InLCA/LCM conference 2006

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Alternative fuels – a major step towards a sustainable road transportation of tomorrow?

Challenges and potentials from a life cycle perspective ?

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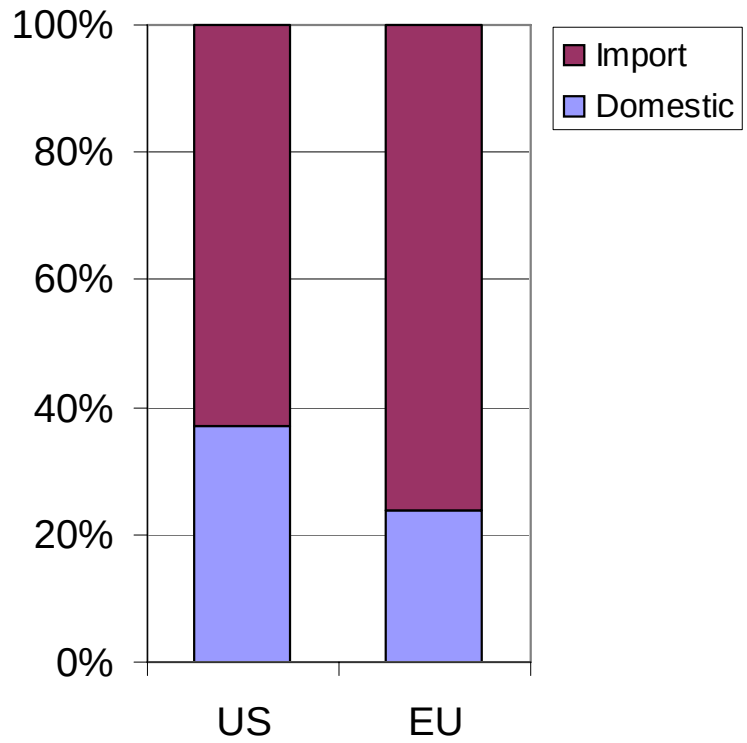
INNOVATION AND EFFICIENCY

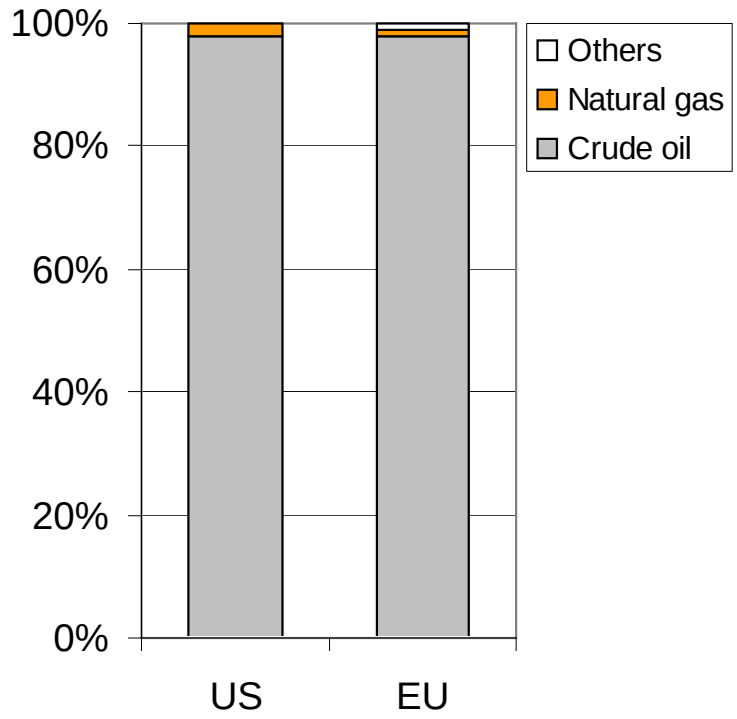
Introduction

Road transport fuels by source



Source: EU: DG TREN, 2005

Crude oil supply by origin



Source: EU: IEA: Oil information 2004

Introduction

Need for alternatives

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Alternatives need to address the following aspects

- Broadening the used energy carrier mix
- Reduce import dependency
- Reduce usage of non renewable resources
- Reduce environmental burdens connected to their use

→ What is the “best” solution?

