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The Potential of Light Electric Vehicles for Climate Protection through Substitution for Passenger Car Trips

Germany as a Case Study

Session 4A. Out of the box: Exploring new use cases for electromobility

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LEV4Climate Study

The Potential of Light Electric Vehicles for Climate Protection through Substitution for Passenger Car Trips - Germany as a Case Study

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DLR Institute

Research questions

→ To what extent might LEVs substitute car trips?

→ How much $CO2_{eq}$ might be saved with LEVs?

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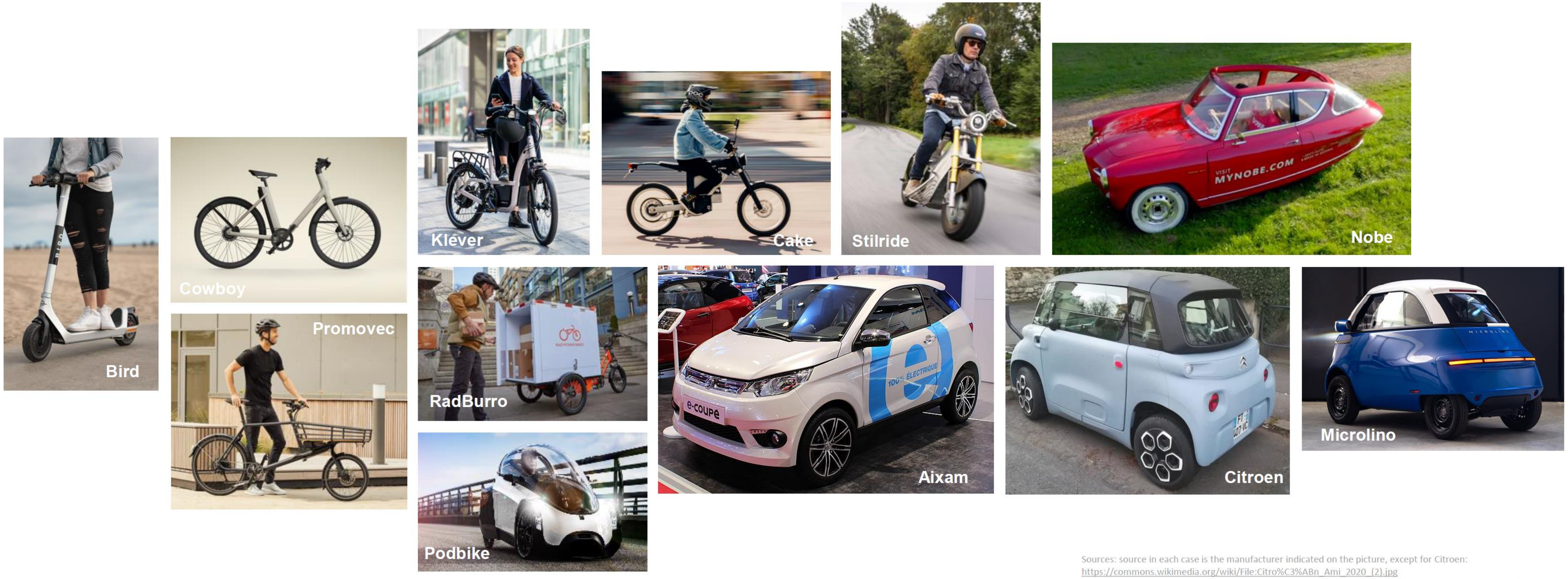
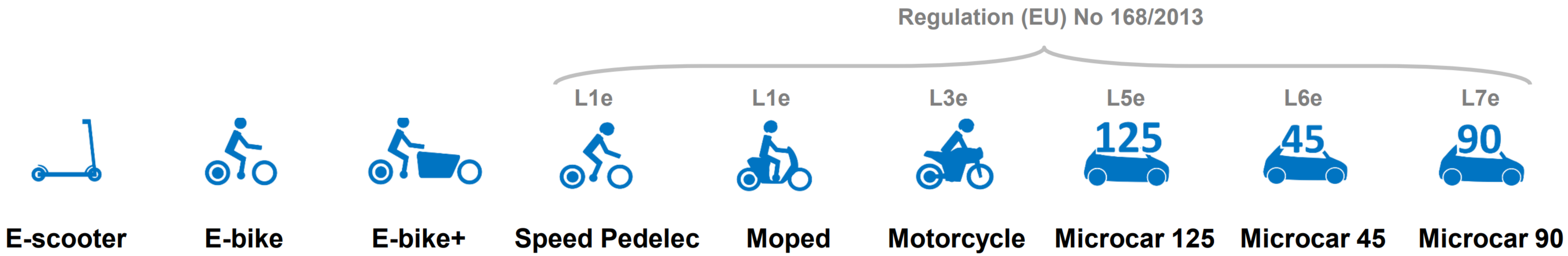
What is a Light Electric Vehicle and which kind are available today?

The market offers a rich variety of vehicles - from electric scooters to 4-wheelers. There are models with top speeds over 100 km/h, with and without cabin, with no, one, two or more seats and with different requirements in terms of age and driver's license possession. The graphics show examples of a wide range of LEVs.



