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Fleet-LCA: An approach for holistic environmental impact assessments of fleets

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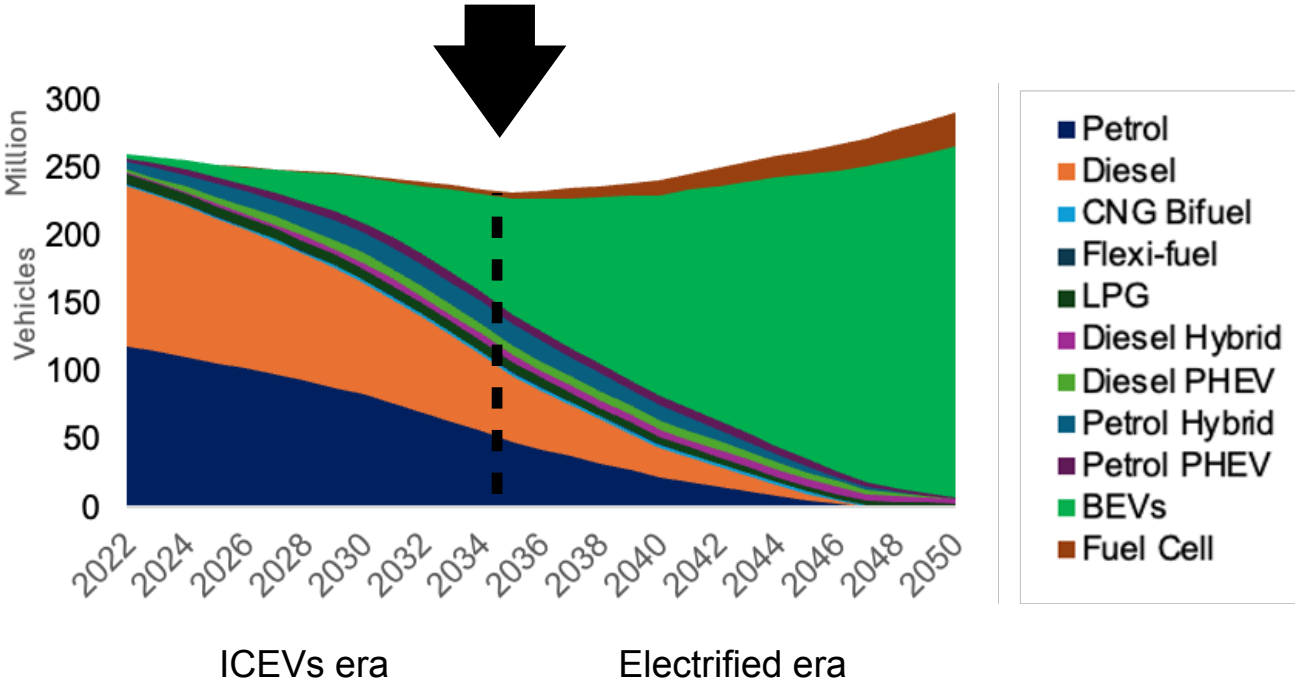
ERMES Plenary 2024

*work in collaboration with JRC

Why we need a new approach?

Isn’t the current practise of accounting fleet emissions from tailpipe sufficient?

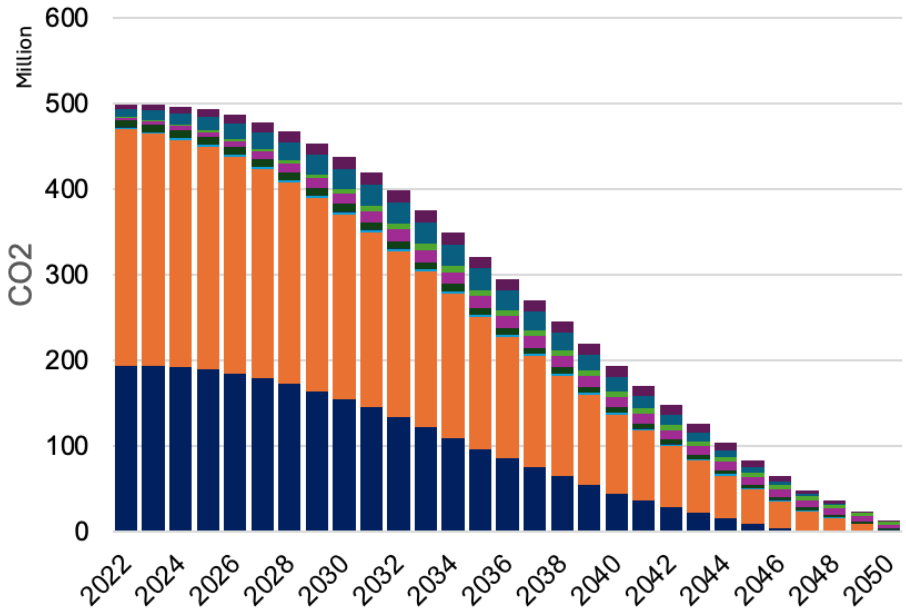
ICEVs new sales marginalised due to EU CO2 targets