Evaluation methodology

Requirements

- Consideration of the complete system transport, not only use of fuel, but also fuel supply + vehicle manufacturing + vehicle EoL

- Consider not only primary energy demand and GHG emissions but also other harmful emissions and environmental impacts from traffic

- Consider regional boundary conditions (origin of resources, operation of transport system)

Life Cycle Assessment

From Cradle-to-Grave

Life Cycle Assessment is a very suitable approach to provide decision support

- ✓ Based on the life cycle approach for evaluating a system, product or service
- ✓ Standardised methodology (DIN ISO 14044)
- ✓ allows consideration of a multitude of emissions/ environmental effects

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Exemplary LCA results - CUTE

Approach

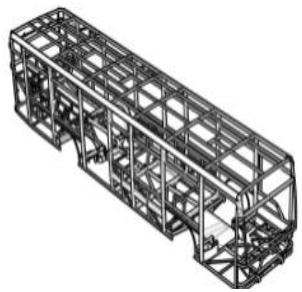
Fuel




benefication → production → operation → end of life

Two main areas defining environmental profile of **all** bus systems:

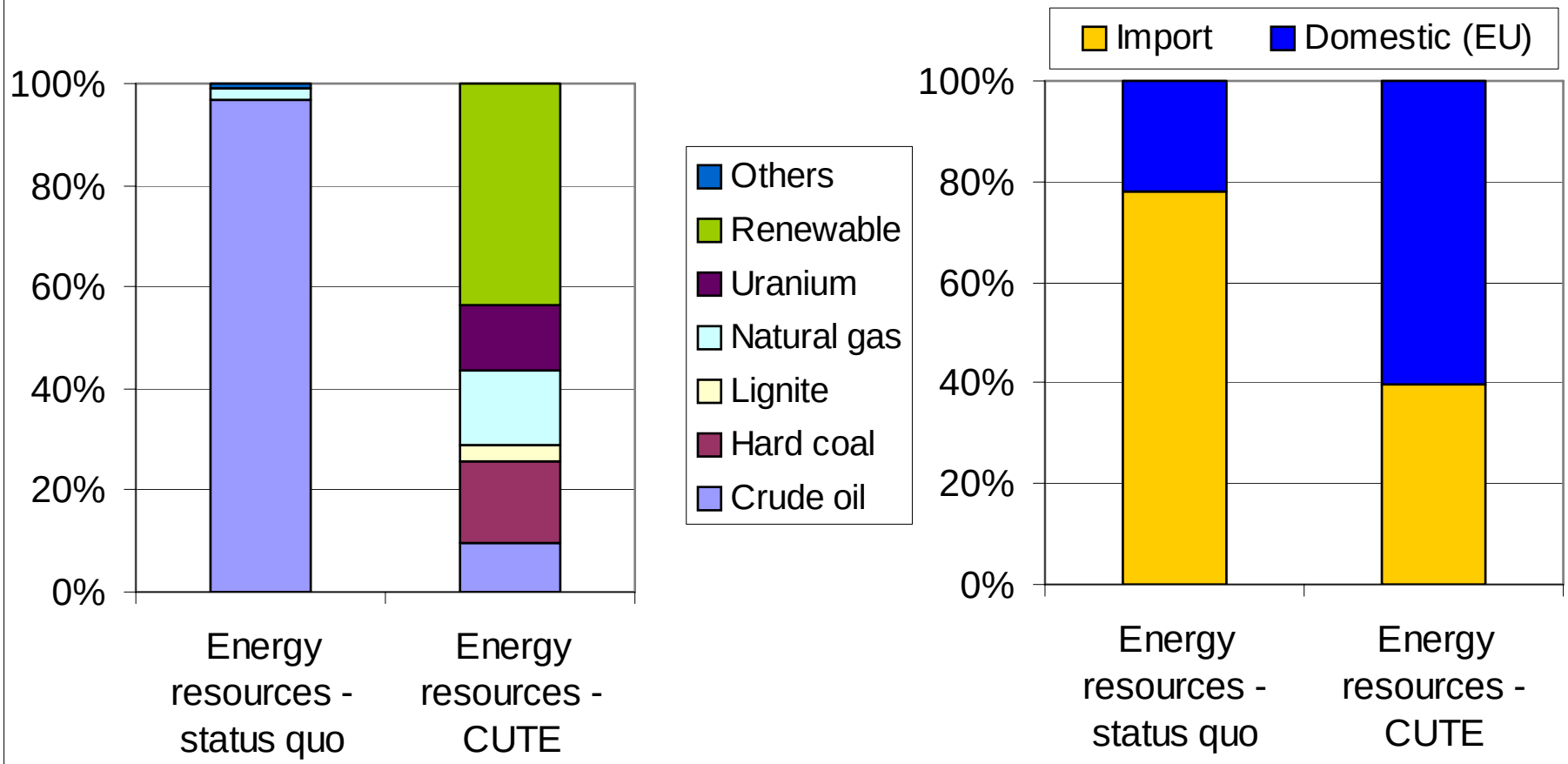
- Fuel supply
- Fuel consumption + emissions during operation

