


**CO2 reductions in road transport  
Cost-effective measures for the next decade**

CEPS Workshop on road transport CO2 reduction  
Brussels, 17-01-2010

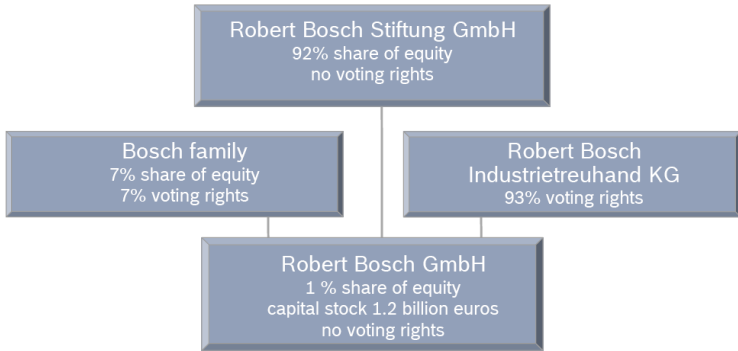
Karl Lucke, Robert Bosch GmbH

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**CEPS Workshop**


**Ownership structure**

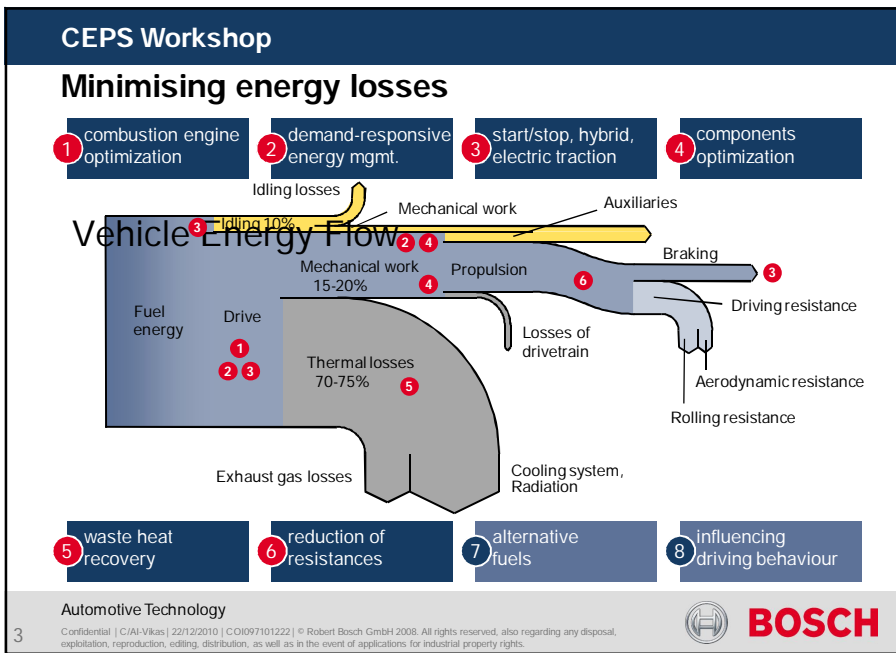


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graph TD
    A["Robert Bosch Stiftung GmbH  
92% share of equity  
no voting rights"] --- B["Robert Bosch GmbH  
1 % share of equity  
capital stock 1.2 billion euros  
no voting rights"]
    C["Bosch family  
7% share of equity  
7% voting rights"] --- B
    D["Robert Bosch Industrietreuhand KG  
93% voting rights"] --- B
  
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### CEPS Workshop

## Clean Diesel & Gasoline Technology Packages

Gasoline		Displacement	Clean Diesel		Displacement
Pkg.	Description	Torque	Pkg.	Description	Torque
G0	Port fuel injection (PFI)	2.0 l 200 Nm	D0	Common rail system, turbo	2.0 l 340 Nm
G1	Direct injection (DI) <sup>1)</sup> , turbo, downsizing, start/stop <sup>3)</sup> , thermo management	1.4 l 210 Nm	D1	+ oCCS <sup>9)</sup> w/ close pre inject. + thermo management <sup>7)</sup> + downsizing + start/stop <sup>4)</sup>	1.6 l 340 Nm
G2	+ downsizing (3 cyl.) + var. valve lifting (VVL) <sup>8)</sup>	1.1 l 200 Nm	D2	+ NO <sub>x</sub> treatment	1.6 l 340 Nm
G2H	+ hybrid <sup>2,5)</sup>	1.1 l 200+140 Nm	D3	+ downsizing (3 cyl.)	1.2 l 290 Nm
			D3H	+ hybrid <sup>2,5)</sup>	1.2 l 290+140 Nm

