OBFCM & OBMM

OVERVIEW OF ACEA's POSITION

DG CLIMA & ACEA Meeting

MS Teams, Online

08th May 2024

27th June 2024

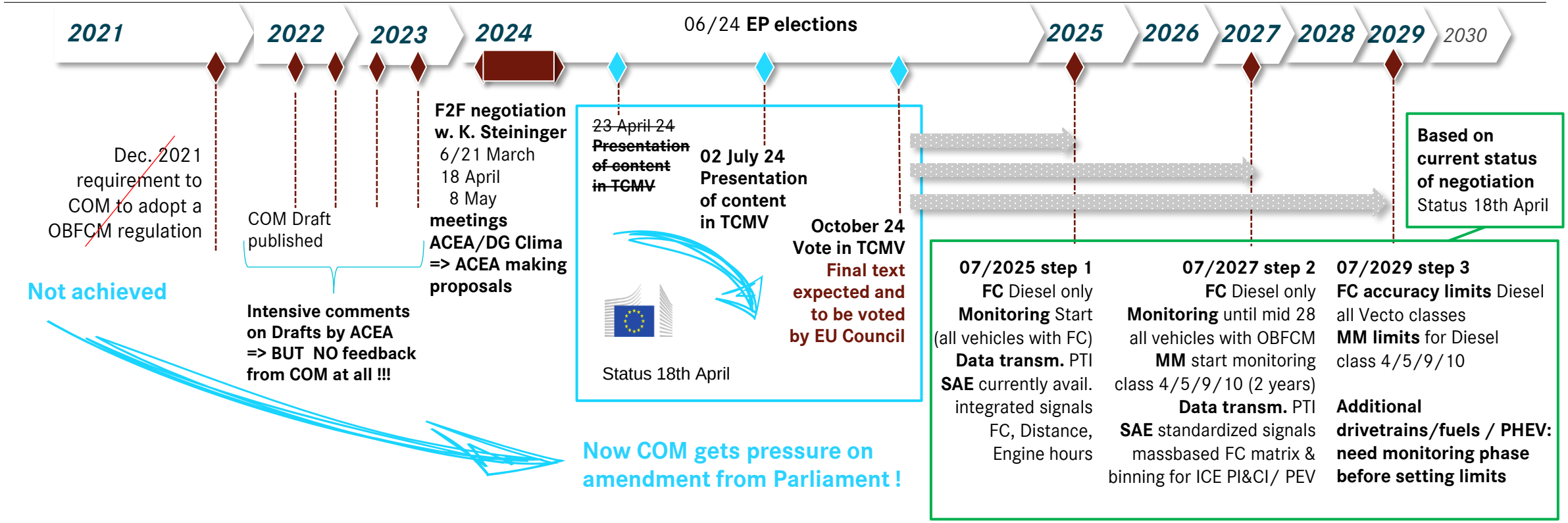
final questions

acea

TIMELINE OBFCM & OBMM

ACEA / EU COM (DG-CLIMA)

Status & Outlook OBFCM & OBMM regulation implementation



Now Industry needs feedback until end of May 2024 => on content and timing for the first two steps 2025 & 2027
Industry can not wait until vote in October 2024 because of already unfeasible development timing for 2025 & 2027

GENERAL

- OBFCM & OBMM start with relevant powertrains / fuels that have a low variation of quality

  => Start with the most relevant Powertrain => ICE-CI-Diesel

- Accuracy
  - FCMC accumulated @TA (lab); COP WHSC

    => No TA. Covered by declaration
- Monitoring
  - VTP & ISV, go in a monitoring phase and set limits based on data generated in monitoring phase
- Timing/Scope on accuracy monitoring VTP COP+ISV & PEMS ISC
  - **FC** Start monitoring from Mid 2025 until Mid 2028
    - all available vehicle classes for FC
    - Do yearly reviews on the Data collected !!
  - **MM** Start a monitoring from Mid 2027 until Mid 2029
    - VECTO Class 4, 5, 9, 10 / exclusions see slide 12
    - Do yearly reviews on the Data collected !!
- Set accuracy Limits for OBFCM (VTP COP+ISV & PEMS ISC)[#] & OBMM (VTP light* + dynamic & hilly conditions)
  - **FC Mid 2029 / MM Mid 2030**

*without Kistler rims

[#] cycle definition & boundaries to be decided/adapted

CONCLUSIONS

ACEA was proposing a possible way to bring OBFCM early into the market by a stepwise approach

The timeline proposed by ACEA is very challenging but possible

- Further shifting of content between the steps to a earlier date is not achievable

Stepwise Approach

- Step 1 07/2025 monitoring fuel consumption for diesel only all vehicle in scope of VECTO
- Step 2 07/2027 add future standardization ICE CI&PI / PEV & Mass Monitoring monitoring phase for VECTO Class 4, 5, 9, 10
- Step 3 07/2029 add PHEV in SAE Standardization implement accuracy limits for FC & Diesel only
- 07/2030 implement accuracy limits for MM (2 years monitoring phase & add one additional year for installation
- All other new powertrains PEV / PHEV / Gas PI Engines / H2 ICE should be included regarding its relevance on the Market
  - But there must be always a monitoring phase of 2-3 years before setting accuracy limits !

Industry can offer a monitoring phase on a limited set of vehicles and under the condition that existing tests are used

- Until Euro 7 (07/2029) no type approval on the OBFCM / OBMM Device
- Use Monitoring data to draw conclusion regarding achievable accuracy requirements
- Standardization need to be done in a stepwise approach, because a lot of signals to be implemented & SAE Work takes time
  - Step 1 07/2025 use data that is already standardized in J1979DA
  - Step 2 07/2027 implement Standardization for OBFCM / OBMM for ICE CI & PI / PEV
  - Step 3 07/2029 add PHEV in the Standardization

Questions regarding Data transfer via OBD port during PTI to TAA during monitoring phase

- Will there be ISV measurement available from 2025 ?
- Can OEM´s also get access to Data read out at PTI ?

AGENDA – FEEDBACK OVERVIEW

- ACEA answers on Questions
  - Market share of steel suspension
  - family definition
    - update & more detailed proposal for OBMM ACEA
  - PEV inclusion in monitoring phase
    - Not possible, because of SAE Work, Development timeline, Signal availability
  - PHEV inclusion mid 2027 => discussion with SAE/COM/ACEA
    - Not possible Regarding to SAE to complex to include in SAE Work for mid 2027
  - statistical approach
    - further meeting after simulation results available (Sanjeev)
  - Testing boundaries OBMM
- Timing & content ACEA needs urgent feedback !!
  - Industry needs feedback on content and timing for first two steps 2025 & 2027 until end of May 2024 !!
  - Industry cannot wait until vote in October 2024 because of already unfeasible development timing for 2025 & 2027

OBFCM AND OBMM STEPWISE APPROACH

ACEA OVERVIEW ON PROPOSED STEPS

ACEA PROPOSAL - OVERVIEW

OBFCM accuracy definition @2028 based on monitoring phase

Mid 2025 step 1 :

- OBFCM only
- Requirements for **OBFCM**:
  - Diesel B7 reference fuel
- No TA, declaration only
  - 5% in FCMC accumulated @TA (lab)
  - 10% COP WHSC engine production
- # OBFCM Vehicle test VTP COP+ISV & PEMS ISC
  - Monitoring phase - until Mid 2028
  - All vehicle classes covered by VECTO 2025
- Use available SAE standardized signals for lifetime
  - FC (liquid) / Distance / Engine operation hours **
- Data readout at PTI
  - It needs to be ensured that OEM have also the possibility to access the Data read out at PTI
  - Data not connected to VIN (*anonymous data for sharing*)
- OBMM and all other technologies: N/A
- Do yearly reviews on the Data collected !!

Mid 2027 step 2 :

- Requirements for **OBMM**:
  - AMT-only, air suspension (OBMM),…
    - **See more on page 11**
- # OBFCM + **OBMM** during VTP COP+ISV & PEMS ISC

  OBMM (just VTP with adaptions)
  - Accuracy monitoring phase starts for weight
  - Class 4, 5, 9, 10
  - Monitoring 2 years until Mid 2029
  - AMT-only, air suspension (OBMM),
  - **Excluded:** manual & powershift gearboxes, full steel suspension, hydrodynamic clutches, torque converter, …
    - **see more on page 12**
- **SAE** implementation: new standardized matrix covered for OBFCM and OBMM (ICE CI & PI / PEV)
- **Data not delivered in monitoring phase for ICE PI Gas & H2 / PEV as very low market share !**

PEV could be excluded from SAE standardization step 2 if the unclear topic´s are not solved / answered !!

Mid 2029 step 3:

- Aligned with Euro 7 “All Registrations” date
  - OBFCM & OBMM with accuracy requirements based on monitoring phase
- # OBFCM **& OBMM** VTP COP+ISV & PEMS ISC:

  OBFCM

  Accuracy limits based on data evaluation (monitoring)

  OBMM
  - End of monitoring Phase Class 4, 5, 9, 10
    - Evaluation of Data
  - Start monitoring Phase additional vehicle set #2&3
- In-Service via ISV (VTP-based)

  OBFCM
  - Accuracy limits based on data evaluation (goal set targets including aging)

  OBMM
  - Accuracy monitoring starts for weight (targets open due to aging)
- Data transfer via readout at PTI and OTA (as required by Euro 7, via ExVe)
- SAE: standardized matrix implemented covering **additionally to Step 2027** OBFCM and OBMM for (**PHEV**)

Every powertrain variant additional to Diesel ICE PI should be added dependent on relevant market share and starting always with a monitoring Phase before setting accuracy limits !

***** without Kistler rims # cycle definition & boundaries to be decided/adapted ** defined for IUPR (Reg 49, Annex 9C – 7.3.1.), reset to zero after reprogramming event required

ACEA PROPOSAL - OVERVIEW

MID 2025

- OBFCM only
- No TA, declaration only
  - 5% in FCMC accumulated @TA (lab)
  - 10% COP WHSC engine production
- #OBFCM Vehicle test COP+ISV & PEMS ISC
  - Accuracy monitoring - until Mid 2028
  - All vehicle classes covered by VECTO 2025
  - Diesel B7 reference fuel

- Use available SAE standardized signals for lifetime
  - FC (liquid)
  - distance
  - engine operation hours**
- Data readout at PTI
  - It need to be ensured that OEM have also the possibility to access the Data read out at PTI
  - Data not connected to VIN
- OBMM and all other technologies: N/A
- Do yearly reviews on the Data collected !!

