# RWR 4015

# Traffic Simulation for Planning Applications

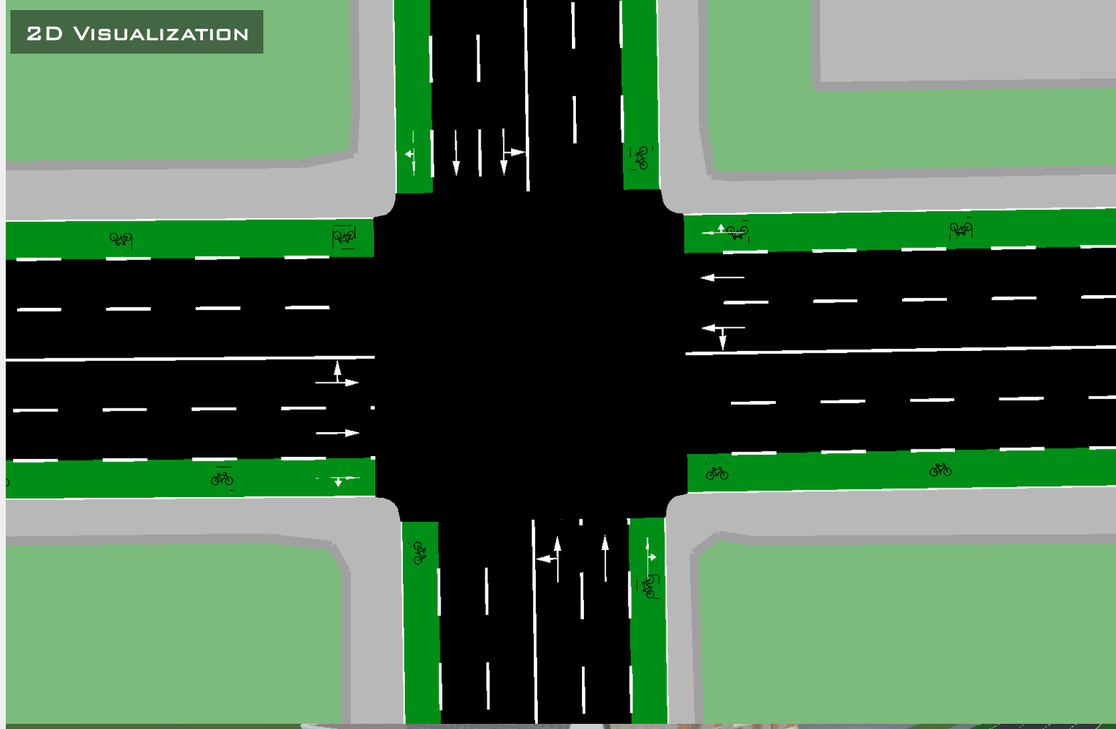
Dr. Ahmad Mohammadi

Week 7 | Lecture:
Environmental Analysis
(Energy, Emissions, Electric Vehicles)