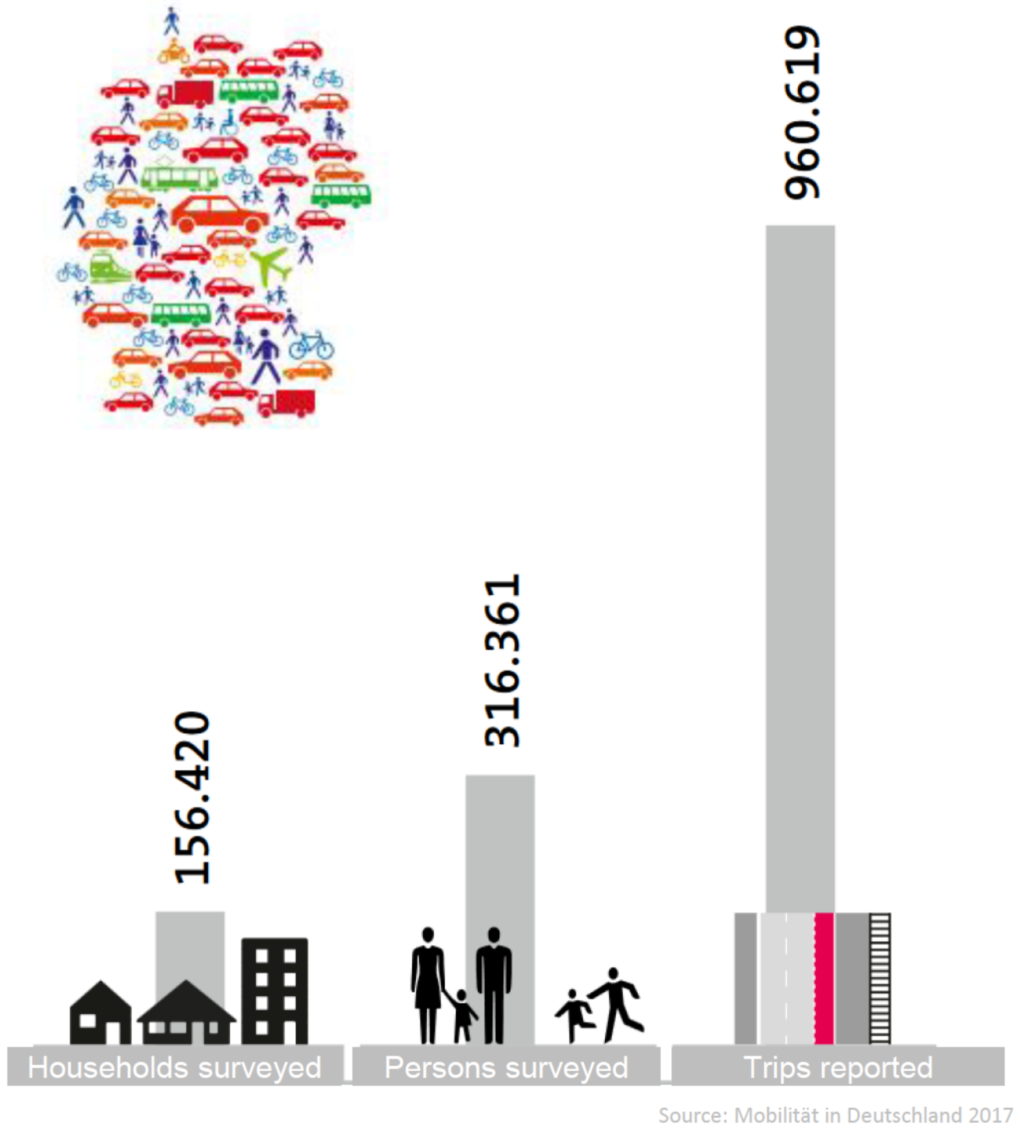
Sources: source in each case is the manufacturer indicated on the picture, except for Citroen:
https://commons.wikimedia.org/wiki/File:Citro%C3%ABn_Ami_2020_(2).jpg
And Aixam: https://commons.wikimedia.org/wiki/File:Aixam_e-Coupe,_Paris_Motor_Show_2018,_IMG_0219.jpg

LEV categories for the analysis



The number behind the name indicates the top speed of the exemplary model. The maximum design speed is limited by law to 45 km/h for category L6e, to 90 km/h for category L7-e** and is not limited for category L5e.

Data to identify the substitution potential of current car trips



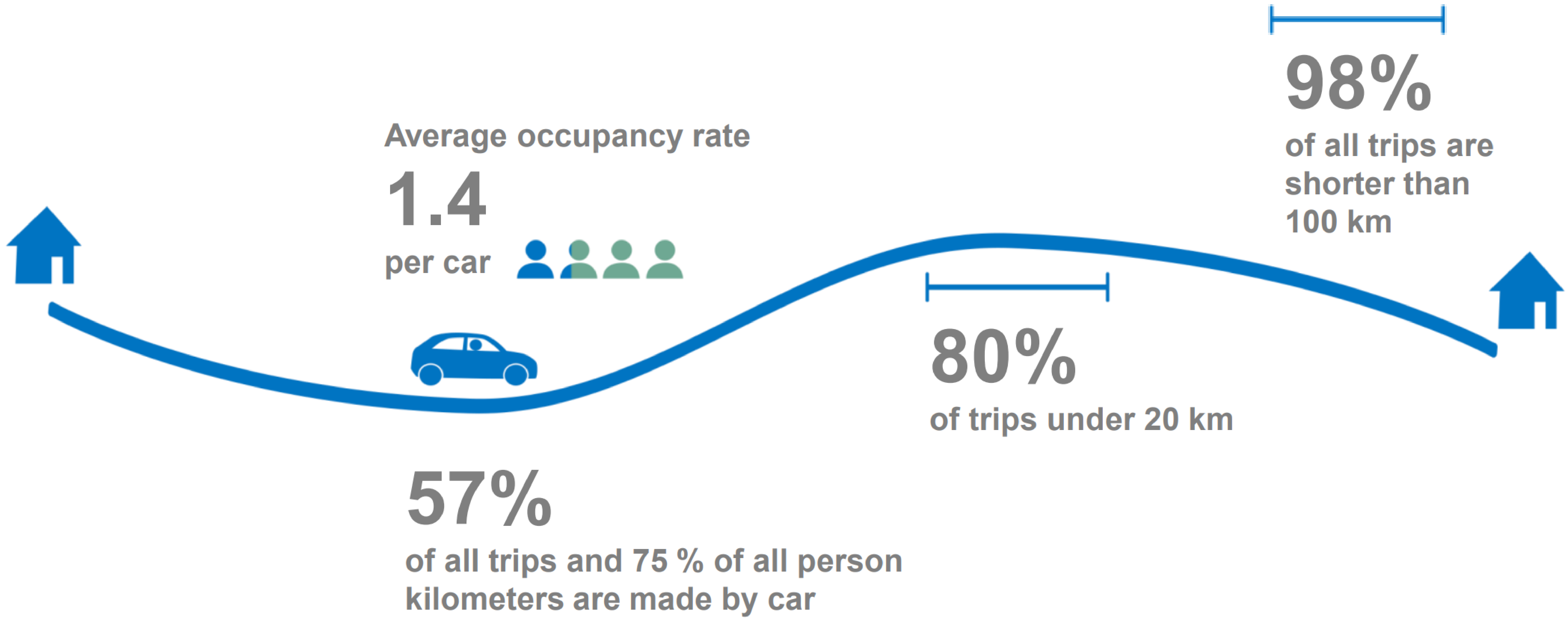
Mobility in Germany / „Mobilität in Deutschland“ (MiD)