** defined for IUPR (Reg 49, Annex 9C – 7.3.1.), reset to zero after reprogramming event required

7.3.1. Reset to zero

Each number shall be reset to zero only when a Non-Volatile Random Access Memory (NVRAM) reset occurs (e.g., reprogramming event). Numbers may not be reset to zero under any other circumstances including when a scan tool command to clear fault codes is received.

cycle definition & boundaries to be decided/adapted

ACEA PROPOSAL - OVERVIEW

MID 2027

- No TA, declaration only
- #OBFCM **& OBMM** Vehicle test COP+ISV & PEMS ISC

  OBFCM
  - monitoring phase continues until Mid 2028 (accuracy target 10%)
  - All vehicle classes covered by VECTO 2027

  OBMM (VTP light* + dynamic & hilly conditions)
  - Accuracy monitoring phase starts for weight
  - Class 4, 5, 9, 10
  - Monitoring 2 years until mid 2029
  - AMT-only, air suspension (OBMM),
  - **Excluded:**
    - manual & powershift gearboxes, full steel suspension, hydrodynamic clutches, torque converter, …
    - See more on page 12

- **SAE** implementation: new standardized matrix covered for OBFCM and OBMM (ICE CI & PI / PEV)
- Data not delivered in monitoring phase for ICE PI Gas & H2 / PEV as very low market share !

PEV could be excluded from SAE standardization step 2 if the unclear topic´s are not solved / answered !!

* without Kistler rims
# cycle definition & boundaries to be decided/adapted

Every powertrain variant additional to Diesel ICE PI should be added dependent on relevant market share and starting always with a monitoring Phase before setting accuracy limits !

ACEA PROPOSAL - OVERVIEW

MID 2028

- End of monitoring Phase for OBFCM CI Diesel
- Evaluation of Data
- Set accuracy Limits for
  - #OBFCM (VTP COP+ISV & PEMS ISC) & OBMM (VTP light* + dynamic & hilly conditions)
  - **FC** Mid 2029 / **MM** Mid 2030
- Do yearly reviews on OBMM Data collected !!

***** without Kistler rims
# cycle definition & boundaries to be decided/adapted

Every powertrain variant additional to Diesel ICE PI should be added dependent on relevant market share and starting always with a monitoring Phase before setting accuracy limits !

ACEA PROPOSAL - OVERVIEW

MID 2029 with Euro 7

- Aligned with Euro 7 “All Registrations” date
  - Diesel B7 reference fuel
  - All vehicles in scope of VECTO 2029
  - OBFCM with accuracy requirements based on monitoring phase
  - OBMM with accuracy requirements based on monitoring phase enforcement 2030
    - **AMT-only, air suspension (OBMM),…**
    - **See more on page 12**
- No TA, declaration only
- OBFCM ***&* OBMM** VTP COP+ISV & PEMS ISC:

  OBFCM
  - Accuracy limits based on data evaluation (monitoring)

  OBMM
  - End of monitoring Phase Class 4, 5, 9, 10
    - Evaluation of Data
  - Start monitoring Phase additionall vehicle set #2&3
  - AMT-only, air suspension (OBMM),…
    - See more on page 11
- Data transfer via readout at PTI and OTA (as required by Euro 7, via ExVe)
- SAE: standardized matrix implemented covering **additionally to Step 2027** OBFCM and OBMM for (**PHEV**)
- Do yearly reviews on the Data collected for powertrains/fuel types in monitoring phase

Every powertrain variant additional to Diesel ICE PI should be added dependent on relevant market share and starting always with a monitoring Phase before setting accuracy limits !

OBMM ADDITIONS & TESTING BOUNDARIES

In Scope:

- AMT gearboxes only (availability of needed sensor signals)
- Air suspension (availability of needed sensor signals vehicles)

Excluded:

- Electric, Hybrids, Manual gearboxes
- Full steel suspension vehicles (needed sensor signals not available) => most vehicles with full steel suspension have a lot of different PTO where it is not clear where the power goes to (not traceable & not quantifiable power take off)
- Vehicles with hydrodynamic clutches (e.g. torque converter) & (additional torque losses; timing delay between torque and acceleration; mostly used as special vehicles)
- Offroad vehicles (torque losses in drive train; tire influence; road/surface influence)
- Vehicles with full or partial hydraulic transmission systems (additional torque losses)
- Heavy haul vehicles (>80to) (slow driving/acceleration jeopardizes the mass monitoring)
- Buses (a lot of stops reset the monitoring; mostly torque converter, change of passengers **& regulated CO2 g/pkm,** mostly torque converter)

Accuracy

- Due to tolerances of engine torque (up to 10%) speed detection (up to 4-5%, see Odometer discussion); grade detection (deviation because also tilt angle of vehicle is measured due to load);
- Further tolerances in air drag influence; road surface;
- Tire influence

=> statistically an accuracy within 10% or better can be reached, but not guaranteed, therefore an **80% approach is proposed**

CoP:

- Existing/already performed VTP-test serve as COP.
- VTP test to be enhanced by dynamics or hilly criteria

  Important: as defined in VTP: Auxiliaries (e.g. PTOs) switched off as much as possible => torque used for auxiliaries is not detected => massive deviation (20% torque deviation ~20% mass deviation)

Content possible COP (VTP testing):

- 10% accuracy of vehicle mass signal, starting 15 minutes after start of test drive (vehicle speed >0 km/h). OEM stores data (binning) and reports to COM for In-Service monitoring.

PEV INCLUSION IN MONITORING & DATA TRANSFER

PEV INCLUSION –

MONITORING & DATA TRANSFER

PEV could be excluded from SAE standardization step 2 if the unclear topic´s are not solved / answered !!

- OBFCM Standardization for PEV
  - Planed inclusion into SAE until Mid 2027
- OBFCM Data Transfer & Architecture for PEV
  - **Protocol alignment**
    - Inclusion of J1979-3 for PEV with introduction of Euro 7 HDV (Mid 2029) planed
    - No standardization is foreseen until Euro 7 HDV !
  - **Architecture**
    - Installation of OBD Infrastructure in the vehicles topology take more time than 2,5 years
    - Architecture implementation did not start yet and covered by the Euro 7 HDV regulation

Limited experience with HDV PEV´s due to very limited vehicle on the market !

Until Euro 7 HDV there will be NO Umbrella regulation which implements a Generic Scantool

Discussion and definition will be done in the Euro 7 implementing Regulation and that not start yet !

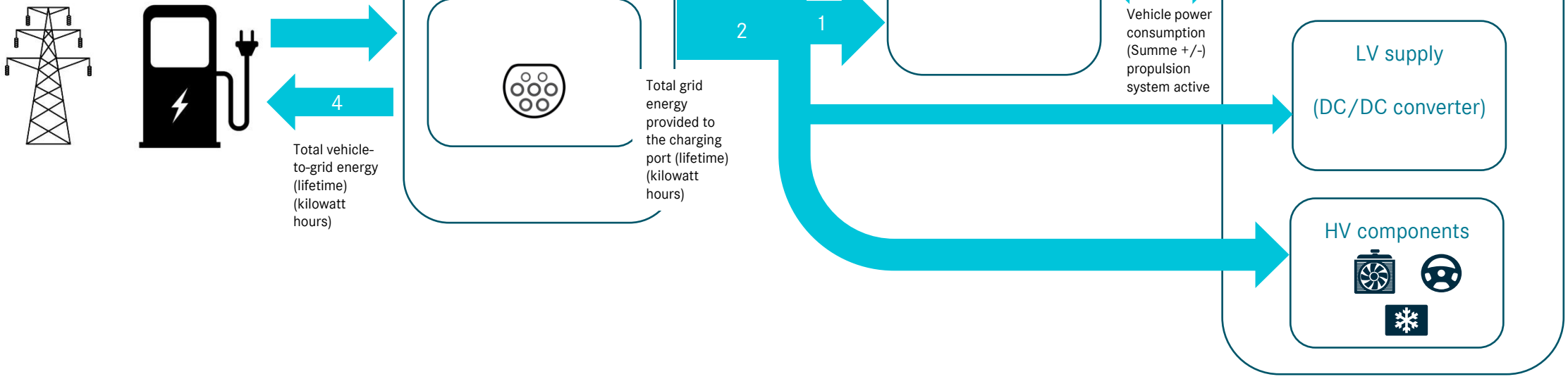
OBFCM DATA REQUIREMENT FOR PURE ELECTRIC VEHICLE

Parameter	Lifetime values	Instantaneous values (see Note 1)	Active accumulating data	Static (accumulated) data[1]
Total grid energy into the battery (lifetime) (kilowatt hours)	Yes			
Total grid energy provided to the charging port (lifetime) (kilowatt hours)	Yes			
Total grid energy into the battery from in-motion charging (lifetime) (kilowatt hours)	Yes			
Total vehicle-to-grid energy (lifetime) (kilowatt hours)	Yes			
Total distance travelled (lifetime) (kilometres)	Yes			
Vehicle electric power consumption (kilowatts)		Yes		
Vehicle electric energy consumption during accumulation period (kilowatt hours)			Yes	Yes
Vehicle speed (kilometres/hour)		Yes (actual speed)	Yes (average speed[2])	
Distance travelled during accumulation period (kilometres)			Yes	Yes
Vehicle total mass (see Note 3) (kilograms)		Yes (actual mass)	Yes (average mass[5])	

- Focus on vehicle energy consumption
- 10 min Periode starts with PT Ready?

SCHEMATIC OVERVIEW OBFCM FOR PEV

	Parameter	Lifetime values	Instantaneous values (see Note 1)	Active accumulating data	Static (accumulated) data[1]
1	Total grid energy into the battery (lifetime) (kilowatt hours)	Yes			
2	Total grid energy provided to the charging port (lifetime) (kilowatt hours)	Yes			
3	Total grid energy into the battery from in-motion charging (lifetime) (kilowatt hours)	Yes			
4	Total vehicle-to-grid energy (lifetime) (kilowatt hours)	Yes			
5	Total distance travelled (lifetime) (kilometres)	Yes			
6	Vehicle electric power consumption (kilowatts)		Yes		
7	Vehicle electric energy consumption during accumulation period (kilowatt hours)			Yes	Yes
8	Vehicle speed (kilometres/hour)		Yes (actual speed)	Yes (average speed[2])	
9	Distance travelled during accumulation period (kilometres)			Yes	Yes
10	Vehicle total mass (see Note 3) (kilograms)		Yes (actual mass)	Yes (average mass[3])	