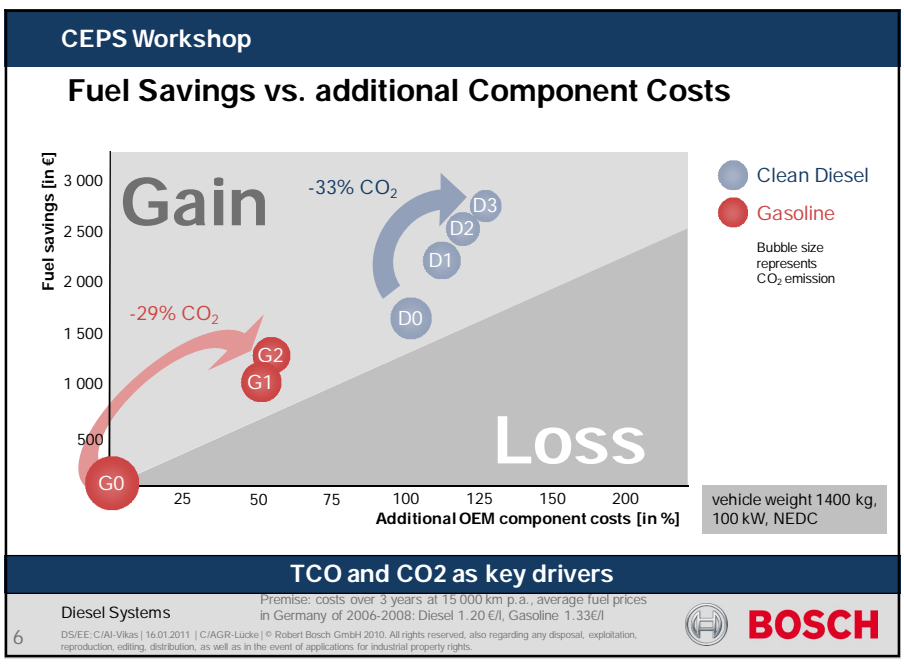
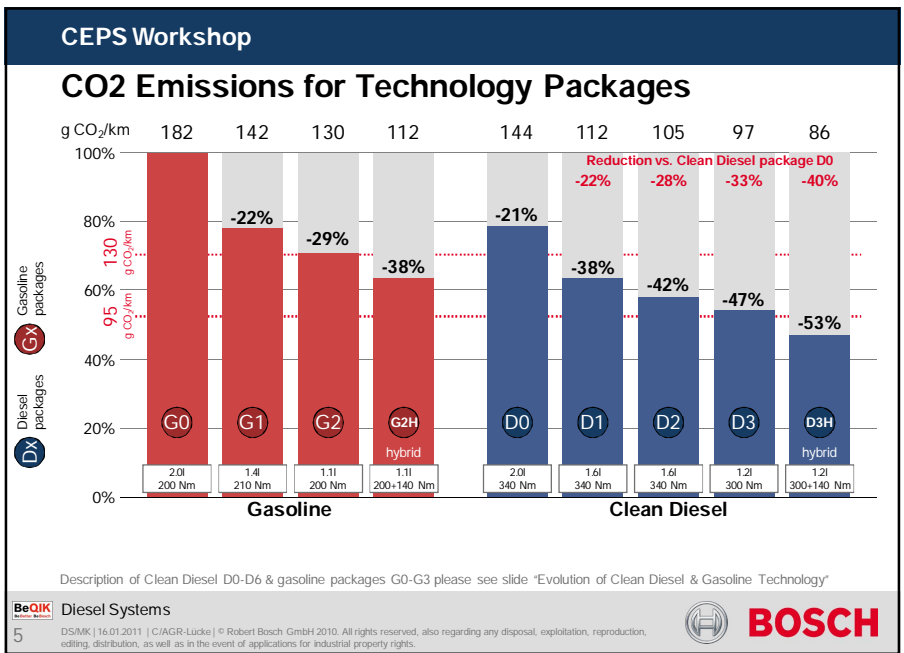
Weight 1 400 kg, 100 kW, NEDC, manual transmission (hybrid: automatic transmission), EU6 (G0/D0: EU5)

