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Sustainable Energy: What Does This Mean for Europe's Liquid Fuels Suppliers?

Tank Storage Association

23rd September 2021

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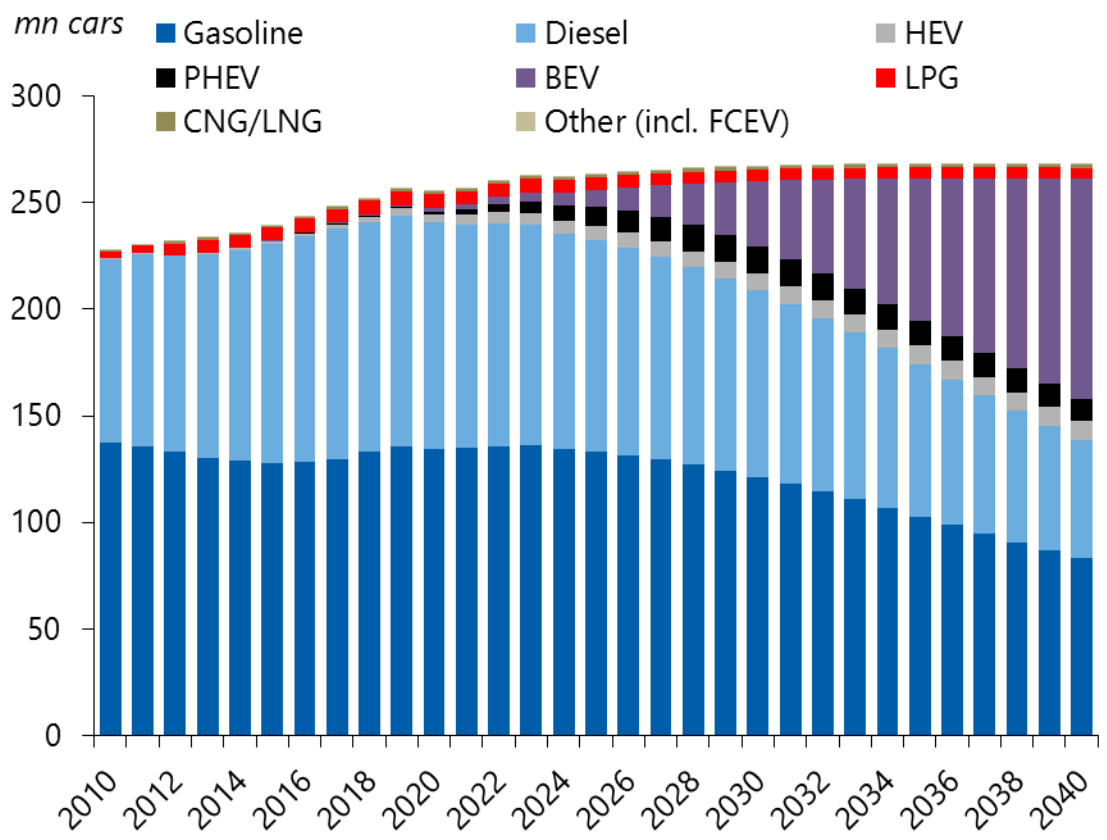
Electric vehicles are forecast to become the dominant drive technology for passenger cars by 2040

European passenger vehicle fleet by fuel, 2010-2040

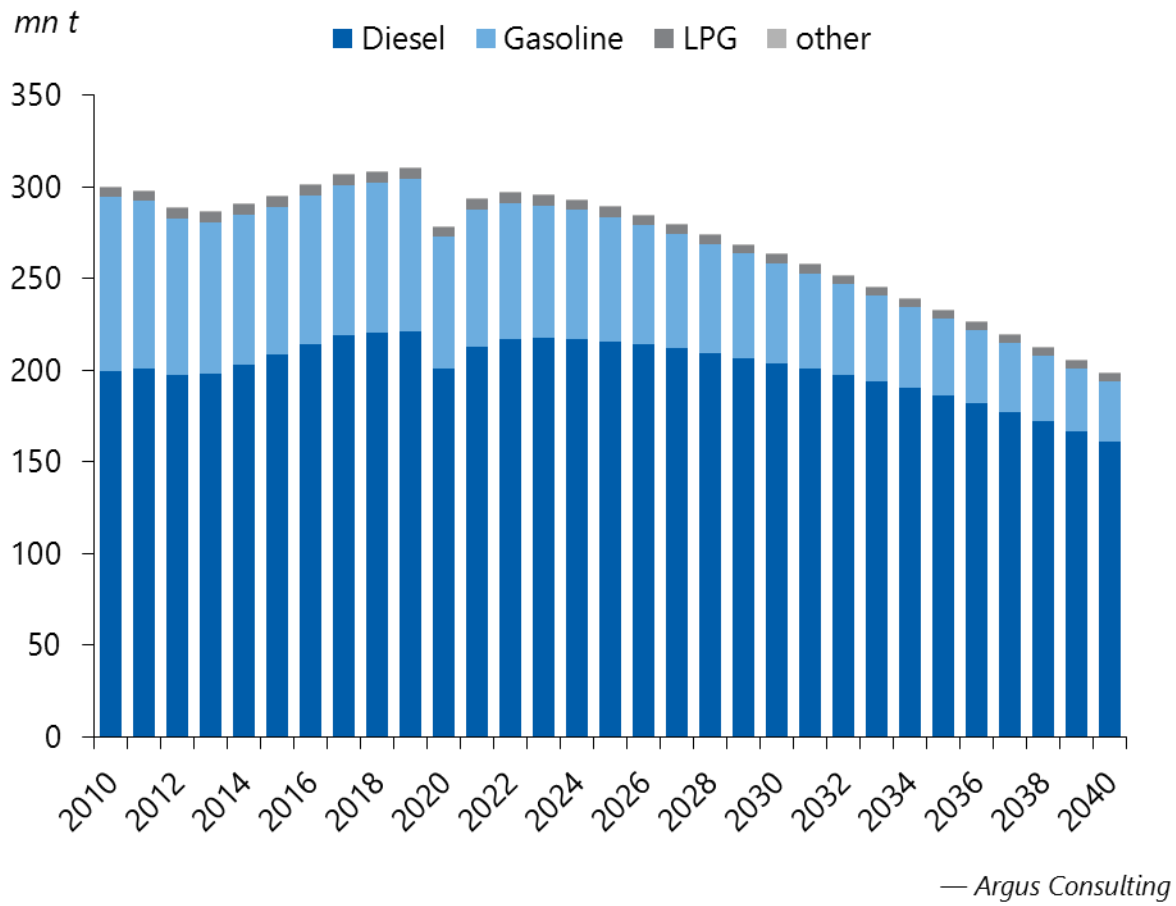


— National statistics, Argus Consulting

- RED II (55) to reduce vehicle CO2 emissions target to 42.5g CO2/km by 2030
- Also from 2035 all new vehicles to reach zero emissions
- The European passenger vehicle fleet is forecast to grow from currently 250mn to above 262mn in 2040.
- Electric vehicle (EV) and alternative fuel vehicle are the fastest growing fuel types.
- In particular, sales of EVs are forecast to grow quickly, making EV the dominant drive technology by 2040.
- Penetration of EVs is currently driven by subsidies and low emission obligations but should be at parity with ICE in about 5 years
- In 2040, the EV fleet could achieve 98mn cars, compared to 84mn gasoline and 55mn diesel cars.

European road fuel demand is past peak and forecast to decline by 29pc until 2040

European road fuel demand, 2010-2040



- European road fuel demand has entered a declining trend in 2020. Despite a recovery in 2021/2022, demand is forecast to remain below 2019 levels.
- Demand is expected to decline by 29pc over the forecast period compared to 2020 levels, corresponding to a CAGR of -2pc.
- Demand for gasoline is forecast to decline faster than diesel, with an annual growth rate of -4pc and -1.4pc respectively.
- This is mainly due diesel being the preferred fuel for heavier vehicles. Fuel switching for heavier vehicles is forecast to be much slower compared to passenger cars, as alternative technologies are not yet market ready.
- A sizable portion of road fuel demand is forecast to remain. Total gasoline and diesel demand is forecast to 195mn t in 2040.

The EU increases ambitions by moving from RED legislation to REDII legislation in 2021

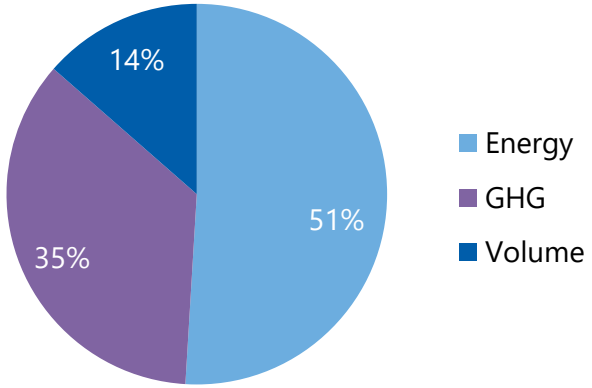
	RED	REDII	REDII – Fit For 55 Proposal
Overall target	10pc energy by 2020	14pc energy by 2030	26pc energy by 2030 (13pc GHG Reduction)
Part B cap	-	1.7pc	1.7pc
Part A mandate	3.5pc by 2030	3.5pc by 2030	2.2pc by 2030
RFNBO mandate	-	-	2.6pc by 2030
Double counting	Permitted	Permitted	Not Permitted
Multipliers	5x electricity in road; 2.5x electricity in rail (post ILUC)	4x for electricity in road; 1.5x for electricity in rail 1.2x for biofuels in aviation/marine (excl. 1G)	Removal of renewable electricity multipliers 1.2x for advanced biofuels and RFNBO's in aviation/marine (no Part B/C/RCF)
Aviation Fuel	-	-	SAF blend 5pc by 2030, 63pc by 2050 Synthetic fuel 0.7pc by 2030, 28pc by 2050

Some member states have targets which exceed REDII (55)

- Countries are permitted to use several different basis for compliance with REDII (GHG, energy or volume), in addition to choosing to implement double counting

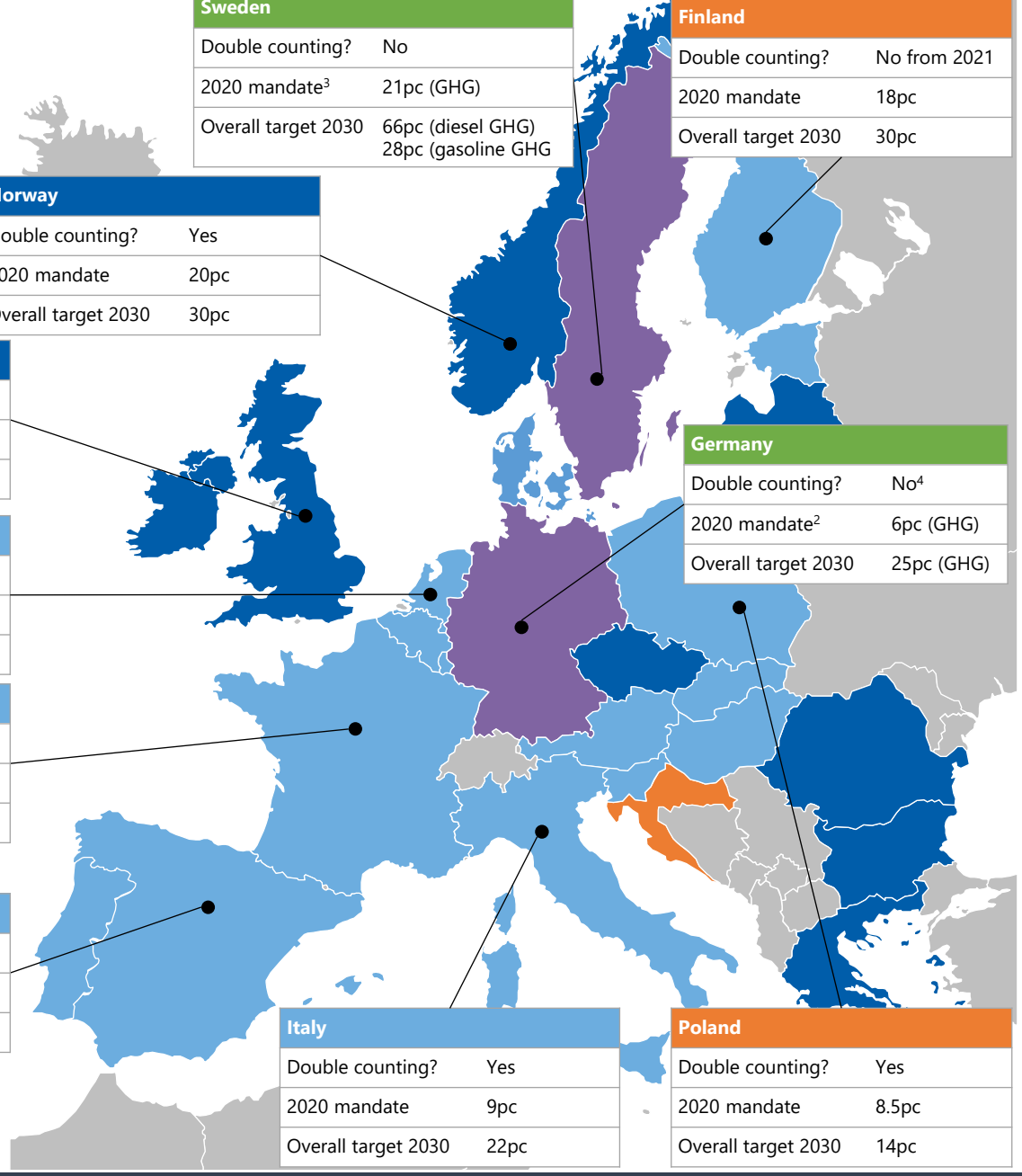
- Some countries are expected to implement legislation that exceeds the blending levels required by REDII, e.g. Germany, Nordics

2030 European biofuel demand by legislation type, pc



— *Argus Consulting*

Energy Basis
Volume Basis
GHG Basis



Sweden	
Double counting?	No
2020 mandate[3]	21pc (GHG)
Overall target 2030	66pc (diesel GHG) 28pc (gasoline GHG

Finland	
Double counting?	No from 2021
2020 mandate	18pc
Overall target 2030	30pc

Norway	
Double counting?	Yes
2020 mandate	20pc
Overall target 2030	30pc

UK	
Double counting?	Yes
2020 mandate	9.75pc
Overall target 2030[1]	16.3pc

Germany	
Double counting?	No[4]
2020 mandate[2]	6pc (GHG)
Overall target 2030	25pc (GHG)

