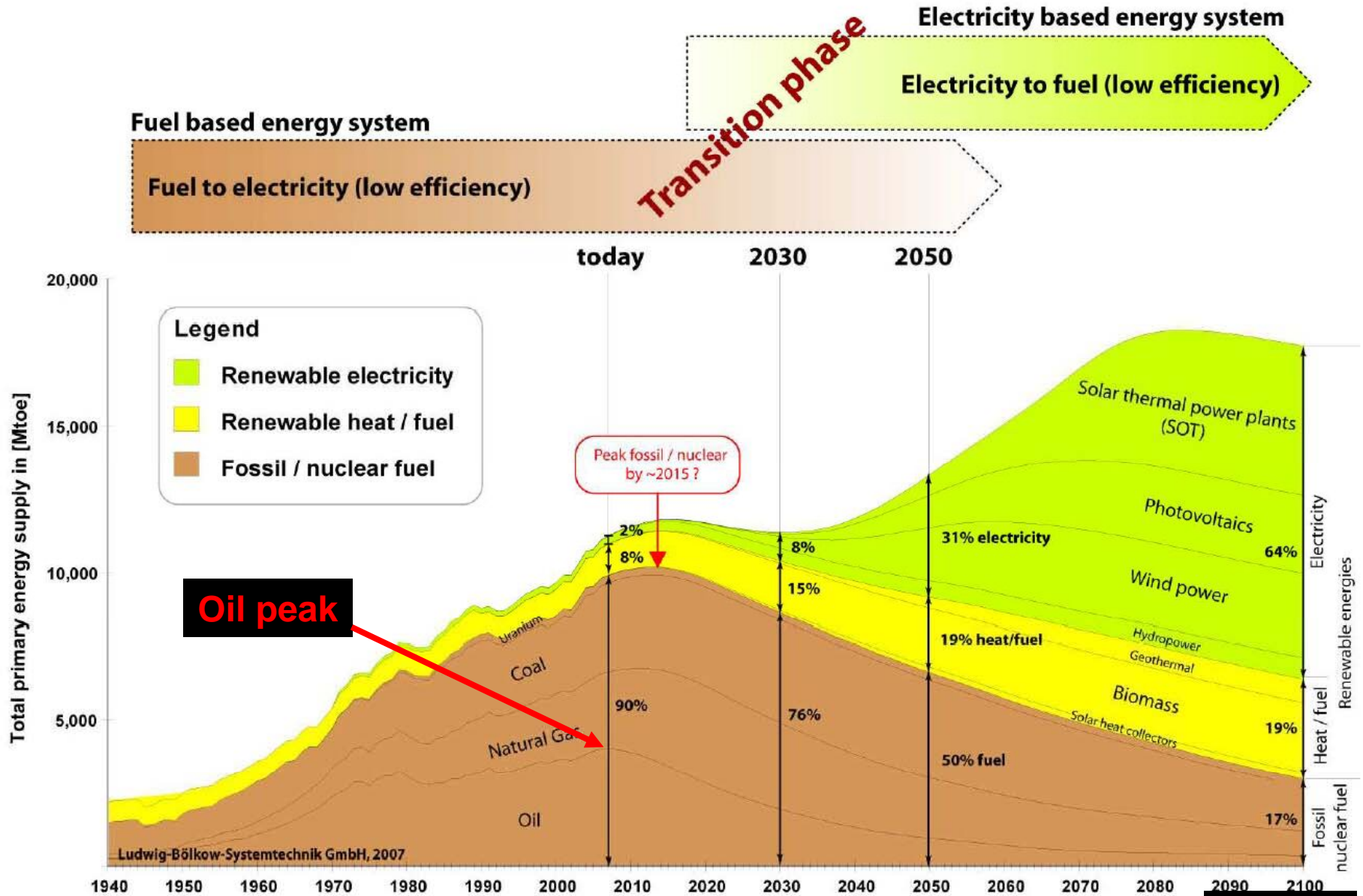


Fuel cells and batteries in future transport applications

Ulrich Schmidtchen

German Hydrogen and Fuel Cell Association (DWV), Berlin

We are at a turning point



What does this mean?

