VECTO workshop for completed heavy buses

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Thursday 9th of March 2023

European Commission

Agenda

1. 9:00 – 9:15   Welcome

2. 9:15 – 9:45   Introduction to VECTO

3. 9:45 – 10:15   Multi-stage type approval

4. 10:15 – 10:30   Obligations for completed & interim vehicle manufacturers

5. 10:30 – 10:45   Break

6. 10:45 – 11:15   Multistep tool

7. 11:15 – 12:30   Live software demo

8. 12:30 – 13:00   Q&A

European Commission

Introduction to VECTO

European Commission

Vehicle Energy Consumption Calculation Tool

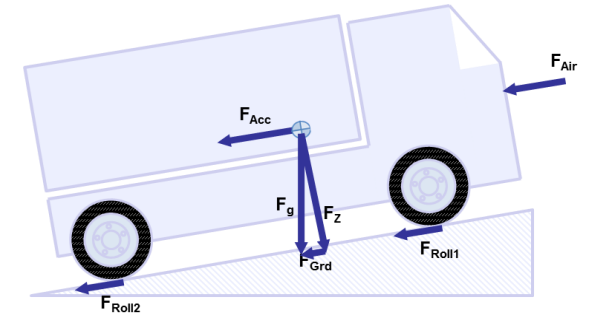**Simulation tool to calculate the energy demand, fuel consumption and CO_2 emissions**

Entire vehicle

Cost effective

Reproducible

Flexible

Regular updates

European Commission

VECTO

Model Input

Vehicle	C_d x A Mass, …
Tyres	r_{dyn} RRC
	Loss maps $i_{gears,}$ max. torque
	Full load curve Fuel map Correction factors
	Rated power, capacity, resistance
	Auxiliaries - generic data for lorries - specific for buses

Component tests

Regulation (EU) 2017/2400 Determination of the CO_2 emissions and fuel consumption of heavy-duty vehicles
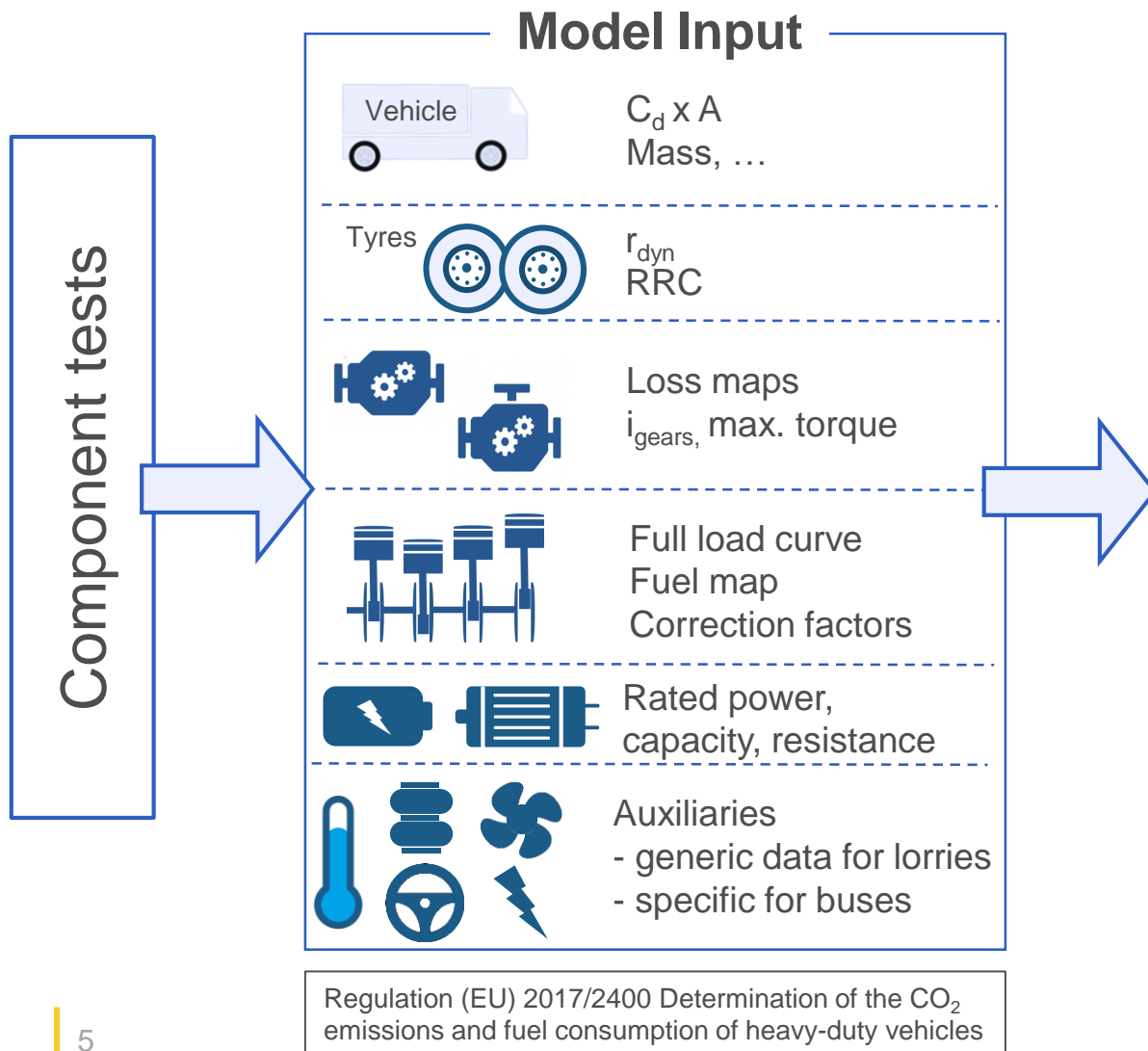
Engine power:

$$P_{Eng} = P_{Air} + P_{Roll} + P_{Grd} + P_{Acc} + P_{Losses} + P_{Aux}$$

Engine speed:

$$n_{Eng} = v \cdot i_{Axle} \cdot i_{Gear} \cdot \frac{60}{\pi \cdot D_{Wheel}}$$

Fuel consumption:

CO_2

European Commission
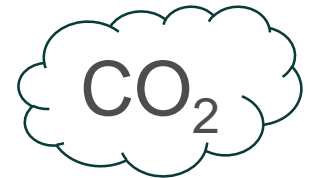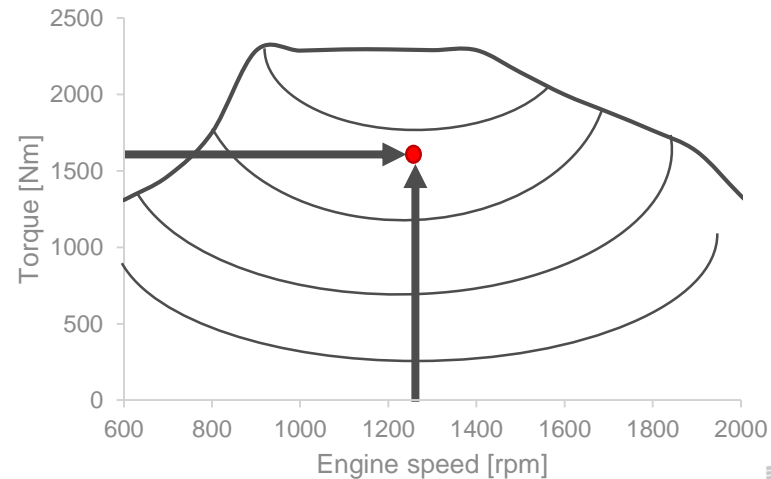
Process

Input

- Component data
- Hashing for integrity

Results

- Each vehicle
- g/km, g/m^3.km, g/ton.km or g/pass.km
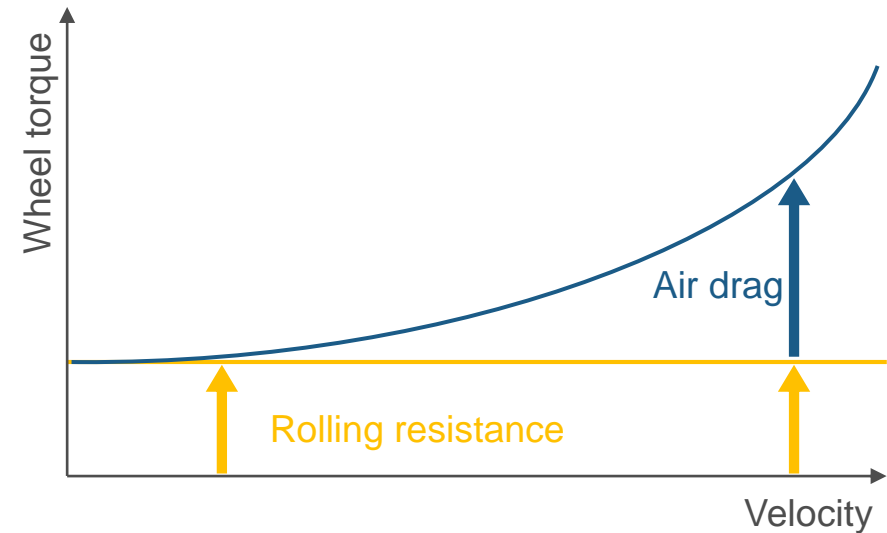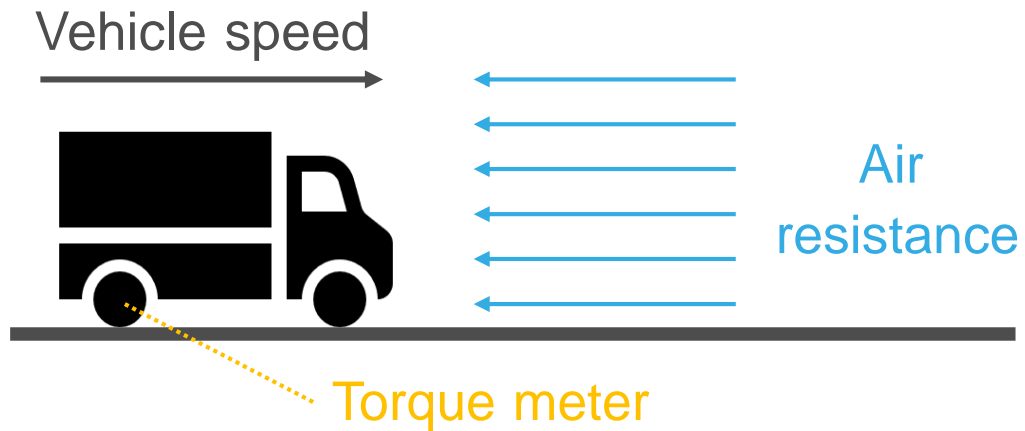
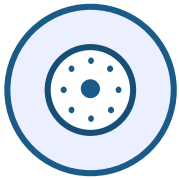## Use

- Certification
- Monitoring
- CO_2 Standards

Manufacturer database

- Engine data
- Retarder data
- Transmission data
- Axle data
- Air drag data
- Tyre data

Job data (vehicle)

VECTO — Vehicle Energy Consumption Calculation Tool

Customer information file

- Customer
- Certificate of Conformity

Manufacturer's records file

- Manufacturer
- European Env. Agency

Regulation (EU) 2017/2400 Determination of the CO_2 emissions and fuel consumption of heavy-duty vehicles

European Commission

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Component testing

Air drag

- Constant speed test
- Standard body/trailer

➜ C_dxA

Vehicle speed

Air resistance

Torque meter

Component testing

Tyres

- Drum test (EC1222/2009) ➔ RRC
- Tyre label

Internal Combustion Engine
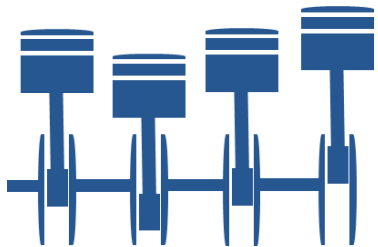
- Engine dyno ➔ fuel map
- UN/ECE R49 ➔ full load & motoring
- Steady-state & WHTC ➔ WHTC correction

Drivetrain
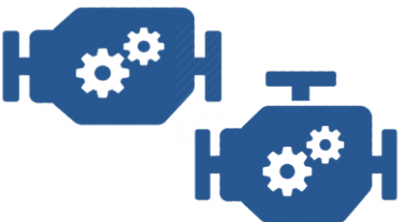
- Torque loss ➔ torque loss map
- Full or reduced measurement

Component testing

Electric machine

- EM dyno
- Steady-state
- Short & long duration

➔ electric power map
➔ full load & drag
➔ cont. & overload

Battery

- Charge-discharge cycle
- Steady-state

➔ capacity
➔ V_{oc}, R_i & I_{max}

Capacitor

- Charge/discharge
- Transient cycle

➔ capacitance
➔ resistance

Component testing

Auxiliaries

| Air Compressor
HVAC
Alternator
Cooling fan
Steering pump |

- Generic values   ➔ power demand
- Technology dependent
- Driving cycle depended
- Buses: passengers & ambient conditions

Reduced testing burden

- Component families

- Standard values

- Transfer air drag value

European Commission

Mission profiles

Lorries

- Long haul

- Regional delivery

- Urban delivery

- Municipal utility

- Construction

Buses

- Heavy urban

- Urban

- Suburban

- Interurban

- Coach

European Commission

Vehicle segmentation – Heavy lorries

Vehicle groups

- Axle configuration
- Chassis type
- TPMLM

- Mission profiles
- Payload
- Body/trailer
- Auxiliary power

Axle config.	Chassis config.	TPMLM [tons]	Vehicle group	Long haul	Long haul (EMS)	Regional delivery	Regional delivery (EMS)	Urban delivery	Municipal utility	Construction
4x2	All	> 7.5 – 10	1			R		R		
	All	> 10 – 12	2	R+T1		R		R		
	All	> 12 – 16	3			R		R		
	Rigid lorry	> 16	4	R+T2		R		R	R	
	Tractor	> 16	5	T+ST	T+ST+T2	T+ST	T+ST+T2	T+ST		
4x4	Rigid lorry	> 16	9	R+T2	R+D+ST	R	R+D+ST		R	
	Tractor	> 16	10	T+ST	T+ST+T2	T+ST	T+ST+T2			
6x4	Rigid lorry	All	11	R+T2	R+D+ST	R	R+D+ST		R	R
	Tractor	All	12	T+ST	T+ST+T2	T+ST	T+ST+T2			T+ST
8x4	Rigid lorry	All	16							R

