

BMW CleanEnergy.
National Hydrogen Association Conference
2007, San Antonio, Texas.



Steps towards a Breakthrough of Hydrogen
Vehicles with LH₂ Storage and ICE.
Dr. Willibald Prestl



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Steps towards a Breakthrough of Hydrogen Vehicles with LH₂ Storage and ICE.

BMW Hydrogen 7

Future Requirements

H₂ Vehicle Concept

H₂ Storage

H₂ Powertrain

Future Potentials



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BMW Hydrogen 7.

BMW takes responsibility.

First BMW H₂ vehicle to hand over to users.

First BMW H₂ vehicle in serial development process.

The only premium H₂ sedan.

**Fascinating the pioneers in Politics,
Business & Science, Culture & Media and Sports.**



→ Ride & Drive Event with Hydrogen 7

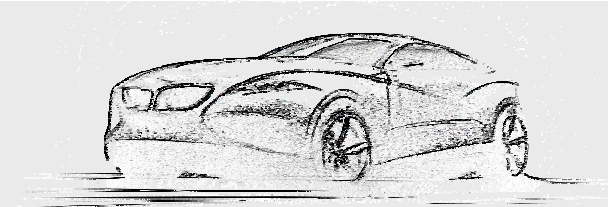
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Transition Curve to H₂.

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Future Requirements
H ₂ Vehicle Concept
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**Market
Penetration**

**Transition Phase: H₂ vehicle in
competition with conventional
and other alternative fuels**



- CO₂ & emission free
- high customer value
- industrialized technology

Transition to H₂-Mass Market

Challenges:

- convincing H₂ specific vehicle advantages
- comparable vehicle properties to conventional cars
- cost effective solutions for transition phase