- For 200 years fuels (coal, oil, gas) were the basis. **Electricity was / is made from fuel.**
- The peak of global oil production has just been passed. The peak of combined fossil and nuclear energy production is less than ten years ahead.
- Many renewables (wind, PV) deliver electricity, some of them heat, but no fuel. The balance will shift from fuel to electricity. In future **fuels will be made from electricity.**
- The car of the future will have an electric motor and a battery. Many of them, probably the majority, will also have a hydrogen tank and a fuel cell.

Car maker's view of Optimal Mobility Scenarios

Long Distance



Interurban



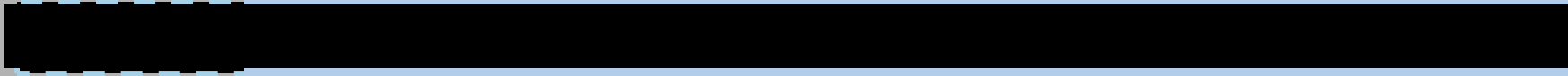
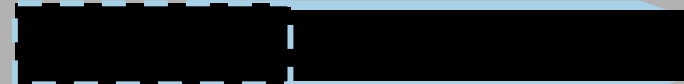
Urban



Combustion Engine



Hybridization

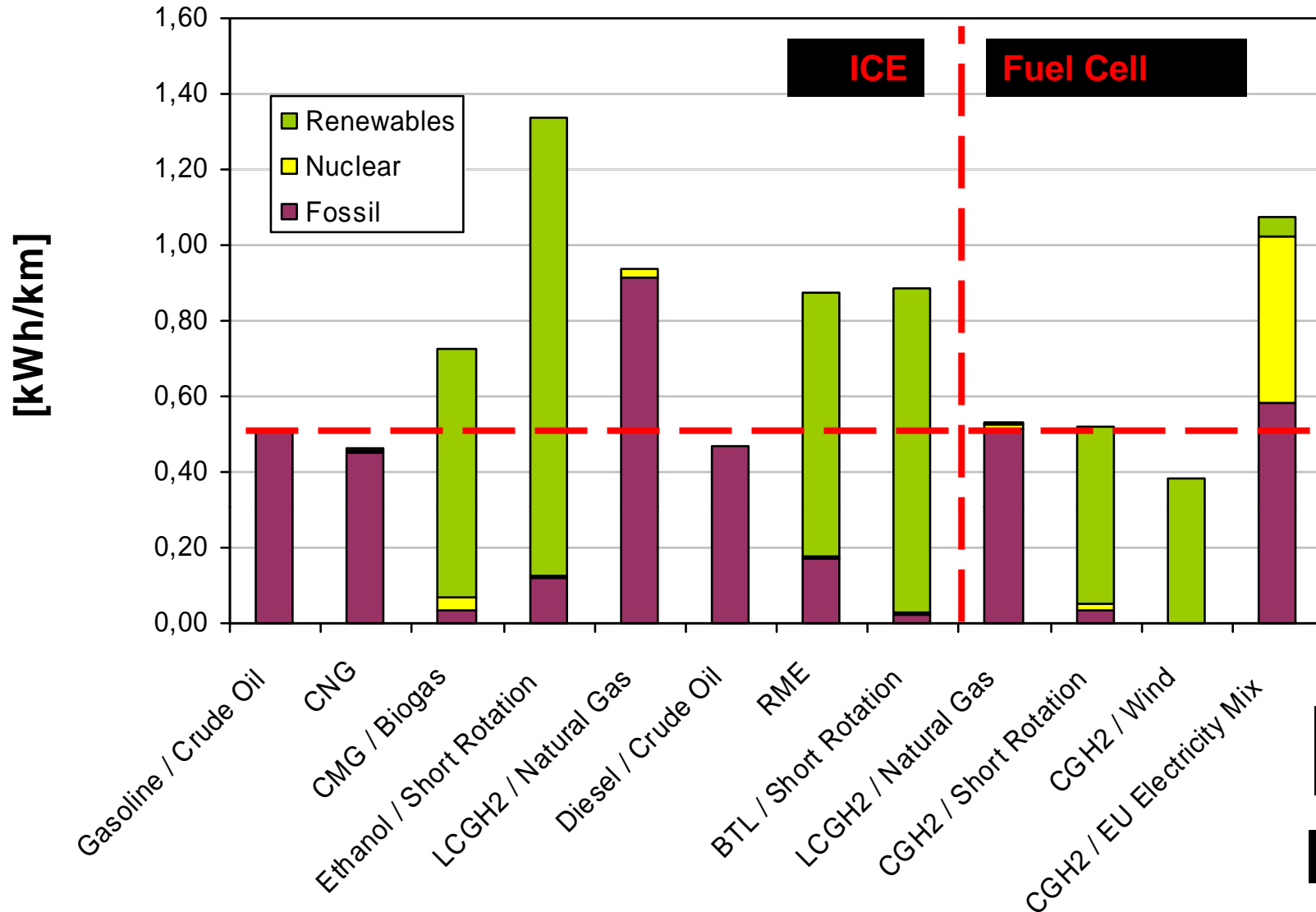


**Does hydrogen fuel
make sense?**

- Hydrogen is **not a source**, but a carrier of energy. It must be generated using primary energy.
- While hydrogen for itself is clean, the ecological balance depends on the primary energy. In the end hydrogen can **not be cleaner** than the primary energy used to generate it.
- And it can **not be cheaper** either.
- **All this is equally true for electricity.**