Netherlands	
Double counting?	Yes
2020 mandate	16.4pc
Overall target 2030	27.1pc

France	
Double counting?	Yes
2020 mandate	10pc
Overall target 2030	15pc

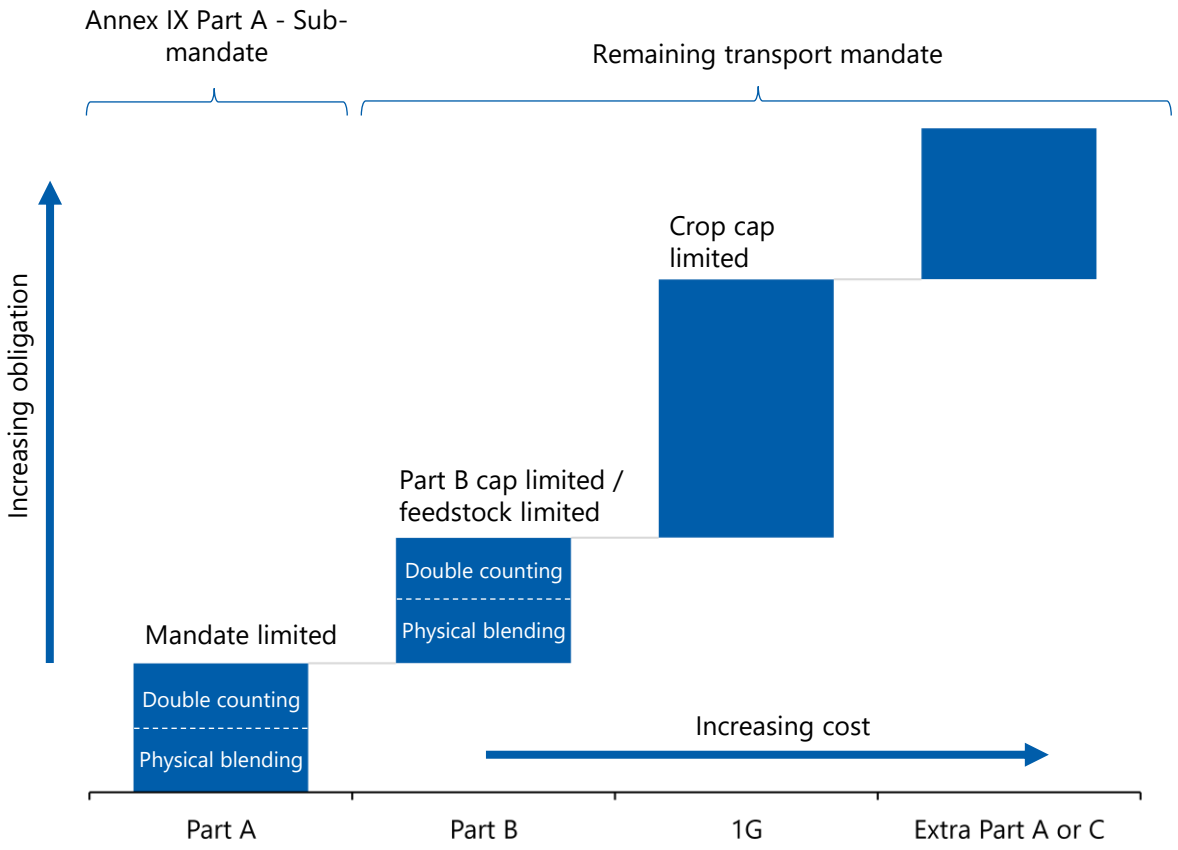
Spain	
Double counting?	Yes
2020 mandate	8.5pc
Overall target 2030	19pc

Italy	
Double counting?	Yes
2020 mandate	9pc
Overall target 2030	22pc

Poland	
Double counting?	Yes
2020 mandate	8.5pc
Overall target 2030	14pc

1 Target shown is for 2032
2 Relative to 2015
3 Relative to 2010
4. Double counting of Part A blended above submandate & E-fuels

Blenders are expected to rely on a range of different green fuels to meet future mandates, varying depending on the specifics of the country



Example fuels	• *HVO Part A* • *2G Ethanol*	• *UCOME/TME* • *HVO Part B*	• *1G Ethanol* • *1G FAME* • *HVO 1G*	• *FAME/ HVO Part C* • *RFNBO / RCFs*

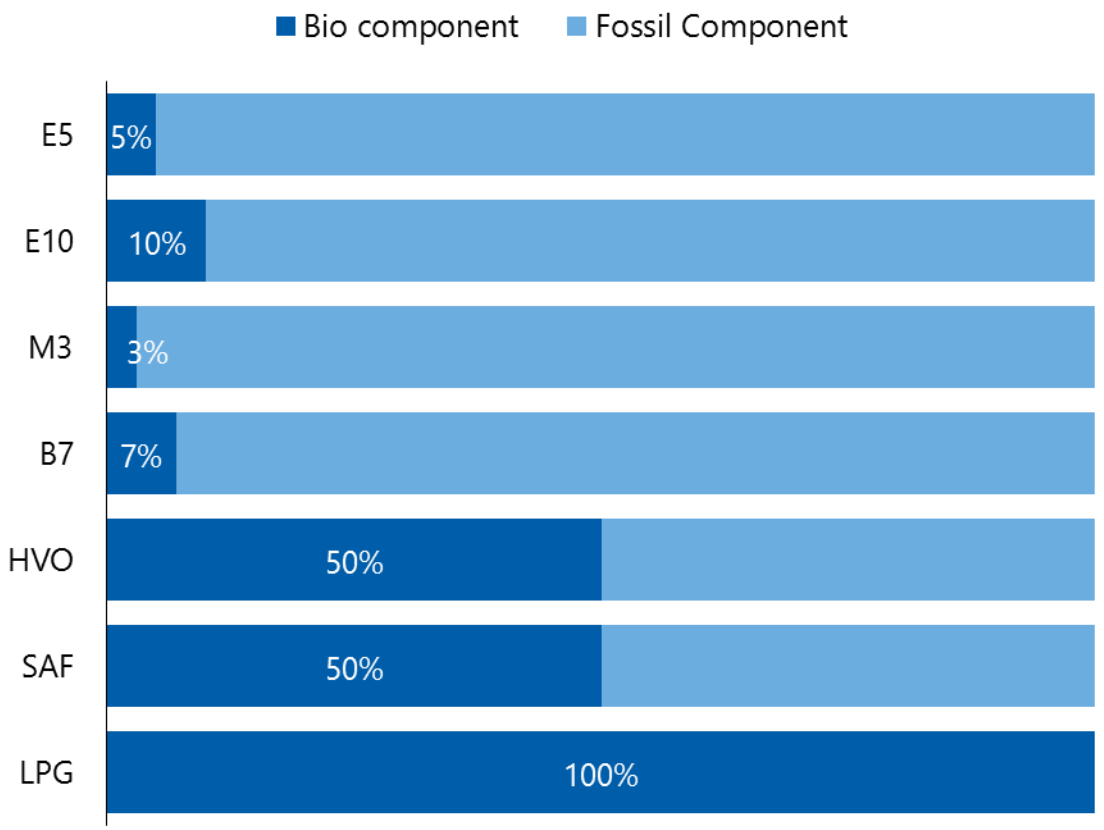
Methodology

- Part A sub-mandate is settled first at half the volume required by the mandate due to double counting.
- After the Part A sub-mandate is filled, modelling assumes Part B is consumed, as it is the most cost effective way to meet the mandate out of the green diesels due to double counting incentives
  - First Part B biodiesels (UCOME/TME) are blended due to lower cost
  - If FAME blend limit (7pc vol) is reached HVO Part B is blended
  - Part B's are blended until 3.4pc energy cap is reached or feedstock/capacity is unavailable
- Biodiesel 1G is consumed up to the blend wall followed by HVO 1G after FAME blend wall has been reached
- Finally, more HVO Part A and/or Part C fuels are needed to meet the overall mandate
  - However, depending on national legislation – Part C's may be prioritized along with Part B/1G
- In countries where SAF can be used to meet blending mandates SAF would typically compete with HVO Part A and B

European legislation will also drive consumption in drop-in fuels because traditional biofuels are constrained by blend walls

- **Ethanol** blended in gasoline is the most restricted, typically limited to 5pc (E5) but E10 has been introduced in a number of markets. It is expected that E10 will be introduced in the remaining markets in the short to medium term.
- **Methanol** blended in gasoline is limited at 3pc under the EU Fuel Quality Directive (2009/30/EC) and the CEN standard (EN228).
- **FAME (biodiesel)** blended in diesel is limited to 7pc. As mandates rise this is becoming a limiting factor. There are no plans to increase this level but higher blends (B30, B100) are offered in some markets.
- **HVO (renewable diesel)** can be blended up to at least 50pc and is therefore mainly used where high mandates need to be met. With minor alterations to fuel systems HVO can be used in pure form (HVO100).
- **Sustainable aviation fuel (SAF)** has been approved for use up to 50pc
- **BioLPG (or biopropane)** is identical to fossil LPG and therefore can be blended without constraints

Technical blending limits for various biofuels in the EU market



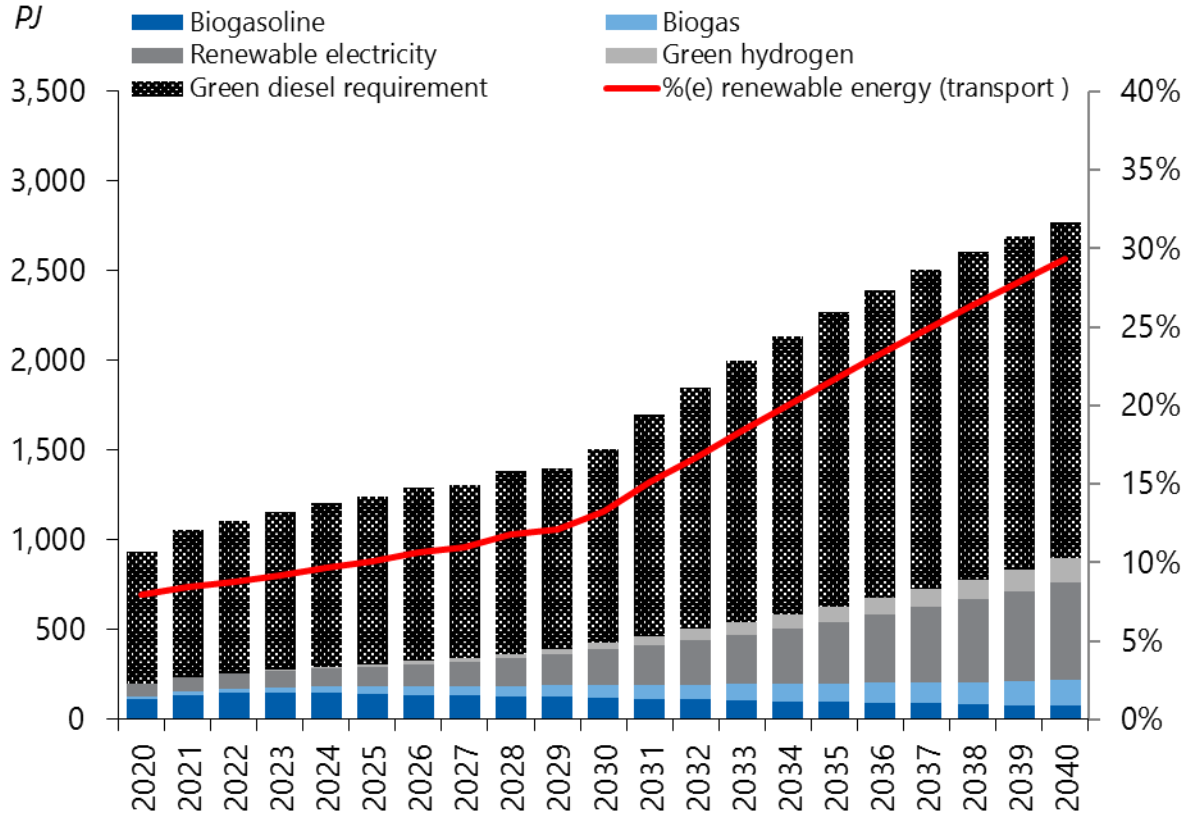
— *Argus Consulting*

Detailed European country level mandates

	Transport mandate (2030)	Basis	Double counting	Crop cap	Part B cap	Part A mandate	Renewable electricity contribution	Comment
Norway	30pc	Volume	Yes	7.0pc	3.4pc	5.6pc	18.1pc	
Sweden	66pc 28pc	GHG	No	-	1.7pc	4pc	17.8pc	66pc for diesel, 28pc for gasoline
Finland	30pc	Energy	No	5.7pc	1.7pc	3.5pc	3.0pc	
UK	12pc	Volume	Yes	2.3pc	-	7.3pc	8.9pc	Part A mandate implied from 2.4pc development fuel mandate
Germany	22pc	GHG	Partial	4.4pc	1.9pc	2.6pc	4.5pc	DC of Part A volumes above submandate level and e-fuels
France	15pc	Energy	Yes	7.0pc	0.9pc	3.5pc	2.6pc	
Portugal	14pc	Energy	Yes	6.8pc	3.4pc	3.5pc	1.6pc	
Spain	14pc	Energy	Yes	7.0pc	3.4pc	3.5pc	2.6pc	
Italy	18pc	Energy	Yes	3.0pc	5.0pc	8.0pc	3.5pc	75pc of Part A mandate needs to be met with biogas

