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PSI

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carculator: open-source LCA libraries suite for individual and collective mobility

78th Discussion Forum on Life Cycle Assessment – September the 14th, 2021 – Zürich, CH

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Objectives

- Open-source and free
- Standalone
- Distributable
- Crowd-reviewed
- Fast
- Reproducible results
- Explain difference between studies
- Explorative
- Plugs into other models

Individual and collective mobility

carculator

carculator_suite

carculator_two_wheelers
v.0.0.1

carculator
v.1.5.9

carculator_truck
v.0.2.6

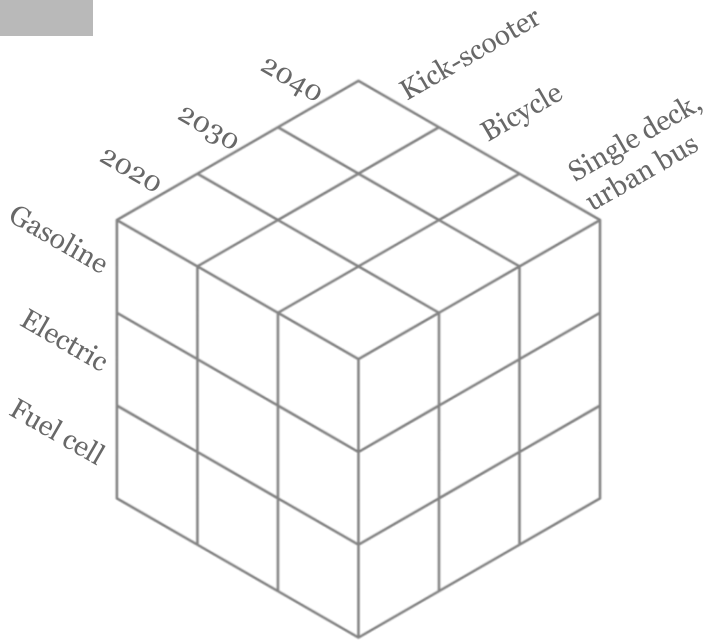
carculator_bus
v.0.0.3

*carculator_plane**

**still in the making*

Workflow

Vehicle building

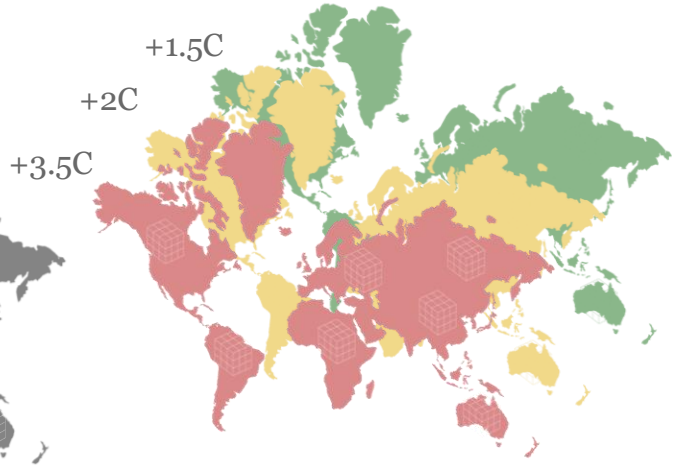


