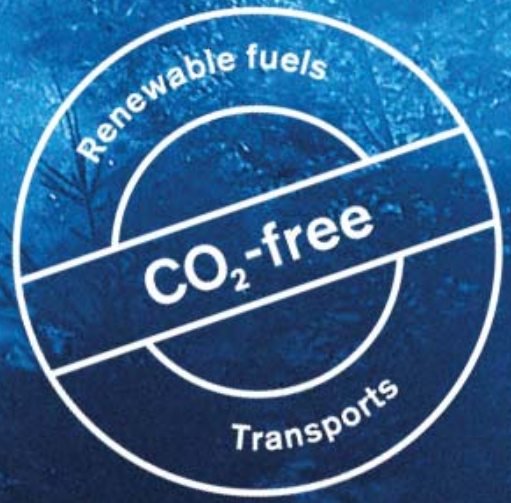
Climate issues in focus



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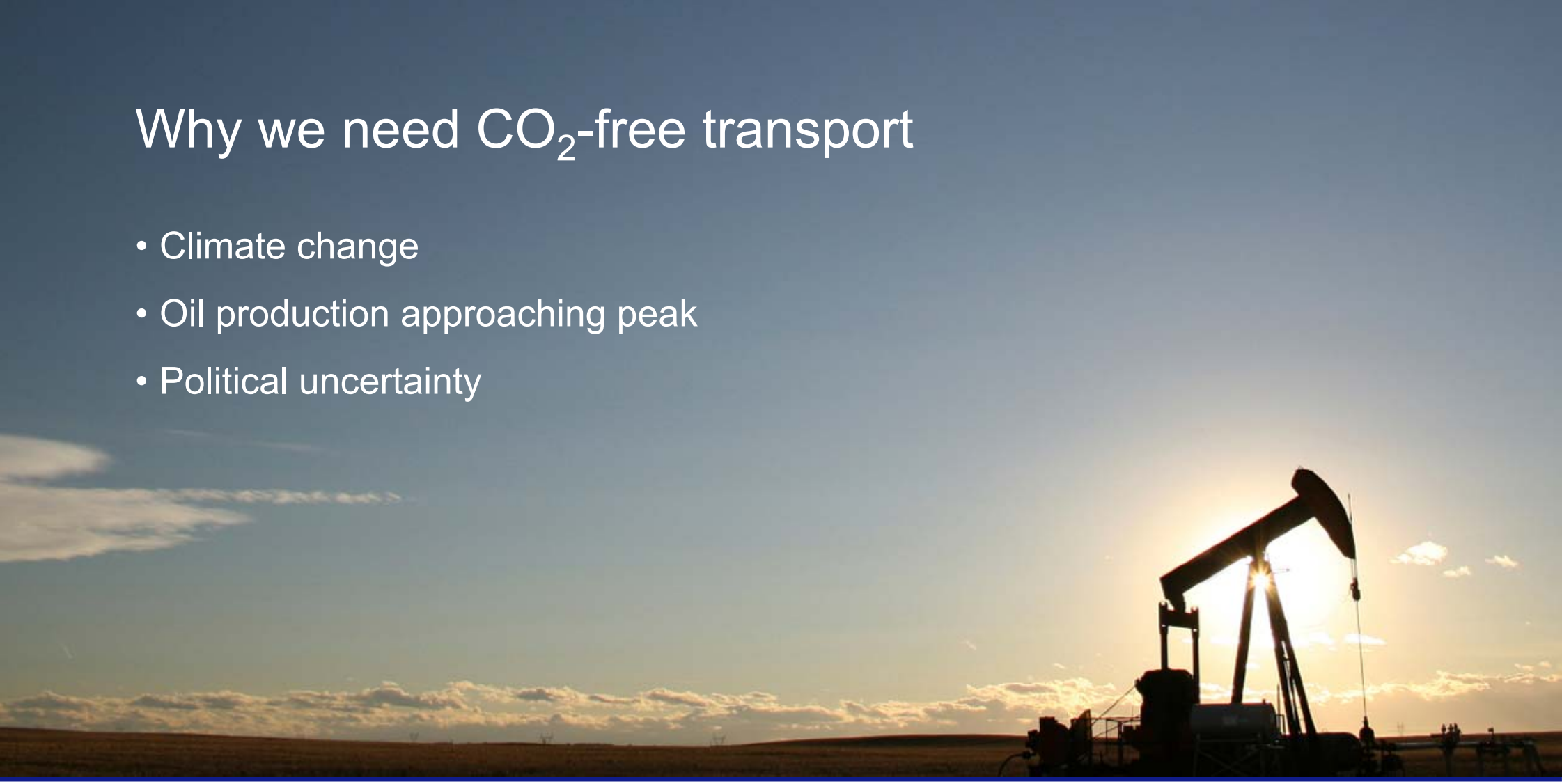
Why we need CO_2-free transport

- Climate change
- Oil production approaching peak
- Political uncertainty



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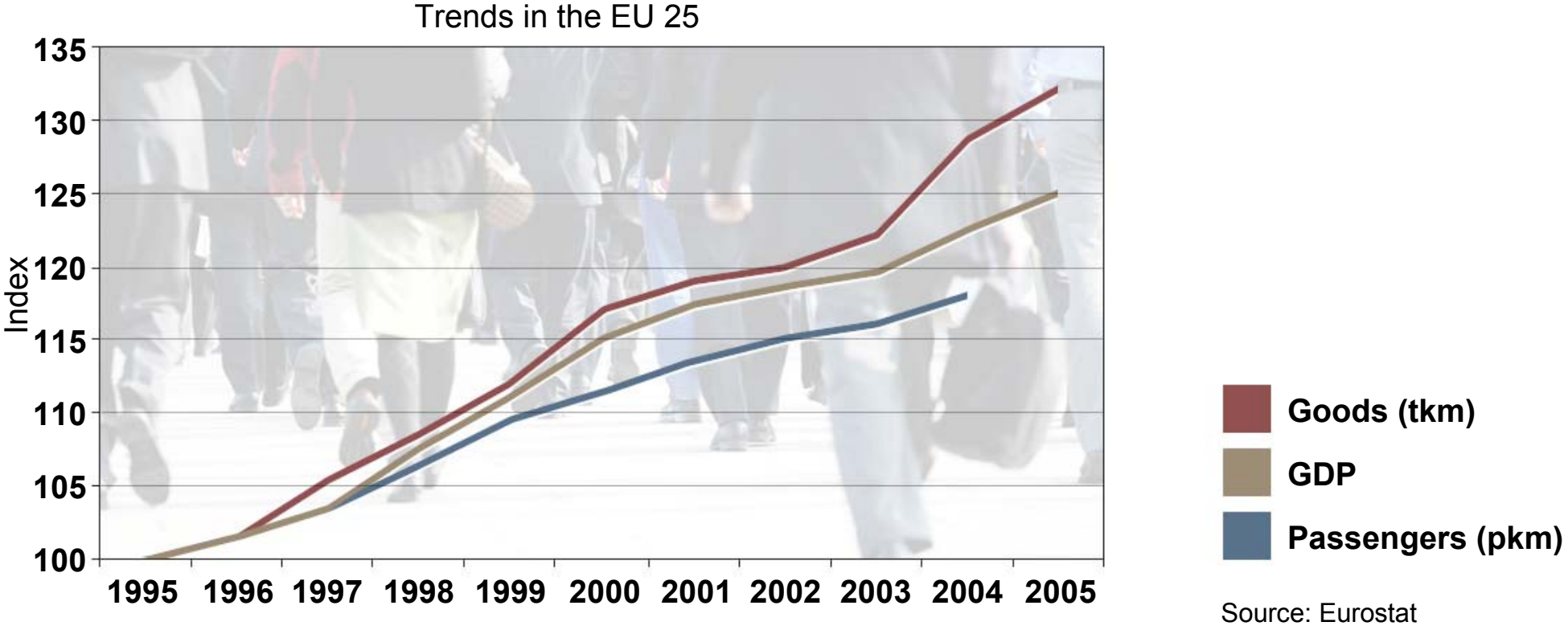
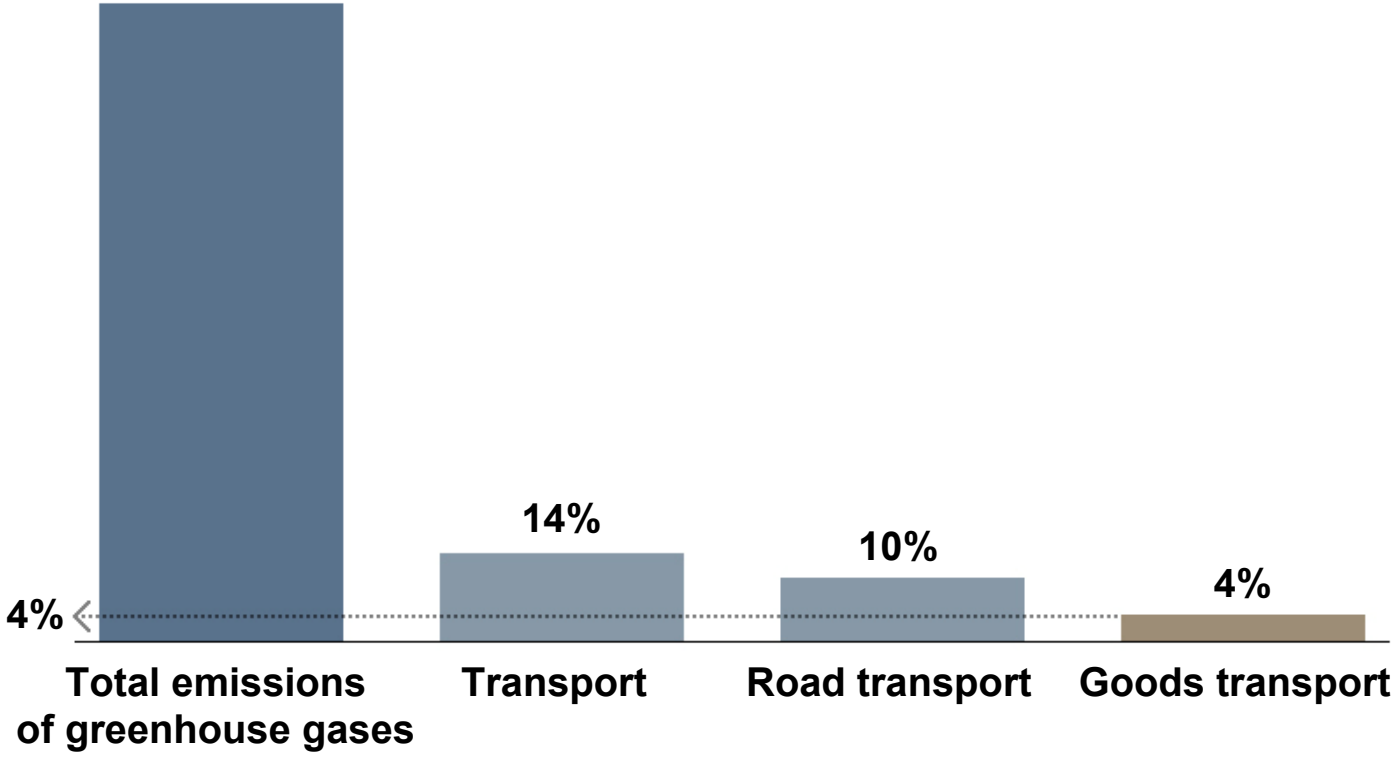
Transport essential for growth



