LIFE CYCLE ANALYSIS FOR VEHICLES RUNNING ON NGV AND BIONGV

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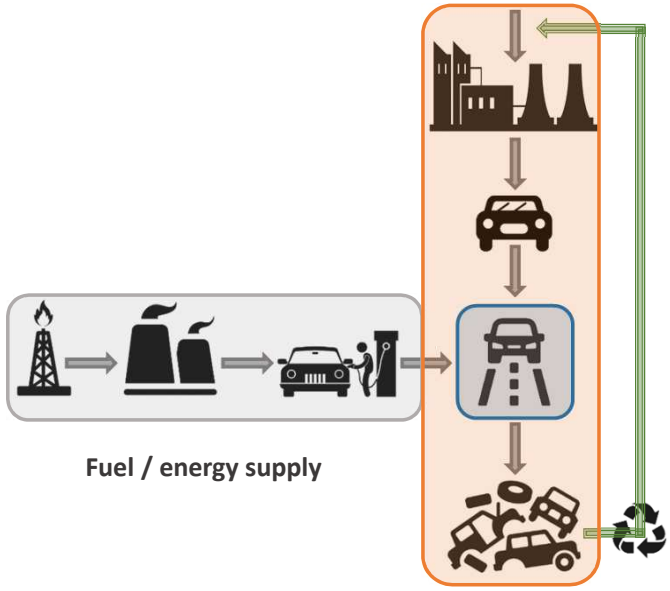
OBJECTIVES: TAKE INTO ACCOUNT ALL GREENHOUSE GAS EMISSIONS AND POSITION NGV AND BIONGV VEHICLES

MOBILITE DURABLE

- Today, **European regulations** and the **95 g CO_2**/km by **2021** objective for all manufacturer sales:
  - only concern emissions from a vehicle's exhaust system
  - makes no distinction between CO_2 of fossil origin (gasoline, diesel, NGV) and CO_2 of biogenic origin (liquid or gas biofuel)

- European research is under way to take into account **total carbon emissions** over the vehicle's **life cycle** : **Life Cycle Analysis** methodology



European research under way

Scope of European regulations

METHODOLOGY USED: LIFE CYCLE ANALYSIS (LCA)

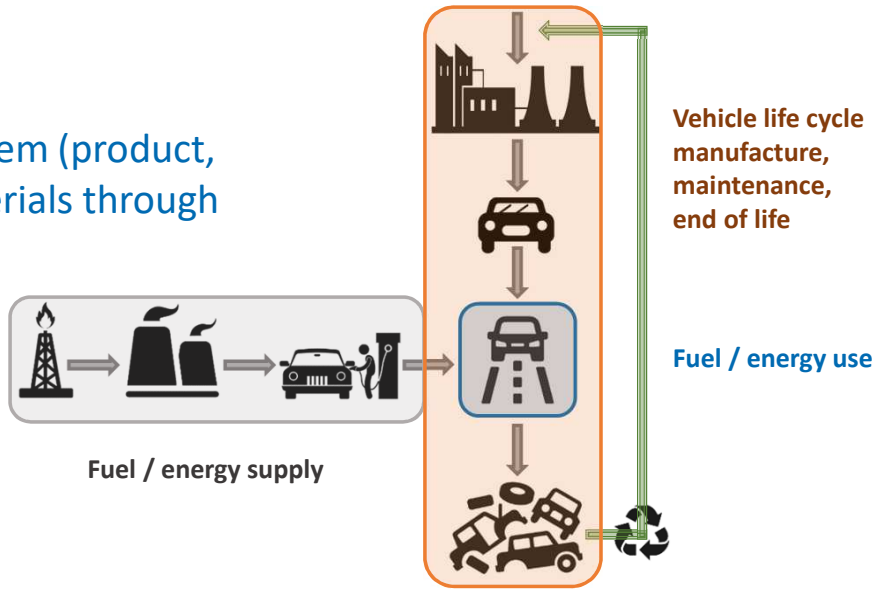
- Methodology governed by ISO standard 14040-44

- that evaluates the potential impacts on the environment of a system (product, service), throughout its life cycle (from extraction of the raw materials through to waste disposal)

➔multi-stage

➔multi-criteria

- Functional Unit: “1 person traveling 1 km”



Analysis of the environmental impacts of different road vehicles, in 2019 and 2030

- The vehicle life cycle: from manufacture to recycling
- The fuel life cycle: production, refining, transport, distribution, combustion

THE STUDY COVERS A BROAD SPECTRUM

- 5 vehicle segments considered
- Various degrees of electrification
- 2 time horizons: 2019 and 2030
- 2 gas sectors: NGV and bioNGV

Medium class vehicle (C)

Upper class vehicle (D)

Commercial vehicle

Bus

Urban delivery HD (12 t.)

