Option 6 – Vehicle On-Board Fuel Molecular Sensor

Description of Technology

Near-Infrared (NIR) spectroscopy is a mature, automotive-grade technology that analyzes thousands of molecular bonds to generate a unique "fuel fingerprint." It enables clear separation between fossil fuels and 100% fossil-free fuels, even when both meet current EU standards (EN590, EN228, EN15940, EN14214, EN15293). The technology has benefited from 15+ years of development with OEMs, engineering teams, and universities. It is already homologated, field-proven, and deployed at scale in the transportation market. While the sensor does not embed geolocation features directly, it can be connected to external geofencing systems and digital certification platforms, enabling full traceability and regulatory compliance throughout the fuel lifecycle. A central element of this solution is the use of a certified CNF molecular database, allowing each analysed fuel sample to be matched with its "fuel digital twin". This digital twin ensures that the fuel's real-time molecular signature corresponds precisely to its certified production origin and declared carbon footprint. This technology is suitable for gaseous fuels but will require extra development.

In order to ensure the reliability, repeatability, and legal compliance of the fuel identification system, the sensor must be installed by a pre-approved technical center following a validated installation protocol (mounting notice). This is aligned with existing regulatory frameworks already in place in Europe.
For instance, in France, similar rules apply to FlexFuel E85 retrofit kits, where installation must be carried out by an approved garage using certified hardware and software to enable an official fuel-type update on the vehicle's carte grise (registration document). This framework has been operational since 2017 for passenger cars (PC), and extended by the CNRV and DREAL to cover light-duty and heavy-duty vehicles (LDV, HDV) for the use of 100% renewable diesel.

This structured installation procedure ensures:

- Secure and tamper-proof sensor deployment,
- Compliance with safety and OBD integration standards,
- Eligibility for tax or regulatory benefits associated with low-carbon fuel use.

It also allows the system to be deployed either as a factory-fitted (OEM) solution or as a certified retrofit, offering flexibility and scalability across the existing vehicle fleet.

Customer & Retail Perspective

Advantages:

- High certainty in fuel type detection
- Fully compatible with existing fuel infrastructure (no changes at petrol stations)
- Security of fuel compliance
- Immediate availability and already homologated in a particular market
- Proven field performance (100M+ km)
- Supports retrofit of existing fleets
- Real-time detection enables partial refuelling and fuel mix tracking
- Increase flexibility for drivers travelling outside the EU

Disadvantages:

- Cost: Higher than basic sensors, but compatible with large-scale automotive production[2]
- Maintenance: No maintenance required in real-world deployments over 3.5 years
- In-vehicle sensors yet to be proven as detection thresholds still require thorough validation.
- Fuel scope: Currently limited to liquid fuels, not applicable to gaseous fuels distributed through gas pipelines.
- Need for an CNF database: Over-the-air-accessible, batch-to-batch certified and up to date

Implementation requirements:

- Early system integration to allow for regulation-based inducement
- Implementation of regulatory geofencing software[4]
- Clearly defined test procedures
- CNF-compliant database monitored by an authority

Regulatory Assessment

Option 6 combines high-resolution molecular detection with the possibility to connect to digital handshake systems option, enabling full traceability from fuel production through distribution to the vehicle's fuel tank. This ensures that the molecular structure of the fuel entering the engine matches the certified product across the supply chain. This end-to-end traceability supports regulatory compliance under CSRD Scope 3 and the Renewable Energy Directive (RED II / RED III) [5]. It also enables identification and certification of emerging synthetic mono-molecular fuels, positioning this technology as a future-ready tool for sustainable fuel policy enforcement and lifecycle accounting.

Option 6 – Vehicle On-Board Fuel Molecular Sensor