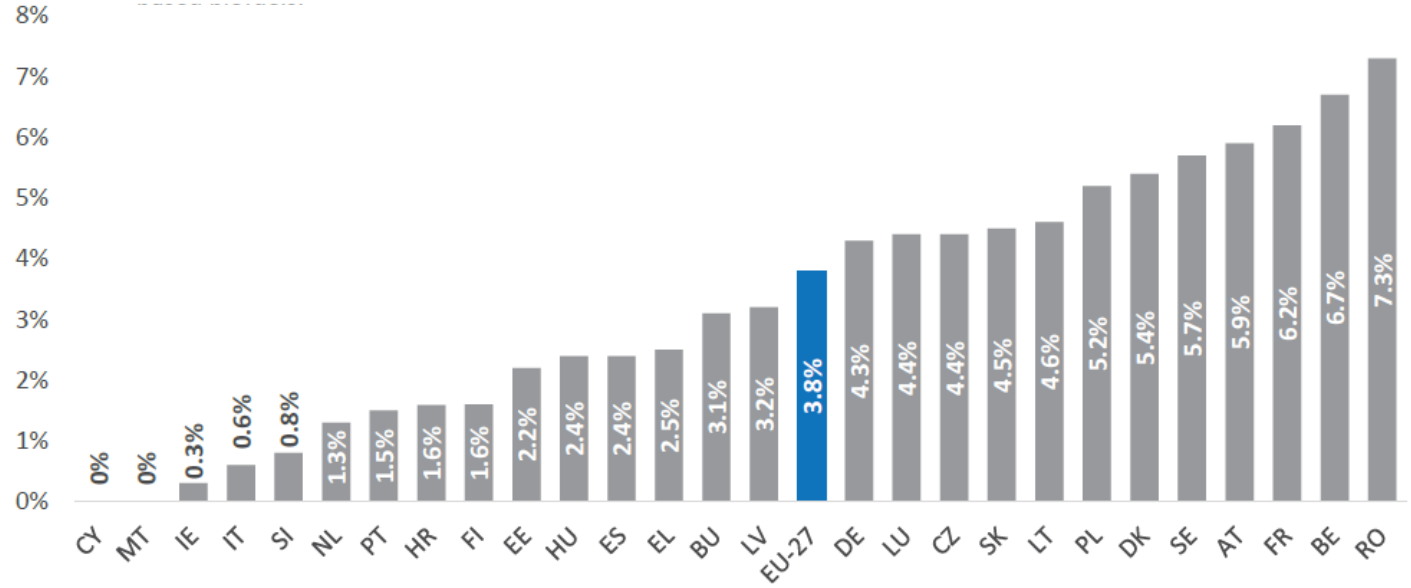
Renewables in Transport



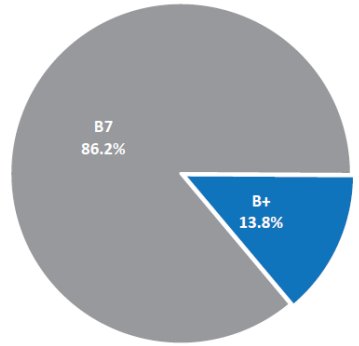


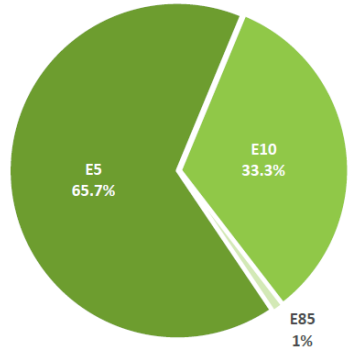
Source: ***: Overview of biofuels policies and markets across the EU, PURE, European renewable ethanol, 2023.