STANDARDIZATION WORK AT SAE

Parameter	Lifetime values	Instantaneous values (see Note 1)	Active accumulating data (10 min)	Static (accumulated) data	SAE J1979DA DID				Comment
Total grid energy into the battery (lifetime) (kilowatt hours)	Yes				tbc	tbc	4 bytes 0.1kWh per bit Min value: 0 kWh Max value:429,496,729.5 kWh	tbd Lifetime counters shall be stored in NVRAM and may not be erasable by any scan tool command or by disconnecting power to the on-board computer, or when the control module containing the counters is reprogrammed. Lifetime counters may only be erased in conjunction with the reprogramming of the Vehicle Identification Number (VIN) or Engine Serial Number (ESN)	Accummulated grid energy stored in the battery during charging events. Grid energy provided by a charging station minus energy losses and the grid energy used for other components during charging (e.g. cooling system).
Total grid energy provided to the charging port (lifetime) (kilowatt hours)	Yes				tbc	tbc	4 bytes 0.1kWh per bit Min value: 0 kWh Max value:429,496,729.5 kWh	tbd Lifetime counters shall be stored in NVRAM and may not be erasable by any scan tool command or by disconnecting power to the on-board computer, or when the control module containing the counters is reprogrammed. Lifetime counters may only be erased in conjunction with the reprogramming of the Vehicle Identification Number (VIN) or Engine Serial Number (ESN)	Accumulated grid energy (measured/calculated) provided to the charging system of a vehicle.
Total grid energy into the battery from in-motion charging (lifetime) (kilowatt hours)	Yes				tbc	tbc	4 bytes 0.1kWh per bit Min value: 0 kWh Max value:429,496,729.5 kWh	tbd Lifetime counters shall be stored in NVRAM and may not be erasable by any scan tool command or by disconnecting power to the on-board computer, or when the control module containing the counters is reprogrammed. Lifetime counters may only be erased in conjunction with the reprogramming of the Vehicle Identification Number (VIN) or Engine Serial Number (ESN)	This is the accumulated energy (not grid energy) into the battery during vehicle motion (recuperation) or This is the accumulated grid energy into the battery during vehicle motion (only overhead line vehicles)
Total vehicle-to-grid energy (lifetime) (kilowatt hours)	Yes				tbc	tbc	4 bytes 0.1kWh per bit Min value: 0 kWh Max value:429,496,729.5 kWh	tbd Lifetime counters shall be stored in NVRAM and may not be erasable by any scan tool command or by disconnecting power to the on-board computer, or when the control module containing the counters is reprogrammed. Lifetime counters may only be erased in conjunction with the reprogramming of the Vehicle Identification Number (VIN) or Engine Serial Number (ESN)	Accummulated energy vehicle to grid
Total distance travelled (lifetime) (kilometres)	Yes				new	Total Distance Traveled (Lifetime)	4 bytes 0.1km per bit Min value: 0 km Max value:429,496,729.5 km	Total Distance Traveled (Lifetime) shall accumulate the distance traveled using the same data source that the vehicle odometer uses. The data shall be updated at a minimum rate of once per second. Data Not Available: There may be two cases where data is not available. 1) The communication network used to obtain odometer from the master ECU is not functioning. 2) The ECU that holds the vehicle odometer (e.g. instrument cluster) is not functioning. Lifetime counters shall be stored in NVRAM and may not be erasable by any scan tool command or by disconnecting power to the on-board computer, or when the control module containing the counters is reprogrammed. Lifetime counters may only be erased in conjunction with the reprogramming of the Vehicle Identification Number (VIN) or Engine Serial Number (ESN)	
Vehicle electric power consumption (kilowatts)		Yes			tbc	tbc	tbd		Vehicle power consumption during propulsion system active (positive and negative values)
Vehicle electric energy consumption during accumulation period (kilowatt hours)			Yes		tbc	tbc	tbd	Positive und negative Werte	Vehicle power consumption during propulsion system active (positive and negative values)
				Yes	tbc	tbc	tbd	Positive und negative Werte	Vehicle power consumption during propulsion system active (positive and negative values)

STANDARDIZATION WORK AT SAE

Parameter	Lifetime values	Instantaneous values (see Note 1)	Active accumulating data (10 min)	Static (accumulated) data	SAE J1979DA DID				Comment
Vehicle speed (kilometres/hour)		Yes (actual speed)			0xF40D	Vehicle Speed Sensor	1 km/h per bit	VSS shall display vehicle road speed. Vehicle speed may be derived from a vehicle speed sensor, calculated by the ECU using other speed sensors, or obtained from the vehicle serial data communication bus.	
			Yes (average speed)		new	Average vehicle speed	0.1 km/h per bit Min: 0 km/h Max: 6553.5 km/h	Average vehicle speed shall display the average vehicle speed of the active accumulation period. Average vehicle speed is calculated based on distance travelled and the number of minutes since the end of the last accumulation period. Average vehicle speed shall be reset to zero at the end of an active accumulation period (after 10 minutes, or on engine switch off).	
Distance travelled during accumulation period (kilometres)			Yes		new	Total Distance Traveled (Accumulation period)	2 bytes 0.01 km per bit Min value: 0 km Max value: 655.35 km	Distance Travelled (Active accumulating data) is the distance travelled in the active accumulation period. Distance travelled must use the same data source as the vehicle odometer. Distance travelled is used to calculate the average speed over the accumulation period. Distance Travelled shall reset to zero when the engine run time in this category reaches 10 minutes, or on engine switch off.	
				Yes	new	Total Distance Traveled (Static data)	4 bytes 0.01 km per bit Min value: 0 km Max value:42,949,672.95 km	Matrix data	Yes
Vehicle total mass (see Note 3) (kilograms)		Yes (actual mass)			tbd	Total vehicle mass	2 bytes 100 kg per bit Min: 0 kg Max: 6,553,500 kg	Total vehicle mass shall display the measured or modeled total vehicle mass in kg. Total vehicle mass shall be set to 0 until the vehicle mass is measured or calculated for the first time in current ignition cycle.	
			Yes (average mass[5])	~~yes~~	tbd	Average vehicle mass	2 bytes 100 kg per bit Min: 0 kg Max: 6,553,500 kg	Average vehicle mass (Active accumulating data) shall display the average total vehicle mass in kg of the active accumulation period. Average vehicle mass shall reset to zero when the engine run time in this category reaches 10 minutes, or on engine switch off.	~~yes~~

Parameter	Lifetime values	Instantaneous values (see Note 1)	Active accumulating data	Static (accumulated) data[1]
Total grid energy into the battery (lifetime) (kilowatt hours)	Yes			
Total grid energy provided to the charging port (lifetime) (kilowatt hours)	Yes			
Total grid energy into the battery from in-motion charging (lifetime) (kilowatt hours)	Yes			
Total vehicle-to-grid energy (lifetime) (kilowatt hours)	Yes			
Total distance travelled (lifetime) (kilometres)	Yes			
Vehicle electric power consumption (kilowatts)		Yes		
Vehicle electric energy consumption during accumulation period (kilowatt hours)			Yes	Yes
Vehicle speed (kilometres/hour)		Yes (actual speed)	Yes (average speed[2])	
Distance travelled during accumulation period (kilometres)			Yes	Yes
Vehicle total mass (see Note 3) (kilograms)		Yes (actual mass)	Yes (average mass[5])	

4. Information to be determined, stored and made available

4.1 Overall requirements

General structure of information to be stored comprises – lifetime values, active accumulating data and static data. In addition, instantaneous values are to be made available.

Lifetime values	This category represents aggregate values accumulated since the first initial engine operation after production
Active accumulating data	Values stored in this category are accumulating instantaneous values up to 10 minutes of operation. The category shall reset to zero and begin incrementing again when the engine run time in this category reaches 10 minutes, or on engine switch off.
Static data.	These are accumulated values (transferred into bins from the active accumulating data category) each 10-minute interval, or on engine switch off, added up over the lifetime of the vehicle. These data are matrices, indexed by average speed and average total mass

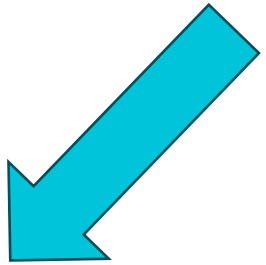
DATA TRANSFER AND AVAILABILITY AT PTI

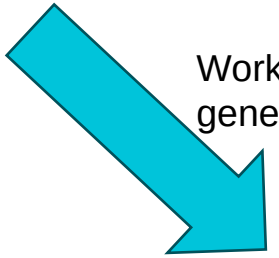
DATA TRANSFER

GENERIC SCAN TOOL INTEGRATION OF SIGNALS & AVAILABILITY AT PTI

ISO 15031-3 Type B connector

ScanTool, ISO27145 / J1979-2 (Fuel Based) J1979-3 (PEV)





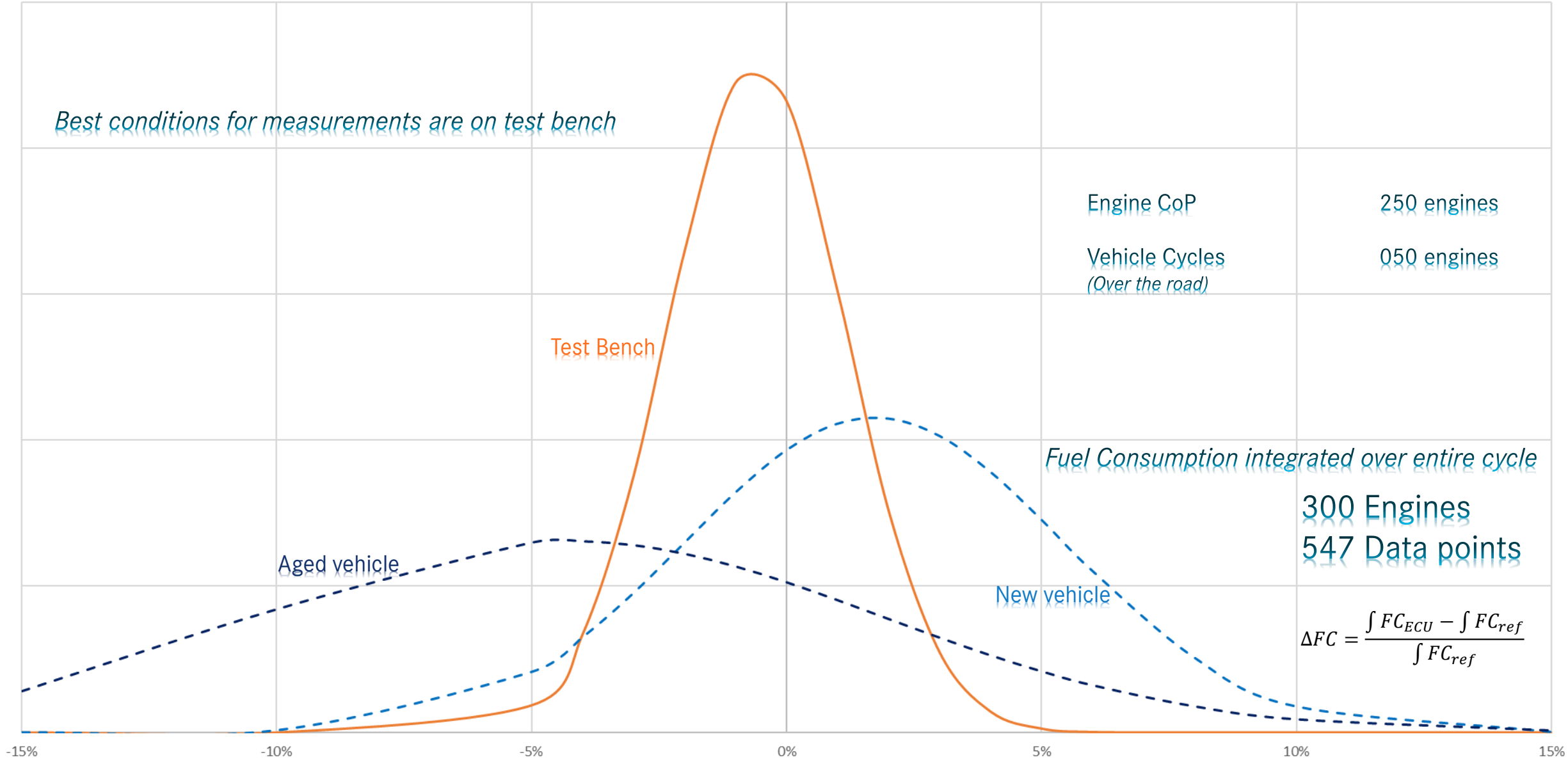
Workshop Tester, Manufacturer individual, generally available (RMI)

