IHS Energy & Natural Resources – Oil Markets, Midstream, Downstream & Chemical

Consulting Report

Final report

France Downstream Sector - Fit for 55 Package Impact

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Content

Scope of work and introduction to the project

Scope of work

- The IHS Markit objective of the report is to develop a scenario to highlight the implications of a scenario proxy to the Fit for 55 scenario on the French downstream sector.

- The scope of work is broken down into 6 tasks:
  1. Fuel demand outlook
  2. Review of existing refinery infrastructure and production adjustments
  3. Review of new refinery investments to decarbonize fuels
  4. Supply outlook and net balances by products
  5. Review of new refinery investments to decarbonize the refinery assets

- The “Fit for 55 Target” scenario has been created, assuming France will meet the F55 targets
  - Target formulated by the European Commission in their package

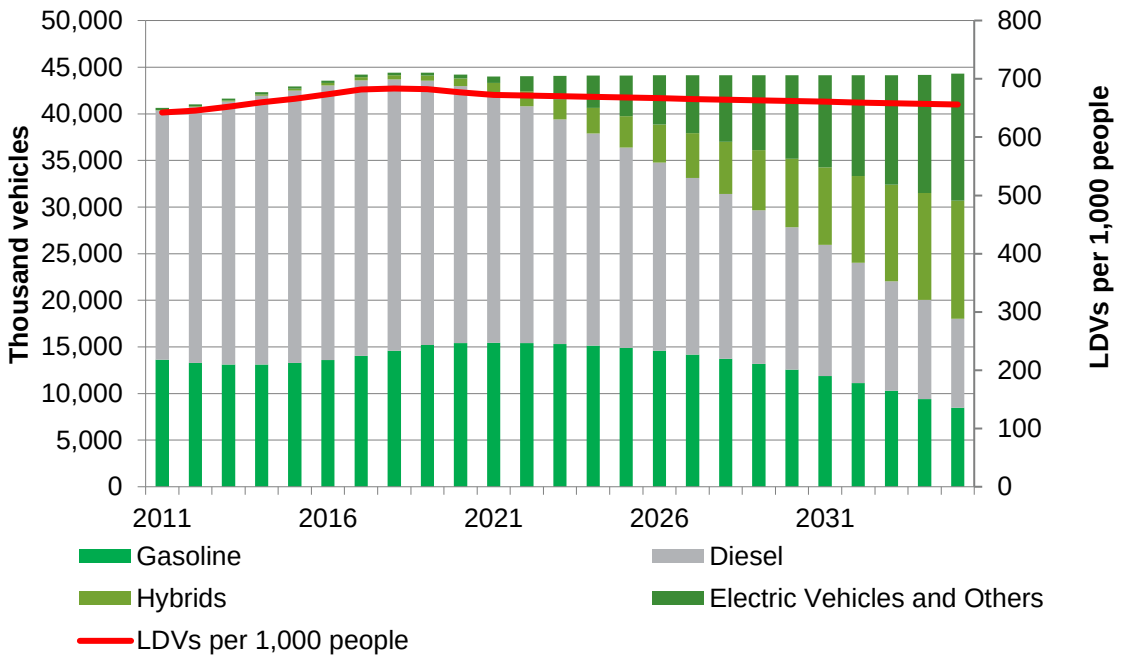
- Achievement of targets in the scenario are in accordance with the “Programmation Pluriannuelle de l’Energie” and harmonization with the “Strategie Nationale Bas Carbone” and then extrapolated to meet F55 targets

Key demand drivers outlook

LDV (Light Duty Vehicle) Outlook – Evolution and key assumptions

1. Total parc is forecasted in line with population and recent vehicle parc evolution
2. ICE 2035 new sales ban is the key assumption for gasoline and diesel fleet car forecast
3. Alternative fleet penetration is based on European Green rules fleet outlook and recent sales trend in France

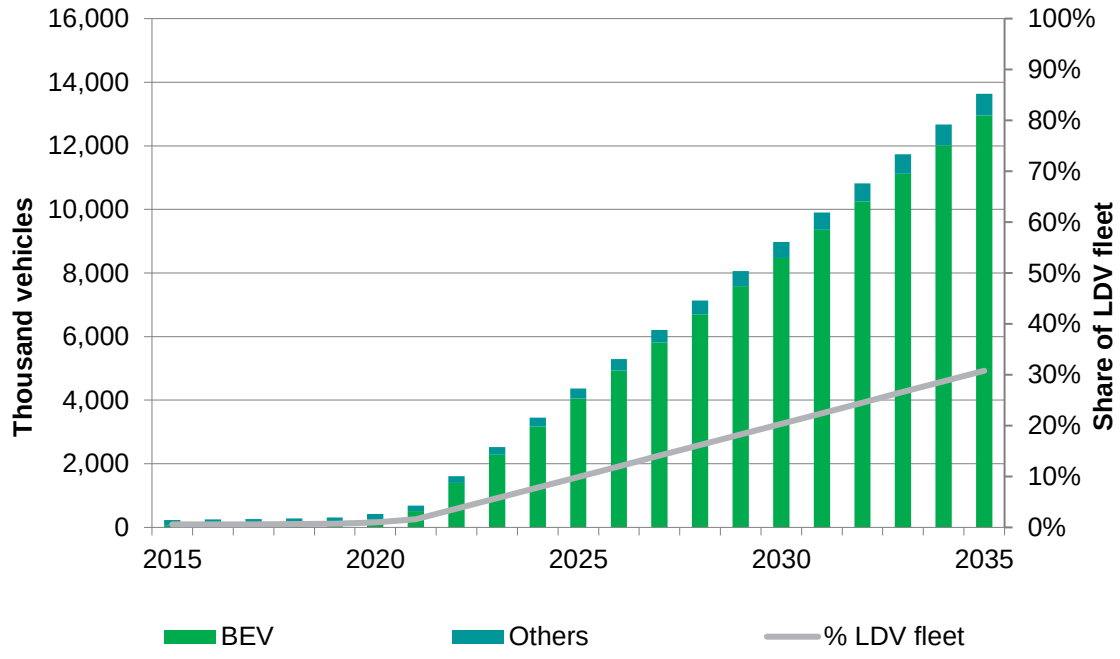
France light duty vehicle (LDV) outlook - Fit for 55 Target



Notes: LDVs are vehicles ≤ 8,500 lbs (~3,856 kg). "Alternative Fuel Fleet" LDVs include LPG, CNG, HEV-Gasoline, HEV-Diesel, PHEV and BEV. Others include CNG and Hydrogen LDV's

Source: IHS Markit

France – Electric vehicles and others outlook – Fit for 55 Target



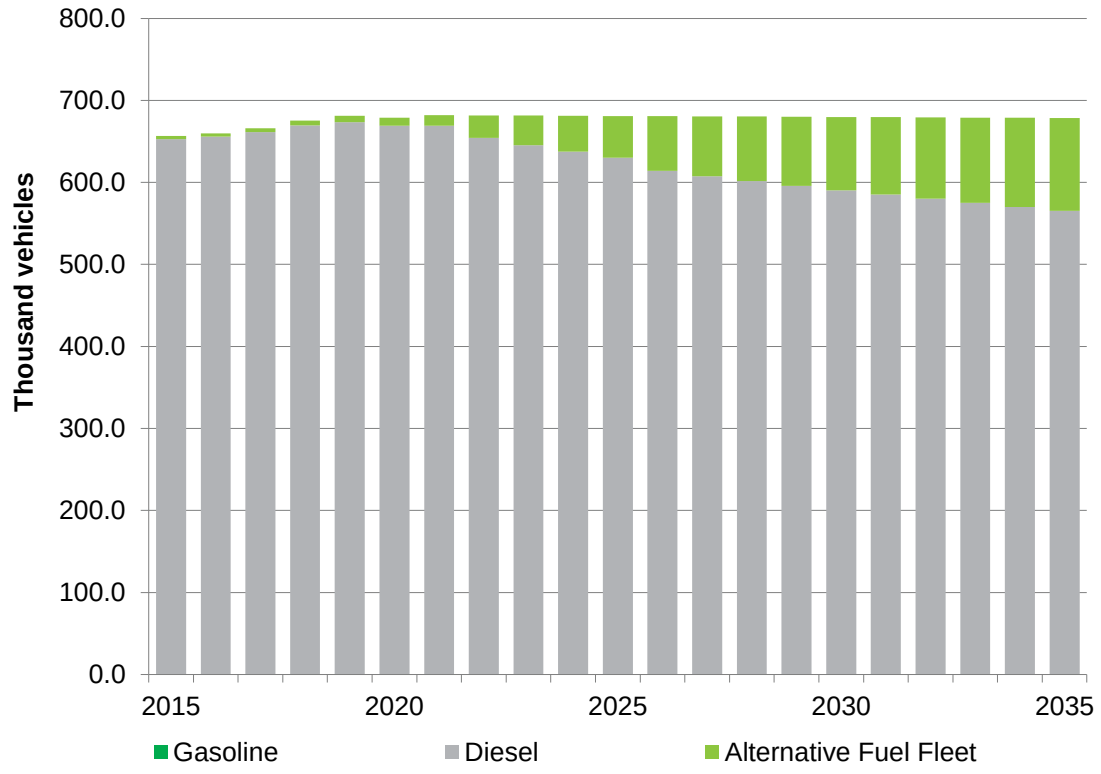
Notes: LDVs are vehicles ≤ 8,500 lbs (~3,856 kg). "Others" include LPG, CNG-LNG and FCEV LDV's

Source: IHS Markit

HDV (Heavy Duty Vehicle) outlook - evolution and key assumptions

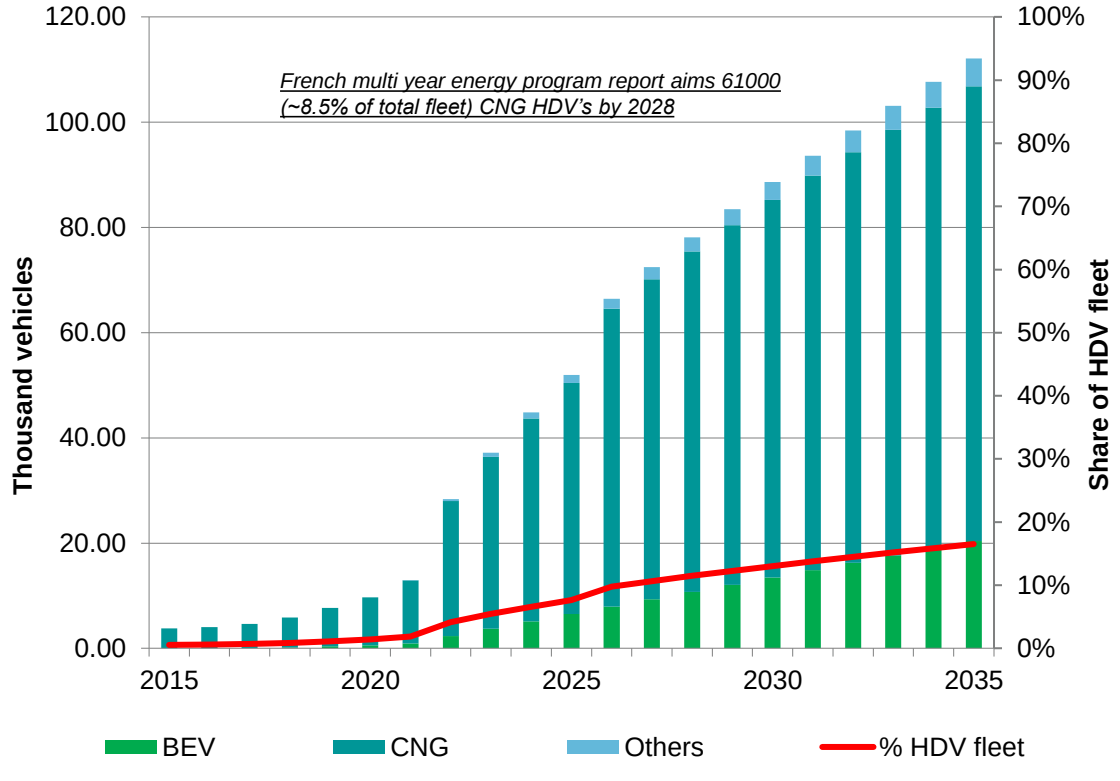
1. Alternative Fleet targets (BEV's and CNG) aligned with the French multi year energy program report

France Heavy Duty vehicle (HDV) Outlook: Fit for 55 Target



Notes: HDVs are vehicles ≤ 8,500 lbs (~3,856 kg). "Alternative Fuel" HDVs include CNG-LNG, Hybrids, FCEV and BEV.
Source: IHS Markit