Biofuels in Transport

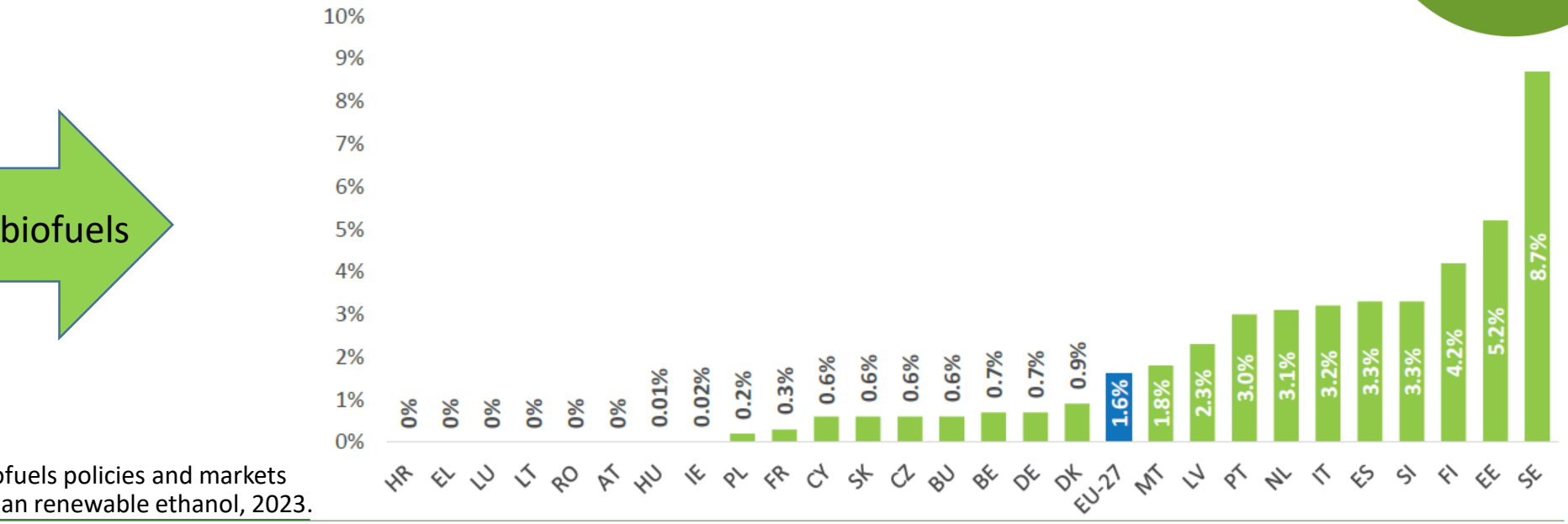


Crop-based biofuels



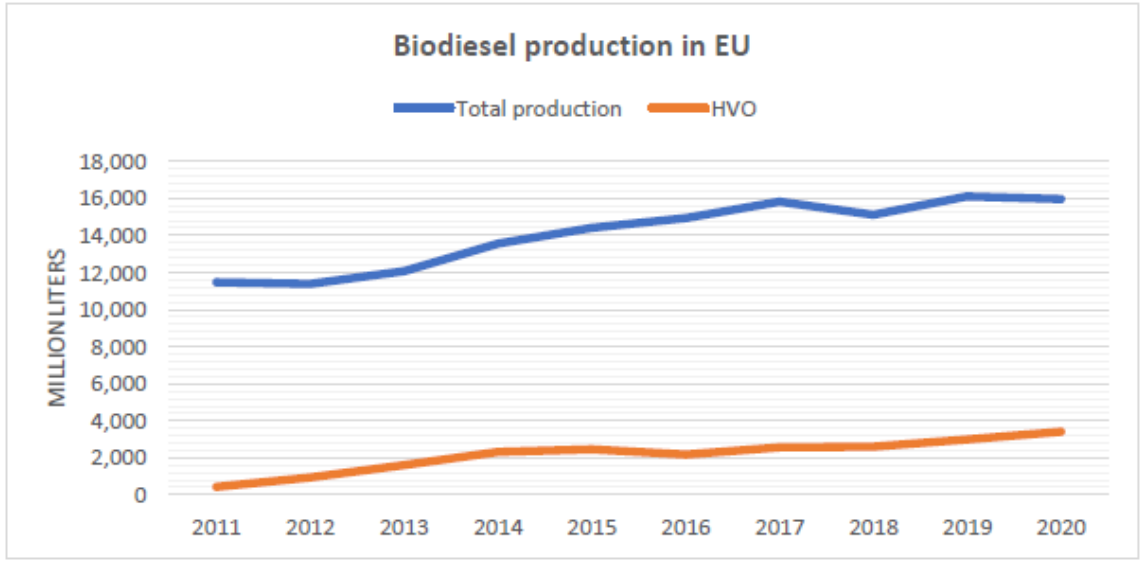


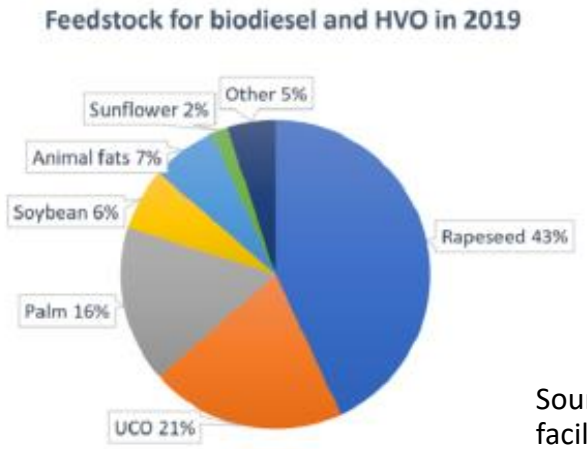
Advanced biofuels



Source: ***: Overview of biofuels policies and markets across the EU, PURE, European renewable ethanol, 2023.

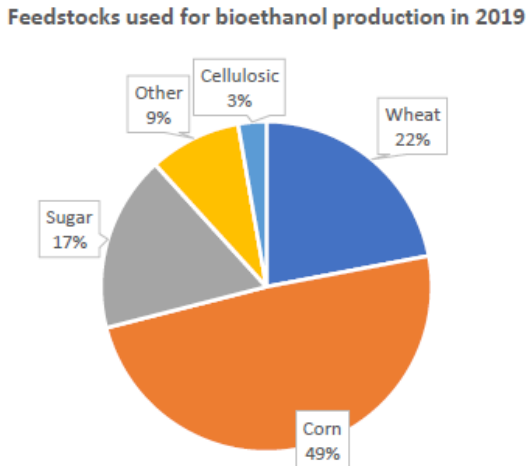
Biofuels production



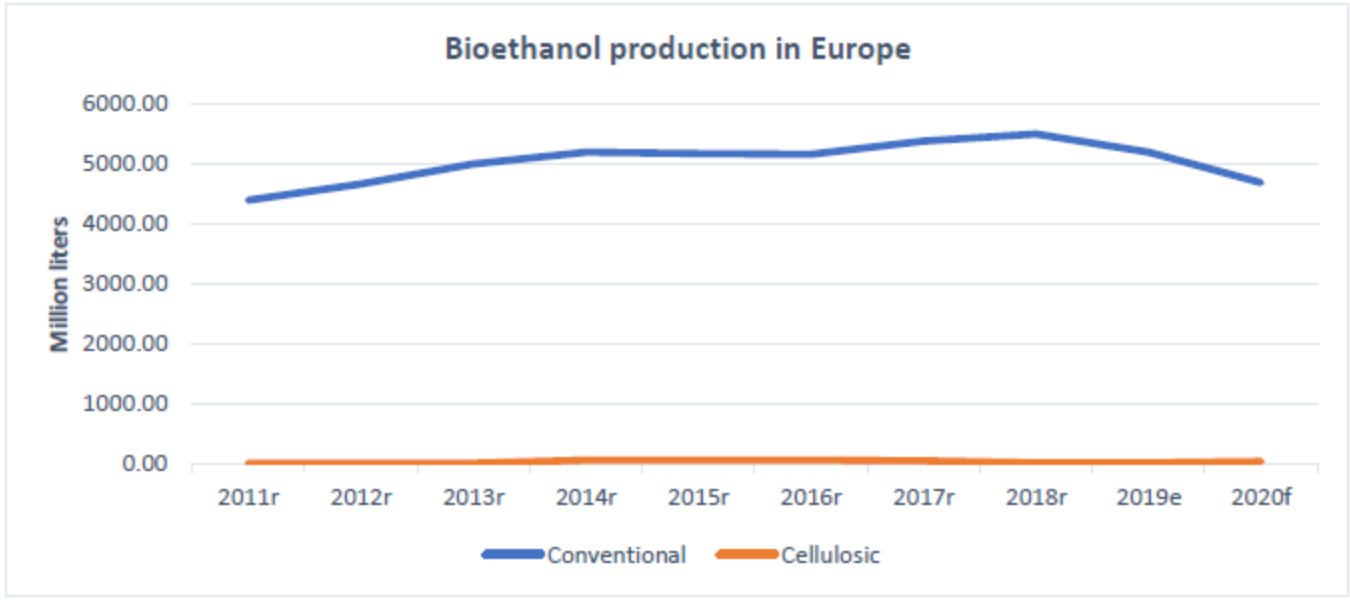


HVO and biodiesel production in Europe

Source: ***: Overview on biofuels production facilities and technologies in Europe, BIKE Biofuels Production at Low – iLUC Risk for European Sustainable Bioeconomy, 2021.