ICEVs era

Electrified era

Tailpipe emissions



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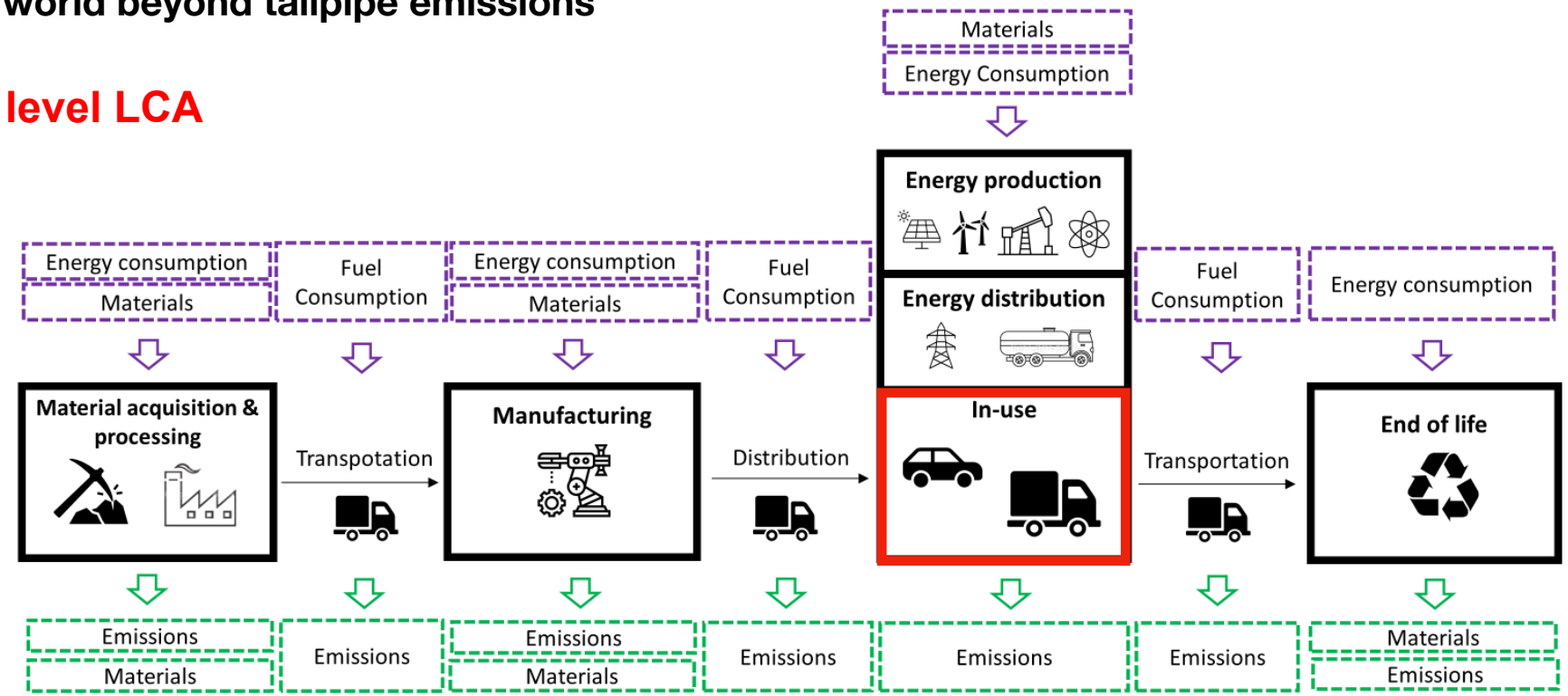
Characterising CO2 from vehicles with LCA