Source: Eurostat

Goods transport by road: about 4% of total emissions

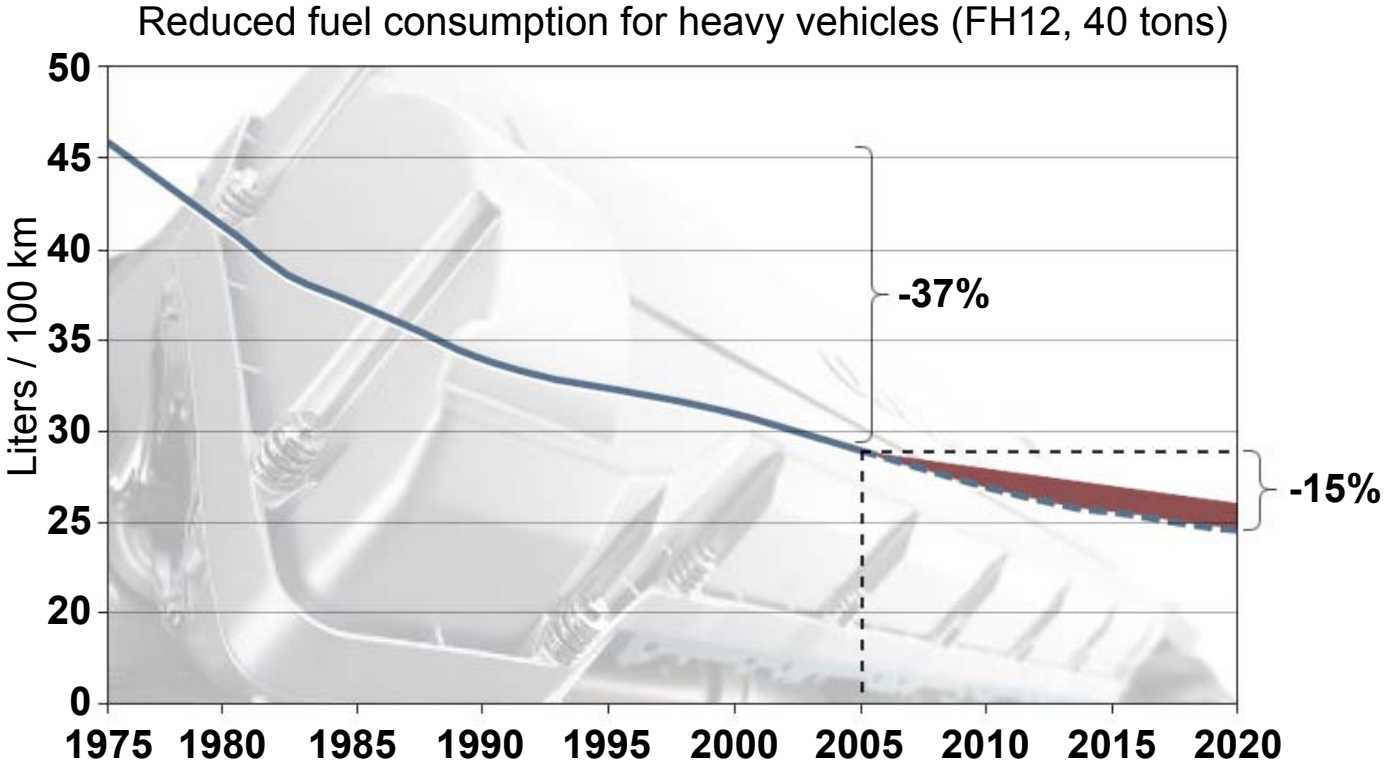


Source:
Stern review: The Economics of Climate Change,
Nature Associates / Volvo

VOLVO

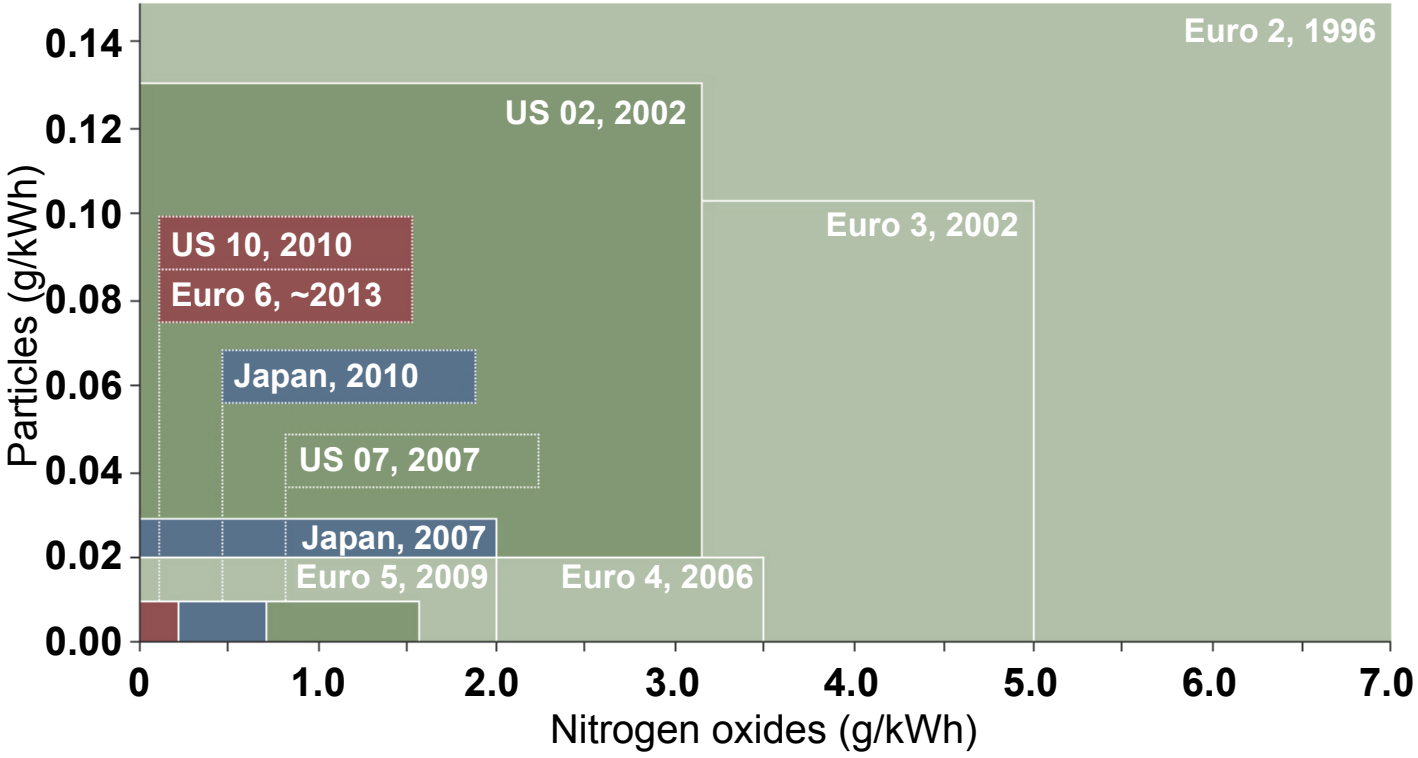
Reduced fuel consumption and environmental impact – a good deal for our customers