Vehicle segmentation – Primary heavy buses

Vehicle groups

- Floor type
- Decks
- Axle configuration

- Mission profiles
- Passengers
- Generic body

Floor type	Vehicle code[1]	Decks	2axle Rigid	3 axle Rigid	3 axle Articulated	4 axle Rigid	4 axle Articulated	Mission profiles
			P31/32	P33/34	P35/36	P37/38	P39/40	
Low floor	CE CF CG CH	Single	P31 SD	P33 SD	P35 SD	P37 SD	P39 SD	Heavy Urban Urban Suburban Interurban
		Double	P31 DD	P33 DD	P35 DD	P37 DD	P39 DD	Heavy Urban Urban Suburban
High floor	CA CB CC CD	Single	P32 SD	P34 SD	P36 SD	P38 SD	P40 SD	Interurban Coach
		Double	P32 DD	P34 DD	P36 DD	P38 DD	P40 DD	

[1] Regulation (EU) 2018/ 858

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Vehicle segmentation – Completed heavy buses

Vehicle groups

- Decks

- Class

- Axle configuration

- Mission profiles

- Passengers

- Auxiliary power

- $(C_d \times A)$

Decks	Vehicle code[1]	Vehicle class[2]	Low entry	Lower deck seats	Body height	2 axle	3 axle		4 axle		Mission profiles
						Rigid	Rigid	Articulated	Rigid	Articulated	
Single	CE (CG)	I / I+II or A / II	no			31a	33a	35a	37a	39a	Heavy Urban Urban Suburban
		I / I+II or A	yes			31b1	33b1	35b1	37b1	39b1	
		II	yes			31b2	33b2	35b2	37b2	39b2	Heavy Urban Urban Suburban Interurban
Double	CF (CH)	I / I+II or A / II				31c	33c	35c	37c	39c	Heavy Urban Urban Suburban
Single	CI	All				31d	33d		37d		
Double	CJ	All				31e	33e		37e		
Single	CA (CC)	II				32a	34a	36a	38a	40a	Interurban Coach
		II+III			≤ 3100	32b	34b	36b	38b	40b	
		II+III			> 3100	32c	34c	36c	38c	40c	
		III or B				32d	34d	36d	38d	40d	
Double	CB (CD)	II / II+III / III or B		≤ 6		32e	34e	36e	38e	40e	
		II / II+III / III or B		> 6		32f	34f	36f	38f	40f	

[1]Regulation (EU) 2018/ 858
[2]UN Regulation No. 107

Vehicle segmentation – Completed heavy buses

Low Entry
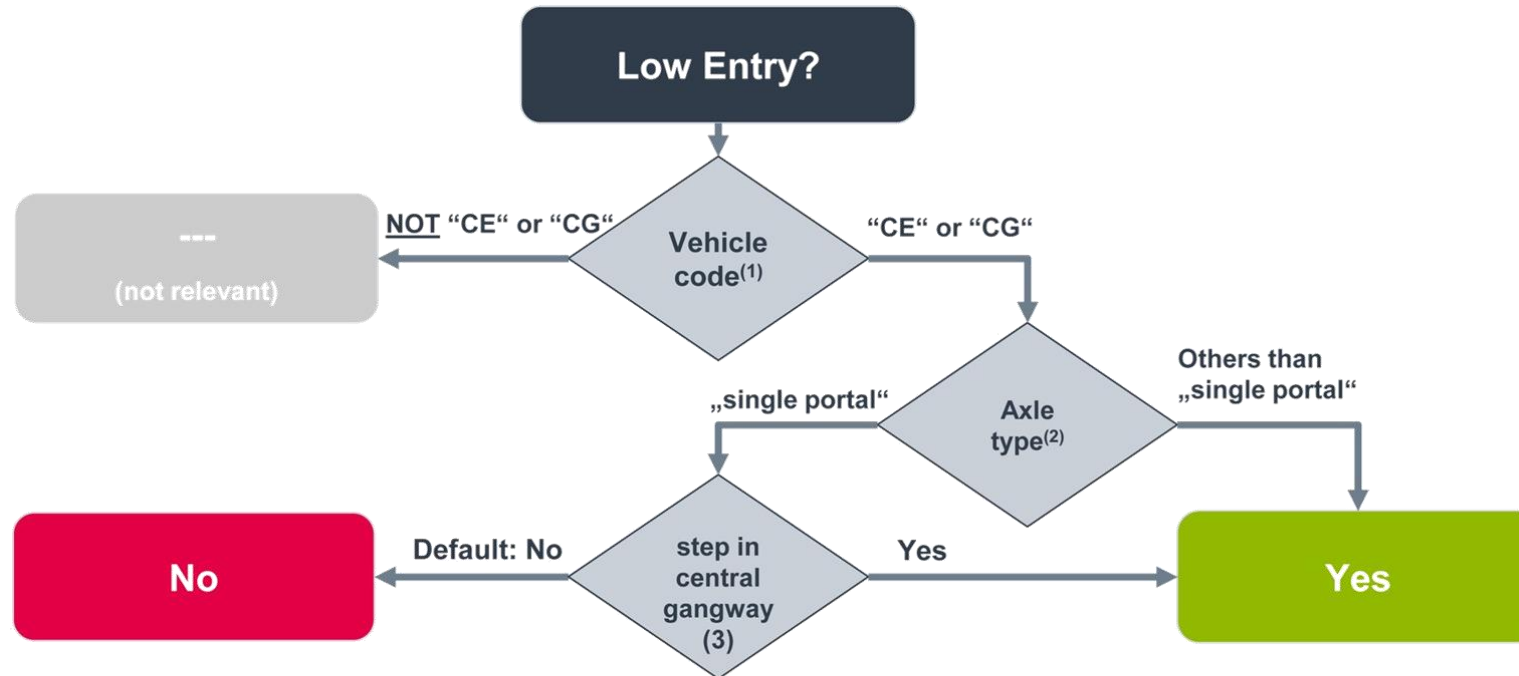
(1) Vehicle code as set out in point 3 of part C of Annex I to Regulation (EU) 2018/858 ("CE": Low Floor Single-Deck; "CG": Low Floor Single-Deck Articulated)

(2) Axle type according to point 2 of Annex VII of Regulation (EU) 2017/2400

(3) Low floor vehicle (according to point 3 of part C of Annex I to Regulation (EU) 2018/858) with at least one step (according to UN Regulation No 107, Annex 3, point 7.7.7 and Annex 4, Figure 8) in the central "gangway" (acc. to UN Regulation No 107, Definitions 2.15, 2.15.1, 2.15.2, 2.15.3 and Annex 4, Figure 25) in front of the (foremost) driven axle.

European Commission

Mission profiles

- Target speed over distance

- Road gradient

- Stop time

- Driver model:

  - Look ahead

  - Overspeeding

  - Gear shifting

  - ADAS

Regional delivery

—— Target speed   —— Actual speed   —— Gradient

European Commission

Mission profiles

- Target speed over distance

- Road gradient

- Stop time

- Driver model:

  - Look ahead

  - Overspeeding

  - Gear shifting

  - ADAS

Regional delivery

—Target —Actual speed —Gradient

Low load

High load

Speed [km/h]

Distance [km]

European Commission
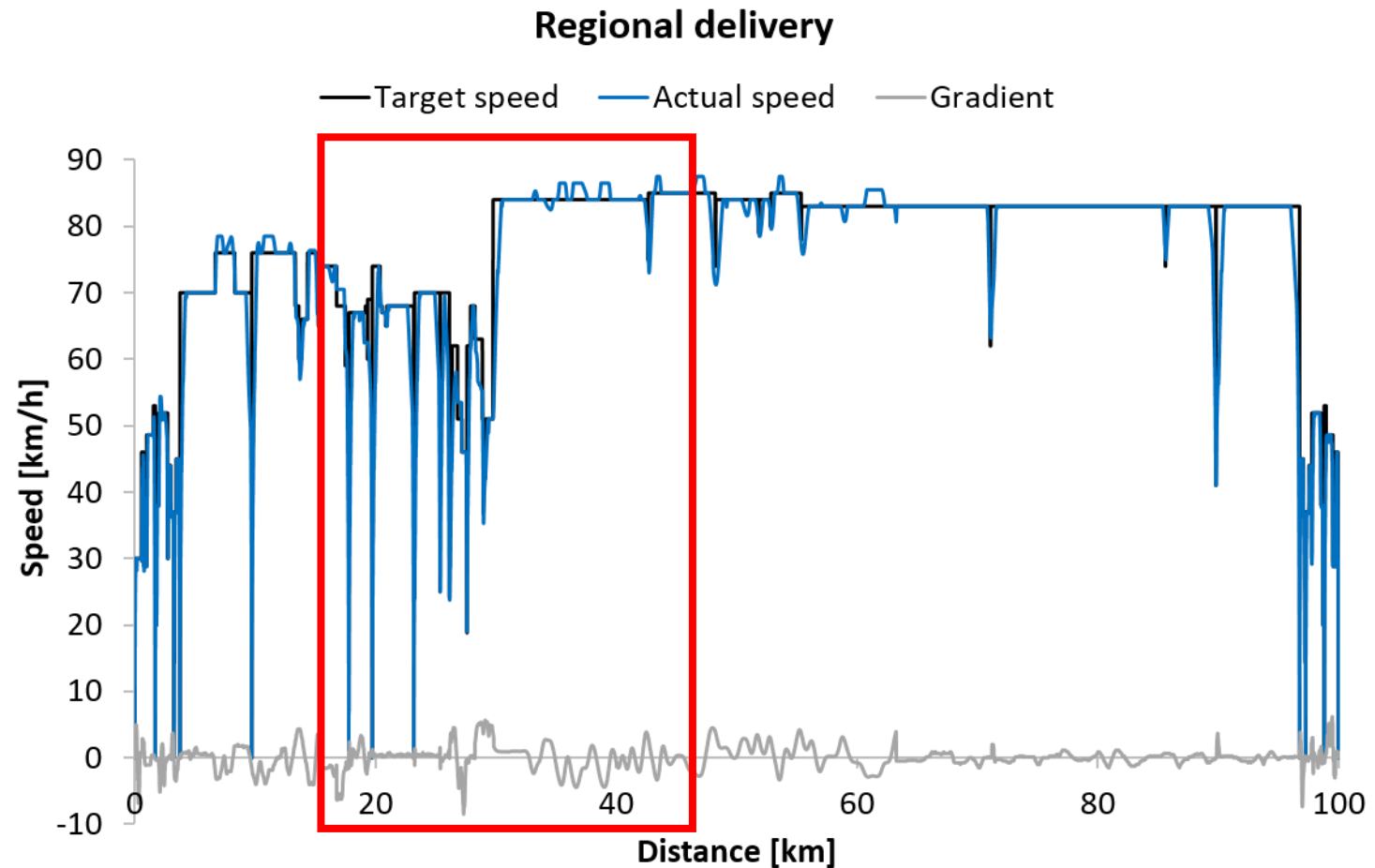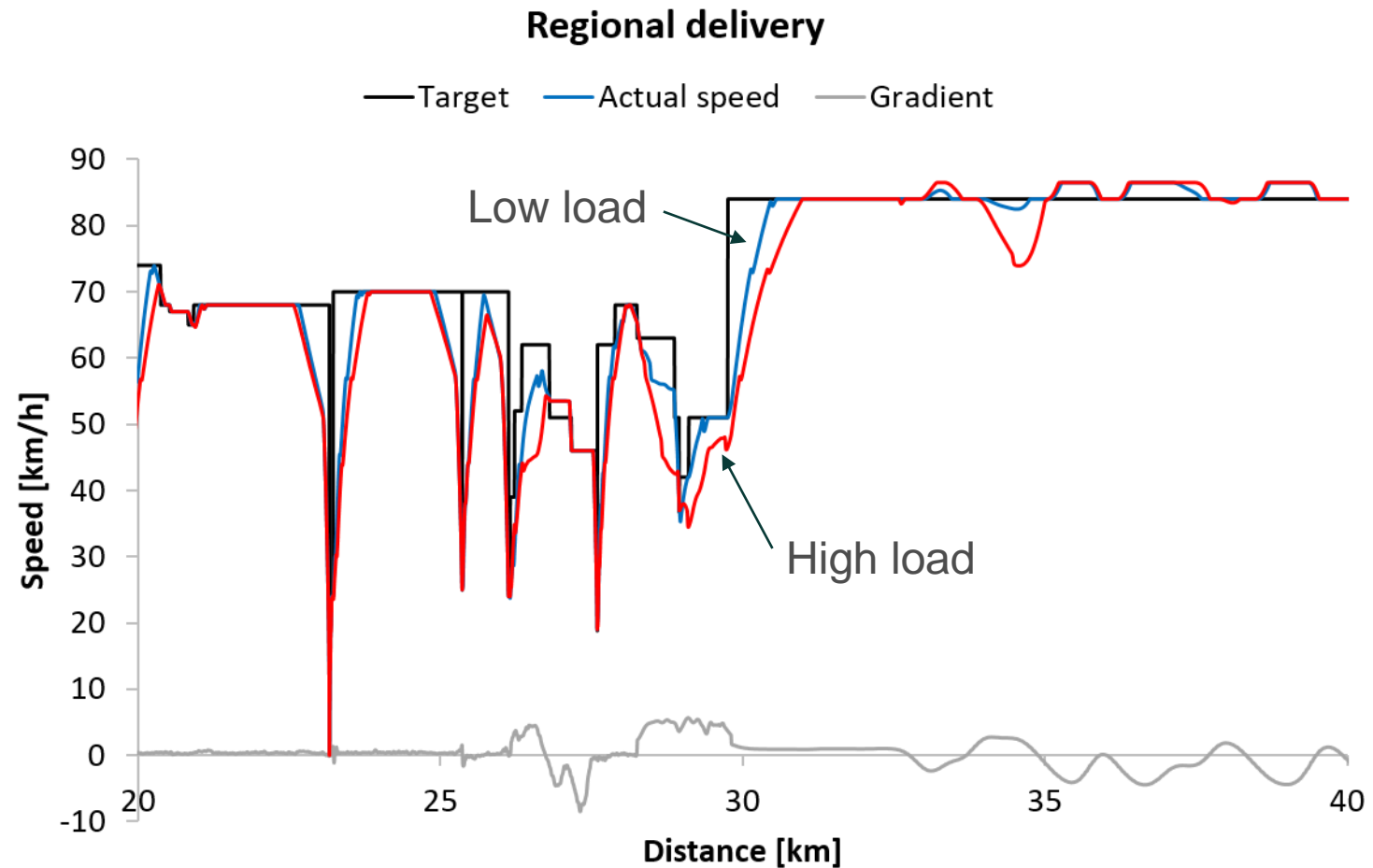
Validation

Test campaigns

- JRC & industry measurements

- Lorries, buses & coaches

- ICE, hybrid & battery electric

- Chassis dyno & on-road

- PEMS + wheel torque meas.