A whole world beyond tailpipe emissions

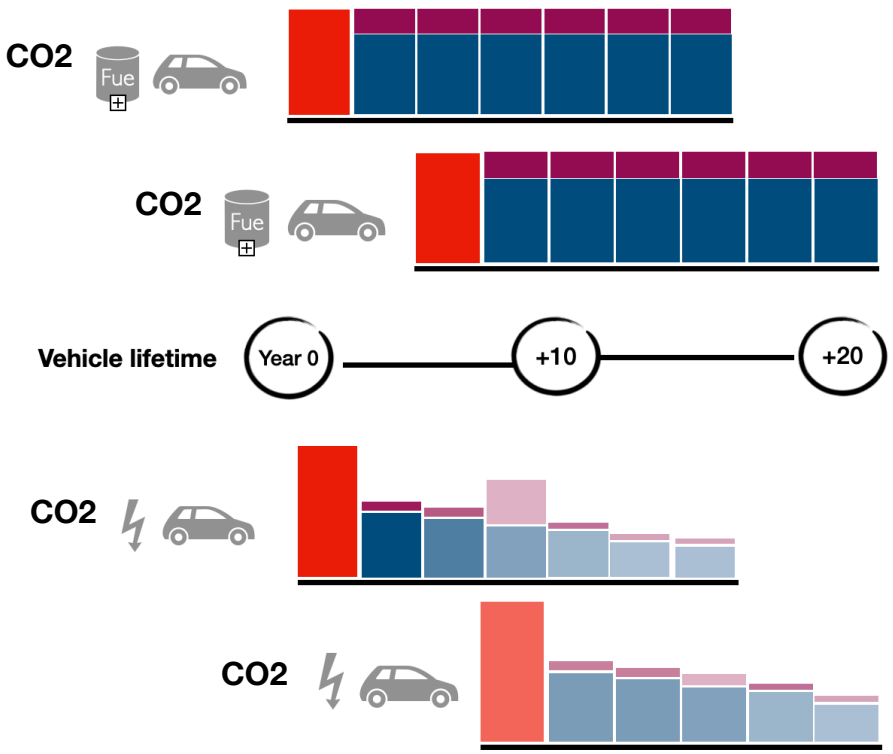
Vehicle level LCA

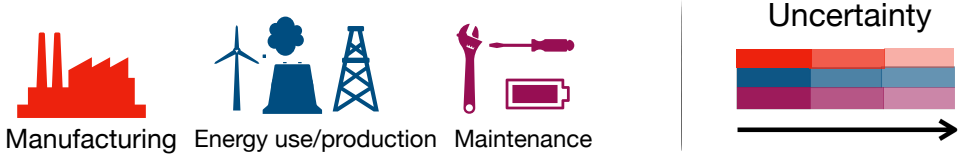


- **Functional unit:** lifetime mileage —> CO2 in lifetime vkm or pkm
- **Target:** impact studies, powertrain comparisons, eco-labelling, type approval (?)

From single vehicle to fleet level LC emissions

Can we just generalise many LCAs for system-wide monitoring?





Relying on **single-vehicle LCAs** seems not enough since:

I. Fleet has no lifetime - Vehicle units with different lifetimes enter & exit from fleet at various instances

- Its **practically** difficult to align these LC emissions in a unique system & allocate them over the years of fleet operation.

II.. **ICEVs** impacts are stable, identified from Year 0 with low uncertainty. **BEVs** impacts are variable over lifetime, predicted with uncertainty

- LCAs quantify total lifetime emissions now, but part will be released in future. Summarising LCAs will generalise the uncertainties from predictions.

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Fleet-level LCA

is a method that:

- treats the entire fleet as a unique product - system
- adds the notion of time in accounting LC emissions
- can be in-line with existing emissions monitoring practices for impact assessments / inventories
- can allocate to road-transport emissions attributed previously to other sectors

Challenges:

I. **Integration in existing models/practise**

II. **Representative vehicles & their LC CO2 definition**

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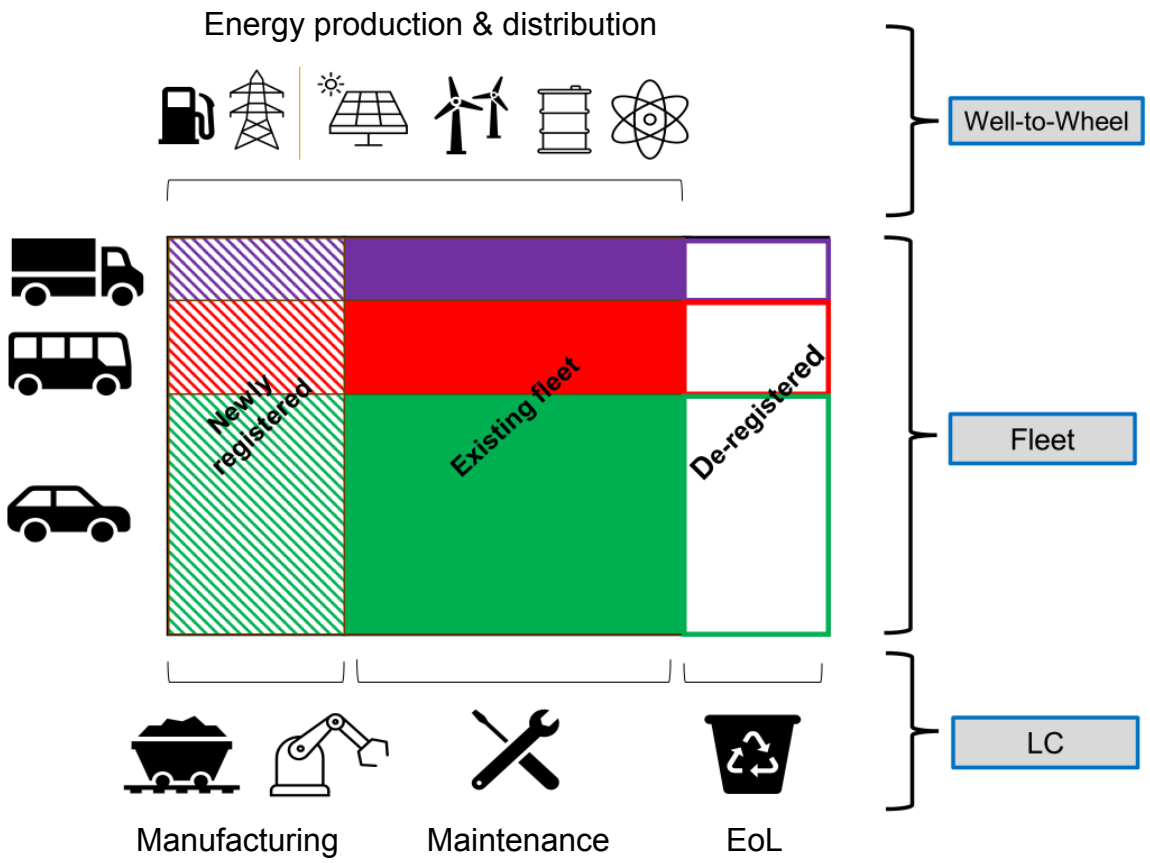
I. Integration in existing practise (incl. method & tools)



Emission Factors

Concawe eucar

ecoinvent

Argonne GREET LIFE-CYCLE MODEL

copert data

Activity, synthesis

sibyl baseline

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Emission Factors

ecoinvent

Argonne GREET LIFE-CYCLE MODEL

- **Functional Unit:** **Fleet operation over a year**
- **Fleet is a product with an annual lifetime incl. all LC stages:**
  - **Manufacturing for new registrations**
  - **In-use for new registrations & existing fleet**
  - **End-of-life for de-registered**

Expected outcome:

- Total fleet-induced emissions for a year, summarising **WtW** & **LC-related**
- Projections are made for the following years

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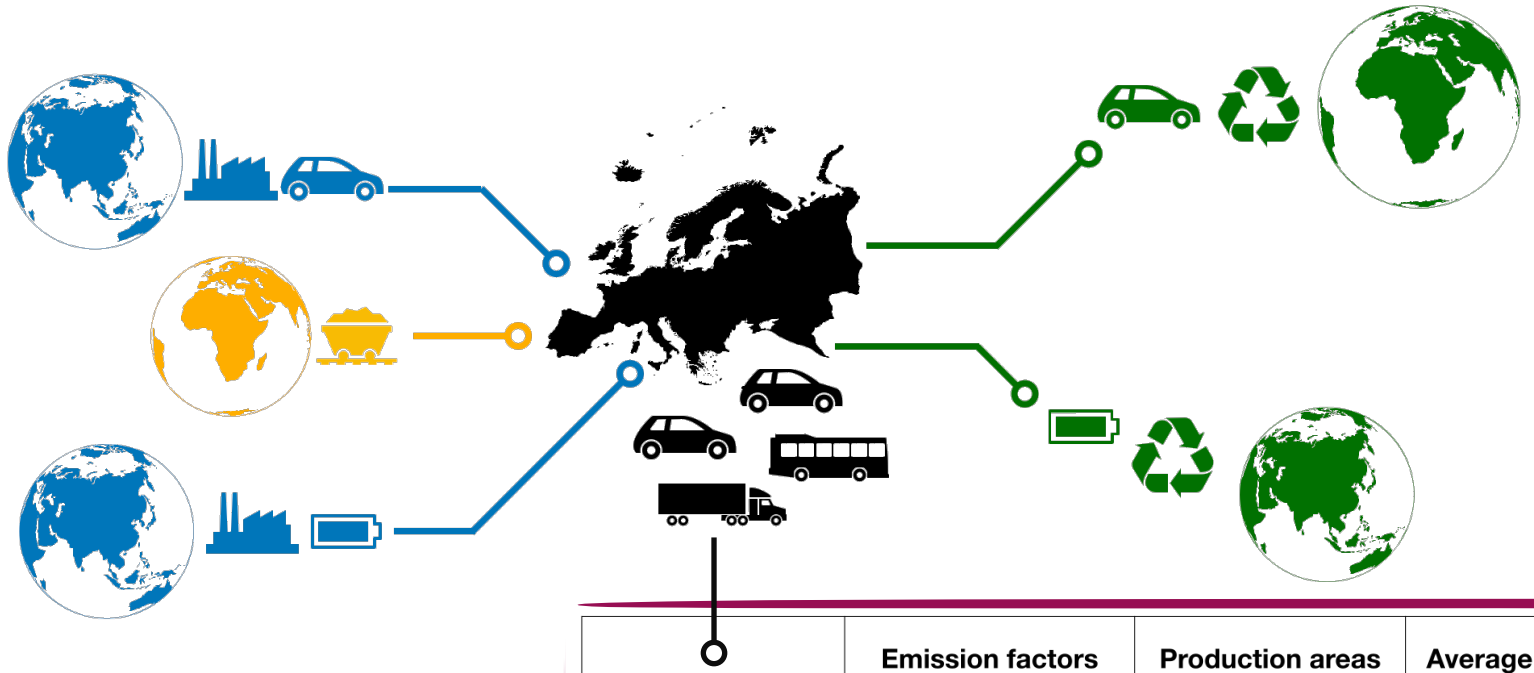
II. Defining representative vehicles & their LC-related CO2 in SIBYL