3 dimensions: type, powertrain, time

Life cycle inventory

1 dimension: space

Climate trajectories



Several scenarios

Vehicles definition

Two-wheelers

Kick-scooter

Bicycle

Cargo bicycle

Scooter <4kW

Scooter 4-11 kW

Motorcycle 4-11kW

Motorcycle 11-35 kW

Motorcycle >35kW

Passenger cars

Mini

Small

Lower medium

Medium

Large

SUV

Van

Vehicles definition

Urban buses

Midi

Single deck

Double deck

Articulated

Coach buses

Single deck

Double deck

Trucks

Rigid, 7.5t

Rigid, 18t

Rigid, 26t

Articulated, 32t and 40t

Articulated, 60t

Vehicles input parameters

All vehicles

Lifetime

Annual mileage

No. of passengers

Technology-specific

Battery lifetime

Fuel cell lifetime

Engine efficiency

Size-specific

Aerodynamic drag

Light-weighting

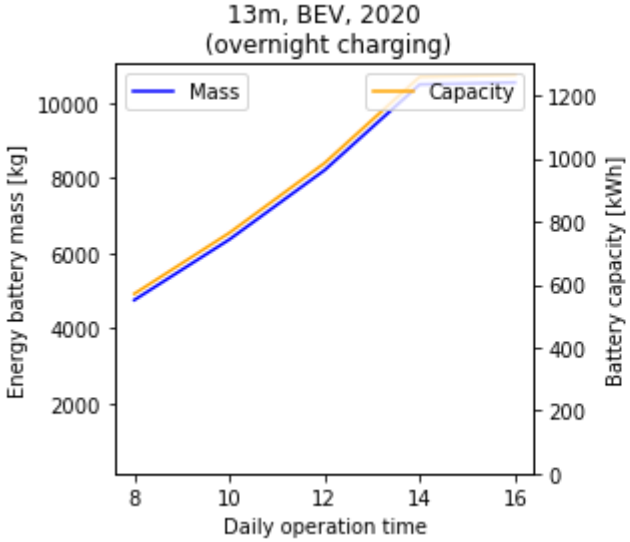
Battery size