Hydrogen vs. bio fuels

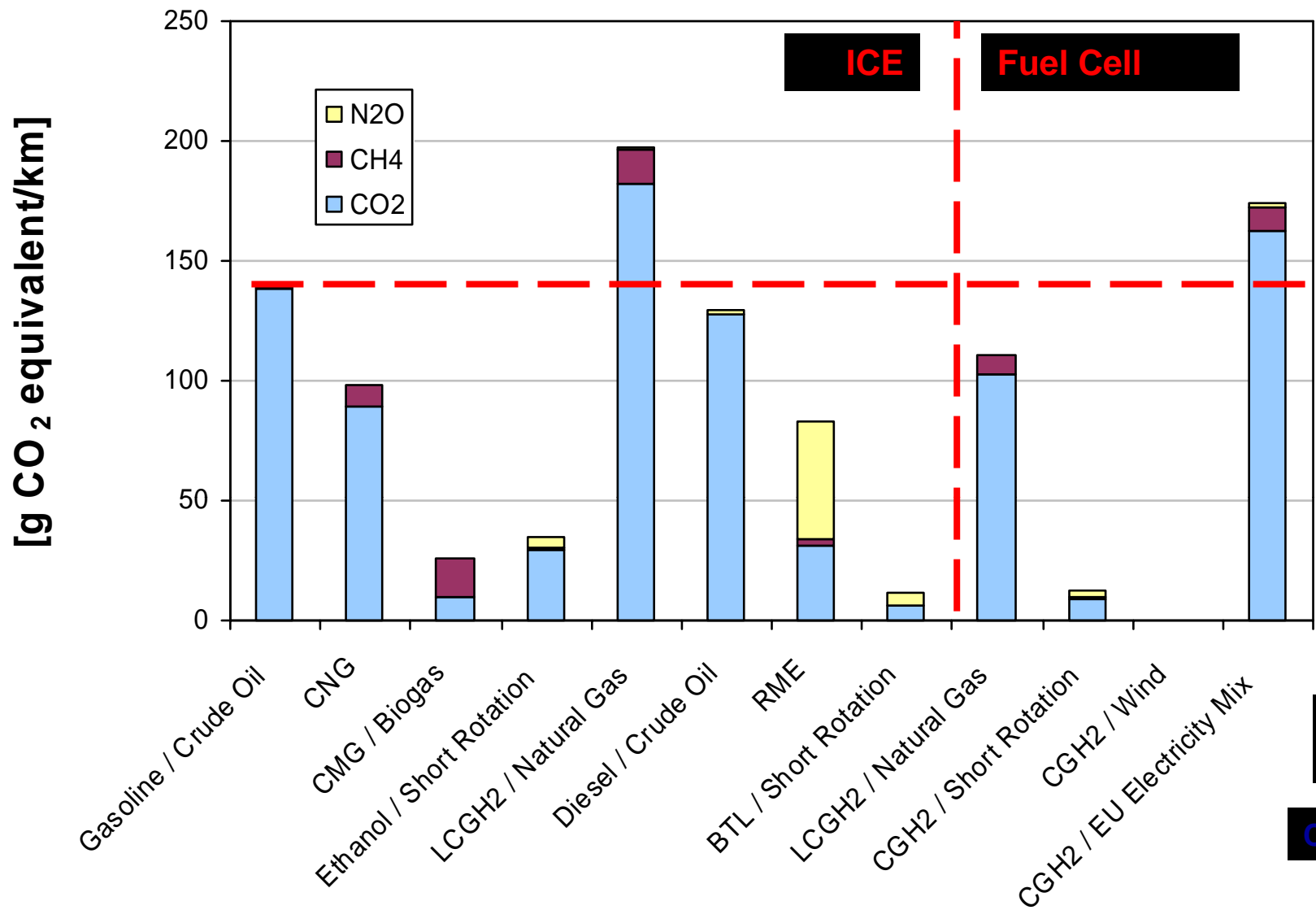
Energy input "Well-to-Wheel", hybrid



Compilation: LBST

Depending on the production path hydrogen is already competitive – and non-fossil