The diesel engine – highly efficient technology



Source: Volvo Trucks

Emissions of particles and nitrogen oxides from new vehicles – approaching zero



Source: EMA, JAMA, ACEA

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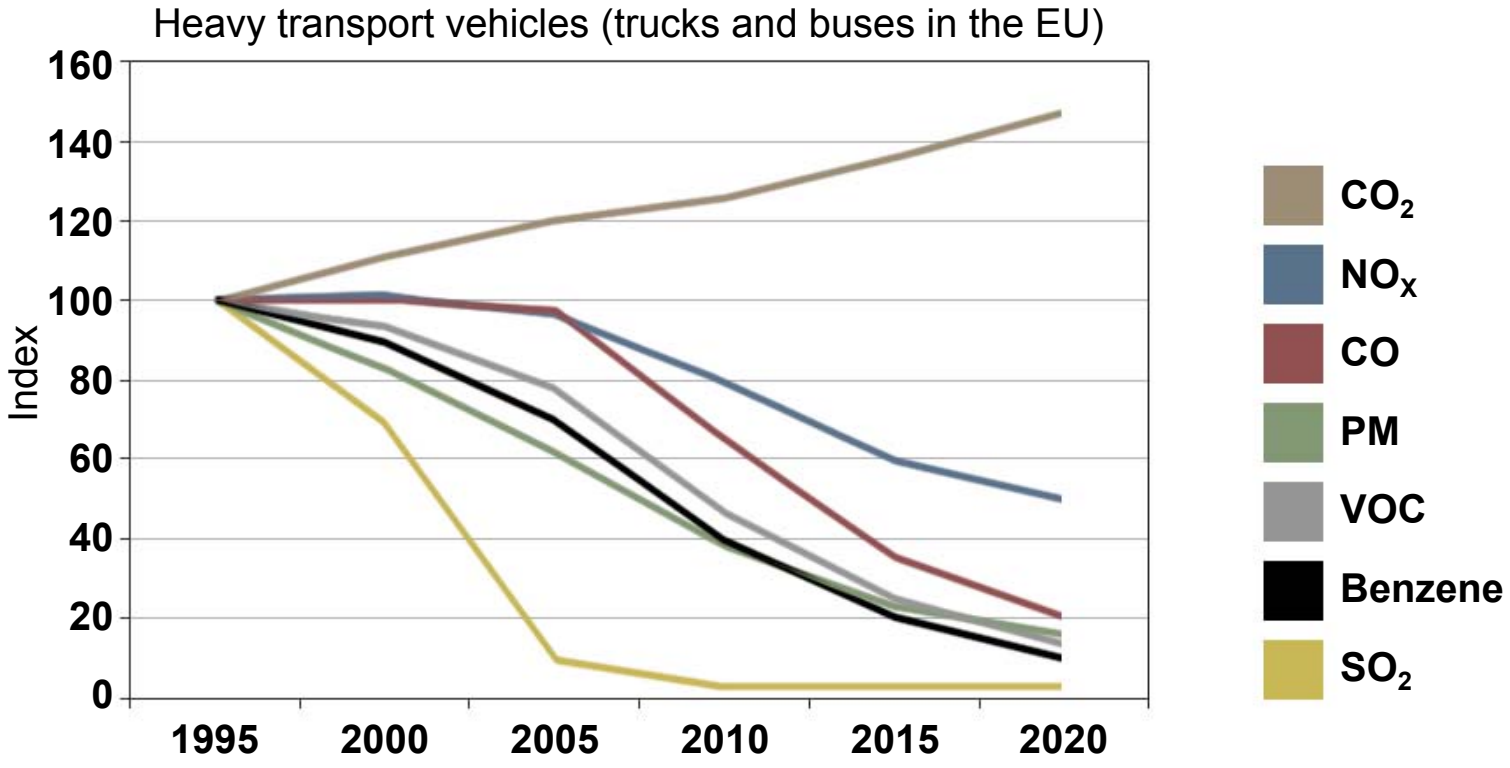
CO_2: our No. 1 challenge



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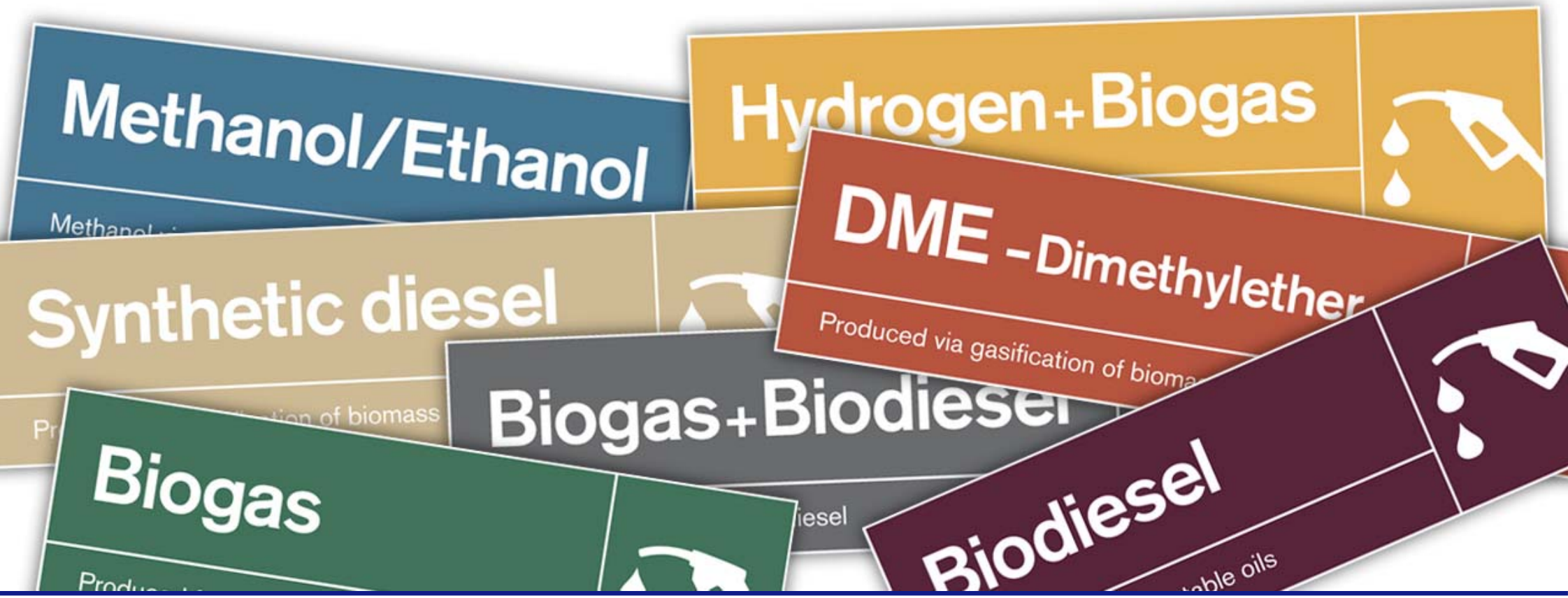
The diesel engine has great potential



