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1st IWG on LCA, 26 October – 28 October 2022
Agenda item 5

Methodology and limitations of assessing the life-cycle GHG emissions of vehicles

1st Meeting of the GRPE IWG on LCA
Okinawa Convention Center, October 26-28, 2022

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Methodological choices in vehicle LCAs

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Step 1: Defining the goal defines the approach

The goal of a LCA defines the approach: Estimating impact of a policy is different from assessing carbon footprint of a product.

➡ **ICCT study:** Which powertrain types allow decarbonization of global vehicle fleet within existing policy frameworks?

	Parameter	Approach
Production phase	Vehicle characteristics (e.g., battery size, vehicle weight)	Segment average in region
	Production emissions (e.g., battery, rest of vehicle)	Industry average in region
	…	
Use phase	Vehicle lifetime (e.g., years of operation)	Average age when scraped
	Usage profile (e.g., annual mileage)	Segment average in region
	Fuel/electricity mix (e.g., share of renewables or biofuels)	Vehicle lifetime average
	…	

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Electricity mix: Which approach suits best?

	Approach	Advantage	Disadvantage
Attributional	Historical average electricity mix	Real-world data available	Implicit assumption that electricity mix will remain constant over vehicle life
	Future-looking, lifetime average electricity mix (that considers growth in electricity demand)	Covers change of mix during vehicle life, covers effect of EV uptake *and* grid expansion	Uncertainty of projection
Consequential	Historical marginal electricity mix	Real-world data available	Limited to historical behavior; does not include change and expansion of grid
	Future-looking, lifetime average marginal electricity mix	Covers change of mix during vehicle life, covers effect of EV uptake *and* grid expansion	Difficult to model and predict all factors; uncertainty of projection

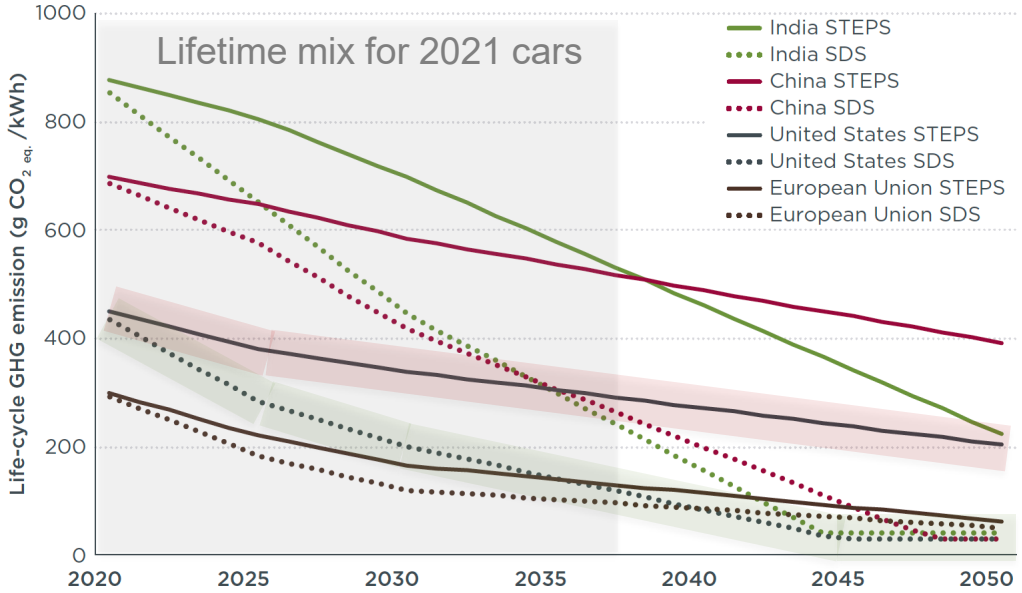
Uncertainties in electricity mix projections

ICCT study: Future-looking electricity mix projection from the IEA's Global Energy Outlook, based on policy frameworks.

Two scenarios to display uncertainty:

- **"Worst case"**: Projected future mix based on current policies, no future increase in ambition
- **"Best case"**: Paris Agreement-aligned development of electricity mix

Life-cycle GHG emissions of electricity consumption



Bieker (2021). A global comparison of the life-cycle GHG emissions of combustion engine and electric passenger cars.