➔ Results ± 5%

Chassis dyno
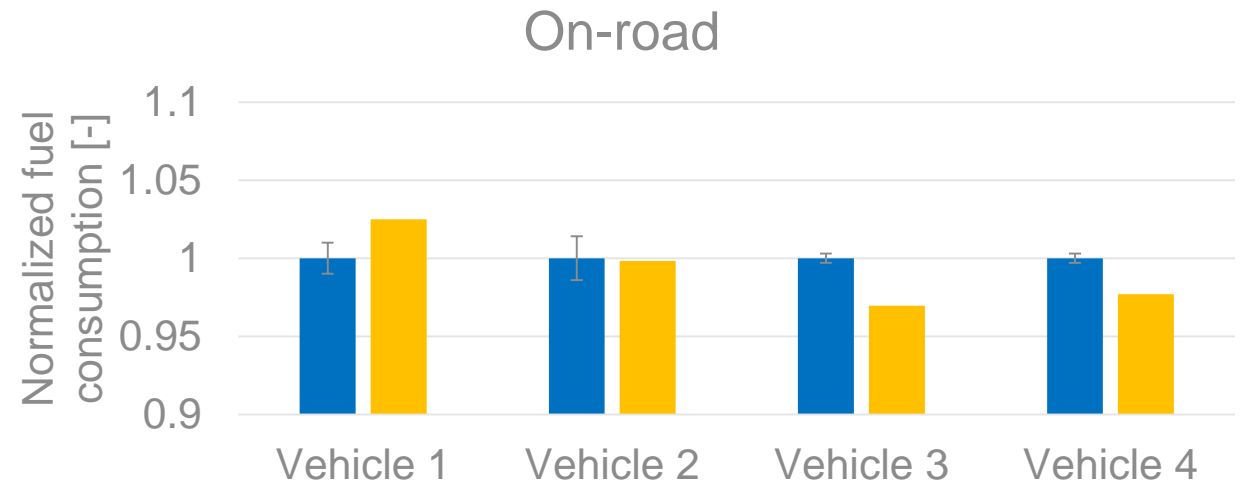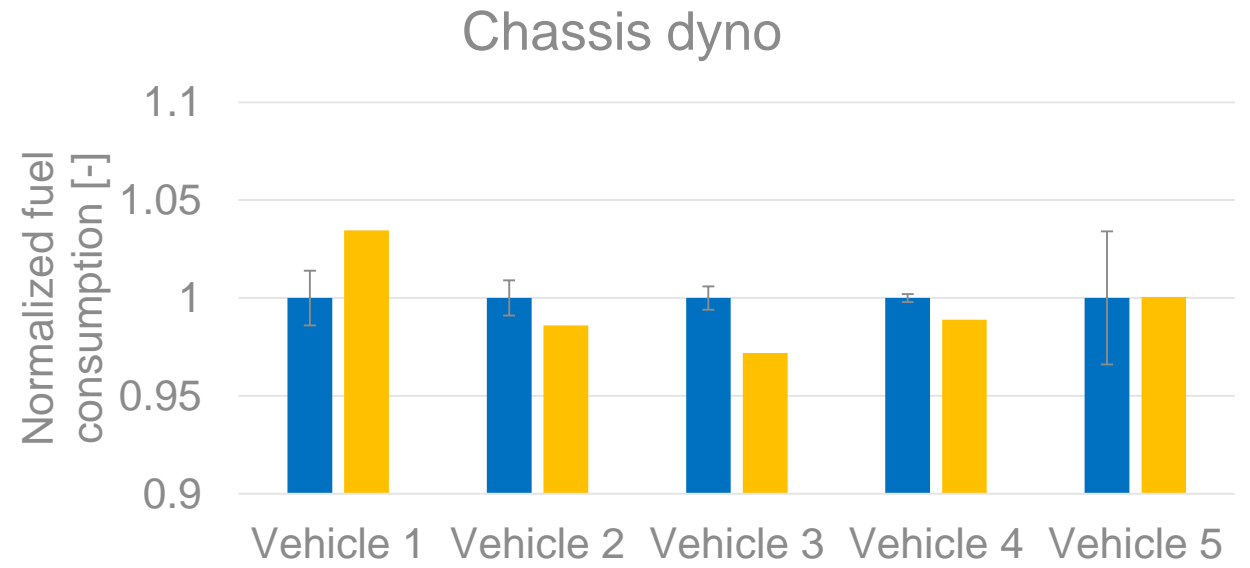
On-road

Measured   VECTO

Validation

Proof of Concept

- 18t rigid & 40t tractor

- Dyno, on-road & track

Normalized FC chart:
- error bars = ±σ
- y-axis: Normalized FC (0.9 to 1.04)
- Fuel flow meter
- Vecto (Sim1) — CO_2 Procedure
- Vecto (Sim 2) — Actual test simulation
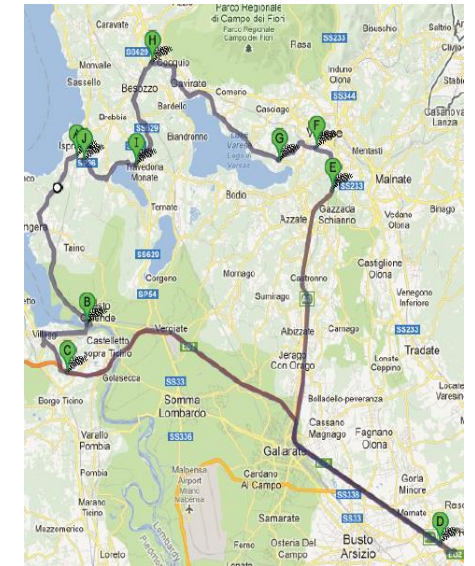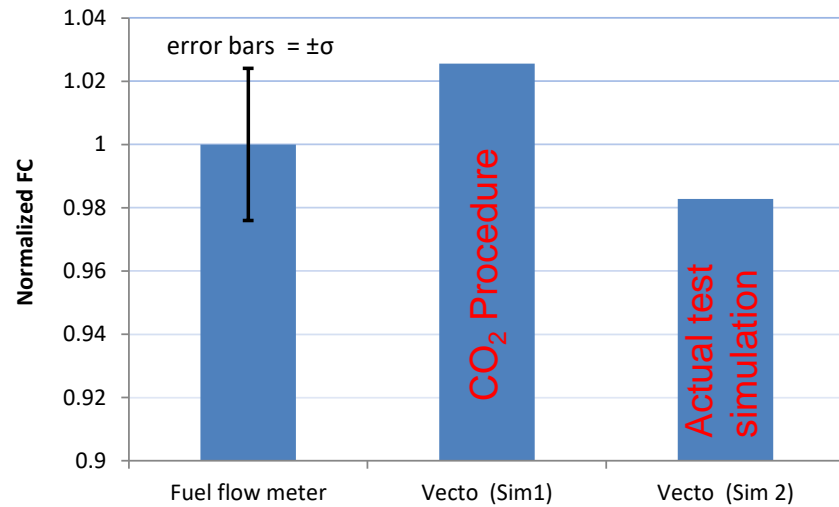
Development of a CO2 certification and monitoring methodology for Heavy Duty Vehicles – Proof of Concept report, 2014

Validation

Buses and coaches

Dyno

- Cycles & real world
- Multiple ambient conditions

Assessment of the Measurement Methodology for CO2 Emissions from Heavy Duty Buses and Coaches, 2018
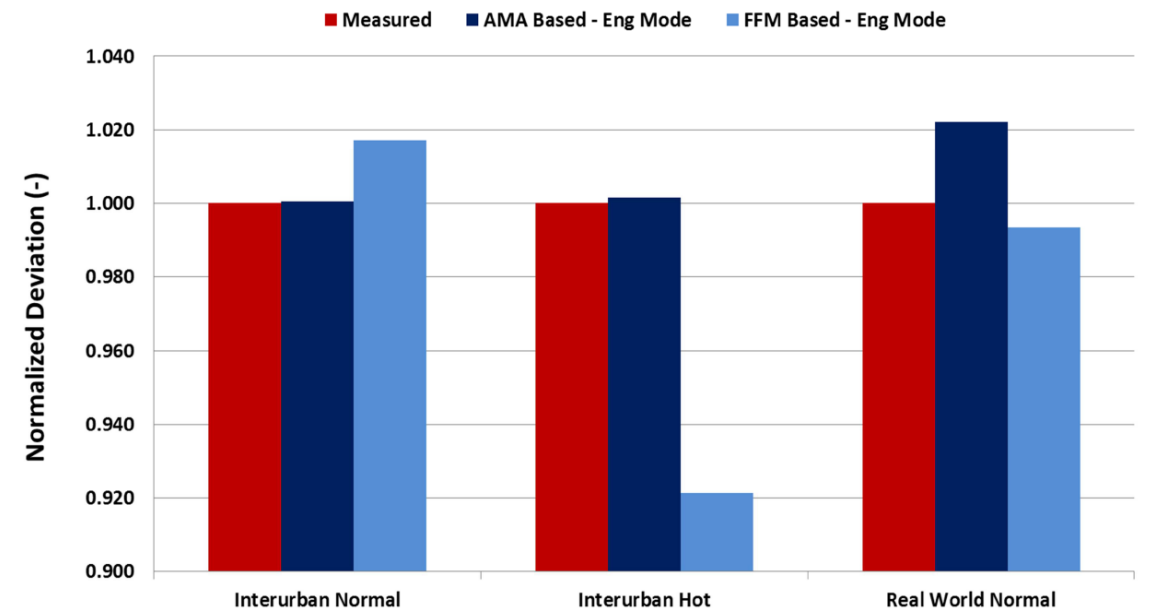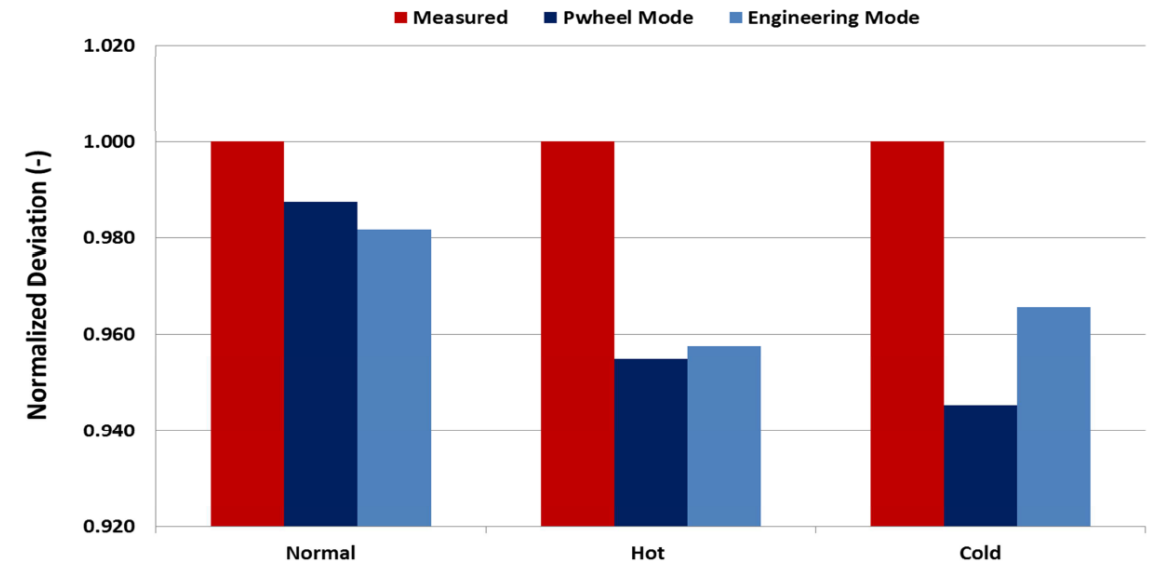
Validation

Buses and coaches

On-road

- Coach
- Interurban bus
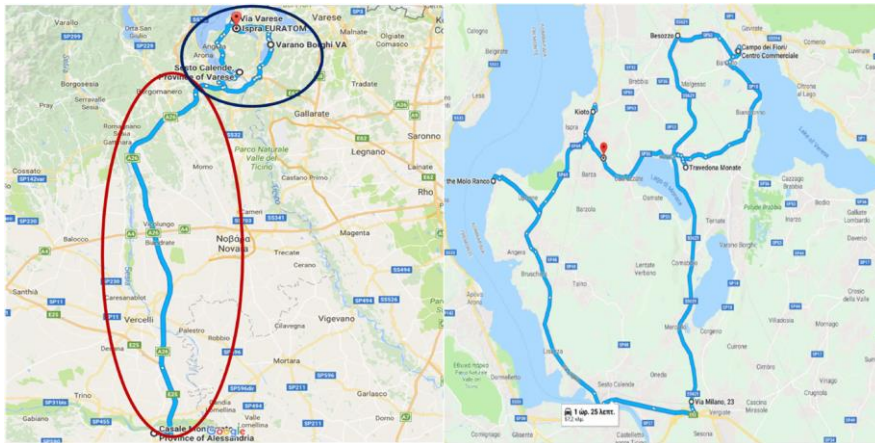
Assessment of the Measurement Methodology for CO2 Emissions from Heavy
Duty Buses and Coaches, 2018
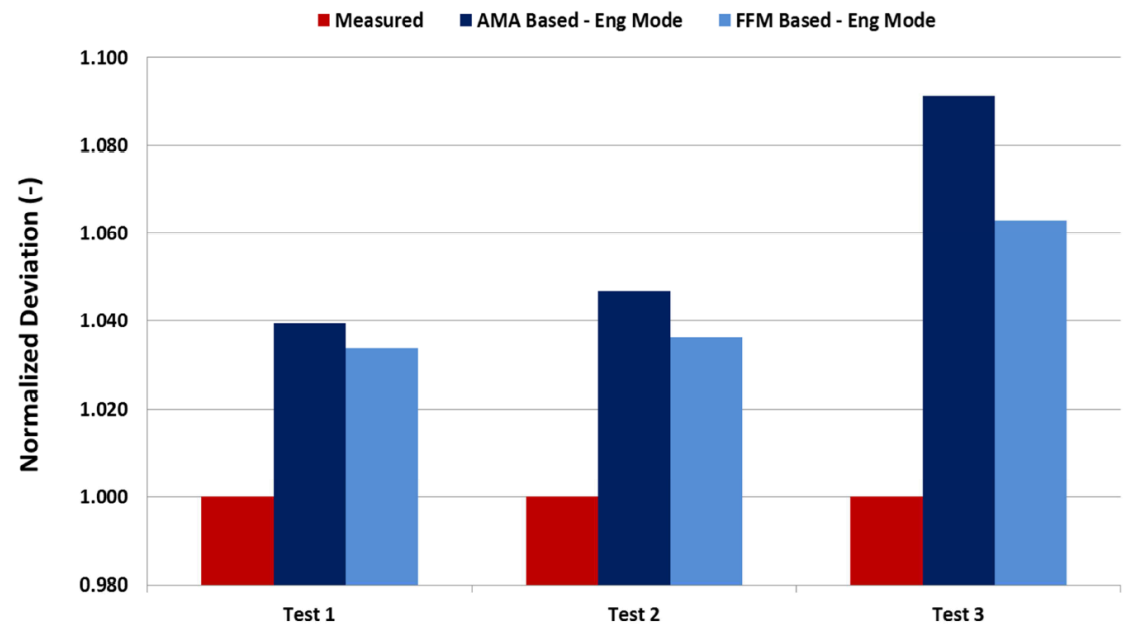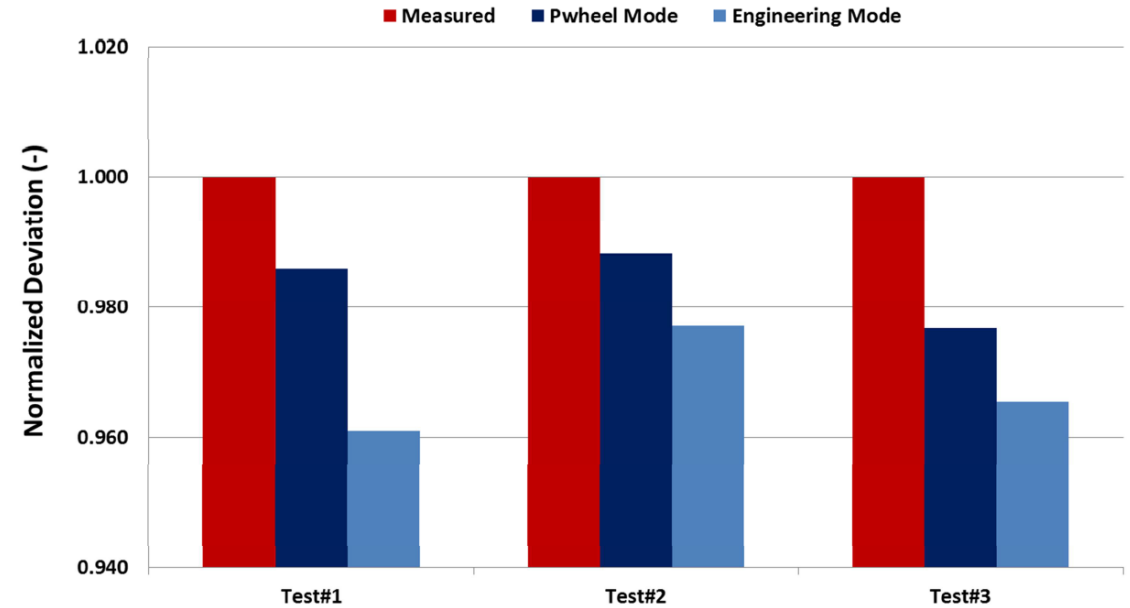
Validation

