“Fuel saving by light-weighting for European articulated trucks“

Brussels, 6 December 2005

Hinrich Helms

IFEU - Institute for Energy and Environmental Research Heidelberg

hinrich.helms@ifeu.de

www.ifeu.de

Overview

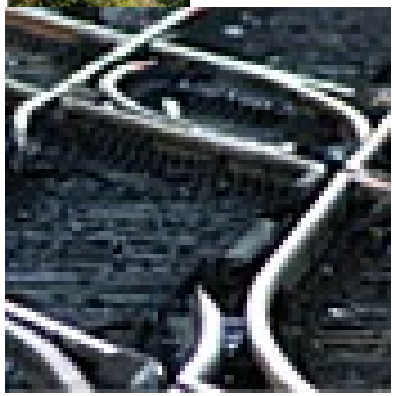
- **Background on energy savings by light-weighting**
  - Energy consumption and resistance factors
  - Specific and life-time energy savings
- **Energy savings for articulated trucks**
  - Modelling fuel consumption
  - Fuel consumption and fuel savings in different situations
  - Average fuel savings for a typical European articulated truck
- **Conclusions**

Hinrich Helms www.ifeu.de

IFEU Company Profile

IFEU = Institute for Energy and Environmental Research Heidelberg, since 1978

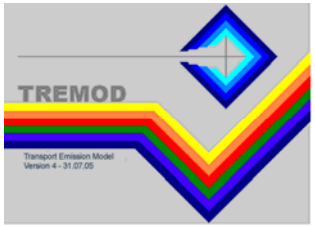
- Independent science
- organised as a private not-for-profit company
- with about 40 scientists



Department: Transport and Environment

Since 1983: Scientific and consultancy work on environmental impact of all transport systems:

- **Inventories**
- **Scenarios**
- **Comparisons**
- **Impact**



TREMOD: Official data base for German emission reporting

For more information visit: www.ifeu.de

Background on fuel savings by light-weighting

Energy consumption of road vehicles

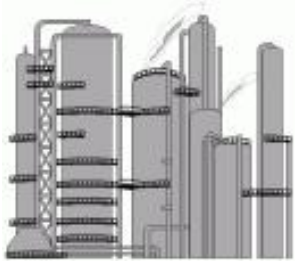
- **The total energy consumption occurs at different levels:**

Energy consumption at the wheel (Physical resistances)

+

Energy losses in the vehicle (Engine and transmission)

