



Going by car, plane, coach or train? – Climate impact from passenger travel re-calculated

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with thanks to Jan Fuglestvedt & Terje Berntsen

Climate impact from transportation

1. Global impact from passenger travel on climate?
2. Impact per passenger-kilometer for each mode?
3. Impact from (European) vehicles on climate?
4. Impact from annual travel on climate?

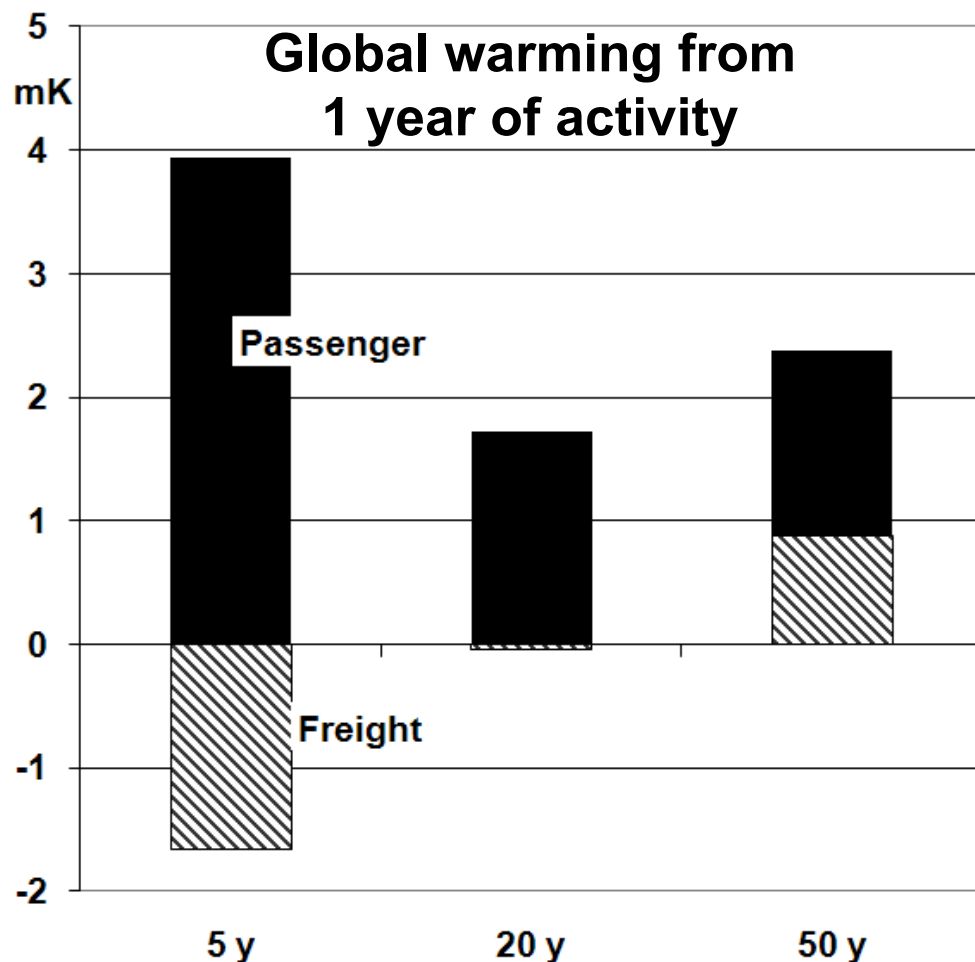
...similar considerations hold for freight transport.

Remember:

- Climate change on shorter and longer time scales
- Values depend on metric used:
=> Future temperature response to emission