- German national travel survey
- Conducted 2002, 2008 and 2017; planned for 2023

MiD 2017

- Field phase: May 2016 – September 2017
- Surveyed approximately 960k trips by 316k people from 156k households
- Dataset also records household, personal, trip and car information
- Trip information includes e.g., trip length, trip purpose, modes used, weather, number of passengers, average speed, starting point
- Weighting and extrapolation factors available: enable calculation of representative figures for day-to-day mobility of German resident population during the survey period

Characteristics of today’s car trips in Germany



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Characteristics of the LEVs included in the analysis

	Exemplary LEV model max. speed	unit	E-Scooter 20 km/h	E-bike 25 km/h	E-bike+, 25 km/h	Speed Pedelec 45 km/h	Moped 45 km/h	Motorcycle 120 km/h	Microcar 45 45 km/h	Microcar 90 90 km/h	Microcar 125 128 km/h
Trip substitution criteria	Relevant travel distance - One way	km	4	15	15	30	30	45	40	70	70
	Relevant travel distance - Round trip	km	8	30	30	60	60	90	80	140	140
	Number of occupants	-	1		1 + 3 children (up to 7 years)	1	2 (excl. children < 10 years); no accompanied shopping trips		2		3*
	Trip purposes (suitability)	-	All, excl. shopping / accomp. / some professional trips**	All, excl. accompani-ment / some shopping and professional trips***	All (accomp: children), excl. some shopping and professional trips***	All, excl. accompani-ment / some shopping and professional trips***	All, excl. some shopping and professional trips***				
	Street category	-	excl. Highway					All	excl. Highway	All	
	Max. age of driver	years	18-70						18 - 99		
	Weather conditions	-	All, without heavy rain, snowfall, or icy roads						All conditions		
	Impairments (suitability)	-	none						Walking impairment		
Input $CO2_{eq}$	Technical electr. Range (nomin.)	km	65	120	70	70	100	130	110	200	256
	Battery capacity	kWh	0.6	0.4	0.4	1.2	2.7	8.5	6.1	14.4	25
	Weight (incl. battery)	kg	20	25	51	29	100	231	440	571	454
	Energy consumption	kWh/100 km	0.8	0.3	0.6	1.7****	2.7	7.7	5.5	7.2	10.0
	Lifetime mileage	km	16,000	50,000	50,000	70,000	70,000	100,000	70,000	160,000	160,000

* for trip purpose shopping limited to 2
** social service, transport of passengers or goods, "other"
*** professional: transport of passengers or goods, "other"; shopping: "other goods"
**** corresponds to 70 km per fully charged battery (1,2 kWh)

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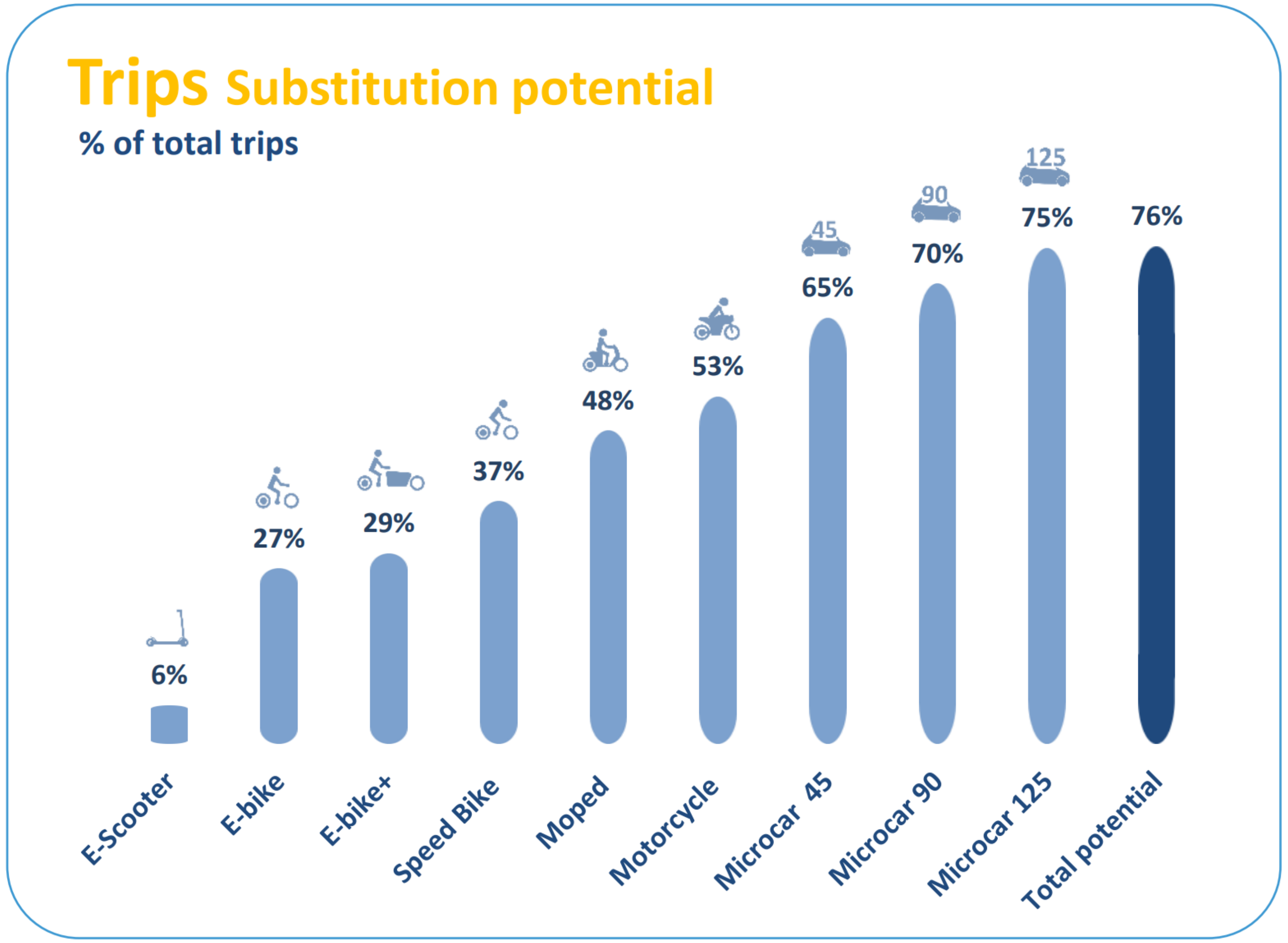
Methodological approach to identify the substitution potential of LEVs