1) turbo-charged with downsizing, var. valve timing (VVT); 2) max. potential w/ downsizing, transmission optimization; 3) Start/Stop w/ recuperation, thermo management (ThM), Decos; 4) Start/Stop w/ recuperation, combustion optimization; 5) Battery 1 kWh, 25kW; 6) ThM, down speeding, downsizing, T/C optimization; 7) CO<sub>2</sub> optimization; 8) VVL in 2-step, down speeding, downsizing; 9) oCCS = optimized combustion process / costs 2014

Diesel Systems

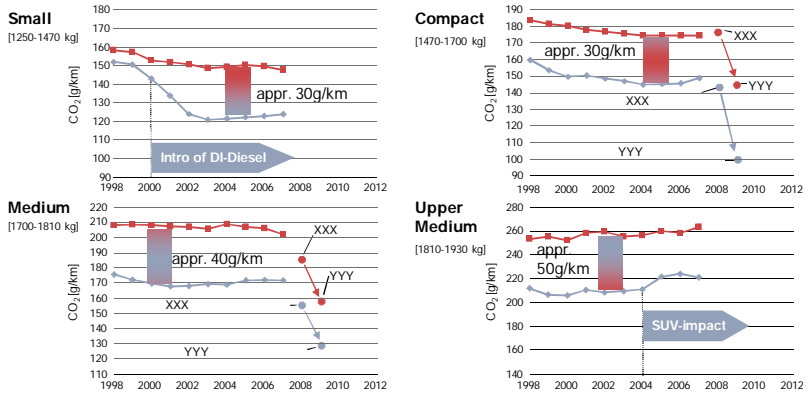
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Development of CO<sub>2</sub> Emissions: diesel & gasoline



Planned Energy Taxation is threat to diesel... and to reaching 95g/km target

Source: Polk Marketing Systems / in brackets: Inertia weight

Clean Diesel Gasoline

BeQIK Diesel Systems

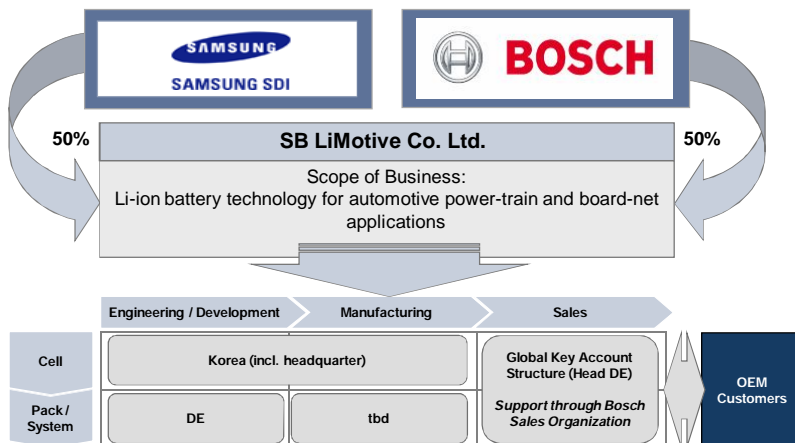
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SB LiMotive BOSCH Samsung JV



Automotive Technology

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### CEPS Workshop

## Work on sub-systems and overall system!

**e-Drive**  
(Inverter w/ DC/DC-Converter and e-Machine)

**Thermal System**  
(Climate and comfort)

**Battery**

**Charger**  
(on-board)

**Infrastructure**  
(Charger, Charging Station)

**Brake-system**  
(Recuperation, ESP + ABS)

**E/E Architecture**

Compare: 1000 person-years for GDI @ Bosch alone...

Automotive Technology

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### CEPS Workshop

## Cost challenge remains for foreseeable future

2015

	Conv. ICE	HEV	PHEV	EV REX	Small EV	Fun EV
CO <sub>2</sub> (g/km) (Well to Wheel)*	140	120	93	88	< 80 (EU)	80 (EU)
OEM Cost Powertrain incl. Battery (t€)	-	3.5	9.5	9.0	7.5	11