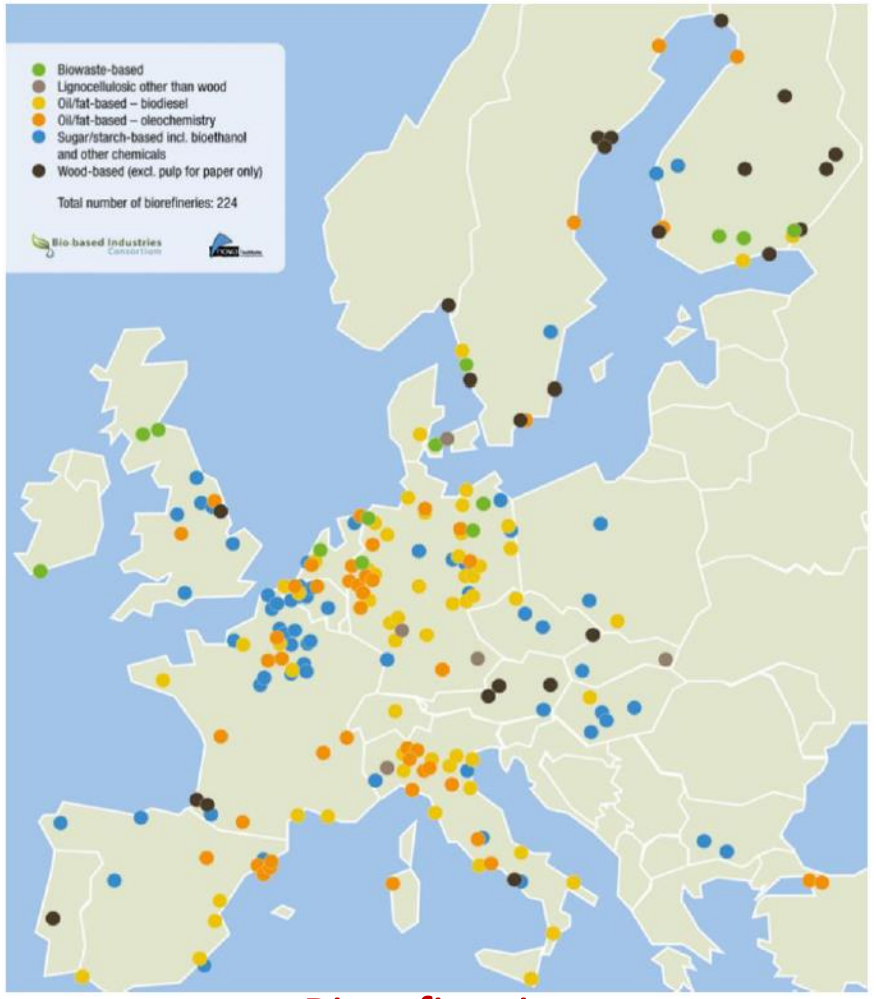


Conventional and Lignocellulosic bioethanol production in Europe



Biofuel production facilities

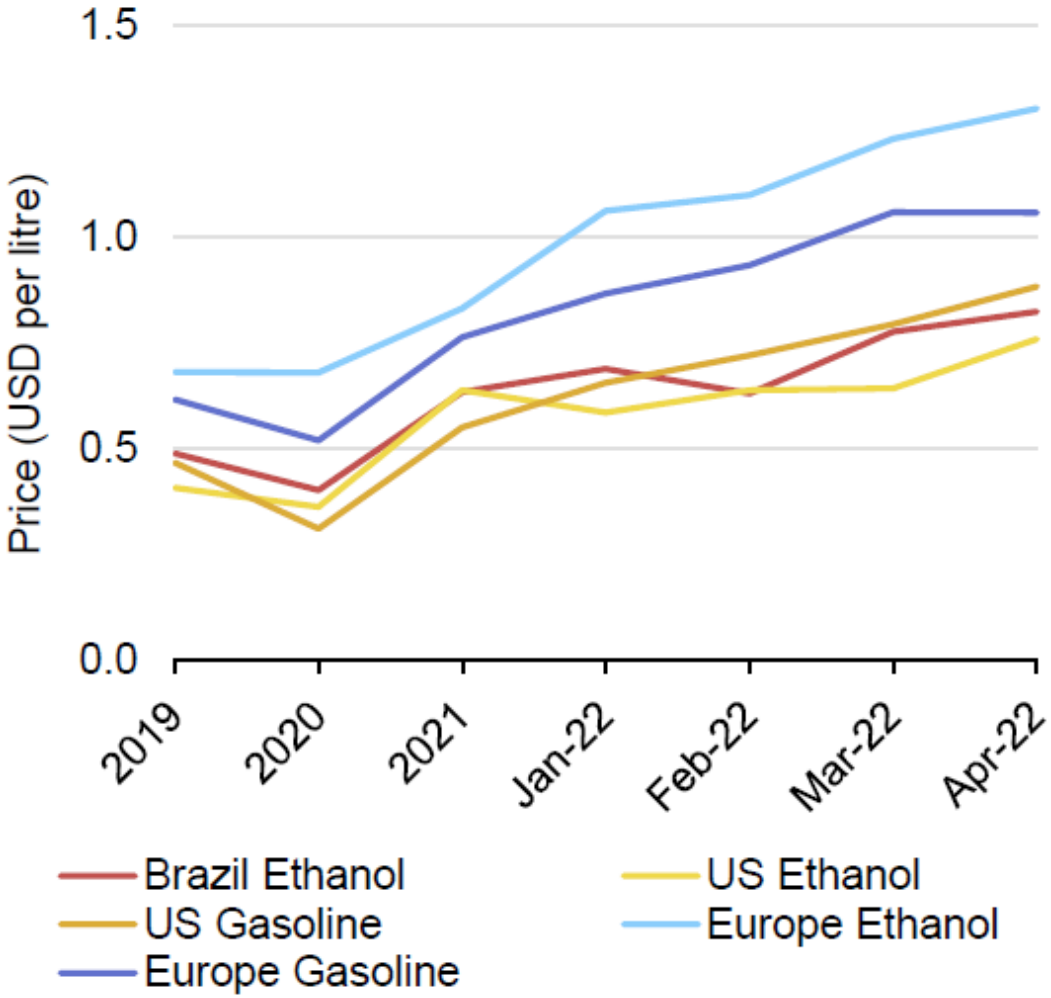
310 liquid biofuels production facilites in EU