Fall 2026

RoadwayVR

roadwayvr.github.io/TrafficSimulationforPlanningApplications

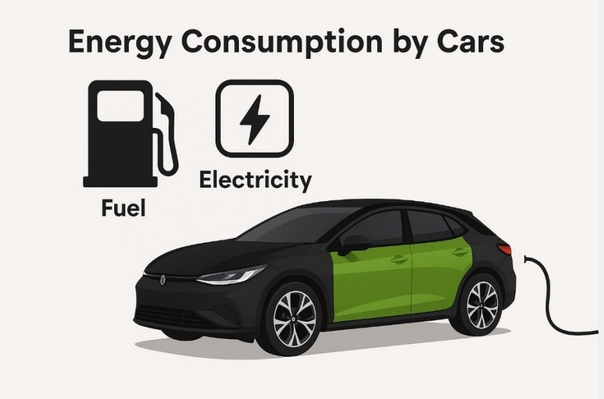


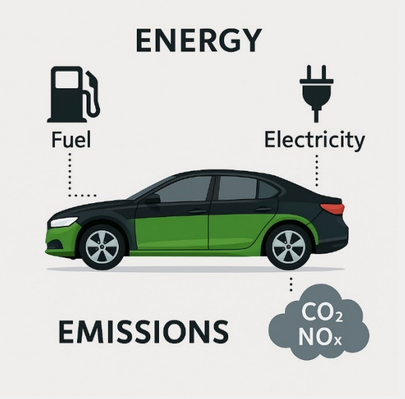

# Agenda

- ❑ Energy and Emission Definition and Impact of Different Vehicle Types
- ❑ Internal Combustion Engine Vehicle and Electric Vehicle
- ❑ SUMO Vehicle Supports
- ❑ Energy Consumption and Emission Models
- ❑ Case Studies in Environmental Analysis

# Energy and Emission

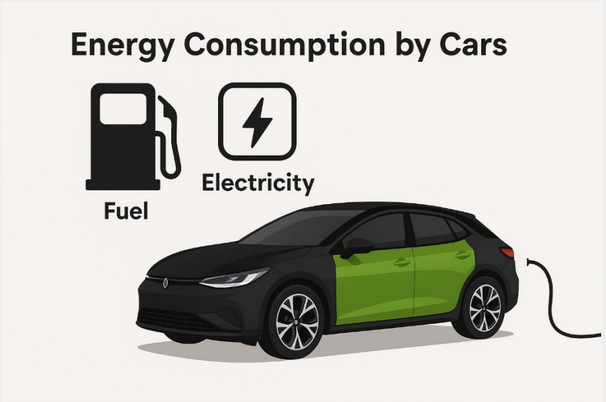
- ❑ Fundamental of Energy and Emission (Combustion Engine Vehicle and Electric Vehicles)
- ❑ Energy, Emission and EVs in SUMO → Hands - on Session

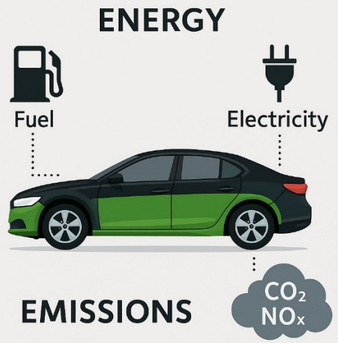


# Energy and Emission Definition

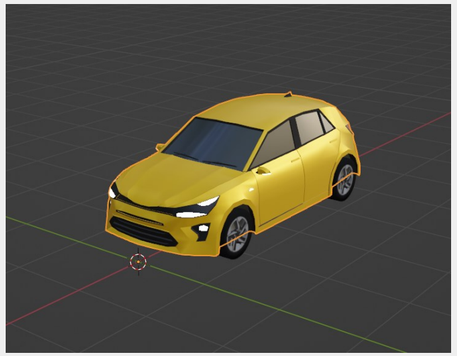
- **Energy:** Fuel or Electricity
- **Emissions:** Pollutants (such as $CO2$, $NOx$)



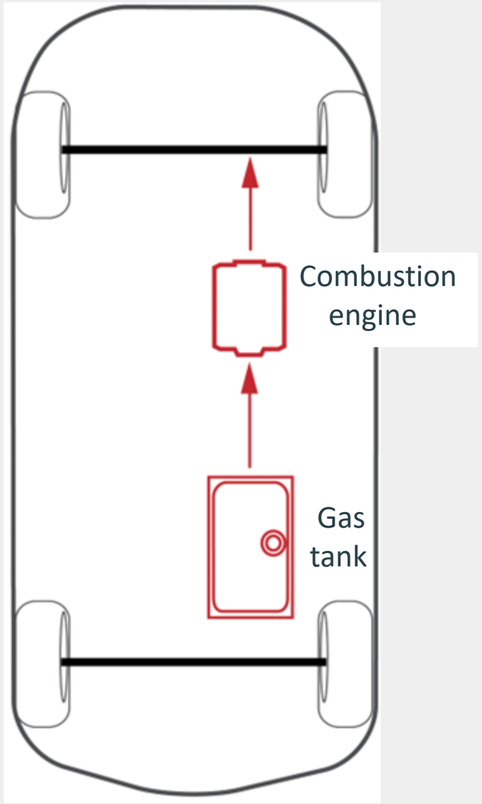

- **Vehicle Type #1:** Internal Combustion Engine Vehicle(ICEV)
- **Vehicle Type #2:** Electric Vehicle (EV)