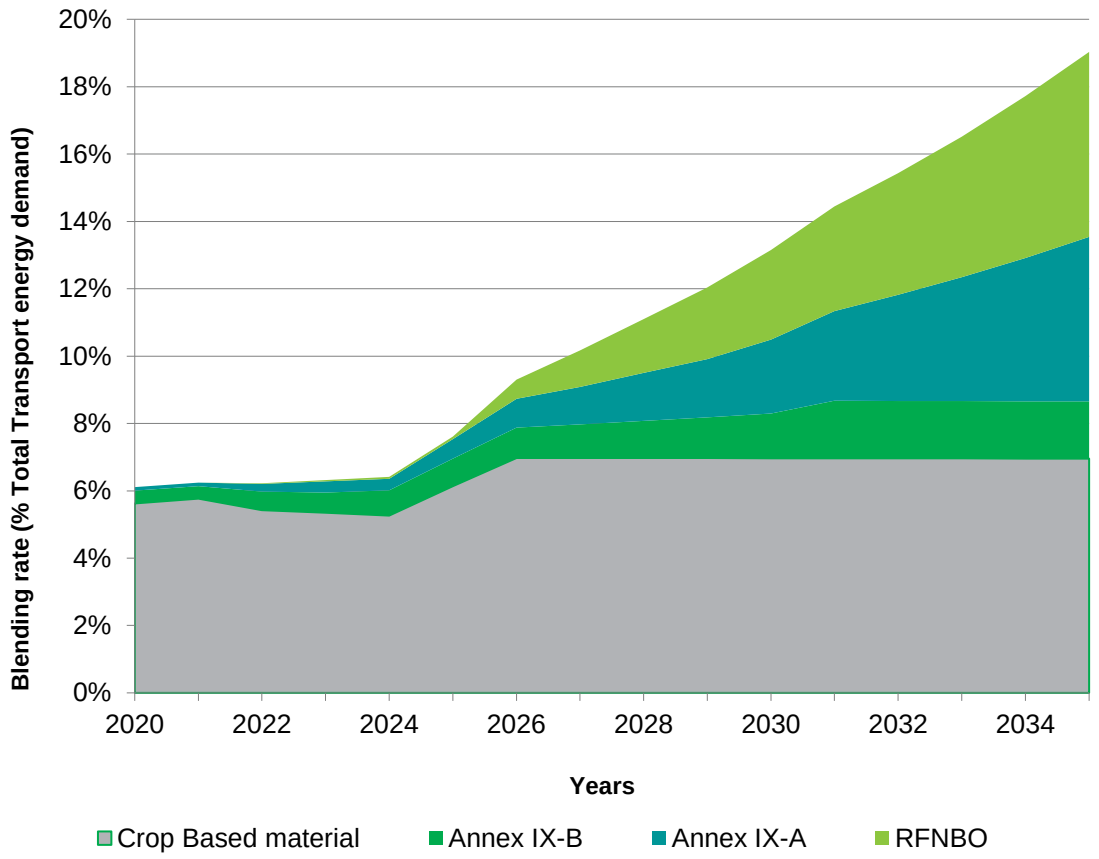
France: Non-dedicated gasoline and diesel HDV fleet outlook – Fit for 55 Target



Notes: HDVs are vehicles ≤ 8,500 lbs (~3,856 kg). "Others" include hybrid and fuel cell powered vehicles
Source: IHS Markit

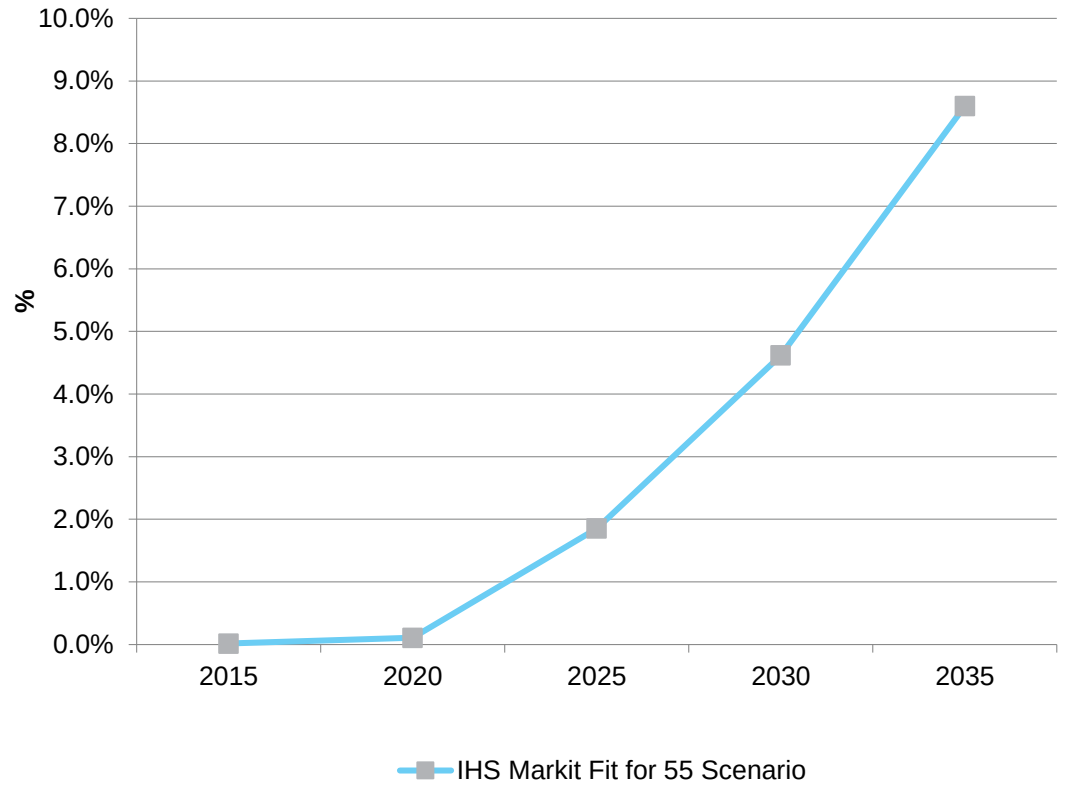
From RED II to Fit for 55, new targets will require high fossil fuels substitution in transport - low carbon fuels content x3 and power to reach 9%

France - F55 Scenario - Low carbon fuels blending rate outlook



Note: Transport sector includes Road, Rail, Aviation and Maritime sectors.
Reported blending rate in physical quantities (multipliers excluded).

Electricity Penetration in Transport



Excludes Maritime and Air Transport
Source: SDES & IHS Markit

Conventional fuels: demand and supply outlook

Conventional fuels expected to gradually decline and crude runs to also decline at lower pace. A reduction in net import requirements is anticipated

1. A decline in refined products demand is to be expected in a F55 target scenario
   - This includes primarily road transportation fuels notably diesel
   - Gasoline to decrease at a slowed rate compared with diesel
   - Jet fuel to only moderately decrease starting from the end of the decade
   - The Heating oil stationary sector is also expected to be impacted and demand to decline
   - Few exceptions are LPG and naphtha as feedstocks for the stable petrochemical industry, and bitumen

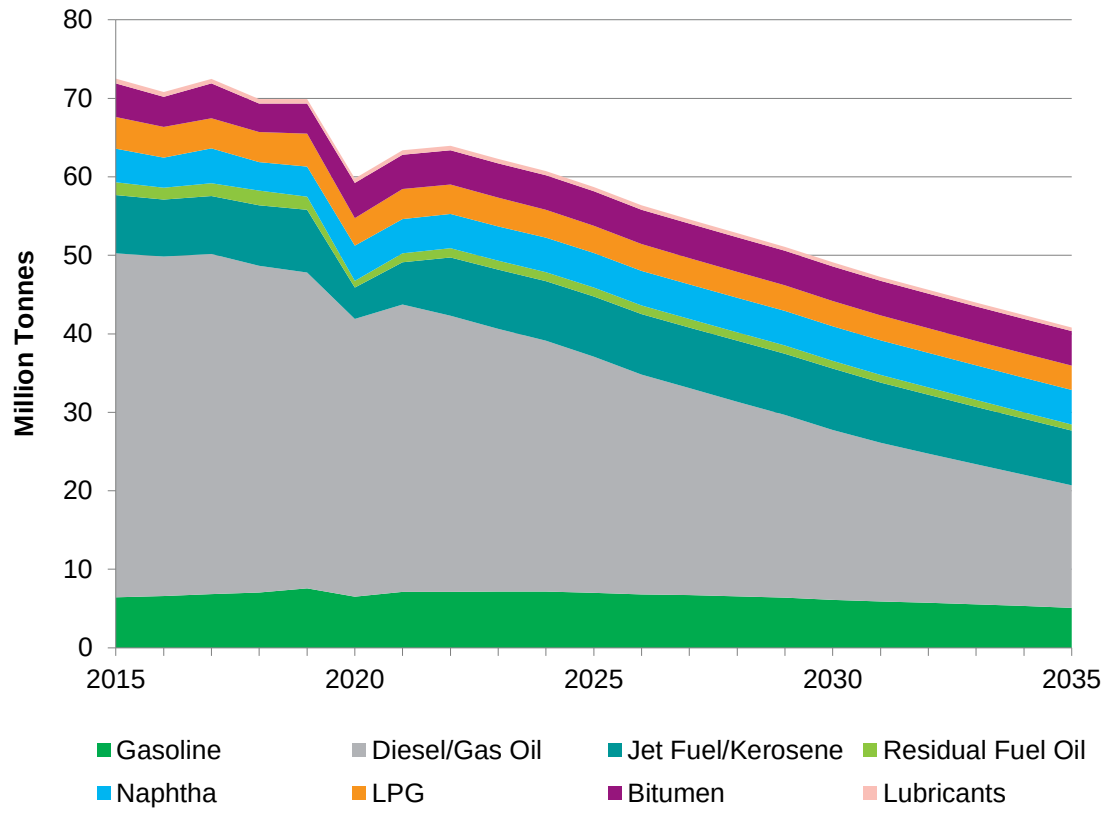
2. Crude runs are expected to decline in France over the next 15 years

3. The refined product demand ratio to gradually shift increasing gasoline vs distillates, would improve the French refineries capability to satisfy the local demand

4. On the net trade, a significant reduction in the net import requirements of diesel/gasoil is anticipated

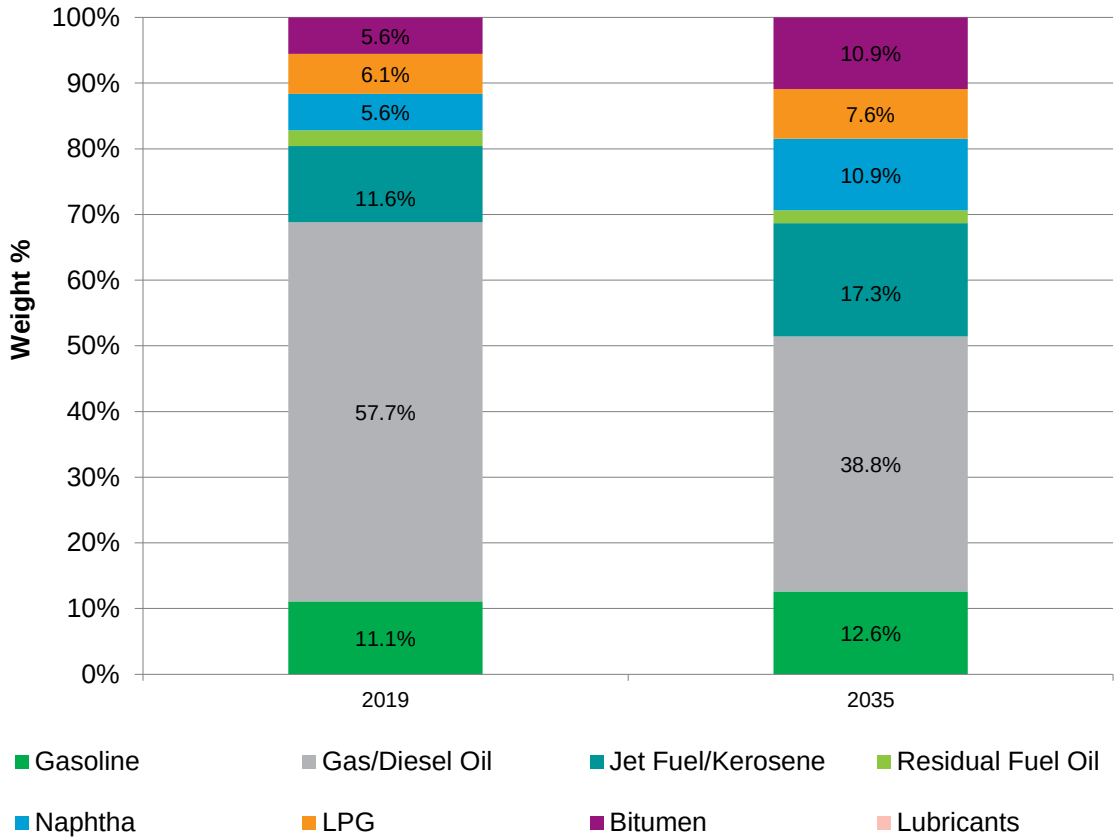
Refined products demand outlook – 40% overall decrease forecast over the next 13 years mainly impact diesel & gasoil demand