Need:
LC-EFs combined with extensive **market data** to construct fleet-representative vehicles and estimate **CO2 of manufacturing & disposal**

	Emission factors [kg/kWh]	Production areas [%]	Average capacity [kWh]	Type market share [%]	CO2 emissions per vehicle
Passenger cars	NMC (EU,..,CN): 61,3 - 69,7 LFP (EU,..,CN): 44,1 - 48,7	**NMC:** CN: 68,5 EU: 16,6 KOR: 7,5 US: 5,7 JP: 0,7 ROW: 0,9 **LFP:** CN: 99,2 EU: 0,6 KOR: - JP: - US: - ROW: 0,2	NMC: 64 LFP: 61	NMC: 90 LFP: 10	4,2 tn
Buses	NMC (EU,..,CN): 56,5 - 64,3 LFP (EU,..,CN): 41,0 - 45,4		NMC: 432 LFP: 384	NMC: 52 LFP: 48	22,4 tn
Light & medium trucks	NMC (EU,..,CN): 61,3 - 69,7 LFP (EU,..,CN): 42,7 - 47,2		NMC: 67 LFP: 75	NMC: 94 LFP: 6	4,5 tn
Heavy trucks: >12 tn	NMC (EU,..,CN): 56,5 - 64,3 LFP (EU,..,CN): 41,0 - 45,4		NMC: 205 LFP: 331	NMC: 85 LFP: 15	13,1 tn

Example:
CO2 from **manufacturing** for fleet-average **BEV batteries** per vehicle category

