Concawe

Environmental Science for European Refining

An introduction to Concawe's vehicle life-cycle CO_2 emissions comparator

8th November 2022

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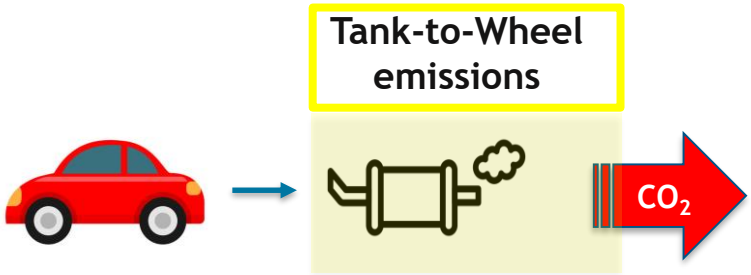
Outline

- **Introduction to life-cycle assessment (LCA)**
  - *Purpose of life-cycle assessment*
  - *Why life-cycle assessment matters*
  - *What is challenging about life-cycle assessment?*
- **Concawe's vehicle life-cycle CO_2 emissions comparator**
  - *Purpose of the CO_2 comparator*
  - *How does it work?*
  - *Demonstration of the CO_2 comparator*
- **Limits to the selected approach**

Purpose of life-cycle assessment



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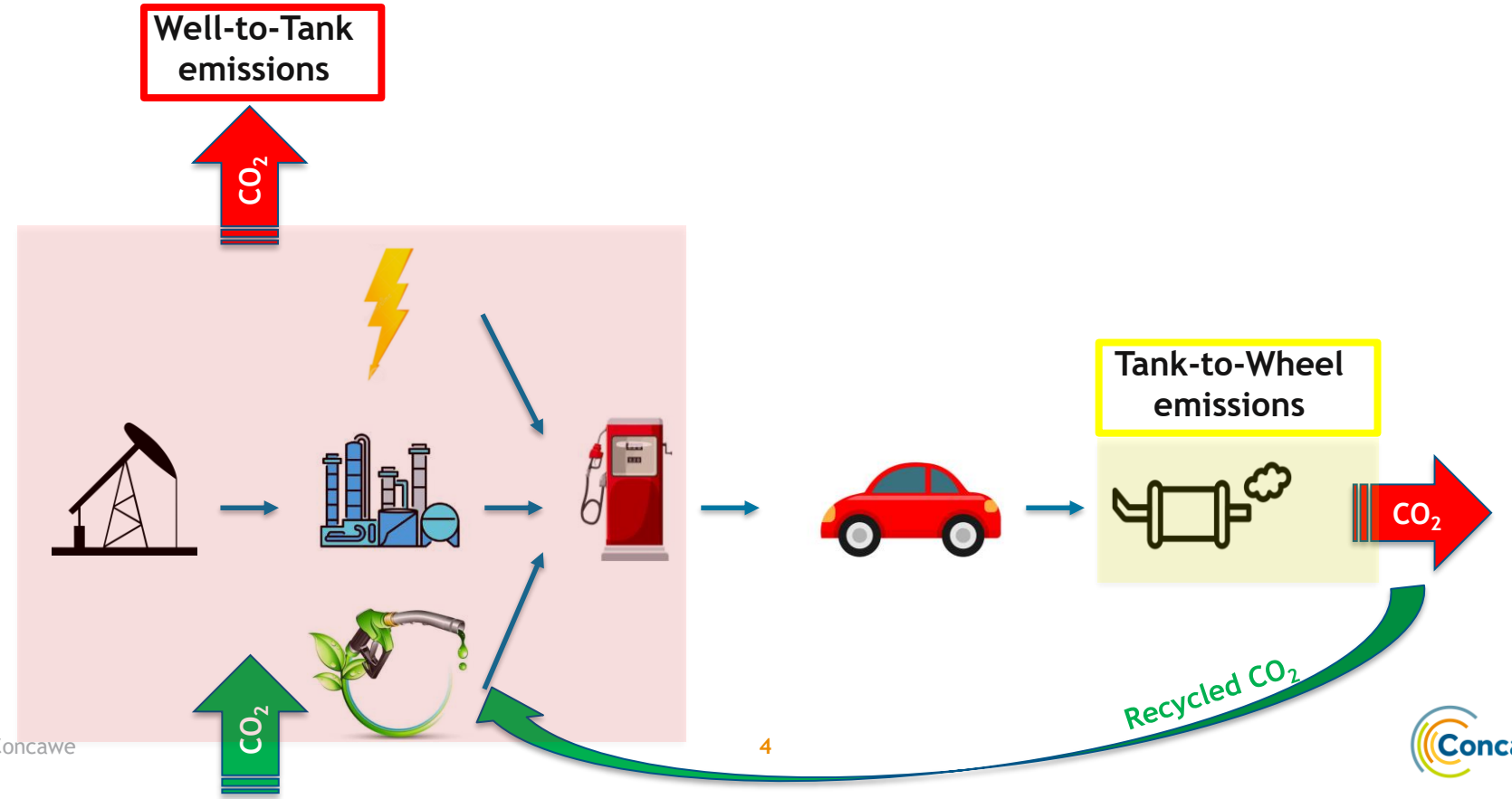

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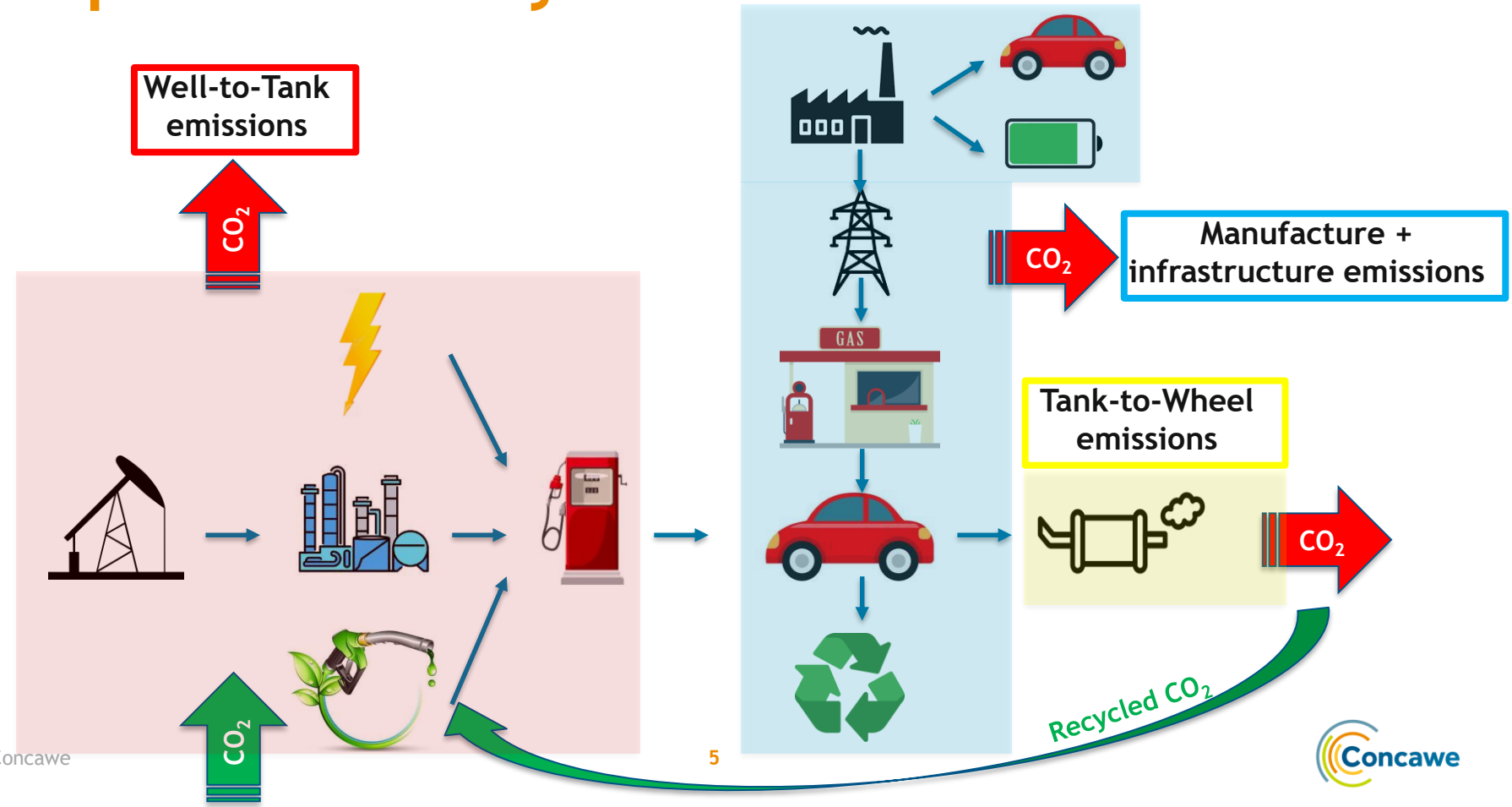