Warming from passenger vs. freight transport

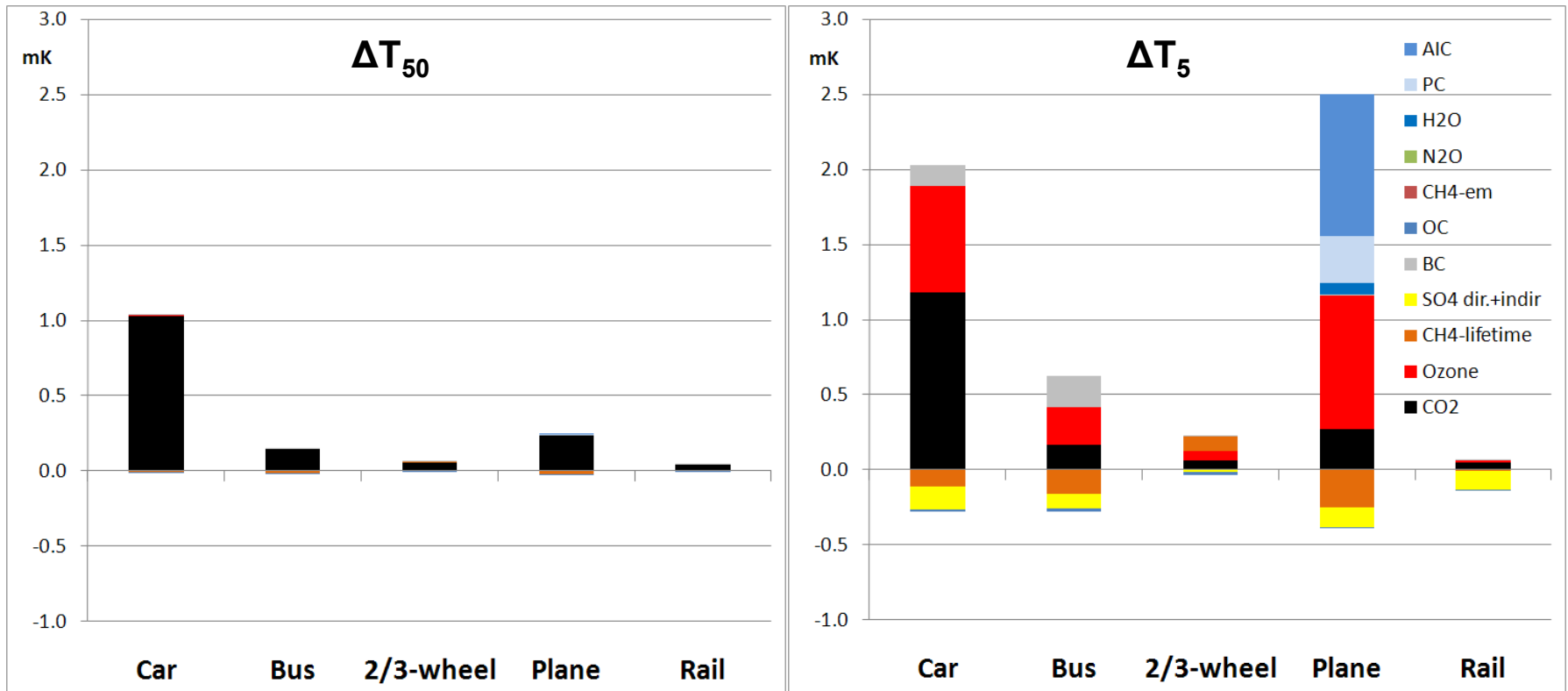


- **Total impact:**
Passenger >> freight transport
(all metrics and time horizons)
- **Long-horizon:**
Lower limit = CO₂ ratio
= 60% passenger :40% freight
- **Short-horizon:**
Freight transport is cooling ⇔
Warming results from passenger
transport only
- **Ratios** depend on time-horizon
⇔ Mix of short-lived compounds



