

Electric driving range estimation for pure electric heavy-duty vehicles – Data and simulation driven approach

Real-World Energy Efficiency and Emissions of Electric Freight Vehicles
Webinar May 5th, 2025

Efficient and low emission assets and energy TG1

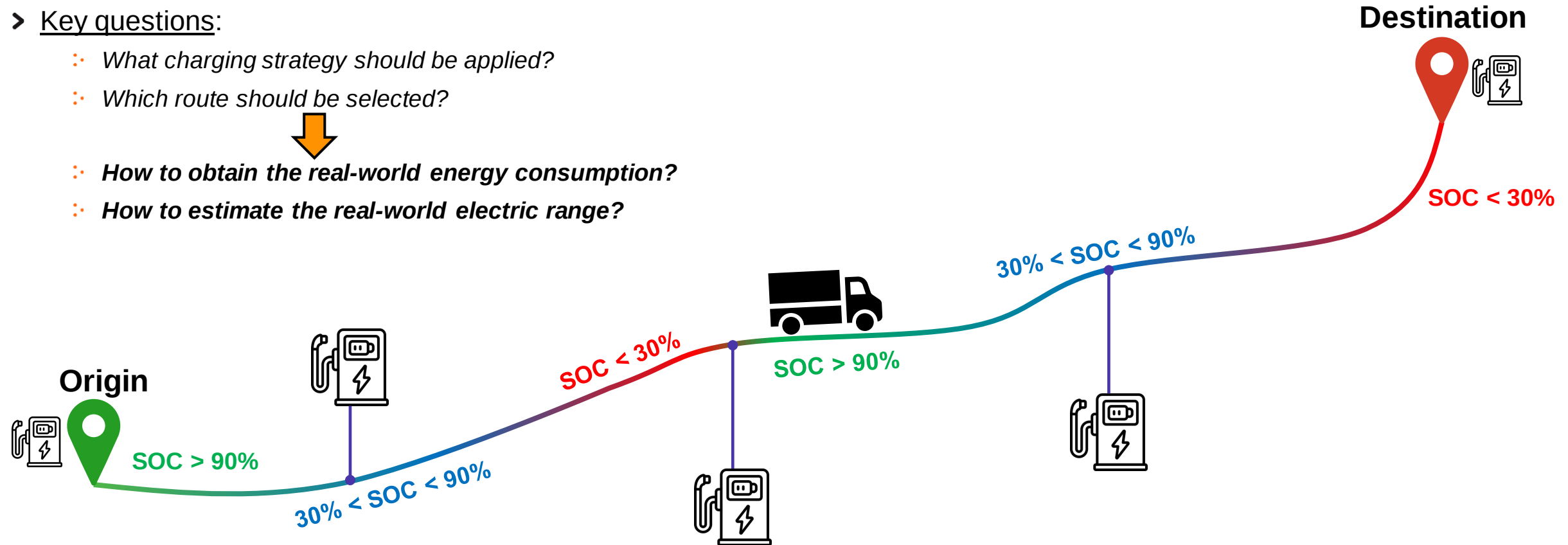
e:misia - Giorgos Mellios

Route planning – A challenge for pure electric heavy-duty vehicles

- Total trip distance: 800 km
- Nominal electric range: 350 km
- Key questions:
 - ⋮ *What charging strategy should be applied?*
 - ⋮ *Which route should be selected?*

