Executive Summary - 100% renewable E85 fuels study (April 2024)

In France, E85 fuel contains an average of 75% bioethanol and 25% of fossil gasoline. Based on 2022 ethanol official GHG data[1], it reduces greenhouse gas emissions by 50% compared to pure fossil gasoline.

Replacing the fossil gasoline part by renewable gasoline bases produces a 100% renewable E85 and helps to reduce greenhouse gas emissions even further .

The present study checks the compliance of such 100% renewable E85 fuels with the pollutant emission limits of the current Euro 6 and future Euro 7 Regulations. Three renewable gasoline bases were tested to replace the 25% fossil gasoline part of current E85:

- an **Ethanol To Gasoline (ETG)** base

- a model **e-naphta** base, a potential co-product of e-kerosene obtained by the Fischer-Tropsch process (e-fuel)

- a model **bionaphta** base, a potential co-product of HEFA paraffinic diesel and aviation fuels (HVO).

The impact of these fuels on pollutant emissions of a flexfuel vehicle was studied at 23°C using the WLTC cycle.

First, the study highlights a 21% to 26% higher fuel consumption of E75 compared to E10 . This extra consumption is due to the lower energy content of bioethanol compared to petrol. Despite this fuel consumption increase, tailpipe CO2 emissions are 5% to 8% lower with E75 than with E10, depending on the tests.

Upstream of the catalytic converter and of the particulate filter, emissions of CO_2, CO, THC, NOx and PN10 particulates remain generally constant or decrease with higher ethanol content:

- Reduction of CO2 emissions due to improved resistance to auto-ignition, which improves overall efficiency.

- Reduction of THC emissions due to dilution by ethanol of the heavy fractions from the hydrocarbon part.

- Reduction of NOx emissions thanks to a lower combustion temperature due to the higher latent heat of vaporisation of ethanol compared to fossil gasoline or renewable gasoline bases.

- Reduction of the number of PN10 particles due to low local richness in the combustion chamber created by a high ethanol content.

According to the Euro 6 standard protocol, the following emission changes can be noted:

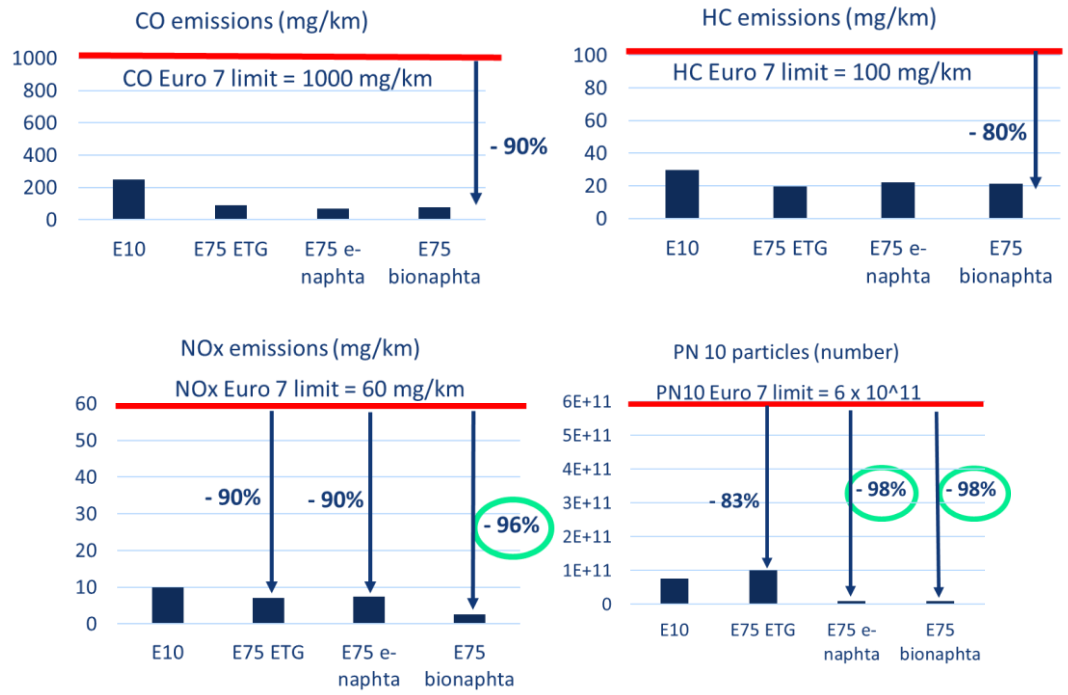
- **CO emissions** for E75 fuels with ETG, e-fuel and HVO bases are 63% to 85% lower than for commercial E10 fuel, and almost 90% lower than the Euro 6 limit of 1000mg of CO per km.

- **HC emissions** for E75 fuels with ETG, e-fuel and HVO bases are 11% to 34% lower than for commercial E10 fuel and around 80% lower than the limit of 100mg of HC per km.

- **NOx emissions** for E75 fuels with ETG and e-fuel bases are 6% to 30% lower than for commercial E10 fuel and around 90% lower than the limit of 60mg of NOx per km. NOx emissions from E75 (bionaphta) are 75% lower than E10 fuel and 96% lower than the Euro 6 and future Euro 7 limits.