**Type #1 (ICEV)**



**Type #2 (EV)**

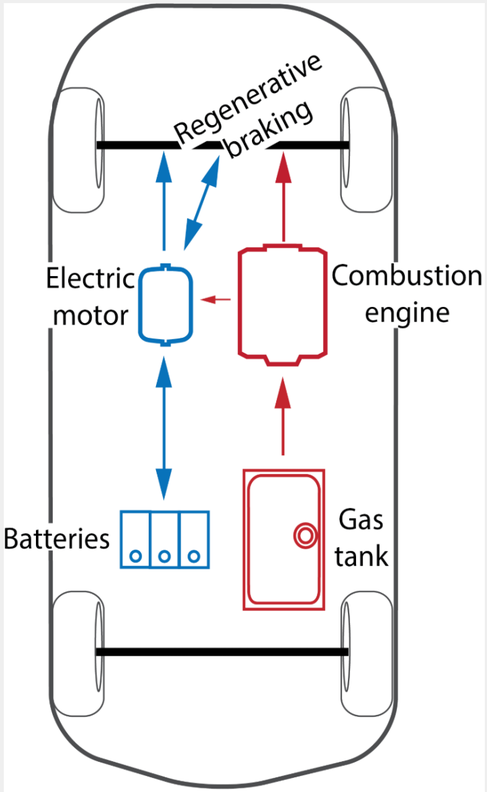
# Internal Combustion Engine Vehicle (ICEV)



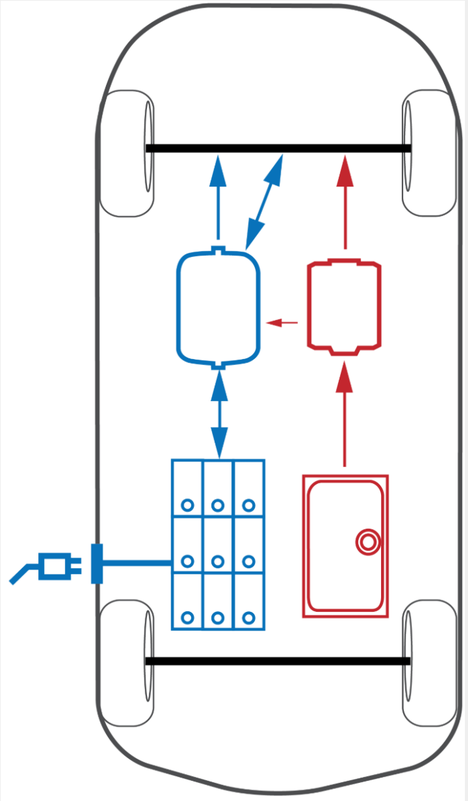

**Combustion engine vehicle**

Haldeman, B., Hummel, R. & Sigmund, W., 2015. Batteries for Vehicles. [Online] Available at: https://www.myfloridahomeenergy.com/help/library/transportation/batteries-for-vehicles/#sthash.u6O43kwZ.1jdSMD4P.dpbs [Accessed 27 September 2017].