Climate impact from current global passenger travel

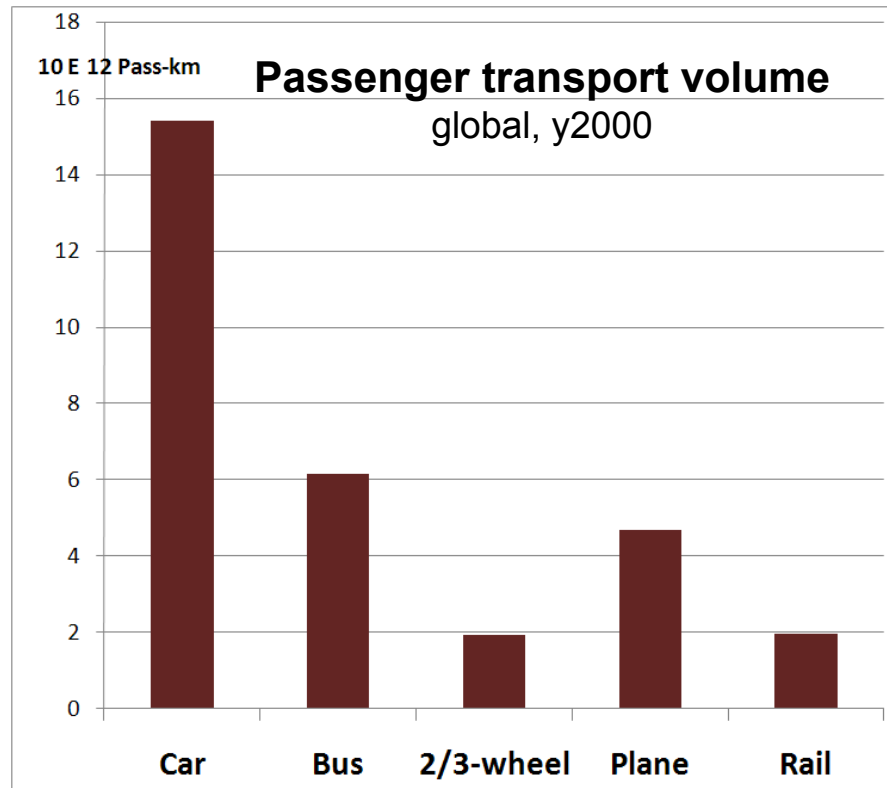
- Impact = short- and long-term change of atmosphere
- In addition to CO₂ large contributions from ozone, clouds, sulphur, soot,
 - both warming and cooling, with different time constants