Electrified vehicles

- Hybrid & battery electric

- Lorries & buses

- On-road

- Dyno

Software family
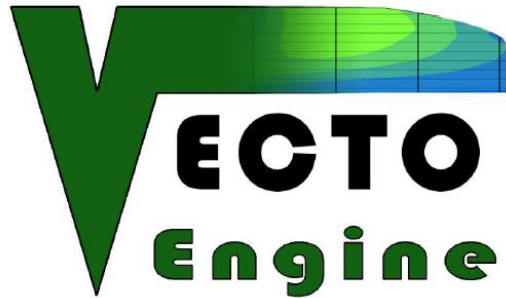
- Calculates tests conditions
- Verifies test data
- Calculates WHTC correction
- Generates input file

- Verifies test data
- Calculates CdxA
- Generates input file

VECTO Hashing Tool

- Generates digest value
- Verifies digest value

Hashing

Data integrity

- Traceability
- Detect modifications
- Without actual data

➔ Cryptographic hashing

➔ Digest value
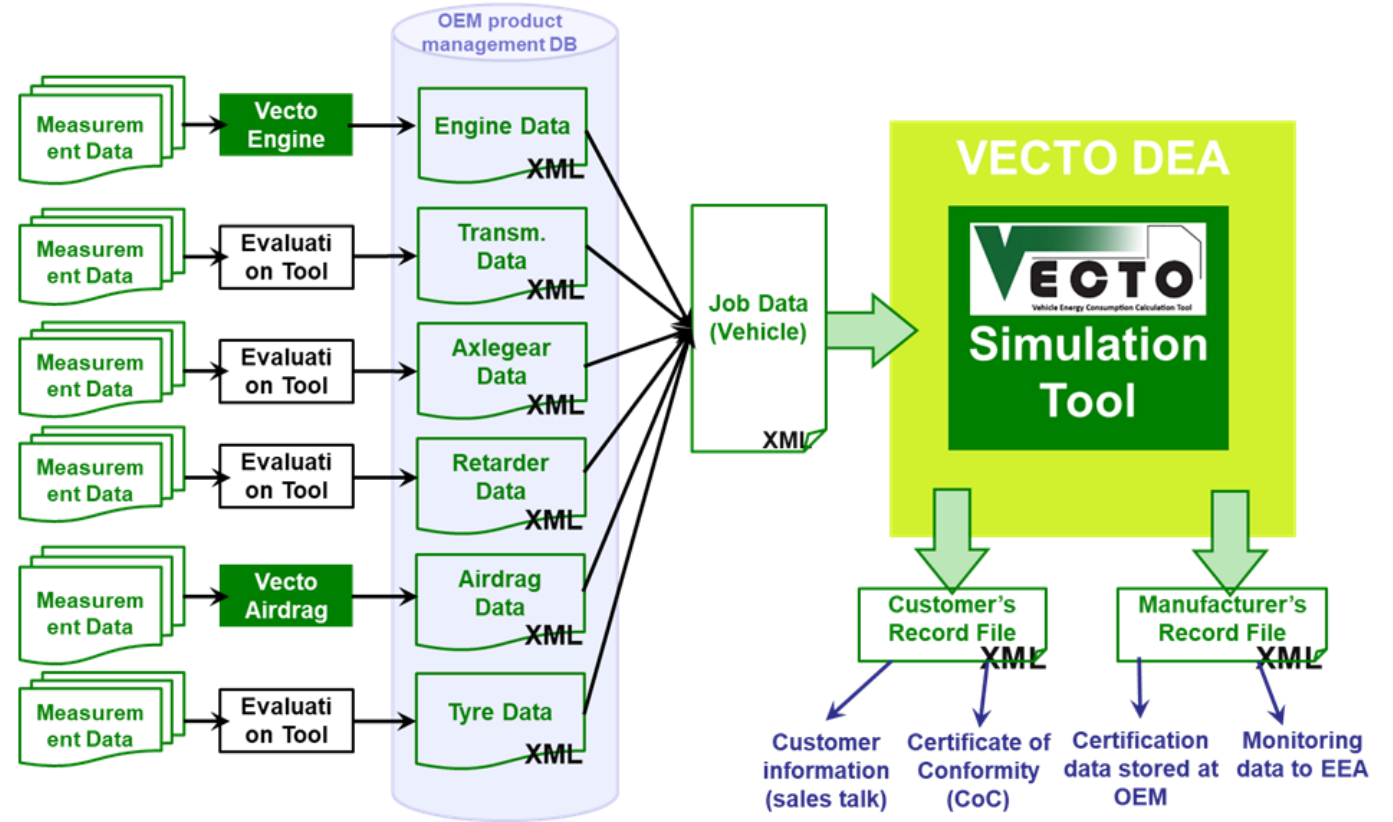
Hashing
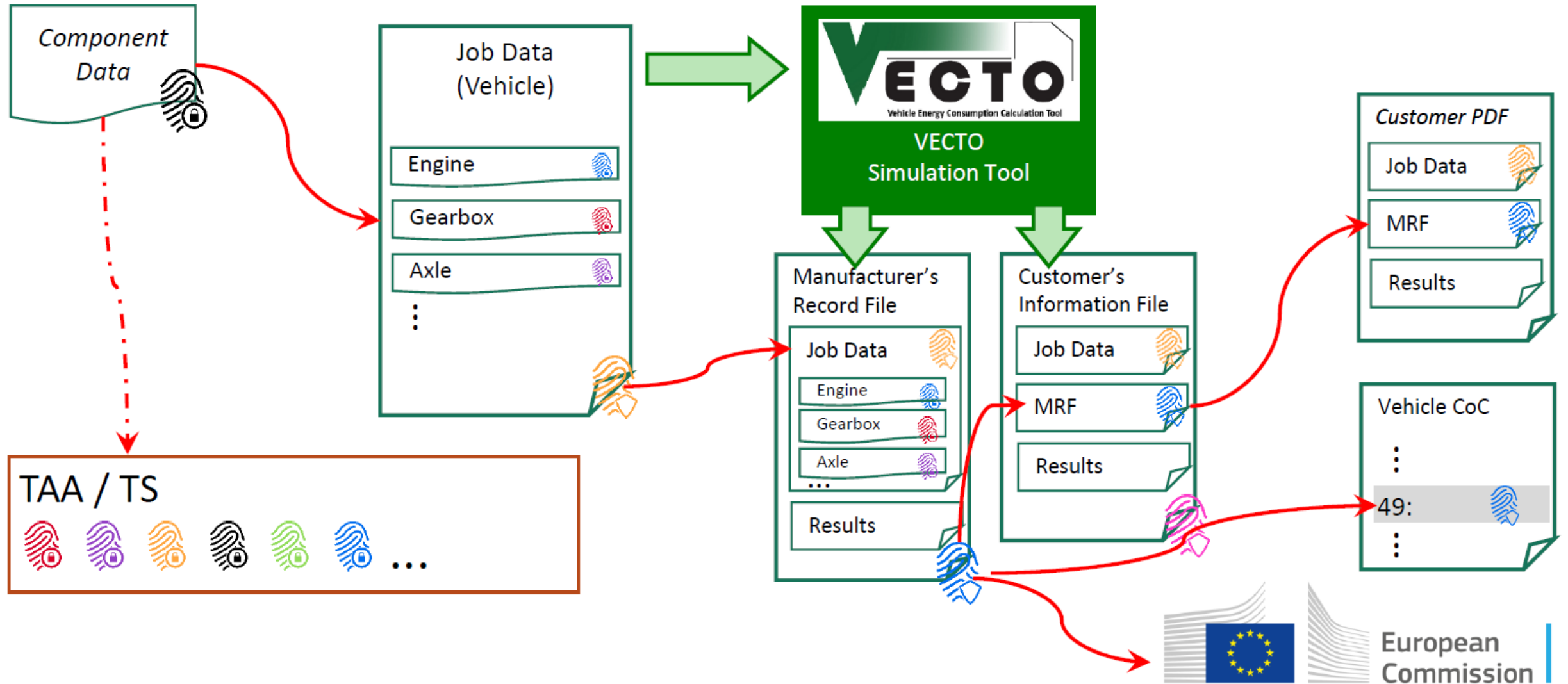
Recent developments

Regulation (EU) 2022/1379 amending (EU) 2017/2400

1. Extension of scope

   - Medium lorries (5t < TPMLM ≤ 7.4t)

   - Heavy buses (7.5t < TPMLM)

2. New technologies

   - Hybrid and battery-electric vehicles

   - Waste heat recovery & dual-fuel engines

   - ADAS in-the-loop & improved gear shifting

European Commission

Bus-specific features

Heavy buses

- Dedicated vehicle (sub-) groups
  ➔ 2, 3 or 4 axles, rigid & articulated, low & high floor, single & double decker (Annex I, tables 3-6)

- Generic air drag value for low floor buses
  ➔ Except sub-groups 31b2, 33b2, 35b2 & 39b2 over interurban cycle

- Multi-stage type approval
  ➔ **Factor method**

Bus-specific features

Advanced auxiliary model

- HVAC model
  - Body dimensions
  - HVAC system configuration
  - Auxiliary heater
  - Passenger count
  - Environmental conditions: weighted average of 11 sets of temperature and solar
- Smart electric or pneumatic systems:
  - Only active during braking events
  - Correction in post-processing

European Commission

Multi-stage type approval

European Commission

Multi-stage type approval

Definitions - Regulation (EU) 2018/858

- '**multi-stage type-approval**' means the procedure whereby one or more approval authorities certify that depending on its state of completion, an incomplete or completed type of vehicle satisfies the relevant administrative provisions and technical requirements;

- '**completed vehicle**' means a vehicle resulting from the multi-stage type-approval that meets the relevant technical requirements of this Regulation;

- '**complete vehicle**' means a vehicle that does not need to be completed in order to meet the relevant technical requirements of this Regulation;

- '**incomplete vehicle**' means any vehicle that must undergo at least one further stage of completion in order to meet the relevant technical requirements of this Regulation;

European Commission

Multi-stage type approval

Definitions - Regulation (EU) 2017/2400

- 'primary vehicle' means a heavy bus in a virtual assembly condition determined for simulation purposes, for which the input data and input information as set out in Annex III is used;

- 'interim vehicle' means any further completion of a primary vehicle where a sub-set of input data and input information as defined for the complete or completed vehicle in accordance with Table 1 and Table 3a of Annex III is added and/or modified

European Commission

Multi-stage type approval

Definitions - Regulation (EU) 2017/2400

- '**manufacturer's records file (MRF)**' contains manufacturer related information, a documentation of the input data and input information to the simulation tool and the results for CO_2 emissions and fuel consumption.
  - ➜ For primary and complete(d) vehicle

- '**vehicle information file (VIF)**' transfers the relevant input data, input information and simulation results to subsequent manufacturing steps
  - ➜ For each manufacturing step

- '**customer information file**' contains a defined set of vehicle related information and the results for CO_2 emissions and fuel consumption
  - ➜ For complete(d) vehicle

European Commission

Multi-stage type approval

Heavy lorry

- Base vehicle

- Generic body

➔ All input data required

➔ Single simulation

Heavy bus

- Complete(d) vehicle

- Actual body

➔ Not sharing sensitive data

➔ Simulation split in:

1. Primary vehicle

2. Complete(d) vehicle

European Commission

Multi-stage type approval

Simulation #1

Primary vehicle

- Specific powertrain
  - Engine full load
  - Transmission type & ratios

- Specific component efficiencies
  - Engine fuel consumption map
  - Gearbox & axle efficiency map