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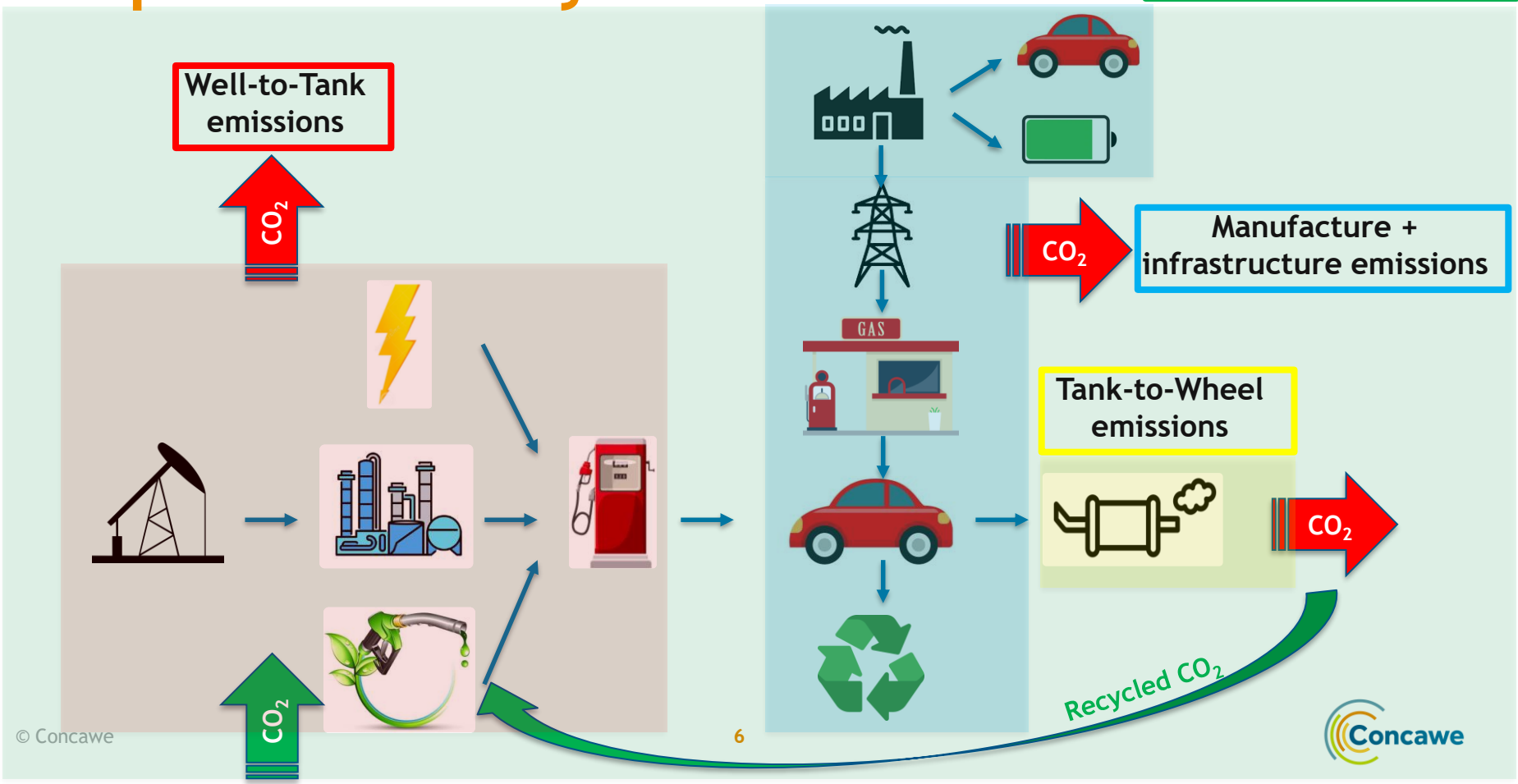

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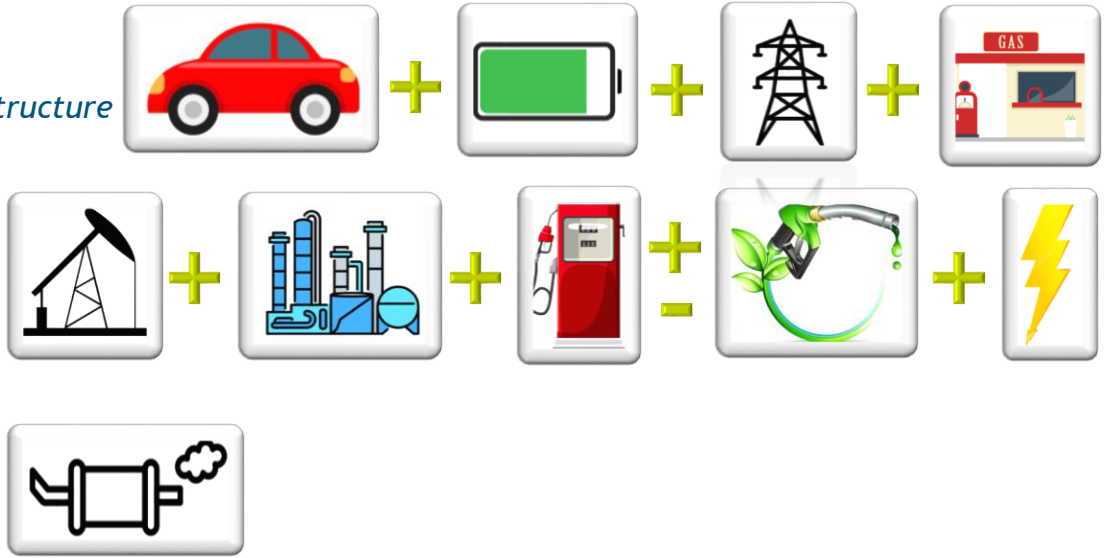
Why life-cycle assessment matters

- **From a climate perspective, it does not matter whether the greenhouse gases are emitted**
  - *During the production of the car and infrastructure*
  - *During the production of the energy carrier*
  - *Or at the tailpipe*



From a climate perspective, only life-cycle emissions matter

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What is challenging about life-cycle assessment?