Criteria	Exemplary trip reported in the large-scale National Mobility Survey in Germany (MID 2017)	Scenario E-bike+ E-bike+ is used here to explain our methodological approach. Same procedure with all selected vehicles.	check
Trip length	8 km (one-way)	Up to 15 km (single trip), up to 30 km round trip	✓
Trip purpose	Commuting	All trip purposes, excluding: • Accompaniment (except children under 7 years) • Professional trips: transport of passengers or goods and "other“ • Shopping trips: "other goods"	✓
Age (driver)	59	18 – 70 years	✓
Weather	Snowfall	Without heavy rain, snowfall, or icy roads	X
Impairments	None	Only people without any health or mobility impairments	✓
Number of persons	1	1 + 3 (only children up to 7 years)	✓

Substitution potential *(% of possible trips and mileage)*



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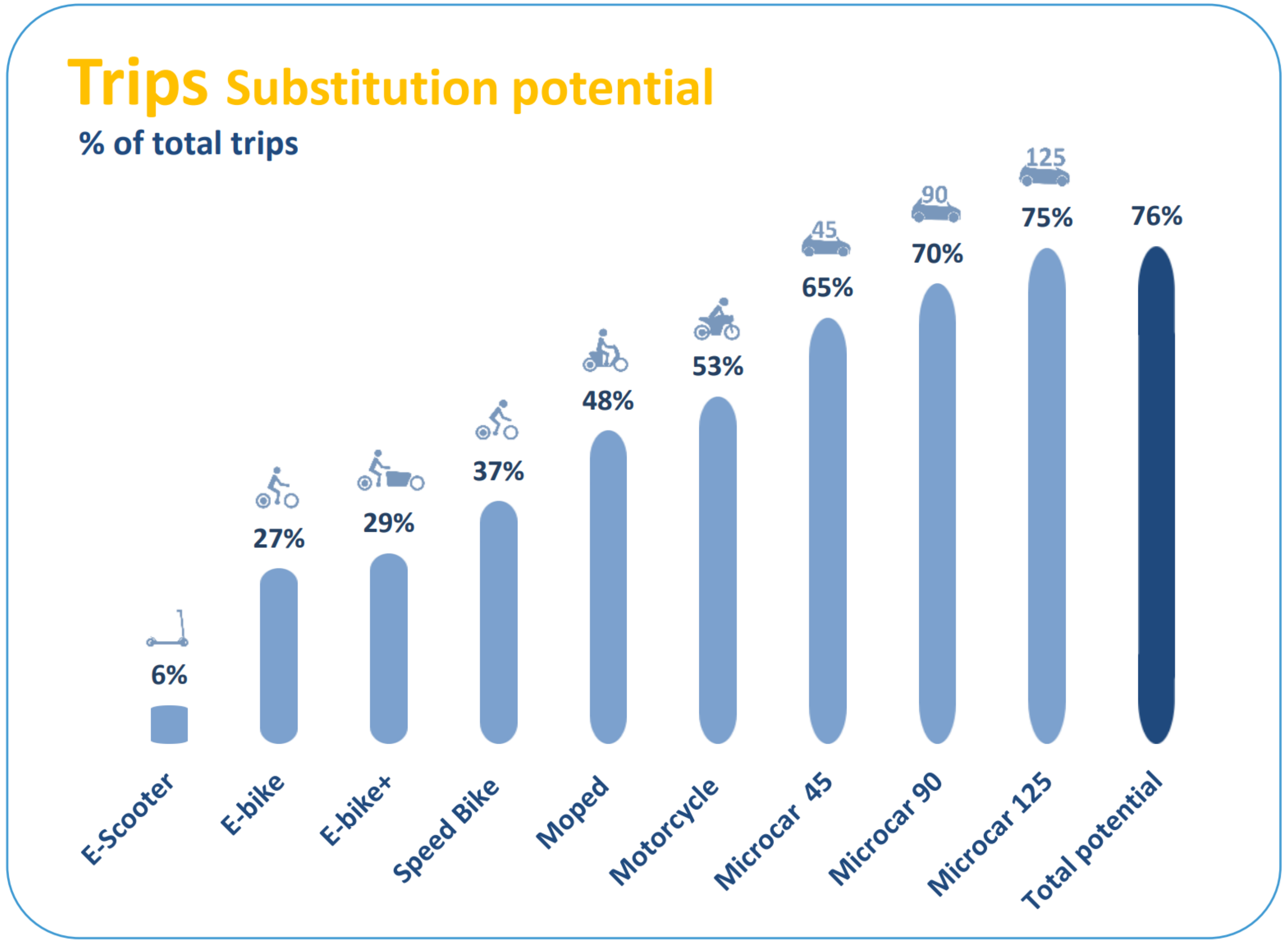

