Vision 1900

(ROAD VEHICLE) PROPULSION TECHNOLOGIES 2050

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Vision 1950

Vision 2015

“All laws of nature are known”
and we are aware of the problem.

But we still do not like to accept it.

Traffic jam in China – or somewhere else?

SCENARIO 2050

Highly integrated & efficient long distance air transport network

Highly integrated inland waterways transport network

Dedicated EU freight train rail network

- average speed 150 km/h
- fully automated container transfer

High speed rail network in Europe – e.g. in Austria

- Vienna – Salzburg 1,5 h
- Salzburg – Innsbruck 1 h
- Vienna – Graz 1,5 h
- Graz – Klagenfurt 0,75 h
- Graz – Linz 1,5 h

Inner city passenger commutation (> 50.000 inhabitants)

- zero emission zone (incl. noise)
- fully integrated multi model passenger transport

Road traffic control and pricing and taxes

- Progressive tolls with increasing trip distance
- Day time dependent tolls
- Highly progressive taxes regarding energy consumption/km

SCENARIO 2050

Road transport:

- Off-road commercial vehicles (agriculture, mining, …)
- Freight distribution by night on distances < 100 km
- Passenger transport on distances 50 < s < 100 km (suburban and rural areas)

Other boundary conditions:

- Fully automated (max.) vehicle speed control
- Automated vehicle safety control
- Highly restricted access to road infrastructure
- Booking of travel slots and parking places in advance
- Fully developed car sharing
- …

CONSEQUENCES FOR ROAD VEHICLE PROPULSION

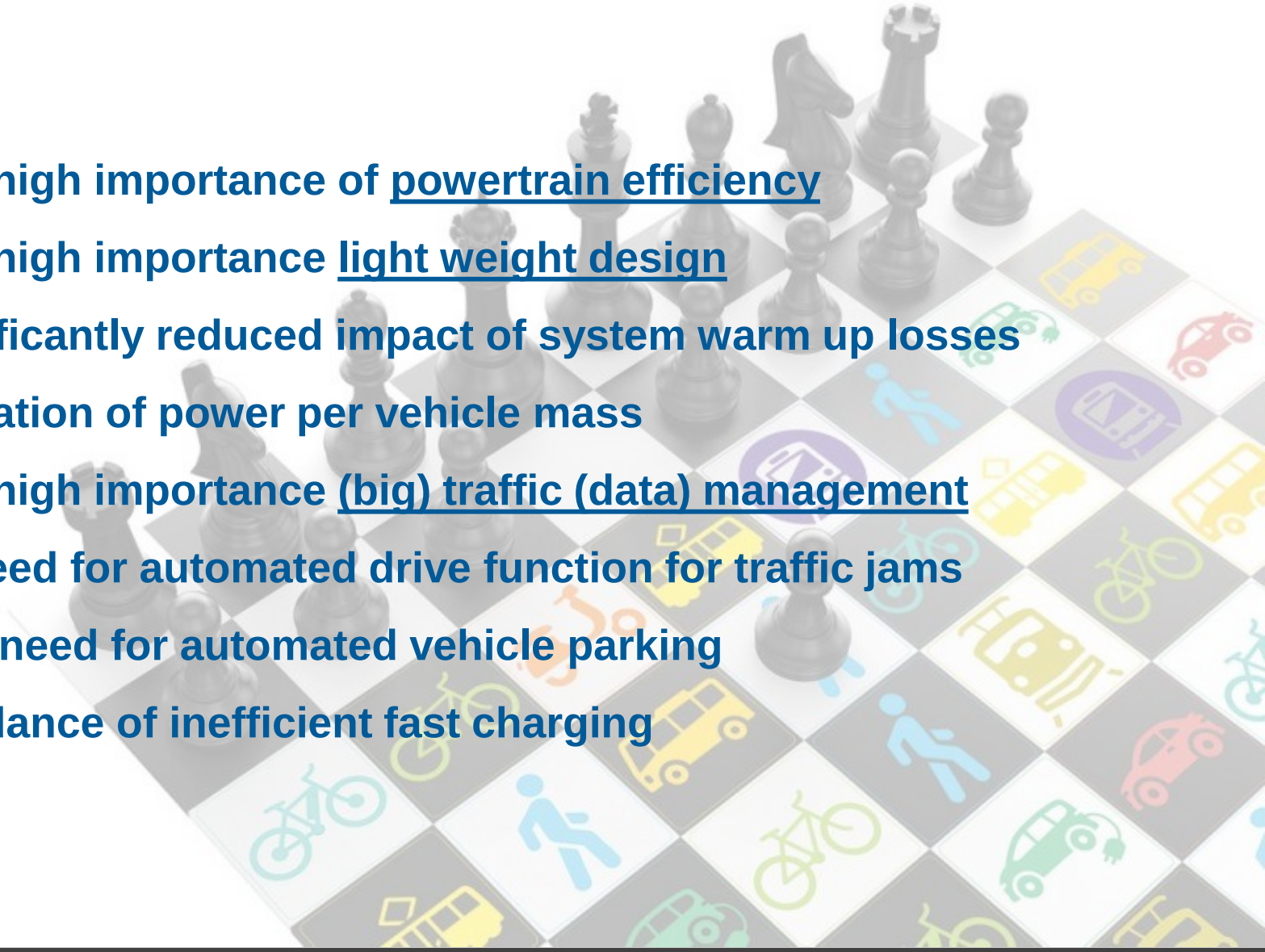
Commercial Vehicles:

- Off-road propulsion with regenerative fuels
- Plug-in hybrid propulsion for N1 and N2 trucks
- Pure electric buses (battery and/or fuel cell)

Passenger Vehicles:

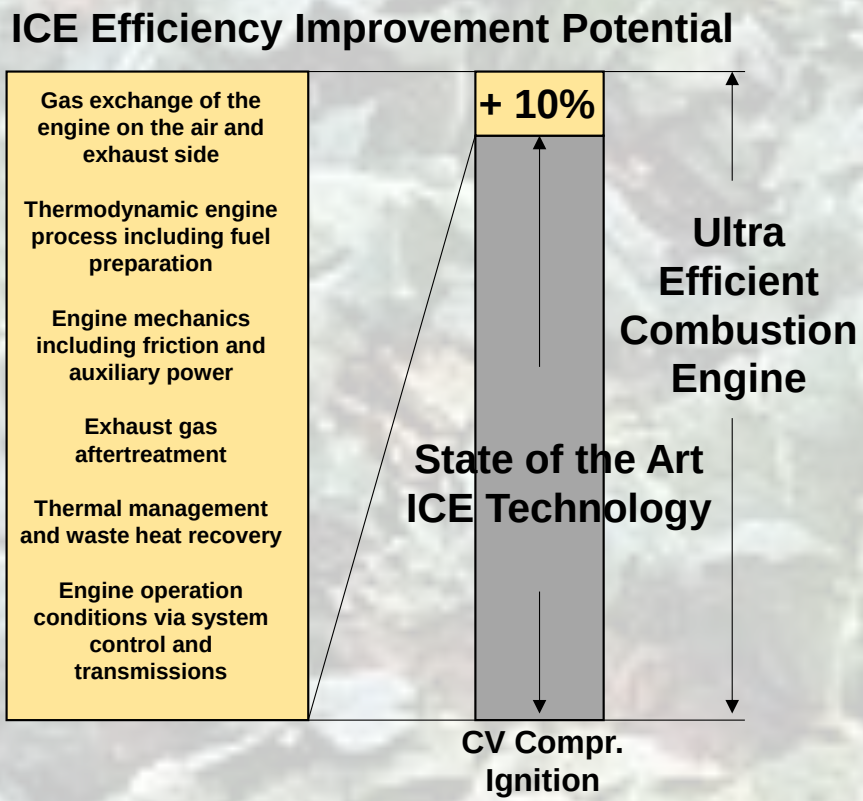
- Fully electric propulsion (inner city)
- Fuel cell electric or hybrid propulsion
- 100% regenerative fuels (H2 from regenerative sources, bio-waste-based fuels)

GAME CHANGERS FOR TECHNOLOGY



- Very high importance of powertrain efficiency
- Very high importance light weight design
- Significantly reduced impact of system warm up losses
- Limitation of power per vehicle mass
- Very high importance (big) traffic (data) management
- No need for automated drive function for traffic jams
- Less need for automated vehicle parking
- Avoidance of inefficient fast charging

LIKELY PROPULSION TECHNOLOGIES



Commercial Vehicles:

- Liquefied bio-mass (harvest residues) based methane
- Single point operation combustion engine with heat insulation, diluted combustion and turbo-compound waste heat recovery
- Electric main and ancillary drives with buffer battery

Impact:

- ✓ 0 g/km net CO_2
- ✓ Approx. 50% efficiency
- ✓ High robustness & availability

LIKELY PROPULSION TECHNOLOGIES

Light Duty Vehicles (incl. Pass.Car):

- Hydrogen from “renewables” (wind, solar, geo-thermal)
- On board electricity generation with fuel cells
- Electric main drive with buffer battery incl. plug-in ability

Impact:

- ✓ 0 g/km CO_2
- ✓ Approx. 60% efficiency
- ✓ No emissions – no noise

SUMMAY & CONCLUSION FOR 2050 PROPULSION

Because of scarce energy and resources, achievement of best possible efficiency will be the decisive factor.

Second priority are the use of regenerative, sustainable sources for energy and materials.

Minimization/elimination of any kind of losses will be forced in by regulations and extremely progressive tax legislation.

Information technology will help to eliminate the seeming need for inefficient transport such as daily commuting