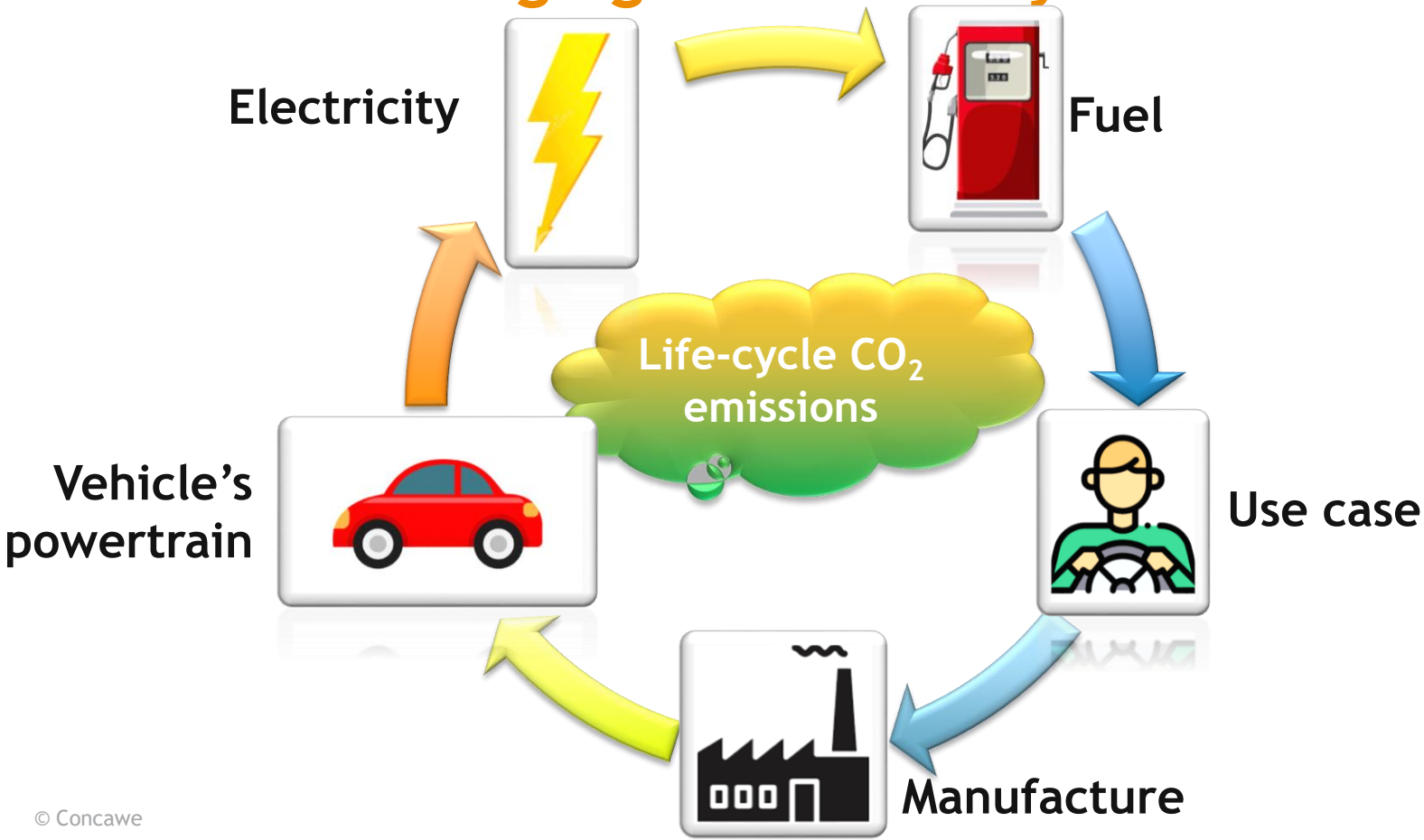
Emissions	Measurable?	Regulated?
Tank-to-Wheel (tailpipe)		
Well-to-Tank		
Manufacture, infrastructure and recycling		
Life-cycle		

What is challenging about life-cycle assessment?

Emissions	Measurable?	Regulated?	Evaluated?
Tank-to-Wheel (tailpipe)	✓	✓	
Well-to-Tank	✗	✗	✓
Manufacture, infrastructure and recycling	✗	✗	✓
Life-cycle	✗	✗	✓

Evaluation means:
- Assumptions
- Scenarios
- Use cases
- Etc.

What is challenging about life-cycle assessment?



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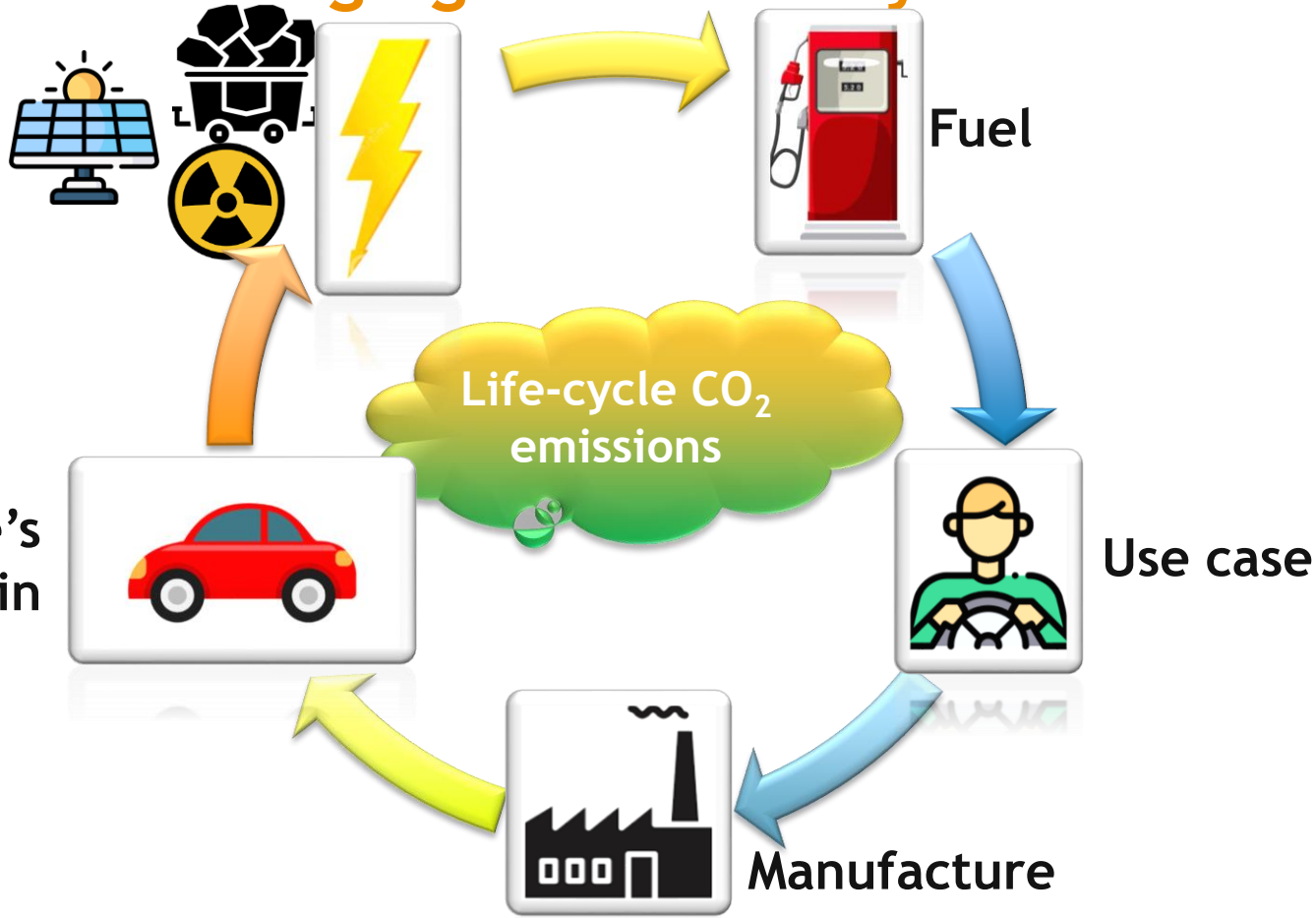