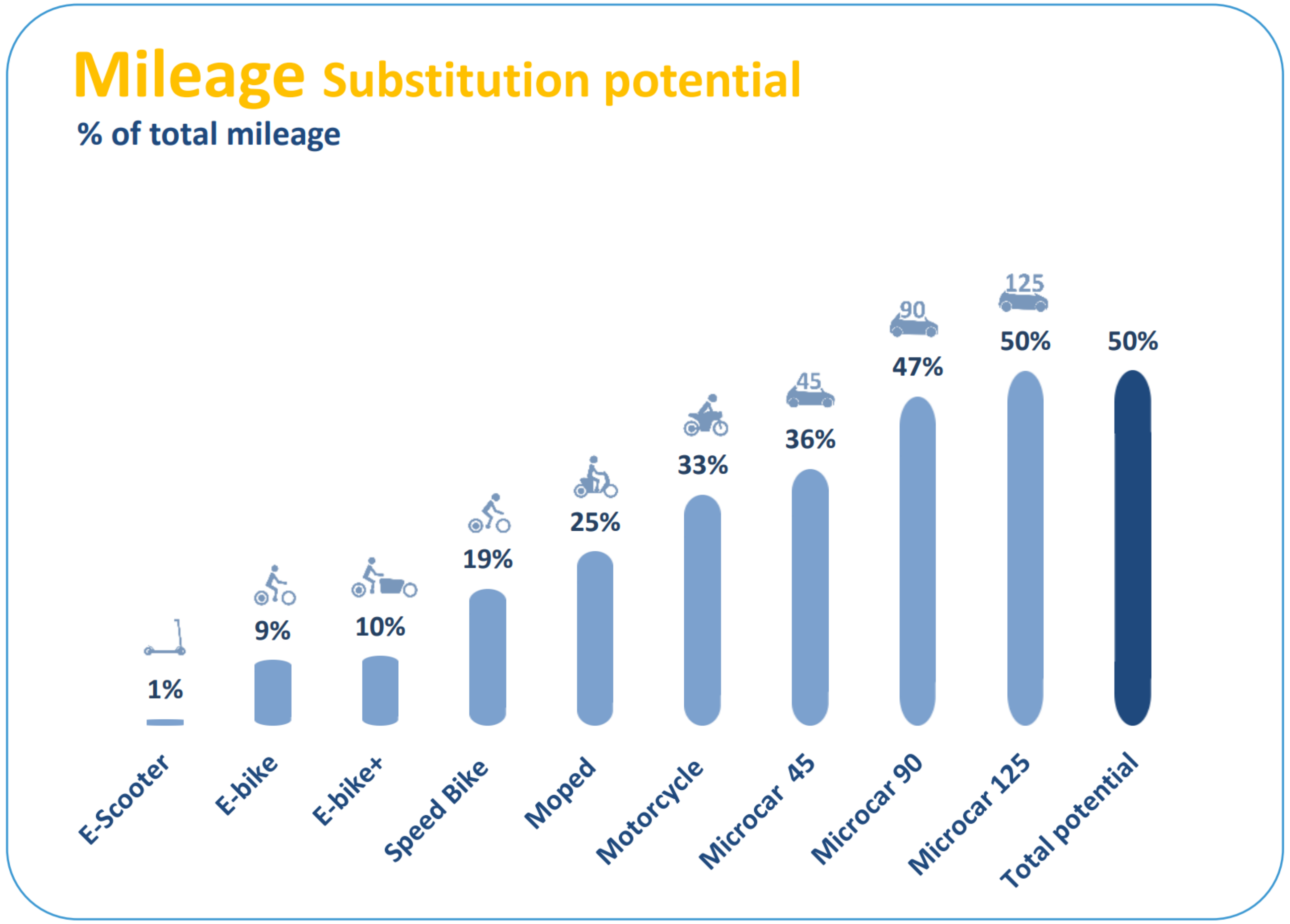

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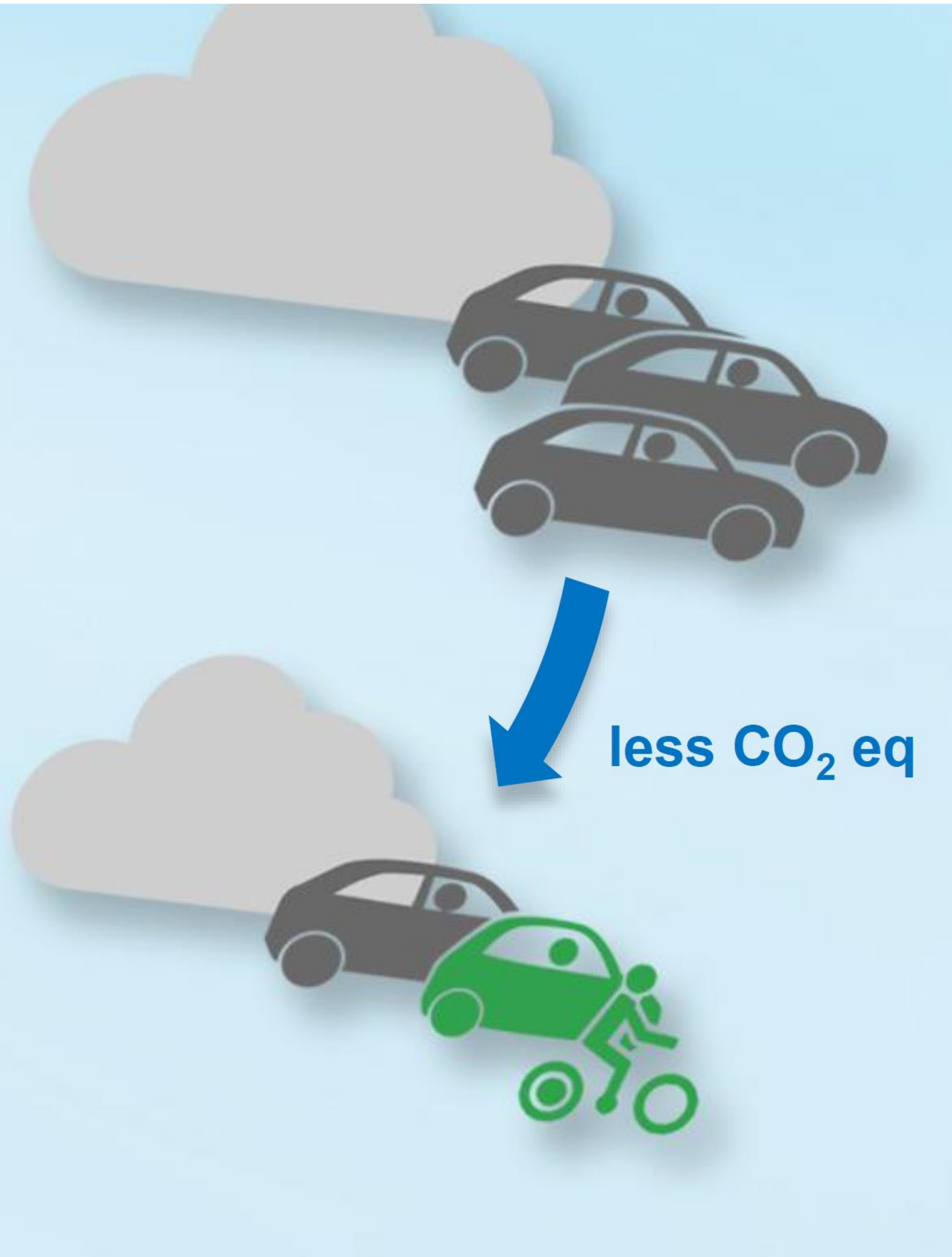