Green diesel demand is calculated after determining demand for other green fuels

European green fuel demand, road and rail transport, 2020-2040



Note: Green diesel includes FAME, HVO and BTL
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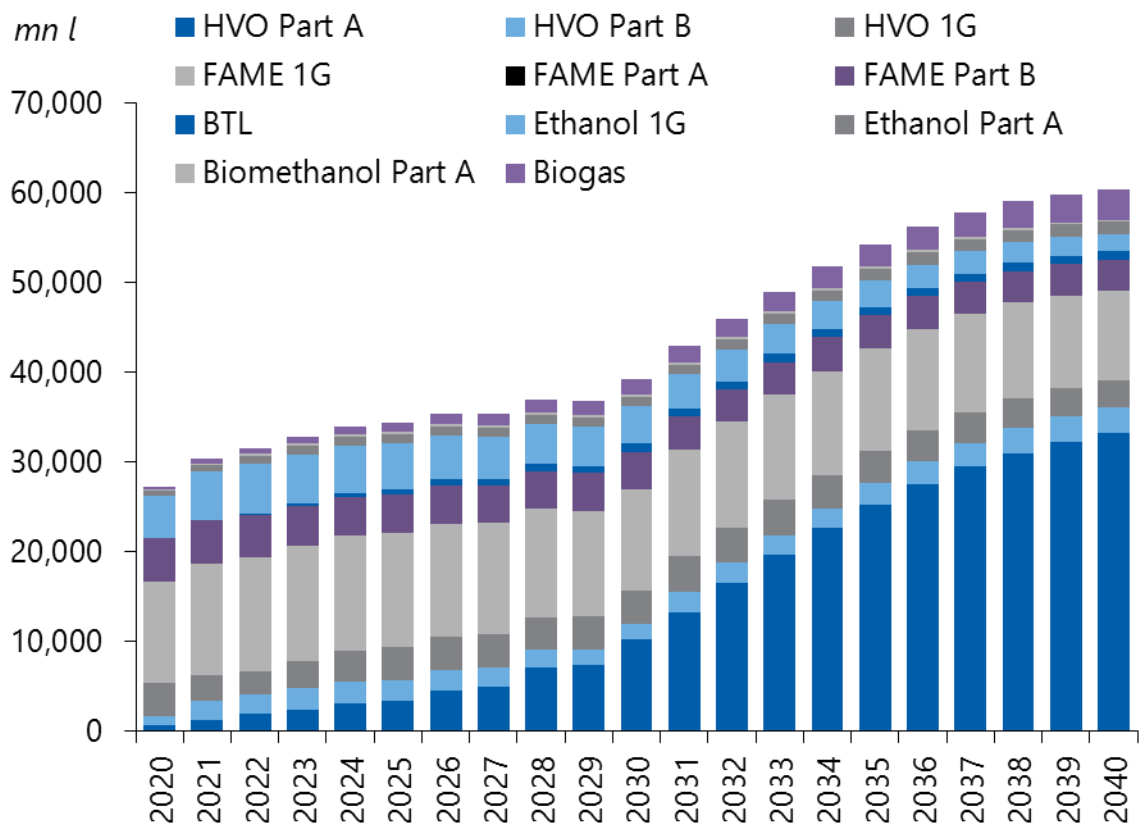
- %(e) of renewable energy in transport determined by each country's national legislation.
- Biogasoline is assumed to be blended up to the technical limit – 5pc or 10pc, depending on the development of E10 in each country.
- Renewable electricity will more than double 2019-2030, as alternative fuel vehicles take market share from traditional vehicles and renewable generation capacity increases.
- Biogas increases six-fold, with Italy responsible for two thirds of demand, but starts from a very low base.
- Whatever is left to reach required renewable energy share, is apportioned to green diesel with biodiesel blending up the technical B7 limit and renewable diesel above.

The majority of future European biofuel demand is forecast to be HVO Part A, with decreasing demand in 1G and Part B fuels

European biofuel demand in road transportation, 2020-2040



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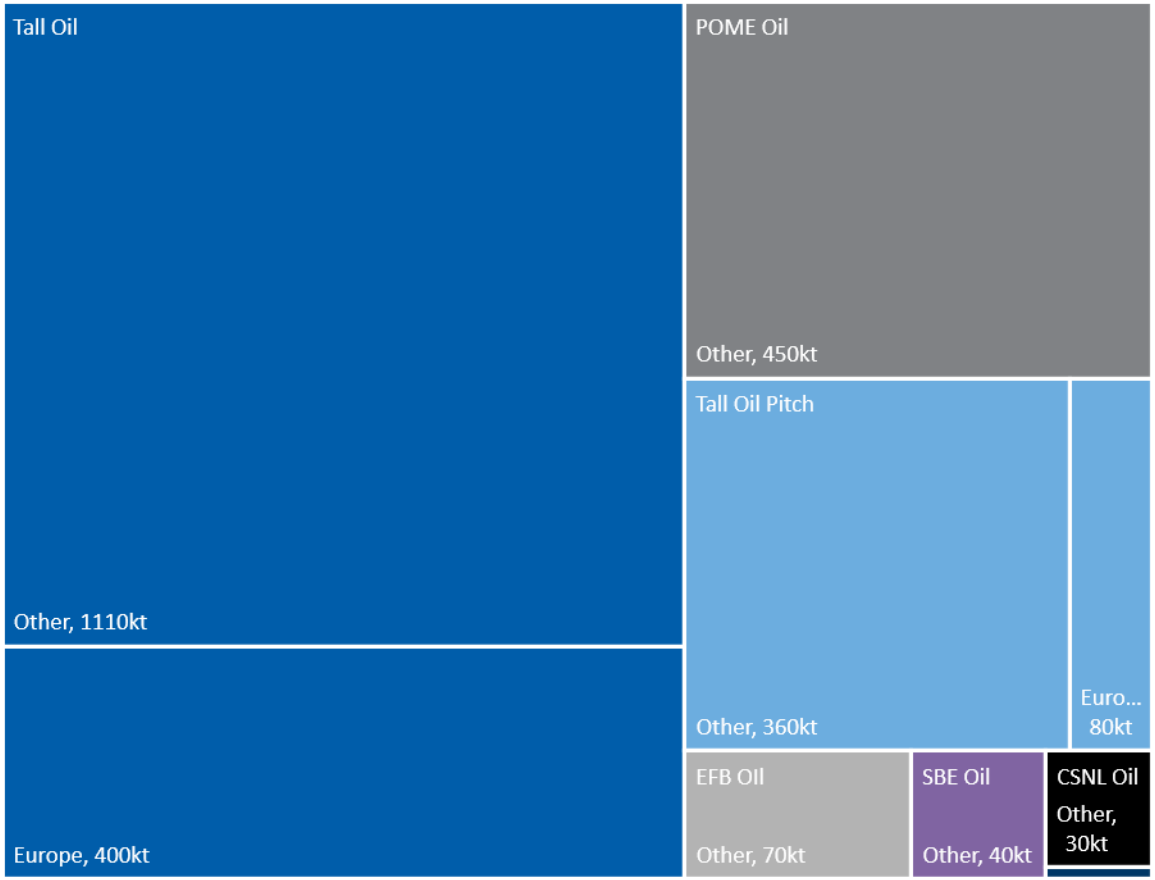
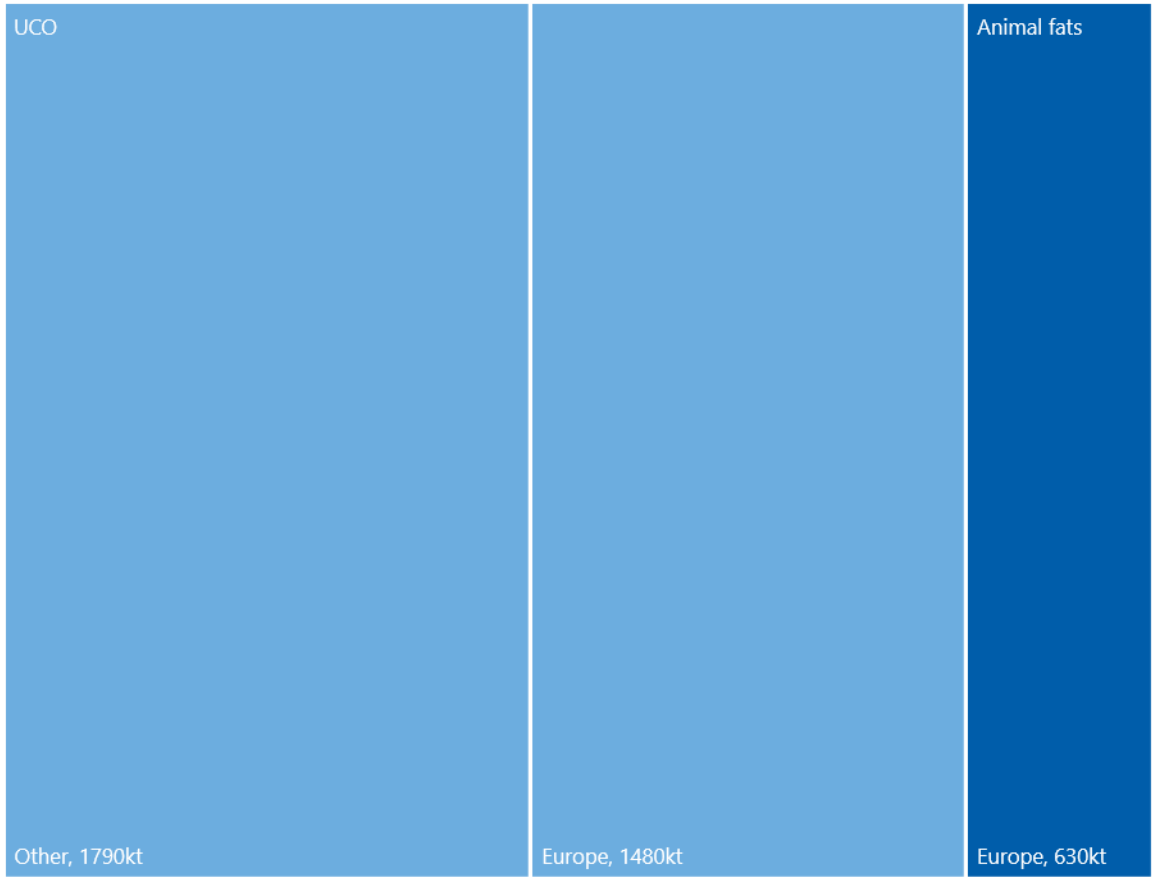
- The vast majority of Renewable diesel Part A is expected to be HVO. This makes HVO Part A the price setter for Part A fuels.
- HVO Part A demand increases from 670mn l in 2020 to over 33bn l in 2040, corresponding to an annual growth rate of 21.5pc.
- Limits on technical blending and plant capacity are expected to restrict the volume of other Part A fuels that can be used to meet the sub-mandate to 4.7bn litres by 2040.
- Demand for 1G and Part B fuels is forecast to decrease due to the crop and Part B cap and declining road transportation fuel demand.
- Over 40pc of Part A renewable diesel demand is forecast to come from Germany by 2030 (5bn litres), with other notable consumers including; Sweden (2.2bn litres), Spain (860bn litres), France and The Netherlands (650mn litres).