- Generic body
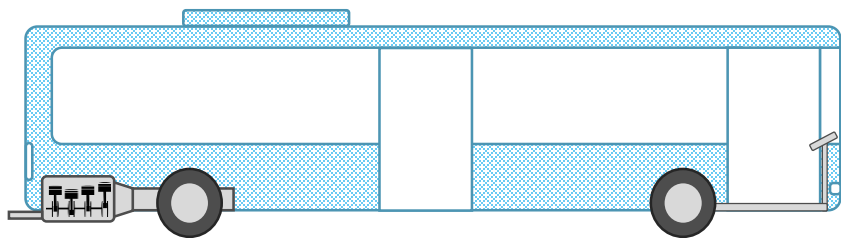
Simulation #2

Complete(d) vehicle

- Specific powertrain

- Generic component efficiencies

- Specific body
  - Mass
  - Air drag
  - HVAC, Electric & pneumatic system
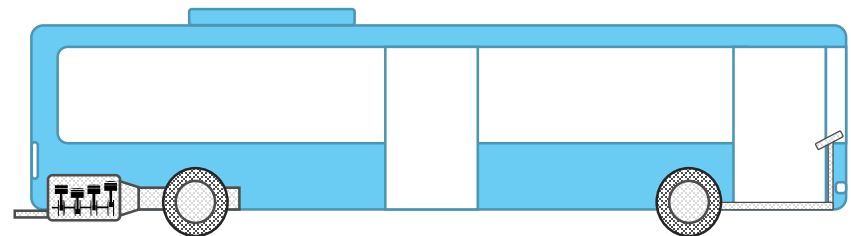
Multi-stage type approval

Factor method

- Combine results for complete(d) vehicle

$$EC\ [MJ/km] = EC_{\text{Spec}\textbf{PT},\ \text{Spec}\textbf{Eff},\ \text{Gen}\textbf{Body}} \cdot \frac{EC_{\text{Spec}\textbf{PT},\ \text{Gen}\textbf{Eff},\ \text{Spec}\textbf{Body}}}{EC_{\text{Spec}\textbf{PT},\ \text{Gen}\textbf{Eff},\ \text{Gen}\textbf{Body}}}$$

VECTO complete(d)

VECTO primary
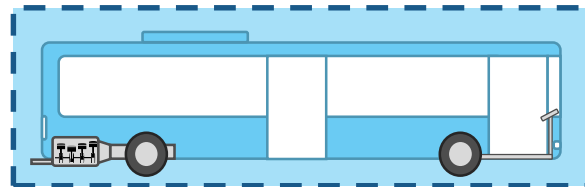
Correction for specific body

Complete(d) vehicle

Primary vehicle

European Commission

Multi-stage type approval

Factor method

- Combine results for complete(d) vehicle

$$EC \text{ [MJ/km]} = EC_{Spec\textbf{PT}, Spec\textbf{Eff}, Gen\textbf{Body}} \cdot \frac{EC_{Spec\textbf{PT}, Gen\textbf{Eff}, Spec\textbf{Body}}}{EC_{Spec\textbf{PT}, Gen\textbf{Eff}, Gen\textbf{Body}}}$$

VECTO primary

VECTO complete(d)

PT ..... Powertrain (ICE full load curve, transmission type and ratios ...)
Eff ..... Component efficiency data (ICE map, ICE correction factors, Drivetrain efficiencies)
Body .. Total vehicle mass, air drag, parts of auxiliaries (HVAC, Pneumatic System, Electric System)

- Energy consumption converted to fuel consumption and CO2 emissions

- Same results complete and complete(d) vehicle

- VIF transfers information

European Commission

Multi-stage type approval

	Primary vehicle	Interim vehicle	Complete(d) vehicle
VECTO input	• Engine • Transmission • Tyres • Subset auxiliaries	• VIF_{i-1} • Subset of specific body data (mass, HVAC, dimensions,…)	• VIF_{j-1} • Remaining and/or updated specific body input data
Simulation	• Primary vehicle group • 4 generic bodies (high and low floor, single and double deck) • All mission profiles • 2 payloads	• None	• Completed vehicle sub-group 1. Vehicle with generic body 2. Vehicle with actual body 3. Combining results with factor method
VECTO output	• MRF primary • VIF_1	• VIF_i with updated information	• MRF completed • VIF_j • CIF

More details in Regulation (EU) 2017/2400, Annex I, point (2)

European Commission

Multi-stage type approval

General case
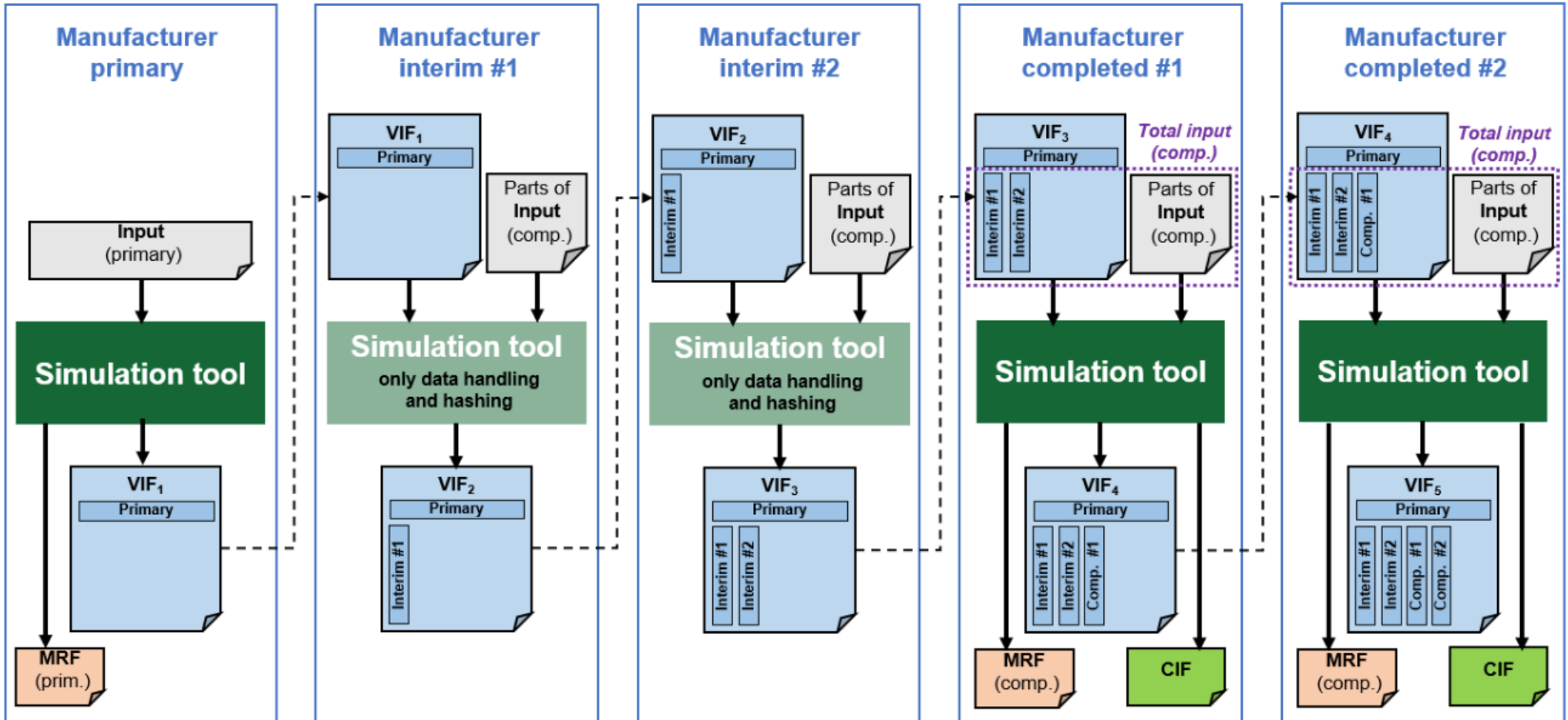
Multi-stage type approval

Complete vehicle case
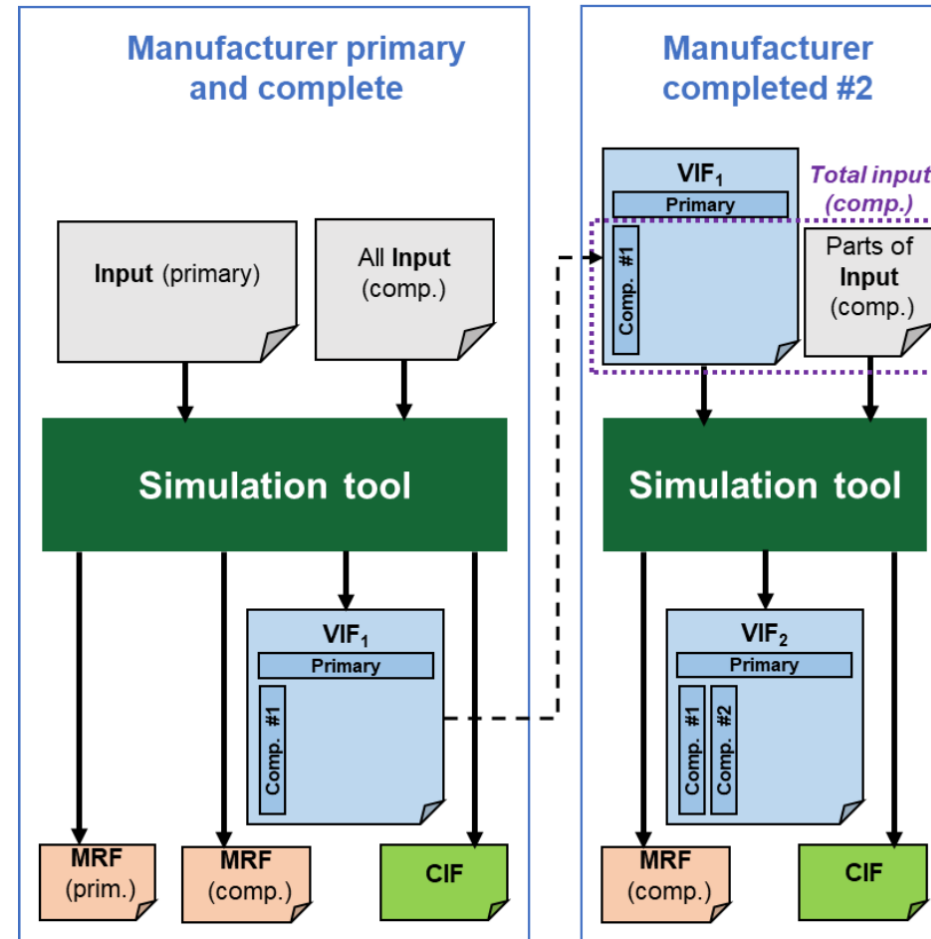
Obligations for interim & completed vehicle manufacturers

European Commission

Regulatory framework

Regulation (EU) 2017/2400

- Laying down the rules for issuing **licences** to operate a simulation tool with a view to determining CO_2 emissions and fuel consumption of new vehicles to be sold, registered or put into service in the Union and for **operating that simulation tool** and **declaring the CO_2 emissions and fuel consumption** values thus determined

- In the case of heavy buses, this Regulation shall apply to **primary** vehicles, **interim** vehicles and to **complete** vehicles or **completed** vehicles.

European Commission

Regulatory framework

Regulation (EU) 2017/2400

- The obligations in Article 9 shall apply for:

  - **Primary heavy buses** (groups P31/32, P33/34, P35/36, P37/38 & P39/40) with production date on or after **1 January 2024**

  - **Complete or completed heavy buses** (groups 31 to 40) with production date on or after **1 January 2024**, if the simulation of the primary vehicle is available

- Member states shall prohibit the registration, sale or entry into service of:

  - **Complete & completed heavy buses** (groups 31 to 40) as from **1 January 2025**

Regulatory framework

Obligations for manufacturers

- Laid out in (EU) 2017/2400

- Apply for license to operate the software to type approval authority

- License requirements in Annex II

- The approval authority assessment <u>four times per year</u>

Regulatory framework

Obligations for manufacturers

- Determine the CO2 emissions and fuel consumption of **each new vehicle** using the **latest available version** of the simulation tool

  - Input data specified in Annex III

  - Software updates: no later than <u>3 months</u> after available

  - Malfunction of the simulation tool: notify the Commission (guide will be available) and simulate with updated software no later than <u>7 days</u> after available

  - Error in previous manufacturing step: <u>14 days</u> after correct VIF is available

- Store MRF, VIF and component certificates for at least <u>20 years</u>

Regulatory framework

Exempted vehicles

- Vehicle with technologies listed in Appendix 1 to Annex III

- E.g. fuel cells, in-motion charging

- Reduced input data to tool Annex III table 5

- No simulation of CO_2 emissions and fuel consumption

- Software generates reduced output data

European Commission

Obligations for interim manufacturers

Interim manufacturer

- Responsible for a subset of input data

  - Add or update information relevant for the completed vehicle

  - Produce an updated and hashed version of the VIF with VECTO

  - Make VIF available to the subsequent manufacturer

- Vehicle modifications that affect primary vehicle input data (e.g. tyres)

  ➔ **manufacturer becomes primary vehicle manufacturer**

European Commission

Obligations for completed manufacturers

Completed manufacturers

- Complement and/or update the input data for completed vehicle

- Operate the simulation tool to calculate the CO_2 emissions and fuel consumption

- Make VIF available to a subsequent manufacturer

- Vehicle modifications that affect primary vehicle input data (e.g. tyres)

> ➔ **manufacturer becomes primary vehicle manufacturer**

European Commission

Regulatory framework

Input data

- Input parameters and format: Annex III

- Requirements per manufacturing step

- Detailed description & definitions:

  - Mass, dimensions & ADAS: Annex III

  - Air drag: Annex VIII

  - Auxiliaries: Annex IX

Example:

Parameter name	Parameter ID	Type	Unit	Description/Reference
Manufacturer	P235	Token	[-]	
Manufacturer Address	P252	Token	[-]	
Model_Commercial Name	P236	Token	[-]	
VIN	P238	Token	[-]	
Date	P239	Date Time	[-]	Date and time when input information and input data is created
Legislative Category	P251	String	[-]	Allowed values: 'N2', 'N3','M3'
CorrectedActualMass	P038	Int	[kg]	In accordance with 'Corrected actual mass of the vehicle' as specified in point 2(4)
TechnicalPermissibleMaximumLadenMass	P041	int	[kg]	In accordance with Article 2, point (7) of Regulation (EU) No 1230/2012

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Multistep tool

Contents

- Introduction to the tool;

- Input parameters of a manufacturing step;

- VIF creation and hashing;

- Choosing the right parametrization and simulation case;

- Simulation of the completed manufacturing step and output files;

European Commission

Contents

- **Introduction to the tool;**

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Introduction

- The VIF at every step is in essence an xml file;

- The VIF can in theory be created independently of the multistep tool and be hashed with the hashing tool;

- The job of the multistep tool is to:

  - Facilitate the creation and appending of the VIF through a dedicated GUI;

  - Provide cryptographic hashing transparently for the user (vehicle manufacturer);

  - Coordinating the simulation of the completed vehicle;