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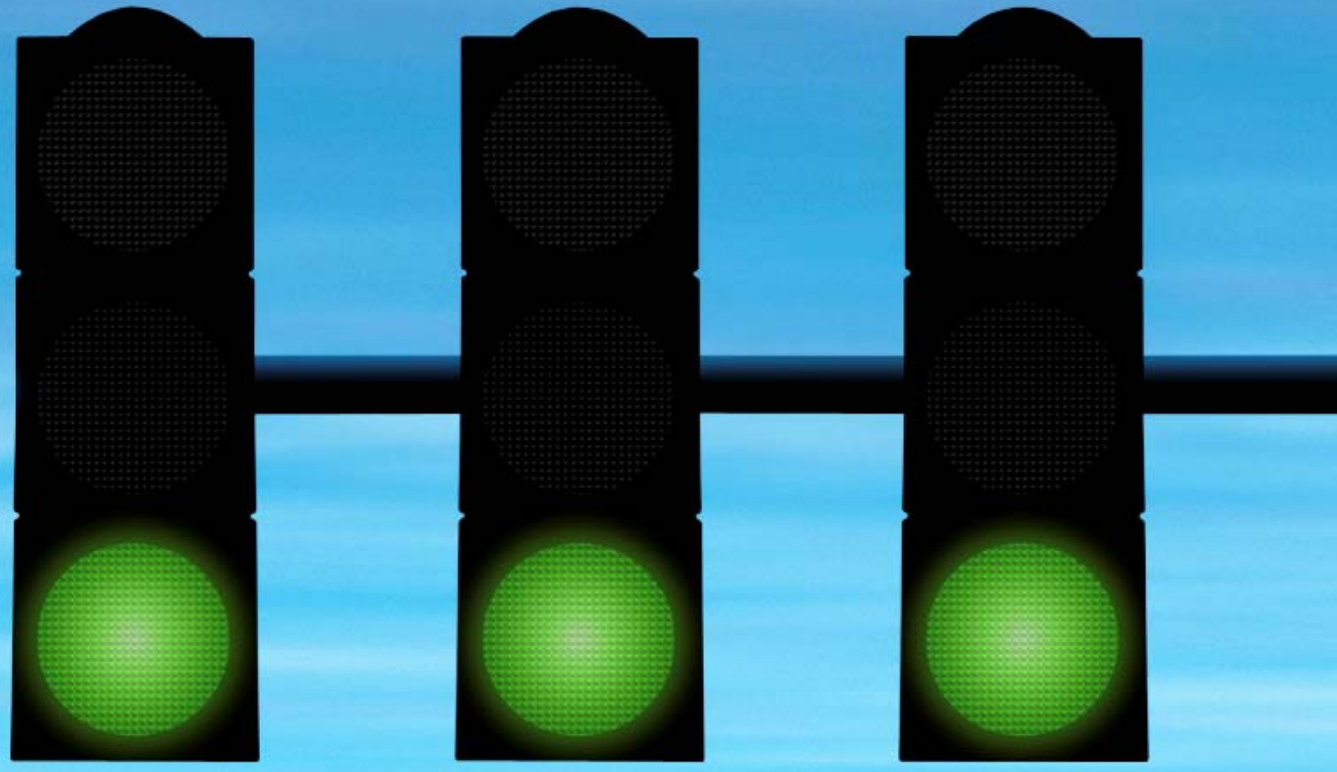
Consensus and international decisions are essential

- Fuels
- Standards
- Supply



The technology exists – but we need the fuels

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We are ready. Let’s get going!

Carbon dioxide-free fuels for commercial transport

Jan-Eric Sundgren
Senior Vice President Public and Environmental Affairs

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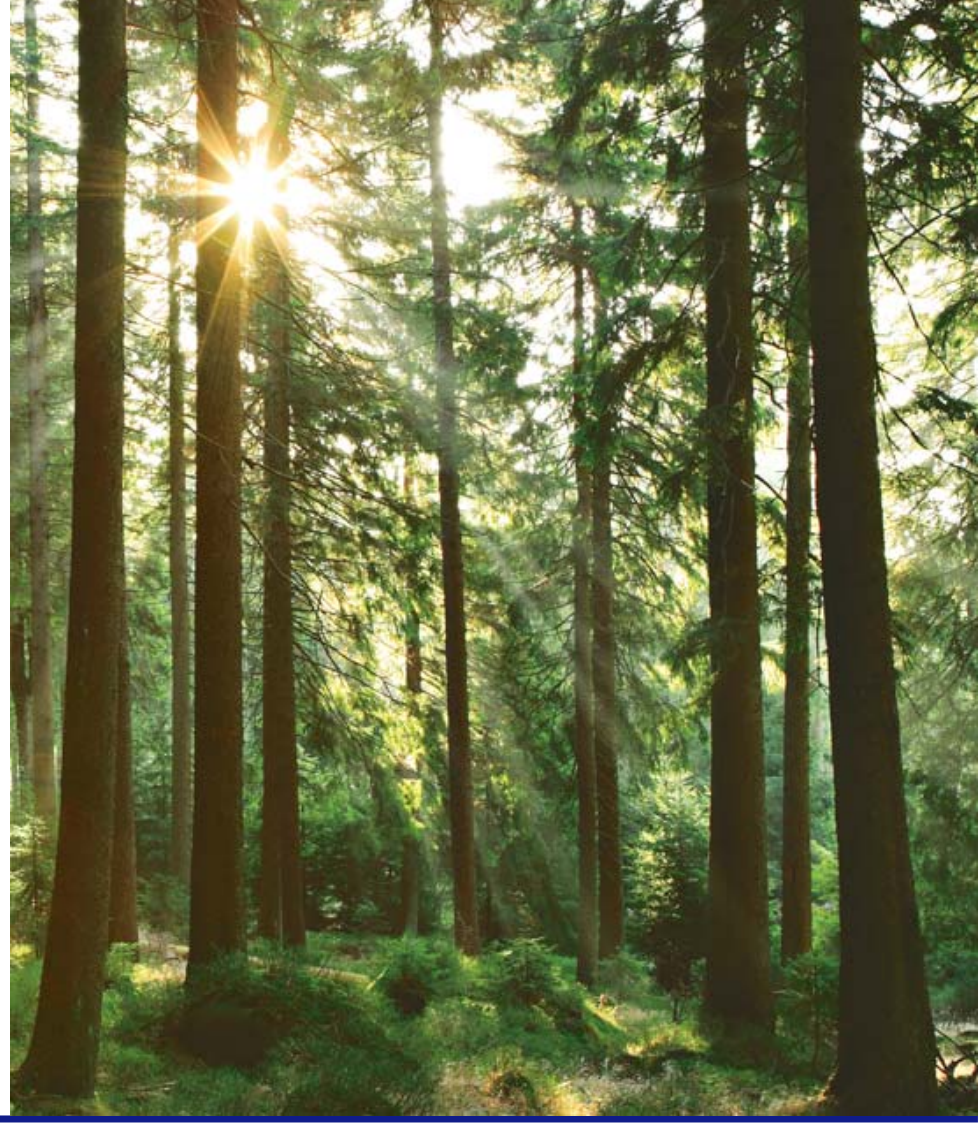
CO_2-free transports

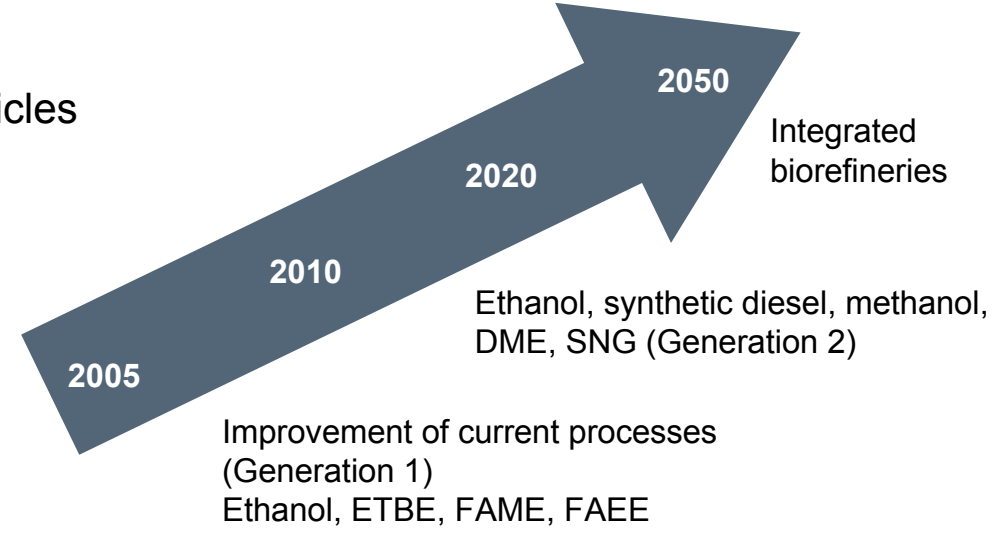
CO_2-free vehicles are powered by fuels produced from renewable raw materials such as biomass. Since these materials do not add carbon dioxide to the ecosystem, they have no impact on our climate.

- The combustion process generates the same amount of carbon dioxide as that absorbed by the biomass during its growth.
- As long as regrowth matches the quantities harvested, the amount of atmospheric carbon dioxide will not increase.