*CO2 from GREET model with modifications by e:misia

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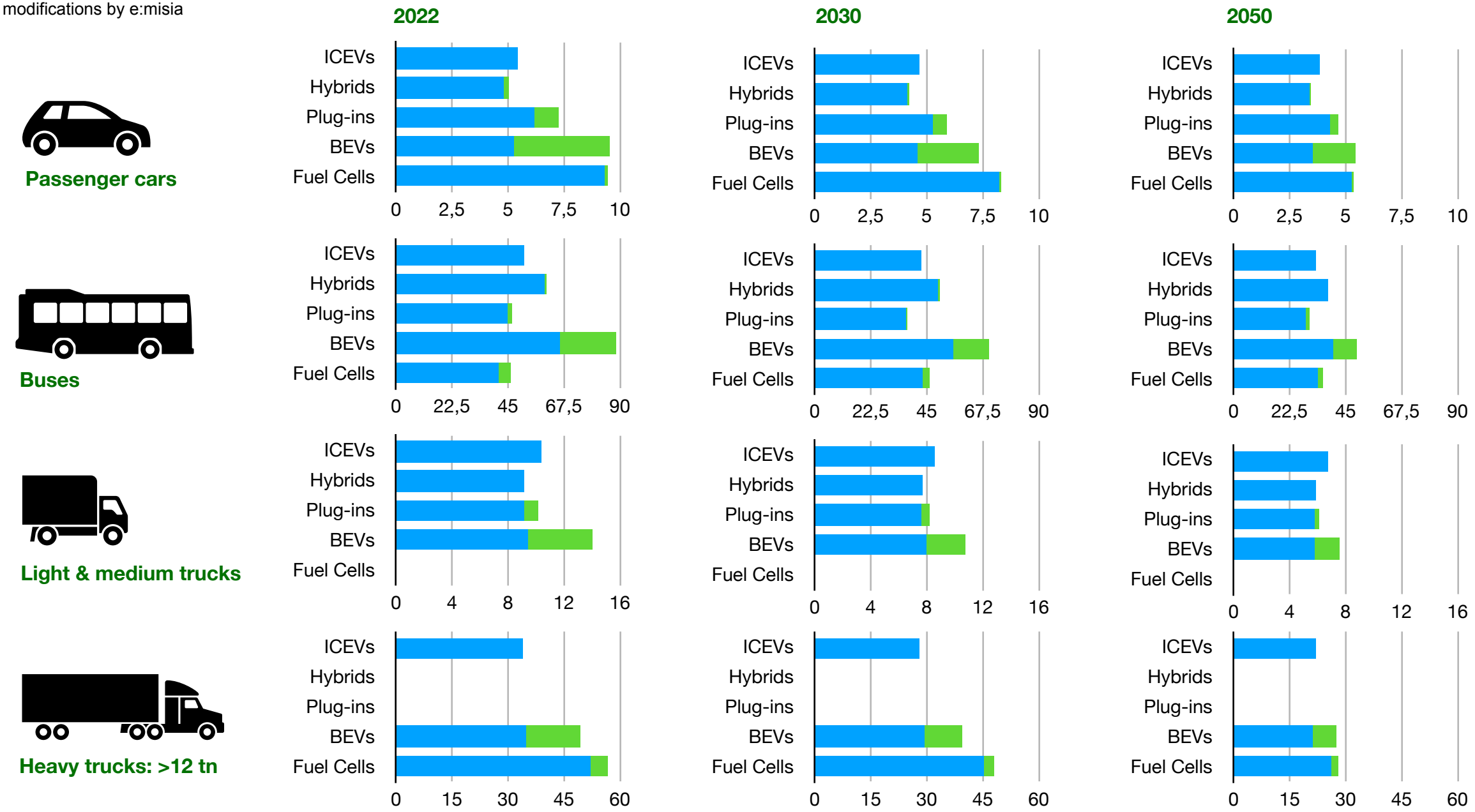
Representative vehicles' CO2 (tn) of manufacturing in SIBYL

Vehicle Battery

*CO2 from GREET model with modifications by e:misia



Case study:

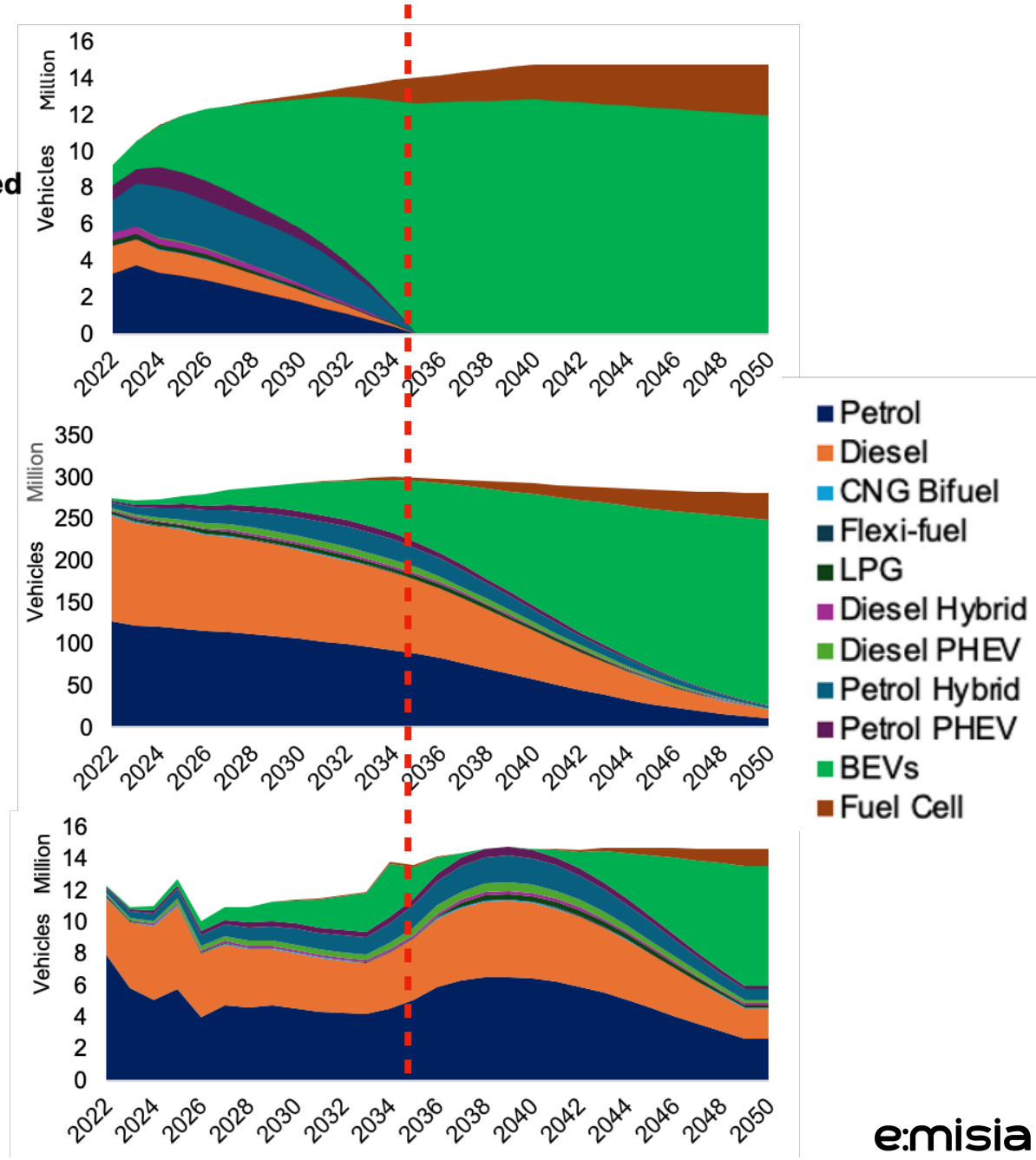
Electrification of the European fleet of passenger cars