Refined Products Demand



Note: Excludes Biofuels
Source: IHS Markit

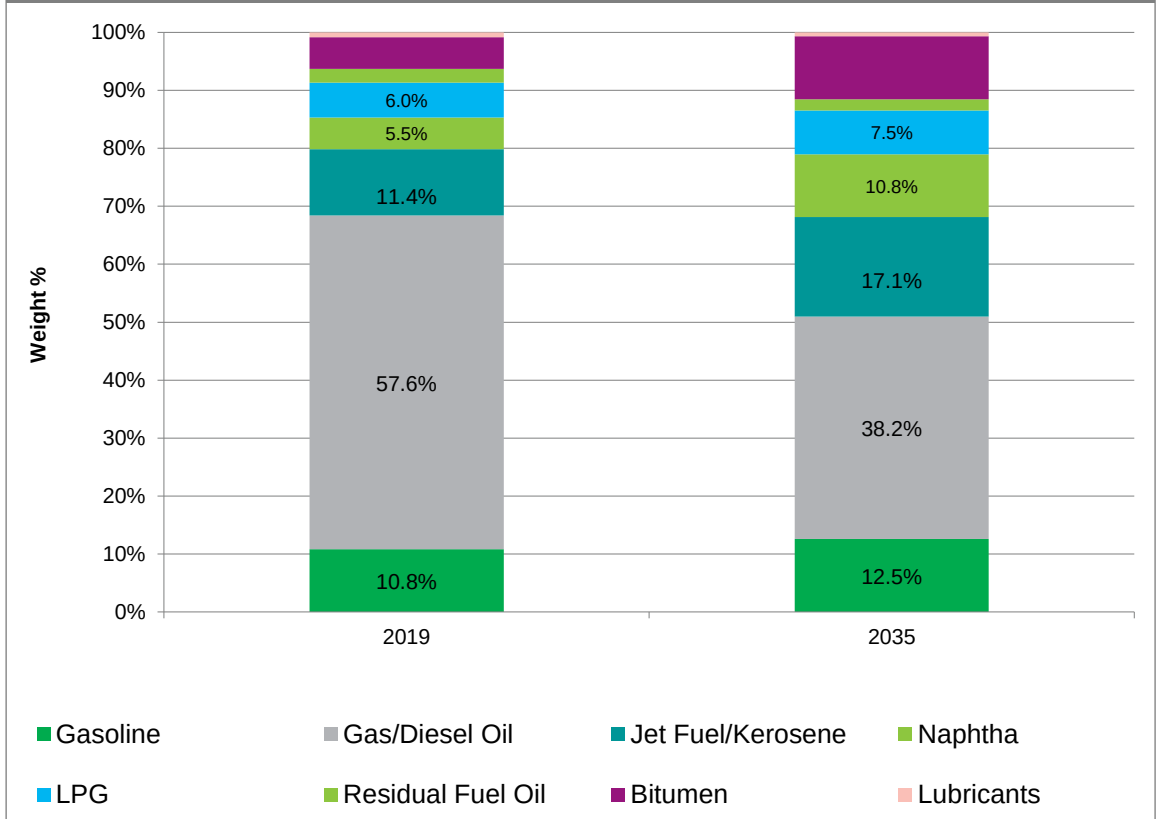
France Refined Products Demand Composition 2019-2035



Source: IHS Markit Forecast/ Historic Data from CPDP/Eurostat

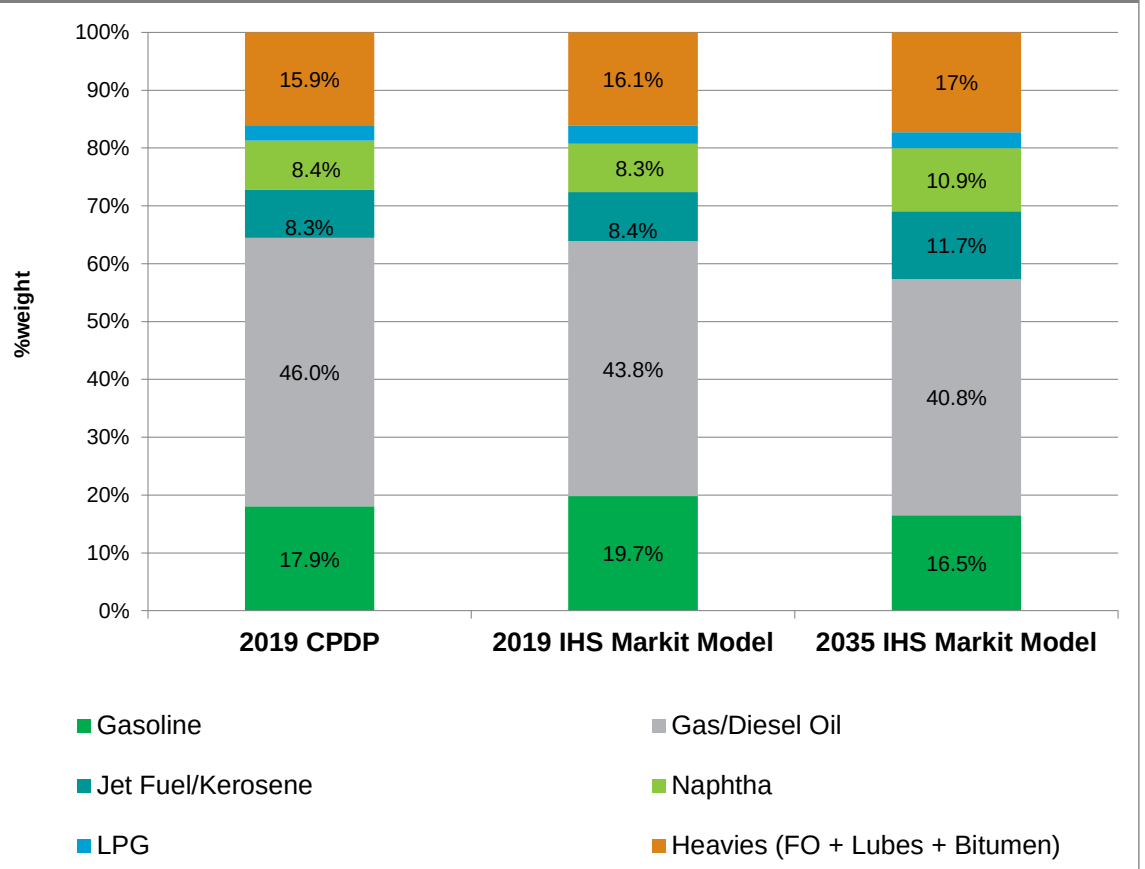
From 2019 to 2035, French demand mix getting more aligned with French supply, gaps remain on kerosene and LPG

France Refined Products Demand Composition 2019-2035



Source: IHS Markit Forecast/ Historic Data from CPDP/Eurostat

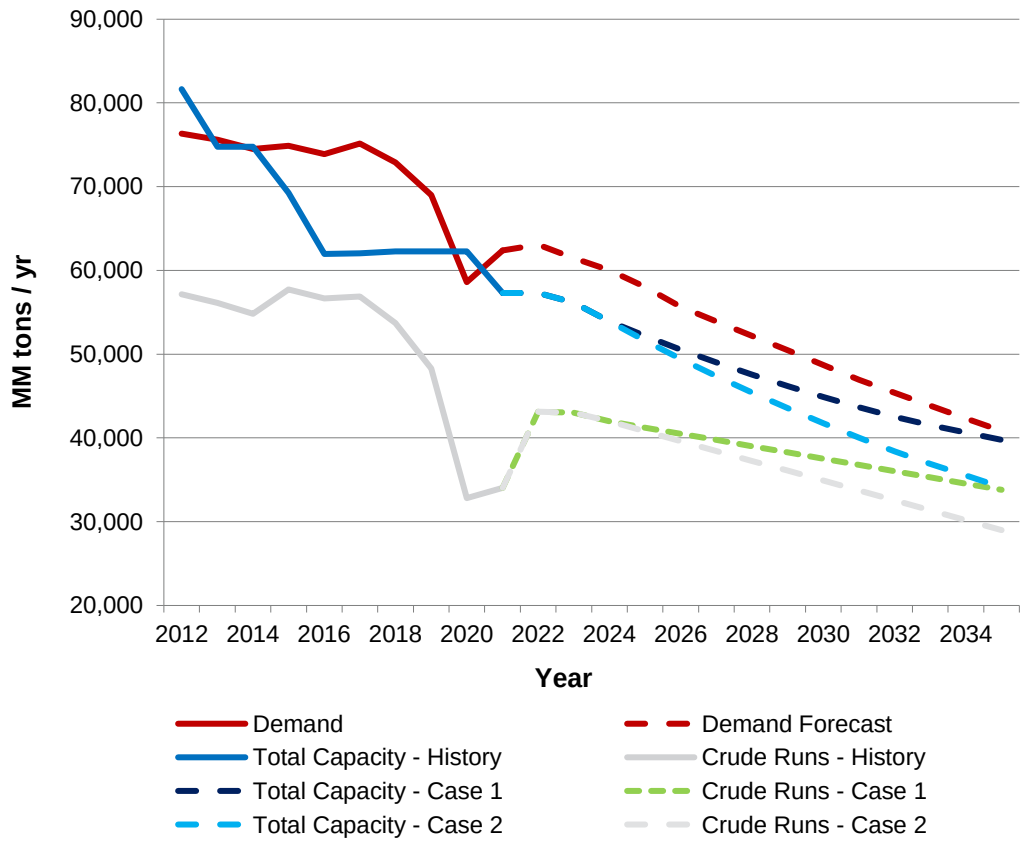
France Refinery Yields 2019-2035



Source: IHS Markit Forecast/ Historic Data from CPDP

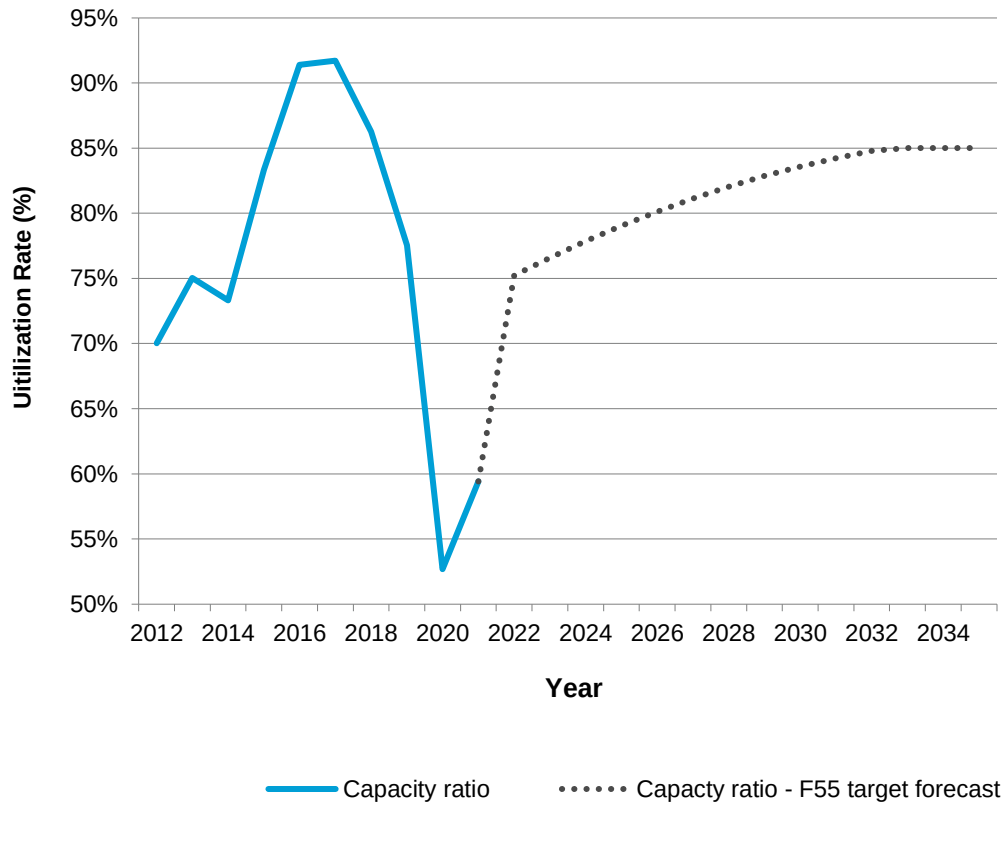
France – Crude runs forecast in a declining demand environment – Utilization rate to be maintained through rationalization (30 to 40% capacity reduction)