and chemistry

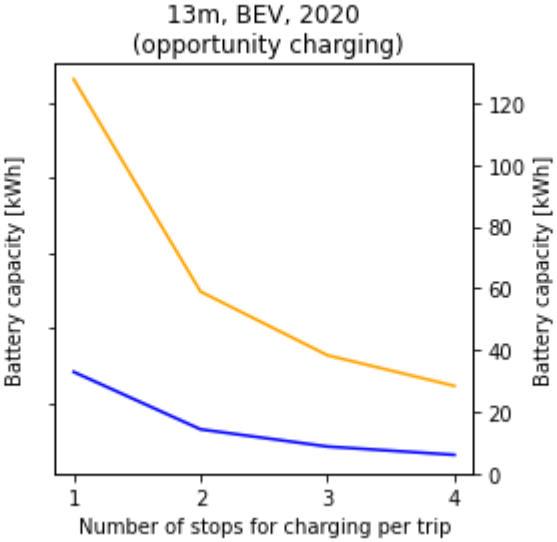
Vehicles input parameters

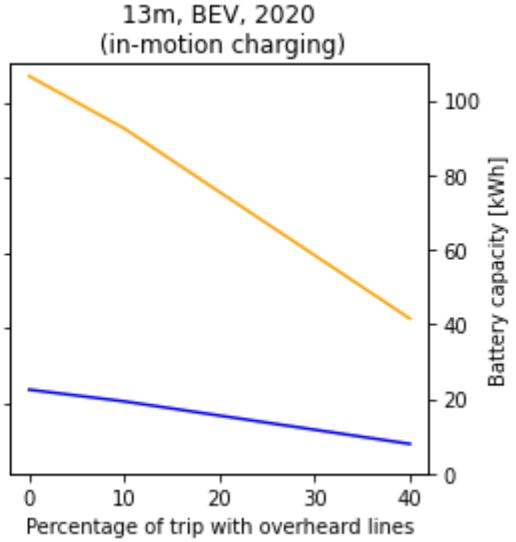
Charging at depot

Opportunity charging

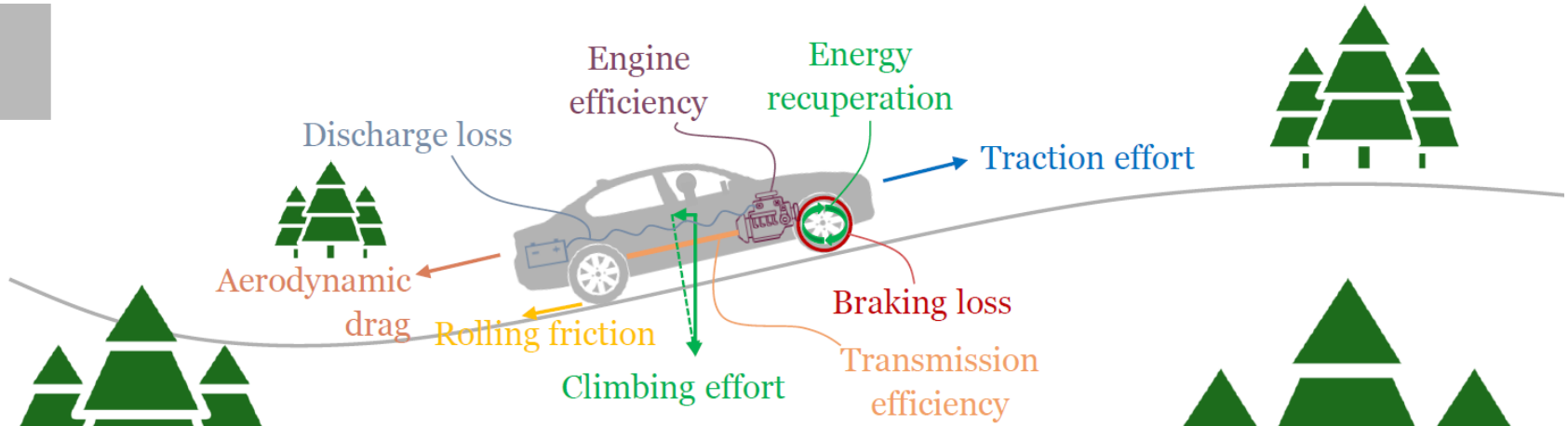
In-motion charging

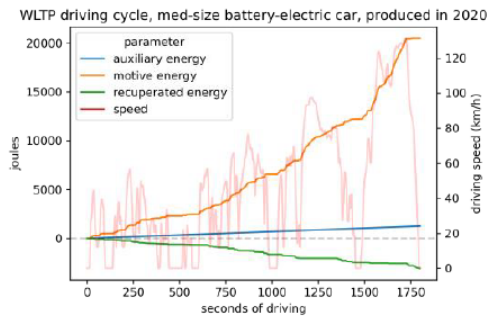






Energy consumption model (tank-to-wheel)





Energy pathways

Liquid fuels

Gaseous fuels

Hydrogen

Electricity

Fossil fuels
Gasoline, diesel

Natural gas

Steam methane reforming of natural gas

National production mixes from 2000 to 2050

Biofuels
Bioethanol and biodiesel from crop oil, grass and wood

Bio-methane
From sewage sludge, household waste, manure

Steam methane reforming of bio-methane

Single fossil technologies
Coal, natural gas, oil, nuclear

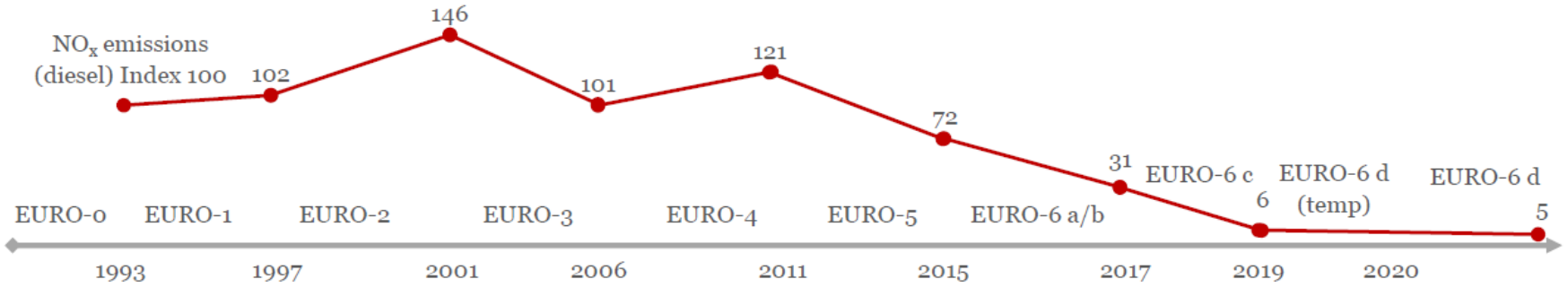
Synthetic fuels
Fischer-Tropsch, Methanol to gasoline