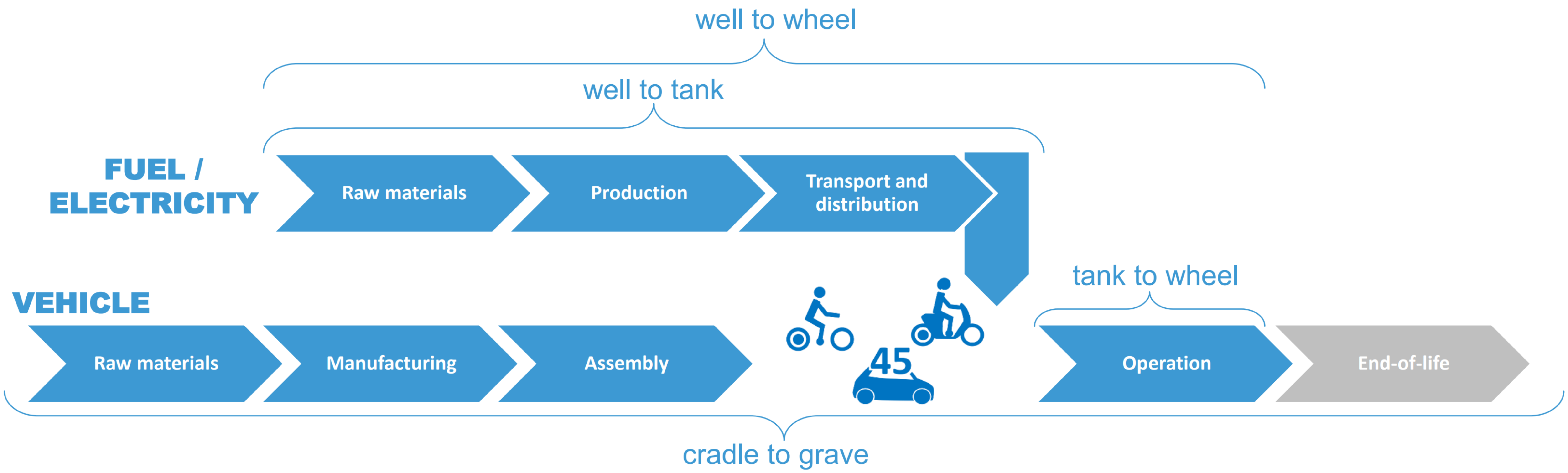
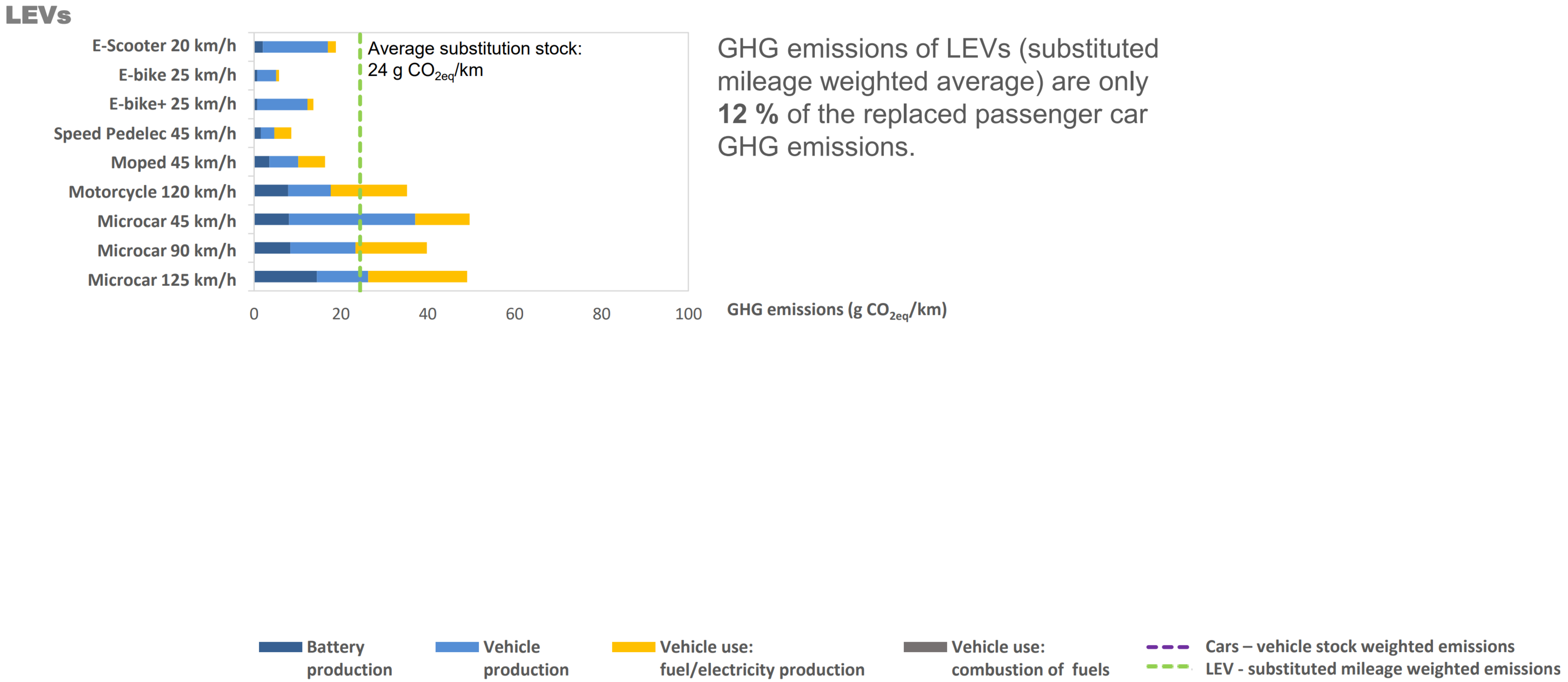
Emission reduction potential



