RWR 4015

Traffic Simulation for Planning Applications

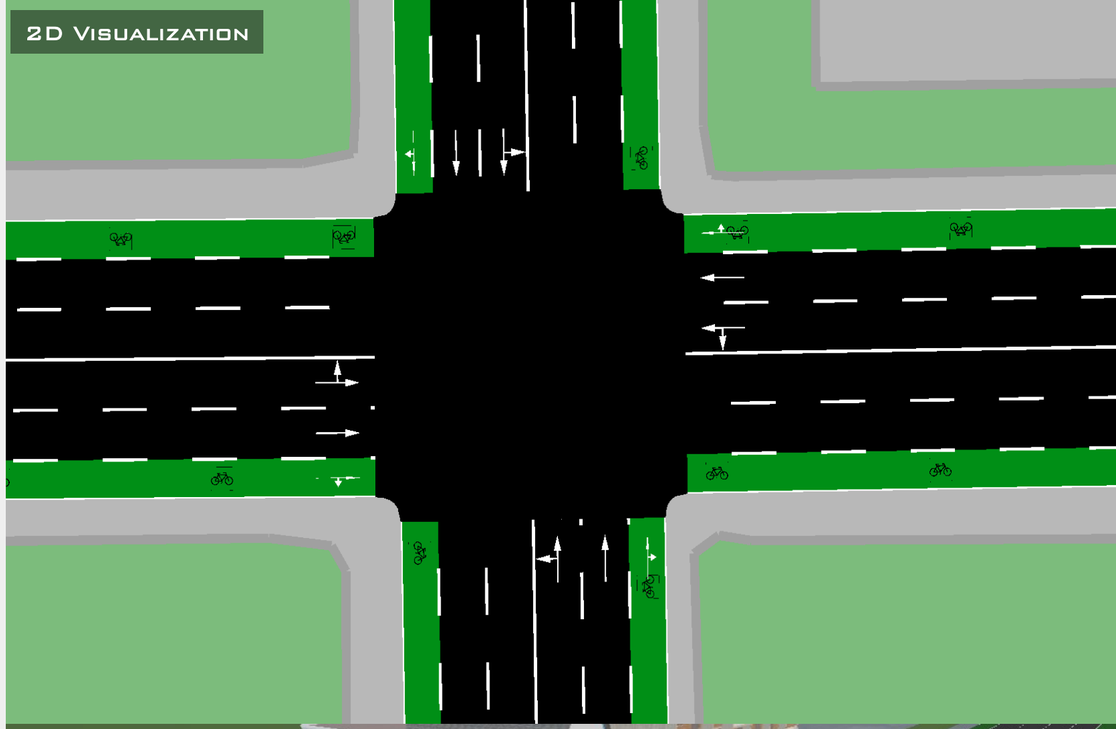
Dr. Ahmad Mohammadi

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

Fall 2026

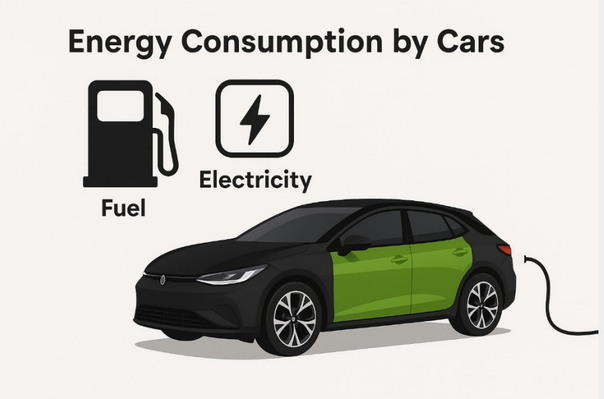
RoadwayVR

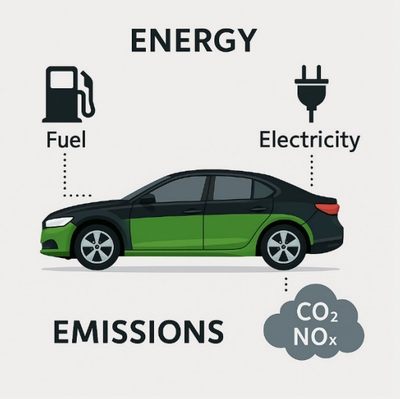
roadwayvr.github.io/TrafficSimulationforPlanningApplications