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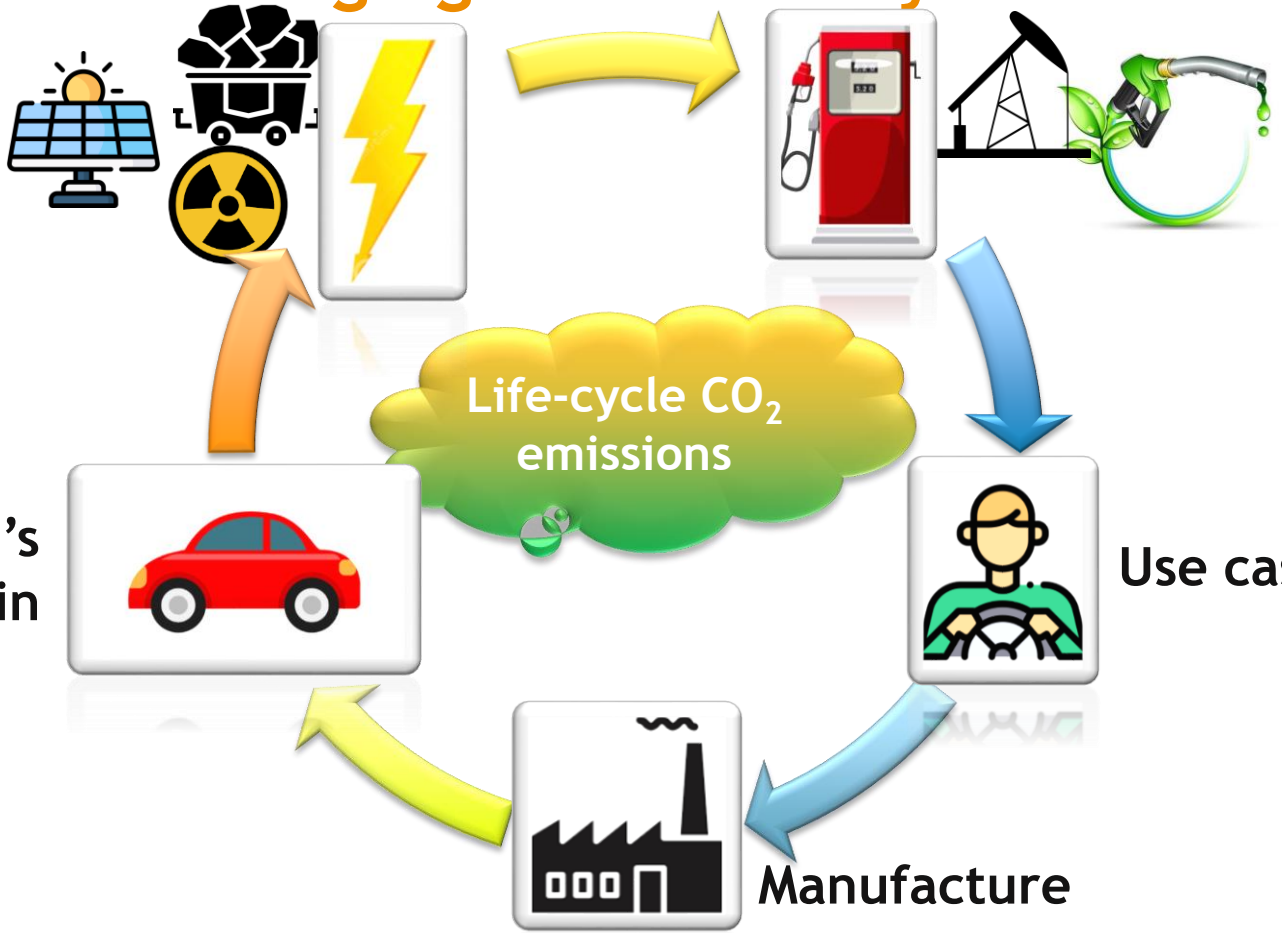

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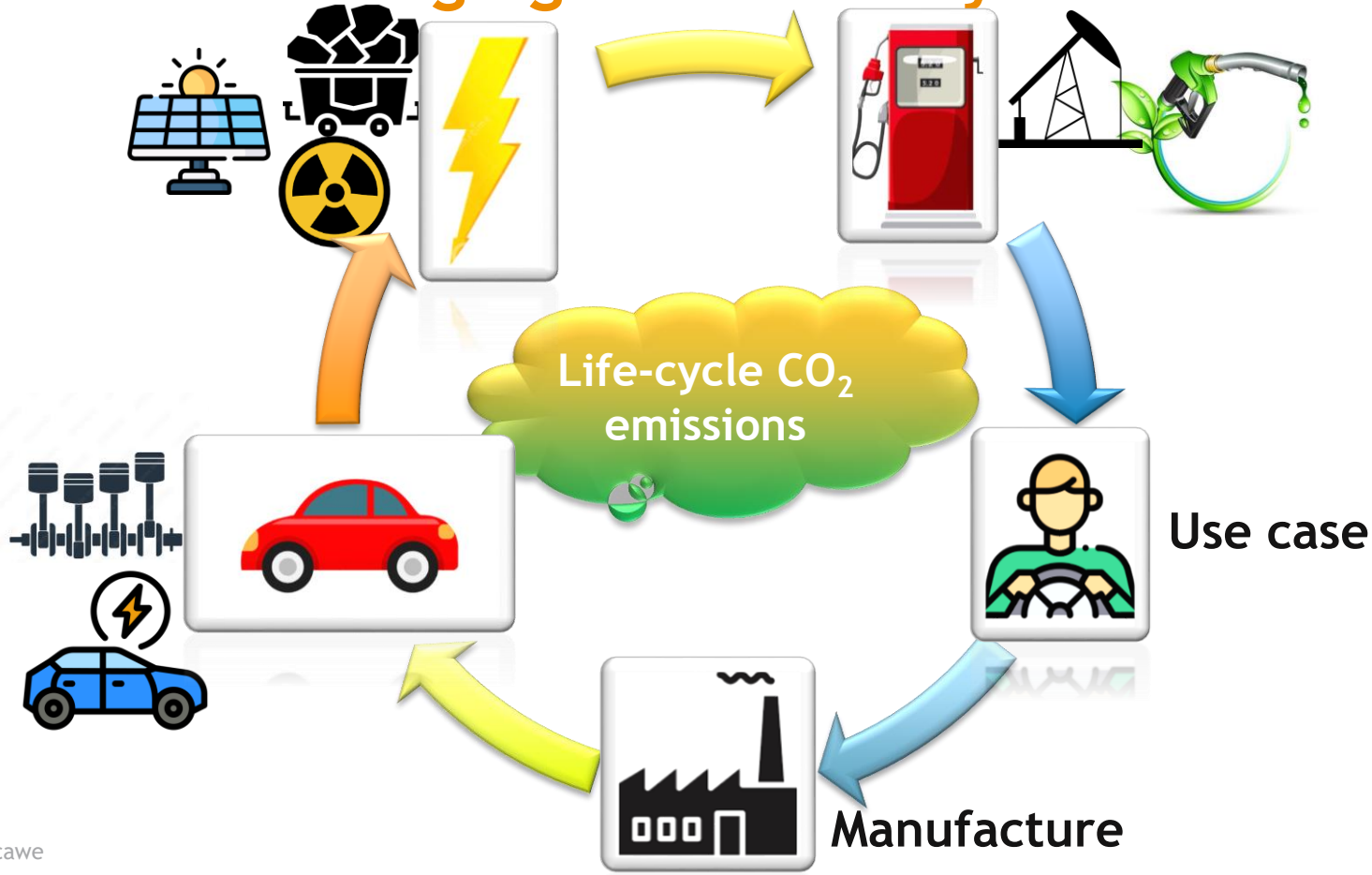