Methodological approach: assessment of carbon footprint



Results: life cycle emissions per kilometer



GHG emissions of LEVs (substituted mileage weighted average) are only **12 %** of the replaced passenger car GHG emissions.

* Kopernikus-Projekt Ariadne 2021

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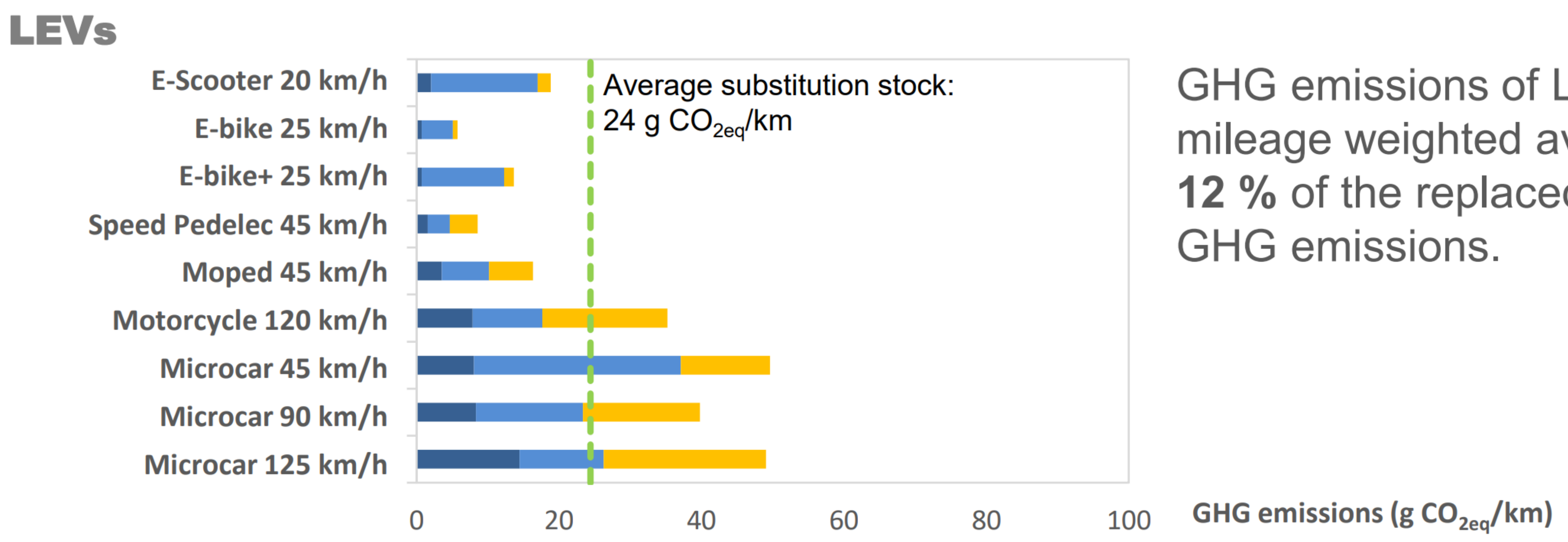

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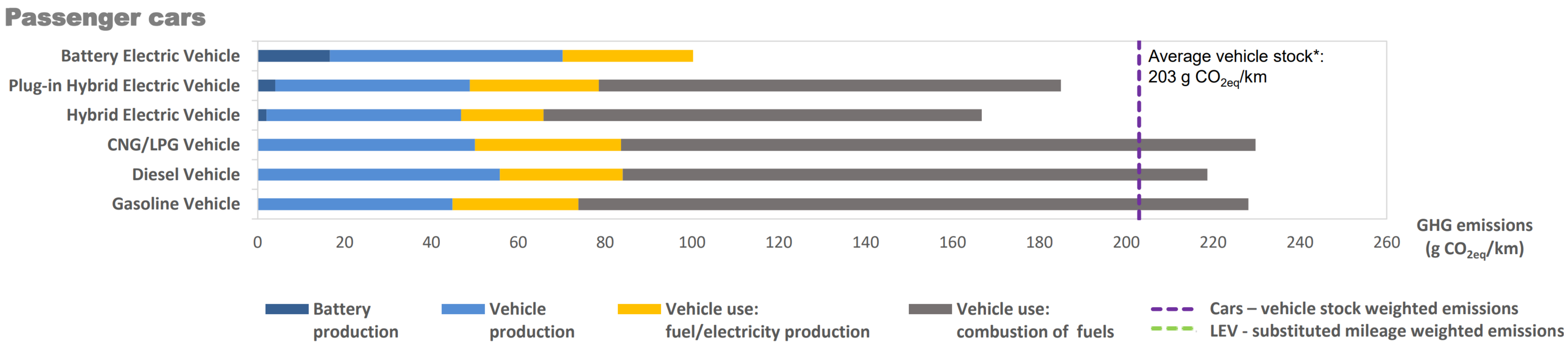