benefication → production → operation → end of life

Exemplary LCA results - CUTE

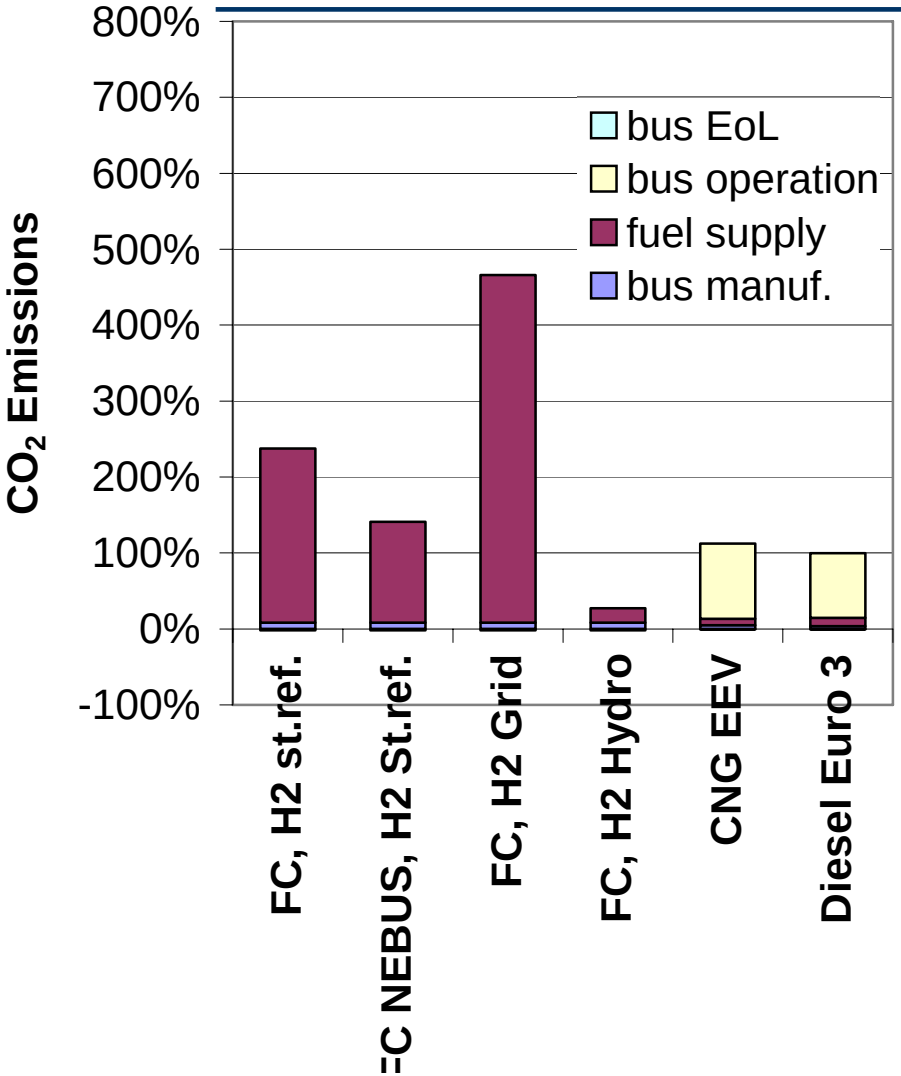
Energie mix

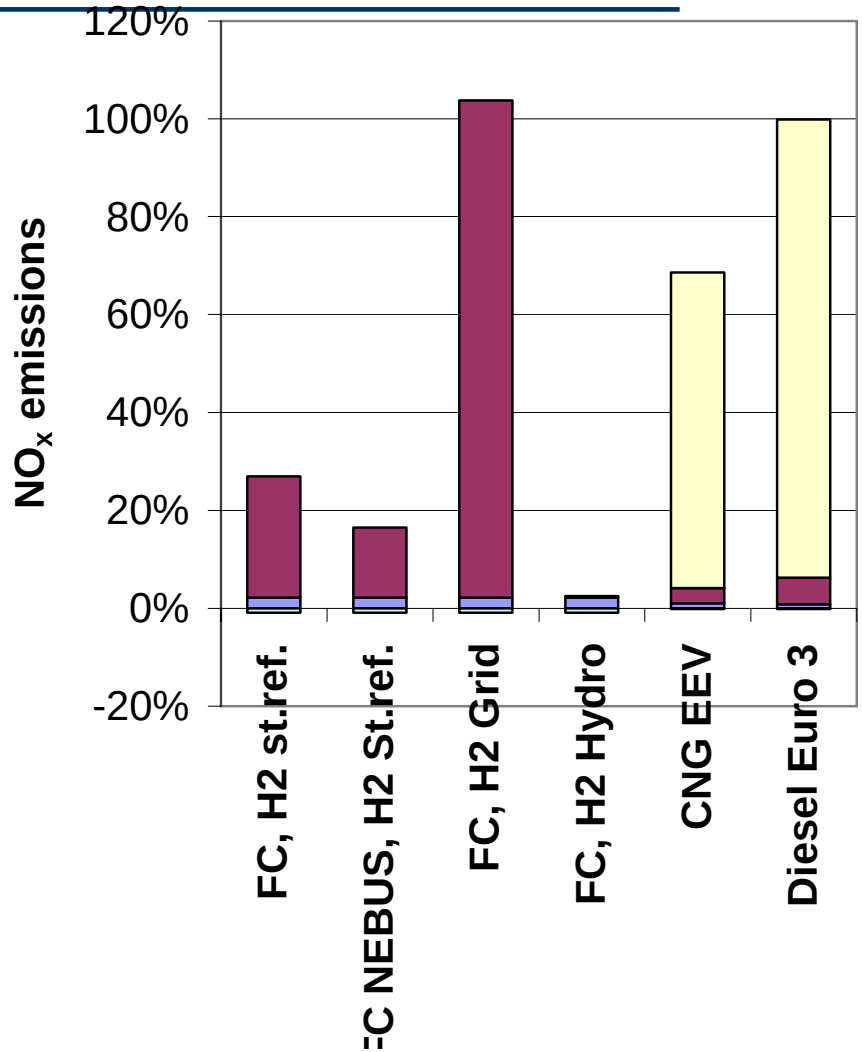


- Share of renewable energies used in the CUTE project increased from ~1% to 44%
- Share of imported energy carries reduced from 78% to 39%

Exemplary LCA results - CUTE

Life cycle





- Shift of emission location
- Emission free operation → improvement of air quality in congested urban areas