Development of biofuels

- Targets within the EU
  - 10% biofuel for vehicles by 2020
  - Today, approximately 1% biofuel for vehicles
- Vision for the EU
  - 25% biofuel by 2030
- First-generation fuel
  - Esterification, fermentation
  - Biodiesel, ethanol and biogas
- Second-generation fuel
  - Gasification
  - Synthetic diesel, methanol, DME, ethanol from cellulose



Seven CO_2-free alternatives

Liquid fuels

Biodiesel – From vegetable oils

Synthetic diesel – Gasification of biomass

Methanol/Ethanol – Methanol via gasification and ethanol via fermentation of biomass

Gaseous fuels

DME – Dimethylether – Gasification of biomass

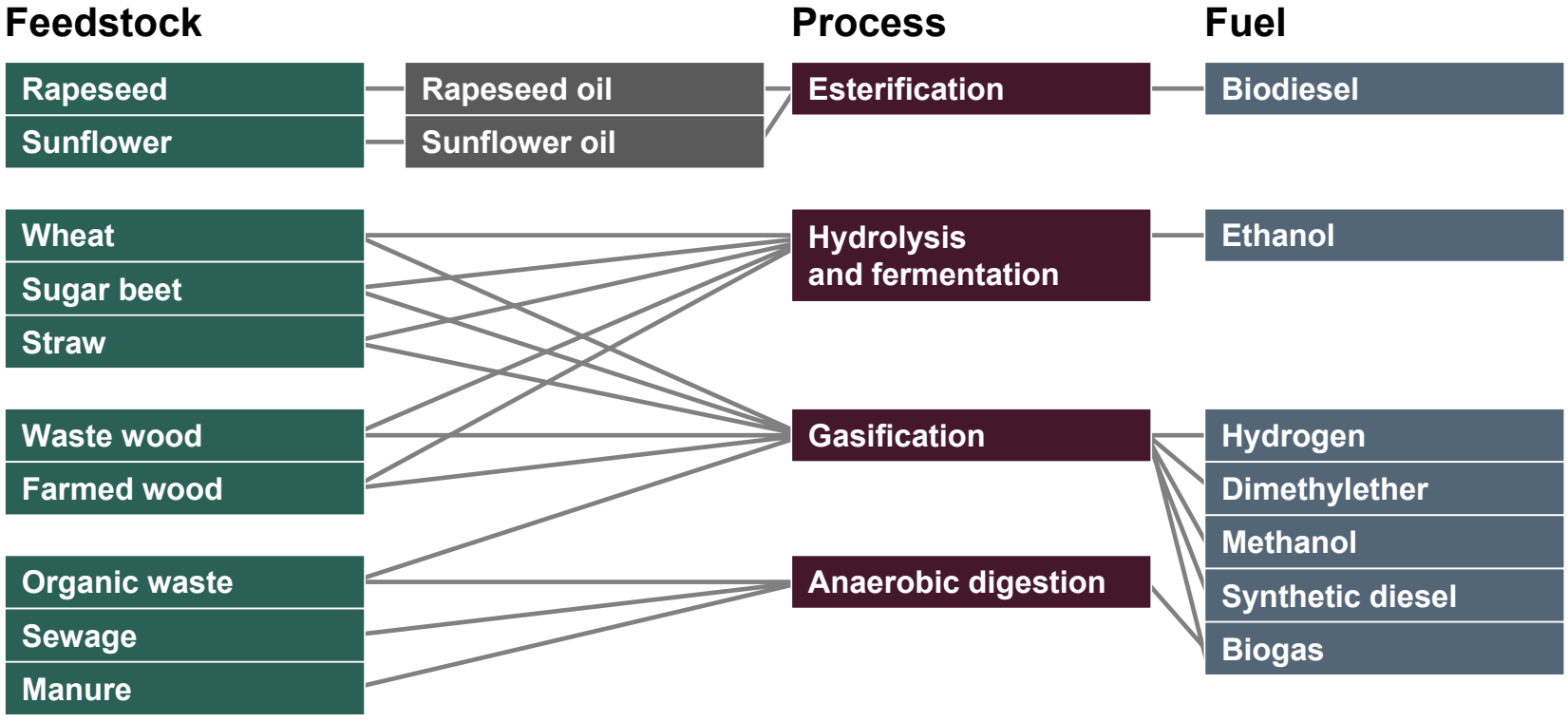
Biogas – Anaerobic digestion of biomass

Hydrogen + Biogas – 8% hydrogen gas, electrolysis of water using renewable electricity

Combination

Biogas + Biodiesel – Dual-fuel technology permits use of biogas in a diesel engine

From raw material to fuel



Seven criteria

1. **Climate impact**
2. **Energy efficiency**
3. Land use efficiency
4. Fuel potential
5. Vehicle adaptation
6. **Fuel cost**
7. Fuel infrastructure

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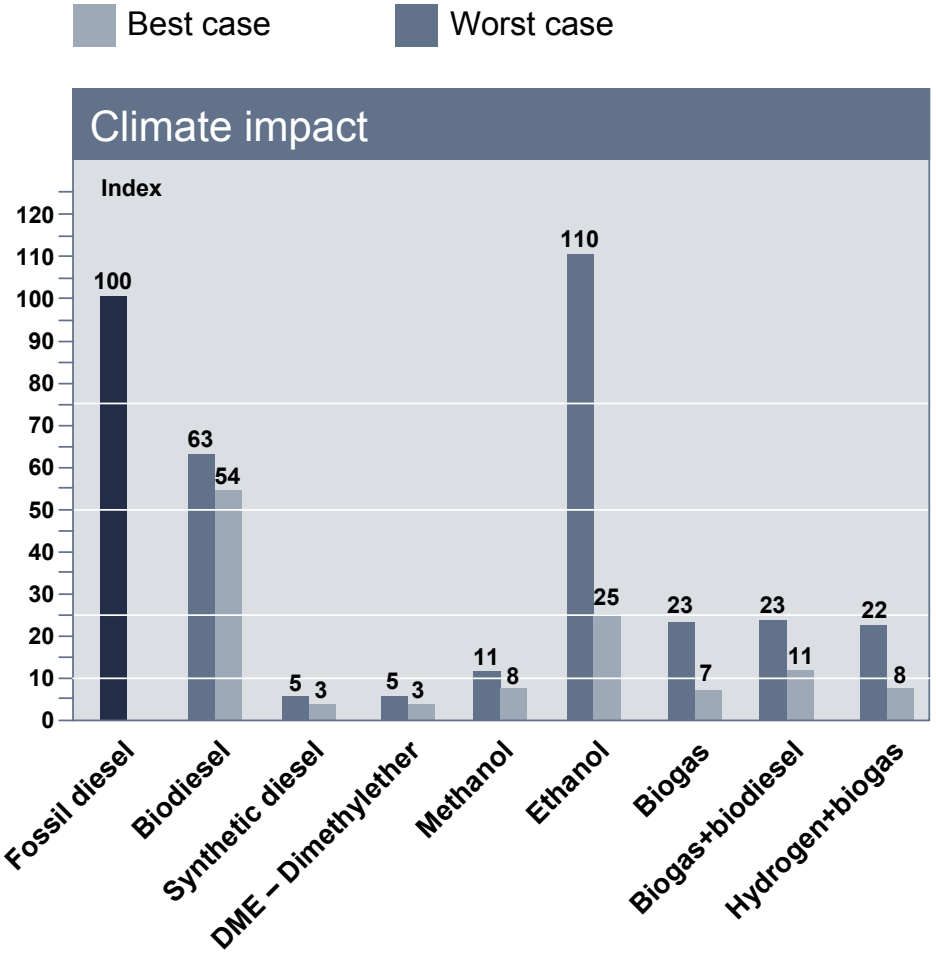
Climate impact – from “well-to-wheel”

- Emissions of carbon dioxide for the entire chain, based on the “well-to-wheel” principle
- Fuels manufacturered via gasification have the lowest impact
- Ethanol (Generation 1) and biodiesel have the highest impact