2019

2030

NGV
BioNGV

THE STUDY IS BASED ON ROBUST MODELING VIA THE ESTIMATION OF REAL CONSUMPTION

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Hypotheses and projections

- Energy densities
- Component efficiency
- Vehicle characteristics

2019 → 2030

Fleet modeling for 2019 & 2030

Vehicle simulators based on cycles

Simulation serving LCA

Estimation of consumption in real conditions

Life cycle Analysis (LCA)

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SEGMENT C: THE BIONGV VEHICLE DELIVERS BETTER RESULTS IN 2019 IN TERMS OF CLIMATE CHANGE

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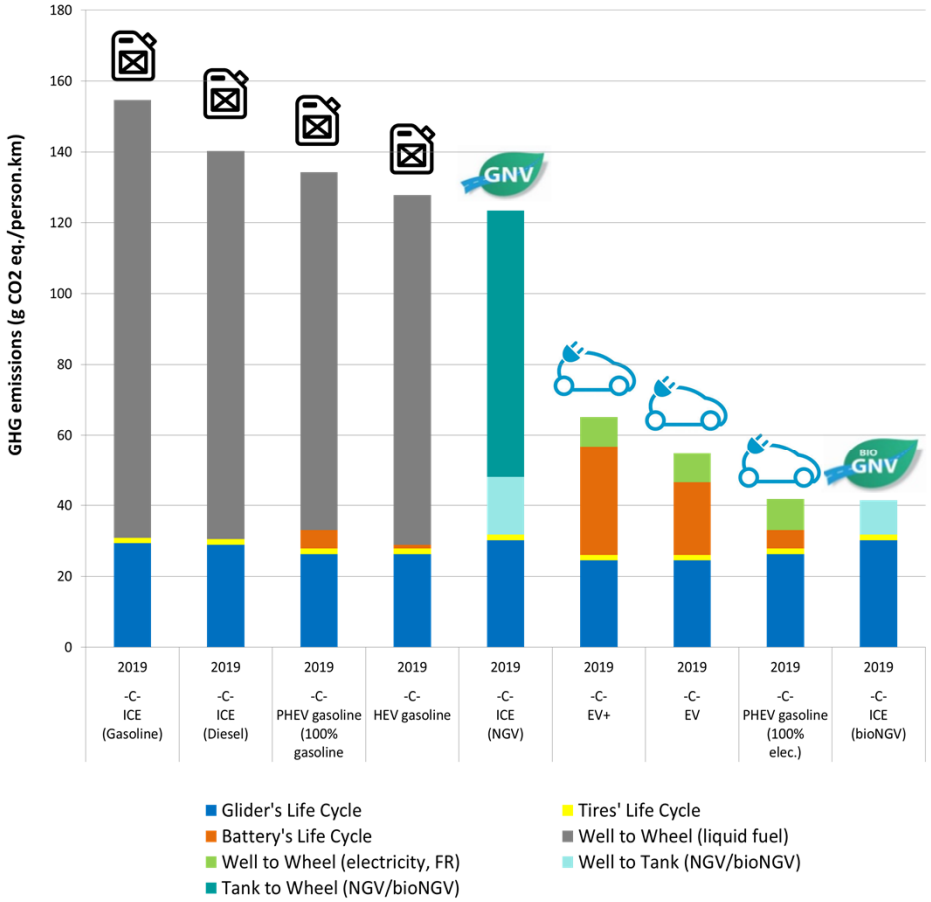
Potential impacts on climate change (segment C)

Time horizon 2019



- ❑ Emissions related to the combustion of bioNGV equal to 0
  - ➔ Carbon of biogenic origin
- ❑ French electric mix (**green**)
- ❑ CO_2 emitted during battery manufacture (**orange**)
- ❑ 10 years of ownership, 15,000 km/year

- ➢ **The NGV vehicle emits fewer greenhouse gases than its IC competitors.**
- ➢ **The vehicle running on bioNGV delivers better results, all powertrains combined: a 36% saving compared to the 60kWh electric vehicle.**

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SEGMENT C: THE BIONGV VEHICLE MAINTAINS BETTER RESULTS IN 2030 WITH A HYBRID POWERTRAIN