European feedstock supply in 2020

Annex IX Part A feedstock availability in 2020

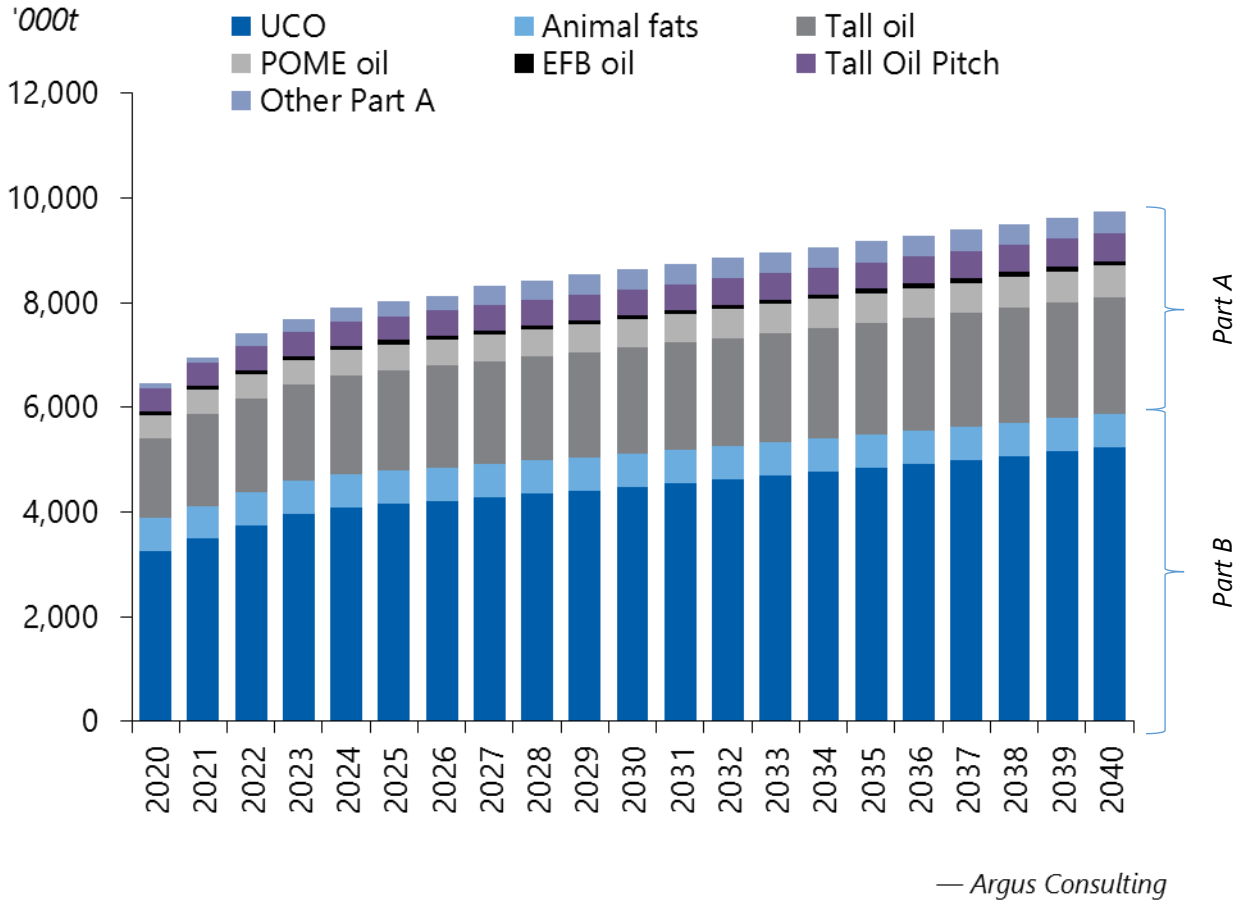


Annex IX Part B feedstock availability in 2020



UCO mostly from Southeast Asia has the most potential for growth

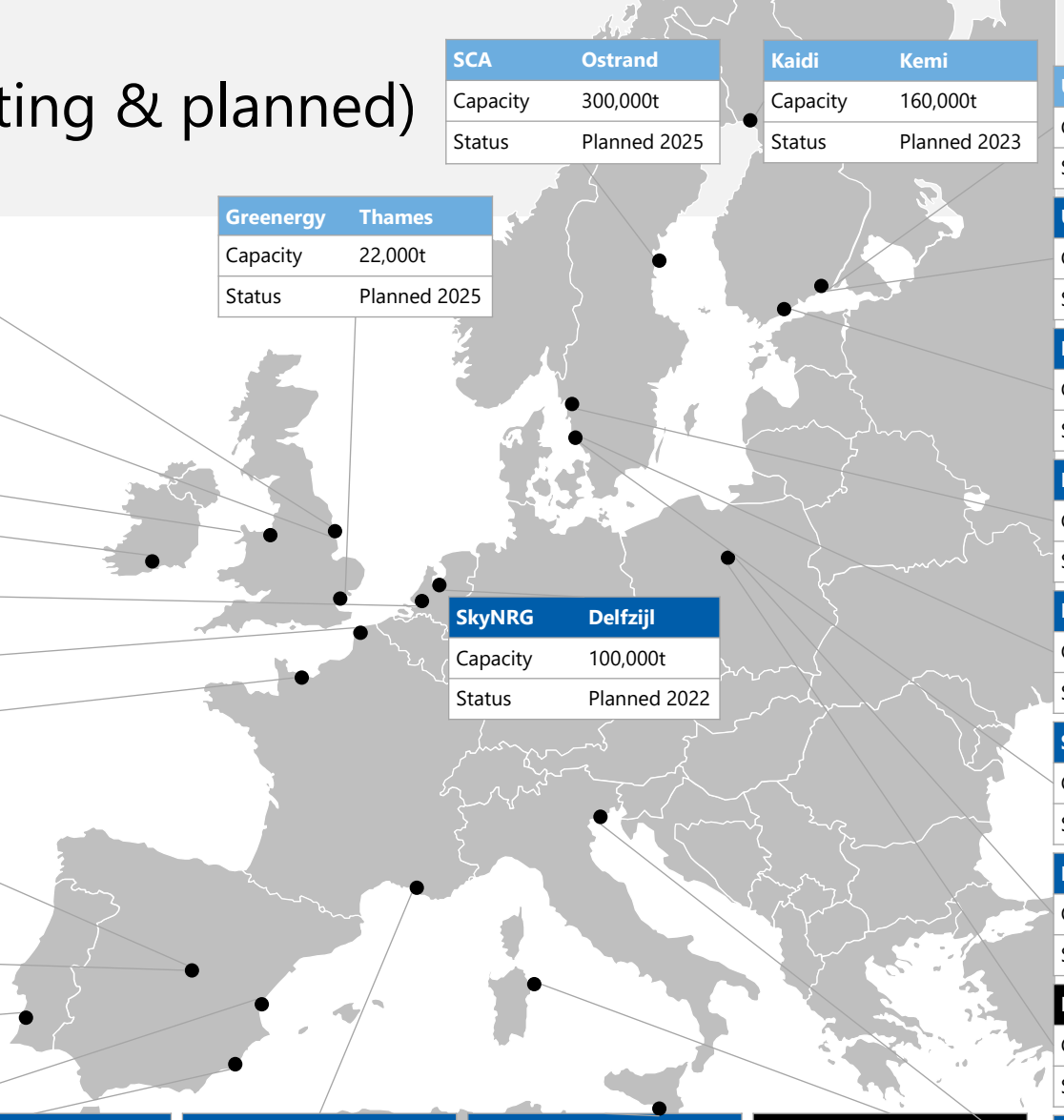
Feedstock availability, year by year, 2020-2040



- Feedstock availability includes domestic and import sources.
- UCO availability forecast to grow significantly with a CAGR of 2.4pc. Increasing supply is sources mostly from China and the rest of the world.
- Modest growth in European UCO supply is attributed to a small increase in household collection.
- Animal fats are forecast to stagnate. In Europe, animal by-products are already well recovered, and trade is restricted because of their potential harm to human health. Population growth is also offset by changing dietary habits.
- Tall oil availability is forecast to increase from 1.5mn t in 2020 to 2.2mn t in 2040. Increasing supply is mainly driven by the US and Brazil, but also Scandinavian countries.
- Tall oil pitch is expected to increase by 1pc annually due to higher tall oil production mainly in North America.
- POME and EFB oil availability grows in line with palm oil production in SE Asia with a CAGR of 1.4pc.
- Woody biomass is capacity limited and forecast to add 0.9mn t by 2030.

HVO and BTL plants in Europe (operating & planned)

HVO
Gasification/Pyrolysis
Co-Processing



SCA	Ostrand
Capacity	300,000t
Status	Planned 2025

Kaidi	Kemi
Capacity	160,000t
Status	Planned 2023

UPM	Kotka
Capacity	500,000t
Status	Planned 2023

UPM	Lappeenranta
Capacity	100,000t
Status	Operating

Neste	Porvoo
Capacity	400,000t
Status	Operating

Preem	Lysekil
Capacity	750,000t
Status	Planned 2024

Preem	Gothenburg
Capacity	1,000,000t
Status	Expansion 2023

ST1	Gothenburg
Capacity	200,000t
Status	Planned 2022

PKN Orlen	Plock
Capacity	300,000t
Status	Planned 2023

PKN Orlen	Plock
Capacity	120,000t
Status	Planned 2023

Eni	Venice
Capacity	420,000t
Status	Operational

Velocys	Immingham
Capacity	50,000t
Status	Planned 2025

Greenergy	Thames
Capacity	22,000t
Status	Planned 2025

Phillips66	Humber
Capacity	270,000t
Status	Operational

Fulcrum	Stanlow
Capacity	75,000t
Status	Planned 2026

Irving	Whitegate
Capacity	45,000t
Status	Operational

Neste	Rotterdam
Capacity	1,300,000t
Status	Operational

Total	BioTFuel
Capacity	200,000t
Status	Planned 2025

SkyNRG	Delfzijl
Capacity	100,000t
Status	Planned 2022

Total	Grandpuits
Capacity	340,000t
Status	Planned 2024

Cepsa	Various
Capacity	115,000t
Status	Operational

Repsol	Various
Capacity	350,000t
Status	Operational

Galp	Sines
Capacity	115,000t
Status	Operational

BP	Castellon
Capacity	80,000t (est)
Status	Operational

Repsol	Cartagena
Capacity	250,000t
Status	Planned 2023

Total	La Mede
Capacity	555,000t
Status	Operational

Eni	Gela
Capacity	600,000t
Status	Operational

Saras	Sarroch
Capacity	150,000t
Status	Planned 2021

Includes firm and likely HVO plants with a capacity of 50kt and above

Capacity is total renewable products

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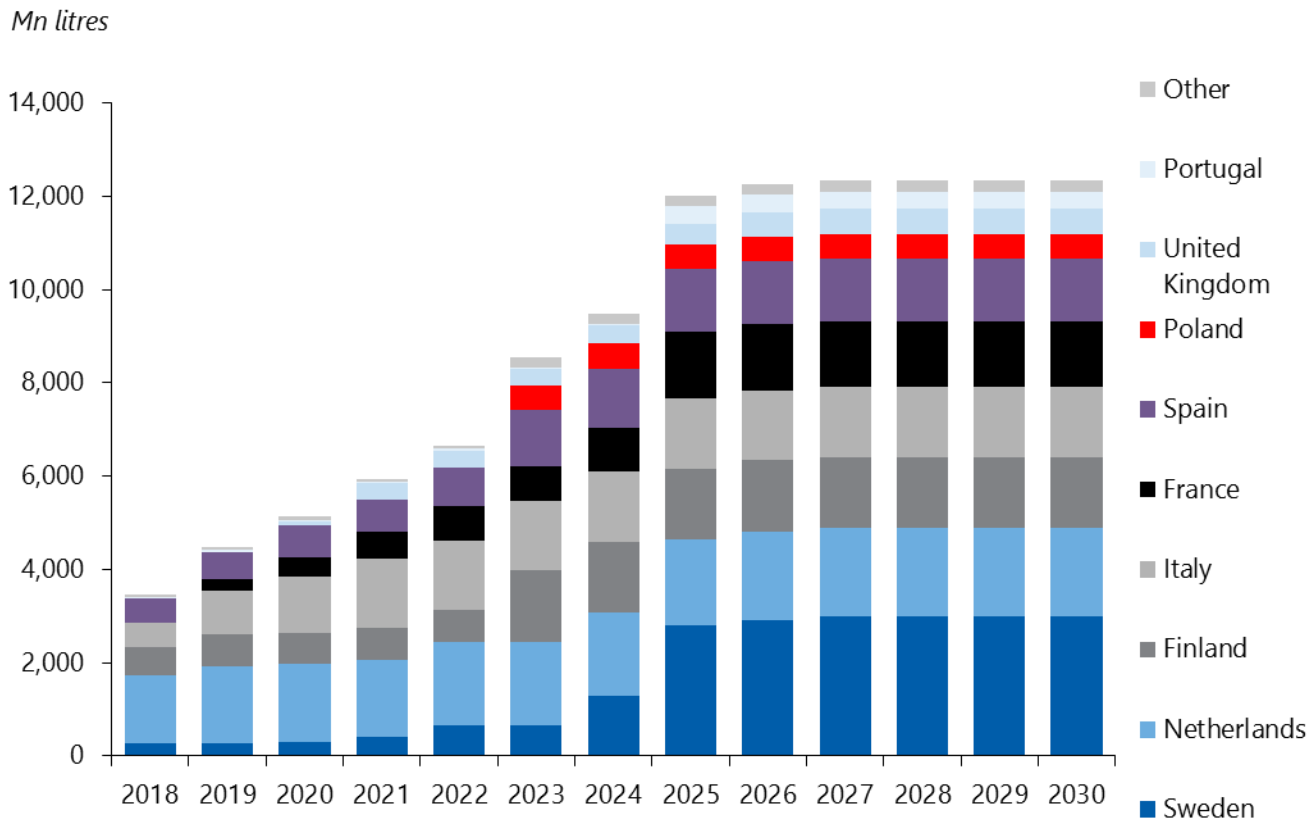
European renewable HVO/BTL capacity is expected to reach ~11.6 bn l by 2025

European HVO-HEFA /BTL capacity, 2018-2030



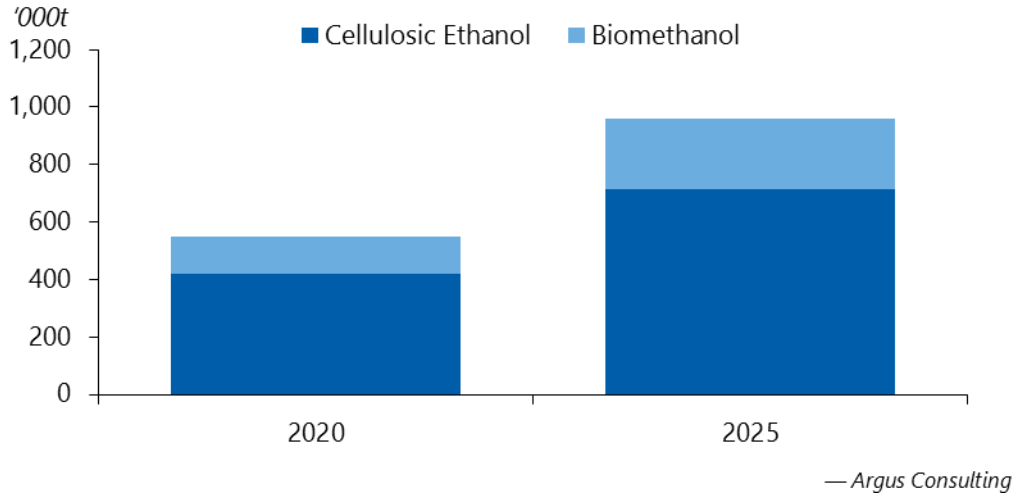
— *Argus Consulting*

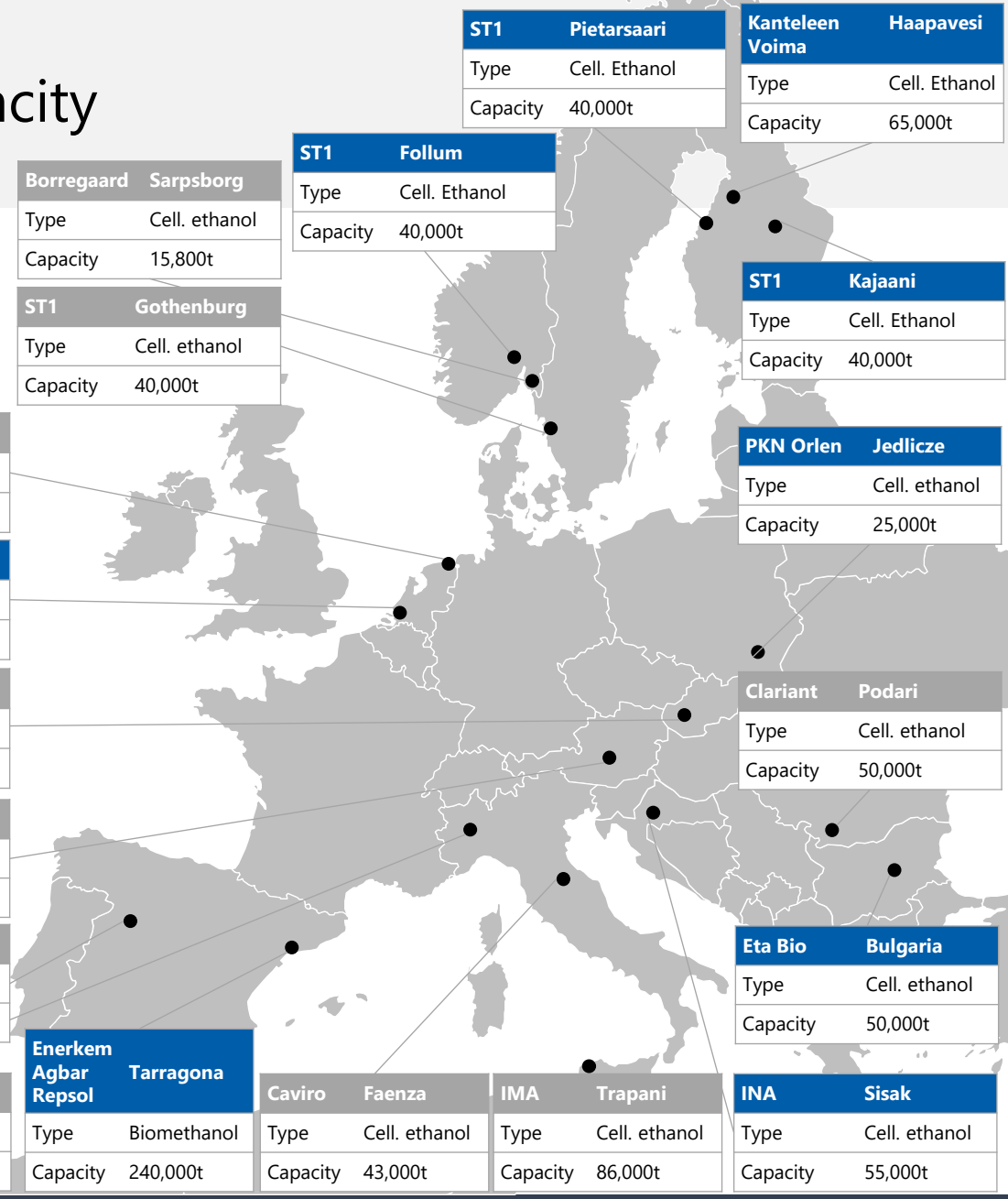
- Netherlands currently has the most renewable advanced fuel capacity in Europe with Neste's Rotterdam plant, however capacity additions in Sweden from Preem and others are expected to make it Europe's largest producer
  - Preem are planning to increase total production to 2.2bn l by 2025, spread across their Gothenburg and Lysekil refinery sites
  - ST1 have a 256mn l (per year) unit planned to start in 2022
- Italy has the third most HVO capacity with ENI having two units – in Venice and Sicily. Saras in Sardinia also do some co-processing
- Outside of Western Europe, Poland's PKN Orlen unit in Plock is expected to come online in 2023, with a capacity of 385mn l
- Approximately 75pc of total capacity is expected to go towards diesel production, with small volumes of renewable jet, naphtha and LPG also produced – 2025 diesel capacity is estimated at 8.4bn litres