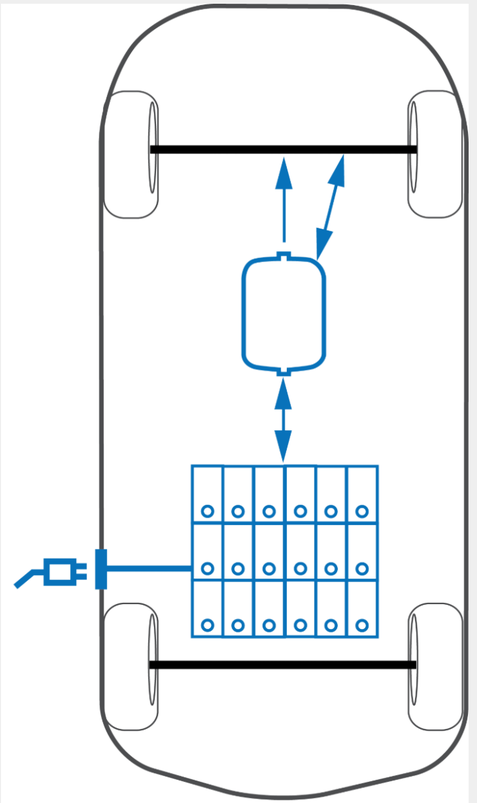
# Electric Vehicles (EV) Types




**Hybrid electric vehicle**



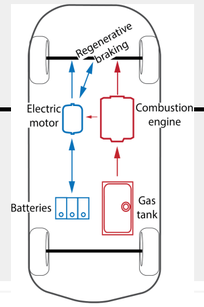
**Plug-in electric vehicle**

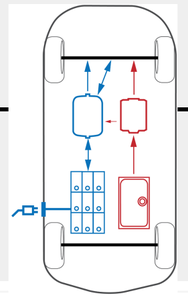


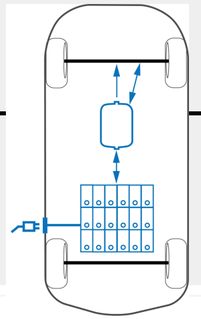
**Pure electric vehicle**

Haldeman, B., Hummel, R. & Sigmund, W., 2015. Batteries for Vehicles. [Online] Available at: https://www.myfloridahomeenergy.com/help/library/transportation/batteries-for-vehicles/#sthash.u6O43kwZ.1jdSMD4P.dpbs [Accessed 27 September 2017].

# Electric Vehicles Types





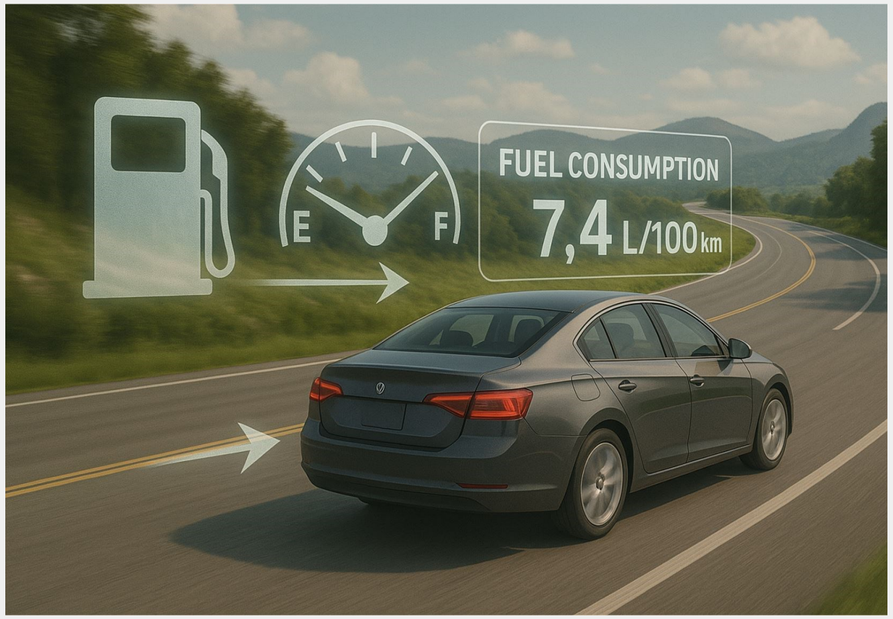
| Feature | Hybrid Electric Vehicle (HEV) | Plug-in Hybrid Electric Vehicle (PHEV) | Pure Electric Vehicle (EV) |
|---|---|---|---|
| **Power Sources** | Gasoline + Electric Motor | Gasoline + Electric Motor | Electric Motor Only |
| **Charging Method** | Internal only (no plug) | External plug + regenerative + engine charging | External plug + regenerative braking |
| **Battery Size** | Small | Medium to Large | Large |
| **Electric-Only Driving Range** | Very limited or none | Moderate (20–50+ km typically) | High (200–500+ km depending on model) |
| **Gas Engine Present** | Yes | Yes | No |
| **Regenerative Braking** | Yes | Yes | Yes |
| **Use of Electric Power** | Assists gasoline engine | Can run on electricity only for short trips | Primary (and only) source of propulsion |
| **Fuel Dependency** | Always needs gasoline | Uses electricity first, then gasoline | No gasoline needed |
| **Emissions** | Moderate (lower than traditional cars) | Low (especially on short trips) | Zero tailpipe emissions |
| **Charging Port** | ❌ None | ✅ Yes | ✅ Yes |
| **Typical Use Case** | Improves fuel efficiency in regular driving | Ideal for daily commutes with gas backup | Best for full-electric lifestyle |