Energy and Emission

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



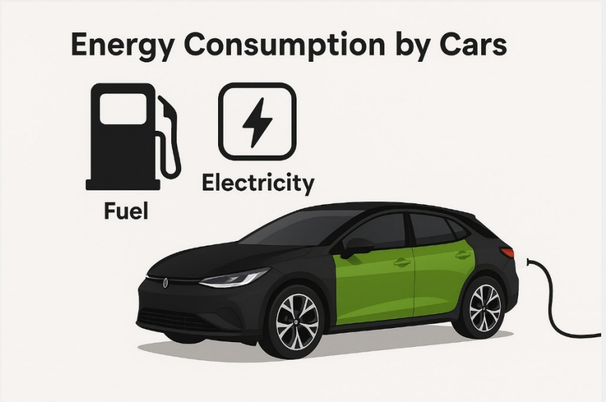


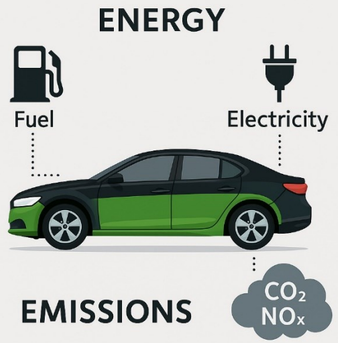
Fundamental of Energy and Emission and Electric Vehicles

- ❑ 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

Energy and Emission Definition

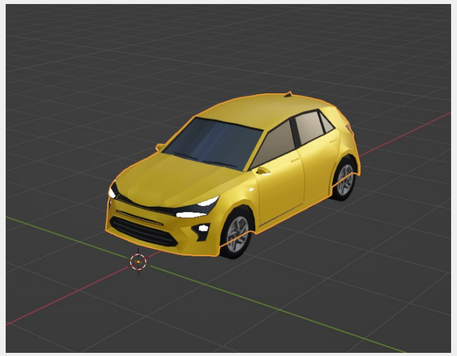
- **Energy:** Fuel or Electricity
- **Emissions:** Pollutants (such as $CO2$, NOx)





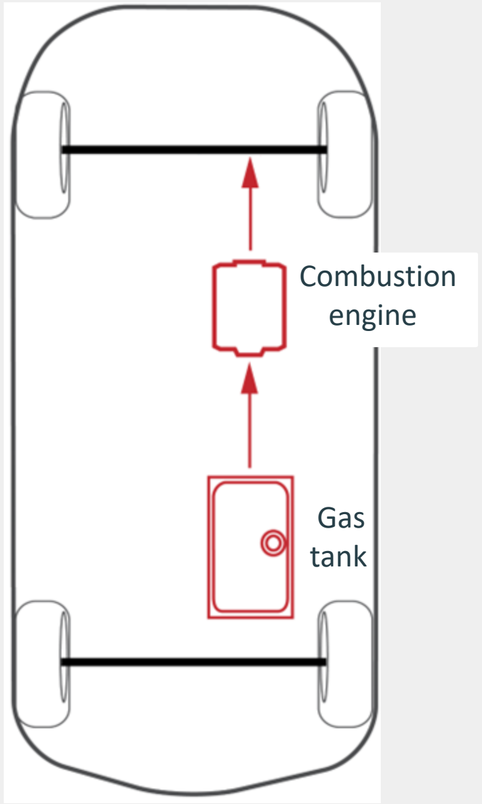
- **Vehicle Type #1:** Internal Combustion Engine Vehicle(ICEV)
- **Vehicle Type #2:** Electric Vehicle (EV)

Type #1 (ICEV)



Type #2 (EV)