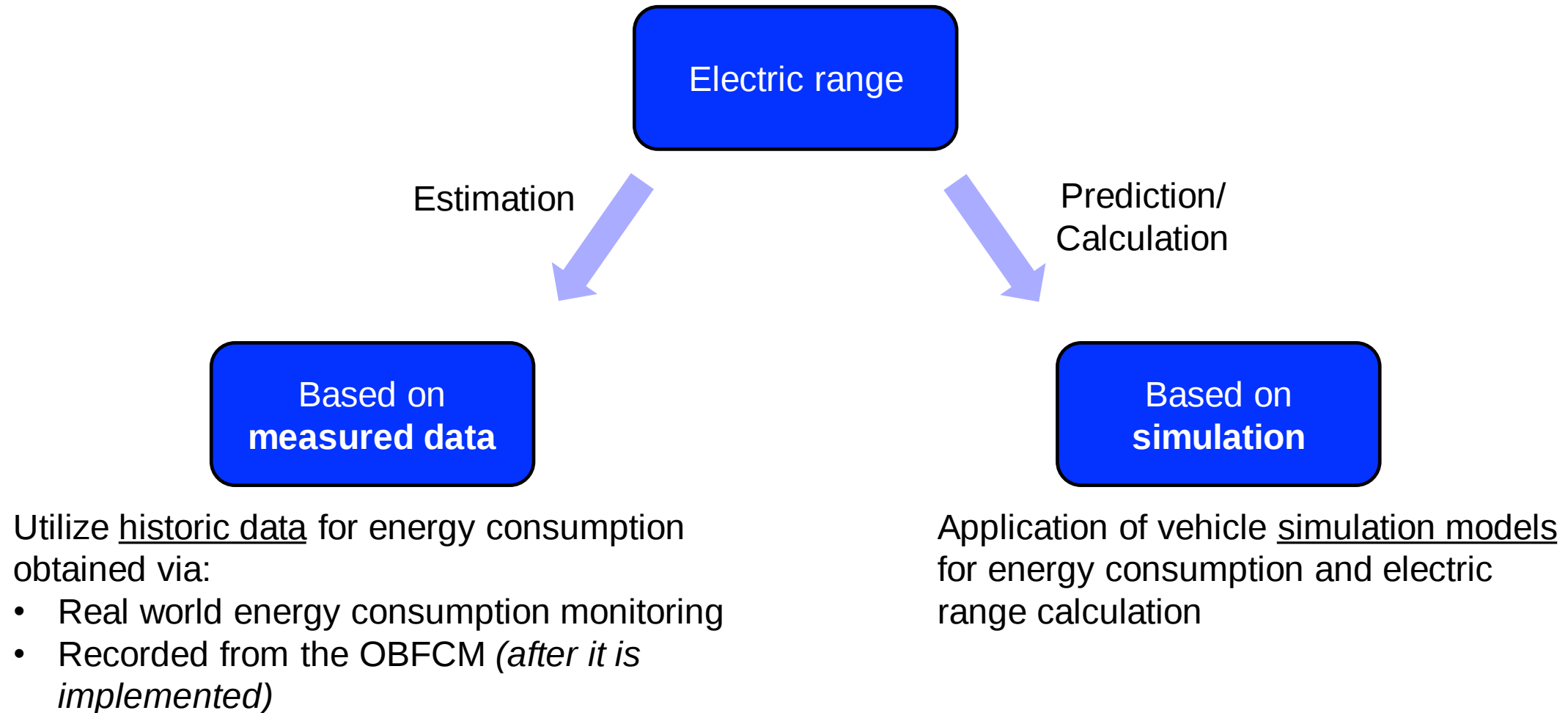


- ⋮ *How to obtain the real-world energy consumption?*
- ⋮ *How to estimate the real-world electric range?*