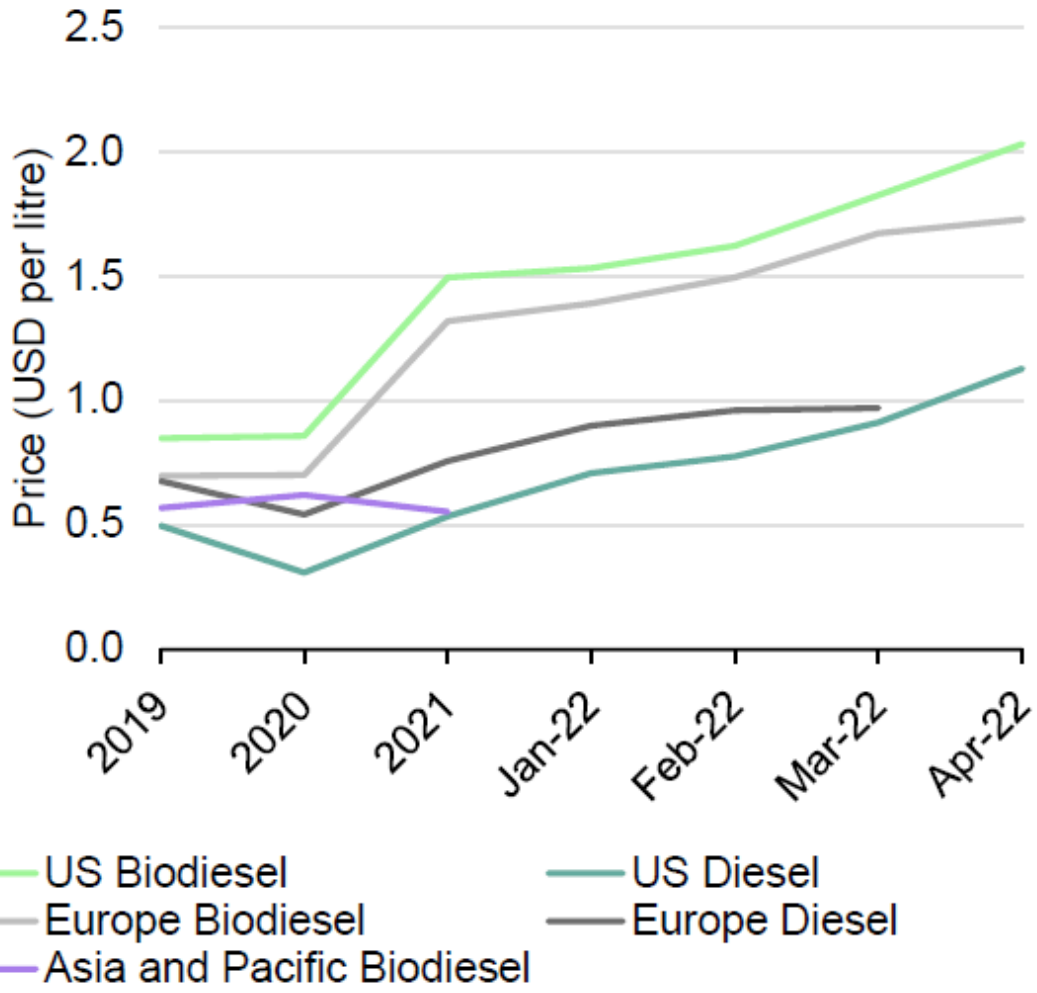


Biorefineries located in Europe

Source: ***: Overview on biofuels production facilities and technologies in Europe, BIKE Biofuels Production at Low – iLUC Risk for European Sustainable Bioeconomy, 2021.

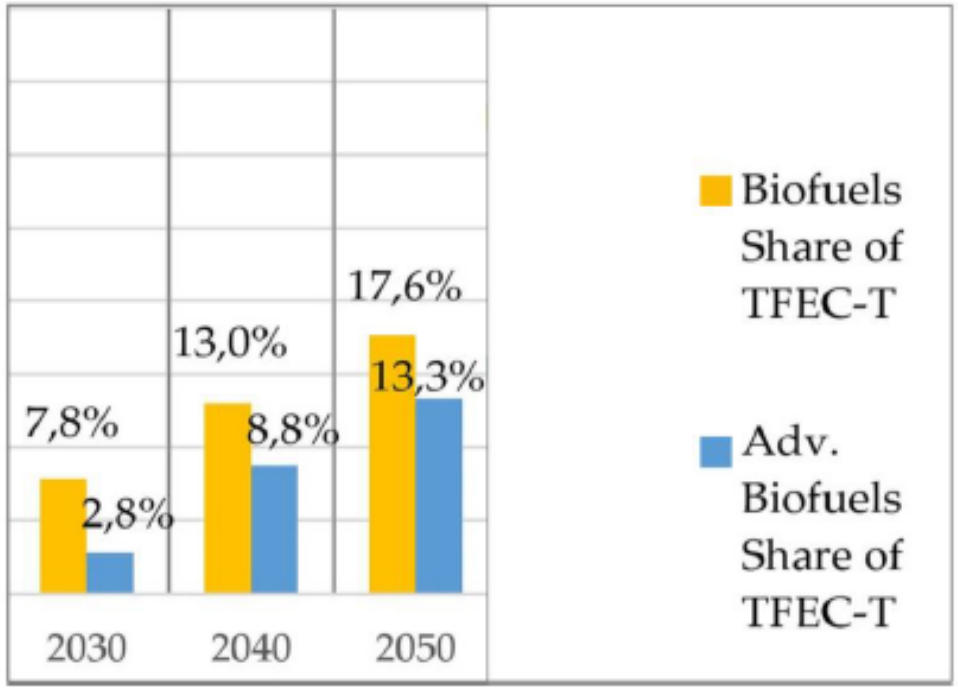
Biofuel and Fossil Fuel Prices





Source: ***: Renewable Energy Market Update Outlook for 2022 and 2023, IEA, 2022.

Forecast to 2050



Forecast to 2050 according to the Paris Agreement Goals:

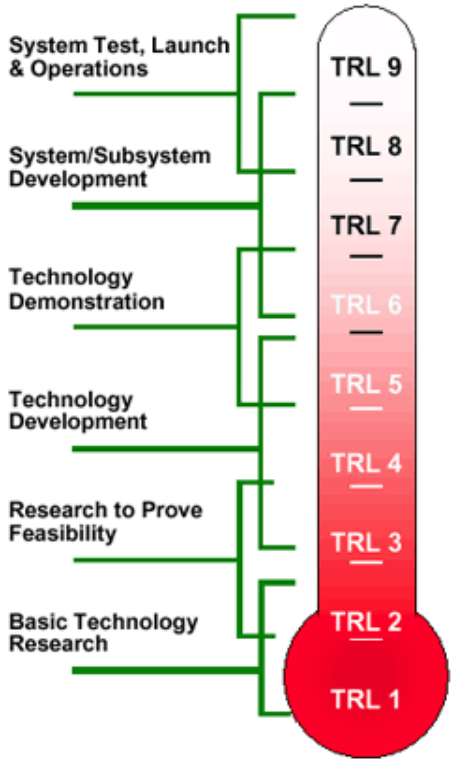
- 1200-1800 PJ - liquid biofuel demand from all transport modes, excluding international shipping.
- 580-960 PJ - the aviation sector biofuel demand
- rapid, strong increase is expected for advanced biofuels produced from low ILUC, non food crops as listed in the Annex IX, part A of the RED II - in the mid scenario, biofuels and advanced biofuels together are expected to contribute to more than 17% by 2050, with advanced biofuel expected to prevail already by 2040.