- ScanTool devices are available in every workshop, PTI station, also used by a lot of drivers
- Standardized data, easy to compare in between different vehicles
- But: Standardization takes time (min. ~2 years)

- Devices are sold manufacturer individual, every PTI station would need one special tester for each manufacturer (=>€€€)
- Non standardized data, individual for each manufacturer (min/max, resolution...) makes it inconvenient to compare
- Could be slightly faster to implement

OBFCM AND OBMM TOLERANCES

STATE OF THE ART SITUATION


Best conditions for measurements are on test bench
Engine CoP
250 engines
Vehicle Cycles
(Over the road)
050 engines
Test Bench
Fuel Consumption integrated over entire cycle
300 Engines
547 Data points
Aged vehicle
New vehicle
$\Delta FC = \frac{\int FC_{ECU} - \int FC_{ref}}{\int FC_{ref}}$
-15%
-10%
-5%
0%
5%
10%
15%

OBFCM & OBMM FAMILY DEFINITION

FAMILY DEFINITION

Current Status on family definition for Tests done for OBFCM & OBMM

- Engine FCMC & COP EOL (declaration only)
  - Family defined according to Engine Families

  => Stick to engine Families (UNR49)

- OBFCM VTP COP+ISV & PEMS ISC
  - OBFCM VTP => Family Definition

    => Group measured Data to engine PEMS Families (UNR49)
  - OBFCM PEMS ISC => regarding PEMS Families defined in Emission regulation

    => Group measured Data to engine PEMS Families (UNR49)

- OBMM VTP COP+ISV (VTP adapted)

  To be defined in agreement between TS & TAA

  Vehicle category according to (EC) 2018/858, Annex I, Part A, shall be minimum criteria for OBMM family.

SAE STANDARISATION

OVERVIEW OF DEVELOPMENT

SAE - INTEGRATION OF SIGNALS - STEPWISE APPROACH AGREEMENT WITH SAE

SAE Step 1 - Mid 2025

Quick Approach

Diesel B7 reference fuel

- Data transfer with SAE standard signals (SAE J1979DA)
  lifetime FC & distance
  - In kg => currently not available
  - In liter => currently available
    => but reset conditions different to HDV requirement
    => PNG / CNG / alt. fuels excluded
- **new: engine operation hours****

** defined for IUPR (Reg 49, Annex 9C – 7.3.1.), reset to zero after reprogramming event required

Parameter just liter possible	Lifetime values	Instantaneous values (see Note 1)	Active accumulating data	Static (accumulated) data[4]
Total fuel consumed (lifetime) (litres and kilograms)	Yes			
Total distance travelled (lifetime) (kilometres)	Yes			
additional: engine operation hours**				
Vehicle fuel rate (see Note 2) (grams/second)		Yes		
Vehicle speed (kilometres/hour)		Yes (actual speed)	Yes (average speed[5])	
Fuel consumed during accumulation period (litres and kilograms)			Yes	Yes
Distance travelled during accumulation period (kilometres)			Yes	Yes
Vehicle total mass (see Note 3) (kilograms)		Yes (actual mass)	Yes (average mass[5])	Yes
Instantaneous brake engine power (see Note 4) (kilowatts)		Yes		
Engine output energy (see Note 4) (kilowatt hours)			Yes	Yes

41	0x17	0xF817	Total Fuel Consumed (Recent)	Max value:42,949,672.95 liters	FC-R xxxxxxxx.xx l	even though the calculation may be active.
42	0x17	0xF817	Total Fuel Consumed (Lifetime)	4 bytes 0.01 liters per bit Min value: 0 liters Max value:42,949,672.95 liters	FC-L xxxxxxxx.xx l	Total Fuel Consumed (Lifetime) shall accumulate the calculated amount of fuel injected into the engine and the calculated fuel injected directly into the aftertreatment system in liters over the sample period (typically one second). Fuel used by a fuel operated heater shall not be included. The data shall be updated at a minimum rate of once per second. See Note B for reset conditions, see Note C for freeze conditions. Note: Data is valid only for liquid fuels, e.g. gasoline, E85, diesel. It is not valid for alternative fuels like LPG or CNG even though the calculation may be active.

SAE - INTEGRATION OF SIGNALS - STEPWISE APPROACH AGREEMENT WITH SAE

SAE Step 2 - Mid 2027

SAE matrix approach

Diesel B7 reference fuel

- Data transfer with SAE new standardized matrix (SAE J1979)
- SAE standardization covers following*: combustion engines / PEV **

* based on SAE standard availability

** SAE position max.to be done until mid 2027

Parameter	Lifetime values	Instantaneous values (see Note 1)	Active accumulating data	Static (accumulated) data[4]
Total fuel consumed (lifetime) (litres and kilograms)	Yes			
Total distance travelled (lifetime) (kilometres)	Yes			
Engine fuel rate (see Note 2) (grams/second)		Yes		
Vehicle fuel rate (see Note 2) (grams/second)		Yes		
Vehicle speed (kilometres/hour)		Yes (actual speed)	Yes (average speed[5])	
Fuel consumed during accumulation period (litres and kilograms)			Yes	Yes
Distance travelled during accumulation period (kilometres)			Yes	Yes
Vehicle total mass (see Note 3) (kilograms)		Yes (actual mass)	Yes (average mass[5])	Yes
Instantaneous brake engine power (see Note 4) (kilowatts)		Yes		
Engine output energy (see Note 4) (kilowatt hours)			Yes	Yes

SAE - INTEGRATION OF SIGNALS - STEPWISE APPROACH AGREEMENT WITH SAE

SAE Step 3 - Mid 2029

Full approach

All vehicles in Scope of VECTO

- OBFCM & OBMM
- FC/MM accuracy check in COP VTP
- Data transfer with SAE new standardized matrix (SAE J1979)
- SAE standardization covers following (combustion engines / PEV / Hybrids)

Parameter	Lifetime values	Instantaneous values (see Note 1)	Active accumulating data	Static (accumulated) data[4]
Total fuel consumed (lifetime) (litres and kilograms)	Yes			
Total distance travelled (lifetime) (kilometres)	Yes			
Engine fuel rate (see Note 2) (grams/second)		Yes		
Vehicle fuel rate (see Note 2) (grams/second)		Yes		
Vehicle speed (kilometres/hour)		Yes (actual speed)	Yes (average speed[5])	
Fuel consumed during accumulation period (litres and kilograms)			Yes	Yes
Distance travelled during accumulation period (kilometres)			Yes	Yes
Vehicle total mass (see Note 3) (kilograms)		Yes (actual mass)	Yes (average mass[5])	Yes
Instantaneous brake engine power (see Note 4) (kilowatts)		Yes		
Engine output energy (see Note 4) (kilowatt hours)			Yes	Yes

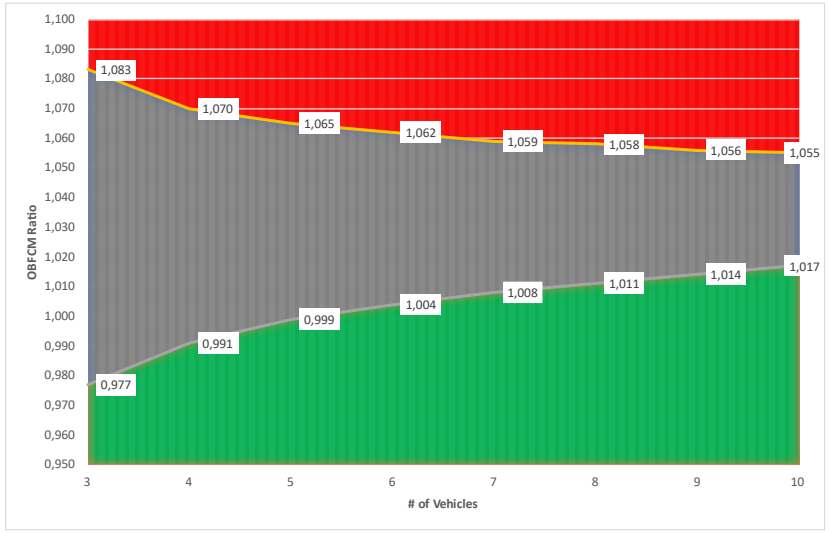
SAE STANDARDISATION

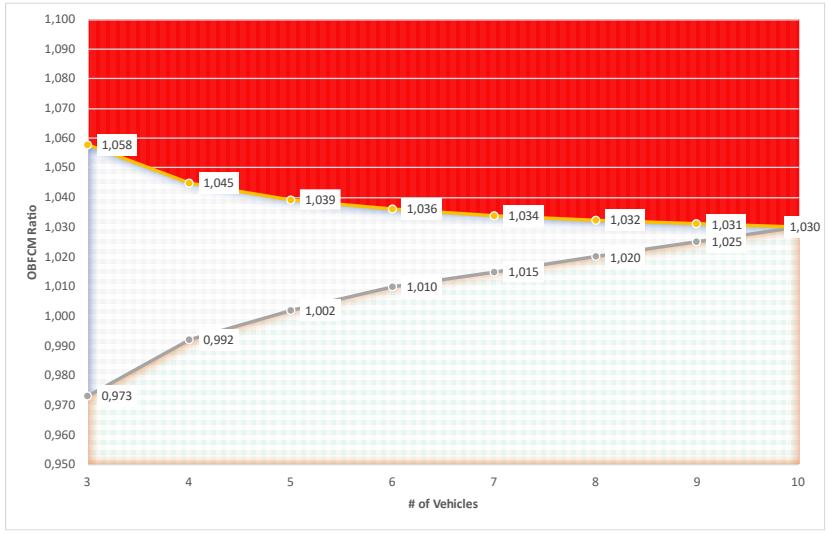
- Unstandardized OBD data communication will result in OEM-specific OBD scan tools, must go through SAE standardization
- Example: CARB “REAL” program i.e. NOx Emission Tracking was >4 year SAE project. OBFCM binning is significantly more challenging!
- Communication Standards:
  - Only ISO 27145 mentioned
  - Euro VI allow both J1939 or ISO27145, but only one standard for OBD communication is allowed in the vehicle!
    - For J1939 new SPN required
    - J1979-2 (OBDonUDS) should also be added
    - J1979-3 (ZEVonUDS for electric vehicle) should also be added
- Calculation of vehicle weight unclear, is the same method as vehicle speed proposed? (i.e. calculation at the end of the period)
- Charge-sustaining operation fuel consumption parameter unjustified. Issue has been resolved by LDV industry