European Commission

Introduction

VECTO Multistep → VIF — Create / Export

VIF_{1ext}, VIF_1 → VECTO Multistep → VIF_2 — Import / Append / Hash / Export

VECTO Multistep → VIF_{final} — Coordinate sim
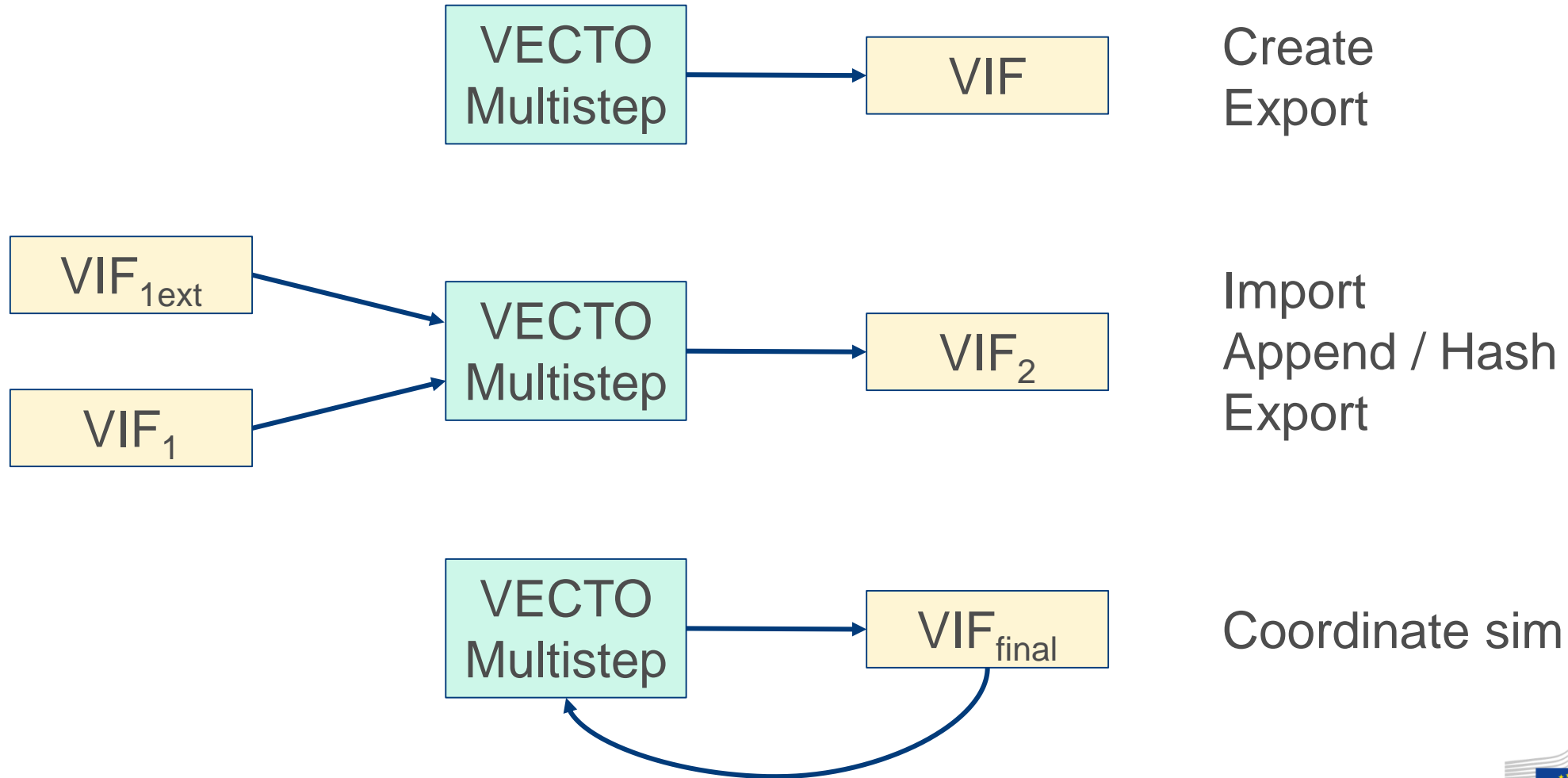
Introduction – Main GUI form
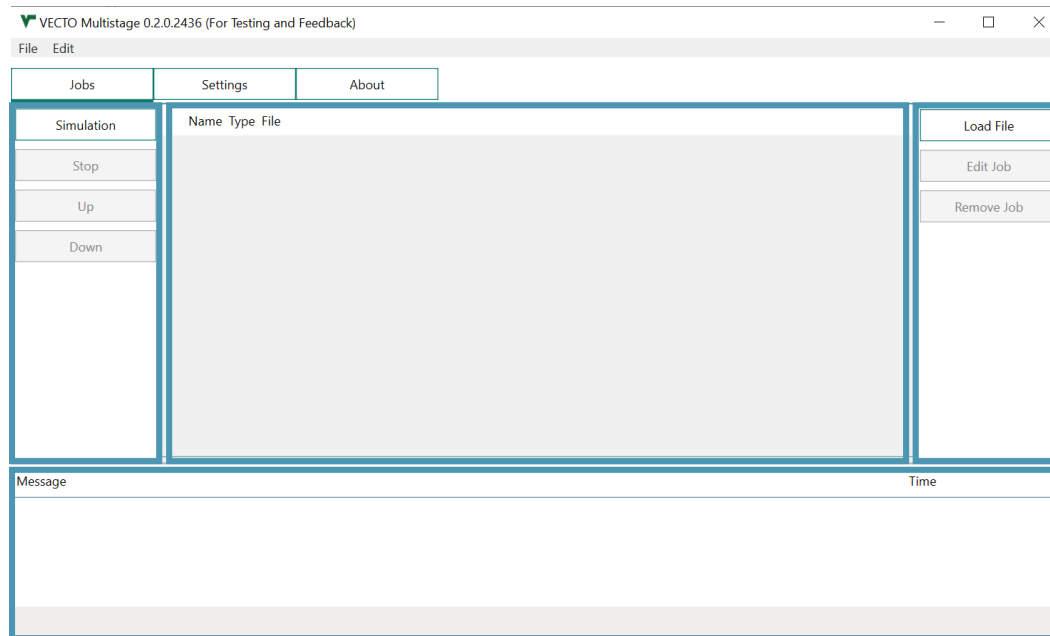
- Simulation coordination

- File selection

- Job list

- Message window

Introduction – Main GUI form

Contents

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Input parameters of a step - Vehicle

- Any of the parameters can be added/updated at every step;

- Declaration type, manufacturer data and VIN always required;

Input parameters of a step – Airdrag*
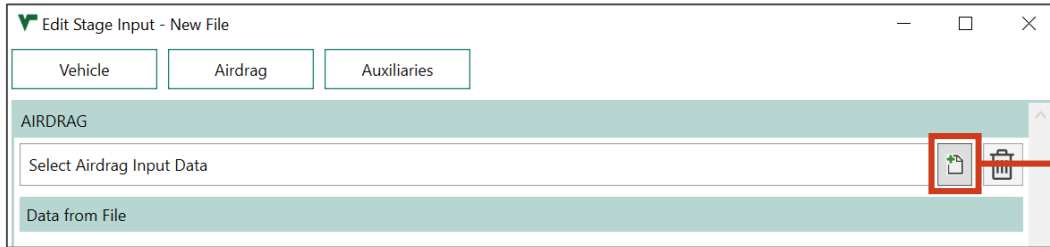
Select new airdrag certification xml
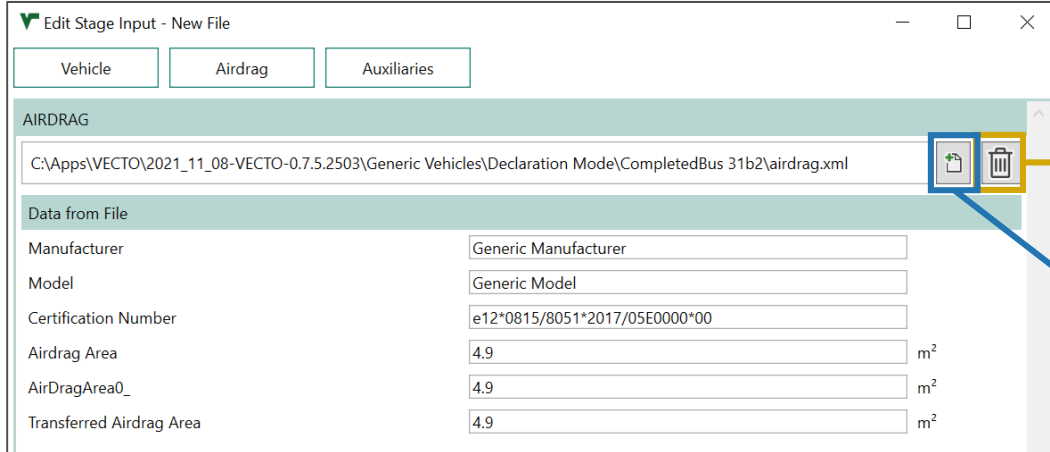
Discard airdrag certification xml

Select other airdrag certification xml

- If the field is left empty, VECTO will use a standard value for Airdrag depending on the vehicle category;

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Input parameters of a step - Auxiliaries

LED lighting declaration

HVAC definition

Input parameters of a step - HVAC

Heating, Ventilation and Air Conditioning

System Configuration	☑	Configuration 6 ⌄

Driver Compartment Heat Pumps

Cooling	☑	not applicable ⌄
Heating	☑	not applicable ⌄

Passenger Compartment Heat Pumps

Cooling	☑	non R 744: 2-stage ⌄
Heating	☑	non R 744: continuous ⌄

Heating, Ventilation and Air Conditioning

System Configuration	☑	Configuration 7 ⌄

Driver Compartment Heat Pumps

Cooling	☑	non R 744: 2-stage ⌄
Heating	☑	non R 744: continuous ⌄

Passenger Compartment Heat Pumps

Cooling	☑	non R 744: 2-stage ⌄
Heating	☑	non R 744: continuous ⌄

Configuration 1
No thermal comfort system
No passenger AC
No driver AC

Configuration 2
No thermal comfort system
No passenger AC
Driver AC – Independent AC compressor

Configuration 3
Thermal comfort system
No passenger AC
No driver AC

Configuration 4
Thermal comfort system
No passenger AC
Driver AC – Independent AC compressor

Configuration 5
Thermal comfort system
Passenger AC – 1 heat pump
No driver AC

Configuration 6
Thermal comfort system
Passenger AC – 1 heat pump
Driver AC – No independent AC compressor

Configuration 7
Thermal comfort system
Passenger AC – 1 heat pump
Driver AC – Independent AC compressor

Configuration 8
Thermal comfort system
Passenger AC – >1 heat pump
No driver AC

Configuration 9
Thermal comfort system
Passenger AC – >1 heat pump
Driver AC – Independent AC compressor

Configuration 10
Thermal comfort system
Passenger AC – >1 heat pump
Driver AC - No independent AC compressor

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VIF handling - Example

In this example:

1. We start from a primary VIF

2. We declare the configuration for lighting and no HVAC (step 2)

3. We declare the configuration of HVAC (step 3)

VIF handling – Step2

VIF handling – Step2

VIF handling – Step2 VS Step3

VIF handling – Step2 VS Step3

VIF hashing

- In every manufacturing step, the hash value of the previous step is added to the current manufacturing step under the element "HashPreviousStep";

- As this hash contains the hash of the previous step (and thus all previous steps) unintended modifications of the VIF can be detected easily;

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Case choice considerations

Which job preparation or simulation case should the manufacturer choose is a result of the questions:
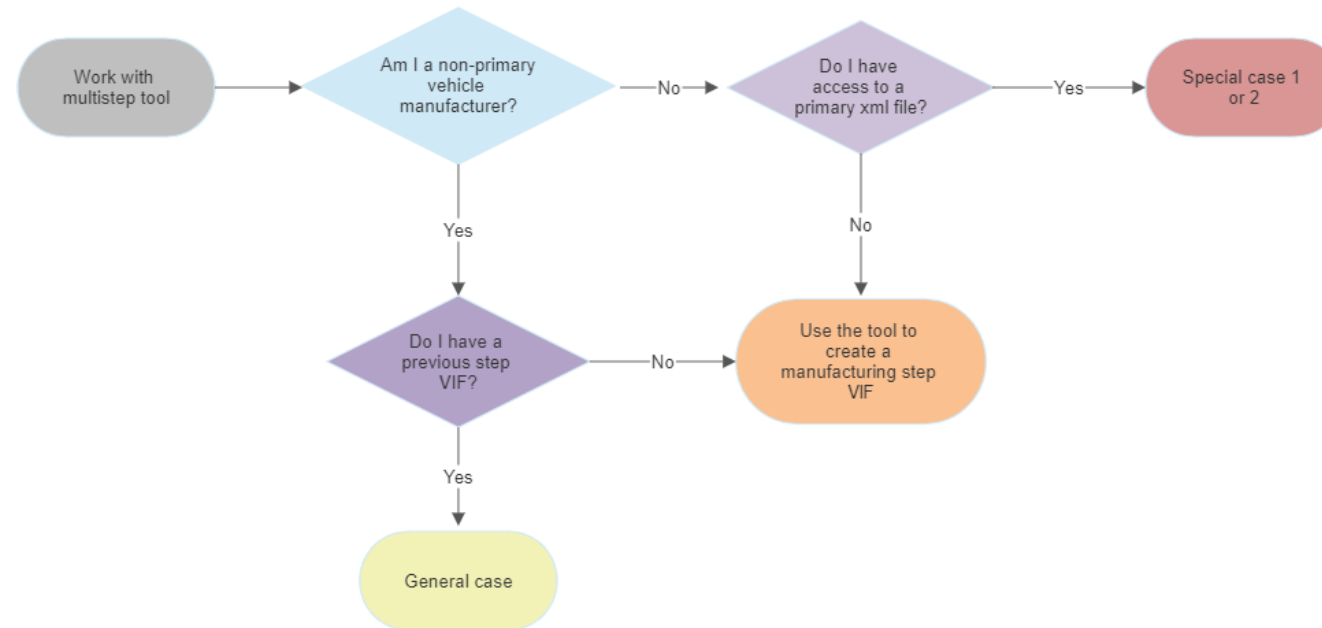
General case: Interim or completed vehicle
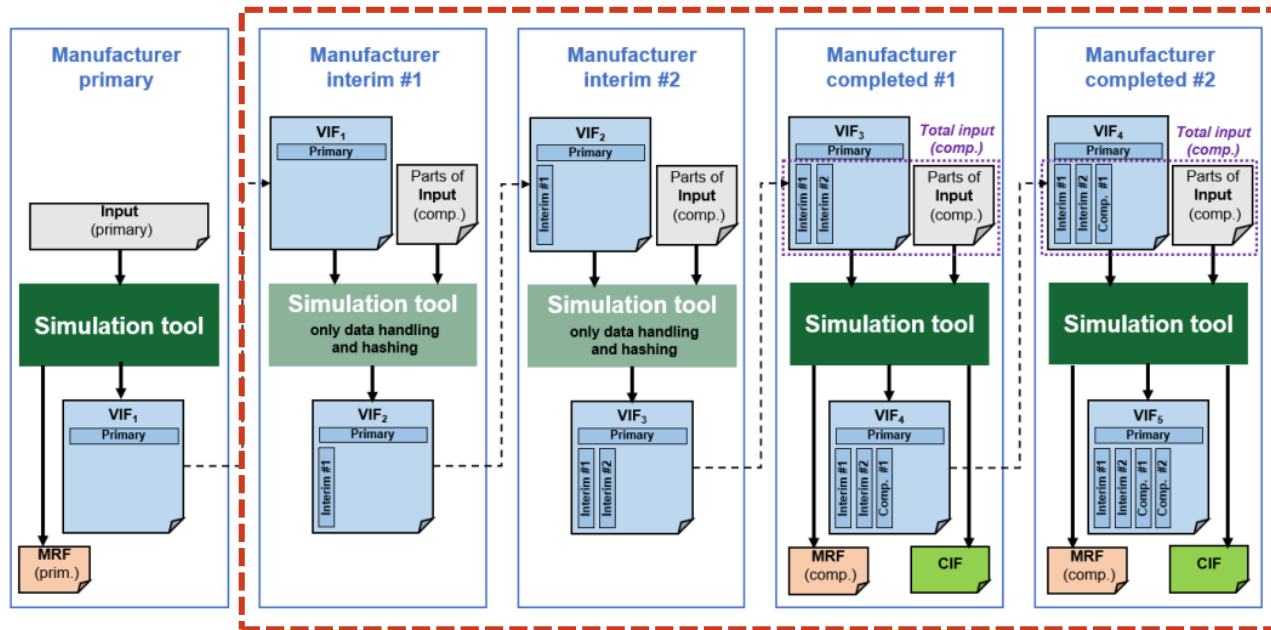
Profile: Non primary vehicle manufacturer;