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Future Requirements

H₂ Vehicle Concept

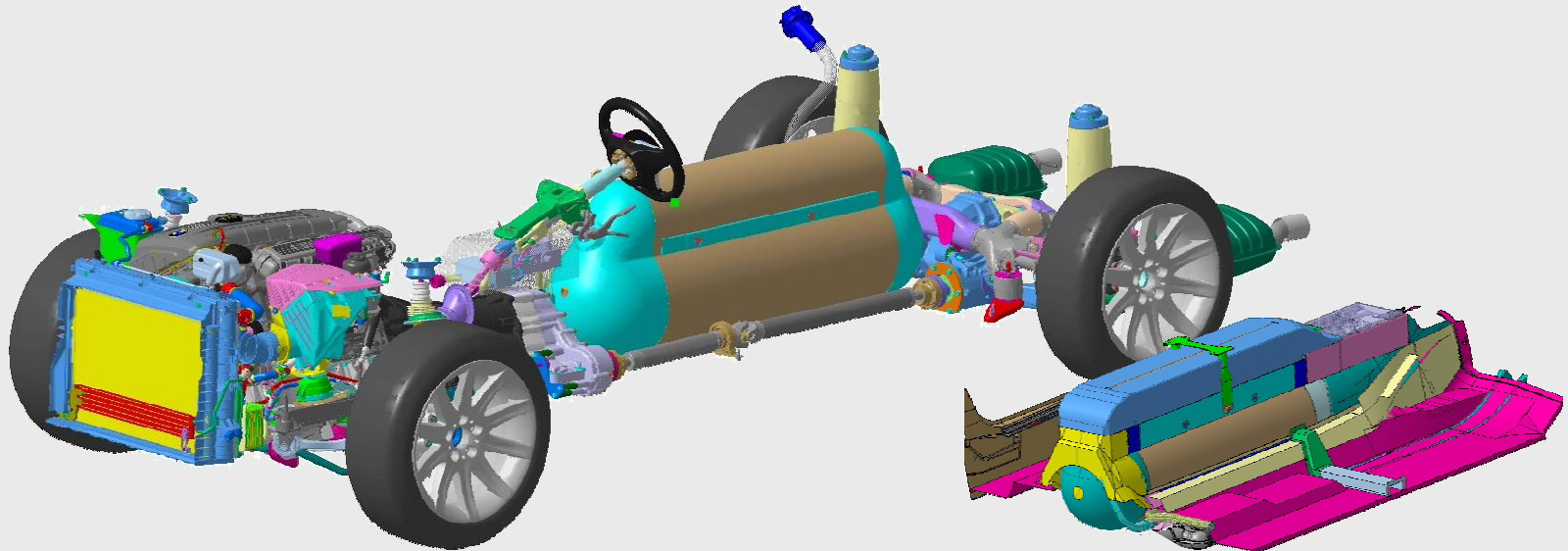
H₂ Storage

H₂ Powertrain

Future Potentials

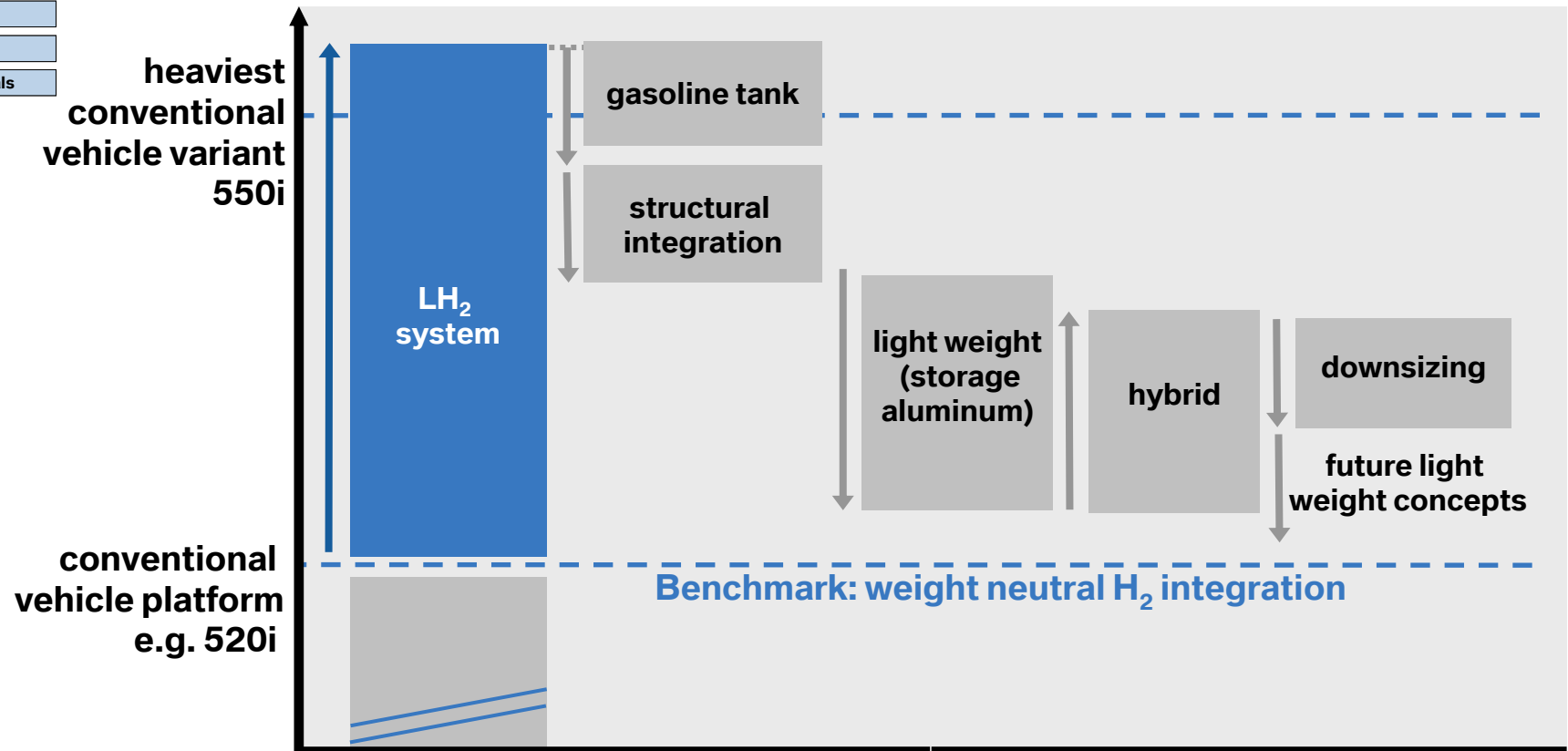
Requirements:

- flexible, cost effective conversion design with maximum communality
- powertrain in same space as conventional powertrain
 - drivetrain of high power density → ICE
- balanced load distribution, optimized inertia, limited additional weight, safest H₂ location:
 - H₂ storage of highest energy density → LH₂
 - central, structure integrated lightweight tank



H₂ Vehicle Concept. Vehicle Weight Management.

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LH₂ Storage System. Light Weight Potential.