Source: ***: Overview on biofuels production facilities and technologies in Europe, BIKE Biofuels Production at Low – iLUC Risk for European Sustainable Bioeconomy 2021.

Conversion Technologies

- Numerous different feedstocks
- Numerous technologies for feedstock conversion into products for various markets

- Biofuels
- Biochemicals
- Other bioproducts



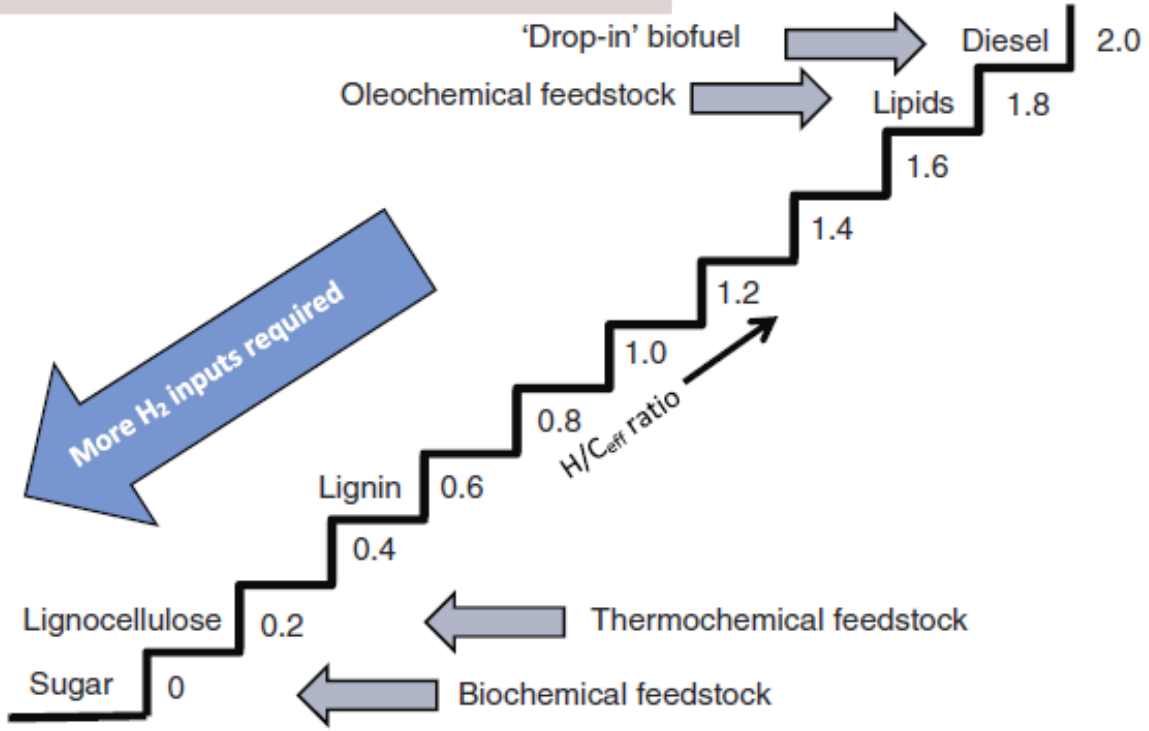
Source: ***: STRATEGIC RESEARCH AND INNOVATION AGENDA 2023, European Technology and Innovation Platform, ETIP BIOENERGY SRIA, 2023.

Conversion Technologies

	Vegetable oil[a]	Fast pyrolysis[b]	Catalytic fast pyrolysis[c]	Hydrothermal liquefaction[d]	Crude oil[b]
C, wt%	77.6	55–65	72	81.4	83–86
O, wt%	10.4	28–40	21.5	9.8	<1
H, wt%	11.7	5–7	6.4	8.7	11–14
S, wt%	0.0006	<0.05	—	0.01	<4
N, wt%	0.0011	<0.4	0.02	0.095	

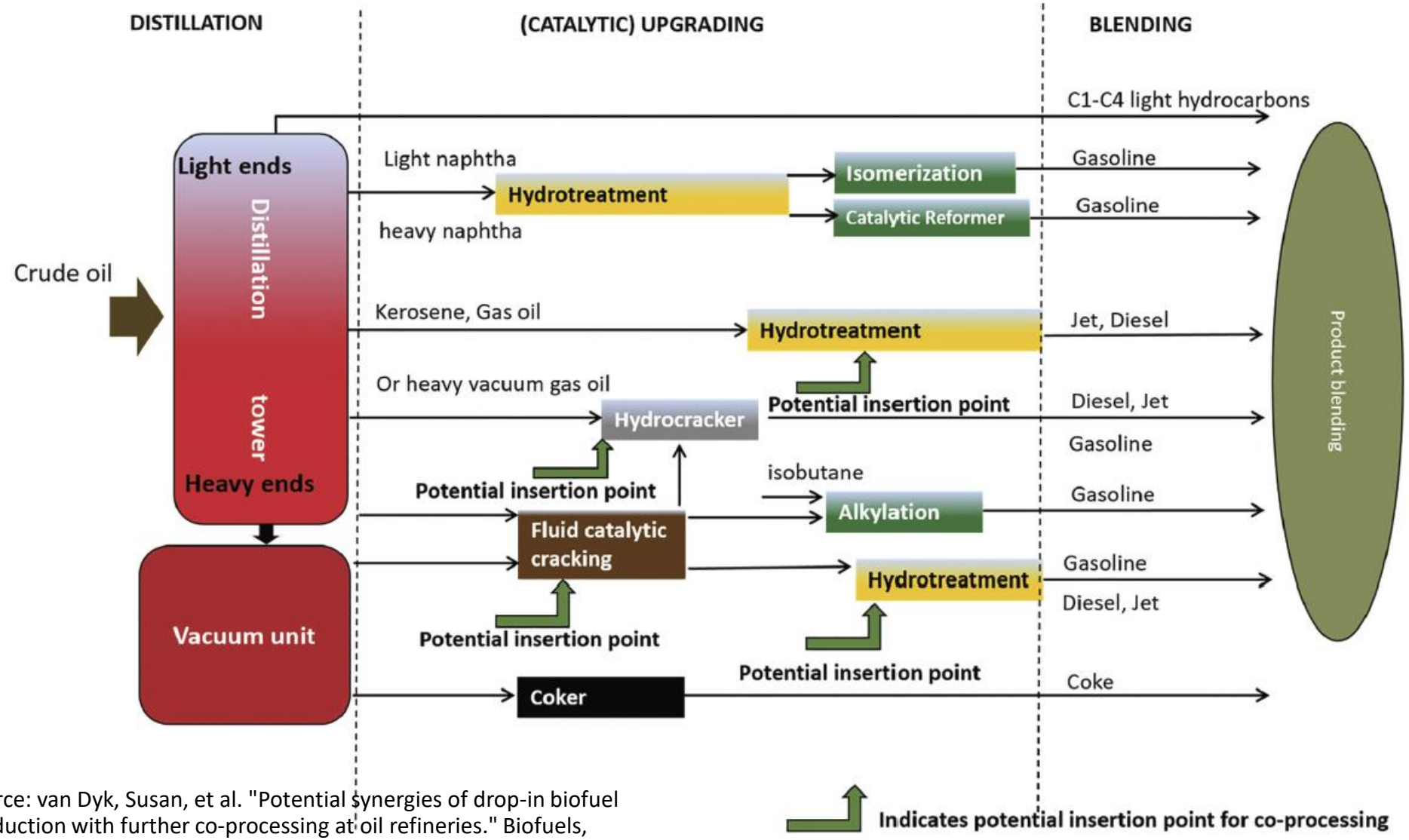
[a]Data taken from Holmgren *et al.*[23] using soybean oil.
[b]Data taken from Mortensen *et al.*[43]
[c]Data taken from Passikallio.[44]
[d]Data taken from Jensen *et al.*[45]