+

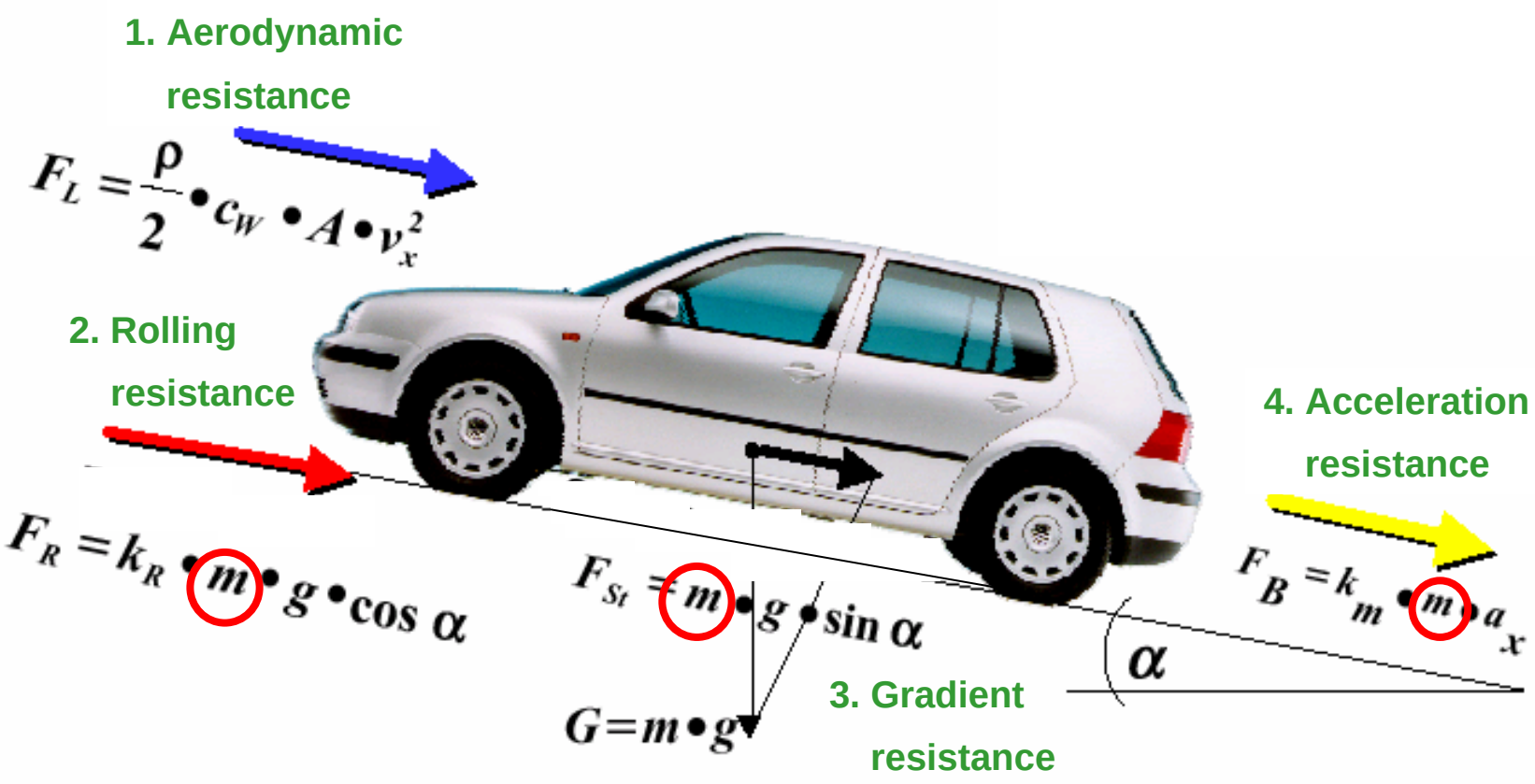


Energy consumption of fuel production (Refineries, Distribution)

A reduction in weight reduces energy consumption at the wheel of the vehicle and therefore also of upstream processes