Refined product Demand vs Crude Runs - F55 Target Scenario



Source: IHS Markit

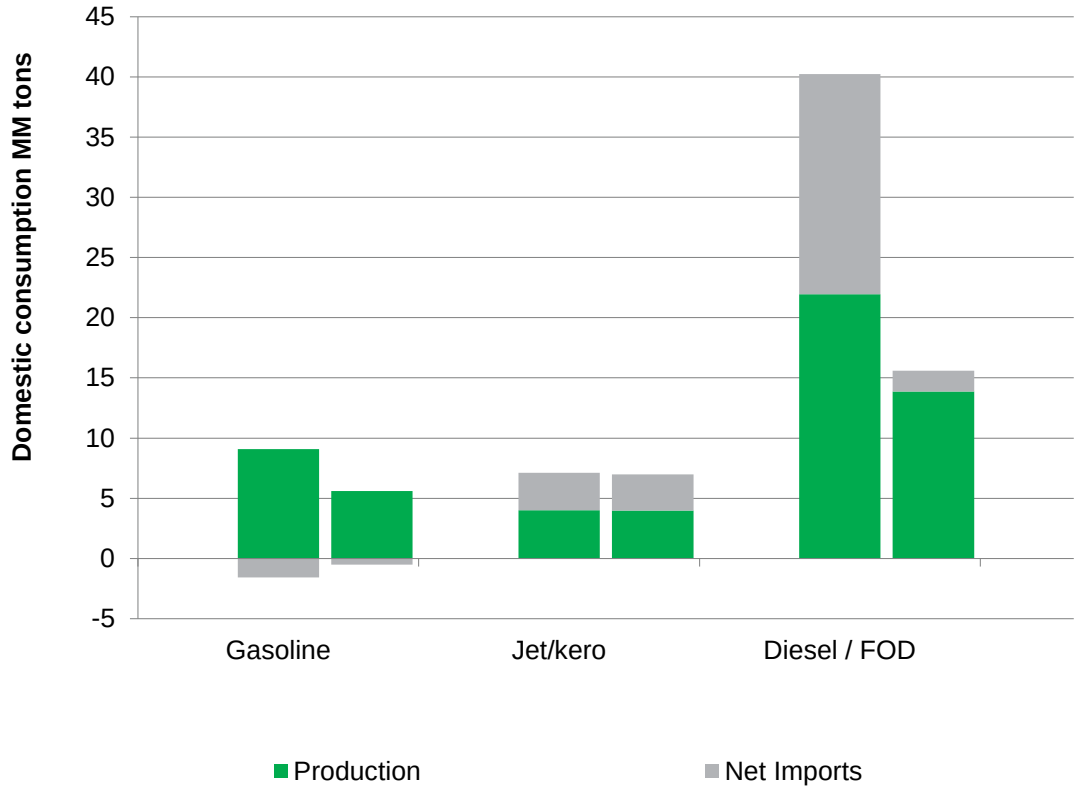
Utilization factor - F55 Target Scenario



Source: IHS Markit

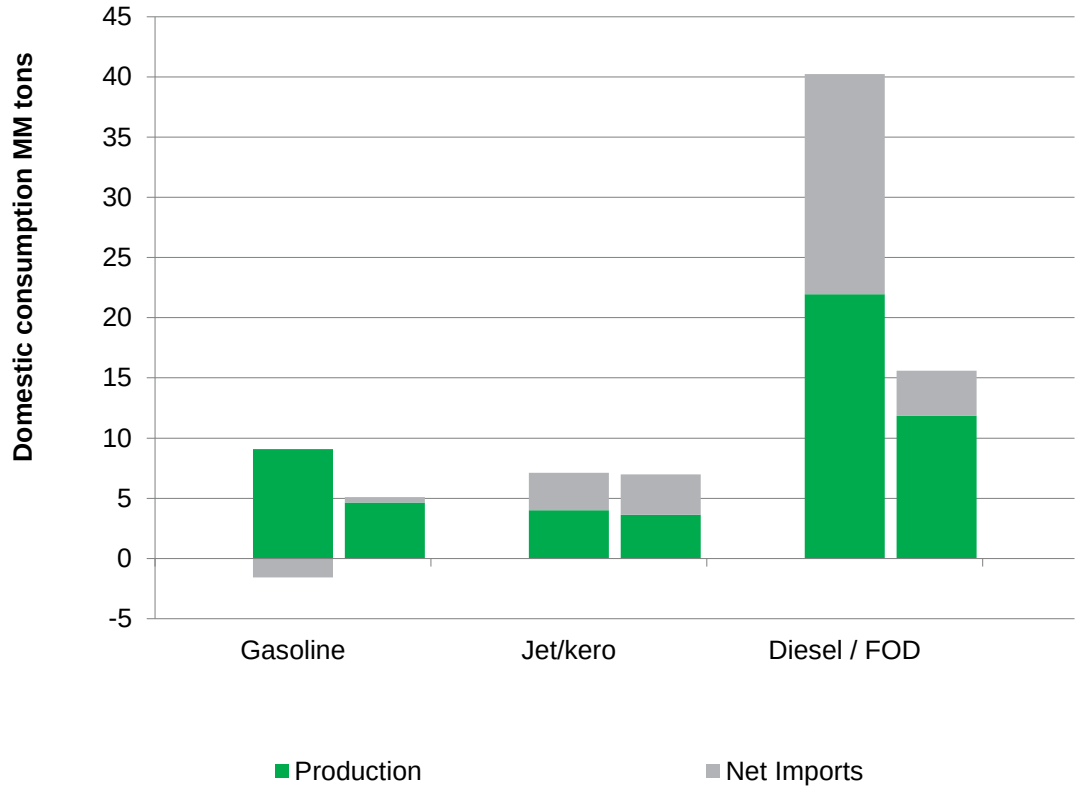
Product by product balance – balanced on gasoline / slight deficit on naphtha, net decrease of gasoil imports in both cases

France – Refined product demand – 2019 vs 2035 – Case 1



Source: IHS Markit

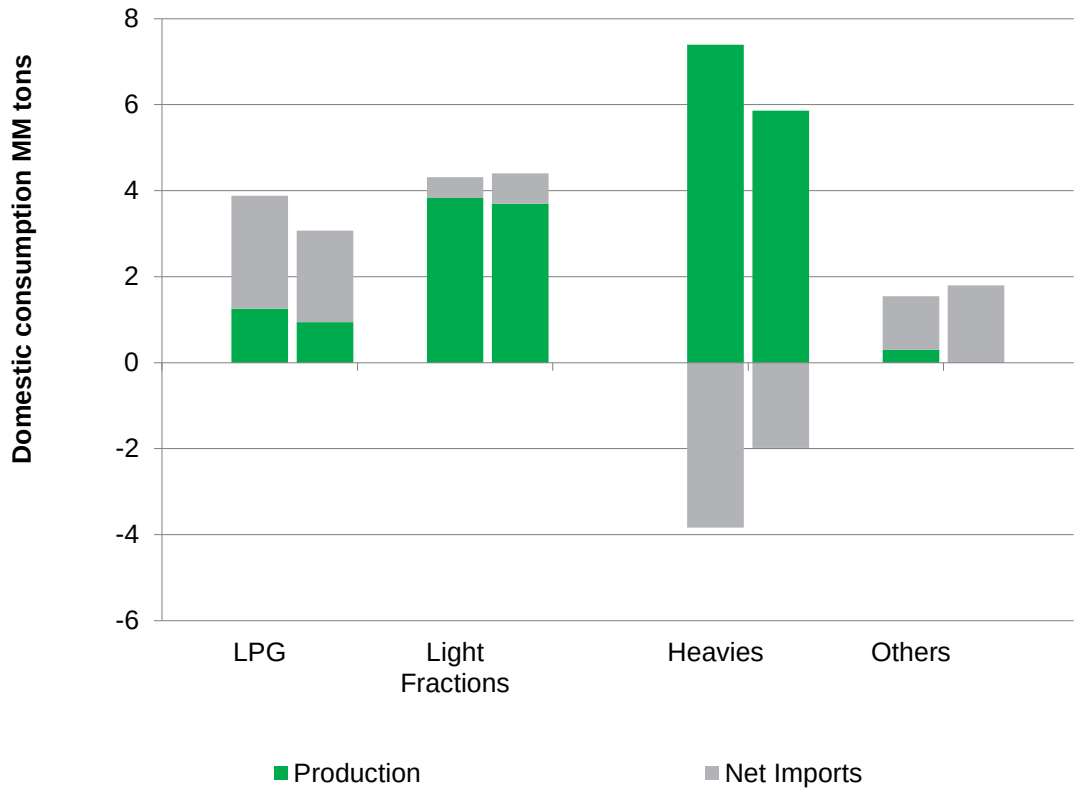
France – Refined product demand – 2019 vs 2035 – Case 2



Source: IHS Markit

Product by product balance – petrochemicals feedstocks (LPG and naphtha) to remain in deficit, higher in Case 2. Heavies exports to drop

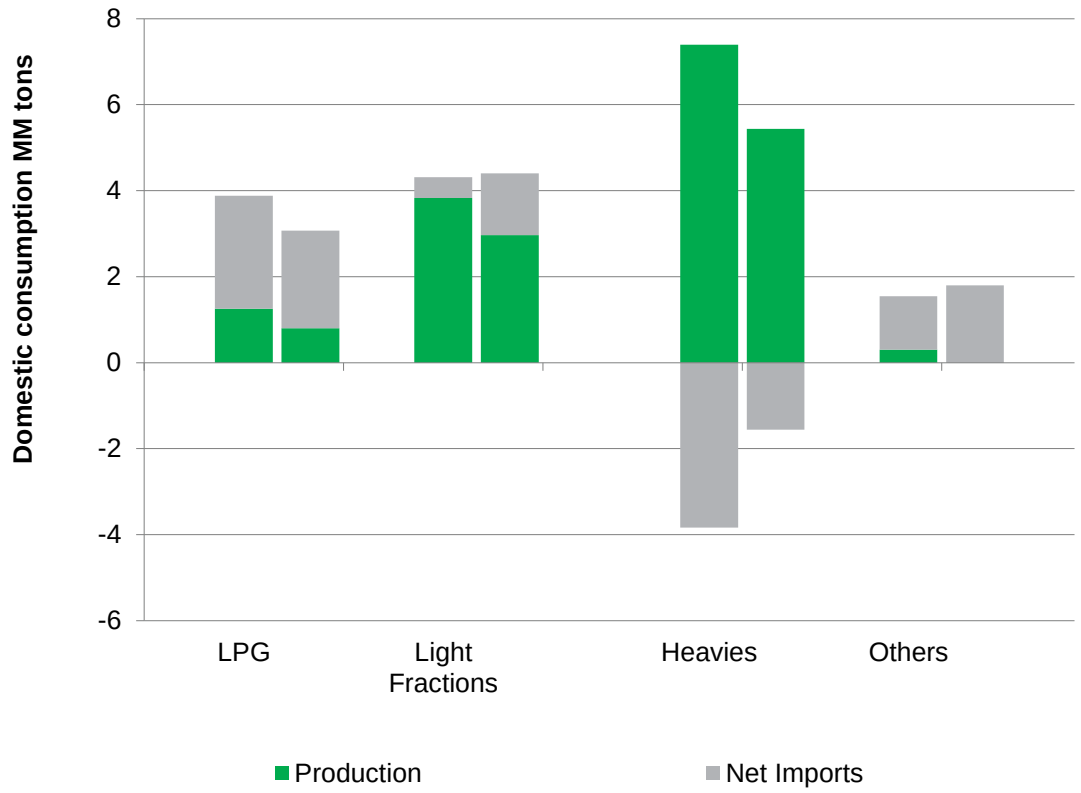
France – Refined product demand – 2019 vs 2035 – Case 1