* Kopernikus-Projekt Ariadne 2021

Results: greenhouse gas emission reduction potential by LEV substitution

CO_{2eq} emissions before LEV substitution

130 million tonnes per year

CO_{2eq} emissions after LEV substitution

73 million tonnes per year

- Overall saving is **44%** of entire passenger car emissions before substitution
- Achieved with **50 %** of mileage substitution

In absolute numbers:

- 157 kilo tonnes CO_{2eq} per day reduced from 356 kilo tonnes CO_{2eq} per day without substitution
- This is equivalent to a reduction of 57 Mio tonnes CO_{2eq} per year

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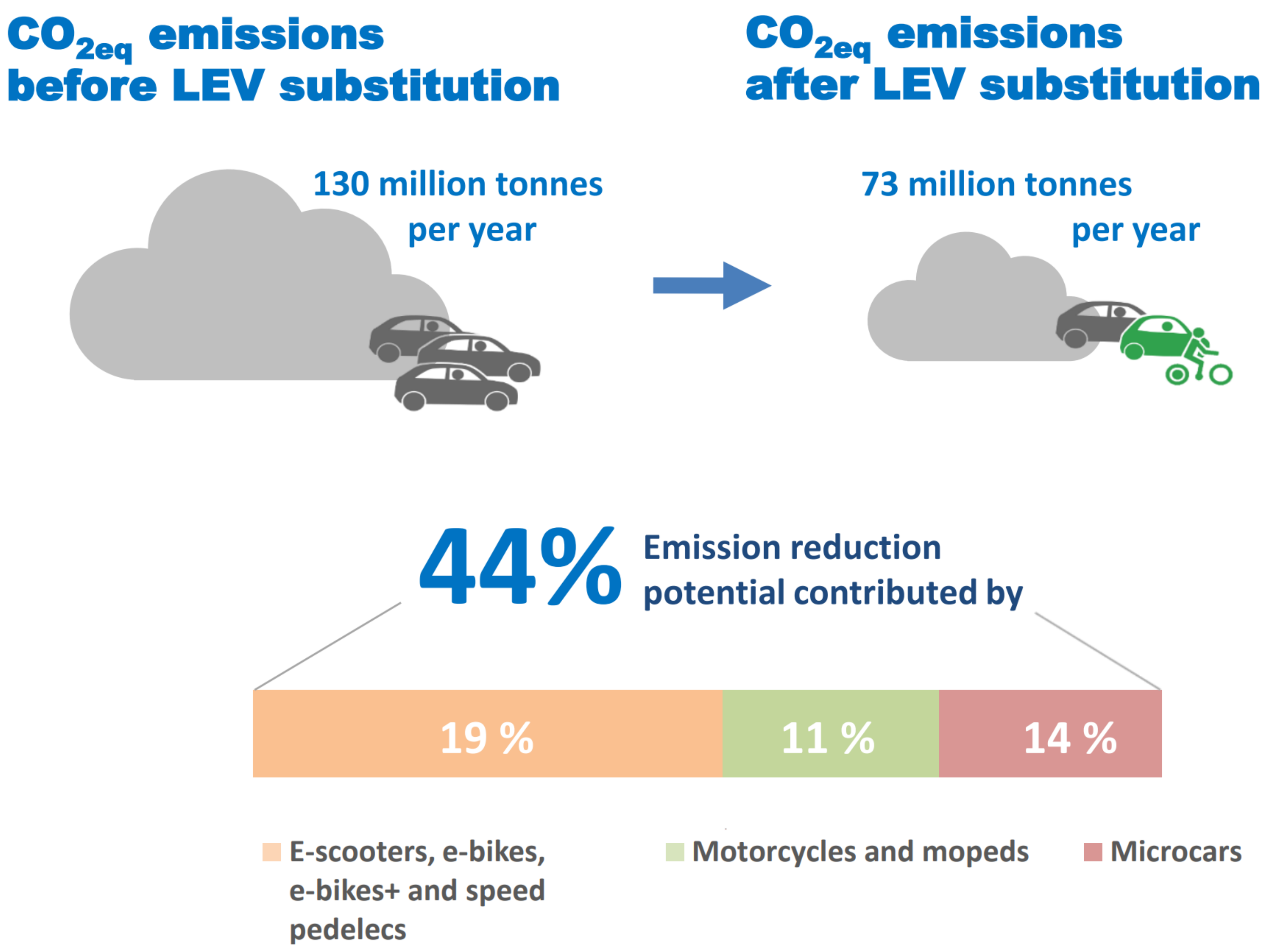

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Conclusion

✓For car trips substituted by LEVs, **88% of the emissions** could be saved.

✓ **44% less CO_{2eq}** could be emitted by replacing three quarters of German car trips, saving 57m tonnes CO_{2eq} per year

✓ The potential of LEV to support climate change mitigation is significant.

✓ This does not take into account any social, political, LEV acceptance or mobility behaviour changes.

Further research

✓ The potential is sufficiently high to suggest that further research into LEV potential is worth pursuing.

✓ This potential shows that further investigation of their wider social, ecological, economic, safety and planning implications is urgently needed.

✓ Future research should include the evaluation of paths toward greater acceptance and use of LEVs.

✓ Without fundamental changes in many areas (regulation, infrastructure, incentives, internalisation of external costs etc.), the potential of LEV will not be achieved to the full.

The full report is available here: The Potential of LEVs for Climate Protection

Thank you for your attention!

For questions:

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