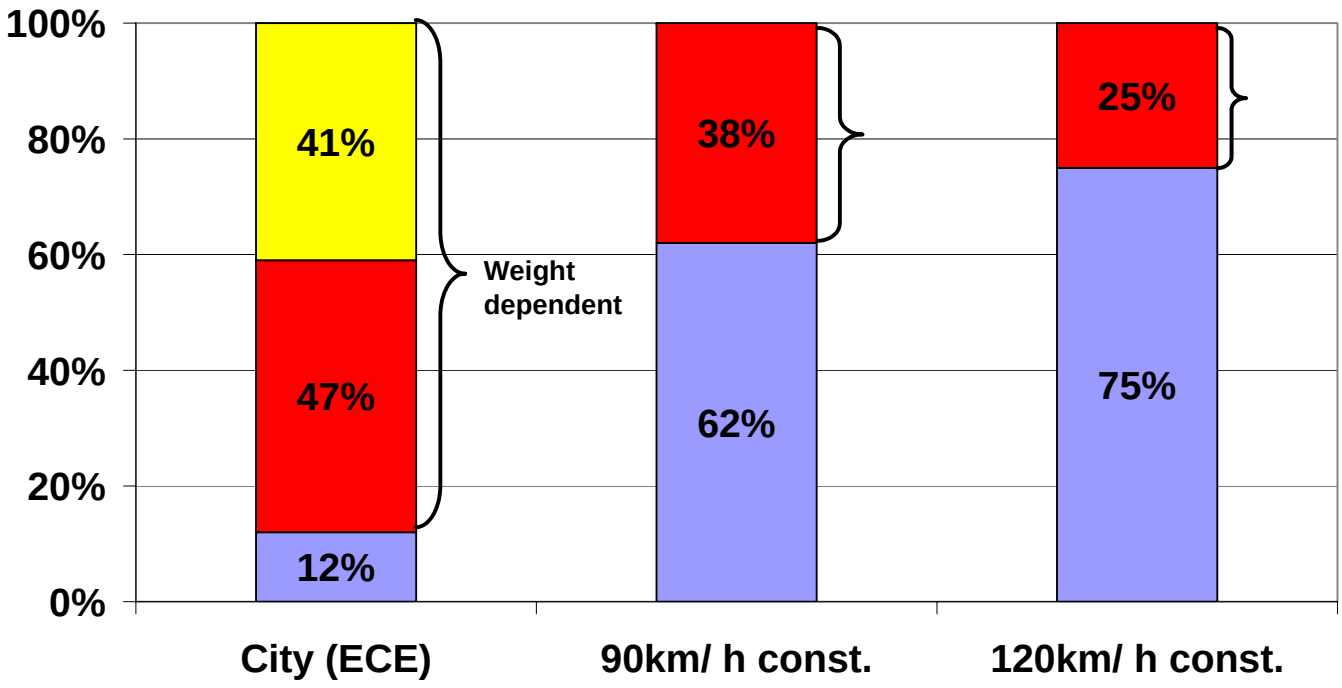
Resistance factors

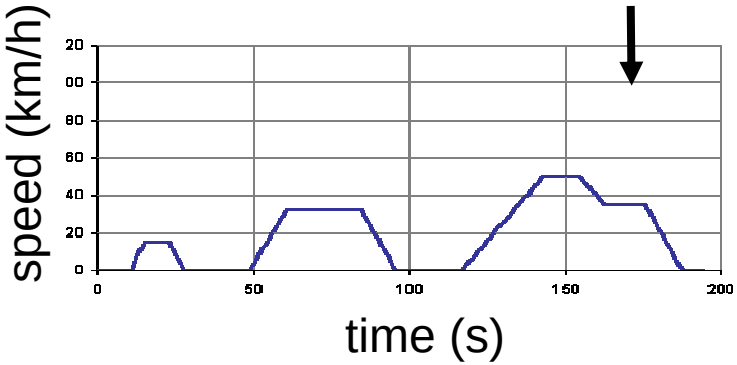
$$F_{Wi} = F_R + F_L + F_{St} + F_B$$



Source: Volkswagen AG

Resistance factors





Hinrich Helms www.ifeu.de

Specific energy savings

- **With the exception of aerodynamic resistance, all resistance factors are linear and depend on the mass of the vehicle**
- **The correlation between energy consumption at the wheel and vehicle weight is therefore linear**
- **Specific energy savings at the wheel for a 100 kg weight reduction are therefore independent of the vehicles weight level**
  - **High savings: Slow vehicles with frequent accelerations (urban traffic); all vehicles on uphill roads**
  - **Low savings: Fast vehicles with steady speed on level roads**