Note: Heavies includes Bitumen, Fuel Oil and Lubricants

Source: IHS Markit

France – Refined product demand – 2019 vs 2035 – Case 2



Note: Heavies includes Bitumen, Fuel Oil and Lubricants

Source: IHS Markit

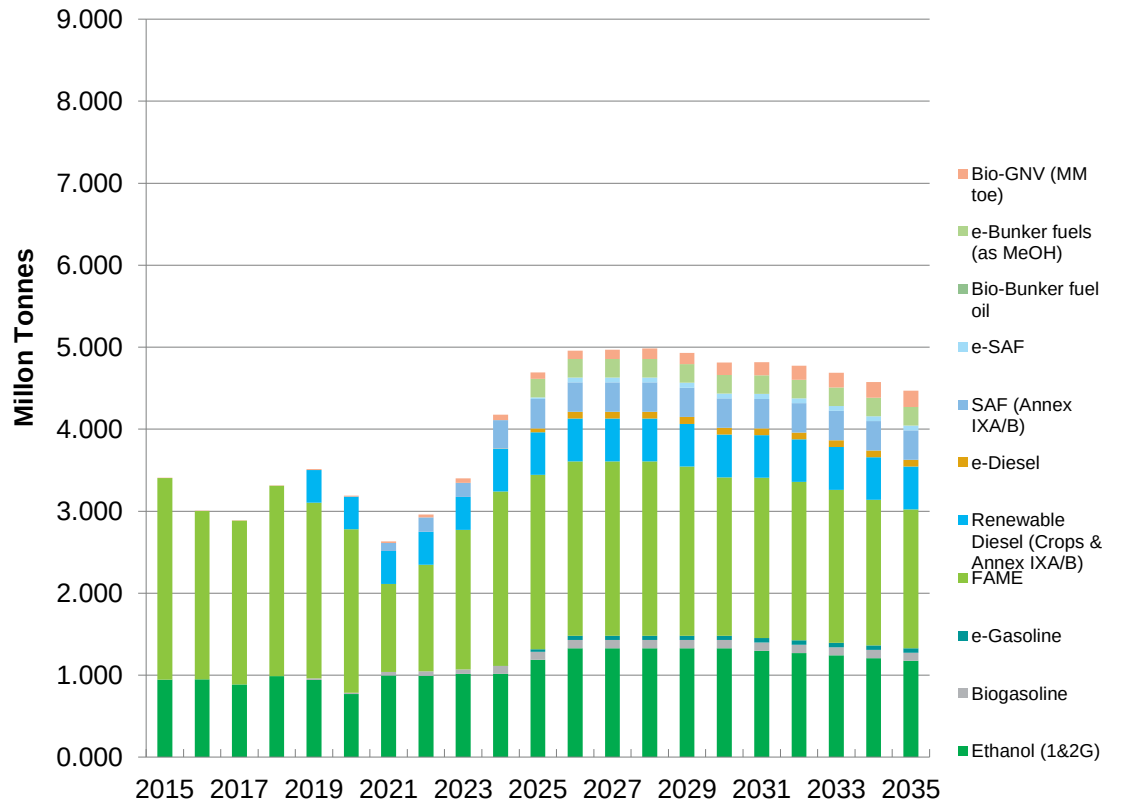
Low carbon fuels: demand and supply outlook with existing assets & announced projects

Low carbon fuels forecasted to face a supply deficit in absence of new investments, particularly Annex IX A, E-fuels / RFNBOs

1. Low carbon Fuels in France – Demand expected to double by 2035 while additional production capacities to increase by only 30% with announced projects
2. In absence of new investments other than the ones currently planned, the French energy sector will gradually be unable to match demand requirements
3. In the longer term, new production units or imports would be required to match the F55 requirements
4. In particular:
   - Annex IX A and Annex IX B SAF and renewable diesel would face significant deficit of supply
   - E-fuels or RFNBOs both on SAF and renewable diesel also would face significant deficit of supply
   - First and second generation Ethanol would be broadly balanced

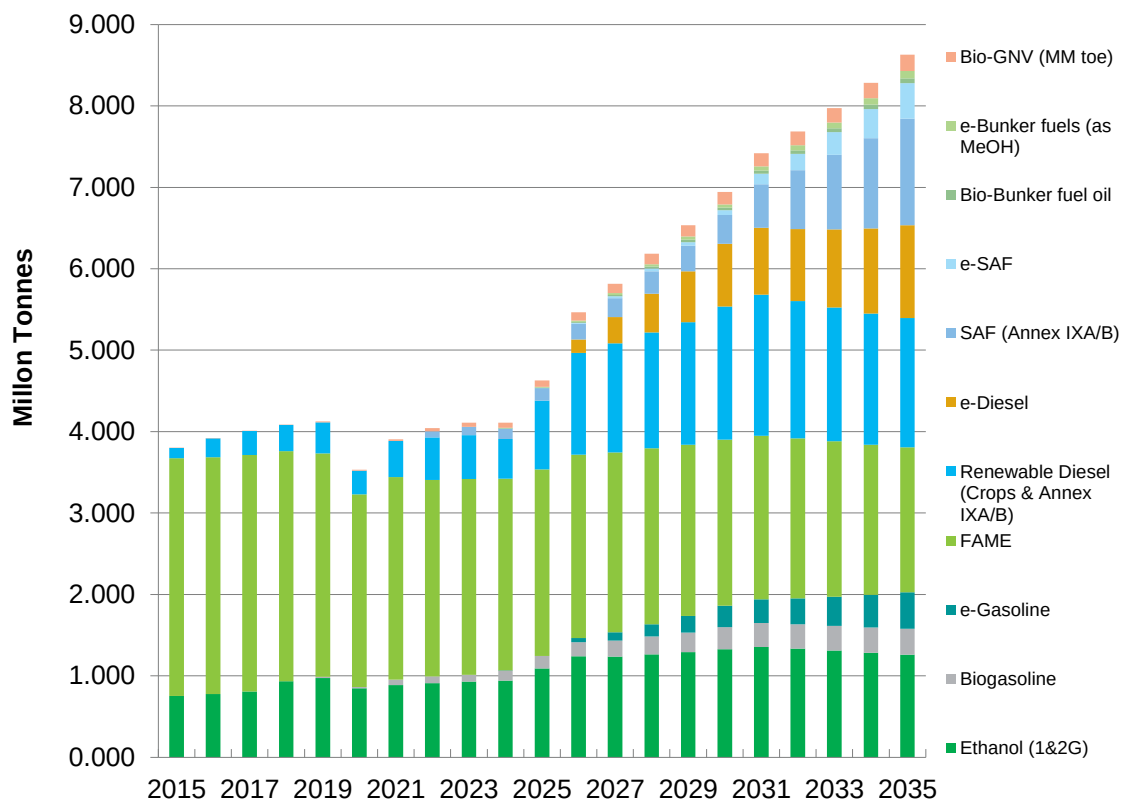
Low carbon fuels in France – demand to double by 2035 with F55 while production capacities to increase by only 30% with announced projects

Total biofuels & RFNBO Supply outlook



Notes: Considering existing units and publicly announced projects at the report date (June 2022)
Source: IHS Markit

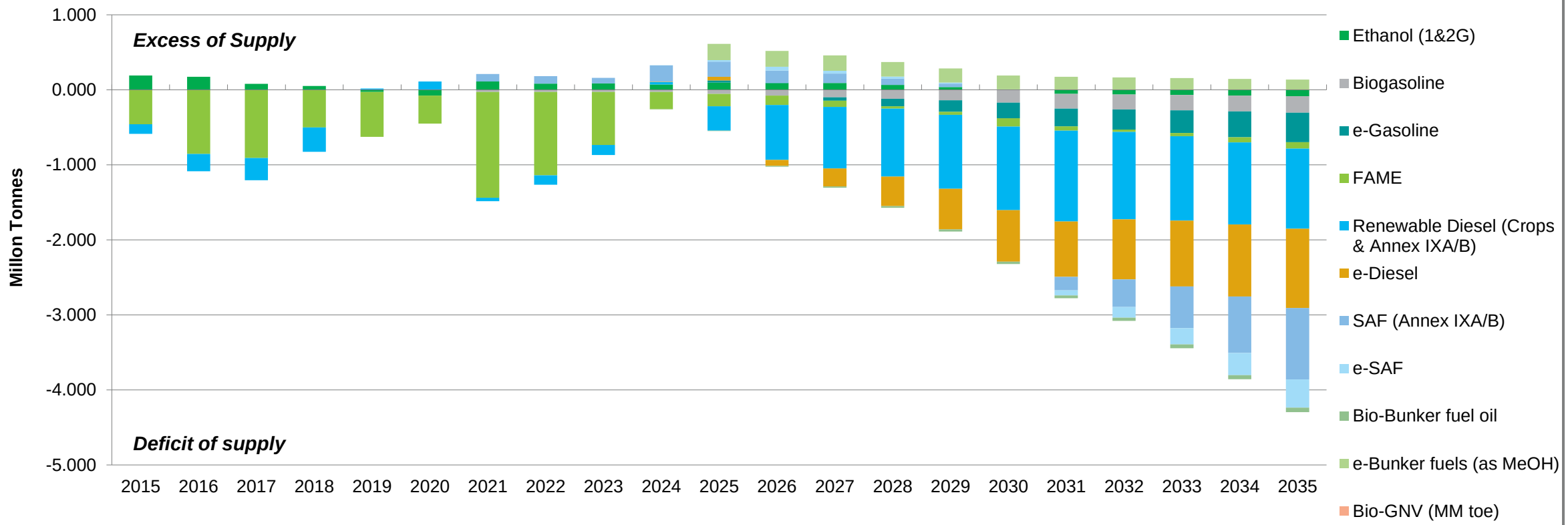
Total biofuels & RFNBO demand outlook - Based of F55 package targets



Notes:
Source: IHS Markit

Biofuels & RFNBO - new sources of supply required to meet F55 mandates

Total biofuels & RFNBO - Net trade outlook



Note: Considering existing units and publicly announced projects at the report date (June 2022) on the supply side.
Source: IHS Markit

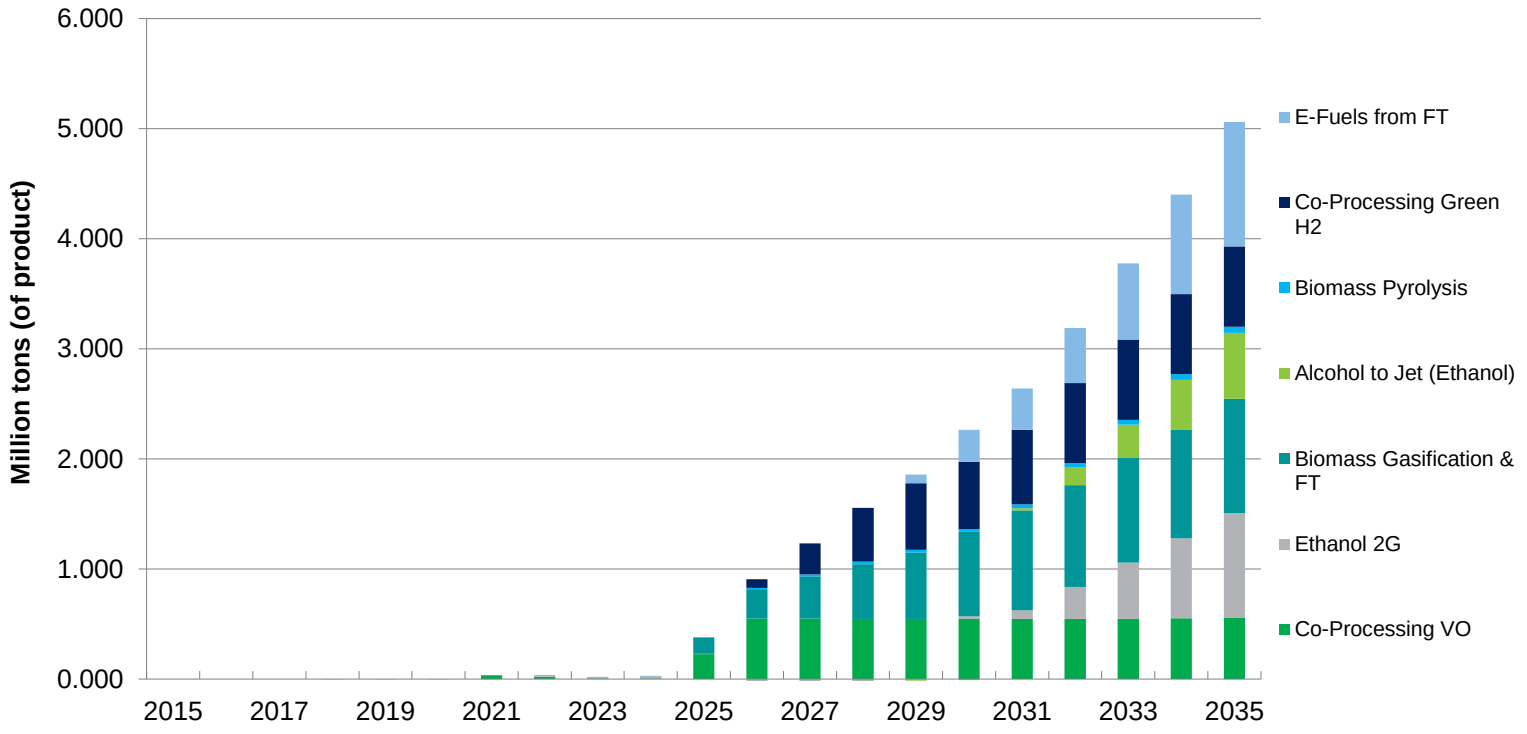
Low carbon fuels: review of new investments to decarbonize fuels