PEV: Pure Electric Vehicle
 HDV: Heavy-Duty Vehicle
 SOC: State-of-Charge

Electric range estimation and calculation methods

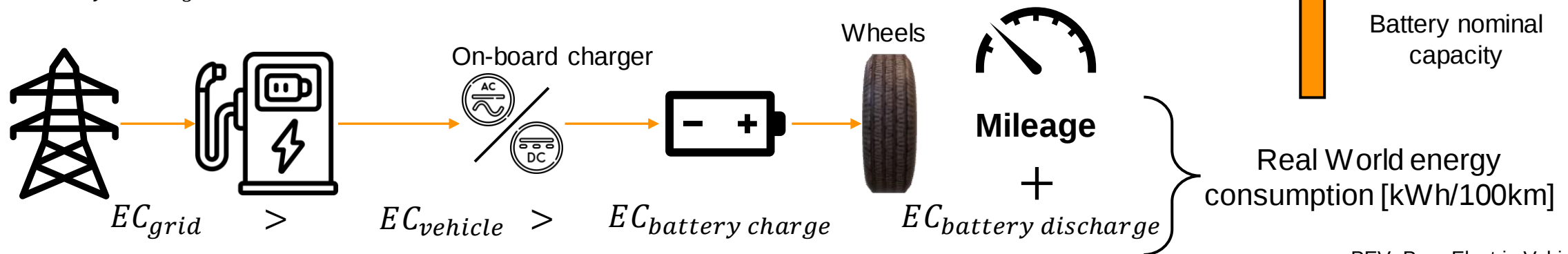


Electric range: distance covered when the vehicle starts with fully charged battery until a low SOC threshold is reached

OBFCM: On-board Fuel Consumption Measurement
SOC: State-of-Charge

Real world energy consumption monitoring

- Current state of the art for vehicles with conventional powertrain → on-board monitoring for total fuel consumed and distance travelled
 - ⋮ Driver's dashboard
 - ⋮ Using OBD/CAN loggers → long term monitoring and automatic data transmission
 - ⋮ Report fuel input and mileage after refueling
- Similar methodology can be applied for PEV HDVs
 - ⋮ Record energy consumed at the of-board charger (EC_{grid})
 - ⋮ Record energy into the battery → Δ SOC from driver's dashboard ($EC_{battery\ charge}$)
 - ⋮ On-board monitoring → energy consumed / battery discharge energy (Δ SOC - $EC_{battery\ discharge}$) & mileage



PEV: Pure Electric Vehicle
 HDV: Heavy-Duty Vehicle
 SOC: State-of-Charge

Real world fuel consumption monitoring

Introduction of OBFCM/OBMM

Heavy-duty vehicles – on-board fuel and/or energy consumption monitors (technical requirements)* → Under public consultation and feedback (10 April 2025 - 08 May 2025)

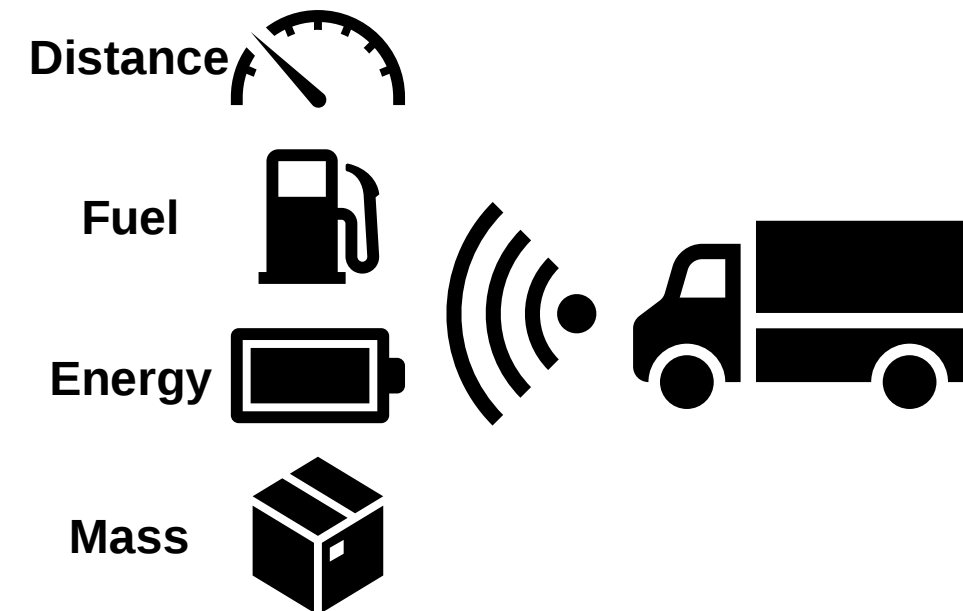
➤ Initiative that defines the technical requirements for the on-board devices to monitor