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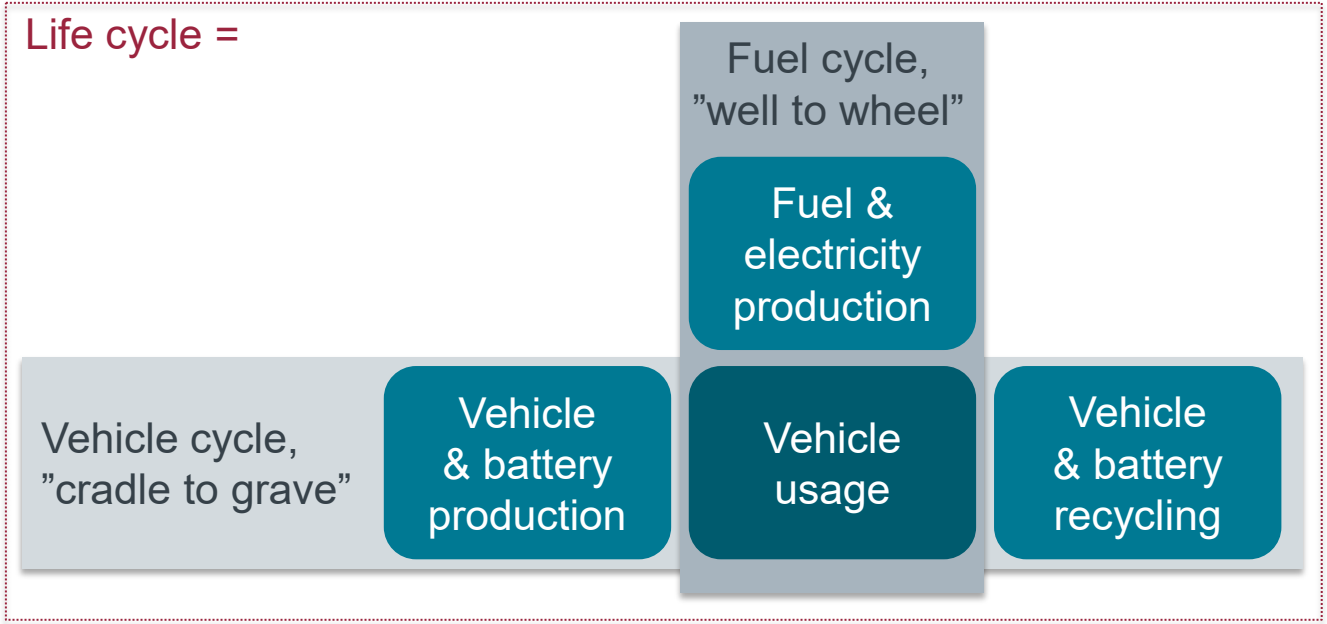
Step 2: Defining the scope of emissions



GHG emissions = CO_2, methane (CH_4), nitrous oxide (N_2O)

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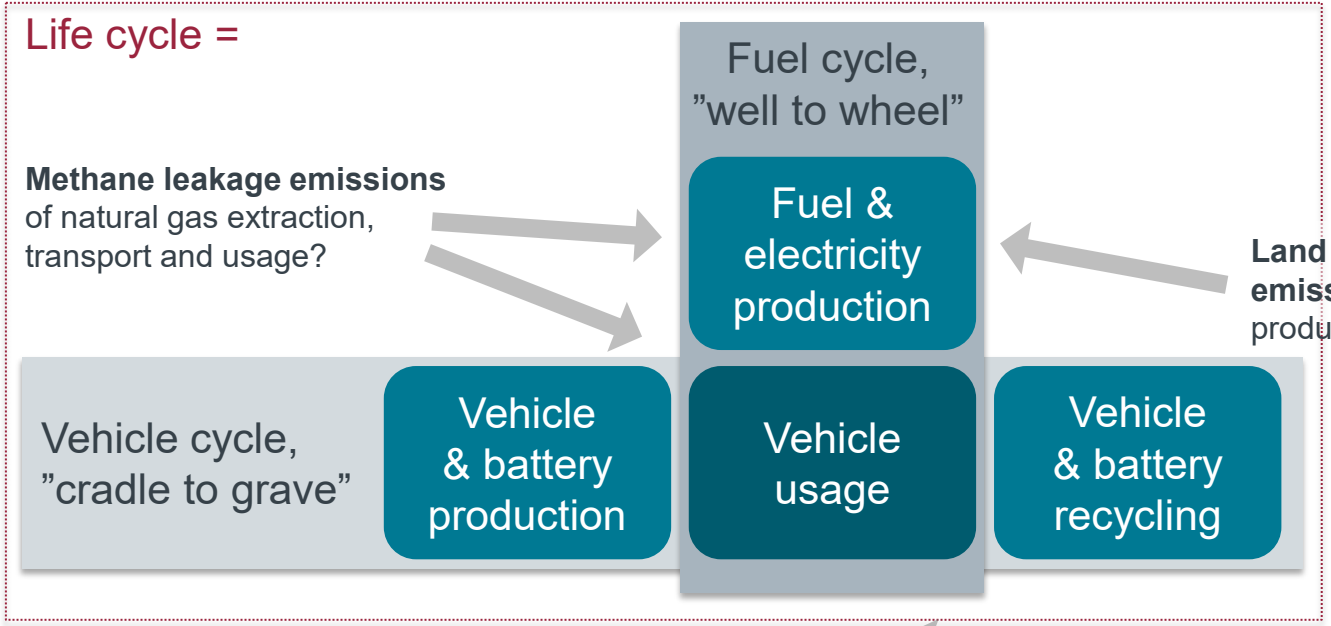
Step 2: Defining the scope of emissions