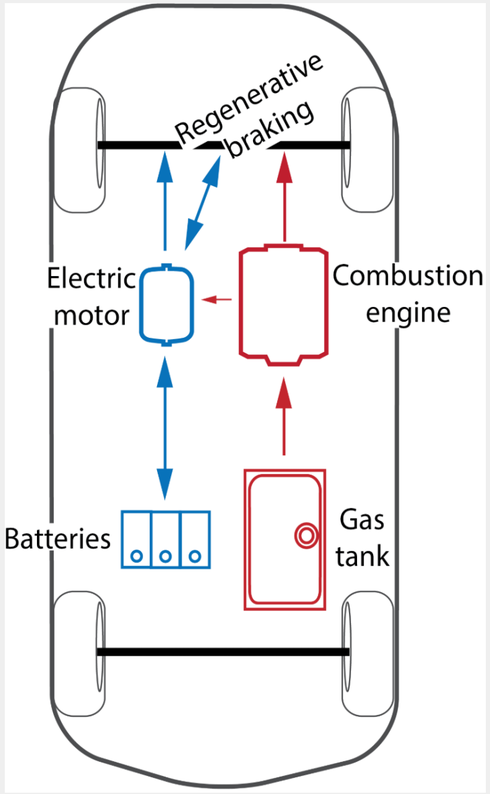
Internal Combustion Engine Vehicle (ICEV)



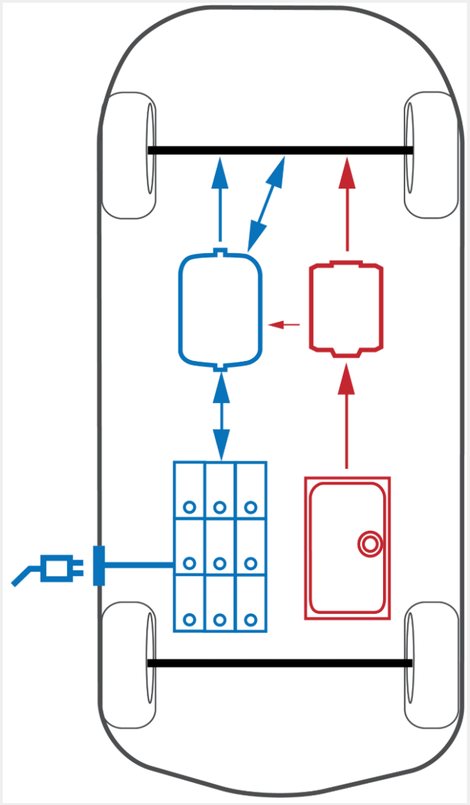
Combustion engine vehicle

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].