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Future Requirements

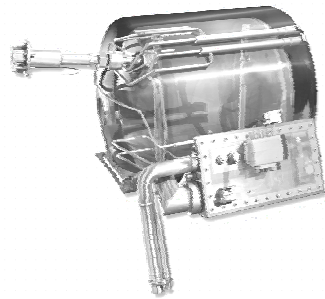
H₂ Vehicle Concept

H₂ Storage

H₂ Powertrain

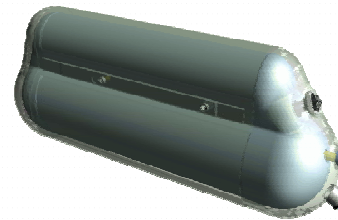
Future Potentials

**current series
storage system**



~ 220 kg

**next generations
storage system**



~ 130kg

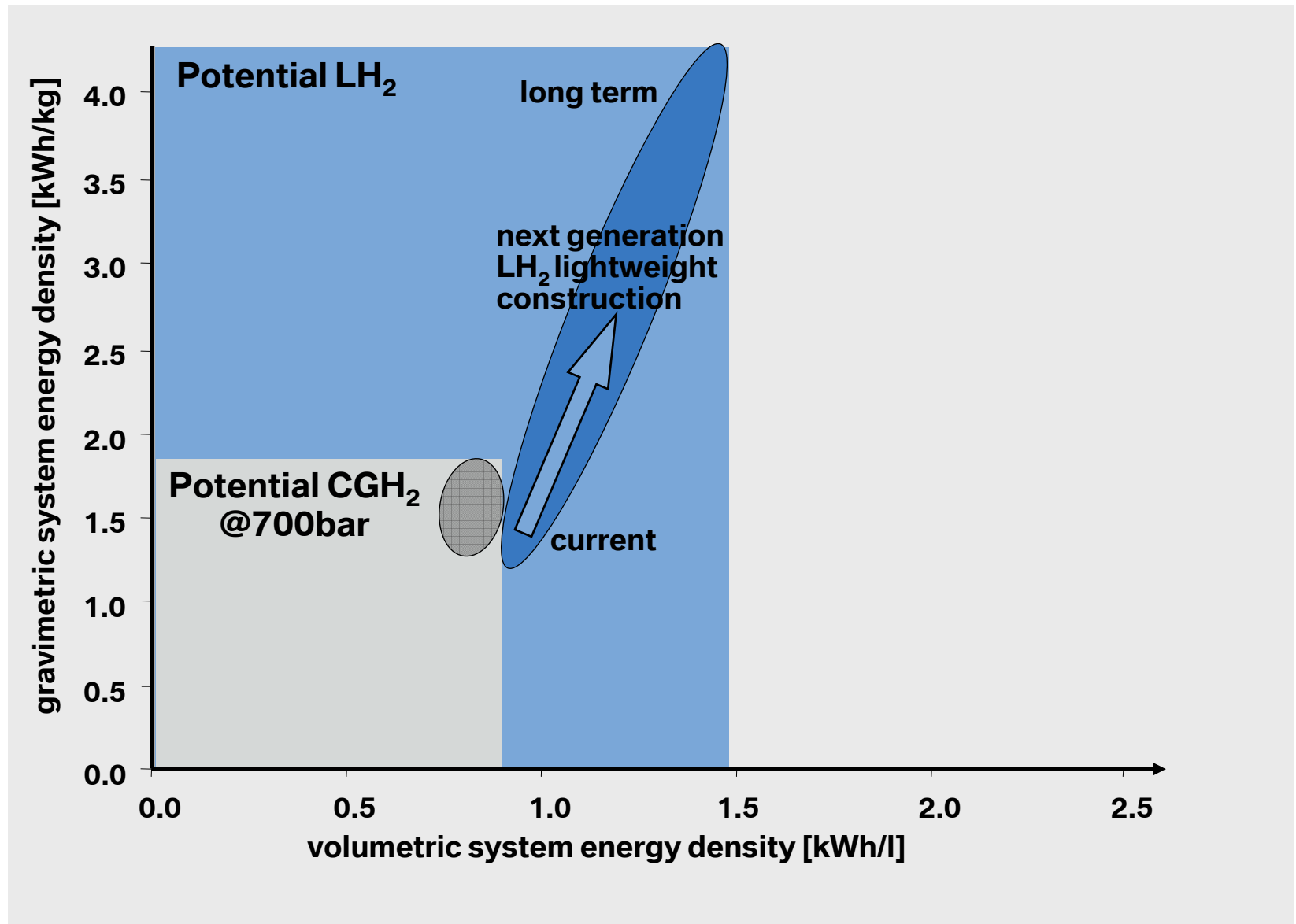
**research
storage system**



~ 80 kg

H₂ storage. Energy density.

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LH₂ Storage System. Boil Off Energy Loss.