Methane leakage emissions of natural gas extraction, transport and usage?

Land use change emissions of biofuel production?

GHG emissions = CO_2, methane (CH_4), nitrous oxide (N_2O)

Scope of usage phase:

- Only in country of first registration?
- Full vehicle lifetime?

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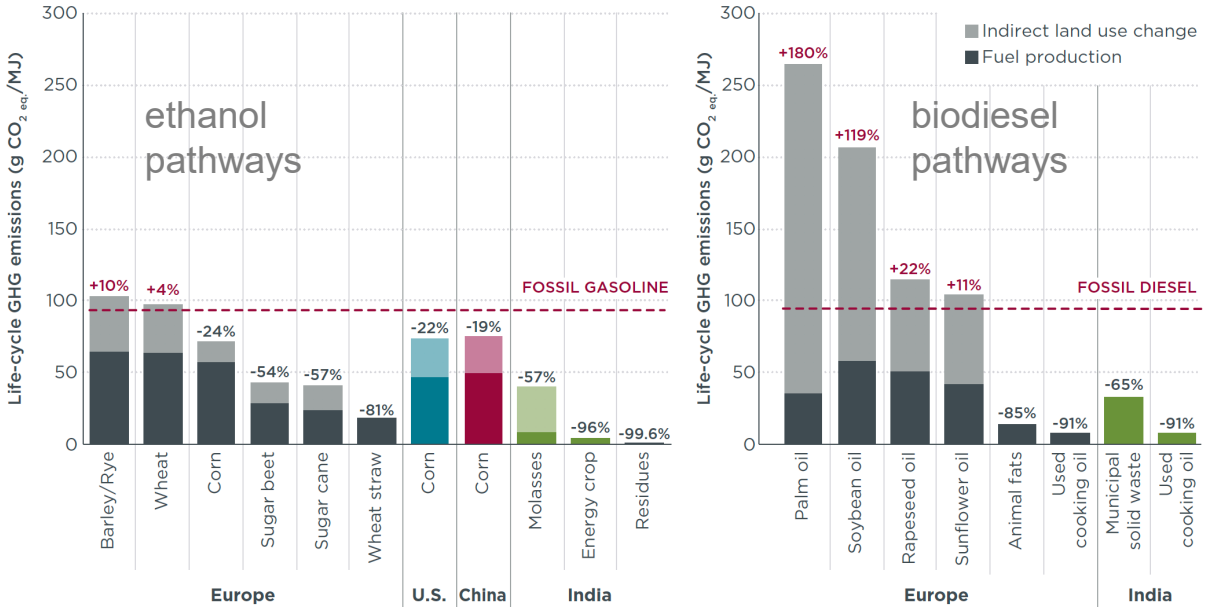
Land use change emissions of biofuel production

Indirect land use change (ILUC) emission of biofuels:

- **Food-based biofuels:** high ILUC emissions
- **Residue- and waste-based biofuels:** low ILUC emissions

Most biofuels are food-based!