Fleet synthesis

Current & projected

A scenario for EU-27 passenger cars that:

- takes account the current (2022) powertrain composition in fleet
- projects the current trends till 2035, taking account the ICEVs sales stop
- goes beyond 2035, enforcing electrification dominance and ICEVs market exit



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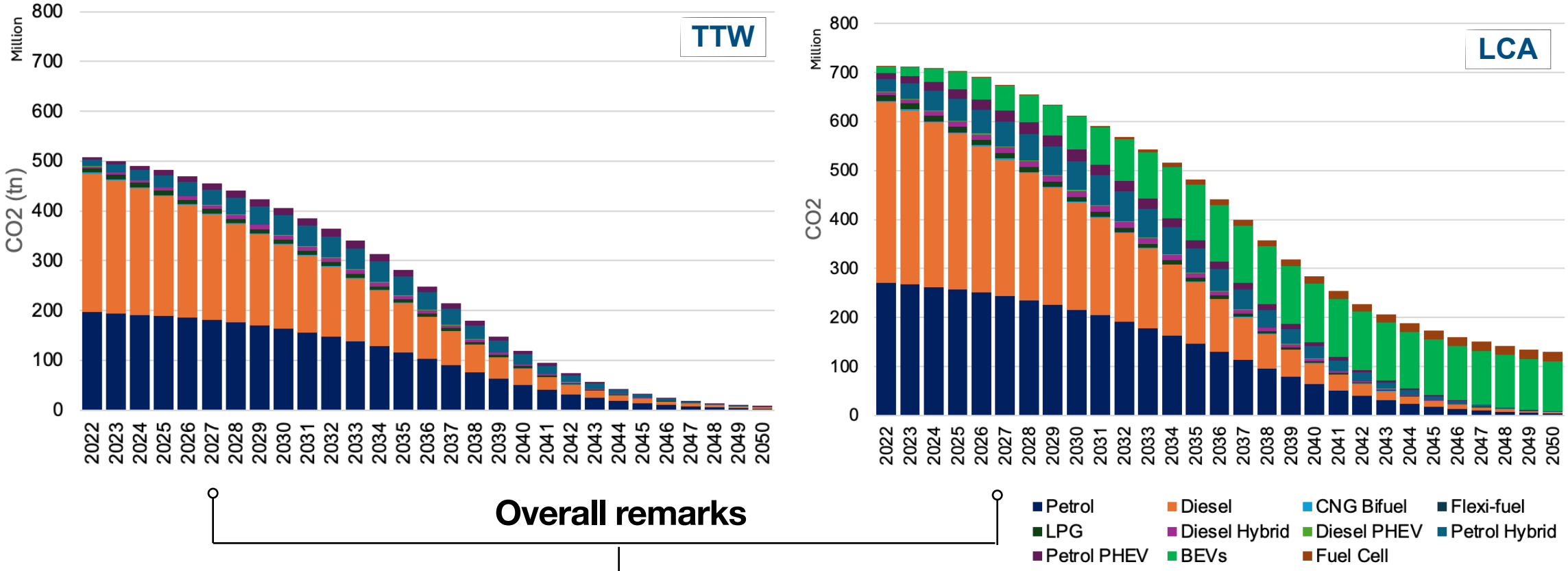
Results