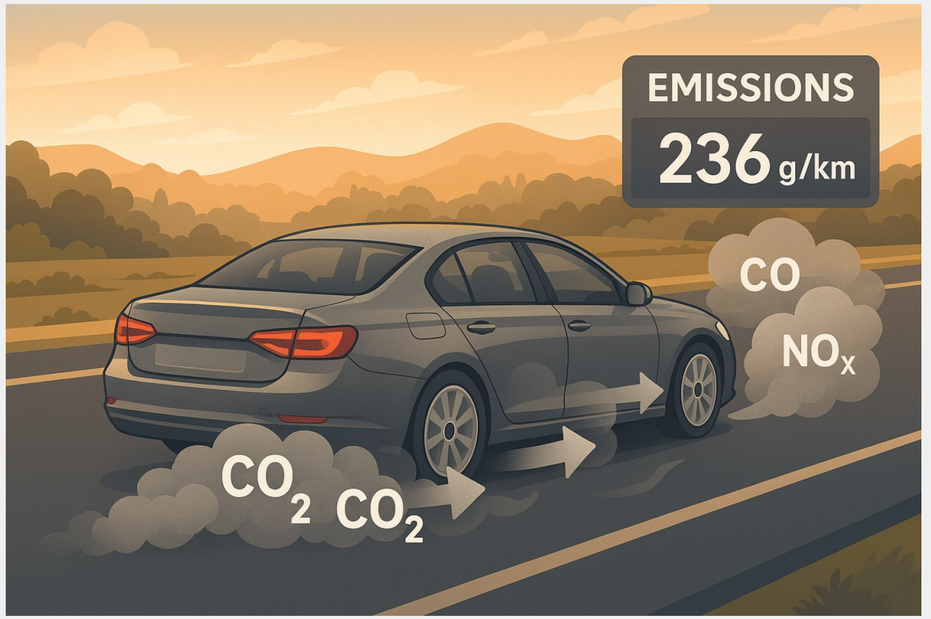
# Energy vs Emissions

# In Internal Combustion Engine Vehicle

**Energy:** Energy consumption refers to the total amount of energy (e.g., gasoline) required to power a vehicle measured in liters of fuel

**Emissions:** Emissions generally refer to the pollutants (such as $CO2$, $NOx$) released into the atmosphere during vehicle operation.