Biofuel production and indirect land use change emissions



Bieker (2021). A global comparison of the life-cycle GHG emissions of combustion engine and electric passenger cars.

Methane leakage emissions of natural gas and natural gas-based hydrogen

Including the global warming potential (GWP) of methane leakage:

- Methane leakage for **natural gas** and for **grey and blue (CCS) hydrogen**

CH_4

CNG cars:
- Natural gas extraction/processing
- Natural gas transport/distribution
- Methane slip from the vehicles

CH_4

Grey and blue (CCS) hydrogen:
- Natural gas extraction/processing
- Natural gas transport
- Steam reforming

Methane is much worse than CO_2:

- 100-year timeframe: **30 times** higher GWP than CO_2
- 20-year timeframe: **85 times** higher GWP than CO_2

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Uncertainties and limitations

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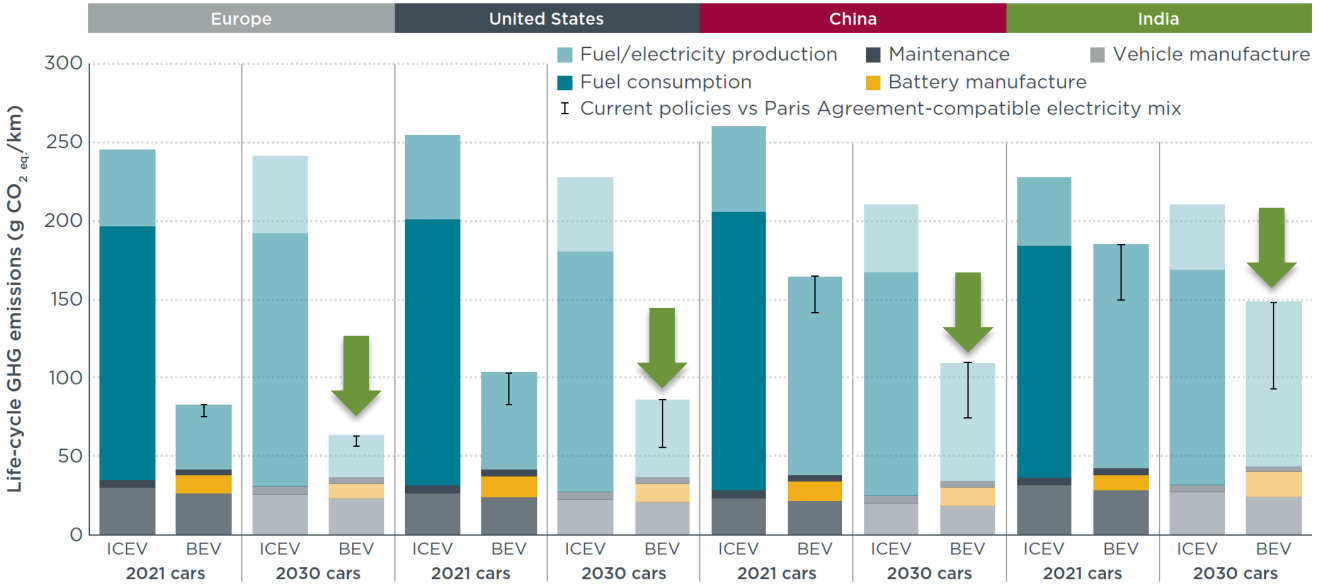
Life-cycle GHG emissions of BEVs are lowest already today. BEVs allow fastest decarbonization.

- **Battery EVs** have the **lowest emissions** for cars registered today**.**
- **Supported by other studies**, e.g., by IEA, Ricardo EAE et al., …

➡ **Indicative** for the emission benefit of BEVs **but come with uncertainties**.

Life-cycle GHG emissions of medium-size cars registered in **2021** and in **2030**



Bieker (2021). A global comparison of the life-cycle GHG emissions of combustion engine and electric passenger cars.