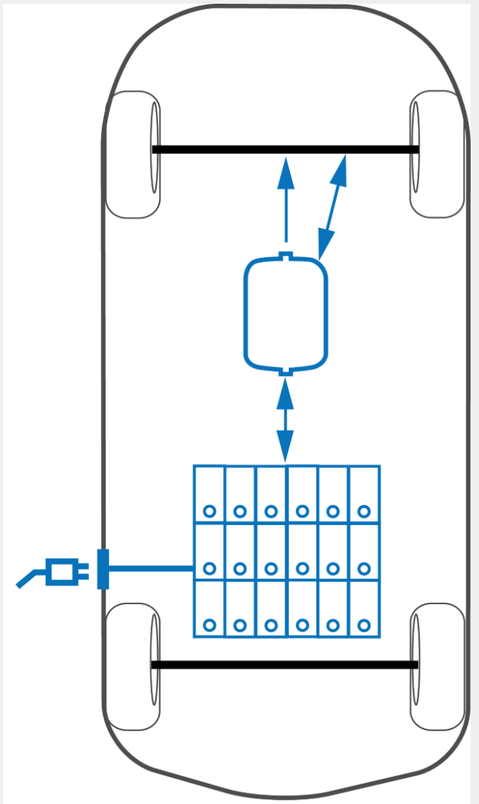
Electric Vehicles (EV) Types



Hybrid electric vehicle



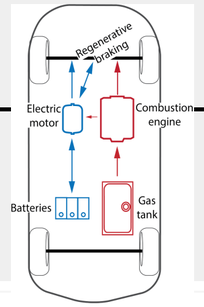
Plug-in electric vehicle

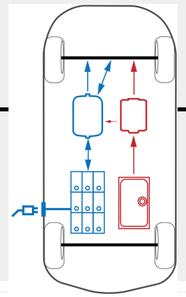


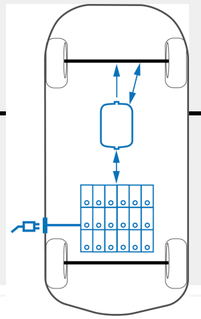
Pure electric vehicle

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







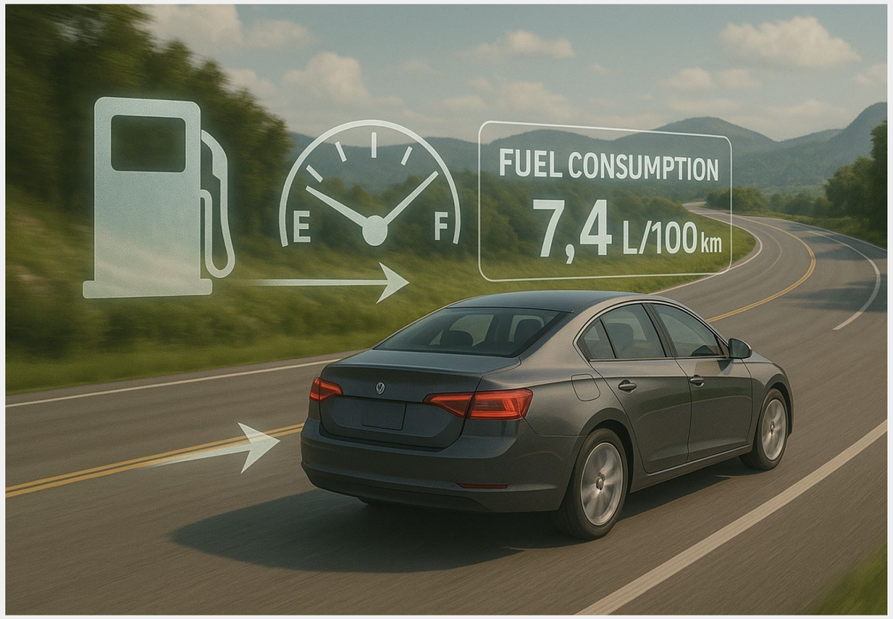
Feature	Hybrid Electric Vehicle (HEV)	Plug-in Hybrid Electric Vehicle (PHEV)	Pure Electric Vehicle (EV)
Power Sources	Gasoline + Electric Motor	Gasoline + Electric Motor	Electric Motor Only
Charging Method	Internal only (no plug)	External plug + regenerative + engine charging	External plug + regenerative 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

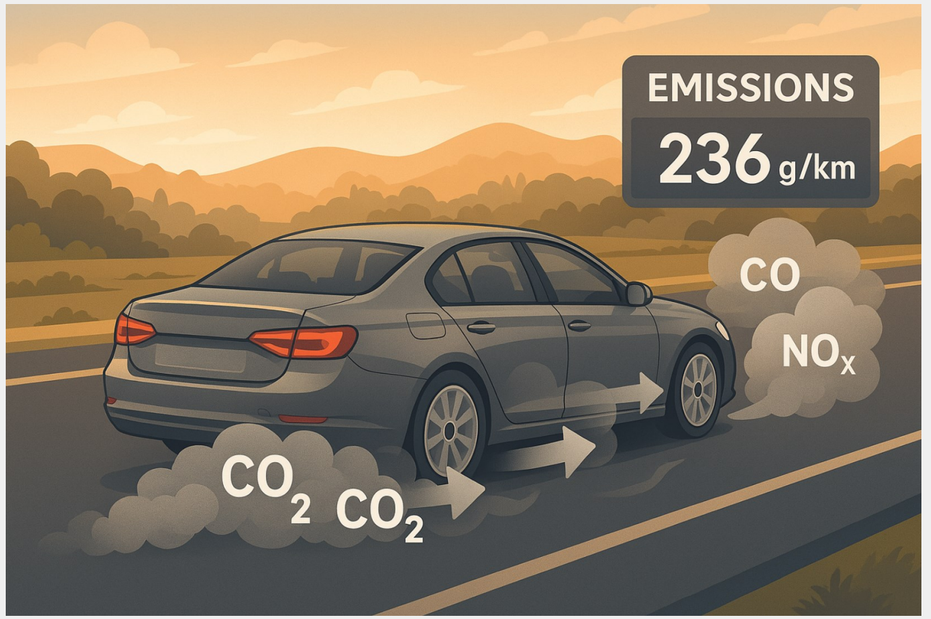
Energy vs Emissions

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.