European advanced biogasoline production capacity

- There is limited capacity for cellulosic ethanol production in Europe at around 420kt, with a further 130kt of biomethanol
- Total capacity is expected to grow significantly to over 960kt by 2025
- Map includes any capacity over 10,000t
- Capacity excludes idle/on hold capacity that is unlikely to enter the market
- Largest cellulosic ethanol plant due to come online owned by NordFuel Oy, which is a subsidiary of Kanteleen Voima Oy – a Finish electricity producer

European cellulosic ethanol production capacity, 2020-2025

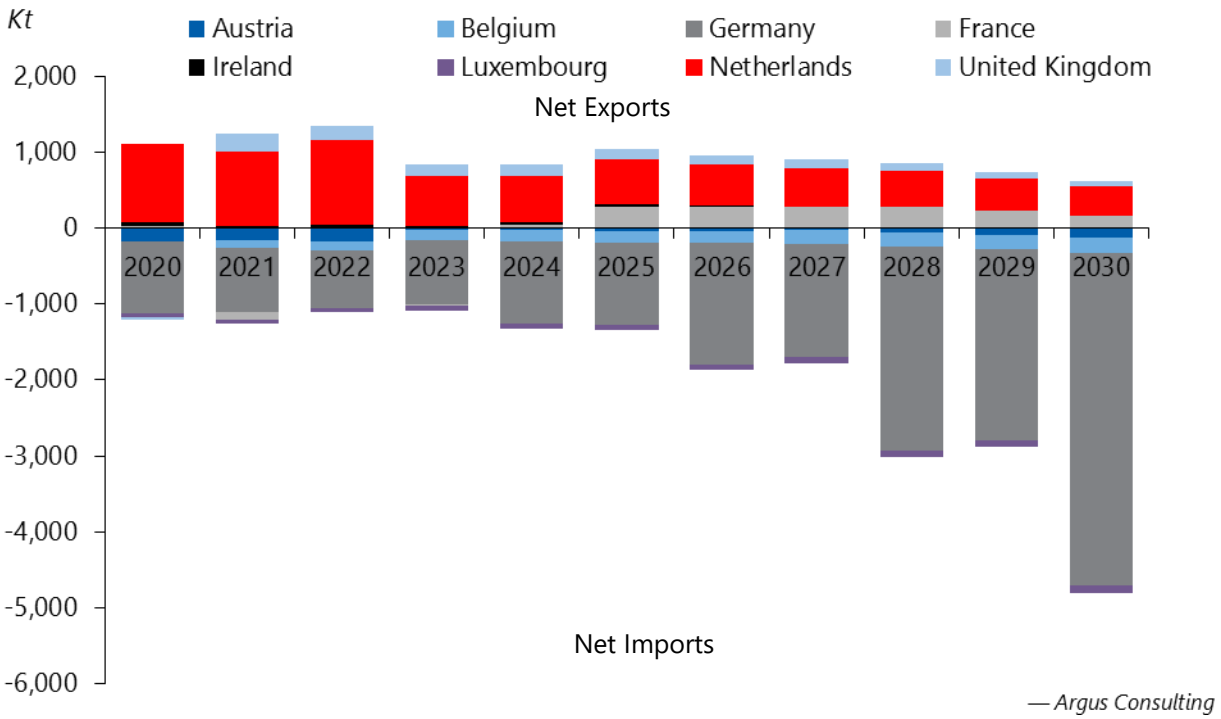




Renewable diesel: Western Europe is forecast to grow increasingly short as German mandates increase

Western Europe renewable diesel supply and demand, 2020-2030

Renewable diesel net balance, 2020-2030

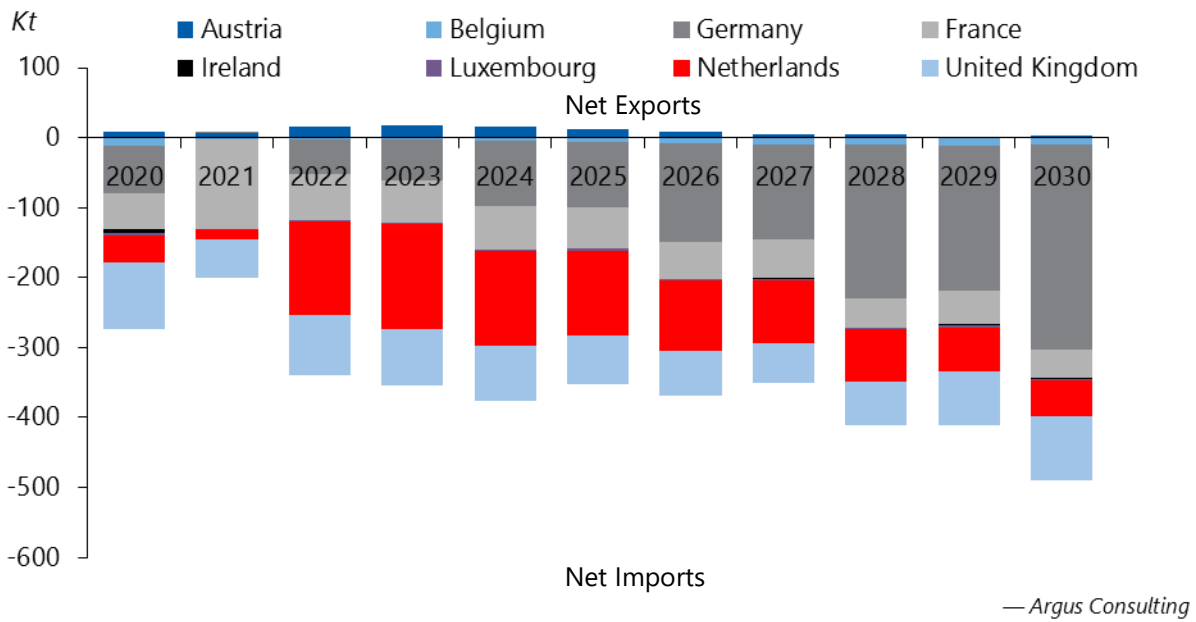


- Western Europe is forecast to change from a relatively well balanced region in 2020-2022, to a net importer of 4.2mn t by 2030 as demand growth from rising road transport mandates outpaces firm capacity additions
- This deficit is primarily driven by increasing German demand towards the end of the forecast period. Germany has an ambitious 22pc GHG reduction target and is forecast to require large volumes of Part A renewable diesel, with limited domestic capacity available to supply volumes
- The Netherlands is forecast to remain a net exporter throughout the forecast period, with large export volumes from Neste's 1mn tonne HVO facility in Rotterdam

Western Europe lacks cellulosic ethanol capacity, demand is forecast to increase as caps on 1G ethanol levels are reduced

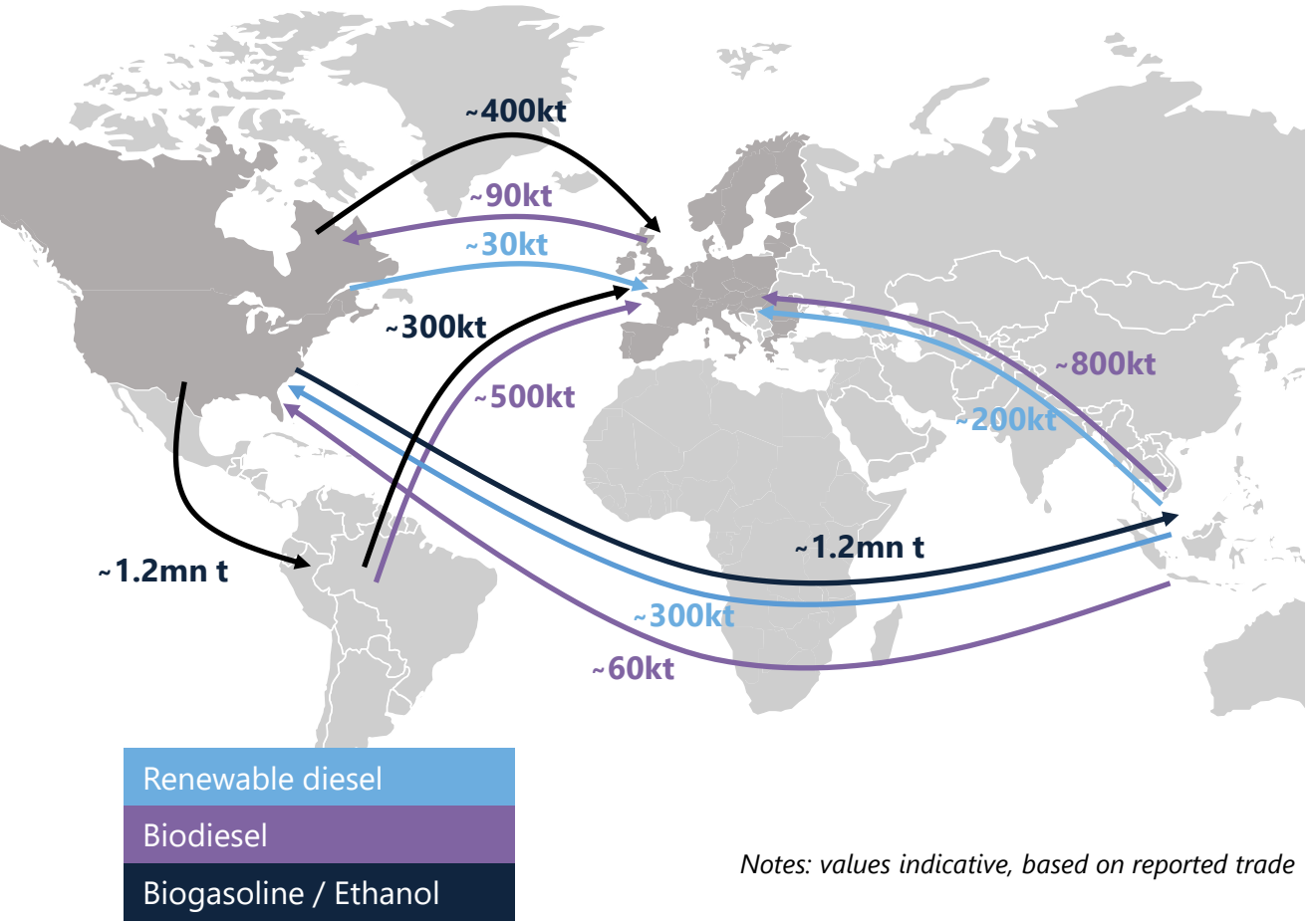
Western Europe cellulosic ethanol supply and demand, 2020-2030

Cellulosic ethanol net balance, 2020-2030



- Western European cellulosic ethanol demand is primarily forecast to be driven by demand from Germany, France, The Netherlands and the UK
- Low or declining caps on the volumes of 1G biofuels that can be blended in these countries means increasing demand for cellulosic ethanol is required to satisfy demand for ethanol blending
- 2021 demand is projected to decline due to rising blending mandates in other parts of Europe, diverting limited cellulosic ethanol suppliers elsewhere
- Cellulosic ethanol supply is forecast to remain flat at 26kt, no new capacity is forecast to come online in the region. The majority of European capacity is located in the Nordics and Eastern/southern Europe – and so imports are most likely to come from these destinations to satisfy demand
- Western Europe's net deficit is forecast to grow from ~250kt in 2020 to 480kt by 2030

European and North American Green Diesel is mostly imported from Southeast Asia, with smaller Trans-Atlantic trade



Notes: values indicative, based on reported trade

Renewable diesel

- Europe is a significant importer of renewable diesel. The most prominent import origin is Southeast Asia, but smaller volumes are currently also being imported from North America.
- North America's net position for renewable diesel is forecast to change, which decreases export volumes to Europe.
- Additional volume of renewable diesel is forecast to be exported from Southeast Asia to serve both the European and North American markets.

Biodiesel

- Europe's most prominent import origins are Southeast Asia and South America. Biodiesel is also exported to North America.
- North America is currently a biodiesel importer, mostly from Southeast Asia and Europe.