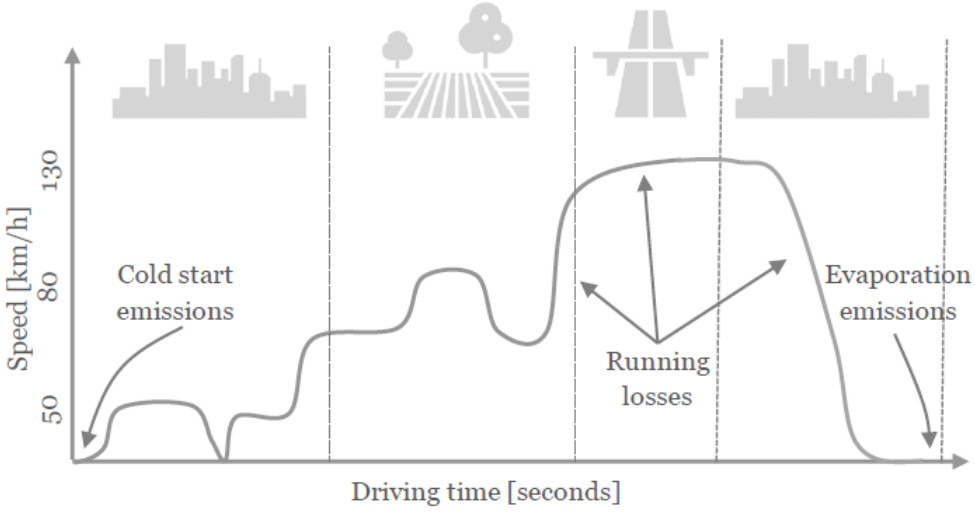
Synthetic gas
From hydrogen with carbon from biomass or direct air capture

