# Option 4 – Hybrid Approach: Upstream: Fuel Marker & Sensor until EU Border Filling Station/ Downstream: Digital Fuel Tracking System (DFTS) with Digital Handshake

## **Description of Technology**

The "Triple Solution" enables market participants (from fuel industries to vehicle manufacturers) to introduce CO2-Neutral Fuel by combining two safety features and a digital solution. The physical features, are colour and a chemical tag. This marking system includes CO2 tracking and certification for CO₂ neutral fuel along the supply chain, from the fuel depot to the filling station, and a digital refuelling monitor in the vehicle. The vehicle performs a digital handshake with the petrol station to confirm the refuelling event. If the fuel is not CNF, the vehicle reacts accordingly. The Hybrid Approach connects all relevant stakeholders, including the customs directorate and Ministries of Finance, for CNF confirmation, plausibility checks, and tracking of fuel and CO₂ footprint. It is important to note that this technology is unsuitable for gaseous fuels.

# **Customer & Retail Perspectives**

#### Advantages:

Upstream (Fuel Marker System):

- Established and familiar system
- · Inducement potential
- · No major behavioural changes for consumers
- · Minimal infrastructure changes needed
- · Enhanced safety and fraud prevention
- Potential for integration with digital tracking and authenticity verification systems
- · Low implementation costs
- · Flexible monitoring capabilities

### Downstream (Digital Fuel Tracking System):

- Technology availability and fast implementation
- · Cost efficiency
- · Ease of use and high customer acceptance
- Data security and compliance
- Enhanced monitoring (extended information transfer beyond simple yes/no information is possible) and flexibility mechanisms
- · Regulatory geofencing capability
- · Future-ready and scalable applications
- Enables real-time emissions auditing and compliance reporting for fleet operators and regulators

#### Disadvantages:

Upstream (Fuel Marker System):

- · Limited usability outside the EU
- · Binary compliance detection
- · Reduced flexibility in inducement mechanisms
- · Compatibility issues with gaseous fuels
- Cost implementation for petrol stations or vehicle depending on placement of sensor
- In-vehicle sensors yet to be proven as detection thresholds still require thorough validation
- Risk of sophisticated counterfeiting or neutralization of the chemical marker by malicious actors

#### Downstream (Digital Fuel Tracking System):

- Special attention regarding vulnerability to data latency and transmission failures necessary
- Increasing effort to reduce susceptibility to system failures by multi trust centre approach
- Data privacy and GDPR compliance as for all digital systems demands special care
- Limitations in EU's external border fuelling flexibility if implemented without regulatory geofencing
- · Limited infrastructure availability initially
- Dependence on continuous internet connectivity may create accessibility issues in remote or underserved regions

# **Regulatory Assessment**

Upstream part: Fuel Marker (as described in option 2), Downstream part: Digital Fuel Tracking System (as described in option 3). As with the digital handshake-only option, preventing fraud at field level remains a challenge, due to the lack of automated, tamper-proof verification mechanisms in real time.