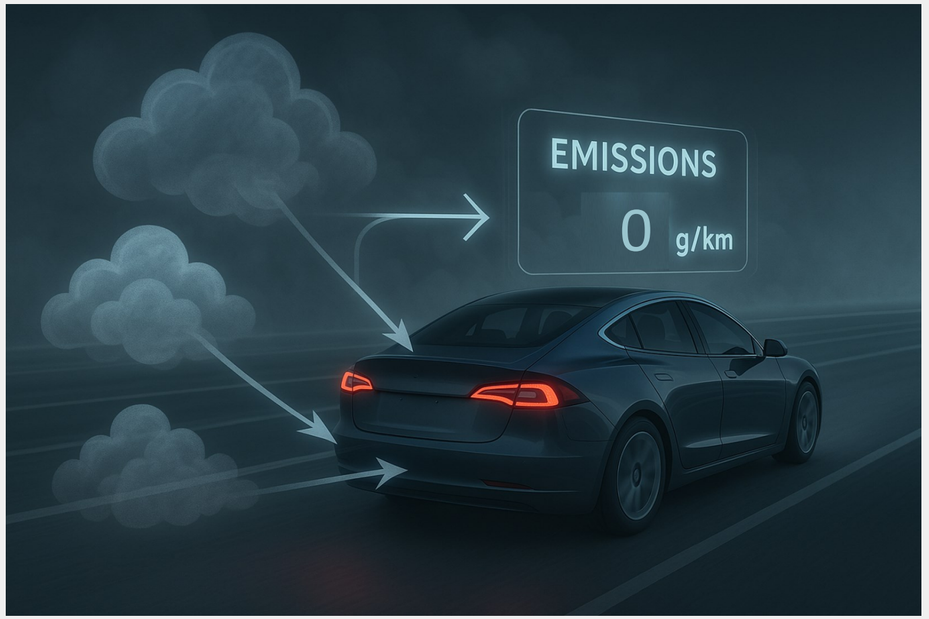



# Energy vs Emissions

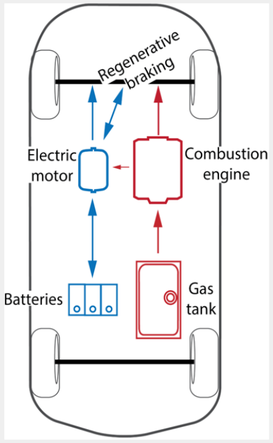
# In Electric Vehicle

**Energy:** Energy consumption refers to the total amount of energy (e.g., electricity) required to power a vehicle measured in kilowatt-hours (kWh).