Hinrich Helms www.ifeu.de

Life-time energy savings

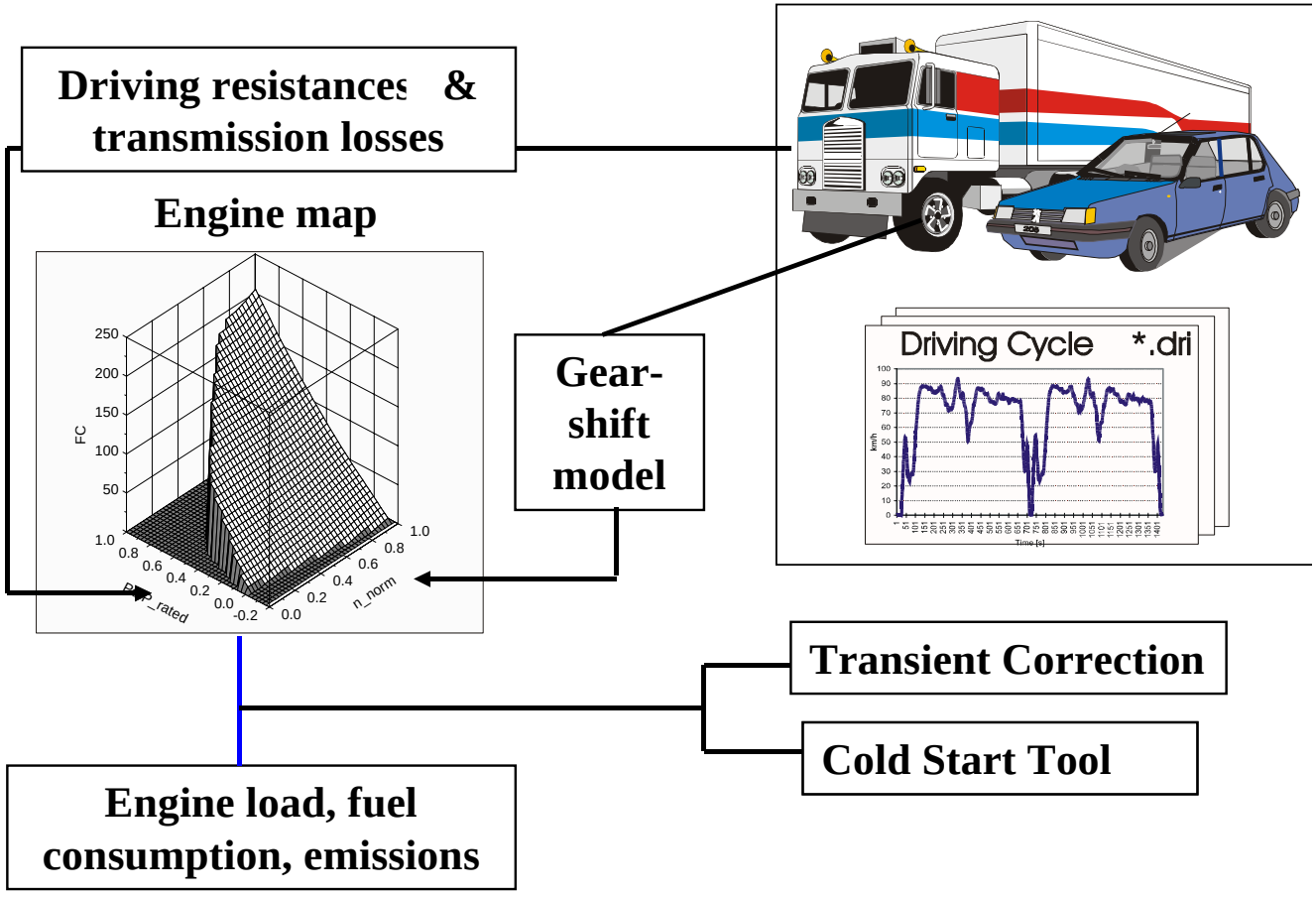
- **A weight reduction leads to fuel savings over the whole operational life of a vehicle**
- **The life-time mileage depends on factors such as:**
  - **Vehicle use (commercial vs. private)**
  - **Road conditions**
  - **Durability of vehicles**
  - **Etc.**

Fuel savings for articulated trucks

Modelling fuel consumption of articulated trucks

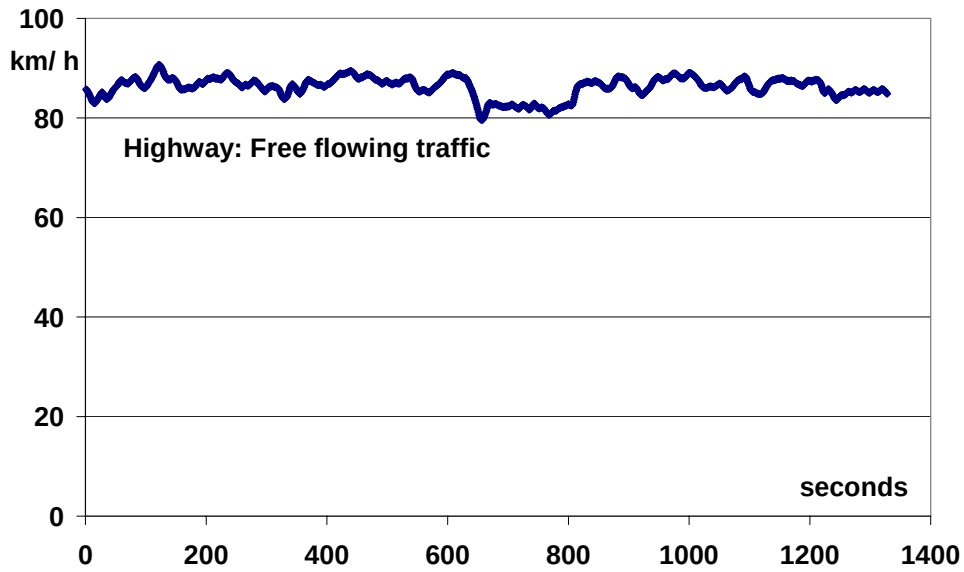
Differentiated modelling has been undertaken and analysed by IFEU in cooperation with the Technical University of Graz:

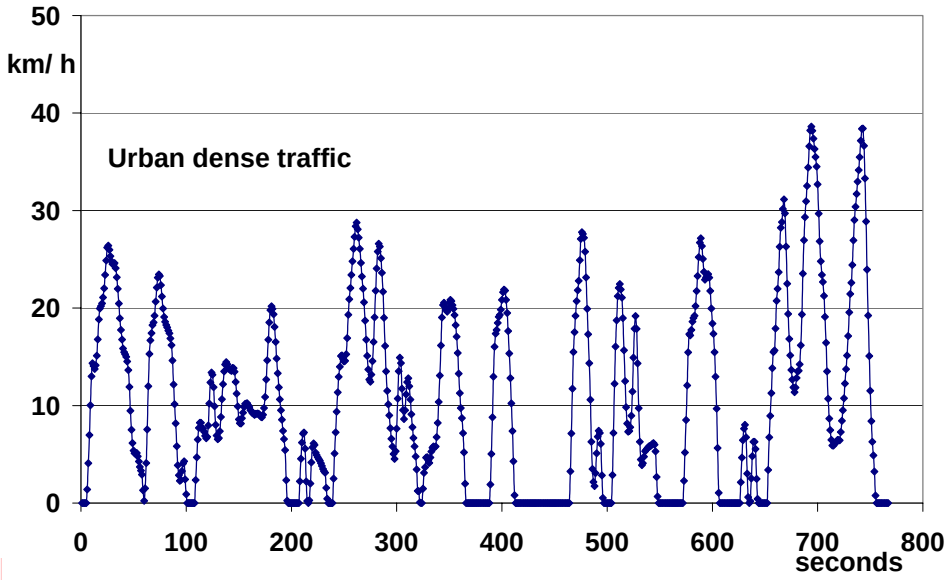
- **"Passenger car and Heavy duty vehicle Emission Model" (PHEM Model)**



Hinrich Helms www.ifeu.de

Modelling fuel consumption (Traffic situation examples)