Manufacturer has access to the previous step VIF:

- Primary manufacturing step VIF

- Interim/completed manufacturing step VIF

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General case: Interim or completed vehicle
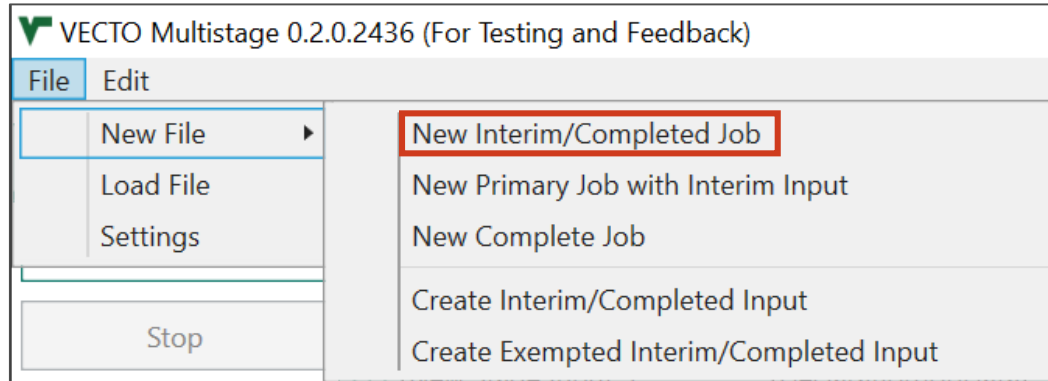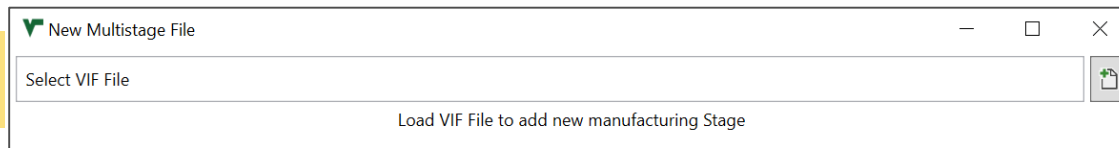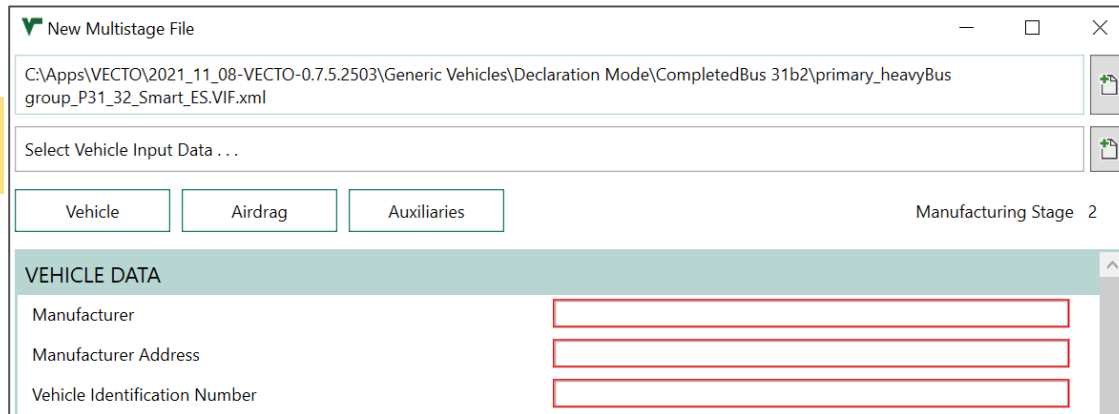
1. Select New File → New Interim/Completed Job;

2. Load VIF from previous step;

3. Enter data from current step or load existing XML for interim/completed step;

General case: Interim or completed vehicle

4. Save data as new VIF and (optionally) input of current manufacturing step;

General case: Interim or completed vehicle

Appends current manufacturing step to input VIF and saves under new VIF

Saves current manufacturing step to a new VIF
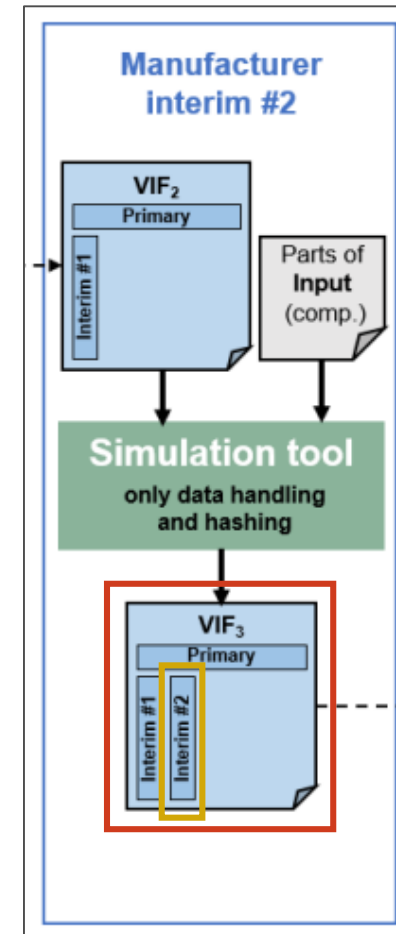
Special case 1: Primary vehicle + interim input
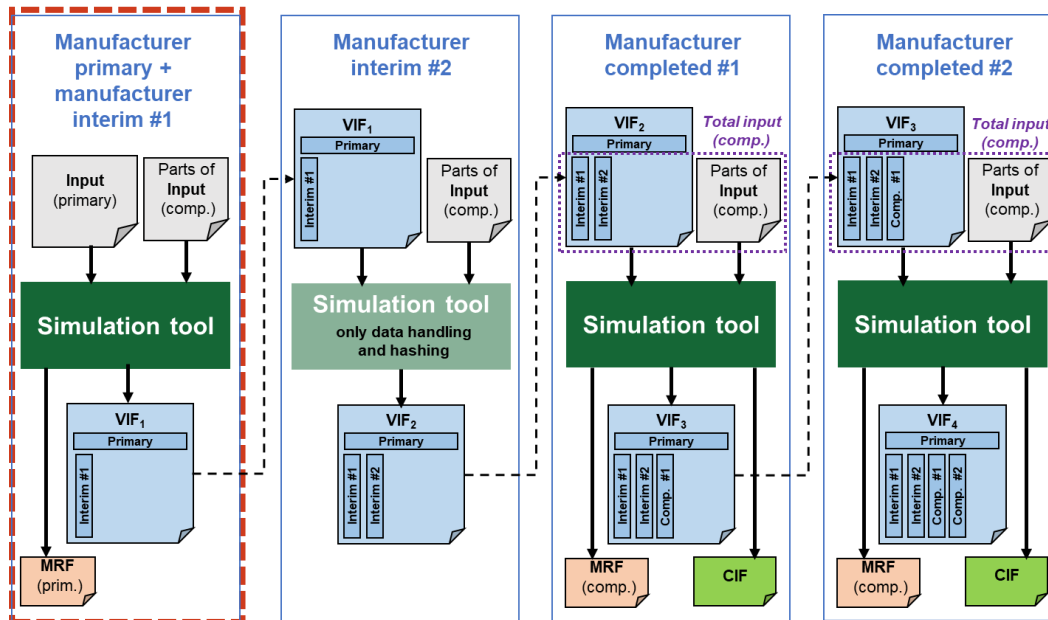


Profile: Primary vehicle manufacturer;

Manufacturer has access to the primary xml file and needs to provide parts of the interim or completed vehicle (i.e. HVAC compressor).

Special case 1: Primary vehicle + interim input
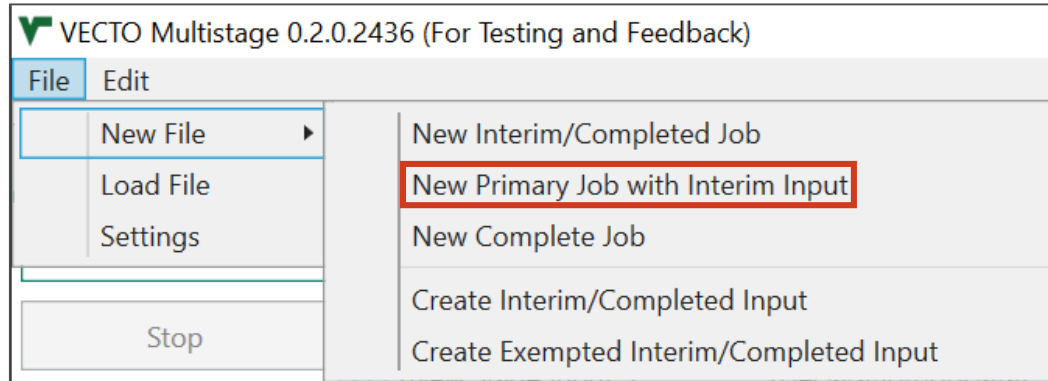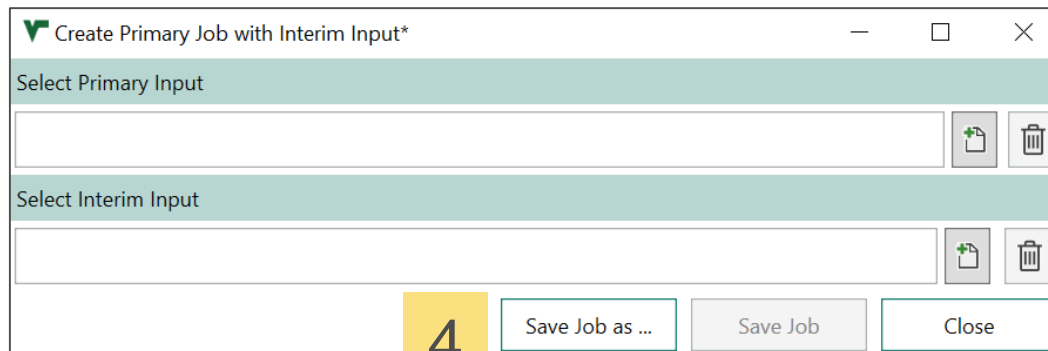
1. Select New File → New Primary Job with Interim Input;

2. Select primary bus input xml;

3. Select interim input xml (created externally or through the multistep tool)

4. Save VECTO job. The job is automatically added to the job list and can then be simulated;

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Special case 1: Primary vehicle + interim input

- The output of the simulation is a new VIF file, which should then be passed down to further interim or completed manufacturers;

Special case 2: Complete vehicle
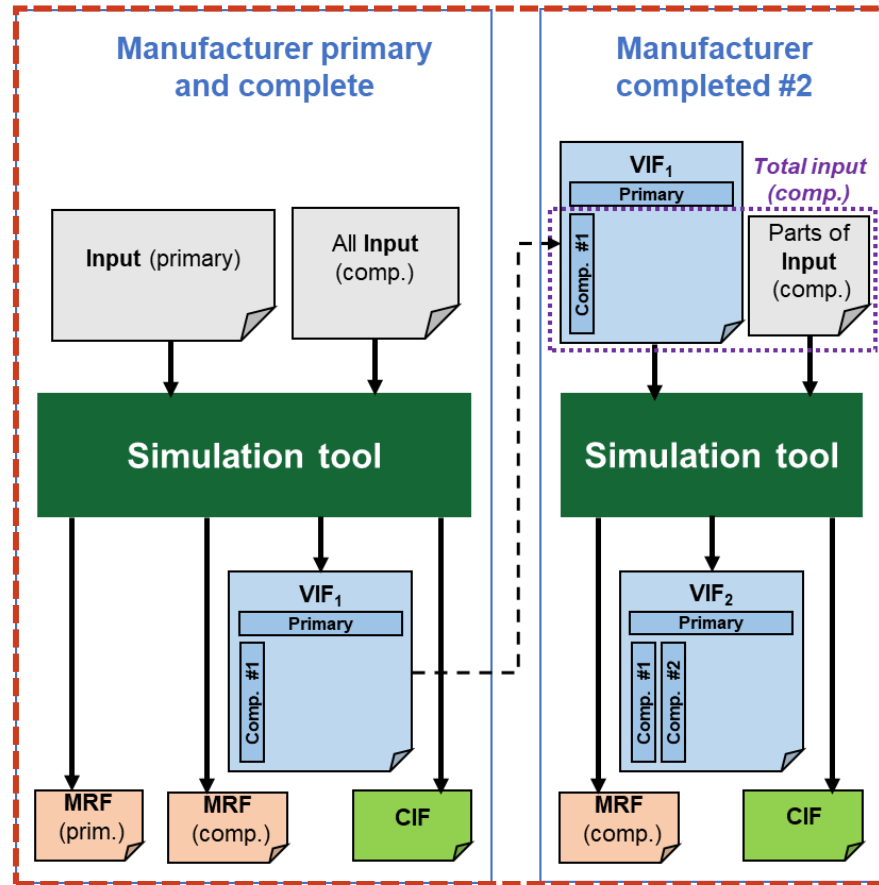
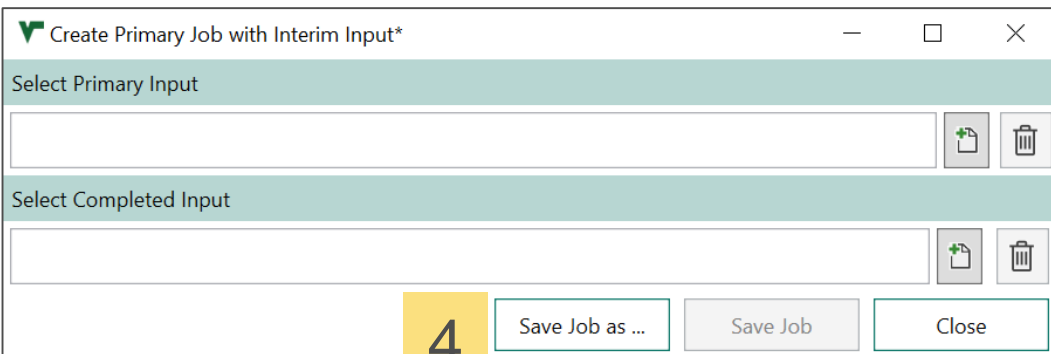
Profile: Primary vehicle manufacturer;