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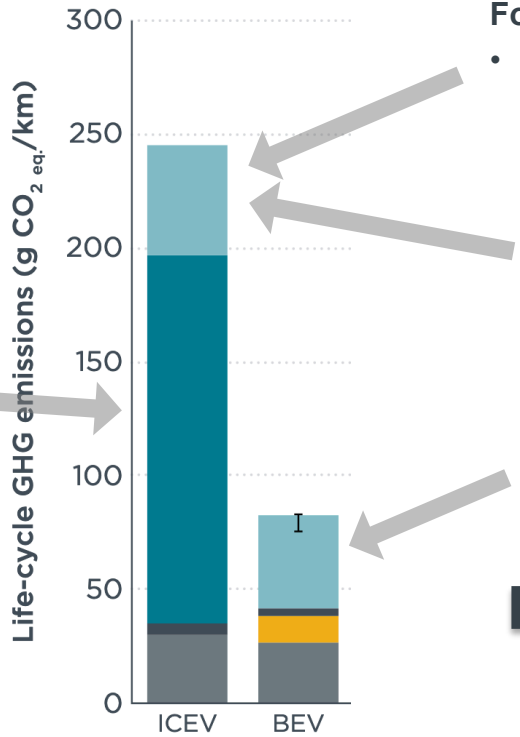
Use phase emissions have high uncertainties

Vehicle lifetime

- Limited data on full vehicle lifetime: used vehicles are typically exported to other countries.

Fuel/electricity consumption

- ICEVs + BEVs: real-world consumption is 14%-20% higher than WLTP values
- Plug-in hybrids: fuel consumption is three to five times higher than WLTP values



Fossil fuel production

- Methane leakage emissions are typically underestimated

Biofuel production

- Land use change emissions of biofuels can be higher than total emissions of fossil fuels

Future-looking electricity mix

- Projections of the development of the electricity mix is uncertain

Use phase emissions:

- Different methodologies
- Lack of data
- Assumptions required

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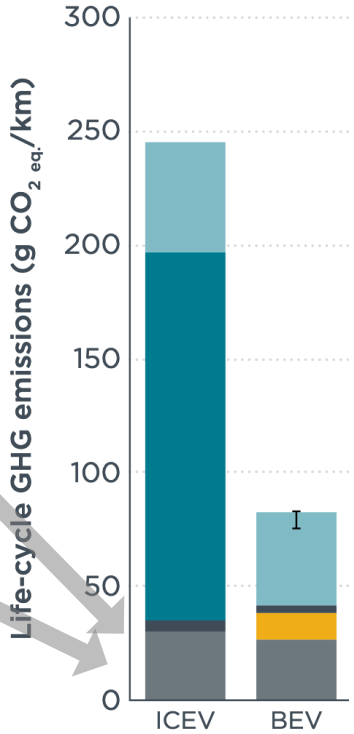
Production emissions require transparent data

Vehicle and battery production

- Composition of vehicle and battery, and carbon intensity of the materials and assembly varies with:
  - vehicle models
  - manufacturing plants
  - suppliers
  - over time

Recycling of vehicle and battery

- Future-looking assumption required
- Vehicle typically reach end-of-life in different jurisdiction than registration



Manufacturer-provided carbon intensity

- Require assessment and reporting along the value chain: from mining to manufacturing
- Require cross-border, thorough, and frequent audit by third parties
- Require transparent/traceable reporting

Generic carbon intensity datasets

- Do not display efforts by individual suppliers/manufacturers
- Require thorough and frequent audit of bill of materials by third parties
- Require transparent/traceable reporting of bill of materials

Leaving the option between both distorts results for the total industry.

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Summary and recommendations

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Summary

Methodology:

- **Vehicle LCAs require several methodological choices**, e.g., on whether the full vehicle lifetime is covered, and on how to assess the lifetime-average electricity mix.
- **The scope of emissions is not trivia**l. Many studies do not consider land use change emissions of biofuel production, or methane leakage of natural gas pathways.

Uncertainties and limitations:

- **The emissions of the usage phase have high uncertainties**, e.g., the vehicle lifetime, future development of the electricity and fuel mix, land use change emissions.
- **The production emissions** either require high efforts in reporting along the value chain, as well as cross-border and frequent audit, or cannot display efforts by individual manufacturers/suppliers.

Recommendations

Vehicle LCA-based regulations are not advised, as different methodologies, lack of data, and future-looking assumptions result in **high uncertainties in the usage phase** emissions.

Developing a comprehensive methodology for vehicle LCA should:

- Cover the full vehicle lifetime, not just the usage in the country of first registration
- Consider future-looking, lifetime average development of fuel and electricity mix
- Cover a broad scope of GHG emissions, including methane leakage and land use change emissions
- Be based on real-world fuel and electricity consumption figures
- Be based on frequently updated, publicly assessable data

Thank you!

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