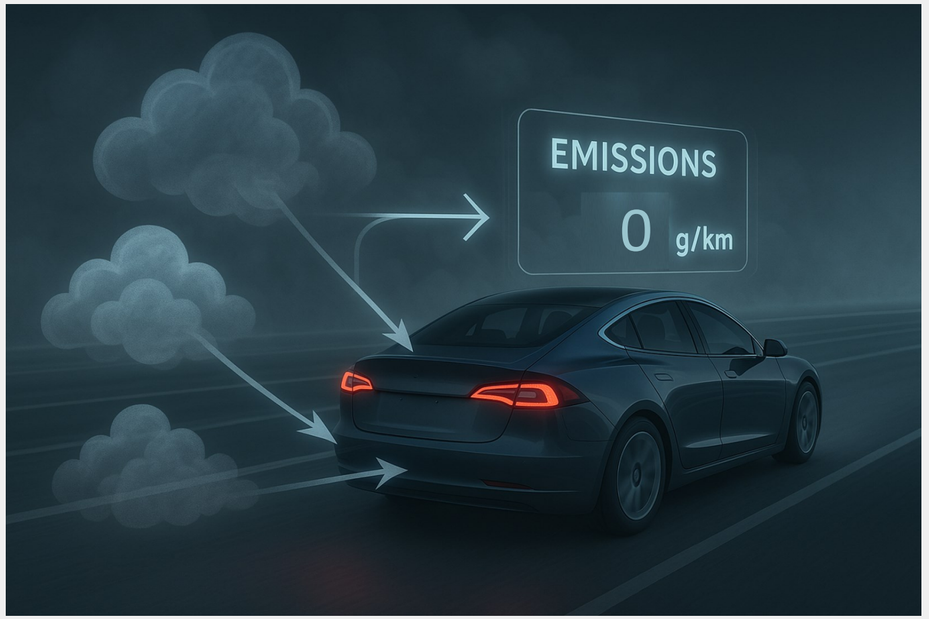


Energy vs Emissions

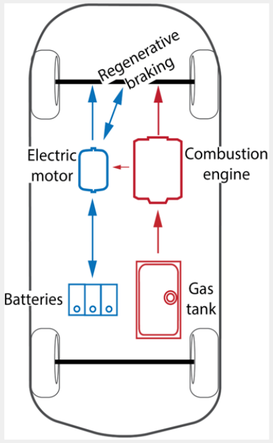
In Electric Vehicle

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

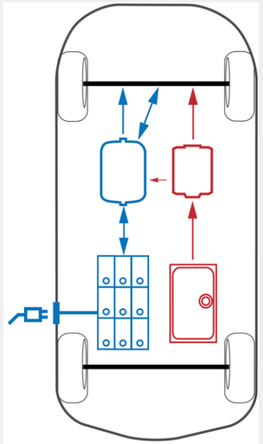
Emissions: 0
life-cycle/grid emissions not considered in