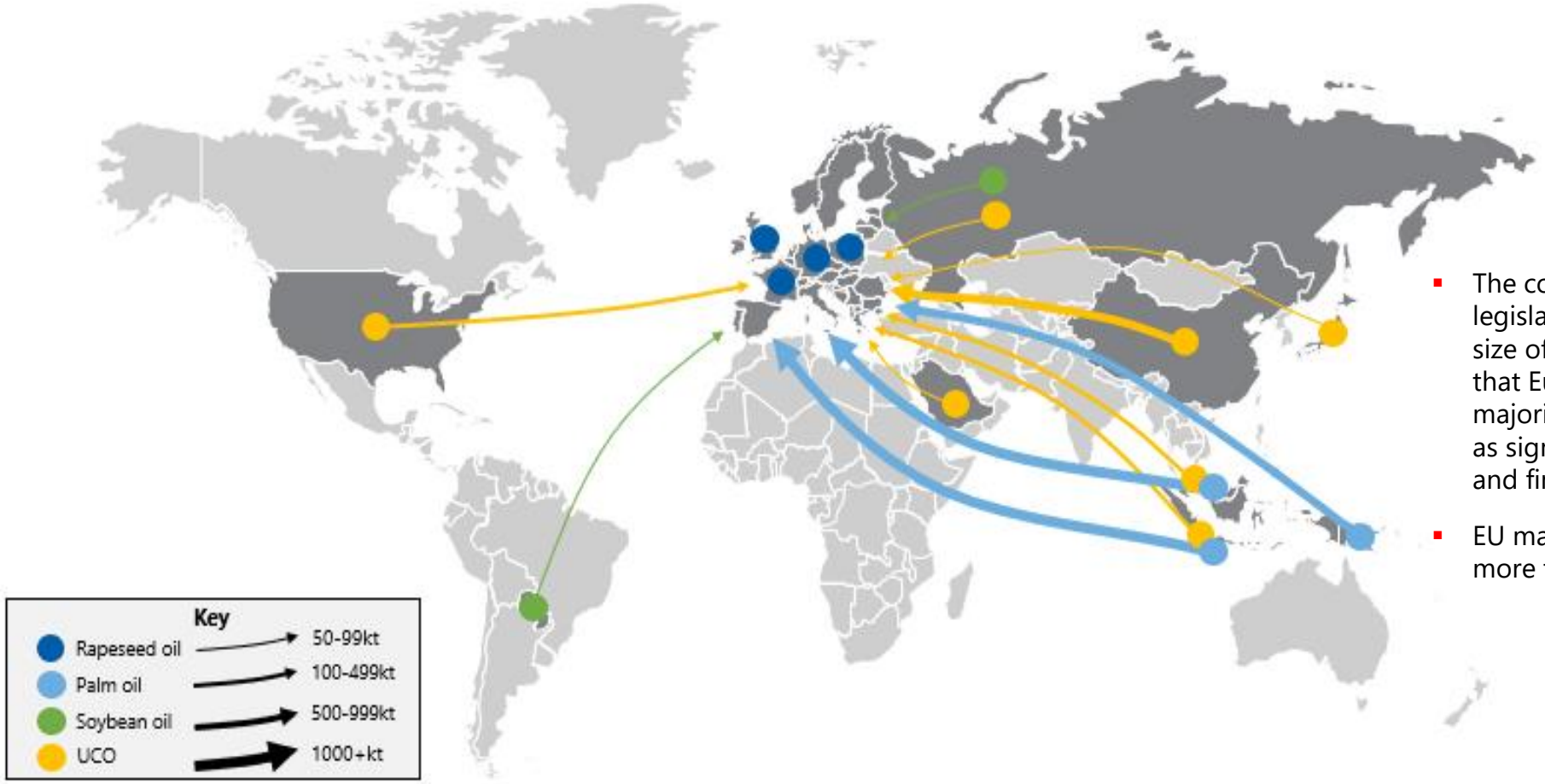
Biogasoline

- North America is a significant biogasoline exporter. Largest trade partners are South America, but smaller volumes ae also exported to Europe.
- Europe also imports smaller volumes from South America.

EU Market

The importance of the EU market in determining price: feedstocks

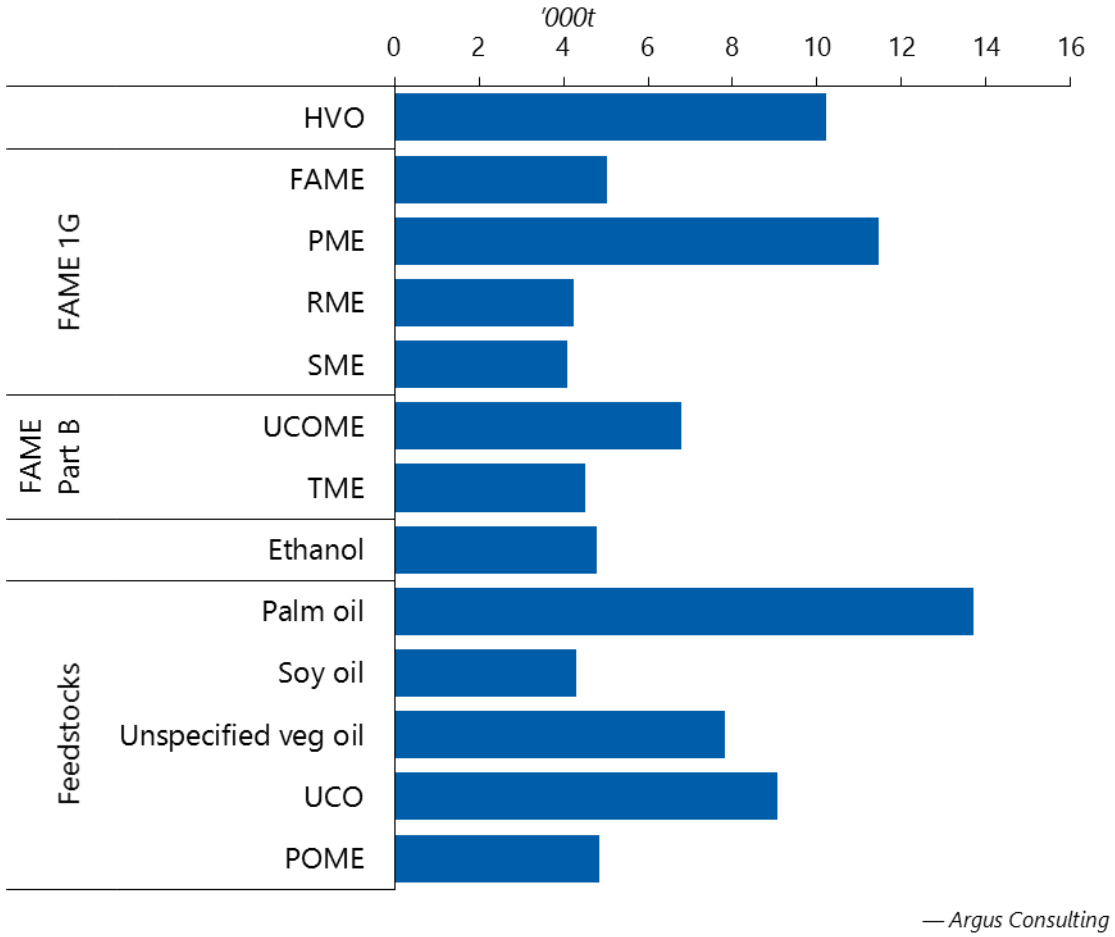
Origin and volume of main liquid biofuel feedstocks consumed in Europe



- The comprehensive nature of the EU legislation on biofuel blending and the size of the market that results, ensures that Europe is the key market for the majority of HVO produced in Asia, as well as significant volumes of both feedstock and finished biodiesel.
- EU mandates will require more HVO and more feedstock imports in coming years.

The majority of biofuels are transported around Europe in 5kt cargoes

Average shipment size of biofuels and feedstocks in Europe, 2019



- The majority of European FAME and ethanol travels in 5kt cargoes, this is unlikely to change in the forecast period
- Asian-sourced biodiesel cargoes, such as PME and UCOME shipments are larger on average as shippers may build cargoes to minimise costs
  - PME cargoes averaged 11.5kt in 2019 – although cargoes up to 40kt were recorded
  - UCOME averaged 7kt in 2019, with some cargoes up to 11kt
- HVO shipment sizes tend to be greater than FAME or ethanol, due to larger facilities with greater output allowing for bigger cargoes
- Feedstocks follow a similar pattern to finished biofuels, with Asian-sourced feedstocks (palm, UCO) transported in larger cargo sizes – larger Asian sourced mixed UCO/UCOME cargoes are common
- Due to limited demand for POME, average shipment sizes are smaller than palm oil, but as demand for Part A renewable diesel grows it is likely shipment sizes will increase

There are limited restrictions to biofuel storage, although biodiesel and veg oils typically require heating

Products	Tank type			
	Mild / carbon steel	Stainless steel	Coated (mild steel)	Heated
Ethanol	✓	✓	✓	✗
Methanol	✓	✓	✓	✗
FAME	✓	✓	✓	✓
SME/RME	✓	✓	✓	★
PME/TME	✓	✓	✓	✓
UCOME	✓	✓	✓	✓
Renewable diesel (HVO/BTL)	✓	✓	✓	✗
UCO	*Yes with circulation and drainage*	✓	✓	✓
Rapeseed / soy oil	*Yes with circulation and drainage*	✓	✓	✗
Palm oil	*Yes with circulation and drainage*	✓	✓	✓
Tallow	*Yes with circulation and drainage*	✓	✓	✓
Gasoline (E5/E10)	✓	✓	✓	✗
Diesel (B7)	✓	✓	✓	✗

★ Product not required to be heated, however due to logistical issues will likely be treated as general biodiesel component and placed in heated tank

Discussion of other competing sectors likely to emerge (SAF, marine, biochemicals)

- Biofuel blending has historically been focused on the road market, however in recent years more focus has been placed on the aviation and marine fuel markets where their international nature have created barriers to adoption of robust legislation
- Beyond the transport markets, interest is growing in the biochemicals sector where demand is growing for feedstocks that can reduce the carbon footprint of traditional petrochemical products. No legislation currently exists that directly drives this change, however there is significant company-level desire to source new feedstocks and reduce embedded carbon.

Sustainable Aviation Fuels

- Mandates are being introduced in a number of European countries which is expected to drive demand
- Demand will be modest in the short term, however it is expected to grow significantly in order to support wider carbon targets
- It is likely to compete strongly for hydroprocessing capacity, where many producers have a degree of flexibility to produce SAF rather than HVO
- This is likely to be mitigated with dedicated facilities based on solid waste feedstocks

Marine fuels

- The requirement to reduce carbon emissions in the marine sector has been growing recently however there are no legislative mandates in place to support it
- There are a number of alternative options to decarbonise the sector, including hydrogen/ammonia, LNG and methanol
- The outlook for the sector is uncertain, however there appears to be less pressure on HVO supplies from this sector, mainly due to the low specification required for marine engines

Biochemical feedstocks

- The broad nature of the petrochemical market means there are a number of different pathways for biogenic feedstocks into chemical products
- While HVO has been reportedly used as cracker feedstock, the most commonly used products remain bionaphtha and biomethanol where the use as a transport fuel is more challenging
- Consequently, while this sector features high on the value hierarchy, HVO is not considered an optimal choice and therefore is unlikely to be widely used

National SAF mandates are being implemented and a EU wide mandate is being discussed

Implemented and proposed SAF mandates in Europe

	Status	Start	Initial level	Target 2030	Target 2050
Norway	implemented	2020	0.5pc	30pc	-
Sweden	proposed	2021	1.0pc	30pc	-
Finland	proposed	2023	1.0pc	30pc	-
France	proposed	2022	1.0pc	5pc	50pc
Netherlands	proposed	2023	-	14pc	100pc
EU	discussed	2023	1.5pc	-	-
Spain	discussed	2025	2.0pc	-	-
UK	discussed	2025	-	-	-

- There are currently five EU member states which have proposed national SAF mandates, but only Norway has translated it into legislation.
- Norway's 0.5pc mandate is planned to increase to 3.5pc in 2021, and is then gradually accelerated to reach 30pc in 2030. Sweden and Finland proposed similar long-term mandate trajectories.
- The Netherlands have announced to introduce a stringent mandate from 2023 onwards if an EU mandate was insufficient. Their target is a 14pc share of renewables in aviation fuel until 2030 and a complete replacement of traditional jet until 2050.
- France has announced a mandate of 1pc starting in January 2022, which would increase to 2pc in 2025, 5pc in 2030 and 50pc in 2050.
- Other countries such as Spain and the UK have signalled the intention to introduce further mandates that support the usage of SAF. But no official proposal has yet been submitted.
- A EU wide mandate of 1-2pc and a higher SAF multiplier is being discussed under the ReFuel framework. It could come into place as soon as 2023.
- Germany has introduced a mandate of 0.5pc SAF from 2026 onwards, accelerating to 2pc in 2030. But it was excluded from the demand forecast as it only comprises synthetic aviation fuel.