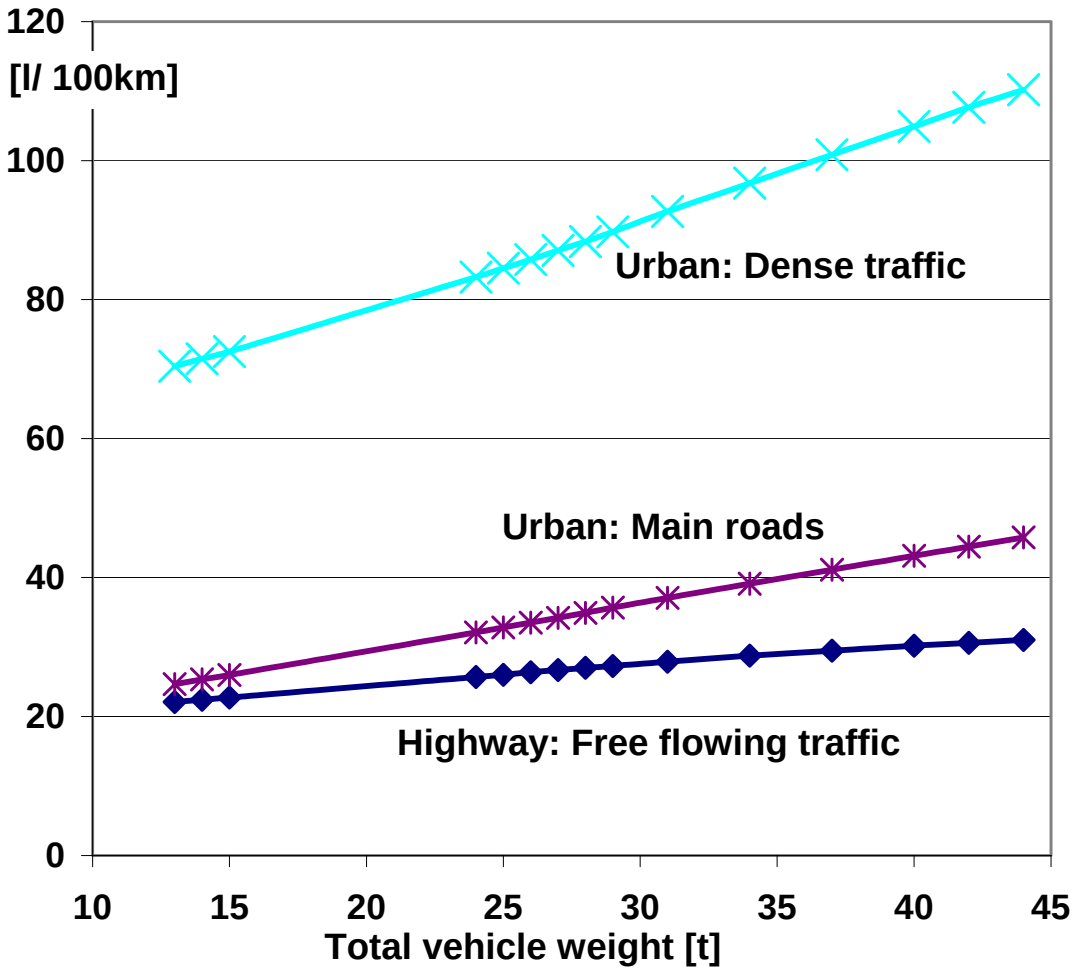




- Different traffic situations and case studies
- Variations in vehicle weight
- Different road grades (up to +/- 6%)

Hinrich Helms www.ifeu.de

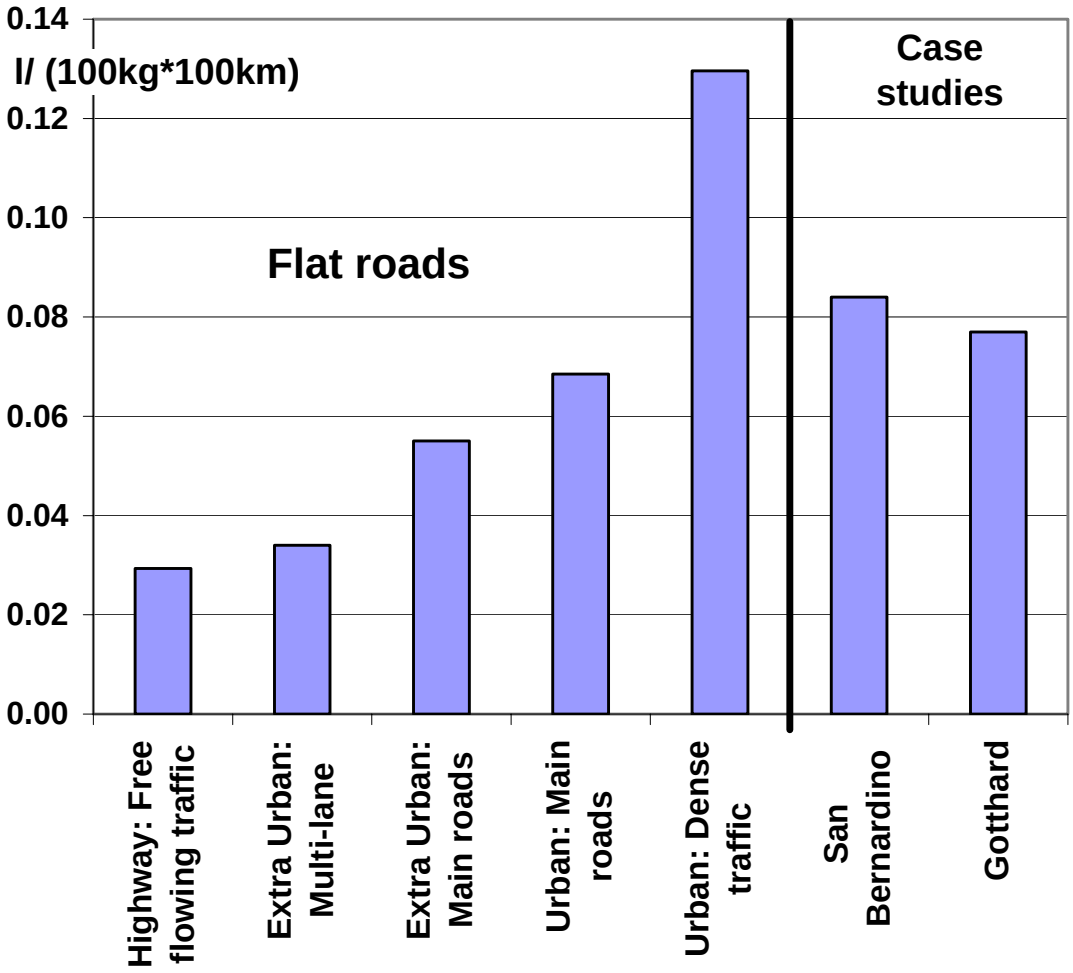
Fuel consumption per 100km (Examples)