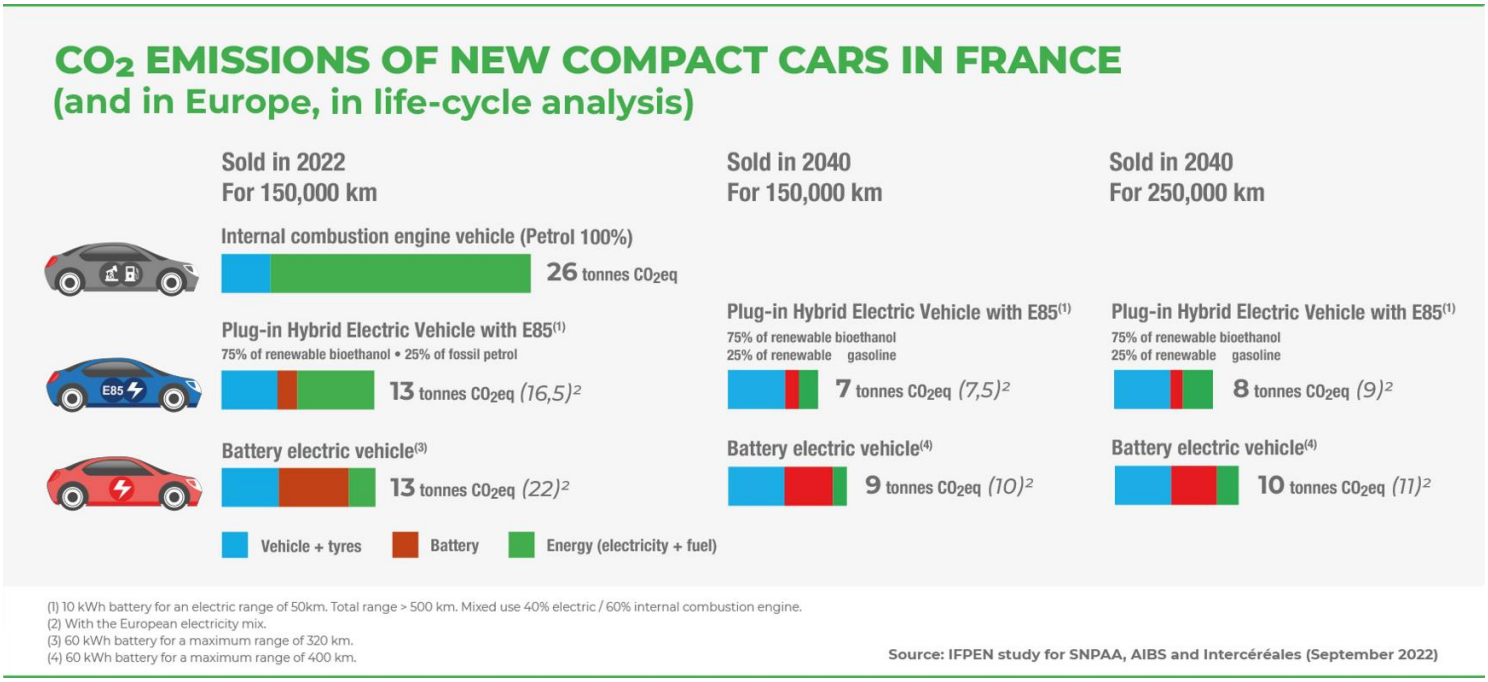
- **PN10 emissions for E75 (ETG) fuel** are from 0% to 31% higher than for E10, while remaining 83% below the PN10 limit of $6x10^{11}$ particles per km. This result is due to the high content of aromatics (35%), particularly C9+, of the ETG base. The ETG supplier indicates that the plant process can be adapted to reduce this aromatic content down to around 25%. It would be useful to test such an ETG base in the future.

- **PN10 emissions for E75 fuels with e-naphta and bionaphta** bases are 87% to 90% lower than for commercial E10 fuel, and at least 98% lower than the limit of $6x10^{11}$ PN10 per km. This result is due to the absence of aromatics in the e-naphta and bionaphta bases.



It should be noted that the e-naphta and bionaphta bases were surrogates formulated on the basis of the available scientific literature and IFPEN's knowledge. Sourcing these bases from a producer would help to confirm the observations made with the two selected formulas of the e-naphta and bionaphta bases.

This study focused on pollutant emissions during the use of the vehicle. It complements the study made on Life Cycle Assessment GHG emissions from flex fuel vehicles that was first published in September 2022[2]. This LCA study highlighted the good performance of plug-in hybrid technologies running on E85 regarding GHG emissions. For example, in 2022, total LCA CO_2 emission level of a C segment plug-in hybrid vehicle running on current E85 is equivalent to a 60 kW battery electric vehicle using France's very low-carbon electricity mix. With realistic assumptions of further CO_2 emissions reduction from bioethanol, electricity and battery production, for a PHEV running on 100% renewable E85, this equivalence would remain valid in 2040.



[1] CarbuRe database, DGEC France, 2022, https://metabase.carbure.beta.gouv.fr/public/dashboard/7850c353-c225-4b51-9181-6e45f59ea3ba?annee=2022 _- weighted average of GHG levels by raw material

[2] Study on greenhouse gas emissions from flex fuel vehicles in Life Cycle Assessment, IFPen, 2022