SAF Global Market

Airports currently utilizing Biojet in notable volumes are concentrated in Europe and North America

- American Airlines, Alaska Airlines and JetBlue have signed deals to use SAF on flights out of San Francisco

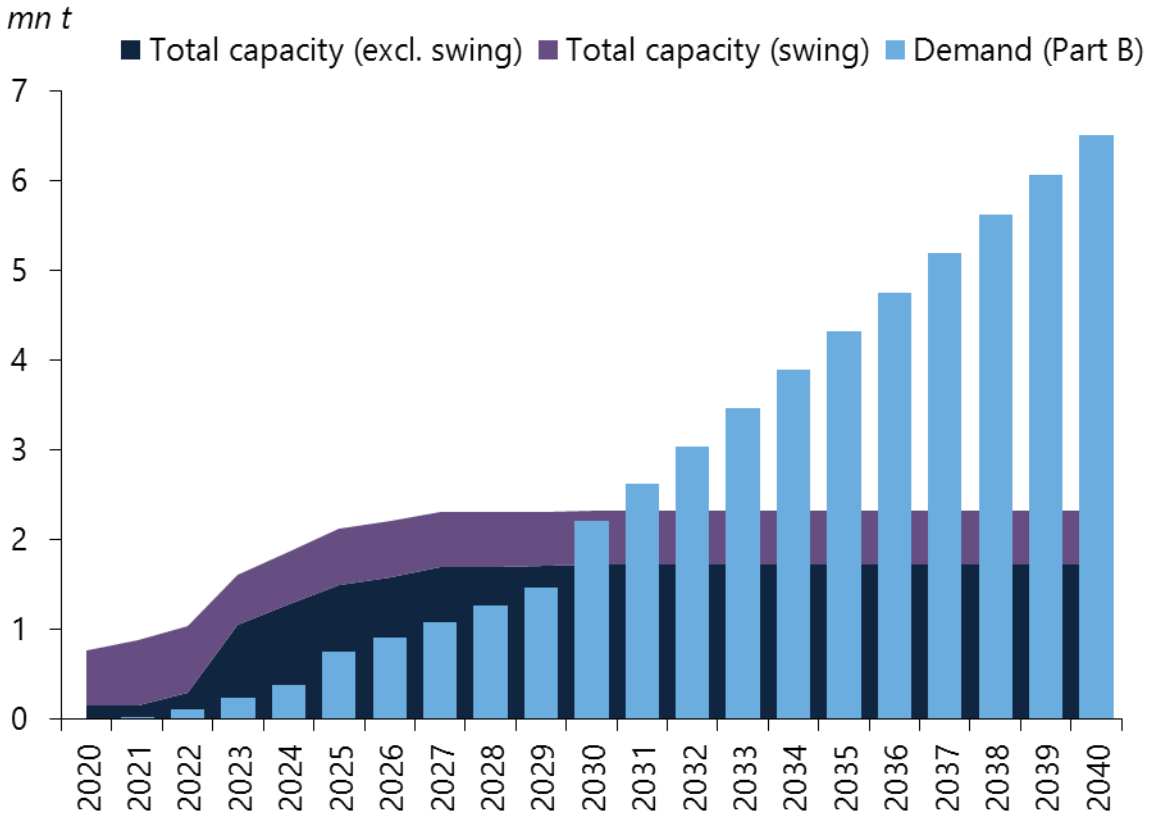
- United Airlines has a contract with World Energy and has invested more than $30mn in California sustainable fuel producer, Fulcrum Energy

- Air BP has supplied sustainable aviation fuel in the Nordics since 2014 at around 10 airports, including most recently at Kalmar airport in Sweden and Oslo airport where they were the first to supply sustainable aviation fuel produced by Neste through the existing airport fuelling infrastructure, in collaboration with other key industry stakeholders. - BP

- Brisbane Airport is the only airport East of Suez to make the list, with Virgin Australia taking volumes from alcohol to jet supplier Gevo

There is sufficient capacity to serve SAF demand until 2030, but new capacity is likely to be required afterwards

European SAF demand vs. capacity, 2020-2040

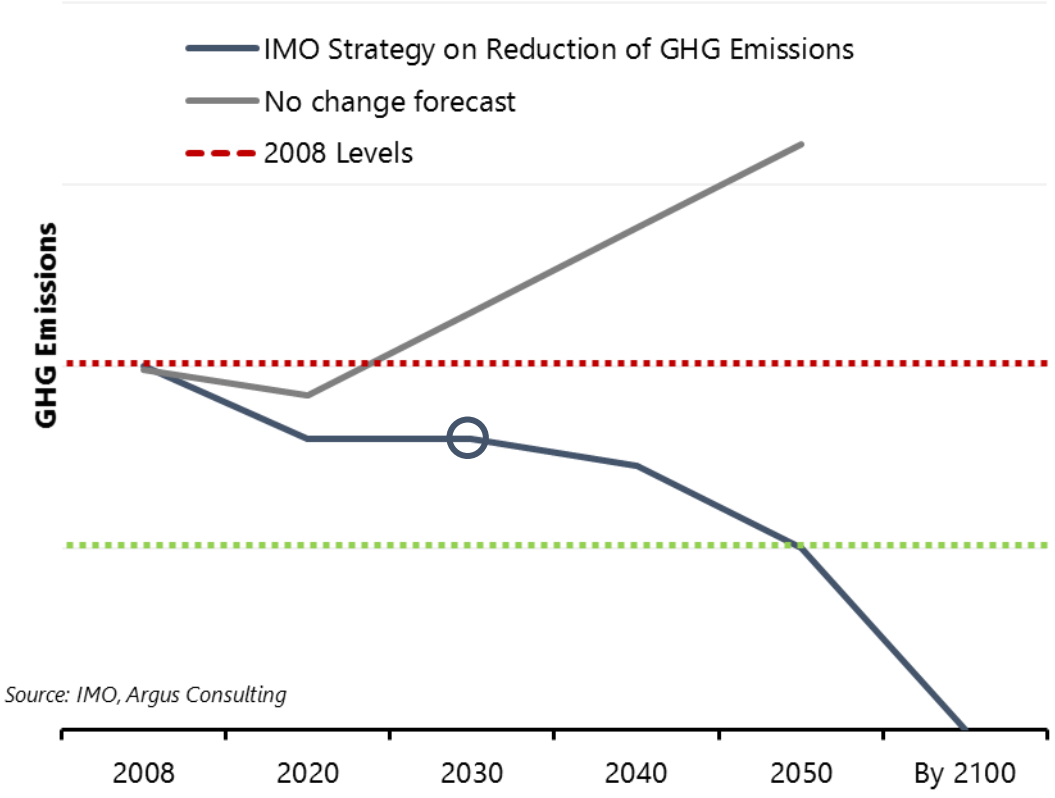


Notes: includes bio and synthethic SAF demand
— Argus Consulting

- SAF demand is, similar to other biofuels, entirely mandate driven.
- Norway is the only country with a currently enforced SAF mandate. The mandate started in 2020 at 0.5pc and is announced to increase to 29.5pc in 2030.
- Sweden has announced to introduce a SAF mandate of 1pc at the end of June 2021, increasing to up to 30pc in 2030.
- Other countries that announced SAF mandates are the Netherlands (14pc by 2030), Finland (30pc by 2030), France (50pc by 2050), Germany (2pc by 2030), Spain (2pc by 2025). The UK is currently consulting on a mandate, which could be as high as 0.5pc in 2025.
- Given currently enforced and announced SAF mandates, announced and planned dedicated capacity is forecast to be sufficient to serve demand until 2030. After 2030, swing capacity and after 2031 new capacity would be required.
- Without the introduction of a submandate or double counting mechanisms for SAF produced from advanced feedstocks, there is insufficient support to stimulate Part A SAF demand.
- SAF produced from 1G feedstocks is currently not supported in national mandates.

IMO 2030: Reduction in average carbon intensity (CO2 per tonne-mile) of at least 40% by 2030

IMO GHG Strategy



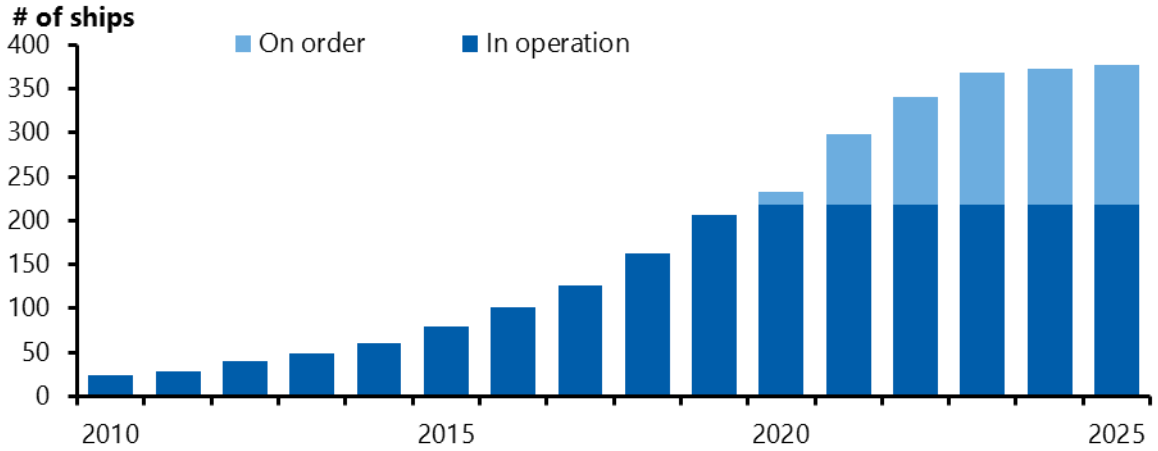
Source: IMO, Argus Consulting

- First up, IMO 2030 targets a reduction in average carbon intensity (CO2 per tonne-mile) of at least 40pc by 2030. This is an improvement in the relative efficiency per tonne mile from the perspective of CO2 emissions. This represents the IMO's medium term goal.
- There will be a number of different contributors to meeting IMO 2030 GHG reduction targets
  - How will the 40pc reduction in carbon intensity compared to 2008 levels be achieved?
  - Tighter Energy Efficiency Design Index (EEDI) requirements for new ships
  - Speed reduction
  - Energy Efficiency Design Index for Existing Ships (EEXI)
  - Carbon Intensity Indicators – annual rating system
  - Ship Energy Efficiency Management Plan (SEEMP)
- In addition to these regulations, an increase in the number of LNG vessels will contribute to CI reductions, as well as a small proportion of zero carbon fuel vessels that will come online as part of smaller scale initiatives by shipowners.
- In truth, the drive towards GHG reduction started much earlier, with the adoption of mandatory technical and operation measures dating back to 2011, when amendments to MARPOL Annex VI regulations codified the requirements with regard to Energy Efficiency Design Index (EEDI) and Ship Energy Efficiency Management Plan (SEEMP).
- **Conclusions**: Although low and zero carbon alternatives to bunker fuel will be a hot topic over the next decade, they are not essential to meet IMO 2030 targets. This does not mean that there will not be growth in demand for zero carbon fuels, it just means that their growth will be driven by company level voluntary investment rather than necessity to meet targets.

Demand for LNG as a bunker fuel is forecast to accelerate further 2021-2030

- In addition to design and operational improvements, a certain degree of fuel switching will also play a part in meeting the 2030 target.
- Demand or LNG as a bunker fuel has increased significantly but remains a relatively small portion of the overall global market. LNG benefits from the fact that is future proof when it comes to sulphur content, there is existing global infrastructure in place to facilitate expansion and the technology is established.
- Further to this, LNG releases around 20pc less CO2 than fuel oil and marine gasoil, meaning that, alongside other measures it is likely sufficient to satisfy targets outline for 2030. Despite being a selling point at present and through the medium-term, this represents a notable drawback in the longer term as LNG's CO2 reduction profile versus established marine fuels is not sufficient to satisfy 2050 targets.
- LNG bunker demand is forecast to increase to around 4mn t based upon the firm forecast. The firm forecast only accounts for demand from vessels in operation and the vessels already on the order book and outlined in this sub-section. Demand in 2024 reflects the vessels on the orderbook.
- LNG fueled vessels are forecast to increase as a proportion of total vessels delivered over the forecast period and these vessels are forecast to be of a greater size due to the increase in popularity in container ships and tankers. As such, LNG bunker demand is forecast to grow to close to 24mn t by 2030.
- The orderbook as a % of the global fleet in DWT terms has been relatively stable in recent years, at between 10-15pc for the past 6 years. This rate is assumed to remain through the forecast period, with the proportion of LNG vessels in DWT terms increasing in line with recent growth rates and the growth rates observed through the next couple of years based on the orderbook. This is assessed alongside analysis of the key drivers supporting investment in LNG fueled vessels to generate the medium-term outlook for LNG bunker demand.

LNG Fueled Vessels in Operation

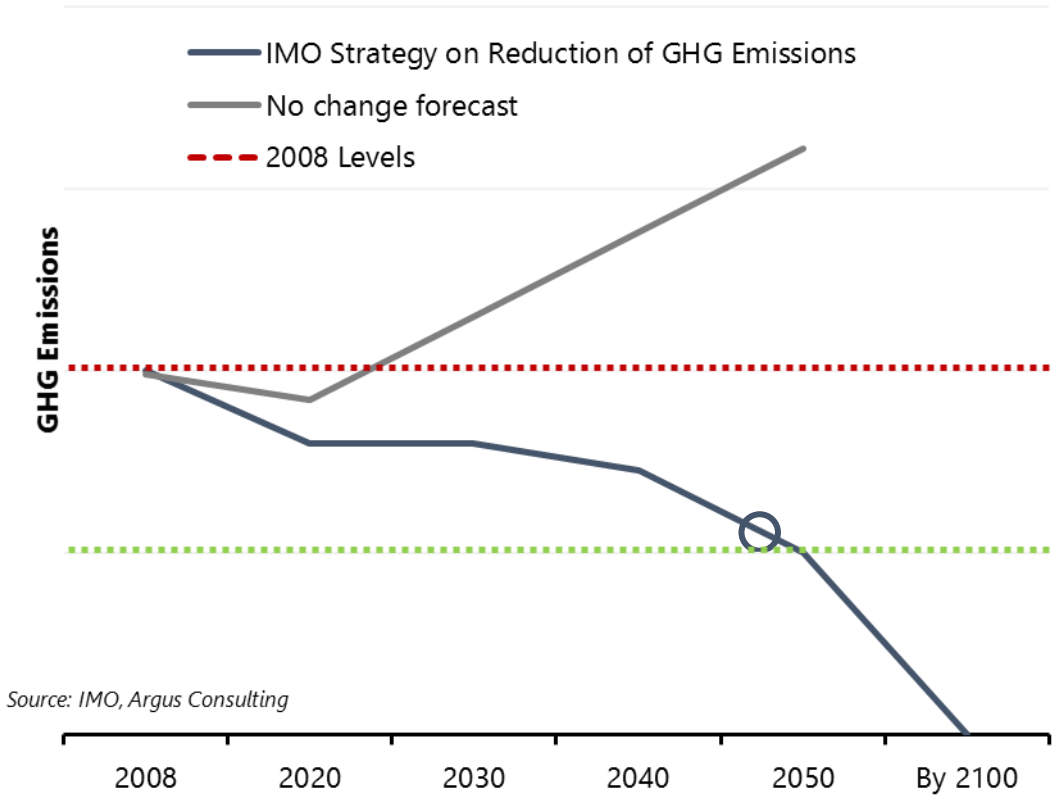


Source: Argus Consulting

Medium-term LNG bunker demand outlook (2021-2030)