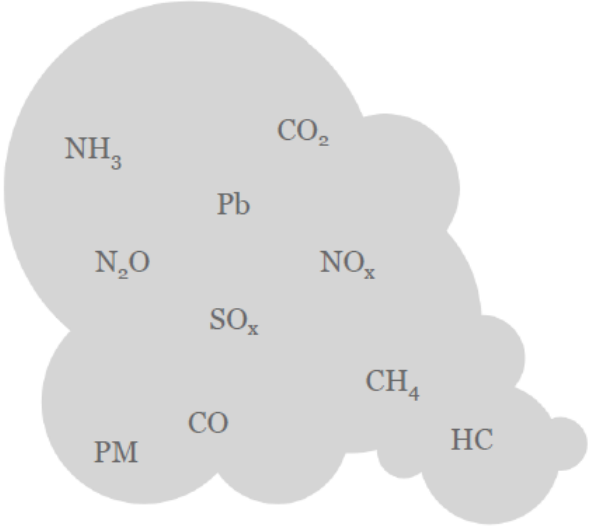
Water electrolysis

Single renewable technologies
Wind, solar PV, hydro, geothermal, biomass

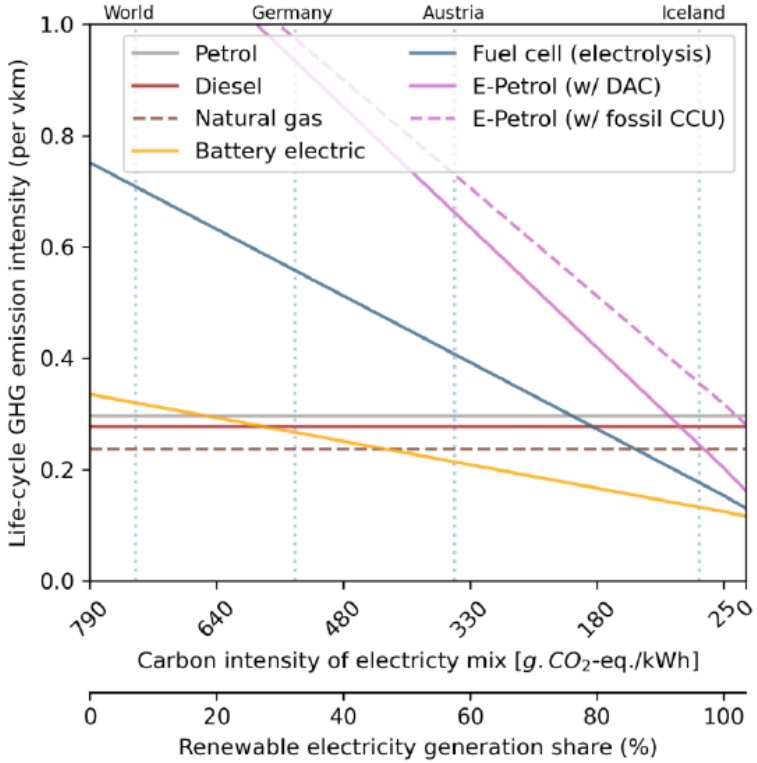
Driving emissions

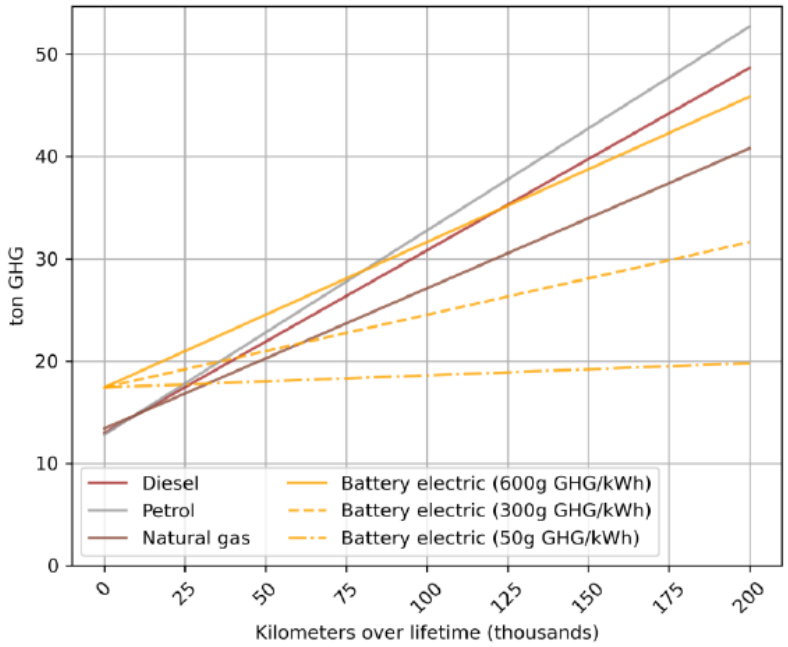






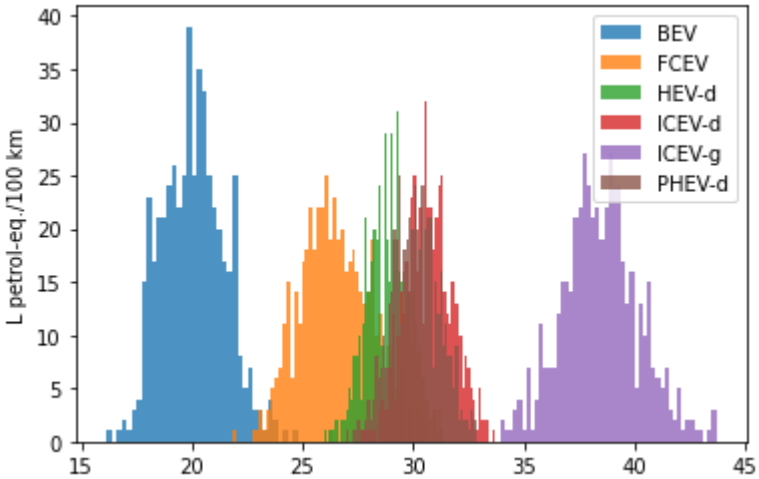
Characterization of impacts



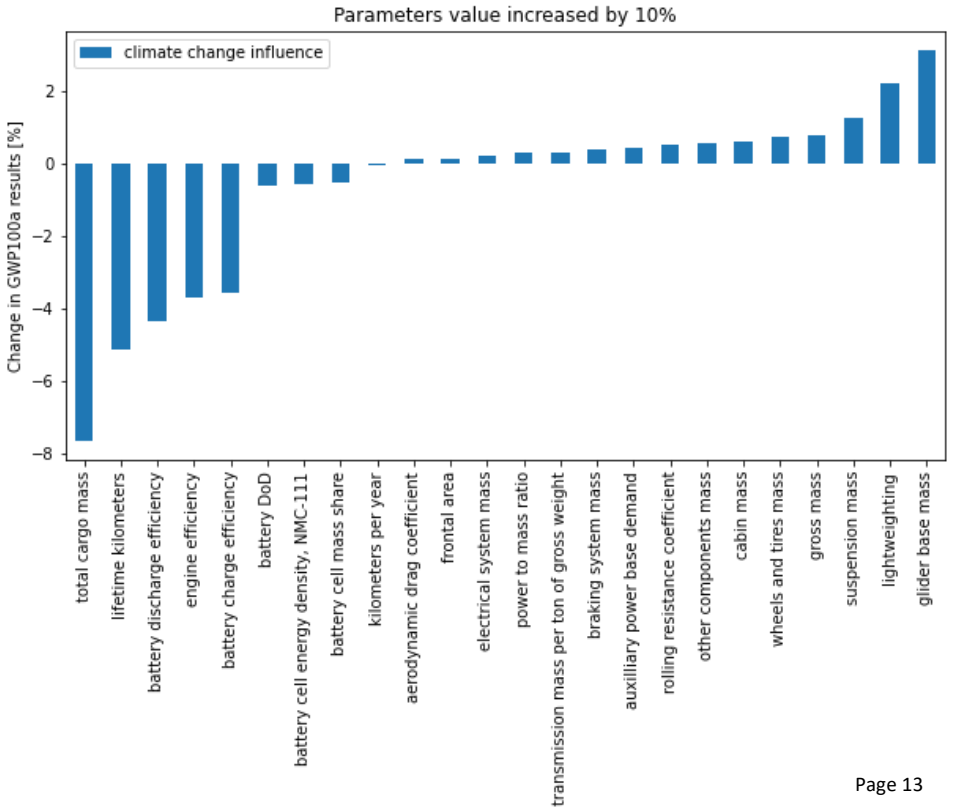


Uncertainty and sensitivity

Tank-to-wheel consumption, 500 iterations, 40t trucks in 2020



Influence of input parameters on GWP100a scores, 40t electric truck in 2020



Export and Graphical User Interface

Export LCI (with uncertainty parameters!) to:

- Brightway2
- Simapro 9

Links to:

- Ecoinvent cut-off 3.5, 3.6 and 3.7.1

Online user interface (only for passenger cars a the moment)

- https://carculator.psi.ch

- Touring Club Switzerland (TCS) and Kyburz are now using *carculator*
- Mobitool update
- Ecoinvent 3.9

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Wir schaffen Wissen – heute für morgen

Technology Assessment Group

https://www.psi.ch/en/ta

Questions?

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