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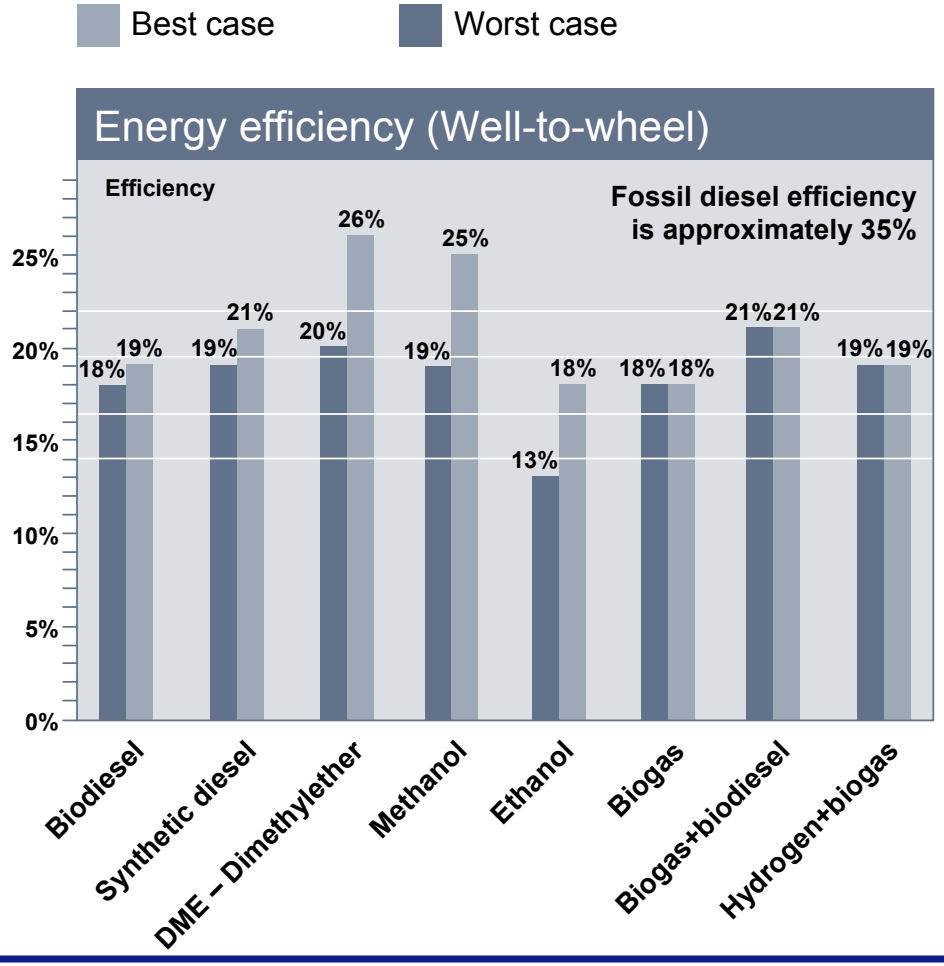
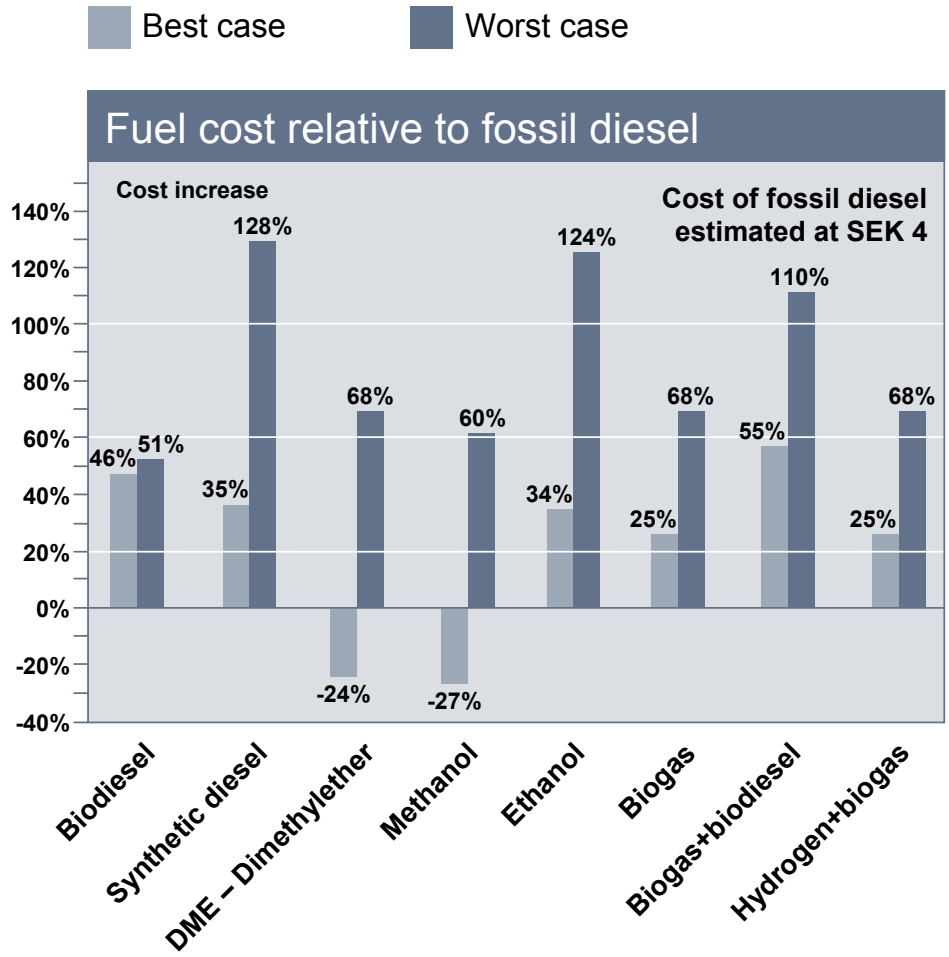
Energy efficiency – from “well-to-wheel”

- Energy efficiency based on the “well-to-wheel” principle is a measure of the proportion of energy reaching the vehicle’s driven wheels
- Energy-rich byproducts are included
- Methanol and DME produced by gasification of black liquor are rated highest



Fuel cost

- Includes all costs except taxes – that is, raw material costs, fixed and variable production costs, transport, and infrastructure costs, and for the energy utilisation in the distribution chain
- Overall, major differences depending on the raw material and production process
- Methanol and DME via gasification of black liquor is competitive today



Comparative assessment of all alternatives

	Climate impact	Energy efficiency	Land use efficiency	Fuel potential	Vehicle adaptation	Fuel cost	Fuel infrastructure
Biodiesel							
Synthetic diesel							
DME – Dimethylether							
Methanol/Ethanol							
Methanol/**Ethanol**							
Biogas							
Biogas+Biodiesel							
Hydrogen+Biogas							

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Energy efficiency is a key issue

- Proper assessment of the various fuel alternatives requires a holistic view
  - All alternatives have advantages and disadvantages
- Production of fuel by gasification technology appears promising
- The supply of renewable raw materials is limited
  - Finding the right track is key
  - The diesel engine is an efficient energy converter
  - Ongoing energy-efficiency enhancement is important and necessary
  - Hybridisation is a promising fuel-neutral technology

Volvo’s Hybrid Technology from a market perspective

Per Lindquist
Vice President Product Planning, Volvo Bus Corporation

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Volvo's hybrid technology
– accelerates transition to CO_2-free transport

- 20-30% lower fuel consumption and emissions of CO_2
- 40-50% lower controlled emissions
- Favorable performance in various traffic environments
- Revolutionary for operators' economy