IMO 2050: 50% reduction of GHG emissions from shipping by 2050

IMO GHG Strategy



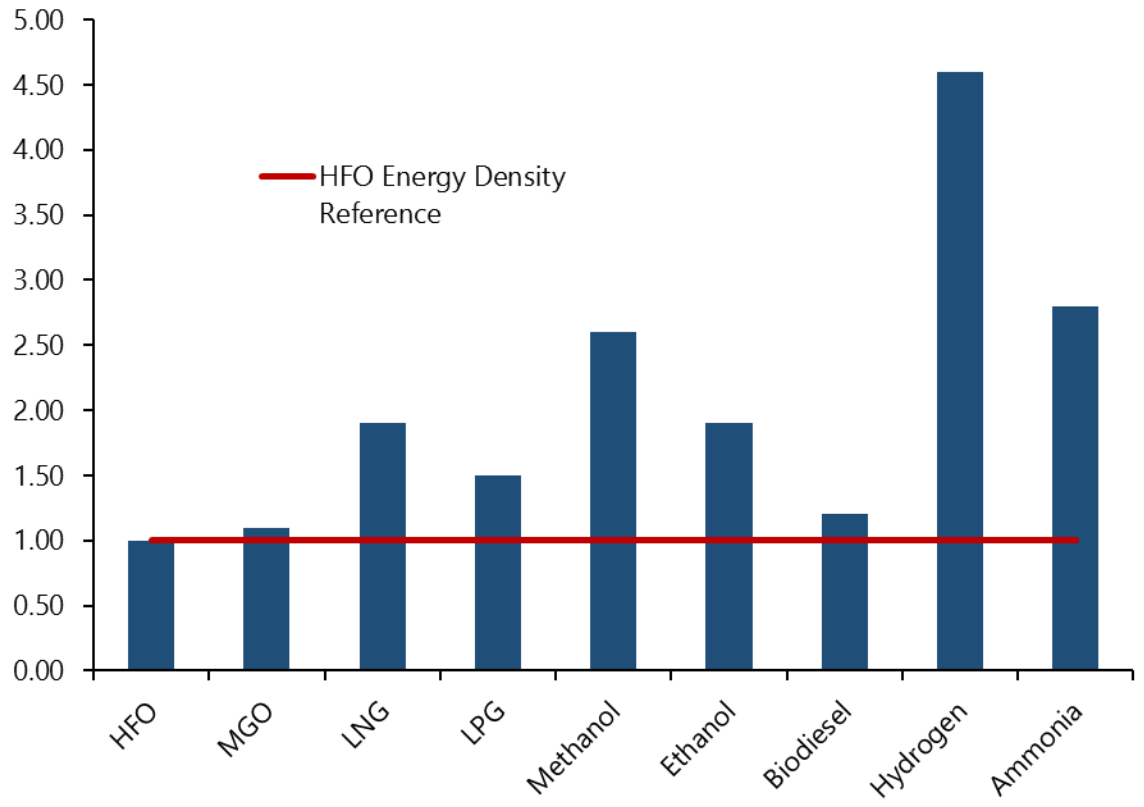
Source: IMO, Argus Consulting

- IMO 2050 will introduce far stricter targets, necessitating a 50% reduction of GHG emissions from shipping by 2050. In order to meet this more aggressive target by 2050, zero carbon fuels will need to play a part in the fuel mix beyond 2030. There are a multitude of possible options, each with own unique selling points and caveats.
- IMO 2050s more aggressive carbon reduction targets should be taken seriously, due to the IMOs track record with implementing regulation changes amid resistance from stakeholders and the push for CO2 reduction across a variety of sectors that have firm targets in 2050.
- Fuel oil and middle distillates will continue to play a part in the bunker fuel mix through 2050, but this role will diminish in line with the life cycle of vessels, with new vessels constructed after 2030 likely to be rare. Attention will likely shift to a variety of zero carbon fuels in the longer term.
- As has already been mentioned, LNG fueled vessels will also have little reason to grow 2030-2050 due to the significant shortfall in their ability to satisfy the more strict targets for 2050.

- **Conclusions**: In order to meet more aggressive target by 2050, zero carbon fuels will need to play a part in the fuel mix beyond 2030.

IMO 2050: 50% reduction of GHG emissions from shipping by 2050

Relative energy density of potential marine fuels

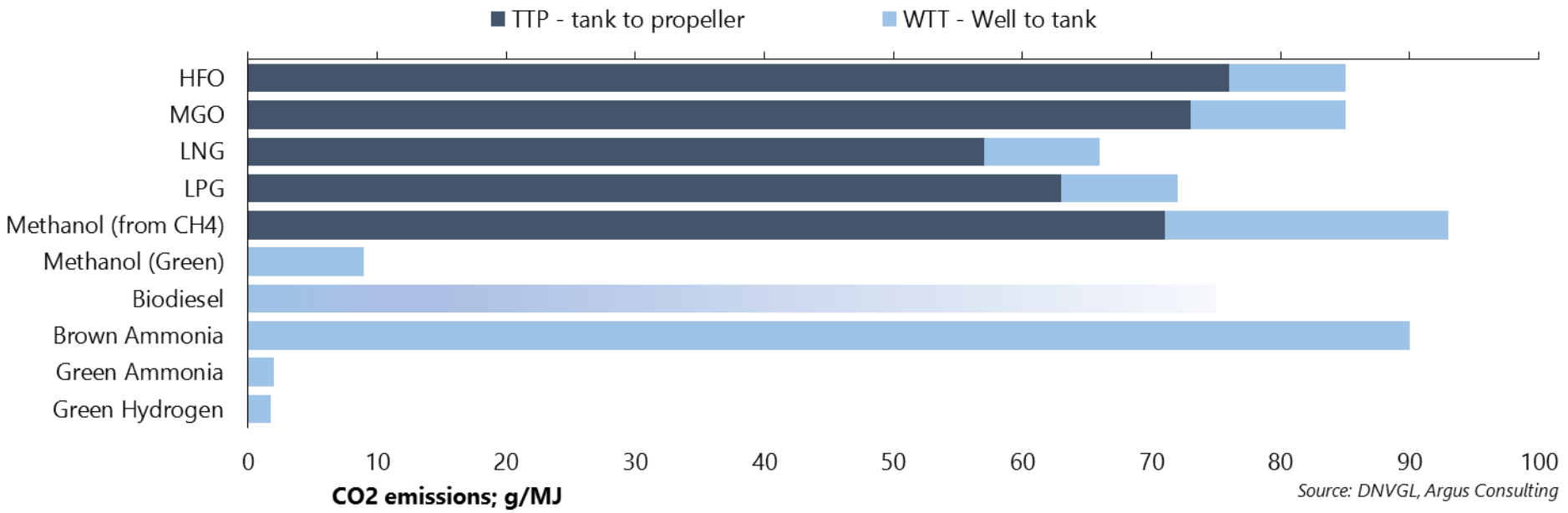


Source: Argus Consulting, DNVGL

- Ammonia, methanol, biofuels, hydrogen and others could all play a part in the fuel mix going forward, but at present it remains unclear which will emerge as the most likely. Each of the potential zero/low carbon fuel options have significantly lower volumetric energy densities than fuels that are currently in use
- Ammonia has an advantage over hydrogen, but is still significantly less dense than current conventional marine fuels. Methanol suffers from the same problem, while hydrogen is unlikely to be viable for long haul voyages/large vessels due to the lack of energy density.
- This presents hurdles when it comes to fuel tank sizes, storage, transportation of fuels etc.
- Energy density and CO2 reduction are just two of the factors that will contribute to one or more of these fuels becoming a prominent marine fuel between now and 2050. Throughout the slides that follow, Argus will discuss the merits and potential of each of these options in order to generate a view of the fuel mix in 2040 and more importantly the demand for ammonia/green ammonia.
- Due to the nascent nature of this market, the outlook for green ammonia as a bunker fuel will presented in two scenarios: a base case that represents a more conservative view and an optimistic case that likely represents the potential upper bound of demand.

IMO 2050: Green Ammonia represents just one of the options for CO2 reduction in the shipping industry

CO2 emissions of potential bunker fuels



- For a fuel to succeed in displacing conventional crude-derived bunkers it needs to be cost-effective, widely available, scalable and have a high-energy density
- LNG is the most advanced in terms of availability and cost, yet global infrastructure remains limited and LNG is seen mostly as a transition fuel
- Ammonia benefits from having existing infrastructure, but the current built up cost of green ammonia is significantly higher than the price of any existing bunker fuel.

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Definitions & Terminology

Market Reporting

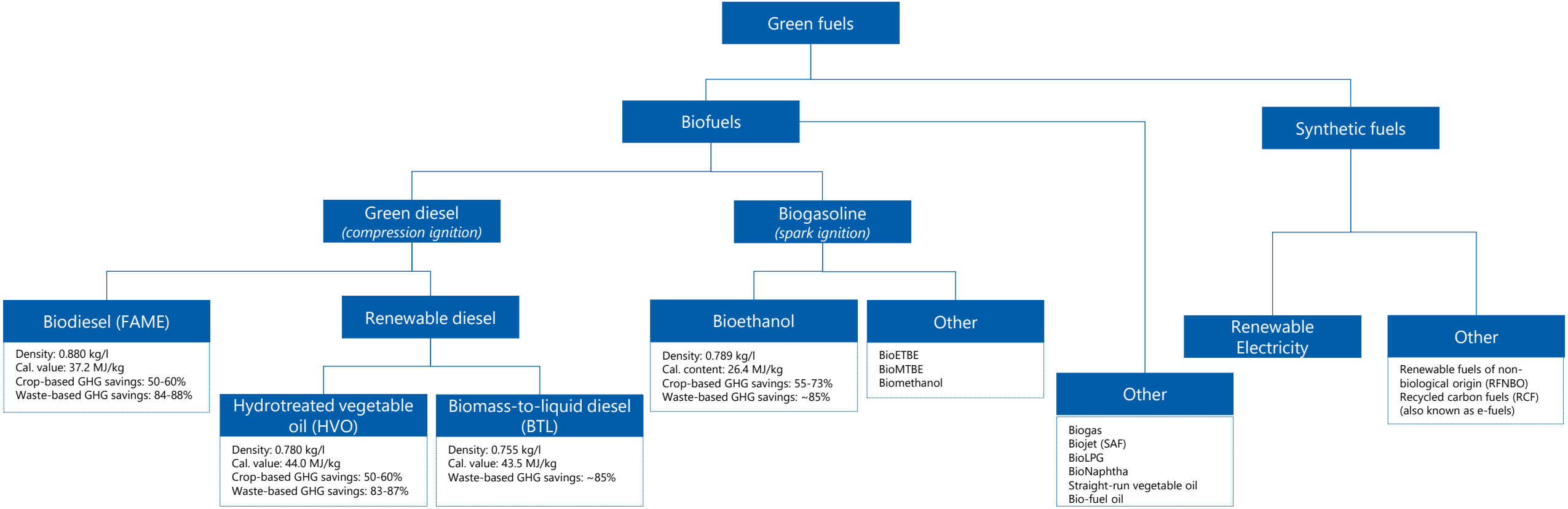
Consulting

Events

illuminating the markets

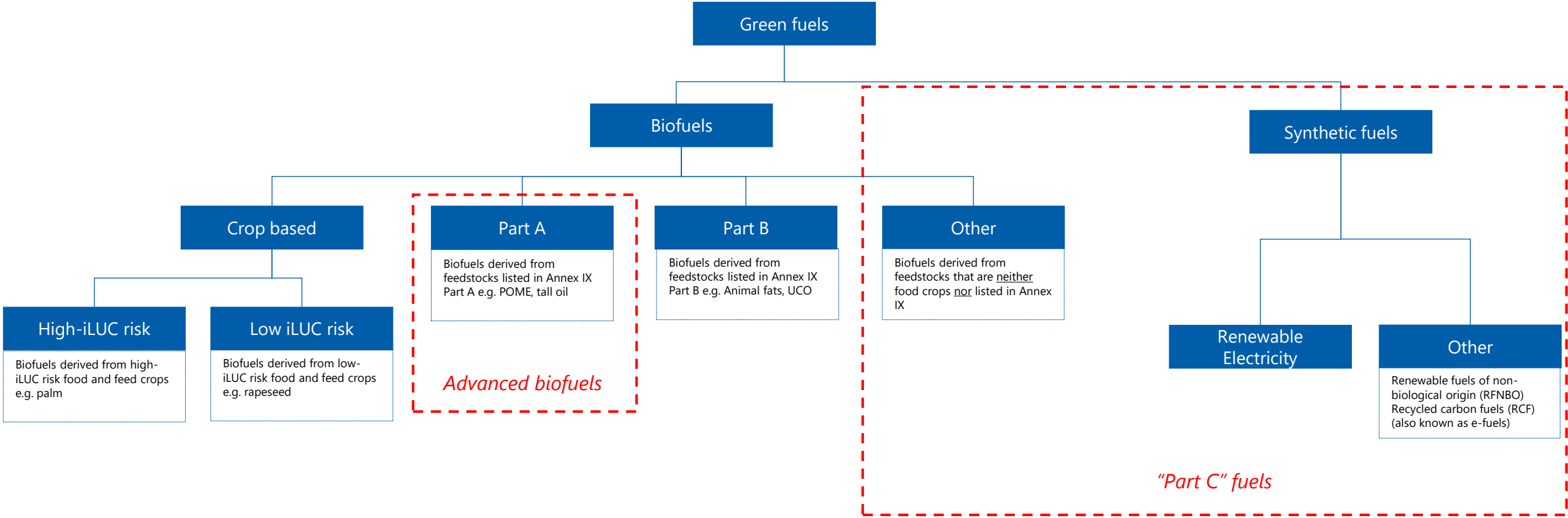
Definitions and specifications

- Terminology varies by market participant



Definitions and specifications

- In addition, EU legislation classifies biofuels based on the feedstock they are derived from:



Under REDII legislation renewable fuels can be divided into 7 categories depending on the feedstock classification

Total target of 14pc in 2030

Part A biofuels	▪ Count towards the target and are double counted, *mandate of 3.5pc in 2030* ▪ Advanced/Part A feedstocks according to Annex IX	Biofuels
Part B biofuels	▪ Count towards the target and are double counted, *capped at 1.7pc* ▪ Part B feedstocks include UCO and animal fats (tallow) categories 1 and 2	Biofuels
High iLUC risk biofuels	▪ Count towards the target, but capped ▪ From 2024 to 2030, the limit will gradually decrease to 0pc	Biofuels
Low iLUC risk biofuels	▪ Count towards the target ▪ 1G biofuels capped at its 2020 level+1pp, but *maximum of 7pc*	Biofuels
Other biofuels ('Part C')	▪ Count towards the target, uncapped and single counted ▪ Feedstocks include animal fats category 3, energy crops (e.g. jatropha, carinata, miscanthus)	Biofuels
RFNBO	▪ Count towards the target - *uncapped* ▪ 70pc GHG savings required ▪ Awaiting delegated act from EU Commission in mid-2021 for further information on GHG Methodology	Non-bio
RCF	▪ May count towards the transport target, but not for overall renewable energy target -*uncapped* ▪ Awaiting delegated act from EU Commission in mid-2021 for further information on GHG Methodology ▪ Member states have the option to accept or exclude RCF for the calculation of their obligation	Non-bio