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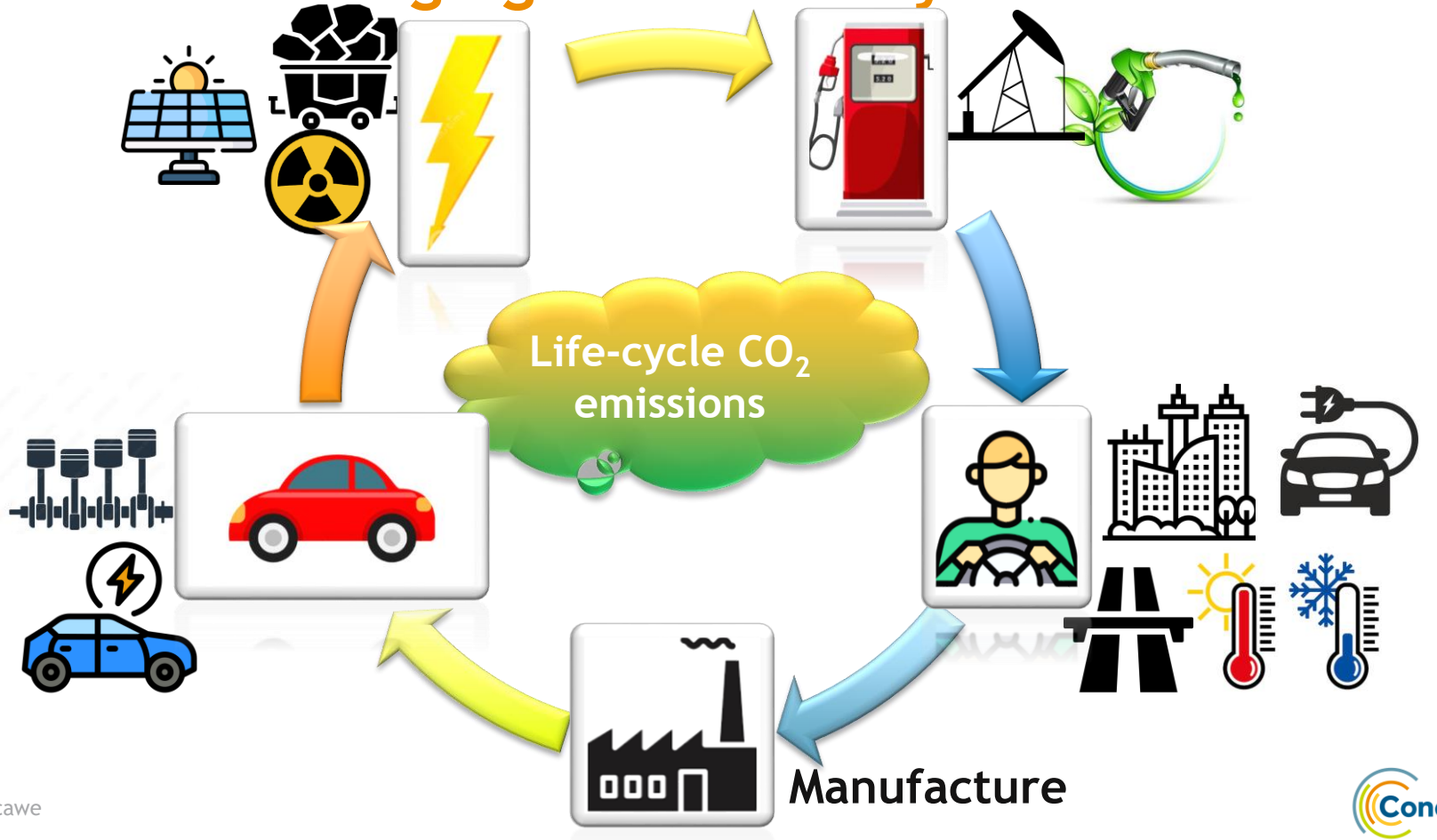

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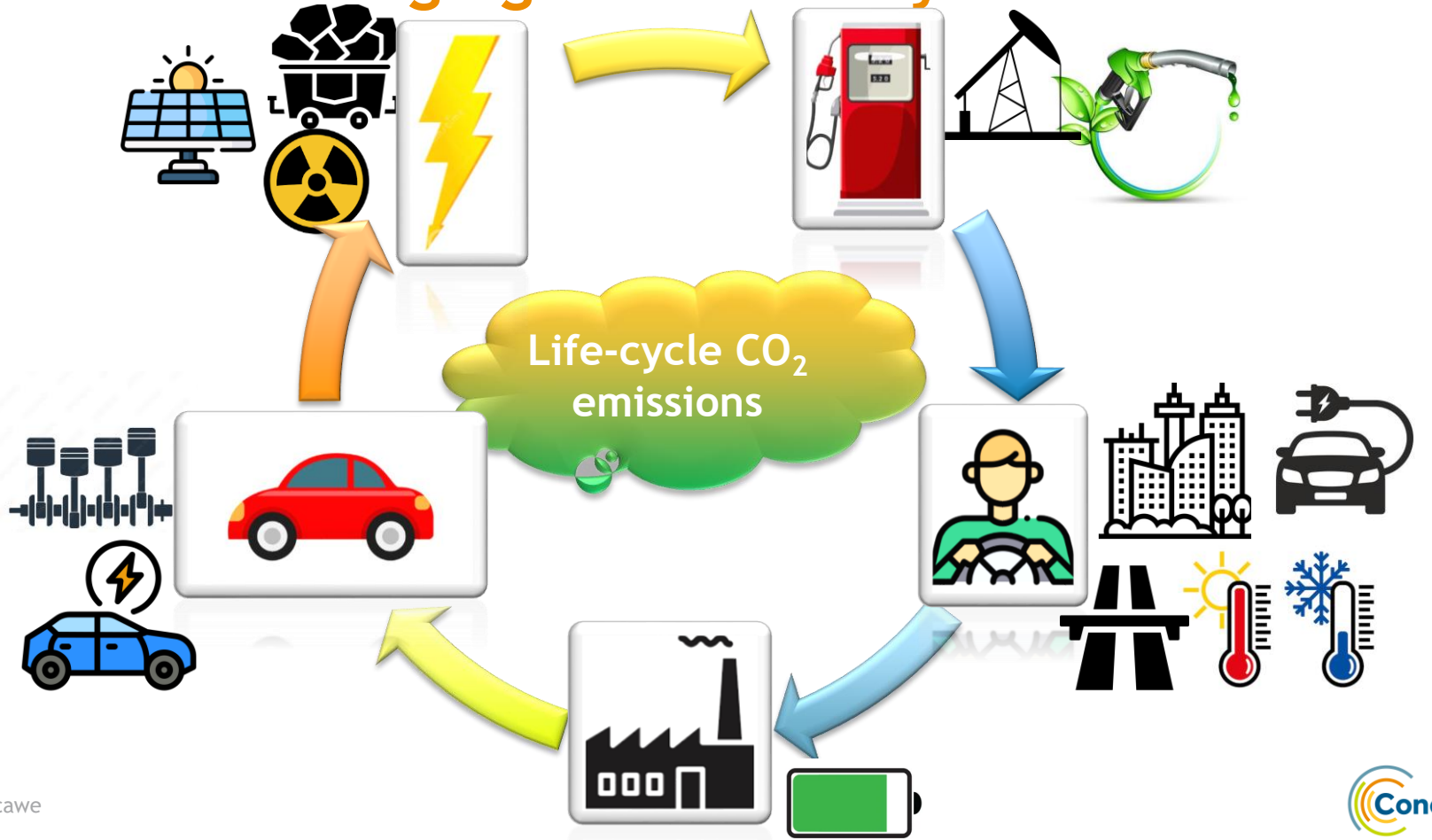