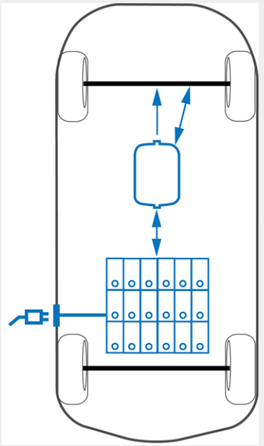
SUMO Vehicle Supports



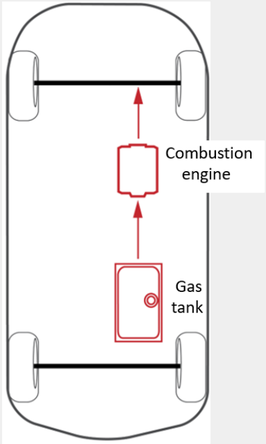
Hybrid electric vehicle



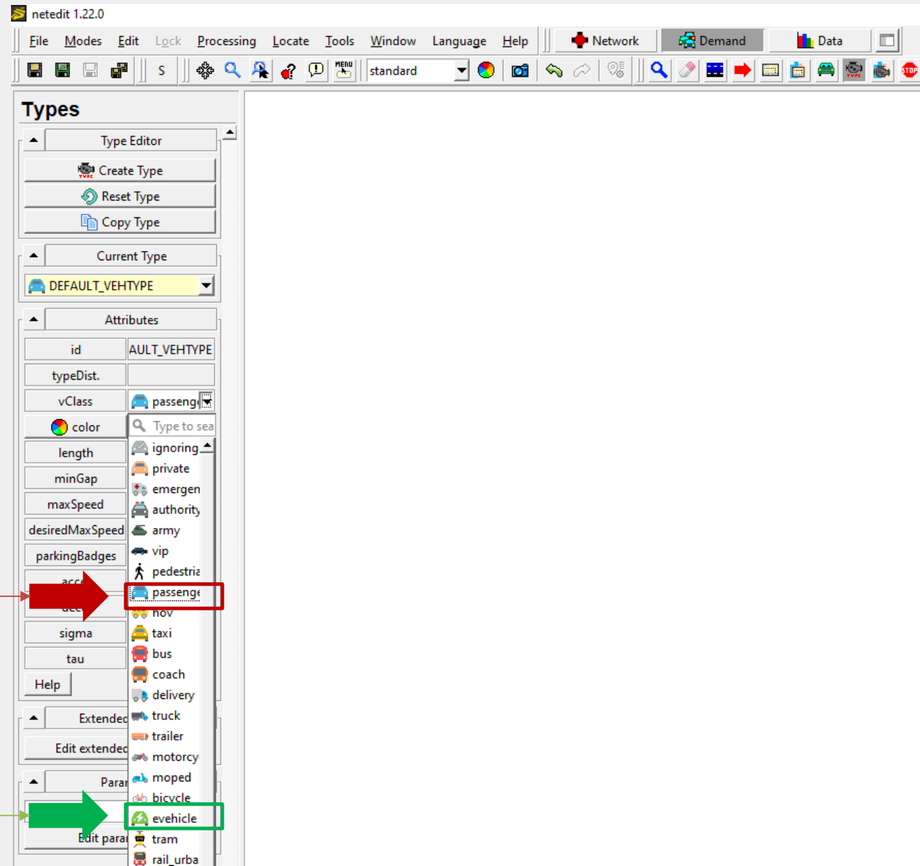
Plug-in electric vehicle



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

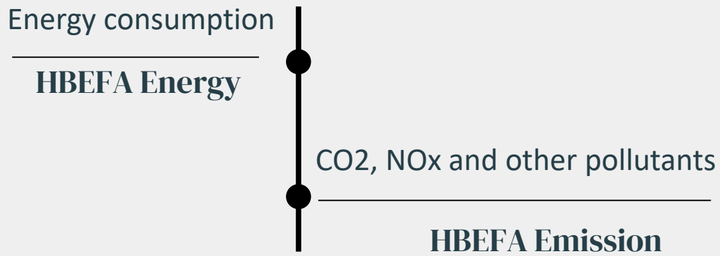
CO2, NOx and other pollutants

0

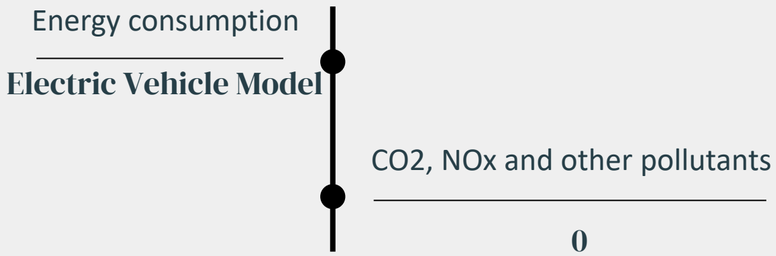
Energy Consumption and Emission Models

This Presentation Focuses on:

Combustion Engine Vehicle



Electric Vehicle

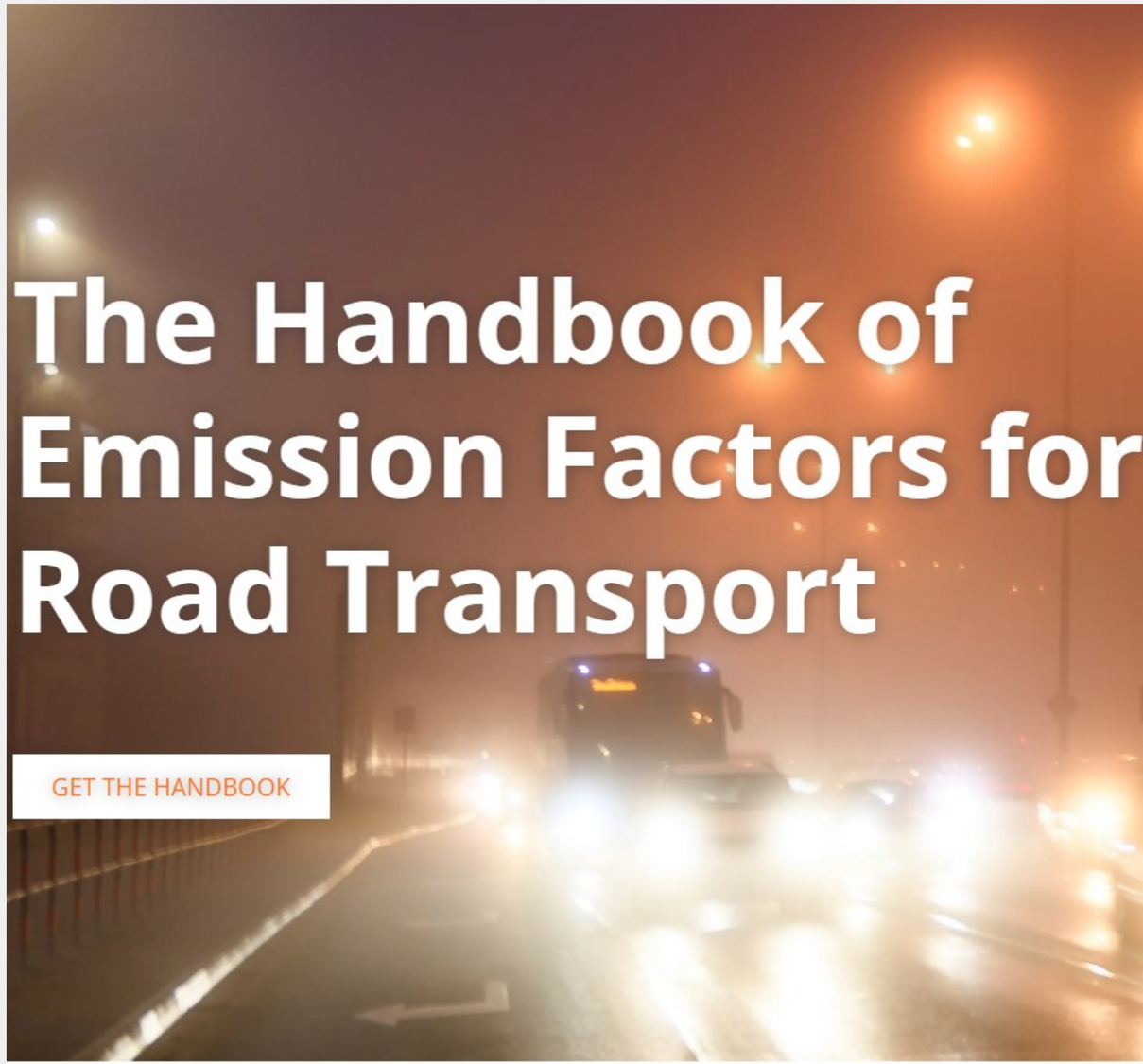


HBEFA → HandBook of Emission FActors for Road Transport

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/