The effective hydrogen to carbon ratio 'staircase' for feedstocks



Source: van Dyk, Susan, et al. "Potential synergies of drop-in biofuel production with further co-processing at oil refineries." Biofuels, Bioproducts and Biorefining 13.3 (2019): 760-775.

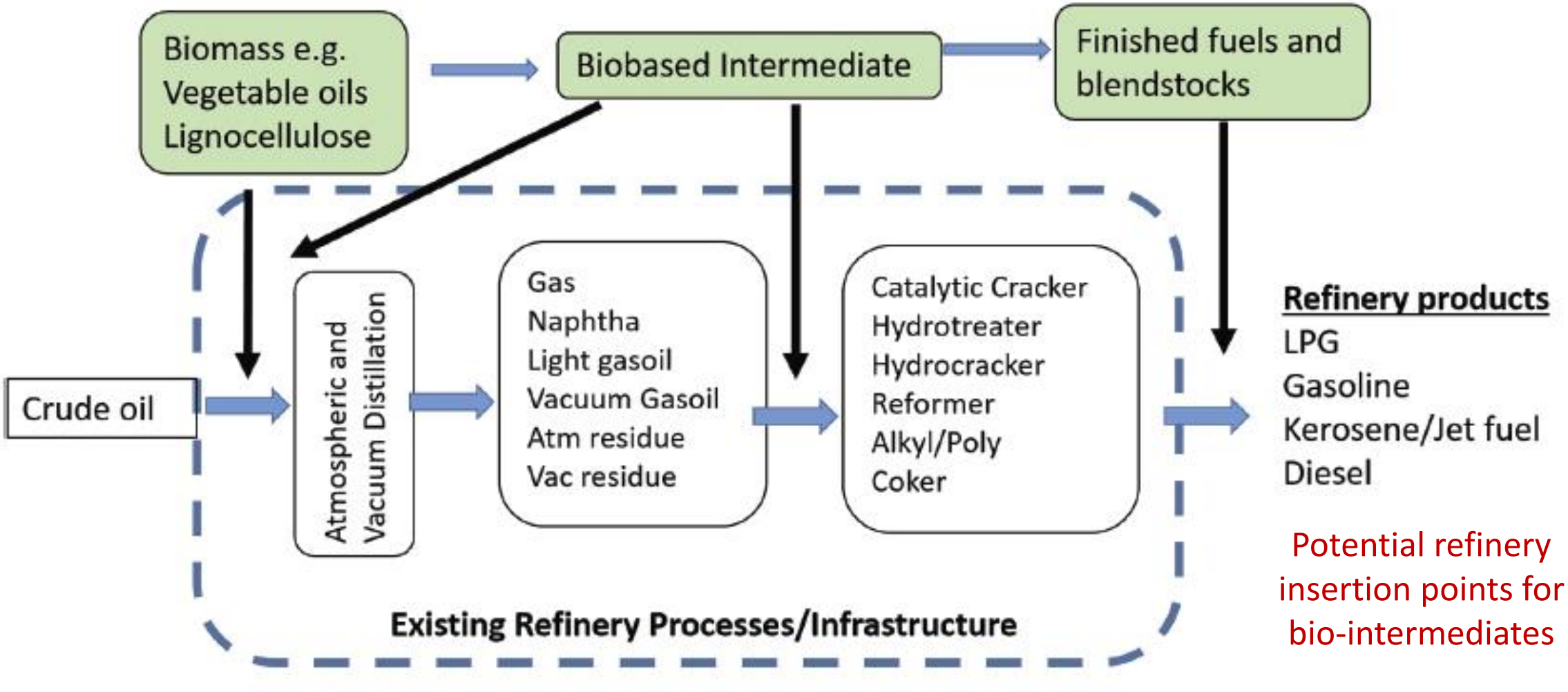
Conversion Technologies



Simplified diagram of an oil refinery

Source: van Dyk, Susan, et al. "Potential synergies of drop-in biofuel production with further co-processing at oil refineries." Biofuels, Bioproducts and Biorefining 13.3 (2019): 760-775.