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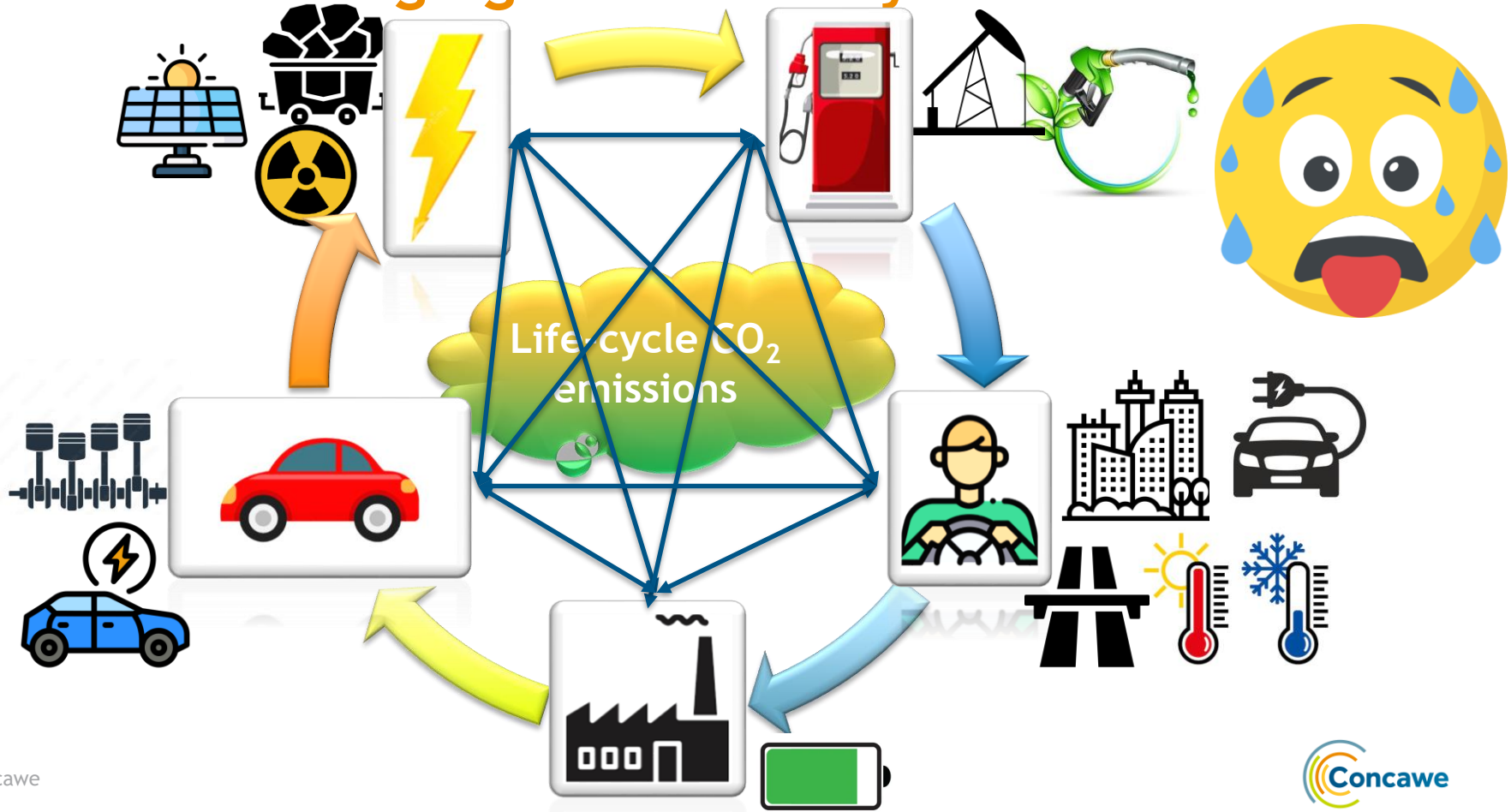

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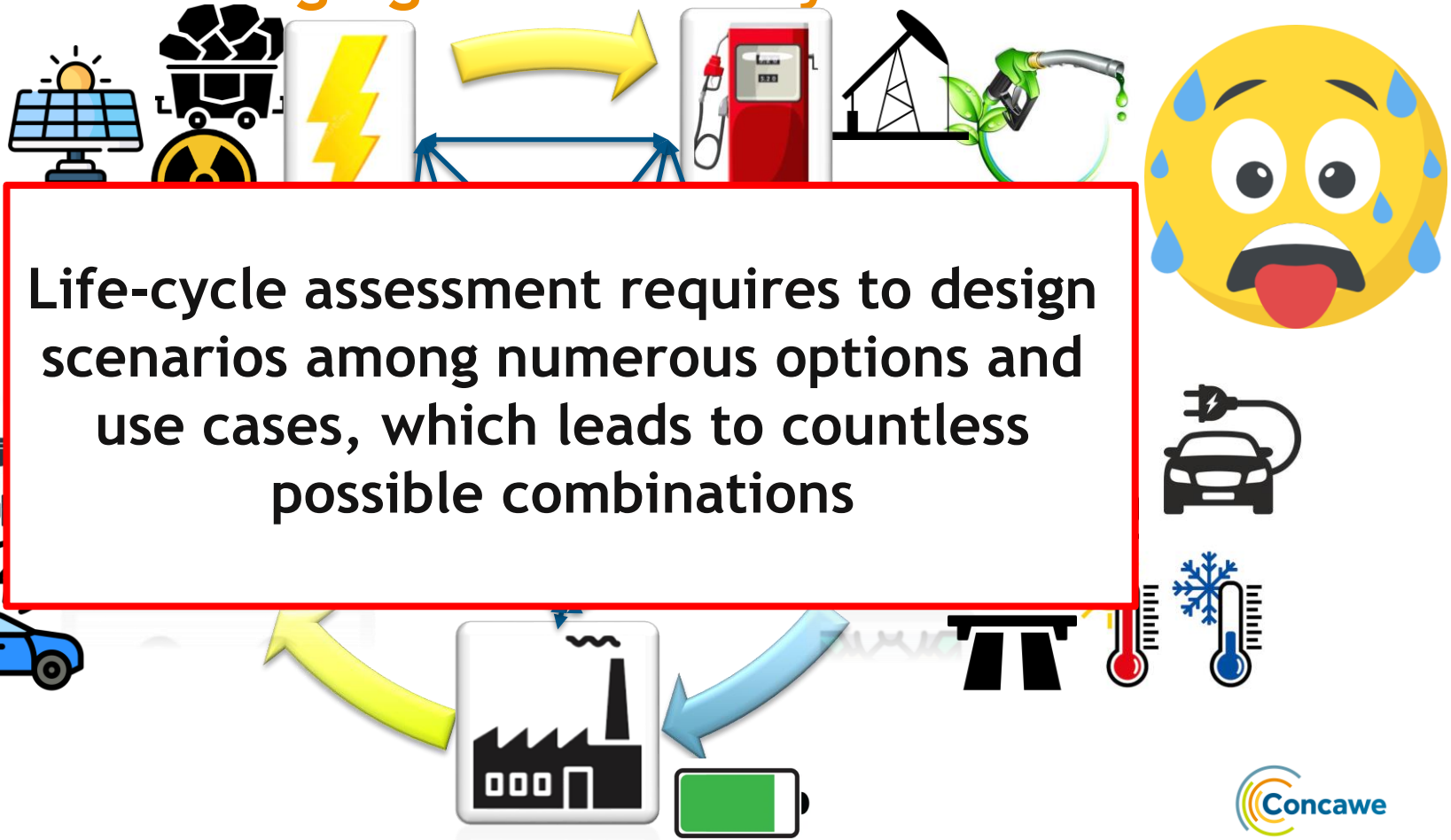

Life-cycle assessment requires to design scenarios among numerous options and use cases, which leads to countless possible combinations

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- Introduction to life-cycle assessment (LCA)
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  - *What is challenging about life-cycle assessment?*

- **Concawe's vehicle life-cycle CO_2 emissions comparator**
  - *Purpose of the CO_2 comparator*
  - *How does it work?*
  - *Demonstration of the CO_2 comparator*

- Limits to the selected approach

Purpose of Concawe's vehicle life-cycle CO_2 emissions comparator

What is the best combination of electrification options and energy carriers to decarbonize passenger cars?