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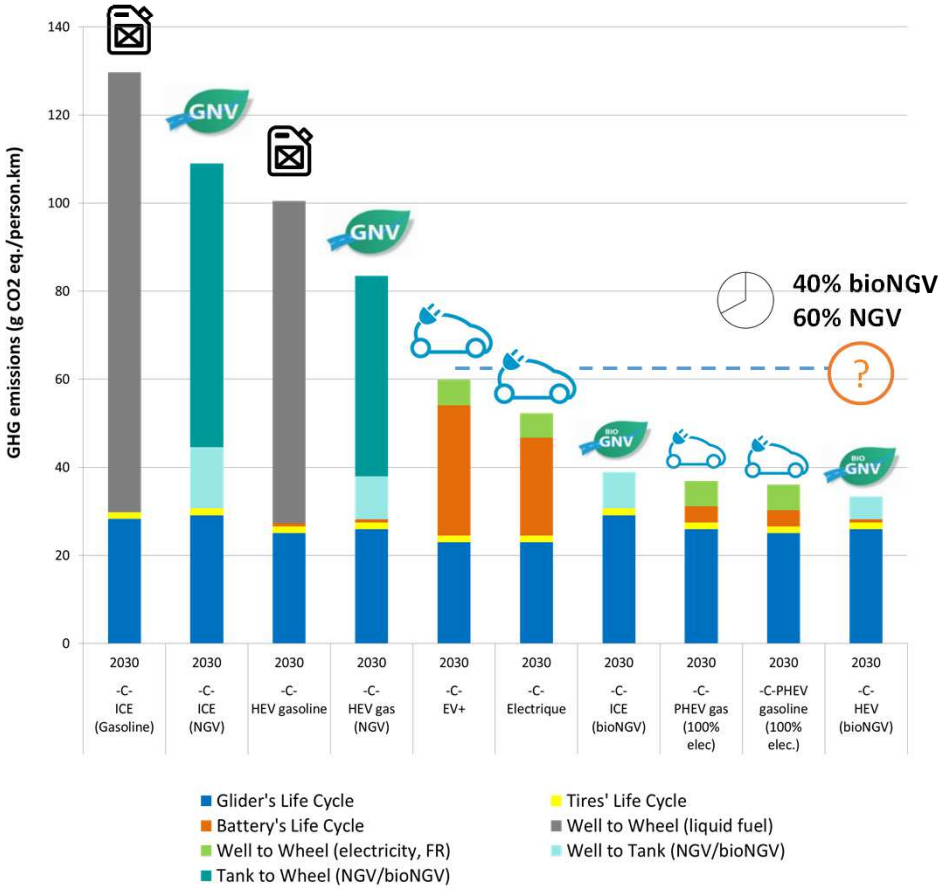
Potential impacts on climate change (segment C)
Time horizon 2030



- **The NGV vehicle emits fewer greenhouse gases than its IC competitors.**
- **The vehicle running on bioNGV delivers better results, all powertrains combined.**
- **A 60% NGV– 40% bioNGV mix used in a non-plug-in hybrid vehicle gives the same results as an electric vehicle with an extended range.**

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THE LIGHT COMMERCIAL VEHICLE RUNNING ON BIONGV IS THE BEST ALTERNATIVE