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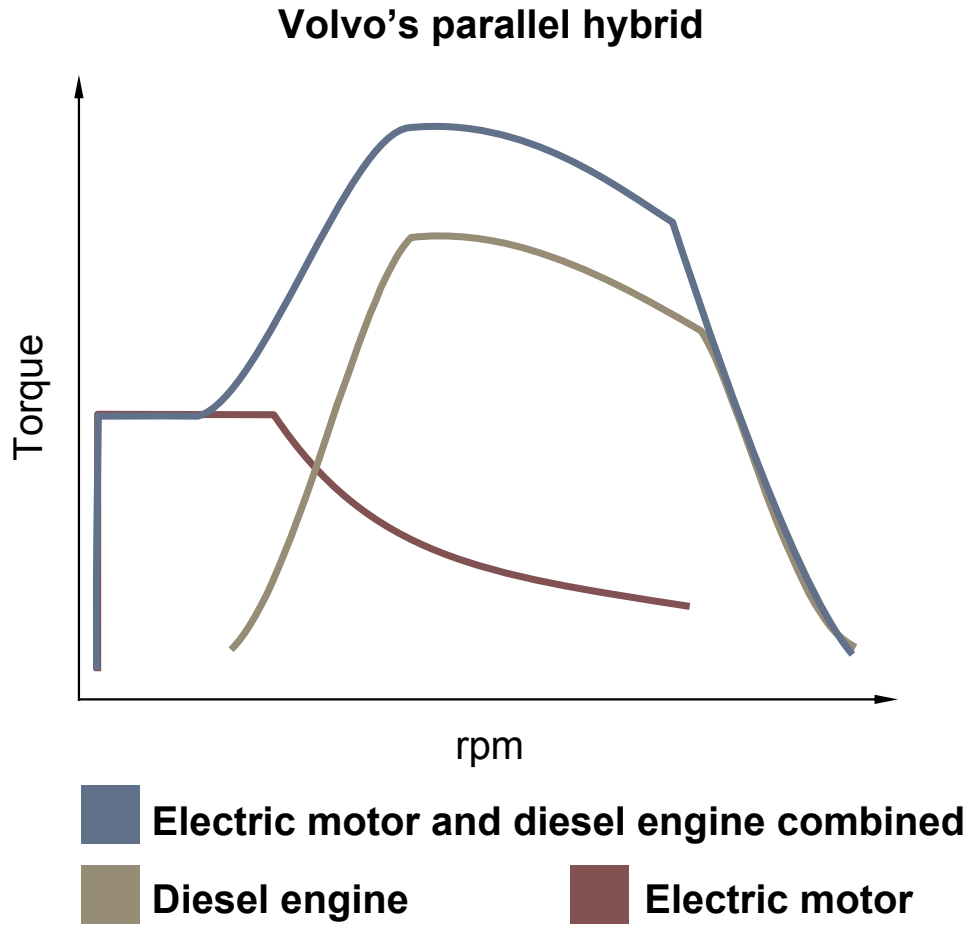
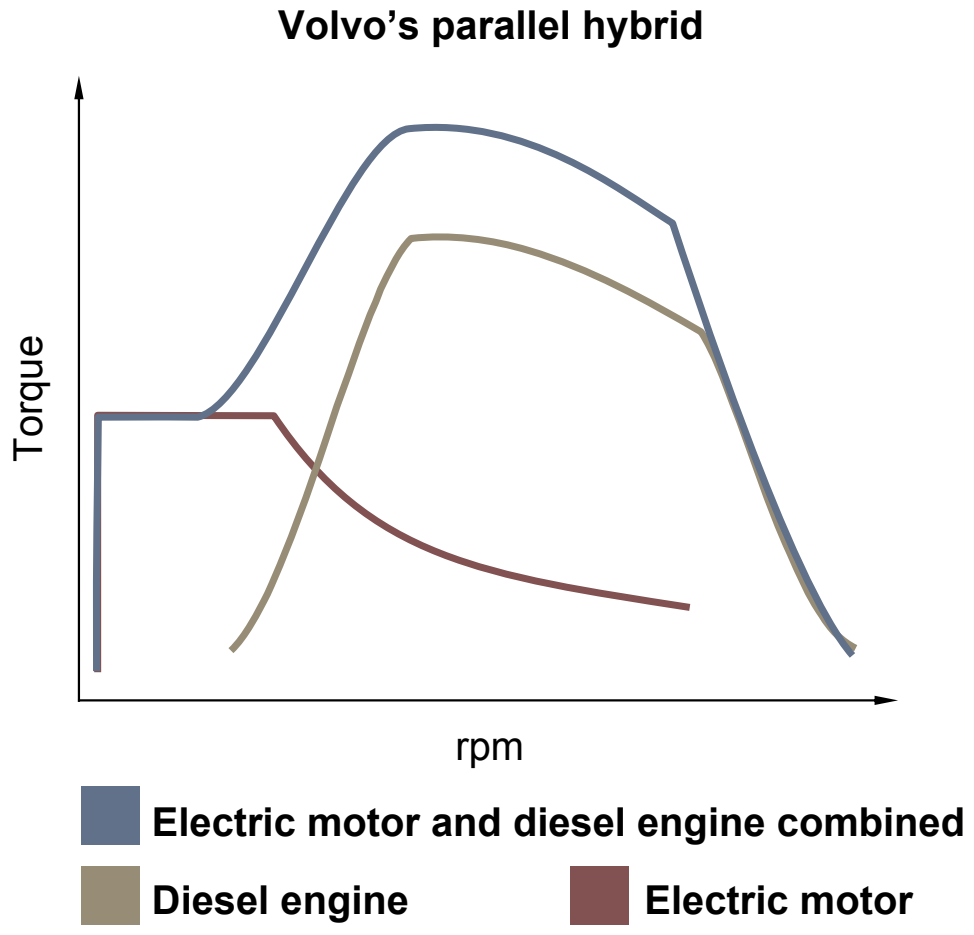
Optimised performance

- Energy-efficient diesel engine combined with electric motor
- Can jointly or separately power the vehicle
- Diesel and electric operation coordinated optimally for best performance and lowest environmental impact

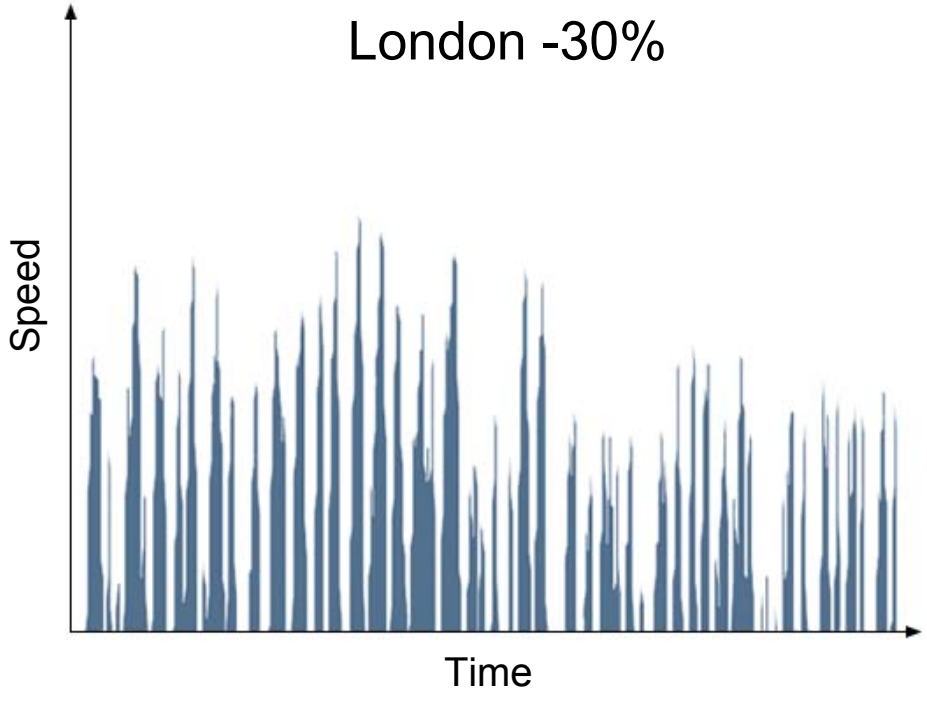


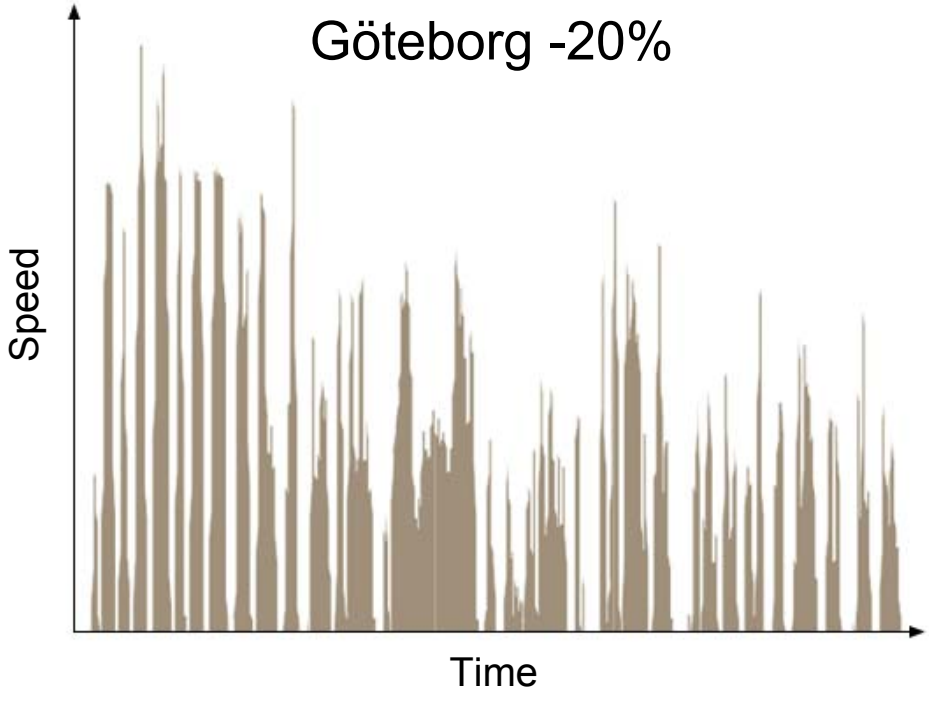
Parallel hybrid principle

- Electric motor used at start and acceleration up to 15 km/h
- Low noise level at start
- Diesel engine cuts in at higher speeds
- Electric motor's batteries charged
- Braking power used to charge batteries
- Running at idle can be avoided