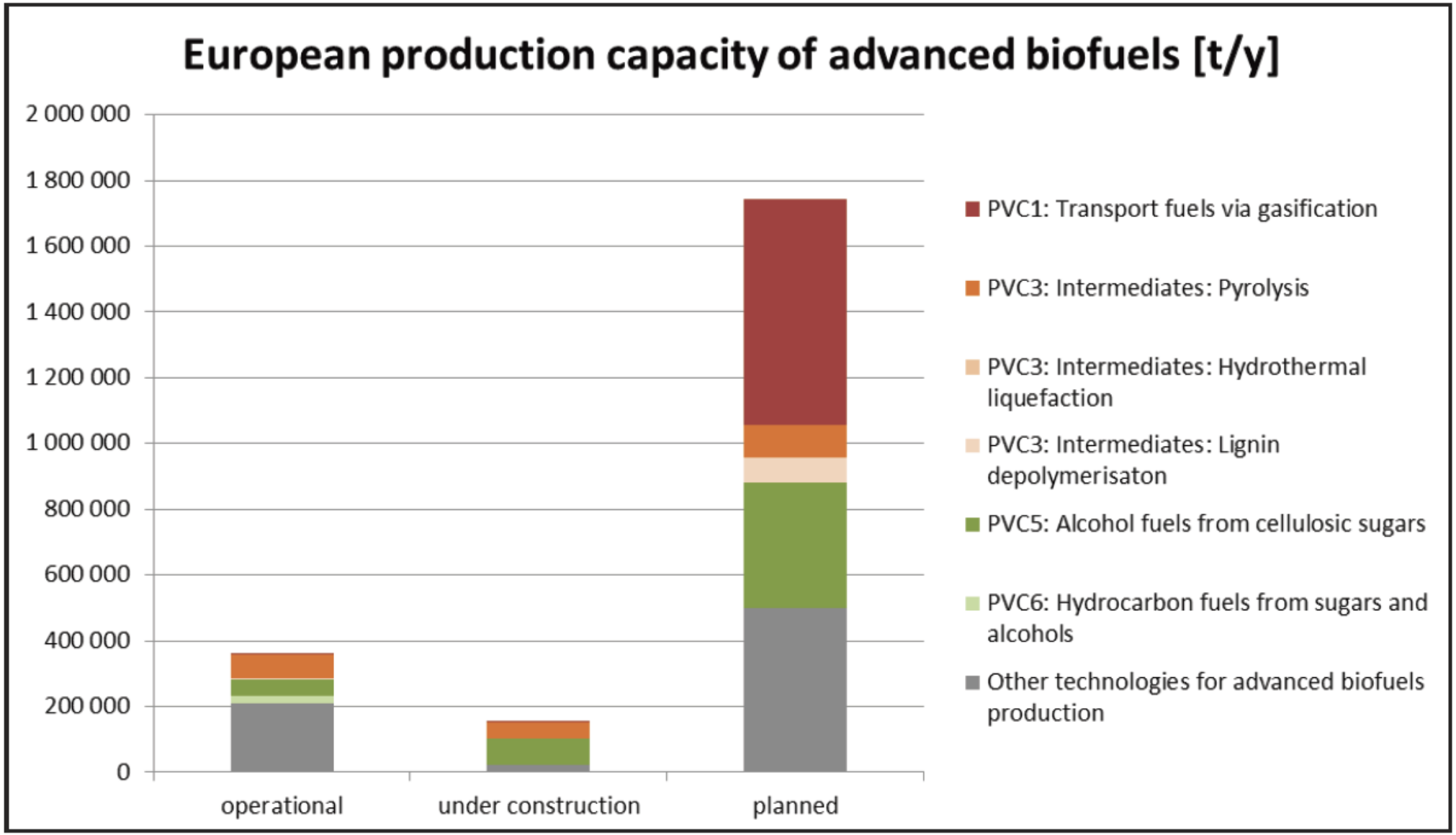
Conversion Technologies



Potential refinery insertion points for bio-intermediates

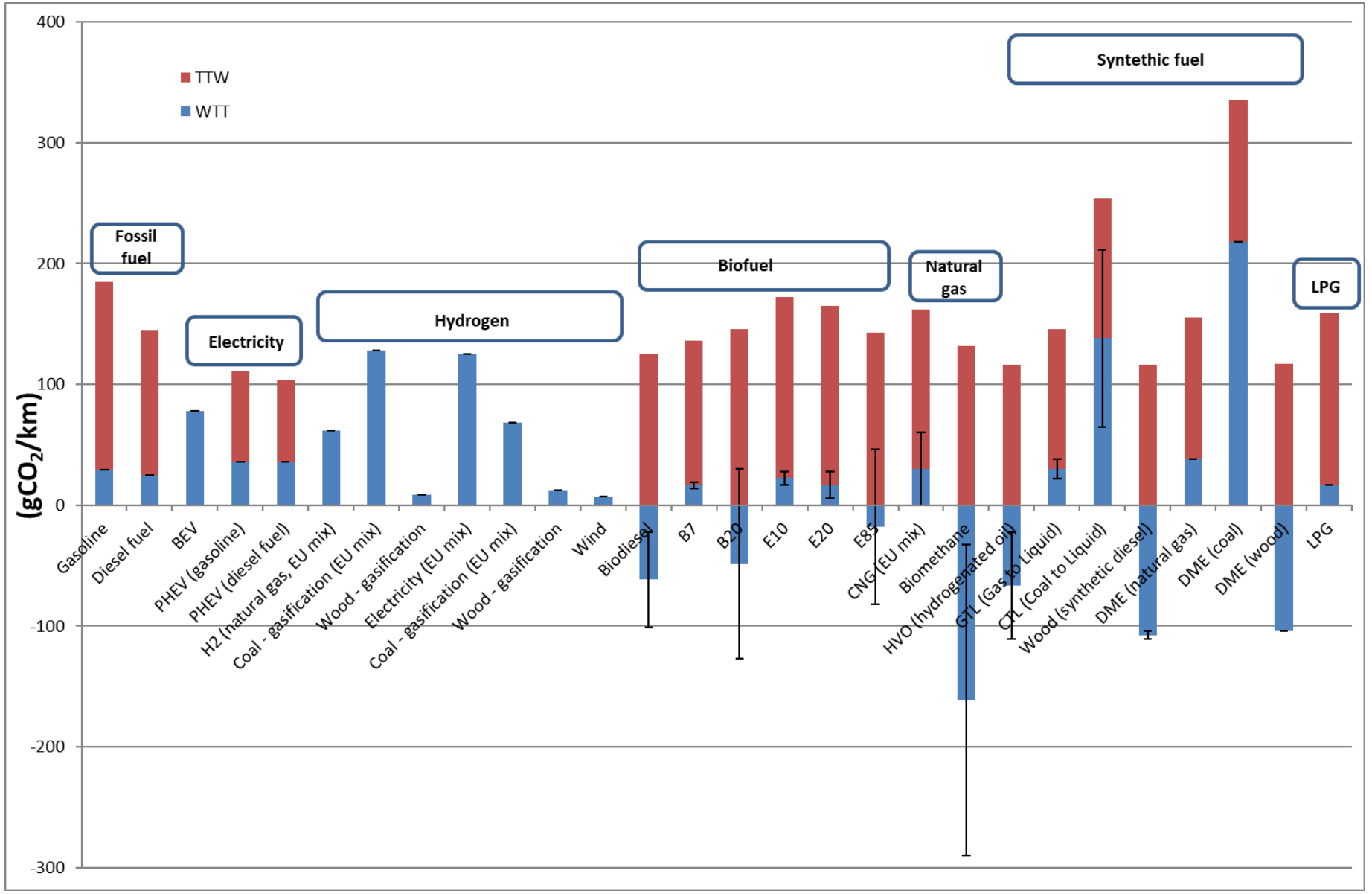
Source: van Dyk, Susan, et al. "Potential synergies of drop-in biofuel production with further co-processing at oil refineries." Biofuels, Bioproducts and Biorefining 13.3 (2019): 760-775.