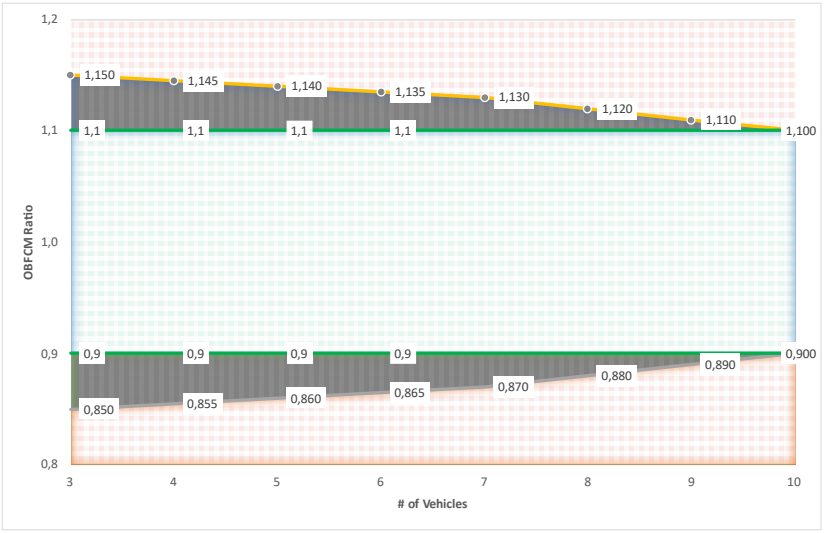
OBFCM & OBMM STATISTICAL APPROACH

STATISTICAL APPROACH

NEW CALCULATION APPROACH ALSO NOT SATISFACTORY | ACEA PROPOSAL TO USE APPROACH SIMILAR TO ENGINE COP

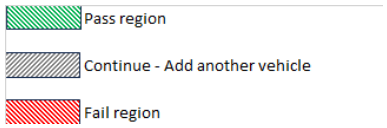






Old Calculation

- $x_i = \frac{FC_{OBFCM}}{FC_{reference}}$
- Factors from JRC report



New Calculation

- $x_i = \frac{FC_{reference}}{FC_{OBFCM}}$
- New factors from LDV
- Further study ongoing from JRC & CLIMA to define suitable factors

ACEA proposal

- Possibility to pass on first attempt while meeting accuracy targets
- Similar to engine CoP, available margin/limit decreases with increasing sample size

Boundary considered for Old & New Calculations : A-Factor 1.03 | SD 2.5%

SALES FIGURES

FULL STEEL SUSPENSION & MANUAL GEARBOXES

SALES FIGURES – TOTAL

Vehicle Manufacturer	% Share - Full Steel Suspension (number of units)	% Only Manual transmission (number of units)
OEM 1	7%	10%
OEM 2	1% (2300)	0.3% (800)
OEM 3	8.6% (8401)	2.6% (2565)
OEM 4	12% (2406)	4% (505)
OEM 5	16.3%	13.5%
OEM 6	13.8% (29600)	2.12% (4550)
OEM 7	10.61% (27245)	2.5% (6589)

SALES FIGURES – BY VECTO CLASS

VECTO CLASS 1,2,3

OEM 1	Quantity	%
Sales number 2021 - 2023	32982	100,00 %
Full Steel Suspension	8859	26,86 %
Manual Gearbox	3985	12,08 %

OEM 2	Quantity	%
Sales number 2021 -2023	17,069	100,00%
Full Steel Suspension	7899	46.27%
Manual Gearbox	5399	31.06%

OEM 4	Quantity	%
Sales number 2021 -2023	10840	100%
Full Steel Suspension	1900	17.5%
Manual Gearbox	554	5.1%

For VECTO class 1,2,3 we propose to not include full steel as OBMM accuracy will be less accurate as we do not have a start up signal form Air suspension

Manual gearbox cannot be included in OBMM as we do not have the information what gear is used => calc. method not possible

SALES FIGURES – BY VECTO CLASS

VECTO CLASS 4,5,9,10

OEM 1	Quantity	%
Sales number 2021 -2023	147583	100%
Full Steel Suspension	0	0,00
Manual Gearbox	0	0,00

OEM 3	Quantity	%
Sales number 2021 -2023	99 179	100%
Full Steel Suspension	325	0.32%
Manual Gearbox	359	0.33%

OEM 2	Quantity	%
Sales number 2021 -2023	140956	100,00%
Full Steel Suspension	4156	2.94%
Manual Gearbox	4151	2.94%

OEM 4	Quantity	%
Sales number 2021 -2023	182675	100%
Full Steel Suspension	1421	0.8%
Manual Gearbox	364	0.2%

For VECTO class 4,5,9,10 we propose to not include full steel & manual gearbox in OBMM as accuracy will be less accurate.

This figures will decrease further as more and more partly air suspended are used

OEM 5	Quantity	%
Sales number 2021 -2023	15968	100%
Full Steel Suspension	695	4,35%
Manual Gearbox	605	3,88%

SALES FIGURES – BY VECTO CLASS

VECTO CLASS 11,12,16

OEM 1	Quantity	%
Sales number 2021 -2023	33387	100 %
Full Steel Suspension	20741	62,12%
Manual Gearbox	565	1,69%

OEM 2	Quantity	%
Sales number 2021 - 2023	22815	100,00%
Full Steel Suspension	4154	18.2%
Manual Gearbox	595	2.6%

OEM 3	Quantity	%
Sales number 2021 -2023	11110	100%
Full Steel Suspension	3147	28.33%
Manual Gearbox	146	1.31%

OEM 4	Quantity	%
Sales number 2021 -2023	26918	100%
Full Steel Suspension	10884	40.4%
Manual Gearbox	185	0.7%

- **For VECTO class 11,12,16 we propose to not include full steel as OBMM accuracy will be less accurate.**
- **We have a high variance of PTO use for this VECTO classes and the OBMM signals are quite inaccurate**
- **Manual gearbox cannot be included in OBMM as we do not have the information what gear is used => calc. method not possible**

BACK-UP

GENERAL

- In the HDV industry, TCO determines the purchase choice of vehicles
- Fuel consumption is one of the most core properties of a HDV and represents about 1/3 of all the costs of an operator
- OBFCM does not lead to different choice of purchase by the operator
- ACEA acknowledges the intention of the OBFCM/OBMM procedure, namely to monitor the relative trend between declared VECTO value and real-world fuel consumption
- This procedure is not an absolute value target regulation, but ACEA understands certain accuracies are necessary for relative comparisons
- To support such a regulation, which has been demanded in 2019/1242, ACEA proposes a stepwise introduction of procedures and accuracies
- Considering the hardware and software development perspective, the lead time until mid 2025 is not feasible for the accuracies and vehicle classes demanded by COM
- ACEA can offer an early introduction on a report basis, with data readout with OEM specific SW, that is available mid 2025/2026 handed over by TS/TAA

SCOPE OF VEHICLE SEGMENTS IN DETAIL

ACEA proposal Vehicle segmentation trucks ≥ 7.5 t

	Identification vehicle configuration			Class	Cycle allocation Vehicle configuration / weight / axle loads					Body/ trailer allocation		
	Axle configuration	Chassis configuration	weight	Vehicle Class	Long haul	Regional delivery	Urban delivery	Municipal utility	Construction	Standard Bodies (B)	Standard Trailer (T)	Standard Semitrailer (ST)
2 axles	4x2	Rigid + (Tractor*)	7.5t - 10t	**1**		R (pc)	R (pc)			B1		
		Rigid + (Tractor*)	> 10t - 12t	**2**	R+T (pc)	R (pc)	R (pc)			B2	T1	
		Rigid + (Tractor*)	> 12t - 16t	**3**		R (pc)	R (pc)			B3		
		Rigid	> 16t	**4**	R+T (14,0t)	R (4,4t)		R (4,4t)		B4	T2	
		Tractor	> 16t	**5**	Tr+ST (19,3t)	Tr+ST (12,9t)						ST1
	4x4	Rigid	7.5t - 16t	(6)	exclude all-wheel-drive vehicles 4x4 (sales volume < 1%)							
		Rigid	> 16t	(7)	exclude all-wheel-drive vehicles 4x4 (sales volume < 1%)							
		Tractor	> 16t	(8)	exclude all-wheel-drive vehicles 4x4 (sales volume < 1%)							
3 axles	6x2/2-4	Rigid	all	**9**	R+T (19,3t)	R (7,1t)		R (7,1t)		B6	T2	
		Tractor	all	**10**	Tr+ST (19,3t)	Tr+ST (12,9t)						ST1
	6x4	Rigid	all	**11**	R+T (19,3t)	R (7,1t)		R (7,1t)	R (7,1t)##	B6##	T2##	
		Tractor	all	**12**	Tr+ST (19,3t)	Tr+ST (12,9t)			Tr+ST (12,9t)##			ST1##
	6x6	Rigid	all	(13)	exclude all-wheel-drive vehicles 6x6 (sales volume < 1%)							
		Tractor	all	(14)								
4 axles	8x2	Rigid	all	(15)	exclude 8x2 (very low sales volume < 1%)							
	8x4	Rigid	all	**16**					R (12,9t)##	(generic CdxA)		
	8x6/8x8	Rigid	all	(17)	exclude all-wheel-drive vehicles (sales volume < 1%)							
EMS 2 axles	4x2	Tractor	all		Tr+ST+T (28t)	Tr+ST+T (18.7t)					T2	ST1-v2#
EMS 3 axles	6x2/ 6x4	Rigid	all		R+D+ST (28t)	R+D+ST (18.7t)				B6		ST1-v2#
		Tractor	all		Tr+ST+T (28t)	Tr+ST+T (18.7t)					T2	ST1-v2#

R=Rigid+Body; Tr=Tractor; B=Body; T=Trailer; ST=Semitrailer; D=Dolly; (x,xt)=payload; (pc)=payloadcurve over GVW; # ST1-v2=ST1 (use ST1 data)