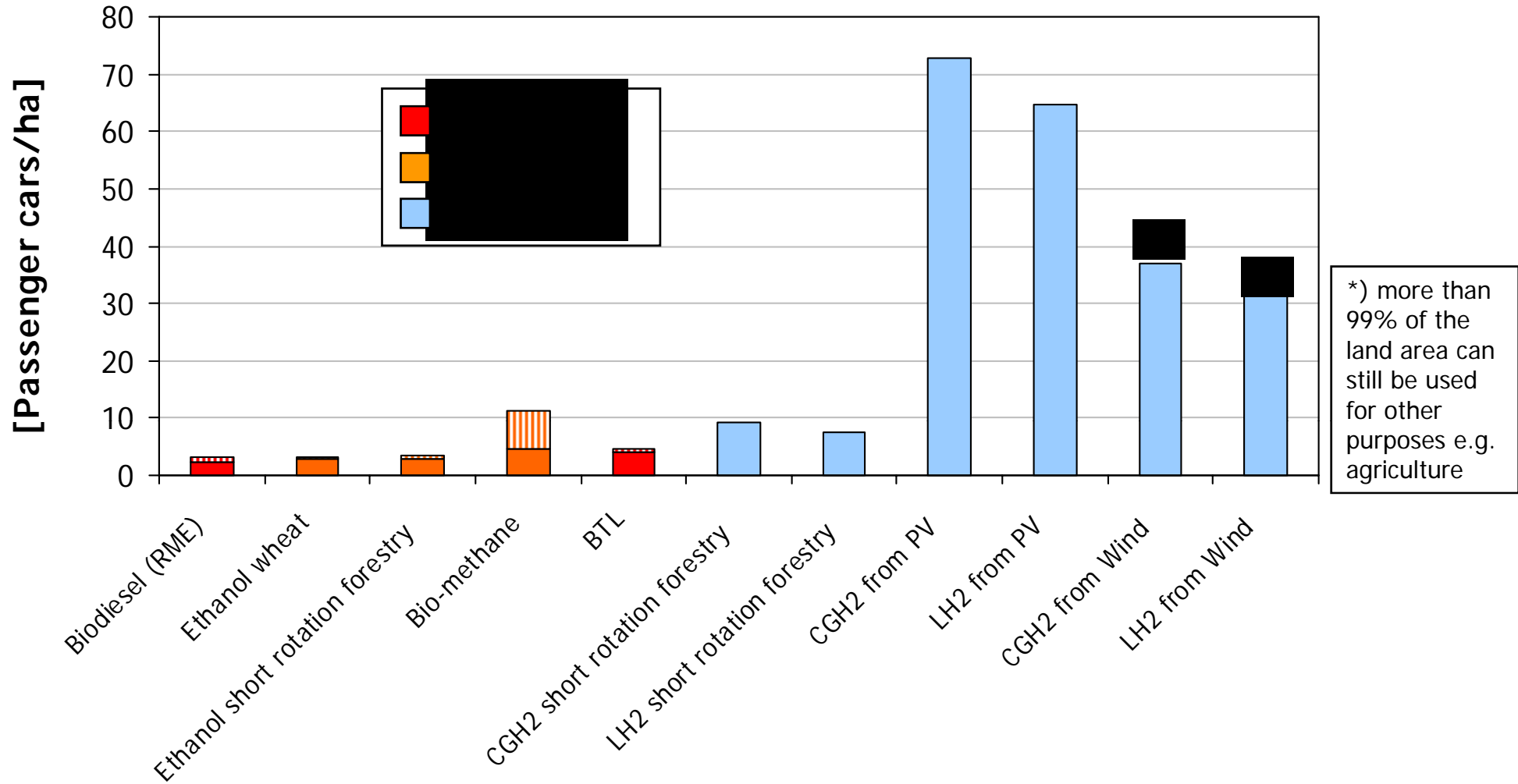
GHG emissions "Well-to-Wheel", hybrid



Compilation: LBST

Source: LBST

Fuel yield from different renewables