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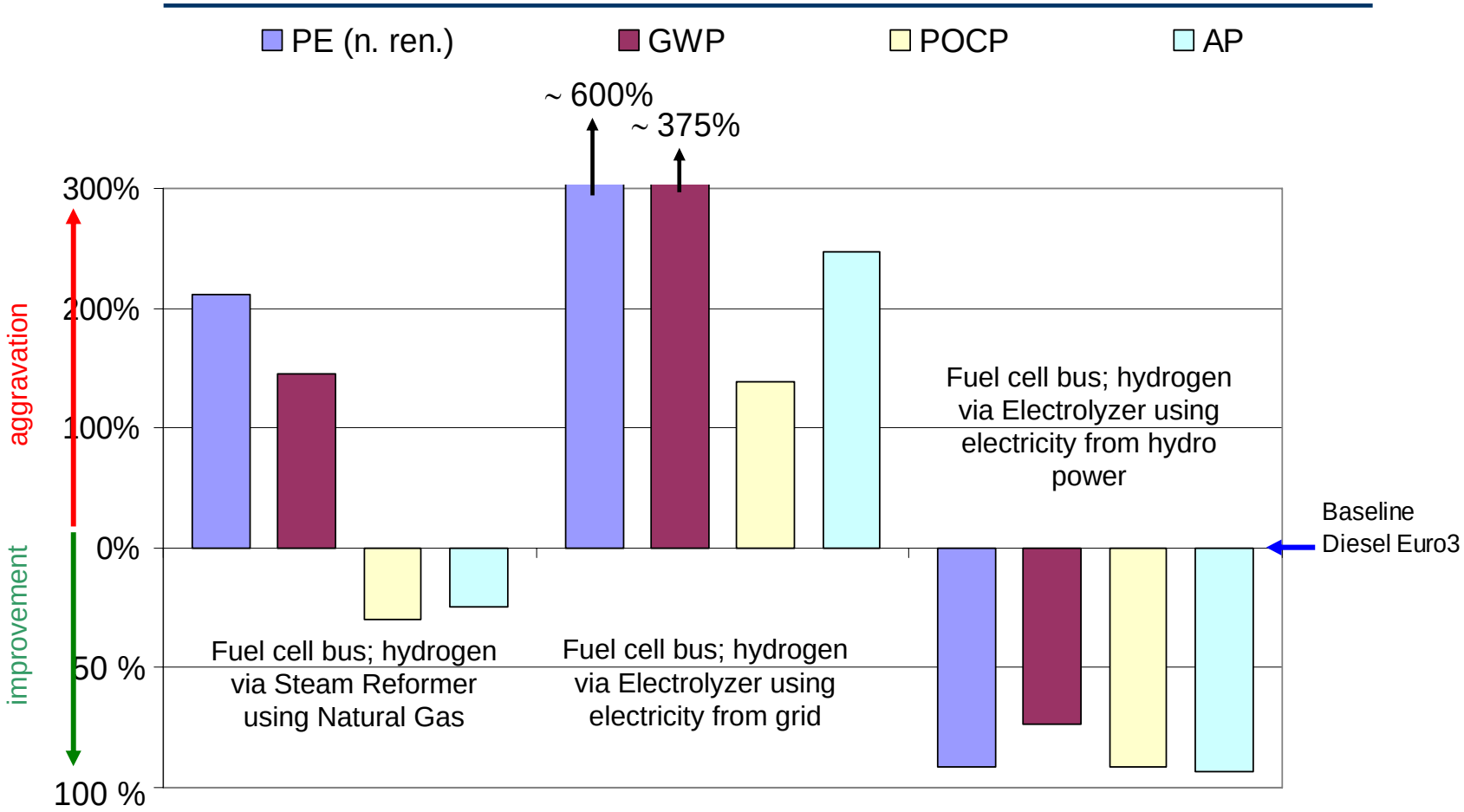
Exemplary LCA results - CUTE

Comparison of Diesel with FC bus system



Exemplary LCA results - CUTE

Comparison of Diesel with FC bus system

The main findings of the conducted LCA:

- the H_2/FC bus systems contribute to improved air quality in congested urban areas by featuring an emission free operation,
- the environmental profile is highly dependant on the H_2 supply route and on the overall efficiency of the whole system
- the usage of renewable energy carriers (e.g. hydro power, biomass)
  - will address the Kyoto commitments and
  - contribute to an increased sustainability in the (public) transport sector by using domestic energy carriers.
- in terms of local environmental effects (e.g. summer smog caused by NOx and HC emissions from traffic) the H2/FC system shows already today its advantages
- regional boundary conditions for the supply of energy carriers such as natural gas or electricity are decisive for the environmental profile of the whole system