* Tractors are treated as Rigids but with specific curb weight of tractor. Airdrag and weight/payload for semitrailer as for Rigid (simplification)

construction vehicles with generic CdxA

SCOPE OF VEHICLE SEGMENTS IN DETAIL

Vehicle group according to Annex I to Regulation (EU) 2017/2400	Cab type	Engine power	Operational range (OR)	Vehicle sub-group (sg) attributed for the purposes of this Regulation*	
				Vehicles other than vocational	Vocational vehicles
53 and zero-emission vehicles in 51	All			53	53v
54 and zero-emission vehicles in 52	All			54	-
1s	All			1s	1sv
1	All			1	1v
2	All			2	2v
3	All			3	3v
4	All	<170 kW	All	4-UD	4v
	Day cab	≥170 kW	All	4-RD	
	Sleeper cab	≥170 kW and <265 kW			
	Sleeper cab	≥265 kW	≥ 350 km	4-LH	
9	Day cab	All	All	9-RD	9v
	Sleeper cab	All	< 350 km		
	Sleeper cab	All	≥ 350 km	9-LH	
5	Day cab	All	All	5-RD	5v
	Sleeper cab	< 265 kW			
	Sleeper cab	≥ 265 kW	< 350 km		
	Sleeper cab	≥ 265 kW	≥ 350 km	5-LH	
10	Day cab	All	All	10-RD	10v
	Sleeper cab	All	< 350 km		
	Sleeper cab	All	≥ 350 km	10-LH	
11	All			11	11v
12	All			12	12v
16	All			16	16v

OBFCM VS VECTO

- VECTO value variation within an example group consisting of
  - 1 model year
  - 1 engine (emission) family
  - 1 vehicle group

- VECTO is not perfect

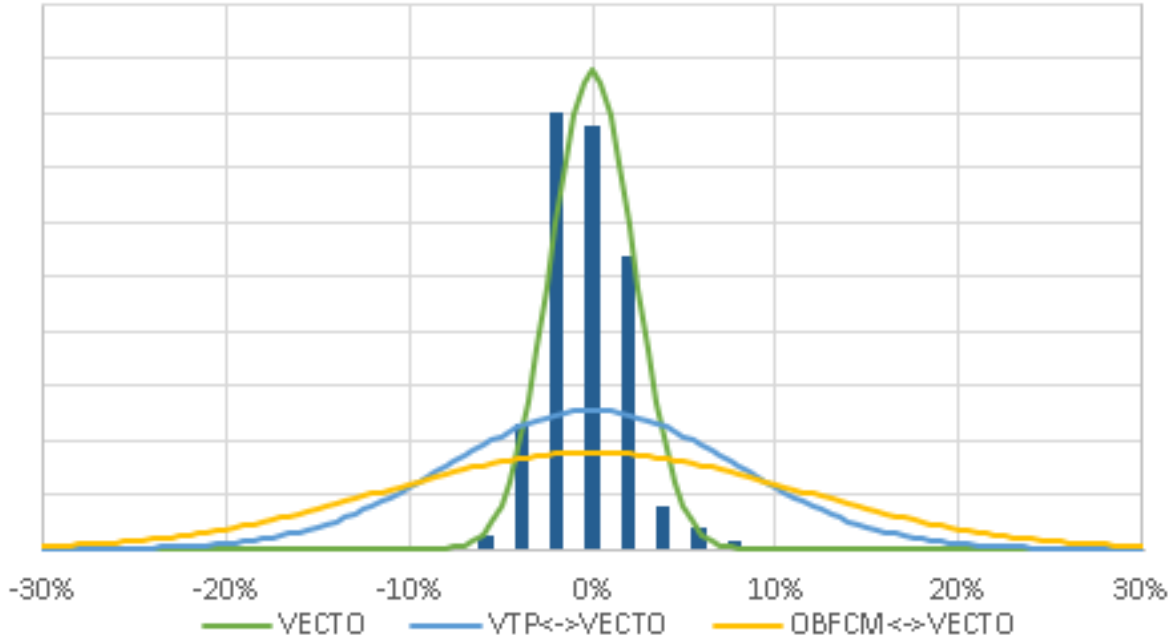
  7.5% allowed compared to VTP

- OBFCM is not perfect

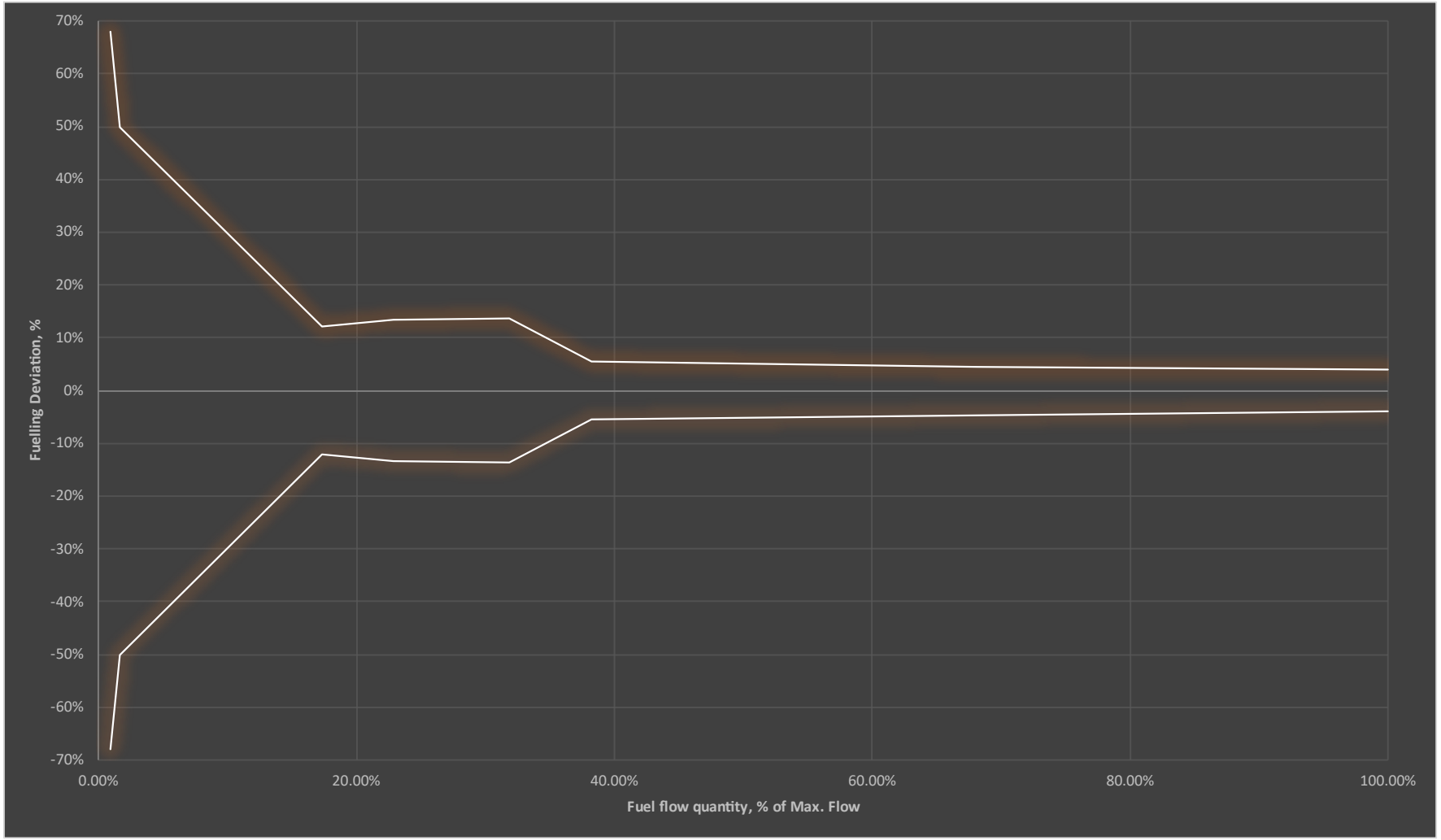
  $\sqrt{5\%^2 + 5\%^2 + 4\%^2} \approx 8\%$ compared to VTP

  (accuracies according to CLOVE proposals, ACEA proposes <u>less</u> stringent accuracies)

- Additionally, real operation is not perfectly represented by VECTO in all cases. Curve will be even more flat in reality.

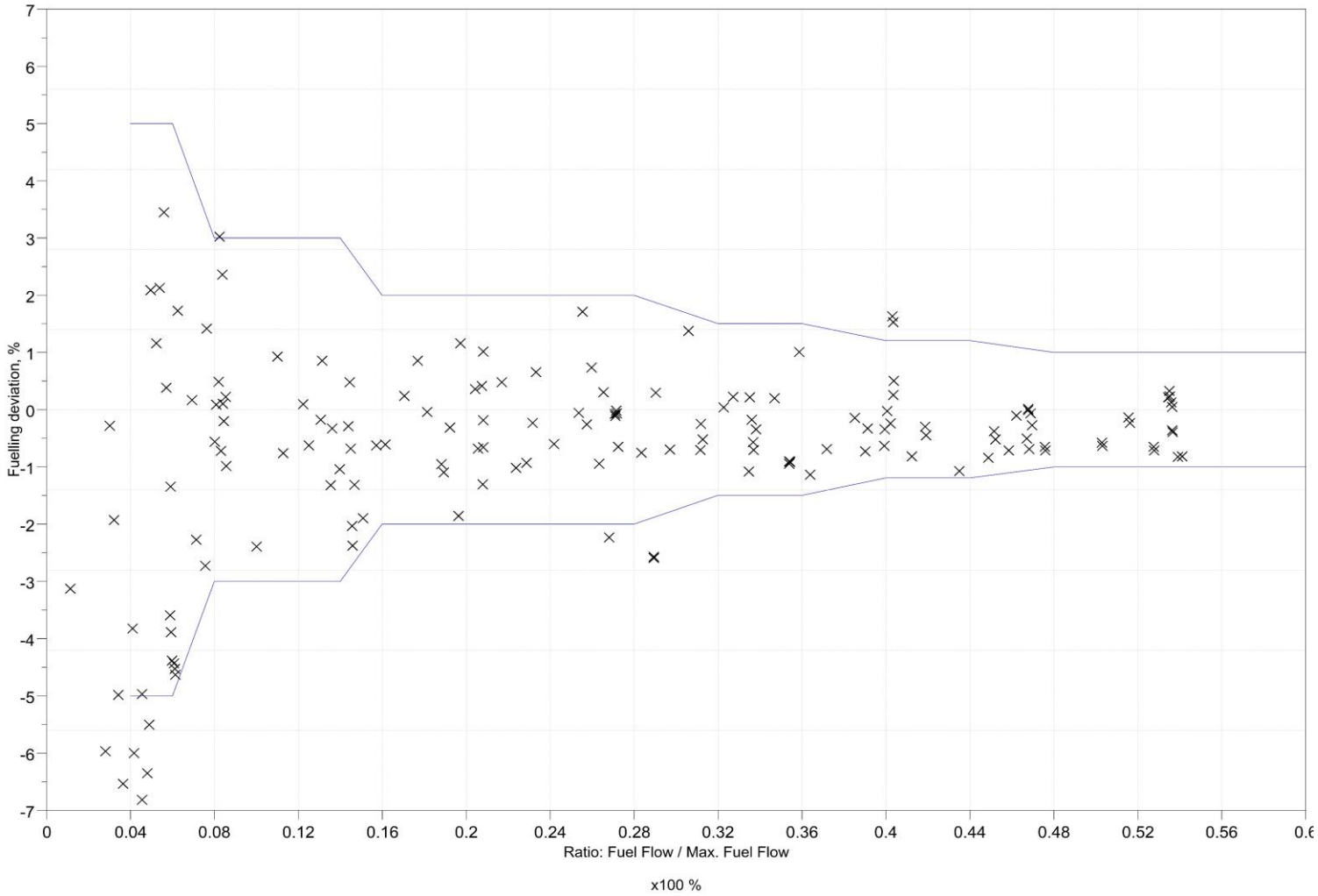


ESTIMATED TEST BENCH END OF LIFE DRIFT FOR NOMINAL INJECTION SYSTEM – SUPPLIER INFORMATION



- Nominal injection system
- Controlled environment
- Injection bench
- Steady state drift
- End of life measurement
- Reference Fuel