New investments – significant investments required in Annex IX-A and RFNBO fuels production

1. Existing capacities for FAME, Ethanol 1G are sufficient to cover for the targets under consideration for F55. No additional investments are required
2. The demand for renewable diesel based on crops or Annex-IX B feedstock can be mostly met with existing and announced capacities
   - The balance could be met by adding capacities via co-processing in the refineries
3. No new capacities for SAF from HEFA pathway (HVO units) are assumed to come onstream in our forecast as current and expected plants would be able to serve demand until 2030.
   - Feedstock for these units will be increasingly difficult to find
4. Mandates on Annex IX-A and RFNBO fuels are the most impacting drivers of the biofuels demand growth. Therefore, most of the new investments shall be dedicated to the production of these fuels.
   - Co-production of Annex IX-A and RFNBO could be possible in case of Fischer-Tropsch synthesis pathways
   - Green H2 use potential in refineries could reach up to 40% of the total RFNBO production by 2035
5. The expected change in demand with an increasing share of SAF and a declining share of conventional fuels such as diesel & gasoline will also require new technologies – such as the Alcohol to Jet pathway - to achieve the required yields

Biofuels & RFNBO – projects required to meet the F55 targets – about 5 million tons of additional capacities will be needed

New projects profile to meet F55 targets



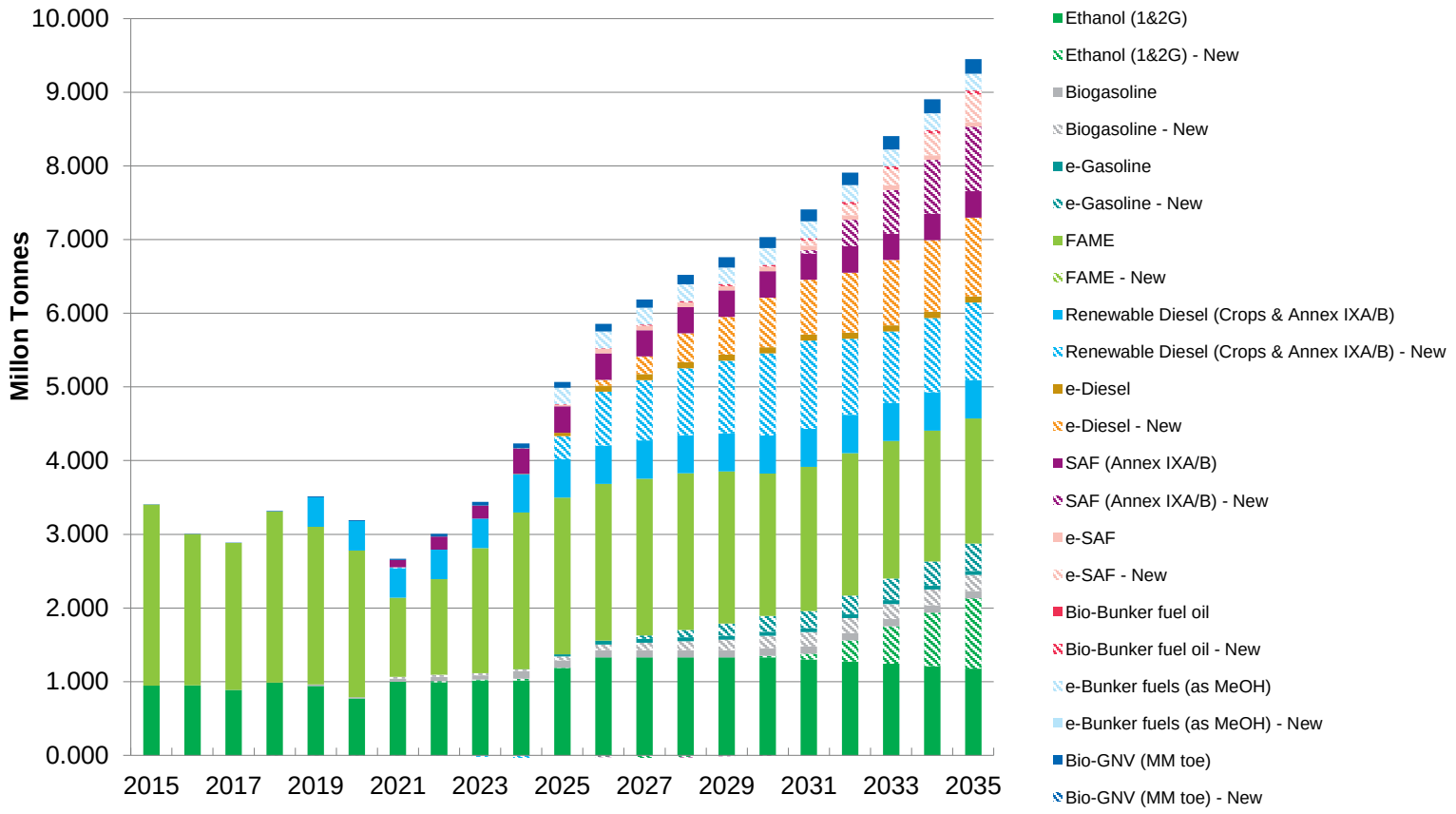
Notes: 1) Biomass Gasification & FT = Annex IX-A Fuels produced by reaction of carbon monoxide (CO) and H2 originated from Biomass
2) E-fuels from FT: produced by renewable hydrogen (from renewable power) and CO2 (converted into CO by reaction with H2)

Source: IHS Markit

- The project profile is shown based on product production capacity
- New production capacity of Ethanol 2G is foreseen to produce the feedstock to the Alcohol-to-jet unit included in the outlook.
- Vegetable Oil co-processing is based on maximum of 2% average VO co-processing in the French refineries hydrotreatment units – sufficient to cover the demand.
- Green H2 used as an intermediate product for co-processing is assuming that the full H2 needs in refineries could be covered with Green H2 to maximize RFNBO production. Product capacity for Green H2 co-processing is expressed in MM tons of Fischer-Tropsch equivalent product.
- Synergies between Annex IX-A fuel production and E-fuels: Annex IX-A fuels and e-Fuels can be by Fischer-Tropsch synthesis. Consequently, it is possible to combine in a project based on FT technology the production of Annex IX-A fuels and e-Fuels. Such combination offers attractive potential yield optimization and also would allow to increase the production potential and decrease the production cost by scale effect.

Biofuels & RFNBO – biofuels supply from existing and new projects units – new projects to be focused on advanced biofuels and e-Fuels

Total biofuels & RFNBO Supply outlook - Current/annouced units and new projects included

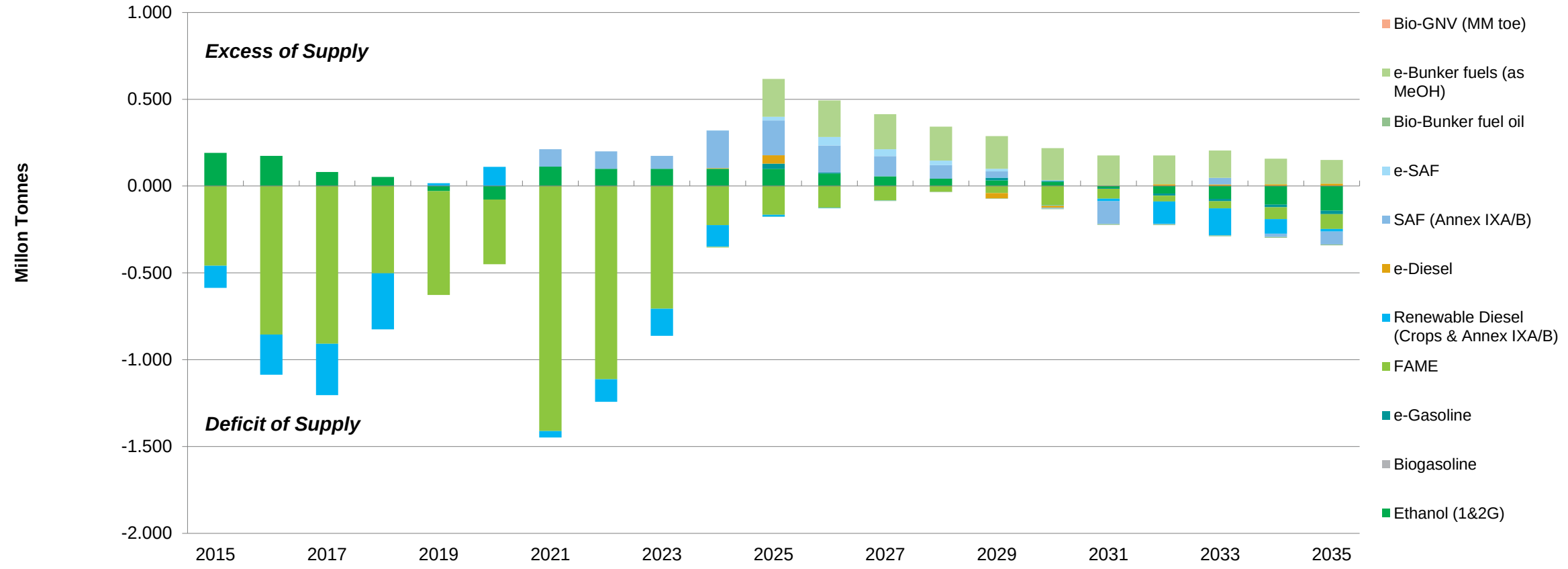


Notes:
Source: IHS Markit

- New bio & e-gasoline: No dedicated units are foreseen to ensure this new production, additional production comes as by-products of the distillates production
- Renewable Diesel (Crops & Annex IXA/B):
  - Needs for RD crops or Annex IX-B based is expected to be met by vegetable oil co-processing.
  - Needs for RD Annex IX-A based is expected to be met by biomass gasification or by-production from Alcohol to jet units. First units would be FT based in order to switch from RD to SAF over the period. HEFA pathway has not been considered for Annex IX-A as no feedstock (POME or Tall Oil) could be sourced of eligible in France.
- SAF (Annex IXA/B):
  - Annex IX-B: No additional capacity is included in the forecast as sector will be limited by feedstock supply. Annex IX-B SAF demand will be satisfied by existing facilities and import.
  - Annex IX-A: Extra supply would be provided by a mixture of Biomass gasification / FT and Alcohol to Jet plants using local biomass.
- RFNBO & E-fuels: Additional production will come from the co-processing opportunities and the FT synthesis plant.

Biofuels & RFNBO – supporting new investments allows to meet the increasing French clean fuels demand reducing the need for imports

Total biofuels & RFNBO - Net trade outlook - Existing / announced unit and New project included



Notes:
Source: IHS Markit

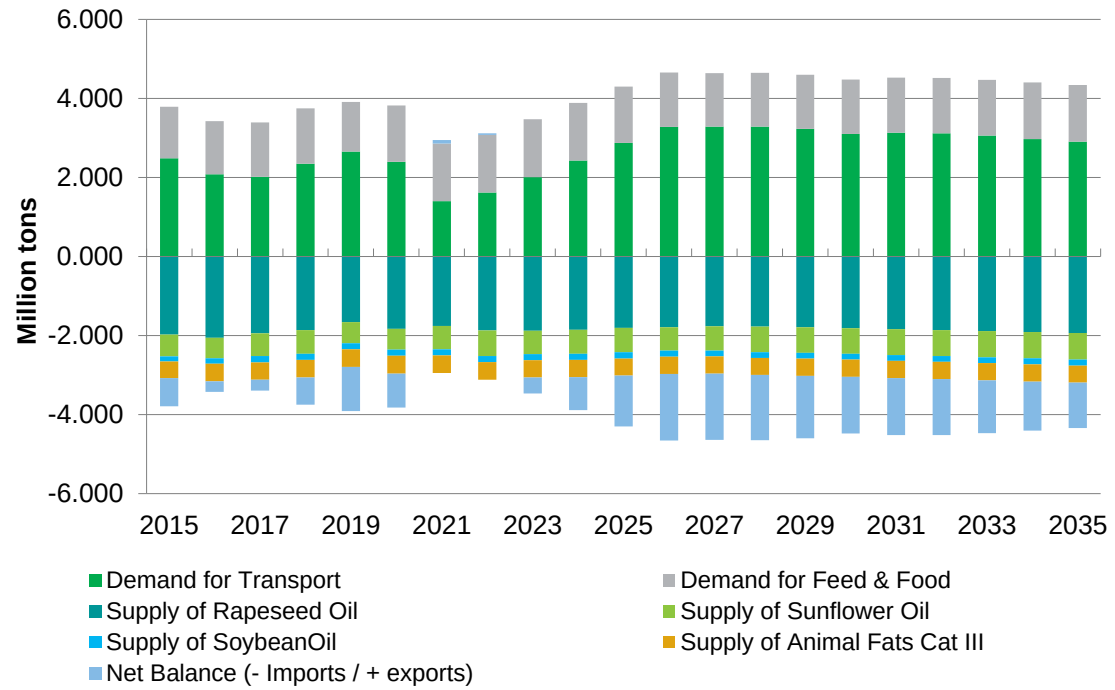
Low carbon fuels: feedstock availability overview

Feedstock availability – achieving F55 targets will put pressure on resources, increase competition between gaseous and liquids fuels and for power renewables use

1. France deficit of vegetable oil and waste oil is expected to increase over the period (assuming a preference for biofuels locally produced).
2. Annex-IX A feedstock (residues) are potential largely available in France.
   - The expected steep growth in biogas (as per governmental ambitious) and the new needs for liquid biofuel may generate tightness in feedstock and require an increased mobilization of the biomass
3. Green H2 production will have to reach 1.6 millions tons / year to meet the RFNBO ambitious targets.
   - If produced from Electrolyzers, this would consume nearly 80 TWh by 2035, equivalent to 25% of the renewable power produced in France or 12% of the total power production by 2035.