Borken-Kleefeld et al., ES&T 2010

Climate impact from current global passenger travel

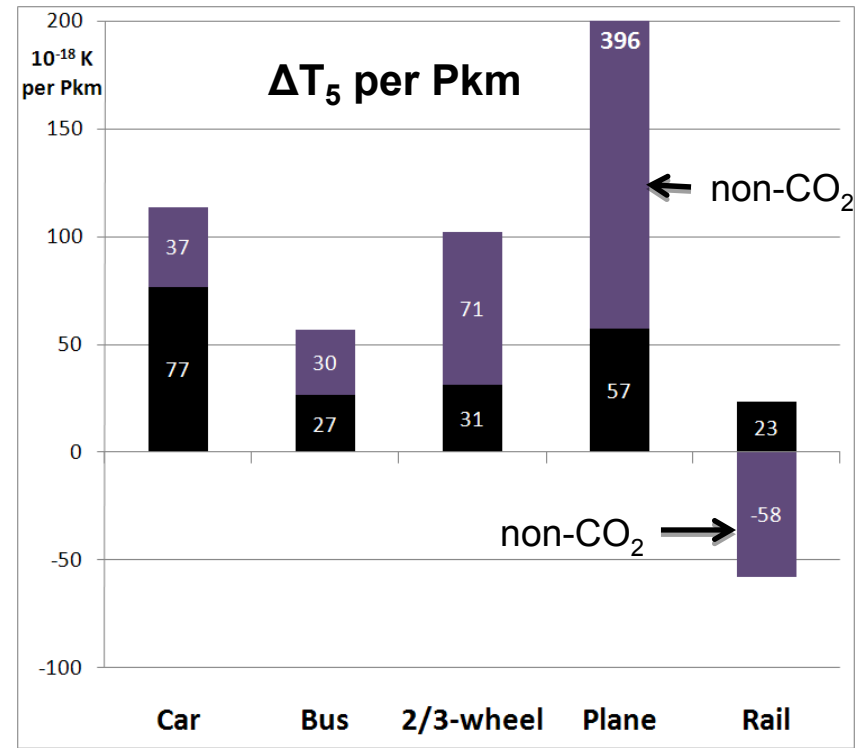
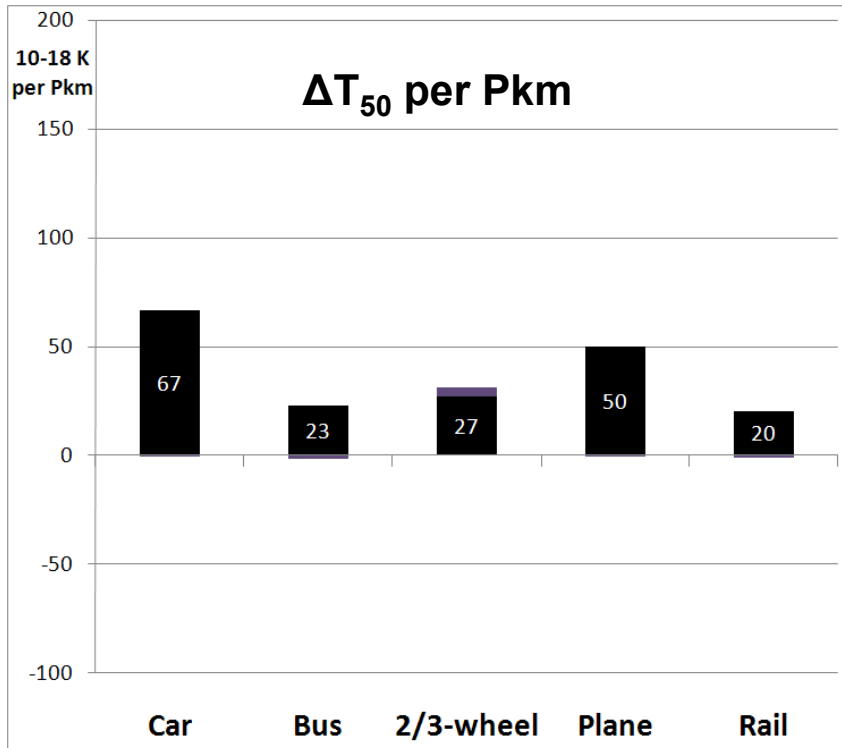
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Climate impact per passenger-kilometer (global average)