- Lifetime fuel & energy consumed
- Lifetime distance travelled
- Vehicle mass

→ **Fuel and Energy consumption calculation → range estimation**

- Combination with battery durability expects to increase the range estimation accuracy, i.e. consider battery degradation via the reported battery state of health (SOH)

✓ **Simplification of data collection is expected due to standardized signals and communication protocols**



OBFCM: On-board Fuel Consumption Measurement
OBMM: On-board Mass Monitoring system

* [Heavy-duty vehicles – on-board fuel and/or energy consumption monitors \(technical requirements\)](#)

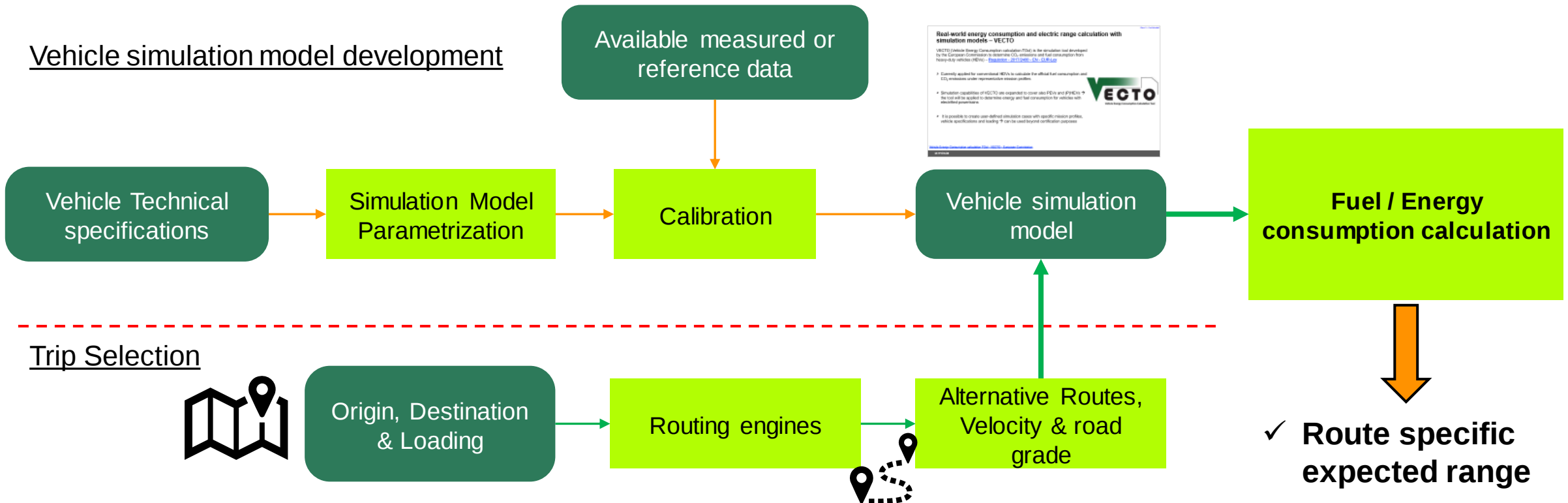
Real-world energy consumption and electric range calculation with simulation models

Application of a simulation-based approach combined with routing



- Used for prediction and planning
- Incorporate routing engines → Obtain realistic velocity profiles and road gradient
- Simulate impact from ambient conditions, e.g. AC operation
- Integrate charging stations' location → route and charging strategy optimization

Vehicle simulation model development



Real-world energy consumption and electric range calculation with simulation models – VECTO

VECTO (Vehicle Energy Consumption calculation TOol) is the simulation tool developed by the European Commission to determine CO₂ emissions and fuel consumption from heavy-duty vehicles (HDVs) – [Regulation - 2017/2400 - EN - EUR-Lex](#)