Biofuel Production Capacity



Source: ***: CURRENT STATUS OF ADVANCED BIOFUELS DEMONSTRATIONS IN EUROPE, ETIP Bioenergy, 2020.

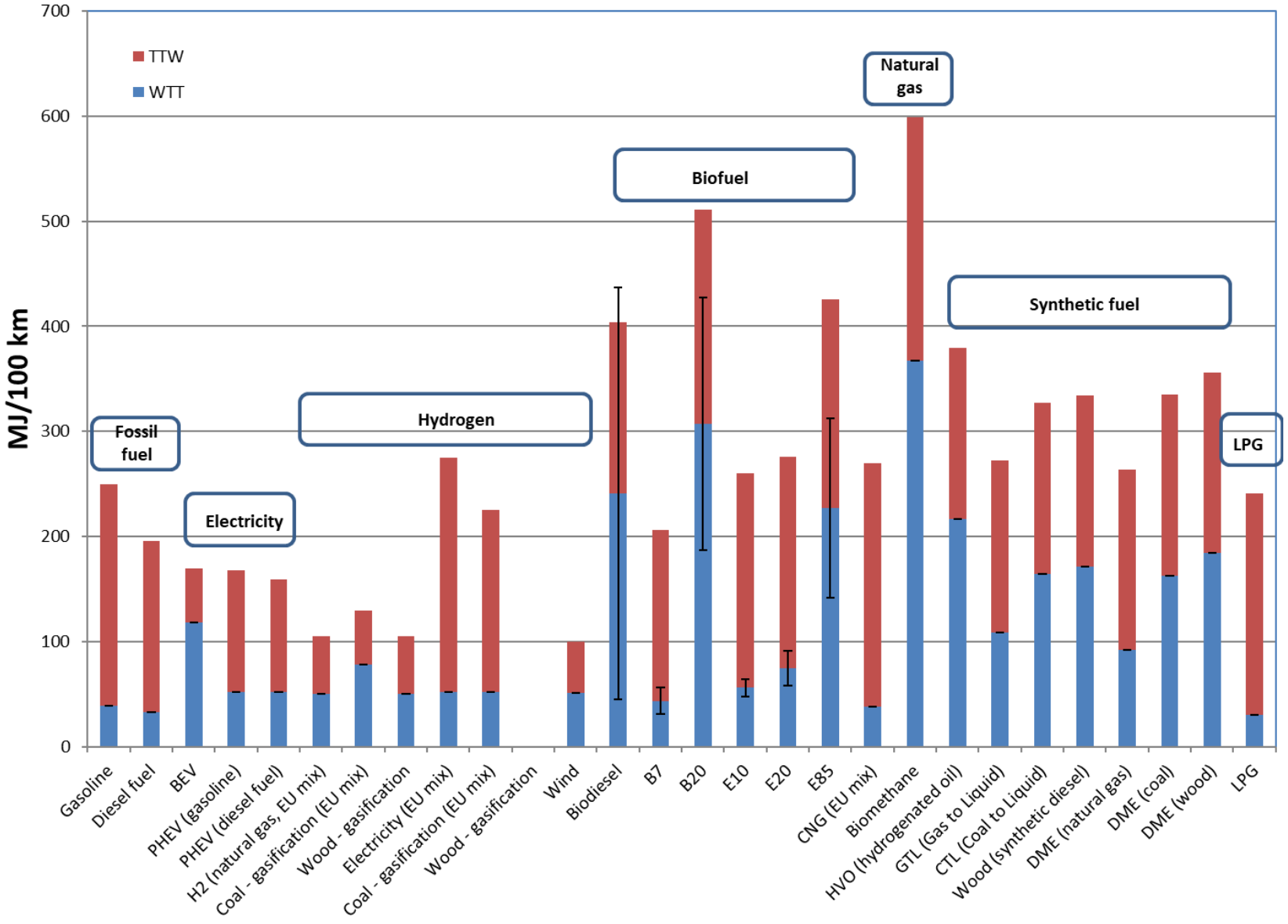
Reduction of CO_2 emission



WTT: Well To Tank
TTW: Tank To Wheel
WTW: Well To Wheel
WTW=WTT+TTW

Source: ***: State of the Art on Alternative Fuels Transport Systems in the European Union, DG MOVE - Expert group on future transport fuels, European Commission, pp. 128, 2015.

Efficiency



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Challenges for Further Deployment

- Mobilizing unused biomass (biogenic) resources
- Further refining of sustainability safeguards
- Using low-quality resources
- Improving conversion efficiency
- Preparing for a move towards long-application sectors
- Developing efficient approaches for infrastructure
- Preparing long-term solutions

Challenges for Further Deployment

- Insufficient development of the technologies for biofuel production in 2050
- Continue R&D on emerging technologies, so they can contribute to decarbonizing the economy by 2040
- Various strategies are under investigation to broaden the feedstock basis of anaerobic digestion, co-digestion of lignocellulosic residues with different organic wastes, digestion of steam-exploded wheat straw, or production of biohydrogen
- Future market opportunities for biofuels are unclear, since EU wants to ban internal combustion engines and crop-based biofuels might be phased out
- RFNBO production is likely to remain very costly in most parts of Europe

Challenges for Further Deployment

- Sustainable Aviation Fuels
  - United Nations agency, adopted a Long-Term Aspirational Goal of Net Zero Carbon in aviation by 2050, stating drop-in sustainable aviation fuels (SAF) are expected to have the largest impact to reduce GHG emissions from aviation
  - Improve the technical, environmental, social and economic performance of SAF
- Marine Fuels
  - Strategy includes and aims zero GHG emissions by 2050, with intermediate steps in 2030 (-40 %) and 2040 (-50 %)
  - Improve the technical, environmental, social and economic performance of alternative shipping fuels

Further Deployment

- The EU Green Deal framework - clear regulatory roadmap for the decarbonization of the aviation, the marine and the road sectors
  - combination of new technology, biofuels, RFNBOs, SAFs, modal shift, and improved efficiency
  - ReFuelEU aviation initiative (dedicated to SAFs)
  - FuelEU maritime initiative (for low-carbon shipping fuels)
  - recast of the Renewable Energy Directive (dedicated provisions for green hydrogen, power and transport)
- Many questions on the future of renewable fuels remain open …

Thank You for attention …