- **Level of fuel consumption depends on traffic situations**
- **Grades indicate level of fuel savings by weight reduction**

Hinrich Helms www.ifeu.de

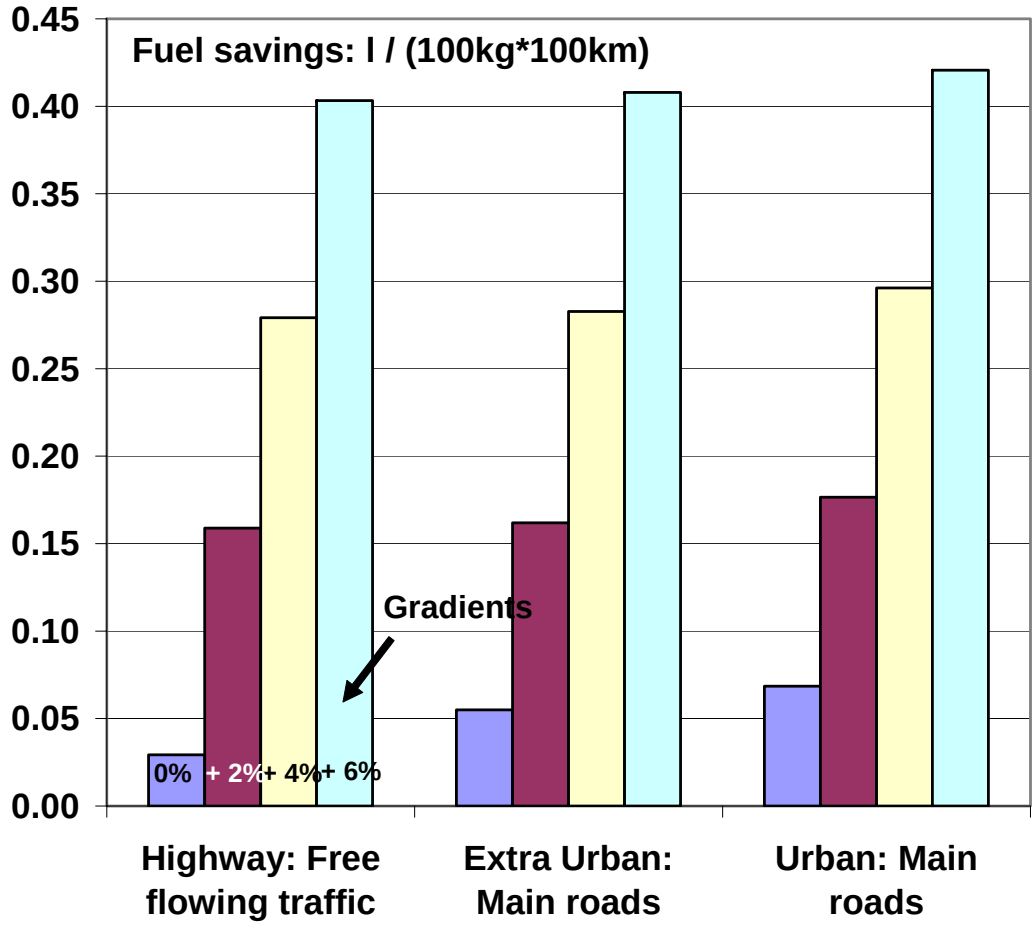
Fuel savings for a 100kg weight reduction (Examples)



- **Fuel savings increase from highways to urban areas**
- **High savings on transalpine routes (case studies)**