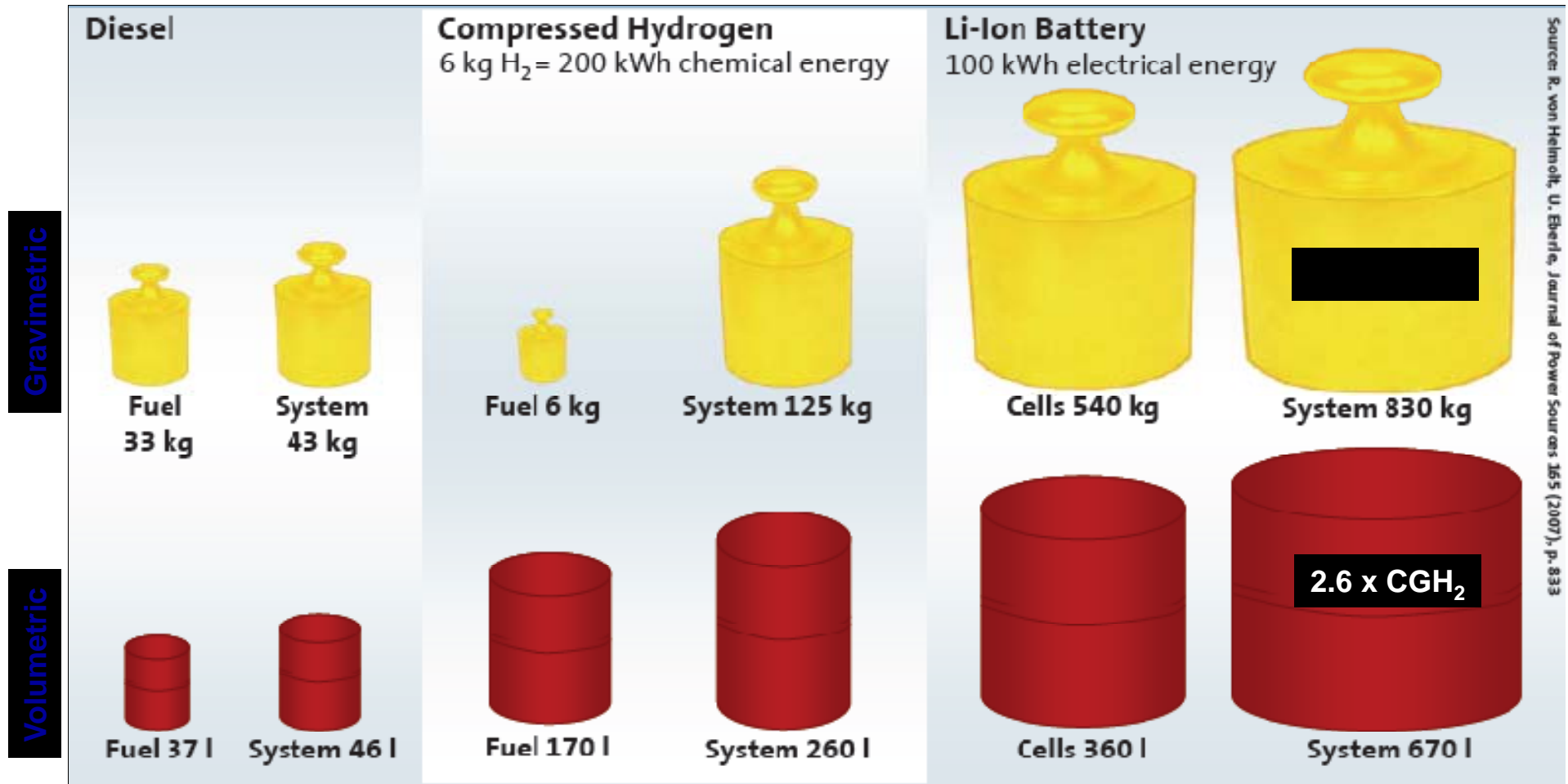
Hydrogen from solar and wind power is the most efficient alternative fuel