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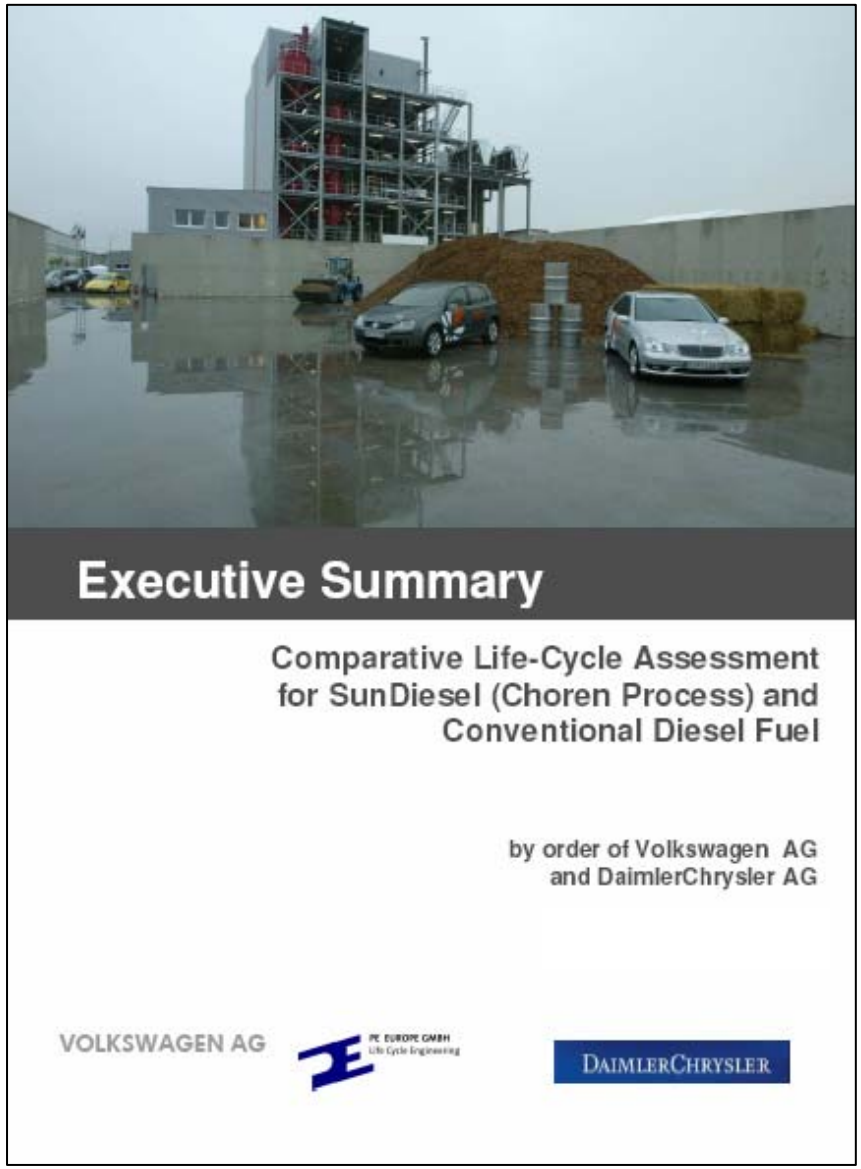
Exemplary LCA results - SunDiesel

Comparison of Synthetic Diesel from biomass and conventional diesel



- Fischer Tropsch Diesel via gasification of biomass (wood) using the CarboV process
- Handed over to the German Federal minister of food and agriculture by the heads of R&D of DaimlerChrysler and Volkswagen AG

Exemplary LCA results - SunDiesel

Approach

- Complete LCA study of the Choren CarboV process (gasification of wood wastes followed by Fischer Tropsch synthesis) to produce Biomass to Liquid (BtL) Diesel
- Conducted with the fuel producer (Choren) and the fuel user (DaimlerChrysler and Volkswagen)
- fuel producer supplied based on questionnaires:
  - general process data
  - detailed process data (mass and energy flows) for a 43 MW plant
- car manufacturers supplied:
  - test bench data on the use of BtL in their vehicles

Exemplary LCA results - SunDiesel

Development of scenarios

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- 3 different scenarios were developed for the large scale BtL production (43 MW plant)

  - self sufficiency (on site production of electricity, hydrogen, oxygen and nitrogen based on biomass)

  - partial self sufficiency (on site production of hydrogen (biomass based), external supply of electricity, oxygen and nitrogen from conventional production)

  - future (electricity, hydrogen, oxygen and nitrogen are produced externally based on renewable resources and delivered to the site)

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Exemplary LCA results - SunDiesel

General conditions and results of the 3 scenarios

	Scenario		
	Future	**Self-sufficiency basis**	**Partial self-sufficiency**
Transportation of wood Forest > Choren Plant	50 km		
Fuel transportation Choren Plant > petrol station	50 km		
Sensitivity analyses	100% standing timber as biomass input Transportation distance, forest-Choren Plant 200 km Transportation distance Choren Plant – petrol station 100 km		
Mass ratio Biomass [kg] to diesel [kg]	≈ 3.4 : 1 (35 % H_2O) ≈ 2.2 : 1 (atro)	≈ 9.3 : 1 (35 %H_2O) ≈ 6 : 1 (atro)	≈ 7.5 : 1 (35 % H_2O) ≈ 4.9 : 1 (atro)
Efficiency Choren Process [%] (Hu Output / Hu Input)	≈ 64 %	≈ 45 %	≈ 55 %
Global warming potential compared with conv. diesel	-91 %	-87 %	-61 %