Parallel hybrid – efficient in different environments





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Profitable for society

Hybrid – more passengers transported and lower CO_2 emissions

- Saves energy regardless of fuel used
- Meets EU's emission target for CO_2
- Halves emission of NO_X
- Distinctly better than EEV

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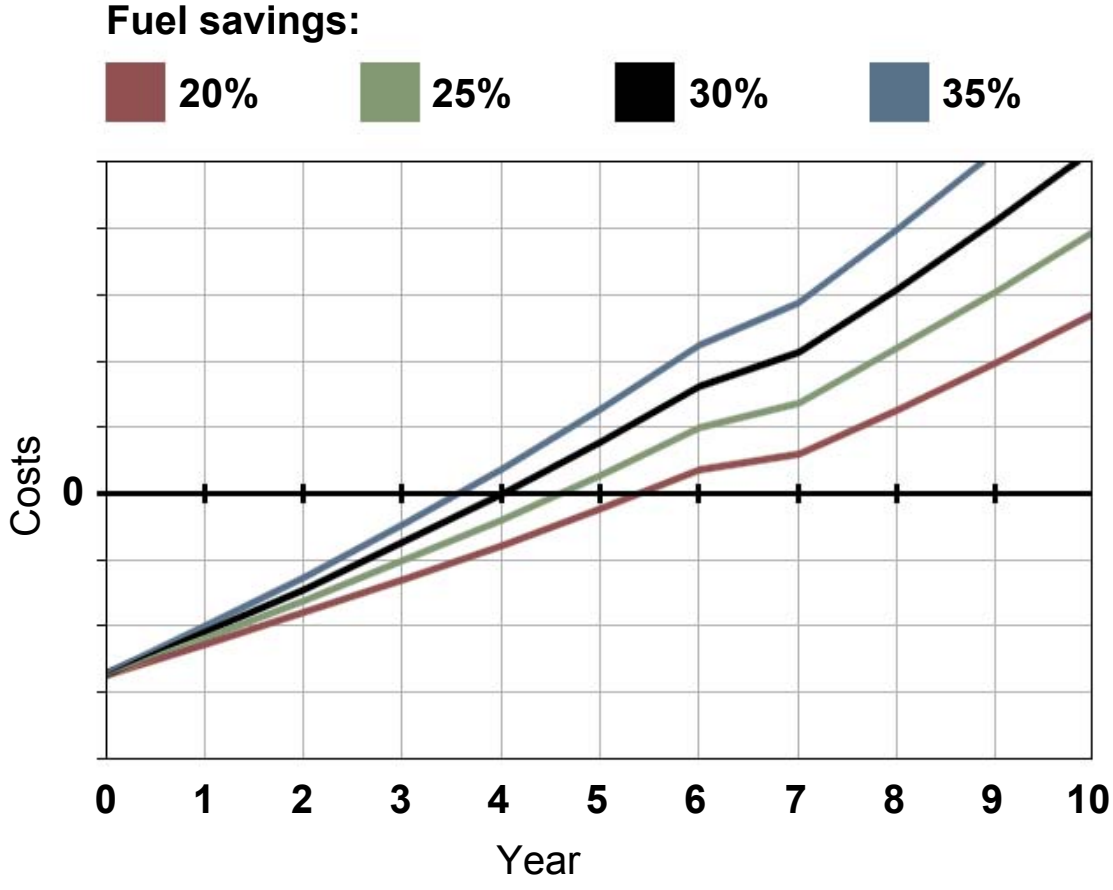
Profitable for operators

Hybrid technology is a strong economic alternative

- Low operating costs
- Investment payback 4-5 years
- High performance, solid reliability and high availability



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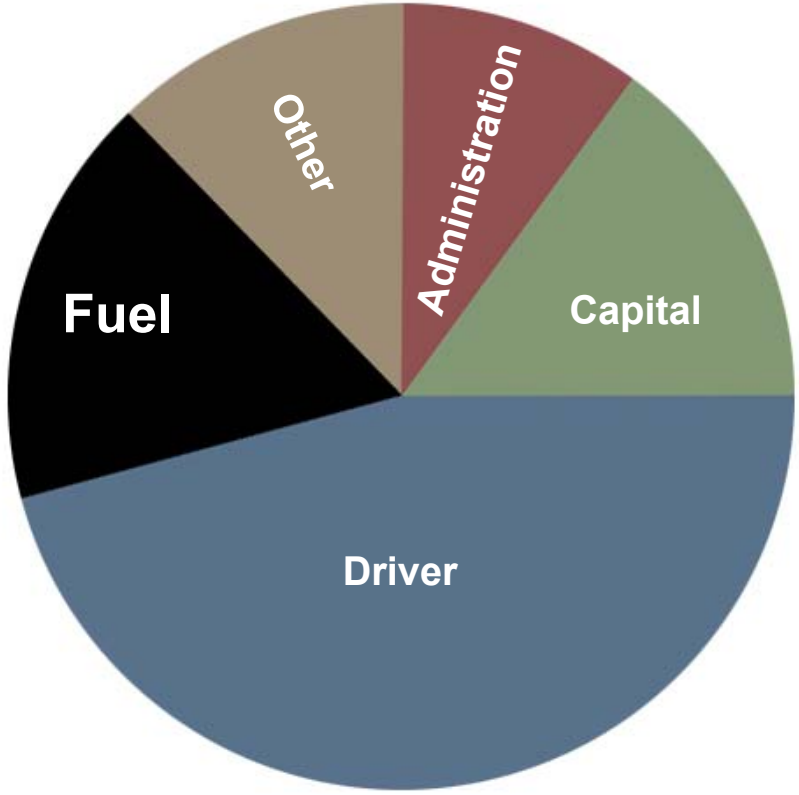
Profitable for operators

- Today, fuel accounts for 20% of city bus operator's total costs
- Volvo's hybrid is revolutionary for operators' economy



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Favourable for passengers

Hybrid is the base for economical, simple, efficient and environmentally friendly public transportation with high availability

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Summary

Volvo's hybrid technology provides overwhelming benefits:

- Accelerates transition to CO_2-free transport
- Parallel hybrid offers good performance in different traffic environments
- Profitable for operator and society
  Favourable for passengers
- Low fuel consumption and low emissions of CO_2
- Lower emissions of NO_X and particles
  Lower noise emissions
- Suitable for all the Volvo Group's vehicles

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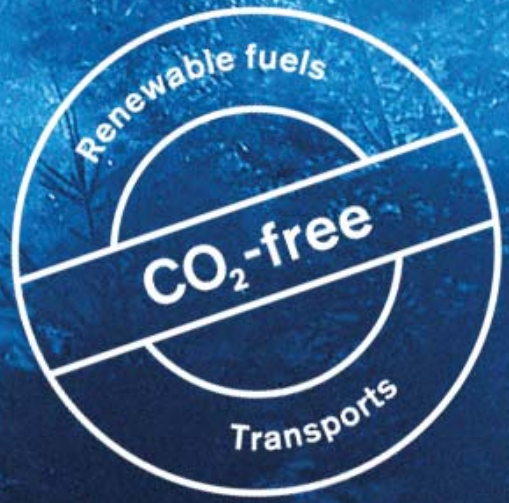
Climate issues in focus



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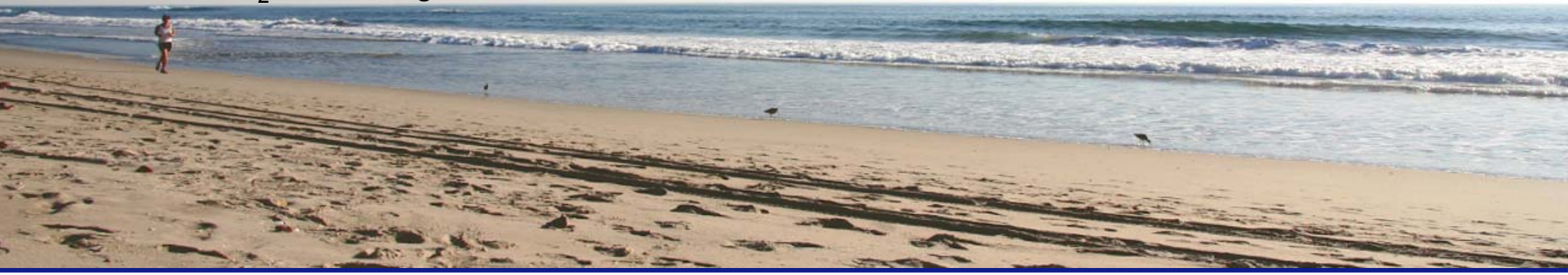
CO_2-free transport on the go

Current situation:

- Much has been done, but much remains
  - Emissions of particles and nitrogen oxides approach zero
  - CO_2 increasing

Tomorrow's possibilities:

- CO_2-emissions can be managed, but investment in research and development needed
- International collaboration is necessity



VOLVO

We are ready. Let’s get going!


VOLVO