- Long-term impact \approx CO₂ impact \approx fuel efficiency per pass-km
- Short-term impact:
 - Planes: Strongly enhanced;
 - Cars, bus, 2/3-wheel: Increased by non-CO₂ pollutants (ozone, soot)
 - Rail: Reduced by sulphur emissions from power plants



Climate impact from 1 year of travel (European conditions)

Distribution of annual travel budget	
	AVERAGE: 20'000 km/a
Urban	200 days * 30 km
Intercity	10 times * 500 km
Long-dist.	6 times * 1500 km

Compare the following vehicles for their climate impact (GWP₁₀₀)

Car: Small diesel car (Euro 4) or Gasoline SUV (Euro 4),

Plane: Airbus A320 with occupancy of 80% (high) or 50% (low)

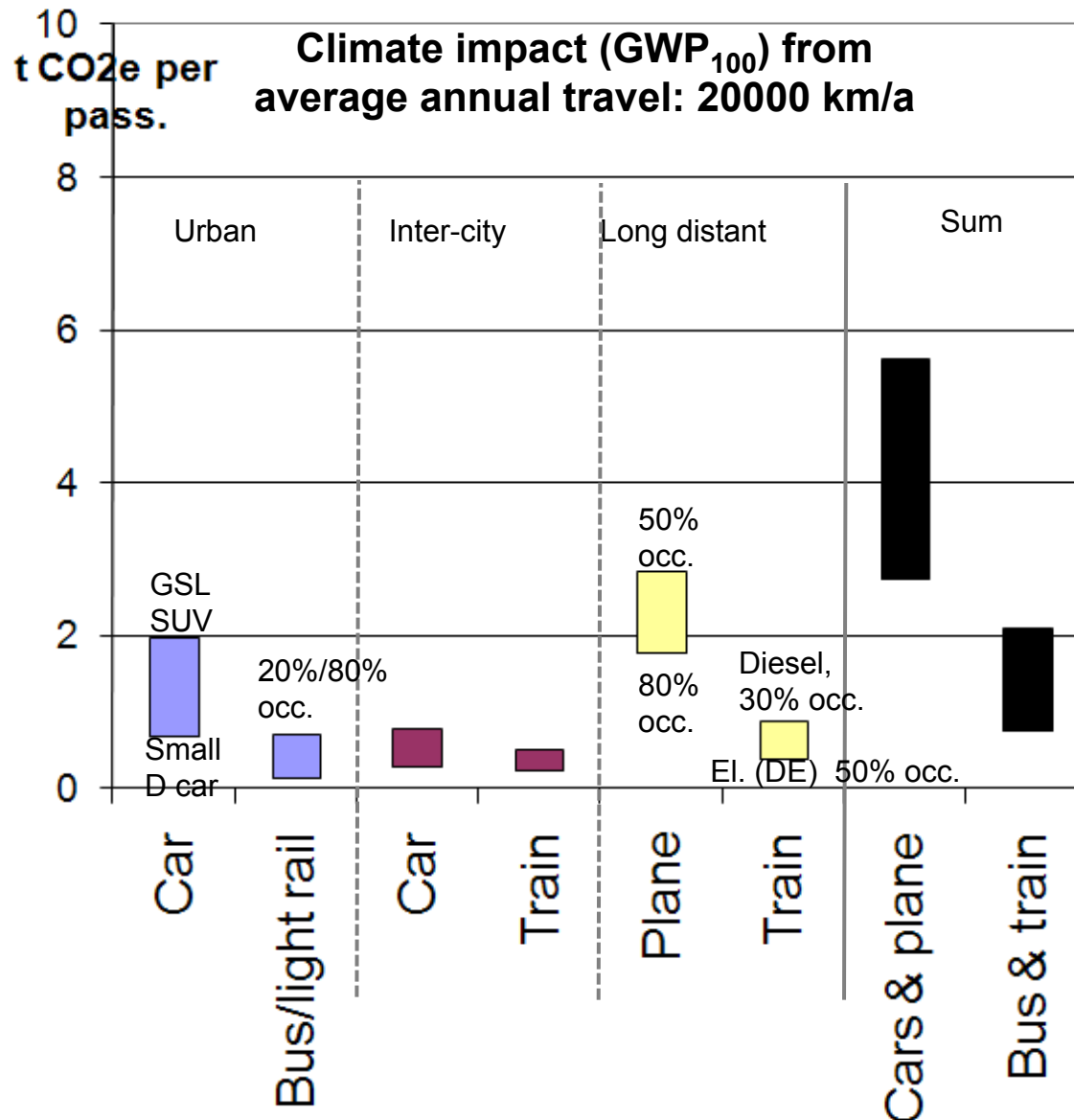
Train: High speed train with German electricity, 50% occupancy;
diesel intercity train with 30% occupancy

Different values on shorter time-scales

Lower rail impact, when more regenerative fuels will be used.



Climate impact from 1 year of travel (European conditions)



Climate travel budget

- urban ~30%
- Long-distance: 50%-60%
- Car & plane: 1.5-3 t CO_{2eq}
- Bus & train: 0.5-1 t CO_{2eq}

Variation: Factors 2-3

Size & occup.: Factor 2

Mode choice: Factor 3

Much higher impact aviation impact at shorter times!

Climate impact from 1 year of travel (European conditions)

Distribution of annual travel budget	
	FREQ. FLYER: 30'000+60'000 km/a
Urban	100 days * 50 km
Intercity	50 days * 500 km
Long-dist.	20 times * 3000 km

Compare the following vehicles for their climate impact (GWP_{100})

Car: Small diesel car (Euro 4) or Gasoline SUV (Euro 4),

Plane: Airbus A320 with occupancy of 80% (high) or 50% (low)