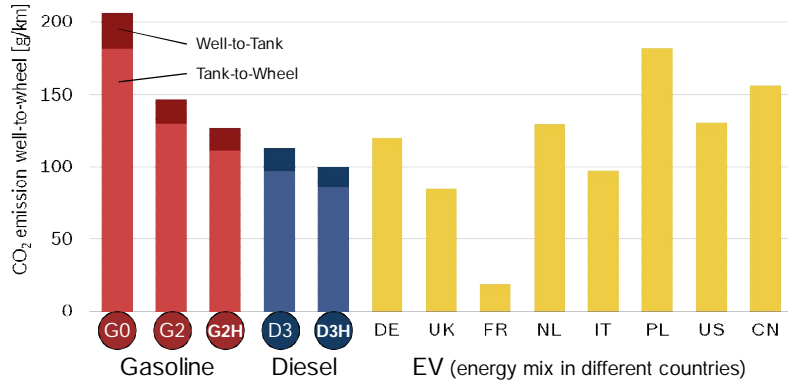
\* El. Mix 2006  
REX: range extender

reference vehicle: SC class

Gasoline Systems

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### Energy challenge based on Well-to-Wheel Emissions

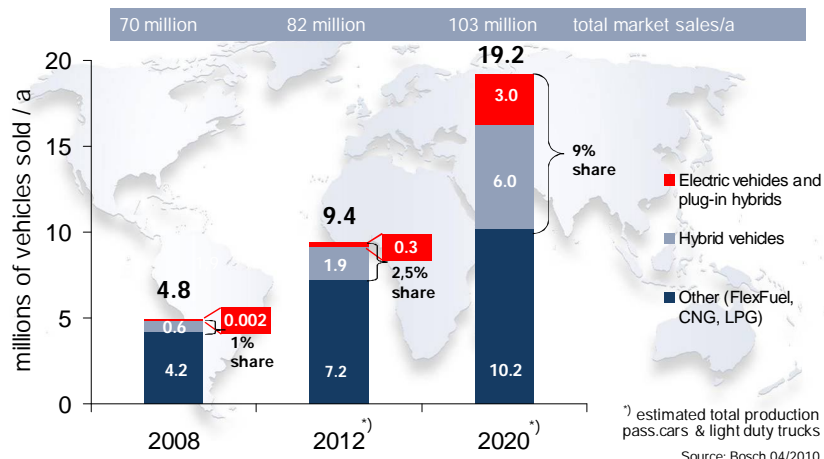


**Diesel is CO<sub>2</sub>-competitive to electric vehicles with existing energy mixes**

\* Assumption EV: Power generation includes net losses, 9% charging loss & 18.8 Wh/km



### Alternative powertrains: prospects 2020

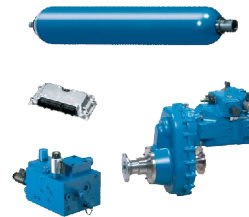
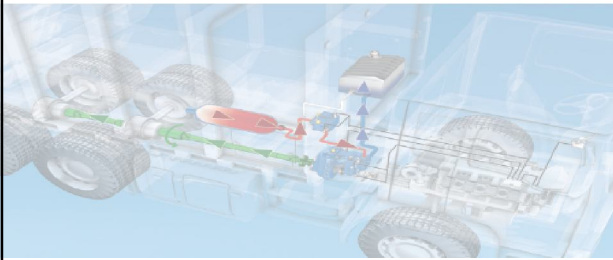


<sup>\*)</sup> estimated total production pass.cars & light duty trucks  
Source: Bosch 04/2010



## Hybridisation ... in different forms

- Besides electric hybrids and full electrification...
- **Hydraulic hybrid:**
  - Lower costs (no battery)
  - High durability
  - CO2 reduction comparable to electric hybrid
  - Overall: Better cost-benefit ratio!



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## Heavy-duty measures

### Promising measures include

- ICE
- Hybridisation (sic!)
- Auxiliaries
- Heat recovery
- Intelligent strategies based on looking ahead

### Lower potential than cars

- Measurement method to cover reduction measures

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Diesel Systems

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## Summary / Key messages

- **ICE still has significant CO2 reduction potential**
  - Including many cost-effective measures
  - 95g/km target remains ambitious
  - Energy taxation clear threat to reaching 95g/km in 2020
  - ???Discussions about 70g/km???
  
- **EVs are coming ... but slowly**
  - Massive investments, in parallel to ICE
  - Systems approach required
  - Cost and energy challenges will remain for foreseeable future
  - Market penetration in next decade limited
  
- **Do we dare picking a technology today?**
  - Let us not forget hydrogen vehicles, hydraulic hybrids, etc.

Diesel Systems

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