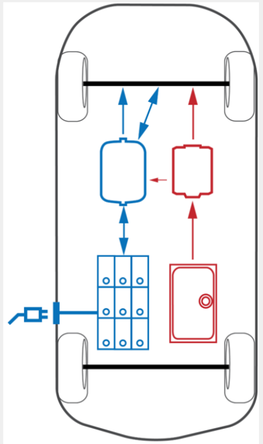

**Emissions:** 0
life-cycle/grid emissions not considered in



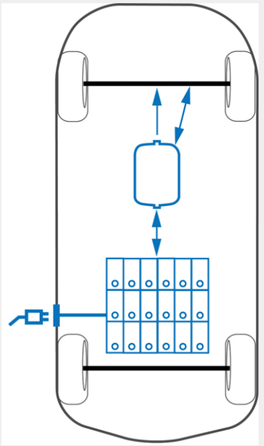
# SUMO Vehicle Supports



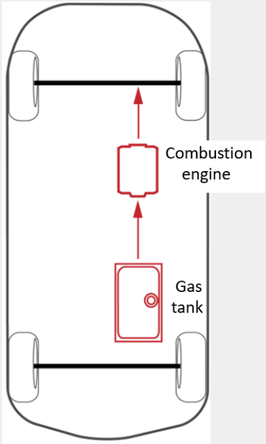

Hybrid electric vehicle



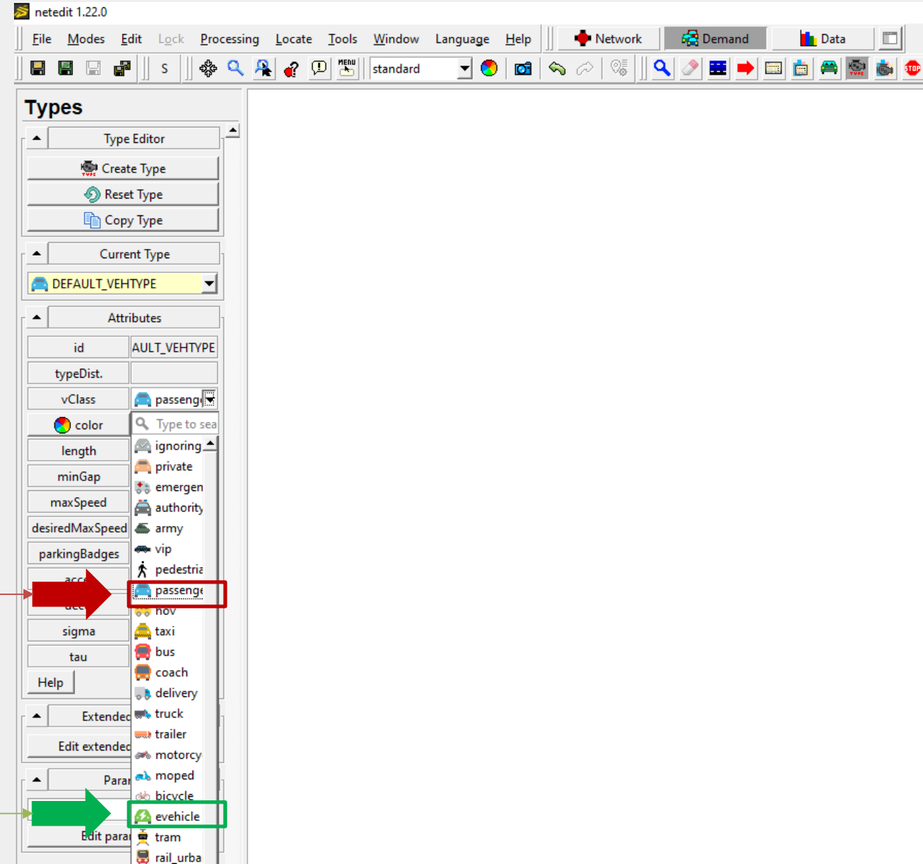
Plug-in electric vehicle



Pure electric vehicle




Combustion engine vehicle



# Energy Consumption and Emission Models

## Combustion Engine Vehicle

### Energy Consumption

HBEFA Energy
PHEM
MOVES

### CO2, NOx and other pollutants

HBEFA Emission
PHEM
MOVES

## Electric Vehicle

### Energy Consumption

SUMO Electric Vehicle Model
Vissim Electric Vehicle Model
Aimsun Electric Vehicle Model

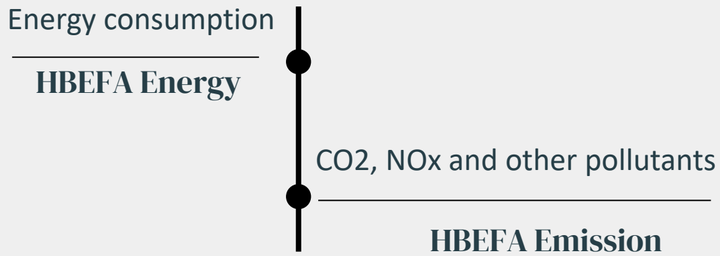
### CO2, NOx and other pollutants

0

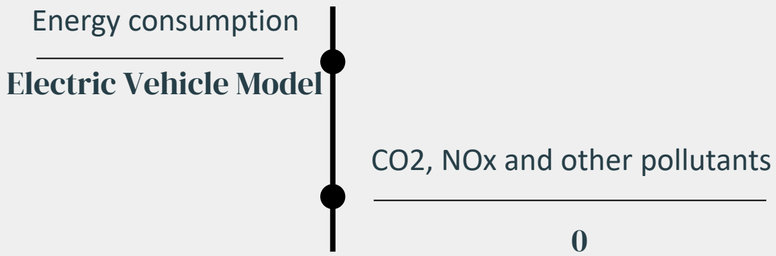
# Energy Consumption and Emission Models