- An interactive tool, with guided scenarios, allowing to compare life-cycle CO_2 emissions from passenger cars, function of your own use case and own sensitivities according to parameters
  - *Configuration and design of the vehicles*
    - Hybrids, Plug-in hybrids and Electric cars
    - Battery capacity and emission related to its manufacture
    - Lifetime mileage
  - *Usage of the vehicles*
    - Recharge frequency for the plug-in hybrids
    - Typical trip profile
    - Climate conditions
  - *Energy carriers*
    - Carbon intensity of electricity used
    - Fuels, with fossil and renewable options

How does it work?

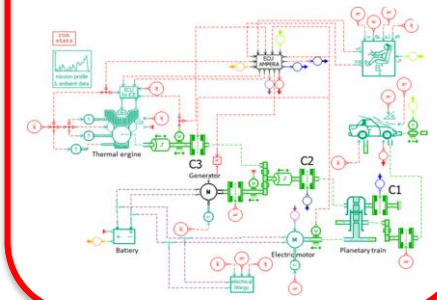
- **Tested cars: 2 PHEVs, extensively tested to generate experimental data**
  - *In-lab and on-road*
  - *Between -2°C and +35°C*
  - *Gasoline, Diesel and renewable fuels*
  - *Recharged and uncharged*
  - *Various driving profiles*

- **Experimental results used as inputs to the creation and calibration of a simulation platform**

Simulation platform workflow

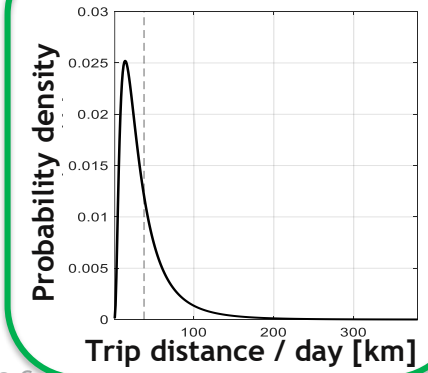
Developped by IFP Energies nouvelles

PHEV simulator



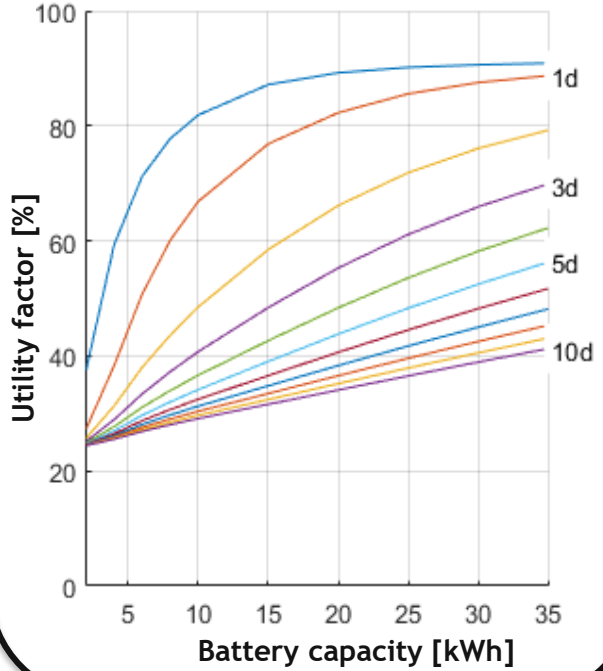
+50’000 simulations!

Use cases



Statistical model

Real-world performance



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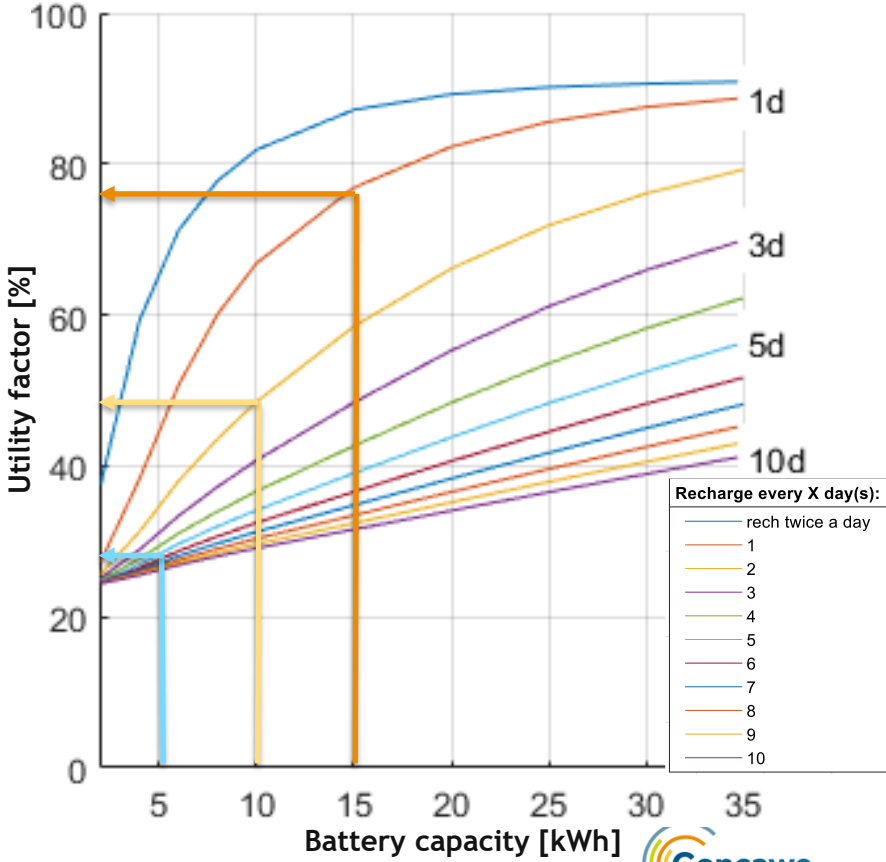
Assessment of Utility Factor under real-world conditions, using simulations

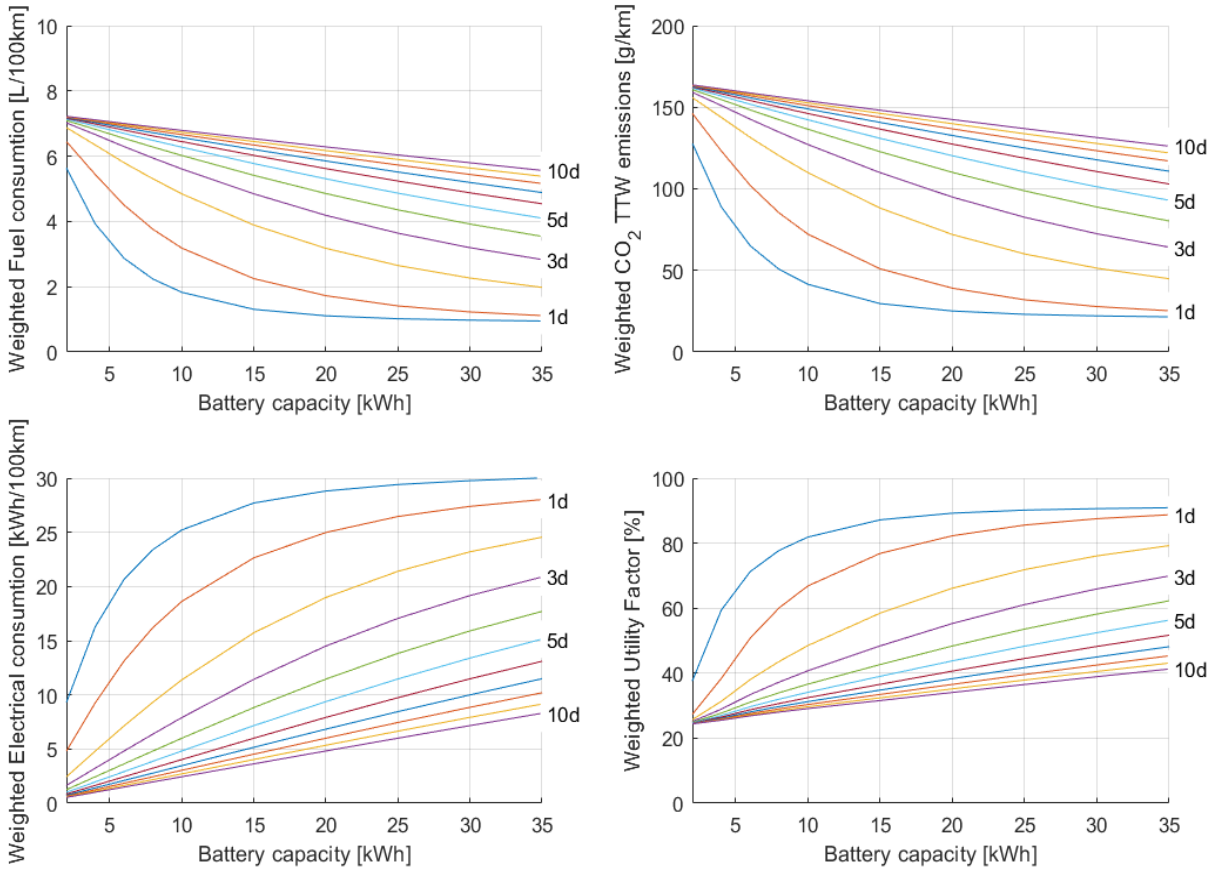
A gasoline PHEV with a **15 kWh** battery capacity **recharged every day** has an average utility factor of **77%**