Exemplary LCA results - SunDiesel

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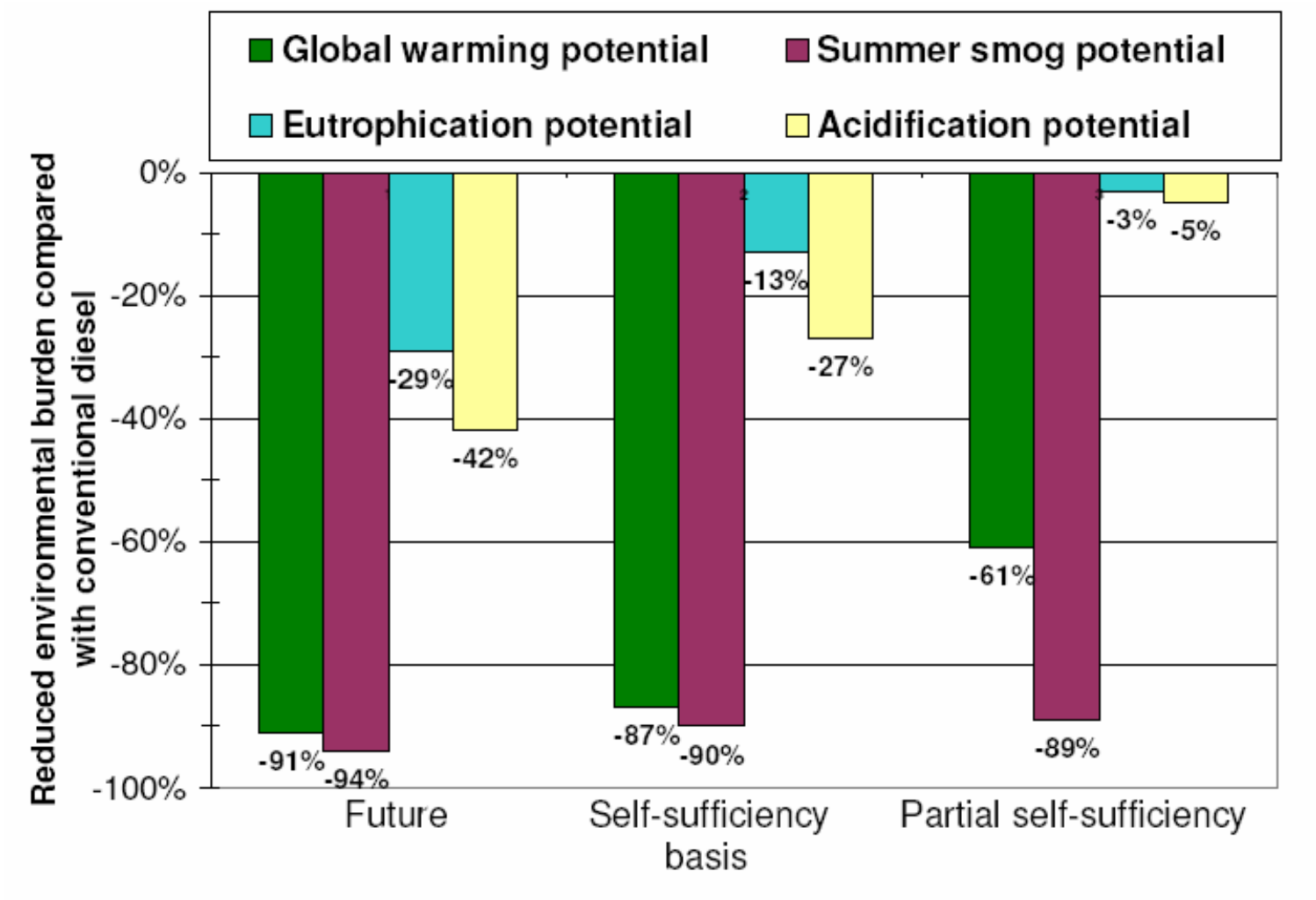
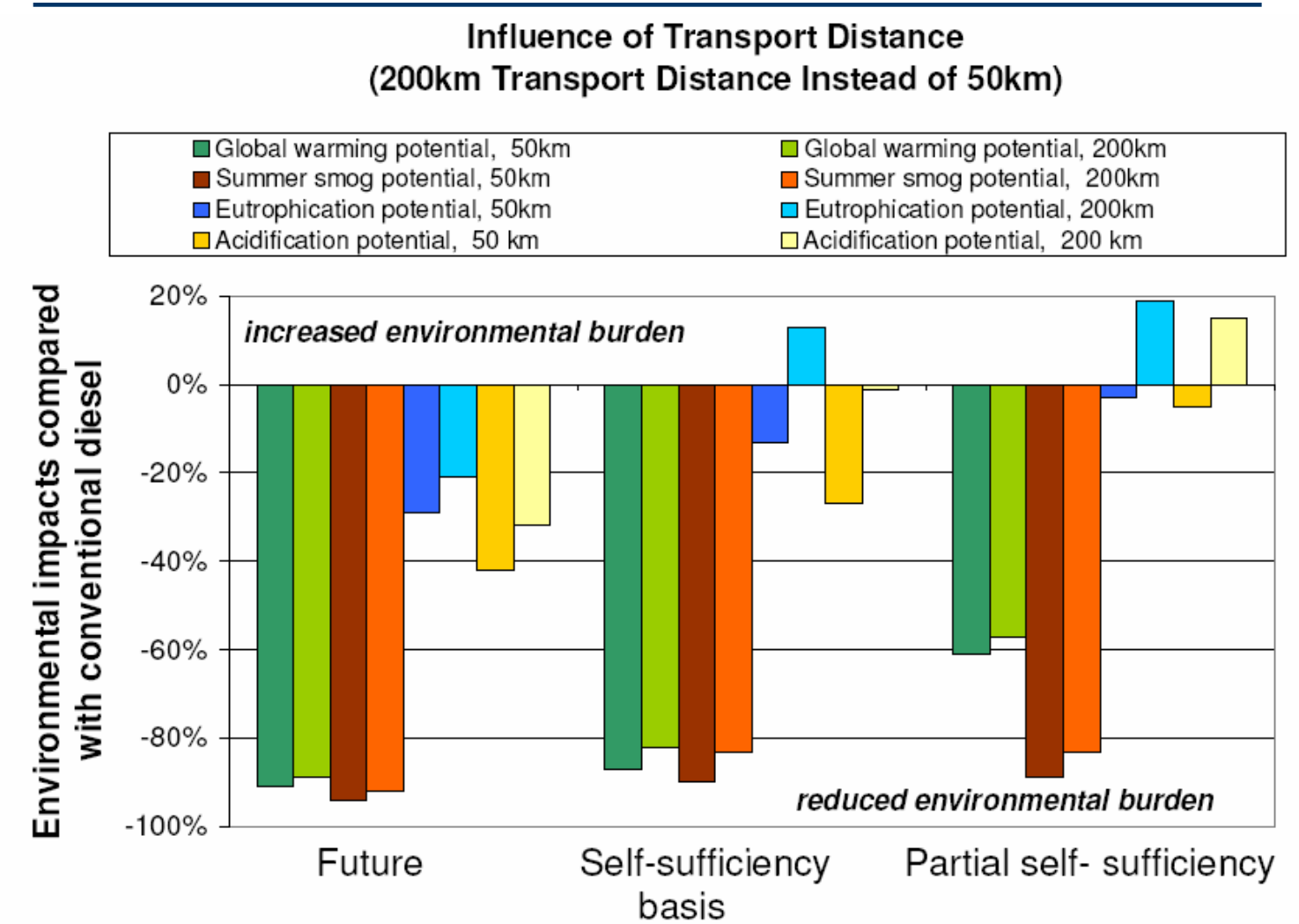
Reduction potential of BtL vs conv. Diesel in the 3 scenarios



- Substantial savings for GWP and POCP
- Savings for AP and EP depending on boundary conditions less clear

Exemplary LCA results - SunDiesel

Variation of transport distance



- Break even points for AP: self sufficiency 120 km
  partial self sufficiency 70 km

Conclusions

- **Alternative fuels/propulsion systems required** to avoid increasing dependency from energy imports and increasing environmental pollution
- Need for **quantitative assessment** of the environmental impact of alternative fuels and propulsion systems in the transport sector
- Essential to **consider the whole life cycle** of a transportation system and not only the operation phase
- **Life Cycle Assessment** appropriate methodology for decision support (quantitative, standardised, transparent, R&D accompanying)
- To ensure that there is no **shift of environmental burdens** between impact categories, it is essential to consider various impact categories
- For fuel supply the **regional boundary conditions**/ the used **primary energy carrier (mix)** and the used conversion technologies are decisive
- **Renewable primary energy carriers** will address the Kyoto commitment, locally relevant emissions (e.g. NO_x, PM) have to monitored
- **Production of transport carriers** becomes more relevant

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Thank you for your attention!

For further information:

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CUTE final brochure: http://www.fuel-cell-bus-club.com/

SunDiesel:

http://www.pe-consulting-group.com/downloads0.html