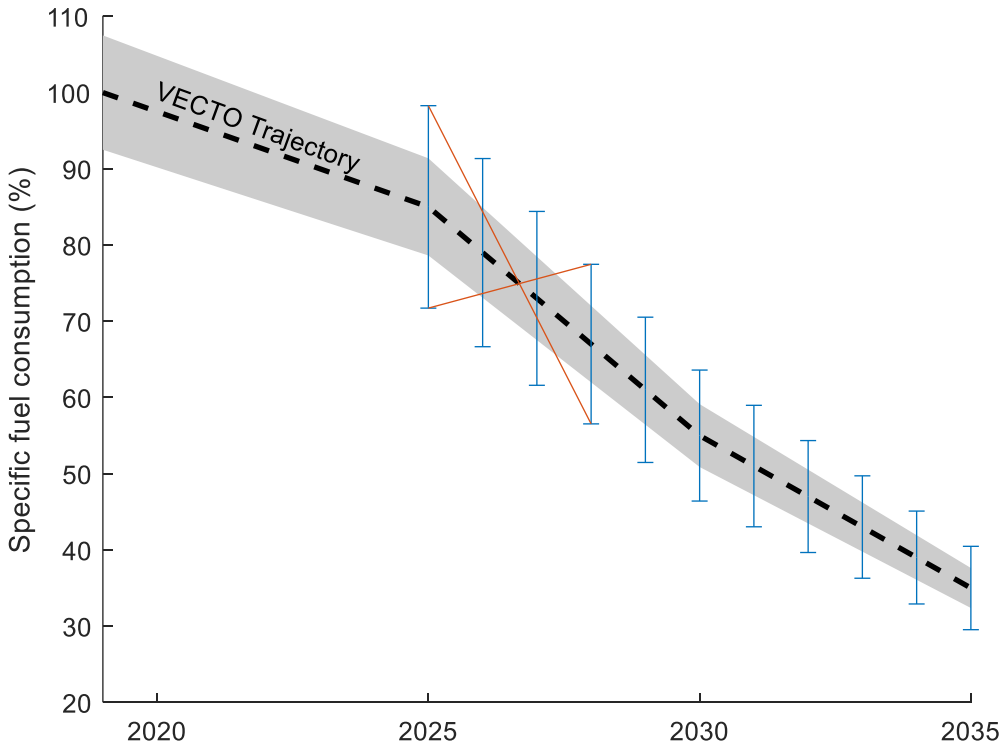
ESTIMATED TEST BENCH FUELLING DEVIATION FOR NEW NOMINAL INJECTION SYSTEM – OEM INTERNAL DEVELOPMENT INFORMATION



- Controlled environment
- Engine test bench
- Steady state drift values
- Internal OEM target including calibration
- Reference Fuel

OBFCM VS TRAJECTORY

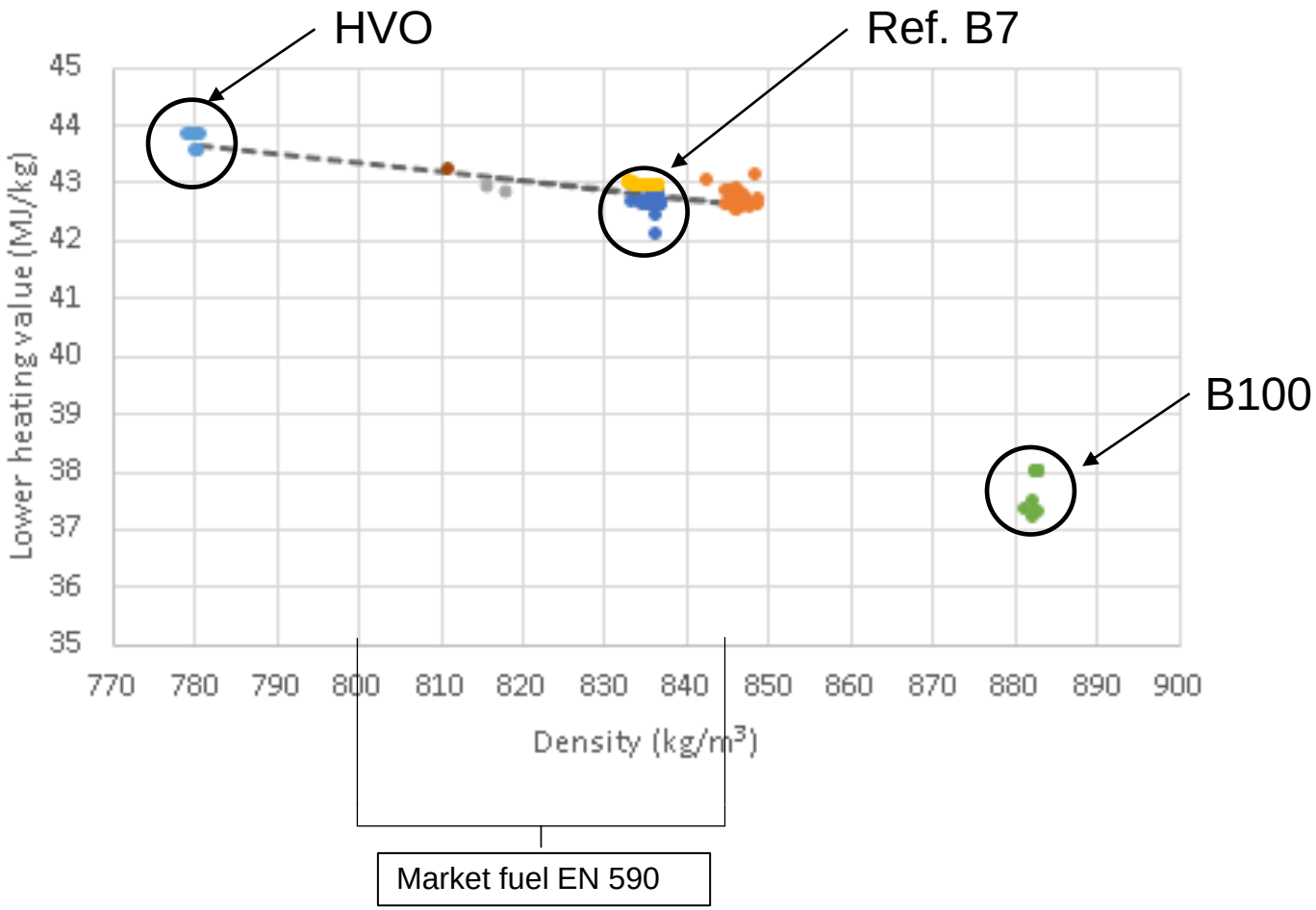
- Large error compared to trajectory* slope
- Even if OBFCM is within accuracy limits suggested by COM/CLOVE, trend could point in the wrong direction
- Hence: what is the intended use of OBFCM data?



*trajectory based on revised CO2 standards trilouge agreement

FUEL DENSITY

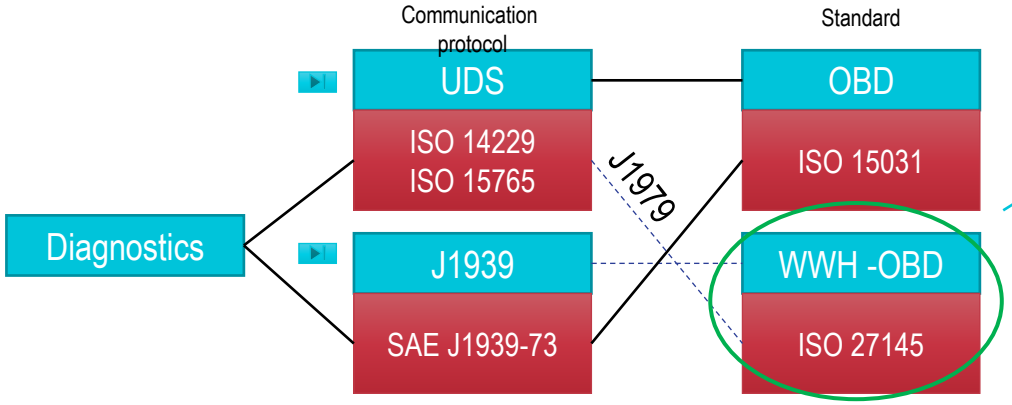
- Very large density range for market fuel compared to reference fuel, B7
- An overestimation of density is compensated by an underestimation of LHV. This keeps torque reporting within accuracy for B7 and HVO
- A “diesel” engine could be certified for B7, B100 and HVO



SAE DEVELOPMENT TIMELINE

CARB NOx Emission Tracking

- 2017 First Proposal from CARB – based on logged data for one month
- 2019 Standardization work first draft version on NOX Binning - SAEJ1979_DA_201905
- 2021 Frozen requirement for Light duty - J1979DA_202104



SAE	Sector	Comment
J1979-DA	WWH-OBD	Relevant for Euro VI, and for Euro 7 Discussion started with J1979-DA Not initiated with J1939 SC
J1939	WWH-OBD	
J1979-2	LD	Euro 7
J1979-3	ZEV	Electric Vehicles