A gasoline PHEV with a **10 kWh** battery capacity **recharged every 2 days** has an average utility factor of **48%**

A gasoline PHEV with a **5 kWh** battery capacity **recharged every 5 days** has an average utility factor of **28%**

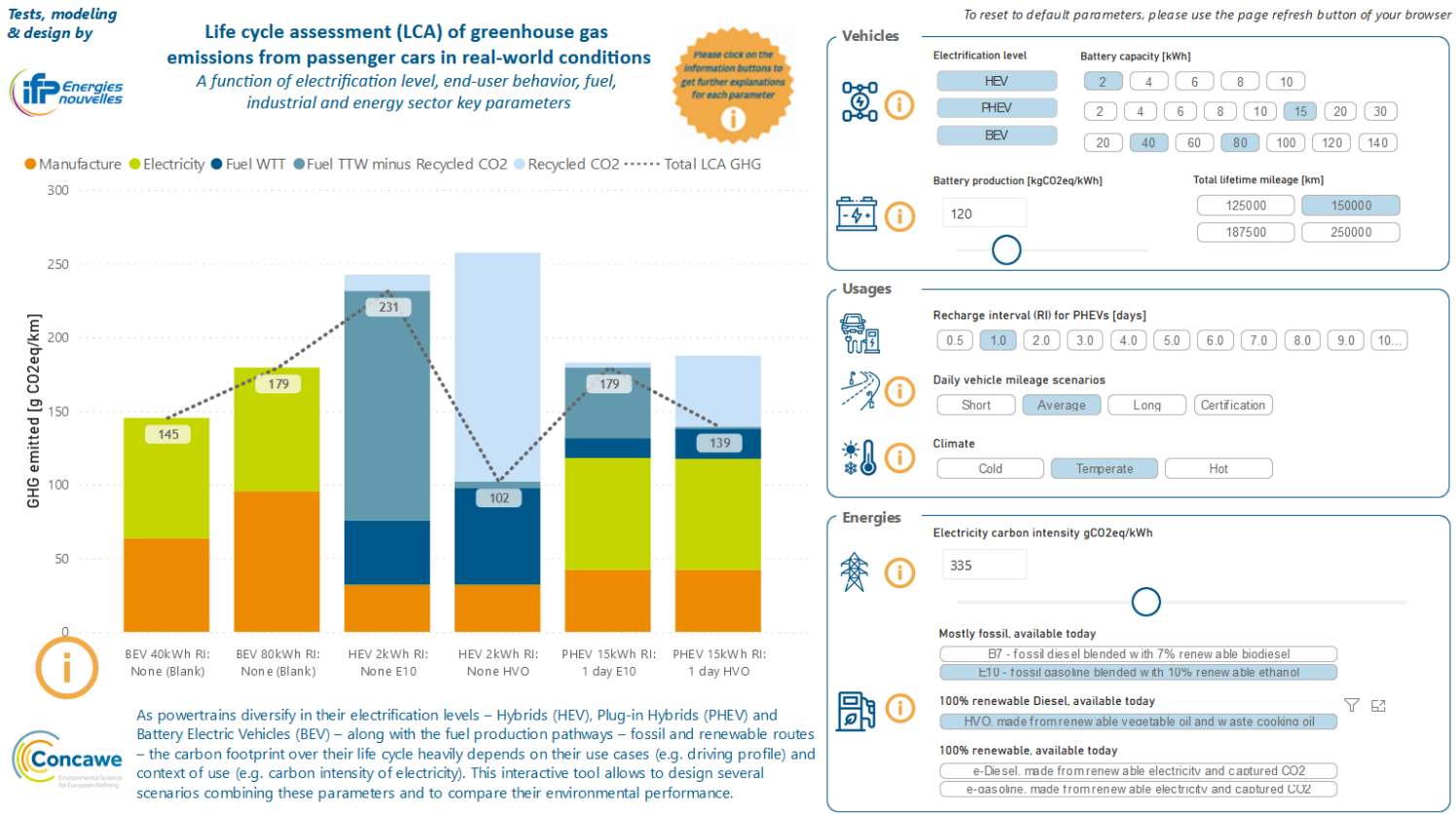


Similar methodology to generate assessment of CO_2 emissions, fuel and electricity consumption



Demonstration of the CO_2 comparator

Access the tool at www.carsCO2comparator.eu



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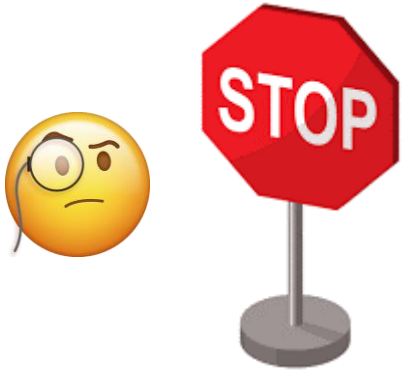

- **Simulation options limited by initial experimental data**
  - *Vehicle: C-segment vehicle only*
  - *Powertrain: no "ICE-only" vehicle, no fuel cell*
  - *Fuel: no E85, no B100, no CNG/LNG, no H_2*
- **The simulator does not address the issue of the availability of the considered options**
  - *E.g. Is there enough battery to build only electric car for everyone within the decade?*
  - *E.g. Is there enough renewable fuels for everyone within the decade?*
  - *Etc.*
- **The simulator only provides a back-to-back comparison and does not provide an optimal solution with a system perspective**
  - *E.g. what is the optimal vehicles sales mix to minimize CO_2 emissions under simultaneous limited availability of batteries and low-carbon fuels?*
    - **Other Concawe work demonstrates that PHEVs are the masterpiece of passenger cars decarbonization, making an optimal use of batteries and low-carbon fuels**

References

- CO_2 comparator user guide
  - https://www.carsco2comparator.eu/user-guide/
- Evaluation of plug-in hybrid vehicles in real-world conditions
  - https://www.concawe.eu/wp-content/uploads/Rpt-10-22.pdf
- Evaluation of plug-in hybrid vehicles in real-world conditions by simulation
  - https://www.carsco2comparator.eu/wp-content/uploads/2022/10/Evaluation-of-PHEV-in-real-world-conditions-Draft-v2-with-appendix.pdf
- Fuel and Recharging Effects on Regulated and Unregulated Emissions from a Gasoline and a Diesel Plug-In Hybrid Electric Vehicle
  - https://www.sae.org/publications/technical-papers/content/2022-01-1125/
- Optimal electrification level of passenger cars in Europe in a battery-constrained future
  - https://www.concawe.eu/wp-content/uploads/Optimal-electrification-battery-constrained.pdf

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