- Currently applied for conventional HDVs to calculate the official fuel consumption and CO₂ emissions under representative mission profiles
- Simulation capabilities of VECTO are expanded to cover also PEVs and (P)HEVs → the tool will be applied to determine energy and fuel consumption for vehicles with electrified powertrains
- It is possible to create user-defined simulation cases with specific mission profiles, vehicle specifications and loading → can be used beyond certification purposes



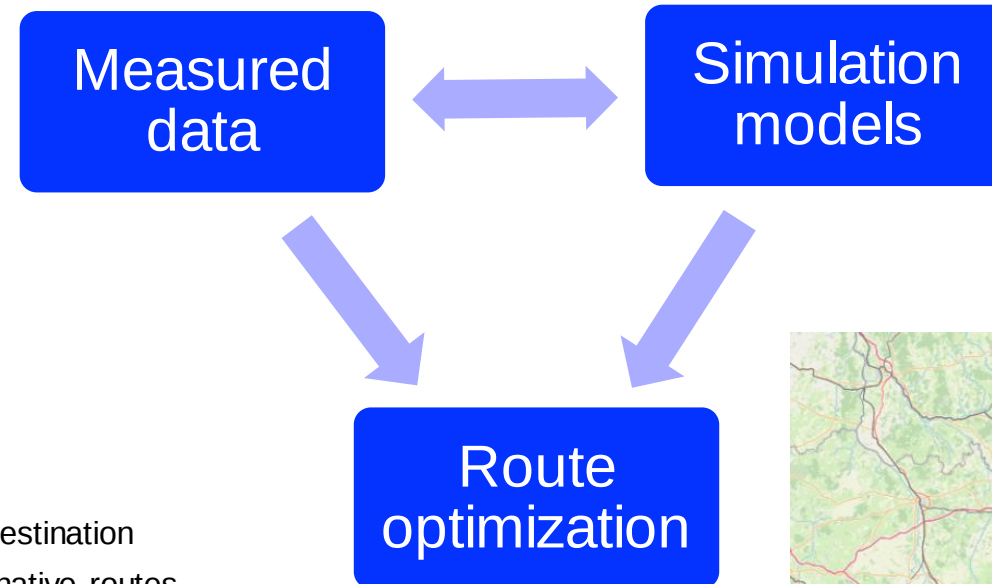
Overview

› Real world energy consumption monitoring and electric range estimation

- ⋮ Requires device installation for data recording and transmission
- ⋮ High quality data for energy consumption
- ⋮ May require intervention by the driver for recording information
- ⋮ Simplification when OBFCM/OBMM is established

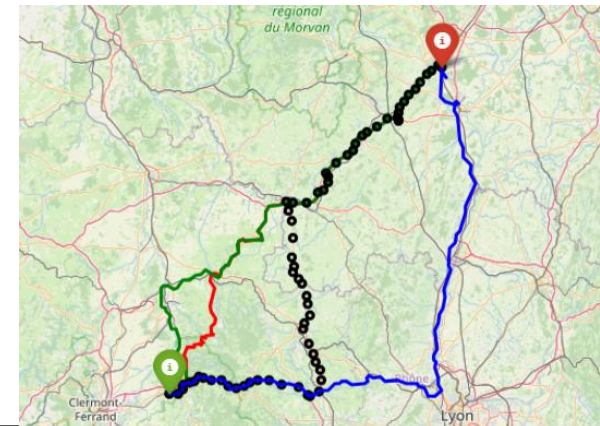
› Real-world energy consumption and electric range calculation

- ⋮ Requires the definition of the simulation models
- ⋮ Can be used for trip specific electric range prediction and impact from ambient conditions can also be considered
- ⋮ Possible to combine with routing engines
- ⋮ A simulation approach is easily integrated to a routing and changing strategy optimization



› Route planning

- ⋮ Definition of origin and destination
- ⋮ Identification of the alternative routes
- ⋮ Calculation of energy consumption and estimated range
- ⋮ Selection of the most efficient route



Thank you for your attention!

Q&A?