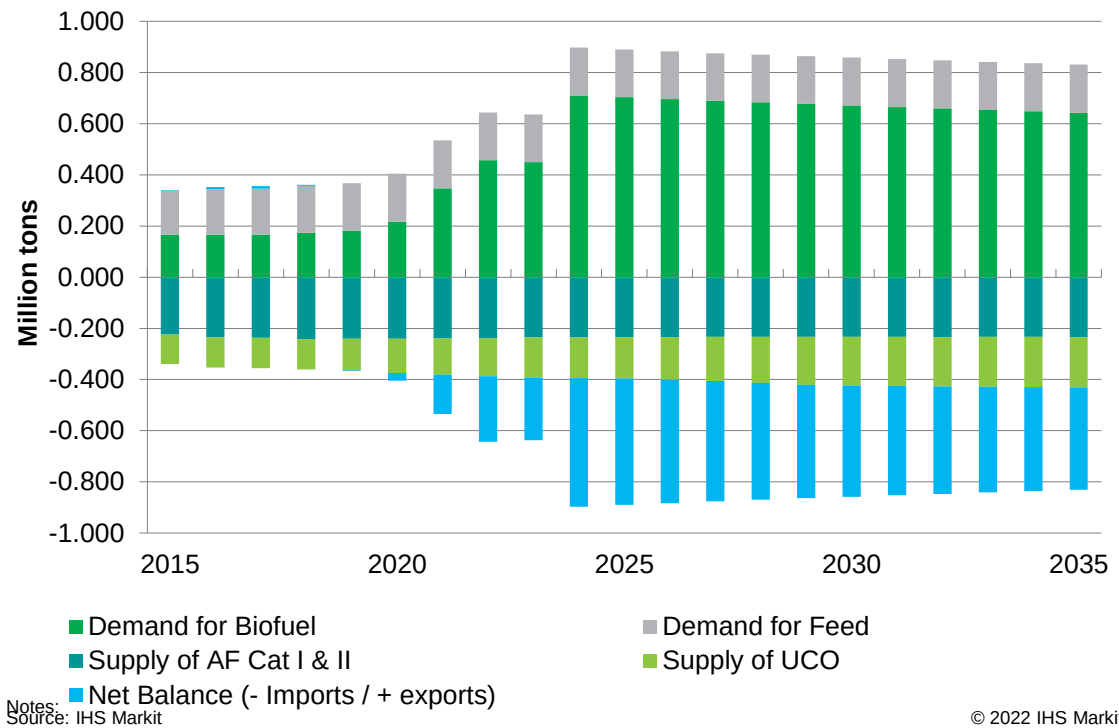
Feedstock required & available in France to reach the F55 package caps on crops and waste oils – vegetable oil & waste oil expected to be in deficit

Total Vegetable Oil feedstock Demand and availability



Notes:
Source: IHS Markit

Total Waste Oil feedstock (Annex IX-B) - Demand and availability

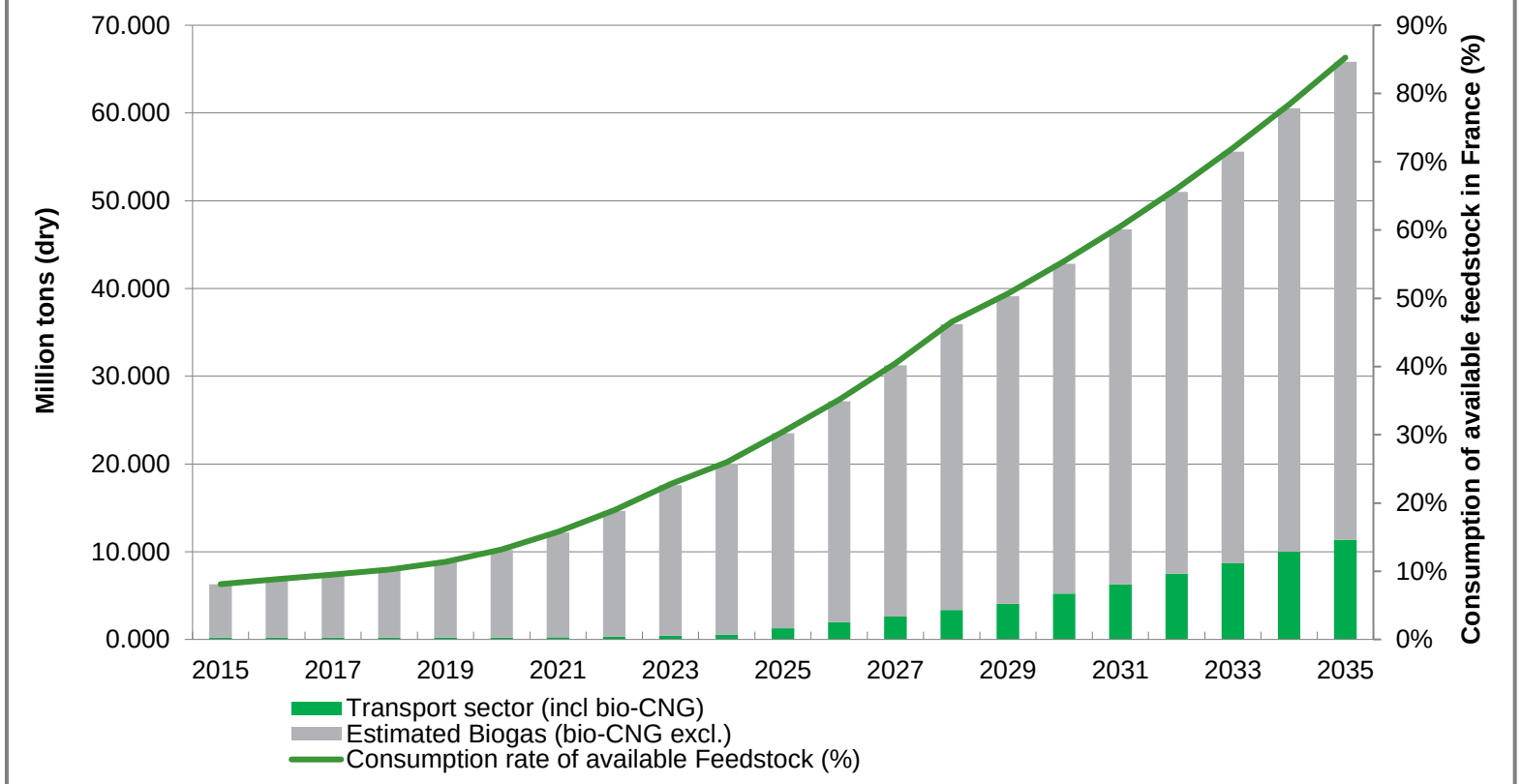


Notes:
Source: IHS Markit

- Vegetable Oil Feedstock availability: High blending rate of crop based biofuels in diesel is consuming most of the resource available in France and lead to either a net import position of France for vegetable Oil or of Biodiesel / renewable diesel.
- Waste Oil: For the SAF, 100% of the French SAF production from HEFA (i.e. 345 KTA from 2024 onwards), has been considered using Waste & Residue feedstock RED compliant, Annex IX-B SAF. For the renewable diesel / biodiesel, 100% of the French demand for Annex IX-B RD/biodiesel has been considered met by French production. In total, biofuels from waste & Residue from Annex IX-B (SAF, Biodiesel / RD and biogasoline) reach 1.7% total energy in the transportation sector (cap specified in the European regulation) in 2031 (with some imports).

Annex IXA feedstocks – feedstock required & available in France to meet F55 targets – High utilization rate expected mainly driven by Biogas, effort on biomass mobilization will be required to meet all the targets

Total Annex IX-A feedstock Demand and consumption rate of available feedstock

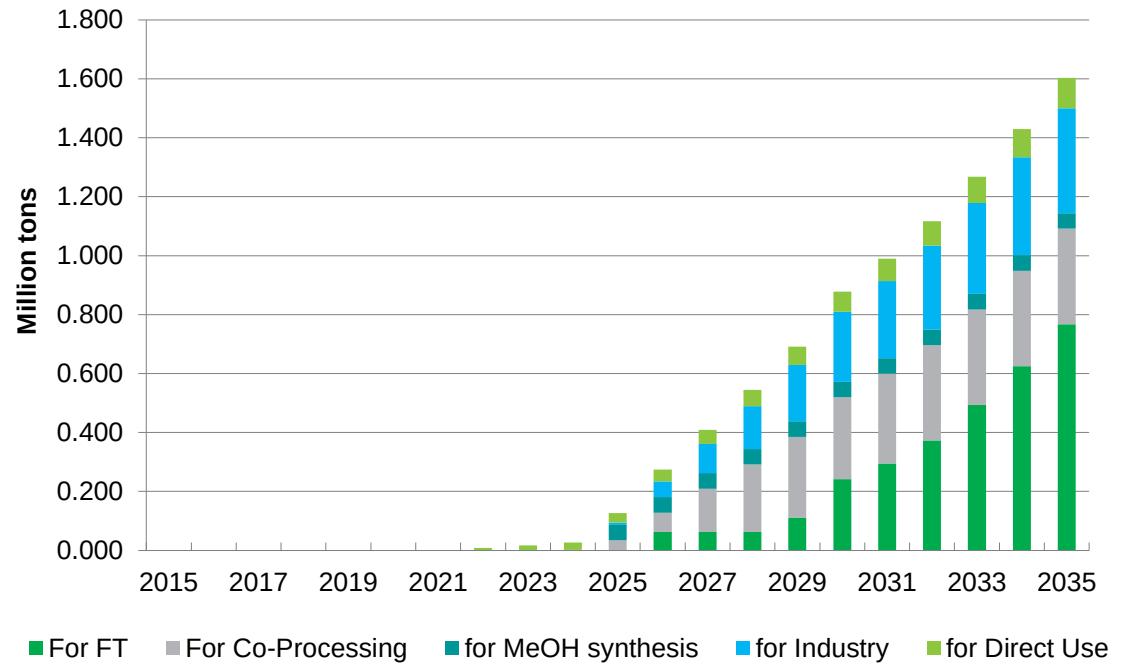


Notes: Total Annex IX-A feedstock supply dedicated for energy - Source: Concawe Report
Source: IHS Markit and Concawe Report

- Feedstock availability: based on the Low mobilization scenario defined in the Concawe report. As per this report, a total of 77.2 millions tons of dry feedstock would be available for France in 2030 in this low mobilization scenario and the availability could increase up to 132.7 millions tons of dry feedstock in the high mobilization scenario.
- Biomass required by the mandate of the transport sector is limited compared to the French potential.
- Estimation of biomass required for the Biogas production is indicative and based on the biogas outlook provided after.