OBFCM Binning					
vehicle mass		speed classification			
min	max	„Idle“ Speed <1,6km/h w/o PTO	„Idle“ Speed <1,6km/h w PTO	„Urban“ Speed >1,6 <60km/h	„High Speed“ Speed >60km/h
2000	2999	4 bytes	4 bytes	4 bytes	4 bytes
3000	3999	4 bytes	4 bytes	4 bytes	4 bytes
4000	4999	4 bytes	4 bytes	4 bytes	4 bytes
5000	5999	4 bytes	4 bytes	4 bytes	4 bytes
6000	6999	4 bytes	4 bytes	4 bytes	4 bytes
7000	7999	4 bytes	4 bytes	4 bytes	4 bytes
8000	9999	4 bytes	4 bytes	4 bytes	4 bytes
10000	11999	4 bytes	4 bytes	4 bytes	4 bytes
12000	13999	4 bytes	4 bytes	4 bytes	4 bytes
14000	15999	4 bytes	4 bytes	4 bytes	4 bytes
16000	17999	4 bytes	4 bytes	4 bytes	4 bytes
18000	19999	4 bytes	4 bytes	4 bytes	4 bytes
20000	22999	4 bytes	4 bytes	4 bytes	4 bytes
23000	25999	4 bytes	4 bytes	4 bytes	4 bytes
26000	28999	4 bytes	4 bytes	4 bytes	4 bytes
29000	31999	4 bytes	4 bytes	4 bytes	4 bytes
32000	34999	4 bytes	4 bytes	4 bytes	4 bytes
35000	37999	4 bytes	4 bytes	4 bytes	4 bytes
38000	40999	4 bytes	4 bytes	4 bytes	4 bytes
41000	44999	4 bytes	4 bytes	4 bytes	4 bytes
45000	48999	4 bytes	4 bytes	4 bytes	4 bytes
49000	53999	4 bytes	4 bytes	4 bytes	4 bytes
54000	58999	4 bytes	4 bytes	4 bytes	4 bytes
59000	64999	4 bytes	4 bytes	4 bytes	4 bytes
65000	72000	4 bytes	4 bytes	4 bytes	4 bytes

No of bytes per element is 4 [worst case]
No of elements required as per EU Slides is 25 per array (Bin 1 – 24)
The parameters required are 3 (SD, FC(Kg), EOE)
The total Parameters per Array is 2 (4) * 25 * 3= 384 = 1536 bytes

Hence, the total will be 1536 bytes for the OBFCM Binning alone

!!! Engine running hours is not considered in this calculation. Ring buffer excluded

Using manufacturer standards can cause risk in having own interpretation. Heavy Duty Euro VI requires both J1979 and J1939. to implement the whole package we require long lead time.

VTP VS PEMS

UN-ECE R49-07, Annex 8

	Euro VI step E	Euro 7
Max temp at start	The temperature of the coolant shall not exceed the ambient temperature by more than 5 °C, and shall not exceed 303 K (30 °C).	Same
Start of logging/sampling	Emissions sampling, measurement of the exhaust parameters and recording of the engine and ambient data shall commence prior to the test start.	Same
Test start	For the purposes of the test procedure, “test start” shall mean the first ignition of the internal combustion engine.	Same
Start of evaluation of trip composition	coolant temperature has reached 343 K (70 °C) for the first time or after the coolant temperature is stabilised within ± 2 K over a period of 5 minutes whichever comes first but no later than 15 minutes after engine start. The period elapsed to reach the coolant temperature of 343 K (70 °C) shall be operated under urban driving conditions.	Same
Payload	PEMS-demo@TA: 50-60% ISC: 10-100%	Same
Trip composition	N3: 30/25/45 M3: 70/30/0	Same
Test duration	4-8x WHTC	Same
Valid windows	Min 50%	Same
Power threshold for valid window	>=10% average power (of declared rated power)	6%
Urban window	At least one (1) window left in urban operation after 90th percentile rule	Same
Cold emissions	100th percentile of windows starting **below** 343 K (70 °C) coolant temperature. The data evaluation shall **start** once the coolant temperature has reached 303 K (30 °C) for the first time or once the coolant temperature is stabilised within +/– 2 K over a period of 5 minutes, whichever occurs first, but in any event no later than 10 minutes after test start	Same
Warm emissions	90th percentile of windows started after the coolant temperature has reached 343 K (70 °C) for the first time	Same

VTP for OBMM (as proposed by TUG)

No.	Parameter	Min.	Max.
1	Vehicle mass estimation test duration [minutes] *start measuring	15* 80	 120
6	Average ambient temperature	5°C	30°C
7	Road condition dry asfalt	100 %	
8	Road condition snow or ice		0 %
9	Sea level of the route [m]		800
10	Duration of continuous idling at stand still [minutes]		3
11	Accelerations > 0.5 m/s^2	5	
11 or	Hilly conditions The route shall include a 30 km section with hills where the average of all up- and down slope gradients in absolute numbers shall be at least 1,5%		

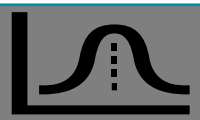
No.	Parameter	Min.	Max.
2	Distance based share urban driving	2 %	8 %
3	Distance based share rural driving	7 %	13 %
4	Distance based share motorway driving	79 %	-
5	Time share of idling at stand still		5 %

ODOMETER ACCURACY

OICA Position

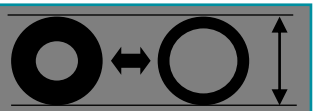
OICA VIEW ON TYRE DIAMETER TOLERANCE

+



Tyre manufacturing tolerance:
±0.2%

+



Effect of rim size and rim tolerance[*1]:
±1%

+

In-service effect[*2]:
+1%

Tyre Tolerances **+4.2%/-2.2%**

*1: ETRTO does not provide for exact circumference-matching for different rim/tyre-size combinations

*2: tyre changes its shape; according ETRTO effect of permanent tire swelling after putting into service due to centrifugal forces and tire pressure

Test-to-test variation:
Axle load variations, tyre pressure accuracy, temp. control
±0.5%

±0.5%

In addition to the electronic system tolerance, slide above, the total tolerance is composed of the tolerances defined by the tyre system plus the test-to-test variation.
Stacking all up gives a tolerance of appr. ±5%.

Odometer electrical and electronics system:
±0.02-0.7%

±0.7%

∑ **+5.4%/-3.4%**

REVIEW OF EXTERNAL SOURCES

SAE-J2976-2022

Clarification obtained from Dr. T. Livernois/SAE on SAE-J2976-2022:

Standard refers to US CAFE regulation. Manufacturer must ensure fuel economy depending on specific vehicle equipment, which includes the specific tyres used. So, for the respective self assessment and declaration of a fuel consumption value only a specific tyre type would be assessed.

→ This procedure excludes some of the variabilities we have to consider under proposed European type approval, assuming the regulated odometer accuracy has to be met for all tyre and rim types fitted as OEM equipment.

TNO 2013 R10297: Fuel consumption meter requirements for light-duty vehicles – Final report (EU FRAMEWORK CONTRACT ENTR/F1/2009/030.1)

This paper focusses on fuel consumption measurement and only lists three parameters, based on theoretical analysis, affecting the tyre diameter, namely

- tyre wear (assuming that for certification purpose the max. tread depth should be 80% leading to a ±0.3% tolerance, whereas the paper acknowledges that in real world using the full tread depth the resp. range may be ±1.25%),
- tyre dimensions per rim size, which is assumed a range of 2.5%,
- input sensor accuracy which is reported to range between 0.02% and 0.7%.

Comparison of Assumptions

	OICA (ETRTO)	SAE	EC (Goethem)/TNO	Comment
Tyre type size specification	-1%/ +2% (range: 3%)	+/-0.5%	**not considered** (see below)	ETRTO allows for +2% for winter tyres
Rim/tyre combination size tolerance (e.g. when different rims are used for summer/winter/all season tyres)	+/-1% (range: 2%)	**not considered** as only one specific tyre considered for FC declaration	**not considered** Acknowledge variation of +/-2.5%, but assume tyre for test is known: "In an eventual test procedure however, tyre and rim dimensions are fixed for the vehicle being tested"	Examples known from fleet where actual difference of diameter of certified tyres is >5%.
Tyre in-service effect (swelling due to centrifugal forces and inner pressure, long-term offset by tyre wear)	+1% (range: 1%)	-0.5%/-1% (refers to tread wear only)	+/-0.3% For tyre wear only; test to be conducted with min. 80% tyre tread depth For real world agree that due to max. wear +/-1.25% will occur.	OICA assumption that certification tests are run with "new" tyres, so no wear at time of test.
Tire-to-tire manufacturing tolerance	+/-0.2% (range: 0.4%)	**not considered** but agreed	**not considered**	
Odometer electrical system tolerance (incl. wheel sensor)	+/-0.7% (range: 1.4%)	+/-0.05%	0.02-0.7%	
Test-to-test variation (incl. pressure determination inaccuracy, pressure/temperature history over test run, environmental temperatures/pressure, etc..)	+/-0.5% (range: 1%)	+/-1% (refers only to over/under-inflation)	**not considered**	

Accumulation	Stack-up:	Stack-up:
	-3.4% / +5.4%	-2.55% / +1.05%
	Statistical:	Statistical:
total range=sqrt(sum(range²))=	±4.1%	±1.5%

Recommendation:	**+/-5%**	**+/-2.5%** (derived from stack-up)	p. 41: "Systematic error Suggestions of parameters that could cause a systematic error were given in paragraph 4.2. Main parameters are tyre wear and wheel speed sensor accuracy. In a chassis dynamometer situation these parameters are causing a total error of plus and minus 1% (0.7% for the sensor and 0.3% for allowable tyre wear). In the real-world situation this would be 3.2% (0.7% for the sensor and 1.25% for tyre wear and 1.25% for tyre dimension variation) and could be even 2% in case the assumed tyre circumference is adjusted according to the tyre dimension that is fitted (0.7% for the sensor and 1.25% for tyre wear)..."

RECOMMENDATION

The recommended total odometer tolerance does assume a certification test procedure where the tyre parameters are well controlled, including:

- Inflation to recommended tyre pressure for given vehicle loading condition
- Controlled tyre temperature
- Known tyre wearing status, resp. use of new tyre
- Controlled vehicle test-speed range

This results in a total tyre diameter tolerance range of +5.4% / -3.4%.
In real world there would be a shift of appr. -1% towards smaller diameters due to tyre wear (→ +4.4% / -4.4%).

Nevertheless, **OICA would recommend a tolerance of ±5%.**

A statistical combination of the individual tolerances (sqrt of sums of tolerances squared) is not recommended, as individual variations may not be statistically distributed around their nominal or center values, but may have systematic deviations.

CONCLUSIONS

- Stated by Commission:
  - Tech requirements set in Q2 2024
  - Implementation for New Types 1 July 2025 (what about All Registrations?)

- This timeline is impossible if proposed requirements remain
  - Development, verification, validation of fuel and weight accuracy estimations **not possible**
  - Type approval takes time and depends on a regulation in force, **not possible**
  - Standardized signals and data storage/transfer **not possible**

- Industry can offer a monitoring phase on a limited set of vehicles and under the condition that existing tests are used
- For implementation including limits for accuracy the same applies but must include a previous monitoring phase

- Standardized data storage/transfer as proposed is **not possible** for 2025 due to SAE work, should be time-aligned with Euro 7