**This Presentation Focuses on:**

## Combustion Engine Vehicle




## Electric Vehicle

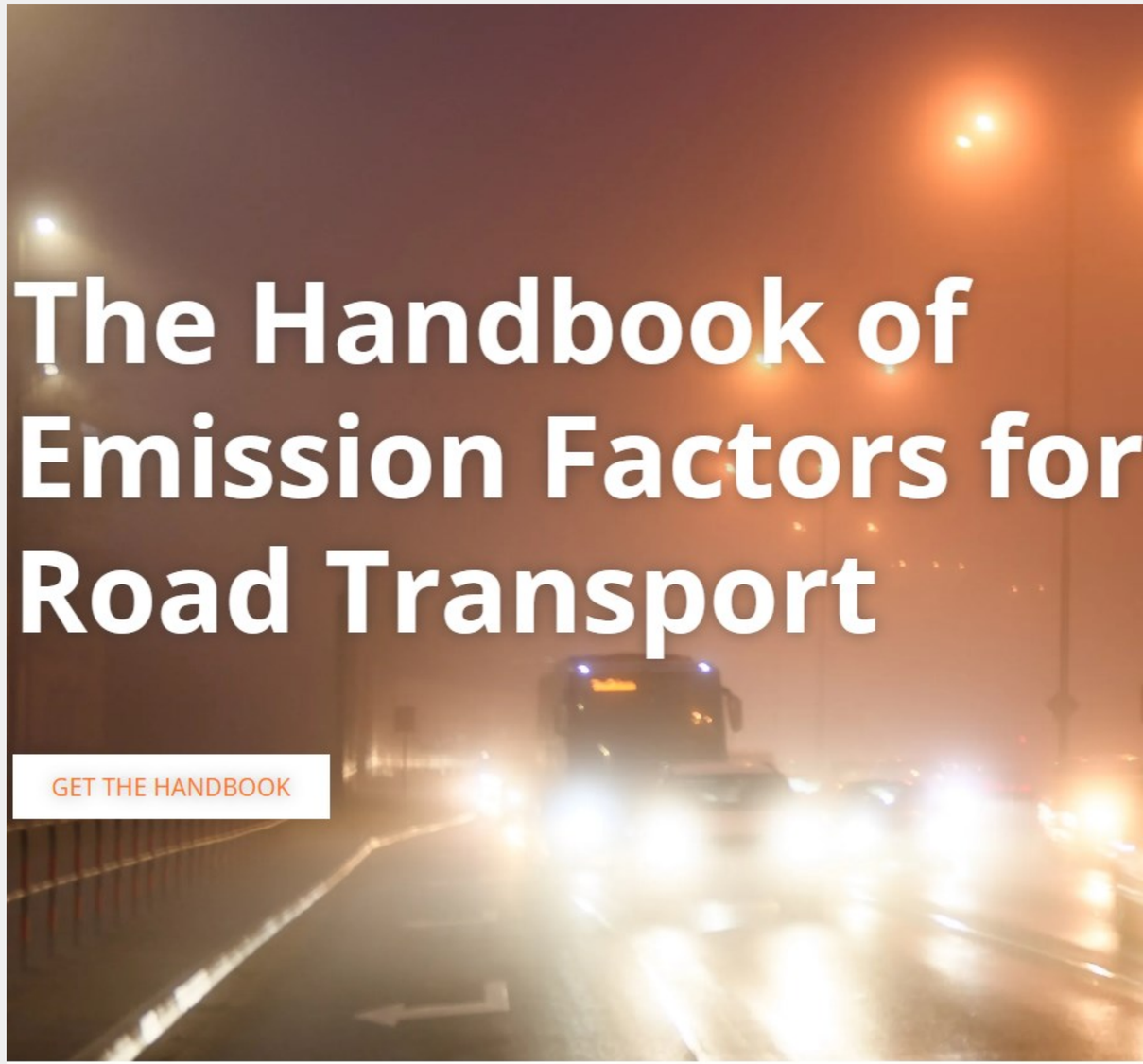



HBEFA → HandBook of Emission FActors for Road Transport

Electric Vehicle Model → Kurczveil, T., López, P. Á., & Schnieder, E. (2013, May). Implementation of an Energy Model and a Charging Infrastructure in SUMO. In Simulation of Urban MObility User Conference

# HBEFA Model

- Includes a wide range of vehicle categories (passenger cars, light-duty vehicles, heavy duty vehicles, buses, motorcycles),
- Different fuel types, and pollutants ($CO_2$, $NO_x$, HC, PM, etc.)




https://www.hbefa.net/