Fuel cell vs. pure battery car

Batteries are not a miracle cure

- Batteries are heavy
- Batteries are large
- Charging a battery takes much time
- Batteries offer only a short range of driving
- While the pure battery car certainly will play a role, it will not be the comprehensive solution

Storage densities for 500 km range



Source: R. v. Helmholtz




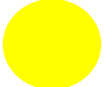
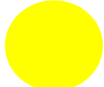



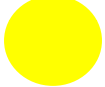

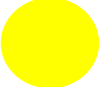




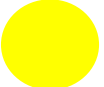


The role of pure battery cars will be mainly for short trips (city traffic)

Car maker's view on fuel cell vs. battery only





E-Drive-Portfolio - Potentials and Limitations

(only technical view!)

Each technology has particular advantages and should be applied where its optimal benefit can be guaranteed

	Compact Class	Medium-Sized Vehicles	Luxury & Family Cars	City-Bus	Overland Bus	LD Truck	MD Truck	HD Truck
Fuel Cell Vehicles								
Battery Electric Vehicles								

Principal technical fit of various propulsion variants

-  Yes – without compromises based on today's
• vehicle requirements and
• vehicle architectures
• range (operating)
• packaging
-  No – principally not
-  not from today's viewpoint
-  Yes - but with compromises

* Solid Oxide Fuel Cell – yet not emission free!

Fuel cell and battery belong together

- There is no contradiction at all between the battery (electrical storage device) and the fuel cell (energy converter). They rather complement each other.
- The pure battery car will not be the general solution for our future mobility needs, but the fuel cell can not perform well without a battery.
- All fuel cell cars operating or being developed now have a buffer battery. No car maker today pretends to be able to do without any type of hybridisation
- The fuel cell engine will also benefit from the progress of the battery

- The energy system of the future will be electricity based, and so will be the cars
- Hydrogen is the alternative fuel with the greatest potential
- Hydrogen production from solar energy will be the most economical way in the long term
- Hydrogen from wind will be the most economical way in the short and medium term
- While the pure battery car does have a role, it will not be the comprehensive solution
- We have no energy to waste – it remains necessary to reduce consumption and to change mobility habits



Deutscher Wasserstoff- und
Brennstoffzellen-Verband

Thank you very much for your attention!

And see us occasionally at

www.h2de.org