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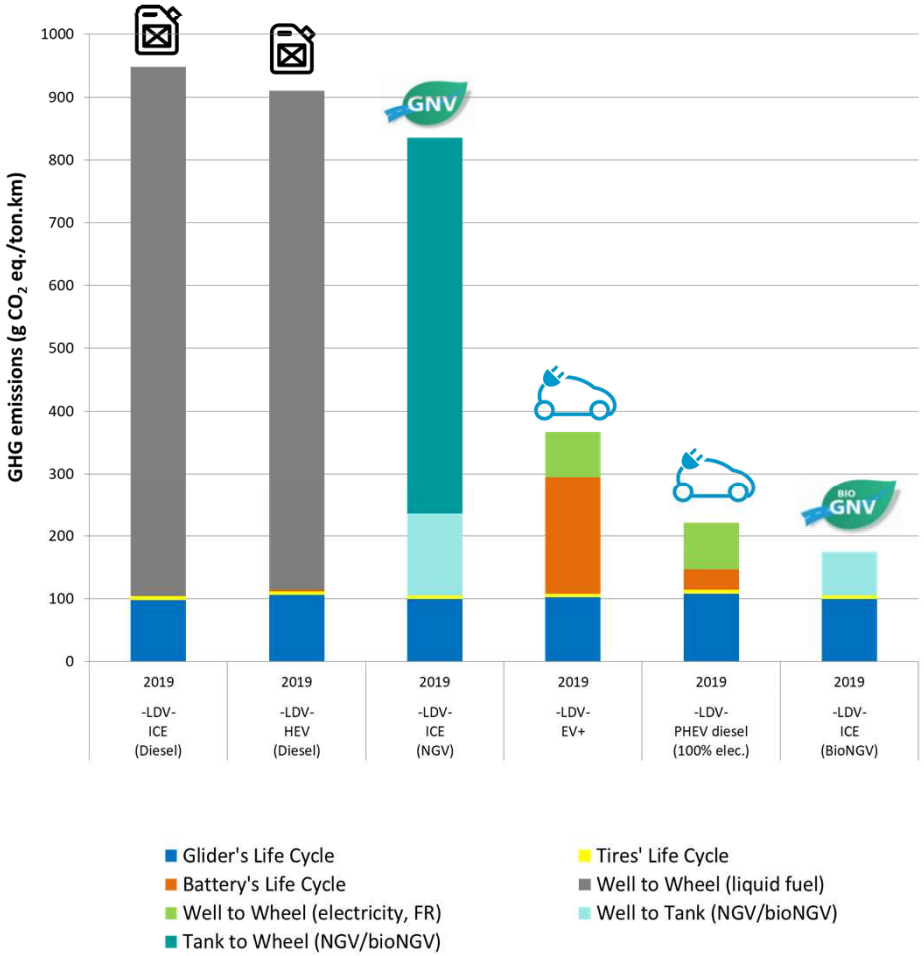
Potential impacts on climate change (light commercial vehicle)

Time horizon 2019



❑ 12 years of ownership, 16,200 km/year

- **In 2019, a light commercial vehicle running on bioNGV emits 174 g of CO_2/t.km versus 366 g CO_2/t.km for the 80 kWh electric light commercial vehicle (a saving of 52%).**
- **In 2030, the same results are observed.**

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THE 12-TON HEAVY TRUCK RUNNING ON BIONGV IS THE BEST CANDIDATE

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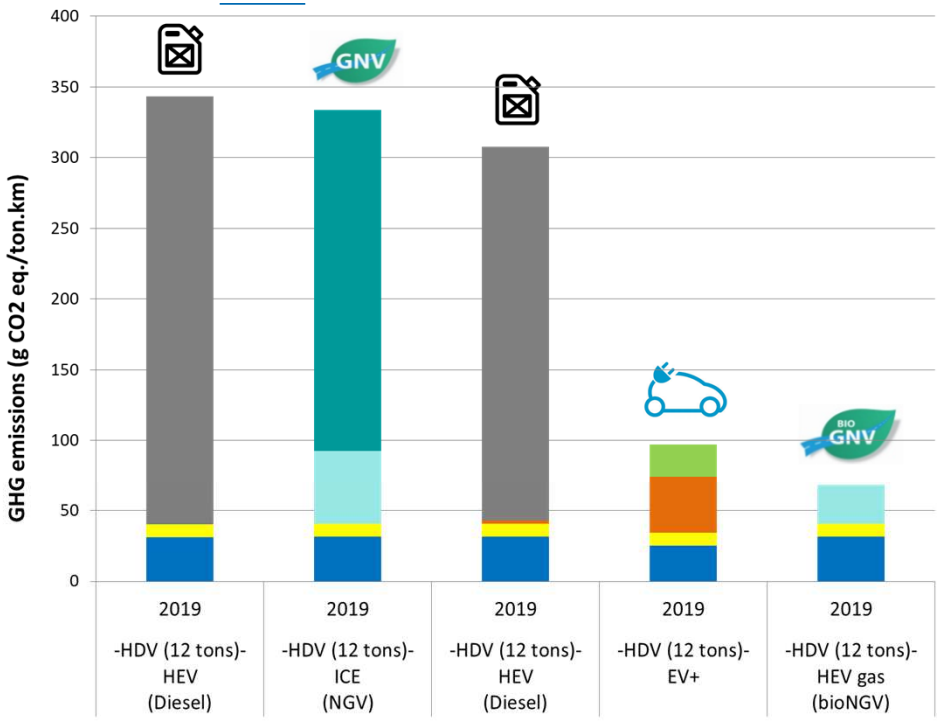
Potential impacts on climate change (12t heavy truck)

Time horizon 2019



❑ 12 years of ownership, 31,000 km/year

➢ **In 2019, the 12-ton heavy truck running on bioNGV outperforms other powertrains: a saving of 35% compared to the 240 kWh electric model.**

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