Tailpipe vs LCA → Emissions accounting: 2022: **30%** gap 2050: **94%** gap



Overall remarks

- Emissions are reduced with electrification from 2022 to 2050, even from an LCA perspective
- Close to net-zero CO2 results appear only with a TTW consideration (2022 vs 2050 reduction by **98%**)
- Actual results with LCA show a **84%** emissions decline between 2022 and 2050

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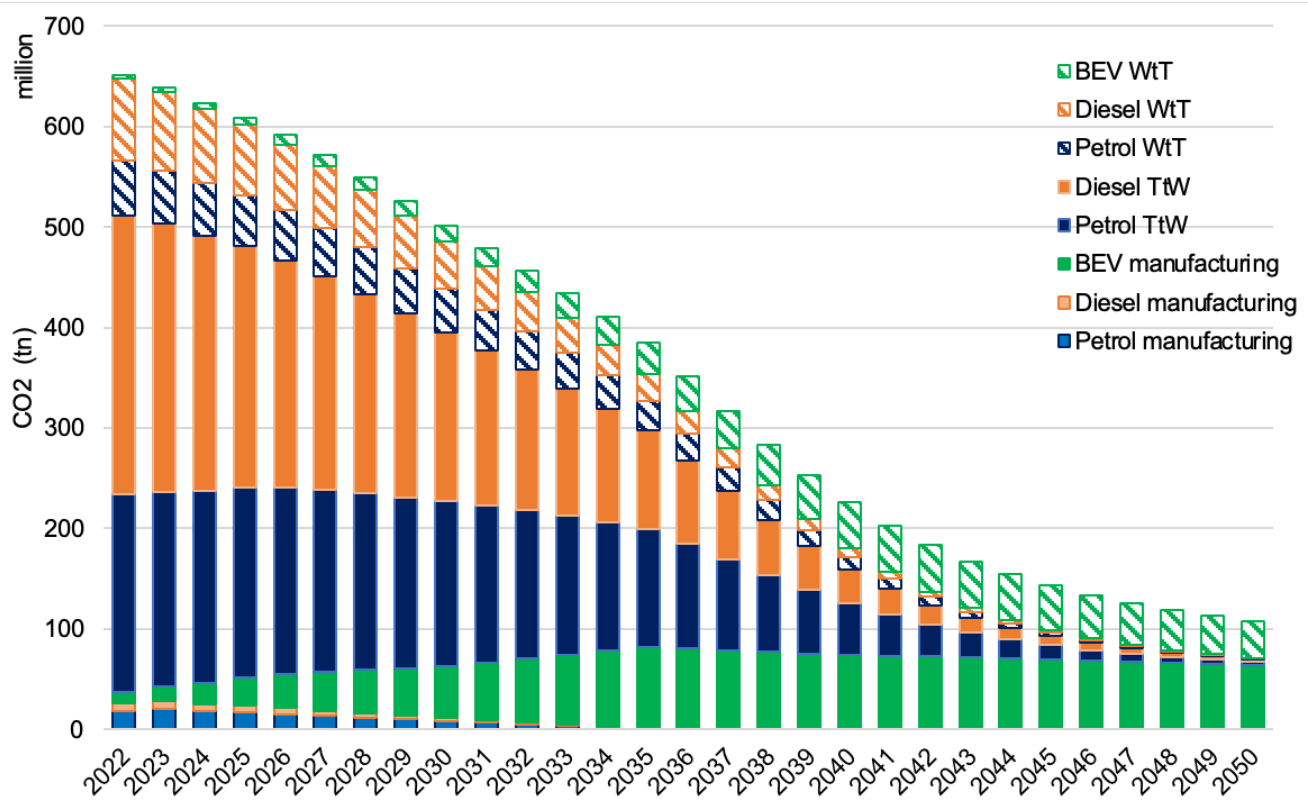
Analysing the source of emissions

Isolating the main powertrain types



- TTW major share in emissions is minimised alongside fossil-fuelled cars exit from market
- WTT of BEVs do not fully substitute TtW ones of ICEVs because of:
  - Electricity mix gradual decarbonisation
  - Powertrain better efficiency
- Manufacturing of BEVs becomes influential:
  - on a higher rate at early years due to increased demand for new vehicles (& batteries)
  - but stabilised at late years due to improvement in batteries footprint, despite increased demand.

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Thank you!

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