Manufacturer has access to the primary xml file and needs to provide complete vehicle data. This is a typical single manufacturer mode.
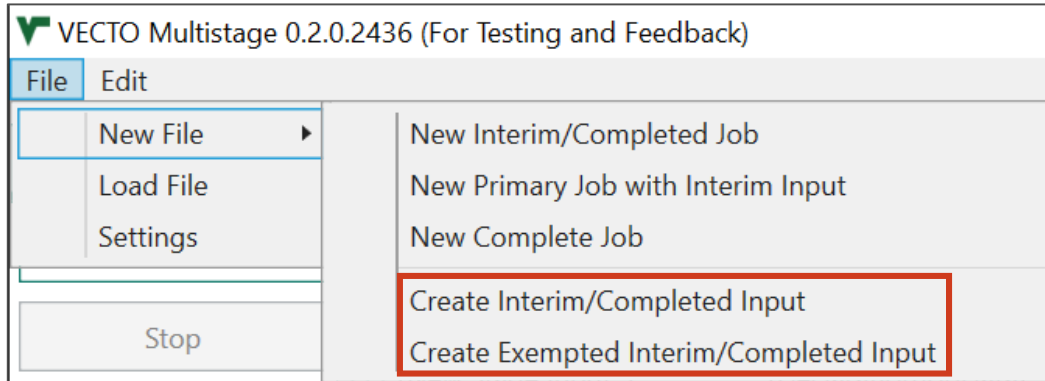
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Special case 2: Complete vehicle
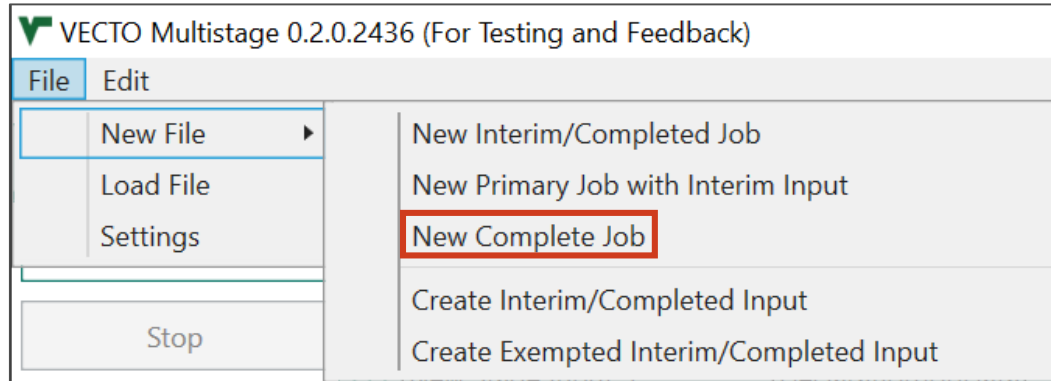
1. Select New File → New Complete Job;

2. Select primary bus input xml;

3. Select completed input xml (created externally or through the multistep tool)

4. Save VECTO job. The job is automatically added to the job list and can then be simulated;

Create single manufacturing step VIF input

Profile: Any manufacturer;

Manufacturer prepares a single dedicated manufacturing step VIF file for repeated use.

Create single manufacturing step VIF input

Manufacturing Step

Exempted Manufacturing Step

Contents

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Customer Information File (CIF)

```xml
<?xml-stylesheet href="https://webgate.ec.europa.eu/CITnet/svn/VECTO/trunk/Share/XML/CSS/VectoReports.css"?>
<tns:VectoCustomerInformation xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="urn:tugraz:ivt:VectoAPI:Cus
  <tns:Data xsi:type="VectoOutputDataType" id="COC-94d3236f39b1435fbcf1">
    <Vehicle xsi:type="VehicleCompletedBusType">
    <ResultDataSignature>
    <Results>
      <Status>success</Status>
      <Result status="success" xsi:type="ResultSuccessType">
        <Mission>Heavy Urban</Mission>
        <TotalVehicleMass unit="kg">11516</TotalVehicleMass>
        <MassPassengers unit="kg">916</MassPassengers>
        <PassengerCount>13.5</PassengerCount>
        <FuelMode>single fuel mode</FuelMode>
        <AverageSpeed unit="km/h">12.3</AverageSpeed>
        <Fuel type="Diesel CI">
        <CO2 unit="g/km">1751.73</CO2>
        <CO2 unit="g/p-km">130.10</CO2>
      </Result>
      <Result status="success" xsi:type="ResultSuccessType">
        <Mission>Heavy Urban</Mission>
        <TotalVehicleMass unit="kg">15178</TotalVehicleMass>
        <MassPassengers unit="kg">4578</MassPassengers>
        <PassengerCount>67.3</PassengerCount>
        <FuelMode>single fuel mode</FuelMode>
        <AverageSpeed unit="km/h">12.3</AverageSpeed>
        <Fuel type="Diesel CI">
        <CO2 unit="g/km">2135.48</CO2>
        <CO2 unit="g/p-km">31.72</CO2>
      </Result>
      <Result status="success" xsi:type="ResultSuccessType">
      <Result status="success" xsi:type="ResultSuccessType">
      <Result status="success" xsi:type="ResultSuccessType">
      <Result status="success" xsi:type="ResultSuccessType">
      <Summary>
    </Results>
    <ApplicationInformation>
  </tns:Data>
  <tns:Signature>
</tns:VectoCustomerInformation>
```

- CO2 emissions for each mission profile and passenger count (loading) in [g/km] and [g/p-km];

- Used to produce the CoC;

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Manufacturer Record File (MRF)

```xml
<?xml version="1.0" encoding="utf-8"?>
<?xml-stylesheet href="https://webgate.ec.europa.eu/CITnet/svn/VECTO/trunk/Share/XML/CSS/VectoReports.css"?>
<mrf:VectoOutput xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="urn:tugraz:ivt:VectoAPI:DeclarationOutpu
  <mrf:Data xsi:type="tns:VectoOutputDataType" id="RESULT-42351177807d4b66b756">
    <vns:Vehicle xsi:type="VehicleCompletedBusType">
    <vns:Results>
      <vns:Status>success</vns:Status>
      <vns:Result status="success" xsi:type="ResultCompletedVehicleSuccessType">
        <vns:Mission>Heavy Urban</vns:Mission>
        <vns:Distance unit="km">30.483</vns:Distance>
        <vns:SimulationParametersPrimaryVehicle>
        <vns:SimulationParametersCompletedVehicle>
        <vns:VehiclePerformance>
          <vns:AverageSpeed unit="km/h">12.3</vns:AverageSpeed>
          <vns:AverageDrivingSpeed unit="km/h">22.1</vns:AverageDrivingSpeed>
          <vns:MinSpeed unit="km/h">0.0</vns:MinSpeed>
          <vns:MaxSpeed unit="km/h">62.9</vns:MaxSpeed>
          <vns:MaxDeceleration unit="m/s²">0.94</vns:MaxDeceleration>
          <vns:MaxAcceleration unit="m/s²">1.00</vns:MaxAcceleration>
          <vns:FullLoadDrivingtimePercentage>3.47</vns:FullLoadDrivingtimePercentage>
          <vns:GearshiftCount>953</vns:GearshiftCount>
          <vns:EngineSpeedDriving>
            <vns:Min unit="rpm">700.0</vns:Min>
            <vns:Average unit="rpm">1132.5</vns:Average>
            <vns:Max unit="rpm">2216.9</vns:Max>
          </vns:EngineSpeedDriving>
          <vns:AverageGearboxEfficiency unit="%">89.31</vns:AverageGearboxEfficiency>
          <vns:AverageAxlegearEfficiency unit="%">93.20</vns:AverageAxlegearEfficiency>
        </vns:VehiclePerformance>
        <vns:Fuel type="Diesel CI">
        <vns:CO2 unit="g/km">1751.73</vns:CO2>
        <vns:CO2 unit="g/t-km">1913.30</vns:CO2>
        <vns:CO2 unit="g/p-km">130.10</vns:CO2>
      </vns:Result>
      <vns:Result status="success" xsi:type="ResultCompletedVehicleSuccessType">
      <vns:Result status="success" xsi:type="ResultCompletedVehicleSuccessType">
      <vns:Result status="success" xsi:type="ResultCompletedVehicleSuccessType">
      <vns:Result status="success" xsi:type="ResultCompletedVehicleSuccessType">
      <vns:Result status="success" xsi:type="ResultCompletedVehicleSuccessType">
```

- CO_2 emissions for each mission profile and passenger count (loading) in [g/km], [g/t-km] and [g/p-km];

- Contains simulation parameters for primary and completed vehicle;

- Average vehicle performance;

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MRF – Same results across all modes

- Simulations with any number of steps VS complete step will produce the same result if we input the same vehicle characteristics;

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Resources

User manual

Generic vehicles

Where is the tool located?

- Users can download the tool through our open source development platform https://code.europa.eu/vecto/vecto/-/releases

- Users are invited to register to the platform https://code.europa.eu/vecto in order to be able to report bugs and get notified about progress and new releases.

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Live demo

Q&A

More information

- Official VECTO website:

  https://ec.europa.eu/clima/policies/transport/vehicles/vecto_en

- Code repository and issue tracker:

  https://code.europa.eu/vecto

- Or contact:

  jrc-vecto@ec.europa.eu

  dimitrios.savvidis@ec.europa.eu

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Keep in touch

EU Science Hub

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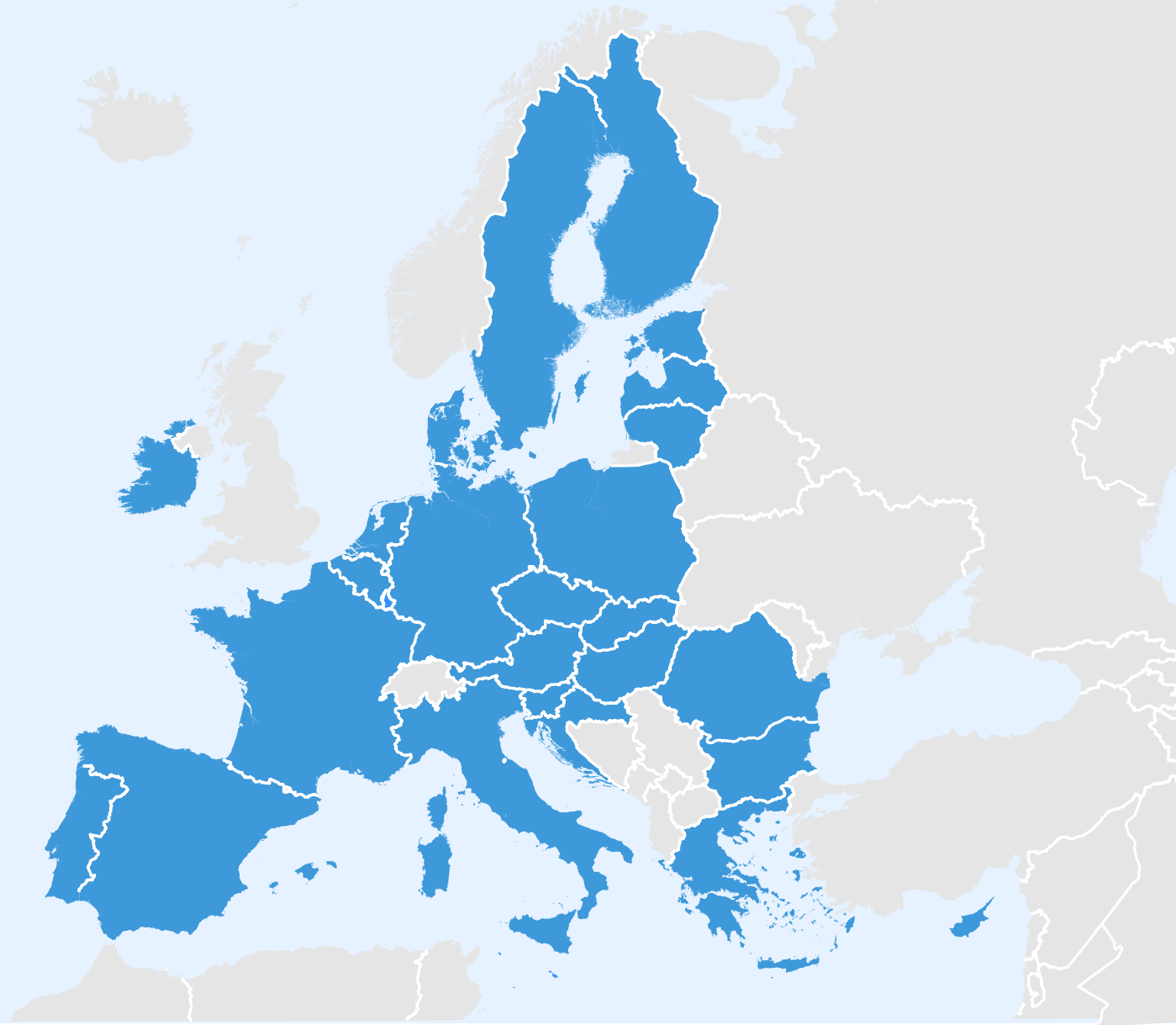in EU Science, Research and Innovation

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Thank you

EU countries

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0   250   500   1,000 Km

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