Hinrich Helms www.ifeu.de

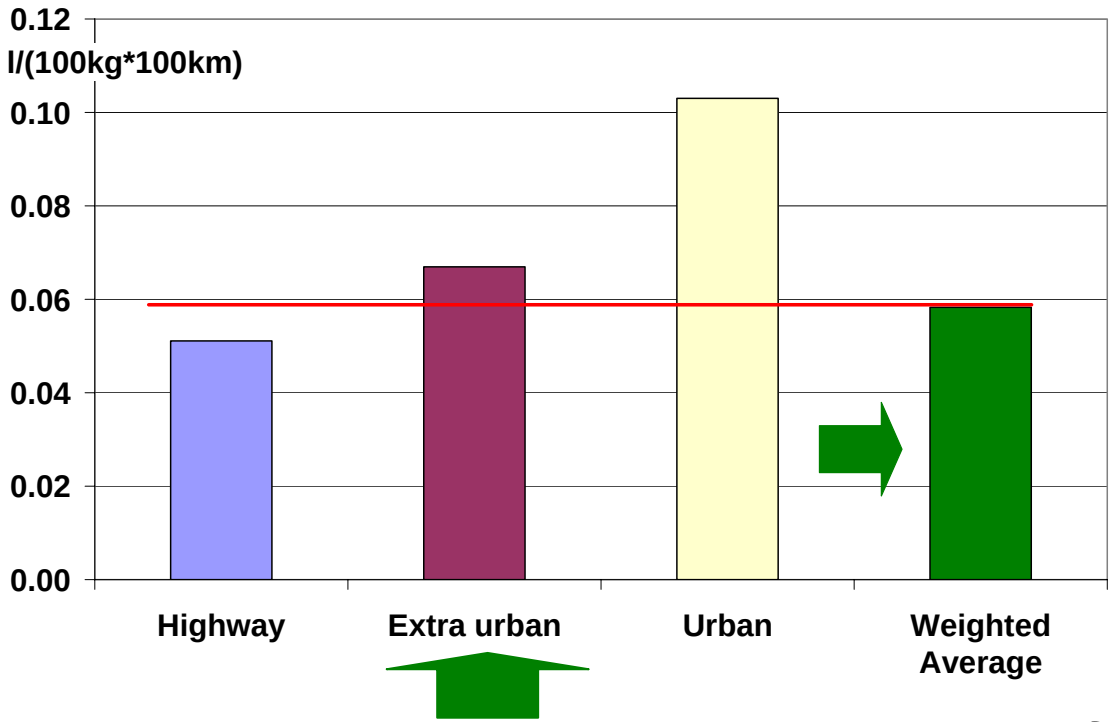
Fuel savings for different road grades (Examples)

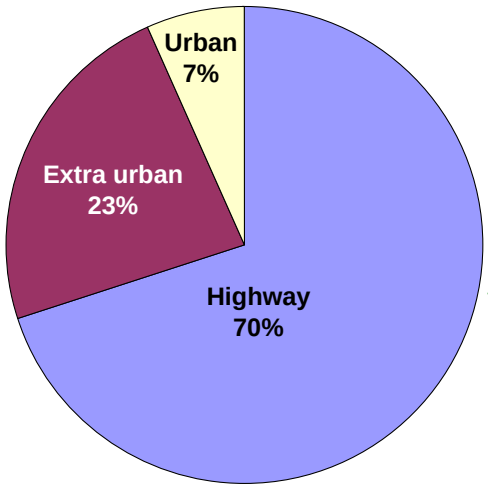


- **Up to 10x higher savings for uphill roads (+6%)**
- **No savings on downhill roads**

Hinrich Helms www.ifeu.de

Average fuel savings for articulated trucks





Average fuel savings consist of fuel savings for different traffic situations

Share of road categories on truck mileage

Hinrich Helms www.ifeu.de

Conclusions

- **Reliable data have been derived for the fuel savings of a typical European articulated truck by light-weighting**
- **Specific fuel savings for a 100kg weight reduction vary according to traffic situation and road gradient**
- **Average primary fuel savings for a weight reduction of 100kg are about 0.06l per 100 km**
- **Considerable use-stage fuel savings due to a high life-time mileage of articulated trucks (often over 1 Mio. km)**
- **Use-stage primary CO_2 savings of around 2t for a weight reduction of 100kg and a life-time mileage of 1.2 Mio. km**
- **CO_2 savings related to increased payload are not taken into account here but will be considered in the next speech**

Thank you for your attention!

Any questions?

Hinrich Helms

Institute for Energy and Environmental Research Heidelberg

hinrich.helms@ifeu.de

www.ifeu.de