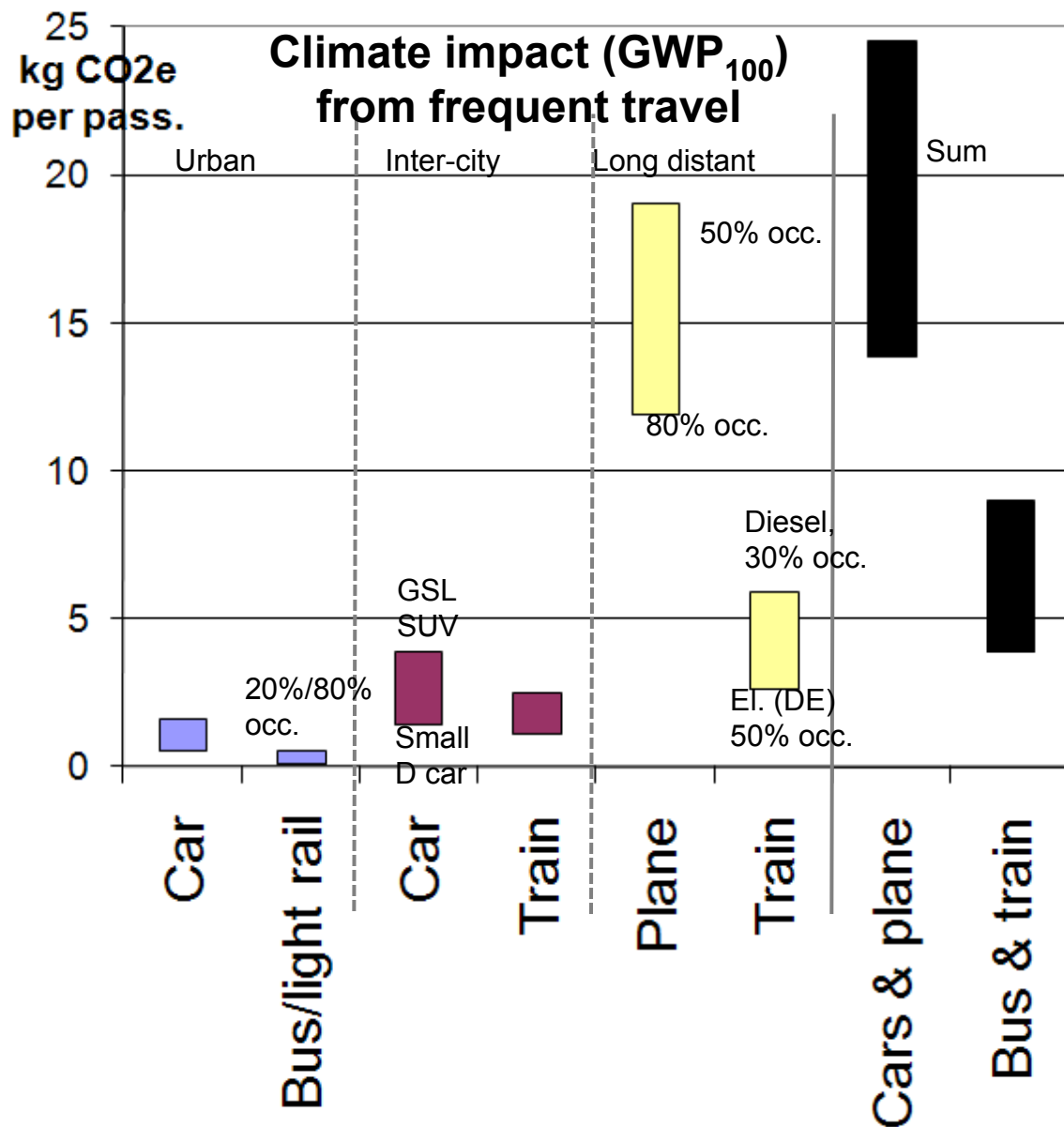
Train: High speed train with German electricity, 50% occupancy;
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Different values on shorter time-scales

Lower rail impact, when more regenerative fuels will be used.



Climate impact from 1 year of travel (European conditions)



Climate travel budget

- urban <10%
- Long-distance: 75%-85%
- Car & plane: 14-25 t CO_{2eq}
- Bus & train: 4-9 t CO_{2eq}

Variation: Factor 2-3

Size & occup.: Factor <2

Mode choice: Factor 3

**Much higher impact
aviation impact at shorter
times!**

Summary

Climate impact per passenger-kilometer

- **Rail** << **Road/Air** (all times & metrics)
- **Air** travel approaches **car travel** (at longer times scales)
- Little difference between modern gasoline or diesel cars, **vehicle size** and **fuel efficiency** are crucial.
 - Specific impacts strongly depend on occupancy

Variation between modes:

- Factor 2 reduction potential for **current cars** available today
- Factor 3 reduction possible, when **bus and trains** used instead
- Biggest reduction potential in **long-distance** and **urban travel**.

Further needs / work:

- Calculate climate impact per region
- Personalise climate travel account