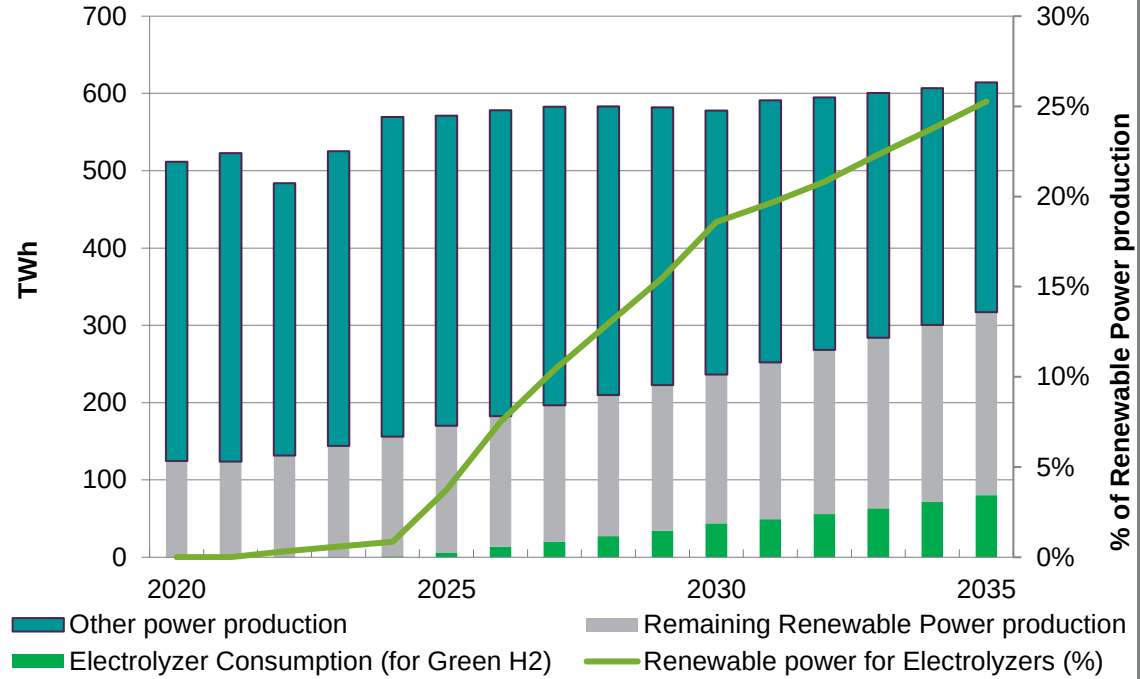
Feedstock required & available in France to meet F55 targets on RFNBO – high demand for green hydrogen

France - Green hydrogen demand outlook



Notes:
Source: IHS Markit

France total power production & Green H2 consumption outlook



Notes:
Source: IHS Markit

- Demand for Green hydrogen will significantly grow from 2025 onwards to achieve the RFNBO target in the transportation and in the industry sectors. Green H2 for co-processing (in refineries) has been maximized as it is considered to be the most economical way to produce RFNBO for transportation. By 2032, all the refinery H2 needs (on-purpose and unavoidable by-product) are met with Green H2, i.e. about 320 kta of H2 (based on UFIP EM estimates for the period 2017-2019 of 450 kta of H2 consumption in French refineries of which about two thirds is an unavoidable by-product).
- Green H2 Power: Green H2 production required to meet the RFNBO mandate and the 50% substitution of H2 used in the industry (refining excluded) will require up to 25% of the forecasted French renewable power production equivalent to about 12% of the total French power production

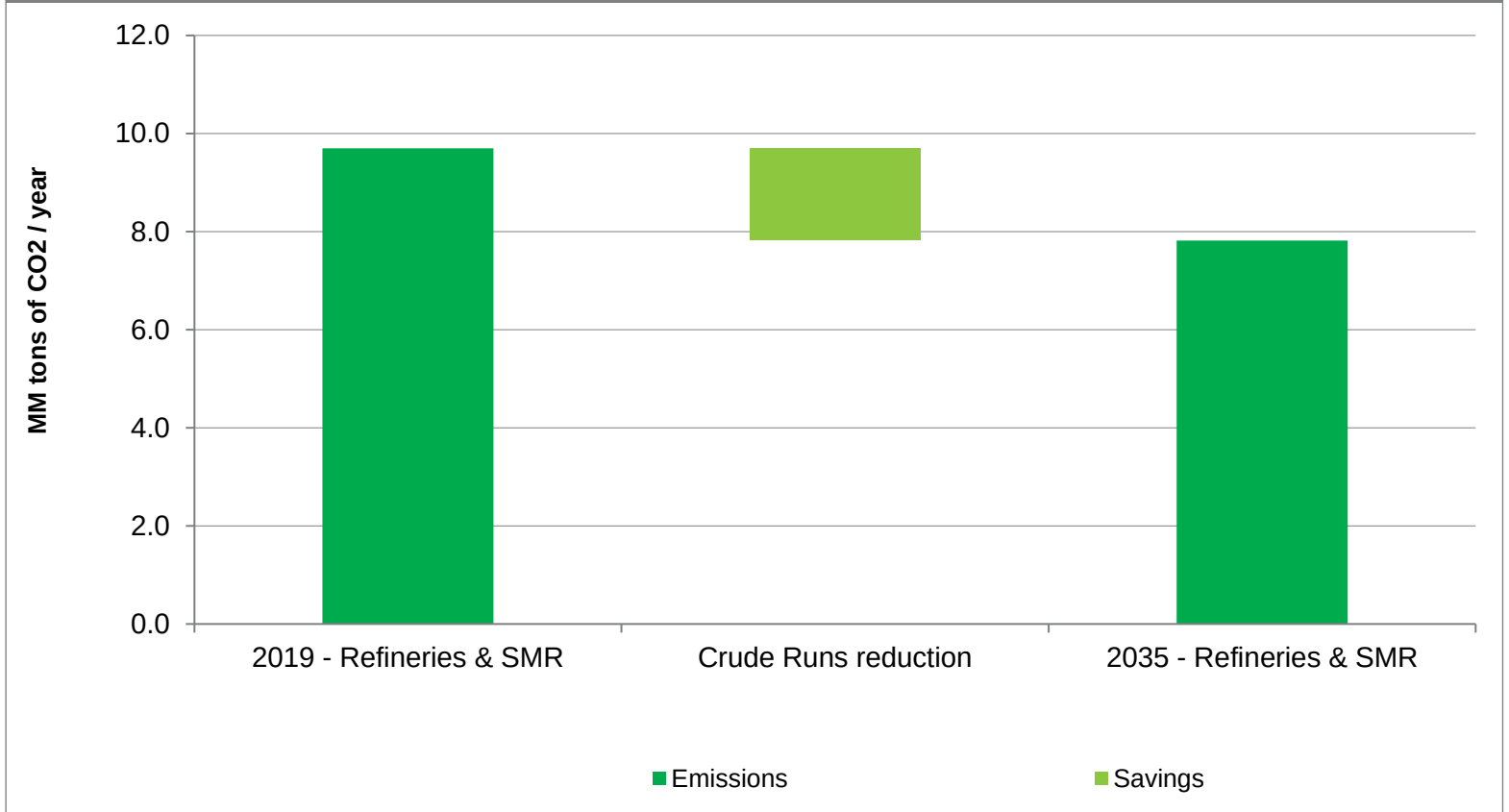
Refining decarbonization: review of new refinery investments to decarbonize the refining assets

Refining assets decarbonization – high potential of GHG savings reductions exists

1. GHG emissions to decrease at a lower pace than crude runs as most complex refineries would marginally increase their production versus simple refineries
2. Energy savings in refineries are expected to have limited potential as refining assets are already optimizing energy consumptions
3. Carbon Capture and Storage in FCC units contribution is expected to have a limited potential
4. Green or blue hydrogen could significantly contribute
   - Using Green H2 eligible for RFNBO as an intermediate product for co-processing (while self-consuming unavoidable by-produced grey hydrogen as fuel gas) could optimize the GHG emission savings.
5. Low grade heat potential is significant and could allow refineries to produce low carbon heat or power.
   - Some mechanism to promote the valorization of the residual heat may be required

Scope 1 & 2 – CO2 emissions in 2019 vs 2035 forecast – refining GHG emissions expected to decrease at lower pace than crude runs

CO2 Emissions (Scope 1 & 2) - 2019 vs 2035 outlook

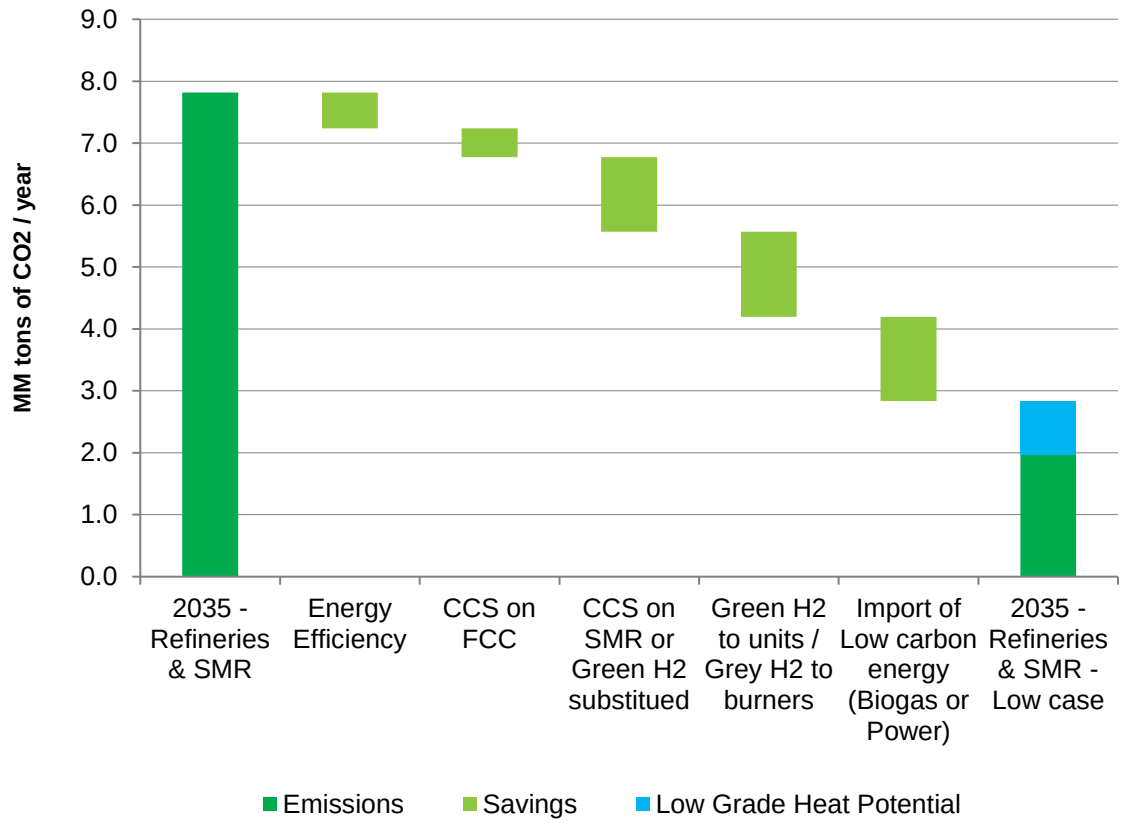


Source: IHS Markit & European Environment agency

- Reported emissions correspond to Scope 1 and Scope 2, including over-the-fence SMR if any.
- Scope 2 (SMR excl.): estimated at 2% of the Scope 1 + 2 emissions and consequently have not been detailed
- Impact of Crude runs reduction: 30% crude runs decrease is forecasted over the period 2019-2030 (corresponding to the case 1). The corresponding GHG emissions reduction is estimated at lower level, i.e 20% without considering any other improvements. This is explained by the fact that the rationalization would impact first the asset with the lowest complexity index that are less energy intensive than the most complex sites.

Scope 1 & 2 – French refining CO2 emissions reduction potential – Green & Blue Hydrogen represent half of the GHG emissions potential cuts

CO2 Emissions (Scope 1 & 2) - Potential reductions



Source: IHS Markit & European Environment agency

- Energy Saving: 10% energy saving is estimated over the period considering at a conservative rate of 0.6% / yr. (by improved heat recovery and electrification i.e. steam turbine replacement by electrical motor)
- CCS: Use restricted to the main emitters i.e FCC flue gas and SMR. CCS on heater stacks expected to remain difficult to implement.
- Green H2: In case Green H2 is used to maximize the RFNBO production in the refineries (consuming only on purpose produced hydrogen), unavoidable byproduced grey H2 will be self-consumed in-situ as fuel gas that could optimize the carbon emissions of the refinery. In such configuration, the Green H2 use would contribute to the RFNBO mandate and the use of the unavoidable byproduced hydrogen as heat source would contribute to reduce the emissions under the ETS system.
- Import of Low carbon energy: Substitution of the imported energy (mainly fuel gas) by low carbon sources (~ 25% of the total energy). If 25% of the refineries energy needs are substituded by Biogas, that would represent 8% of the forecasted French biogas production in 2035 .
- Low Grade heat potential: 30 to 50% of refinery energy consumption is released at low temperature (< 130°C) and . Use of this low grade heat through District heating grid, industrial heat pumps or organic rankine cycle system (ORC) for power generation. Low grade heat or residual heat use are usually not economical and would require incentives to be developed..
- Electrical heater: As ot today replacing fired heater by electrical heater is considered as low potential in the refining sector

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