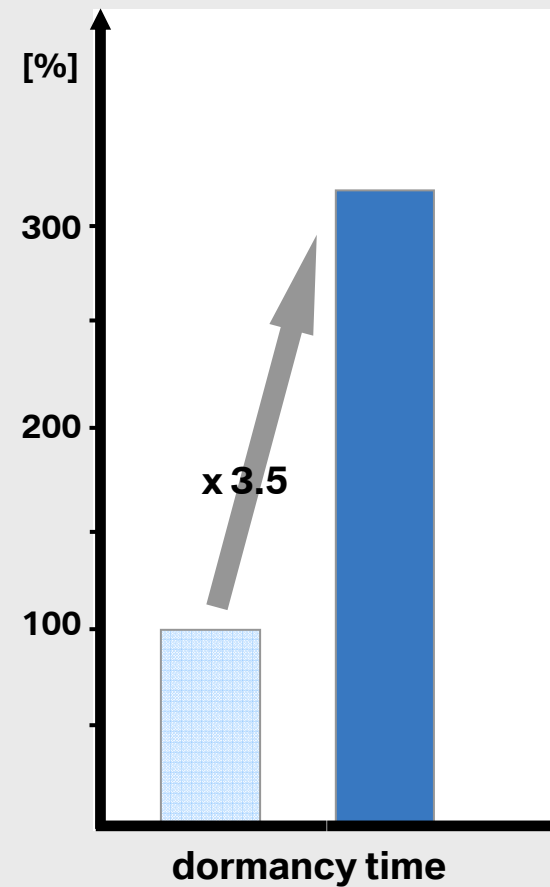
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Thermal Performance:

- significant step in energy loss free time is proven
- **no evaporation losses**
for commuters (8 km / weekday)
in daily use and over weekend

Infrequent Driver:

- LH₂ not recommended

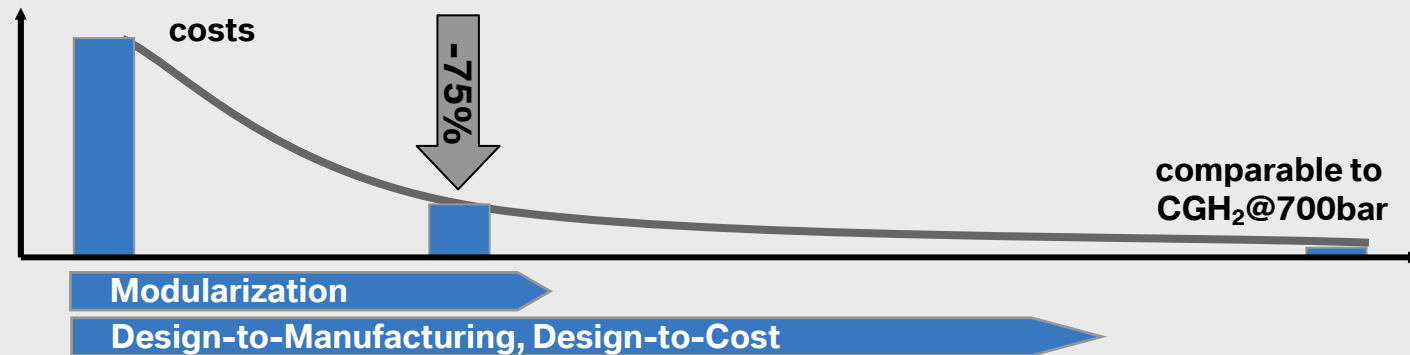


➔ “Liquid Hydrogen Vehicle Storage” by Tobias Brunner

LH₂ Storage System. Industrialization.

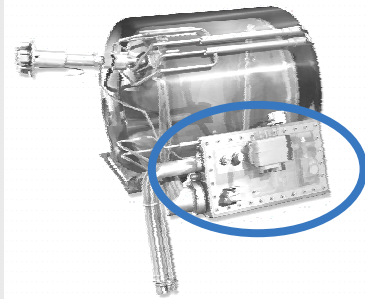
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Cost Development LH₂ Storage:

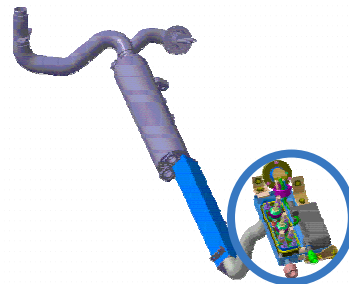


Example - Systems Control Box:

current systems
control box

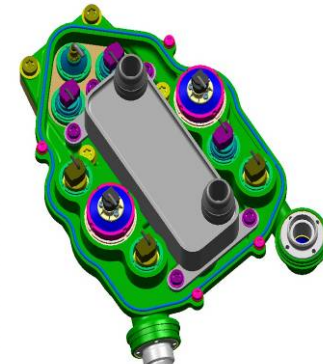


next generations



welded parts

future generations



cast part

H₂ ICE Powertrain. Internal Combustion Engine.

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example Hydrogen 7:
191kW, 390Nm, 6.0l V12

H₂-ICE Properties:

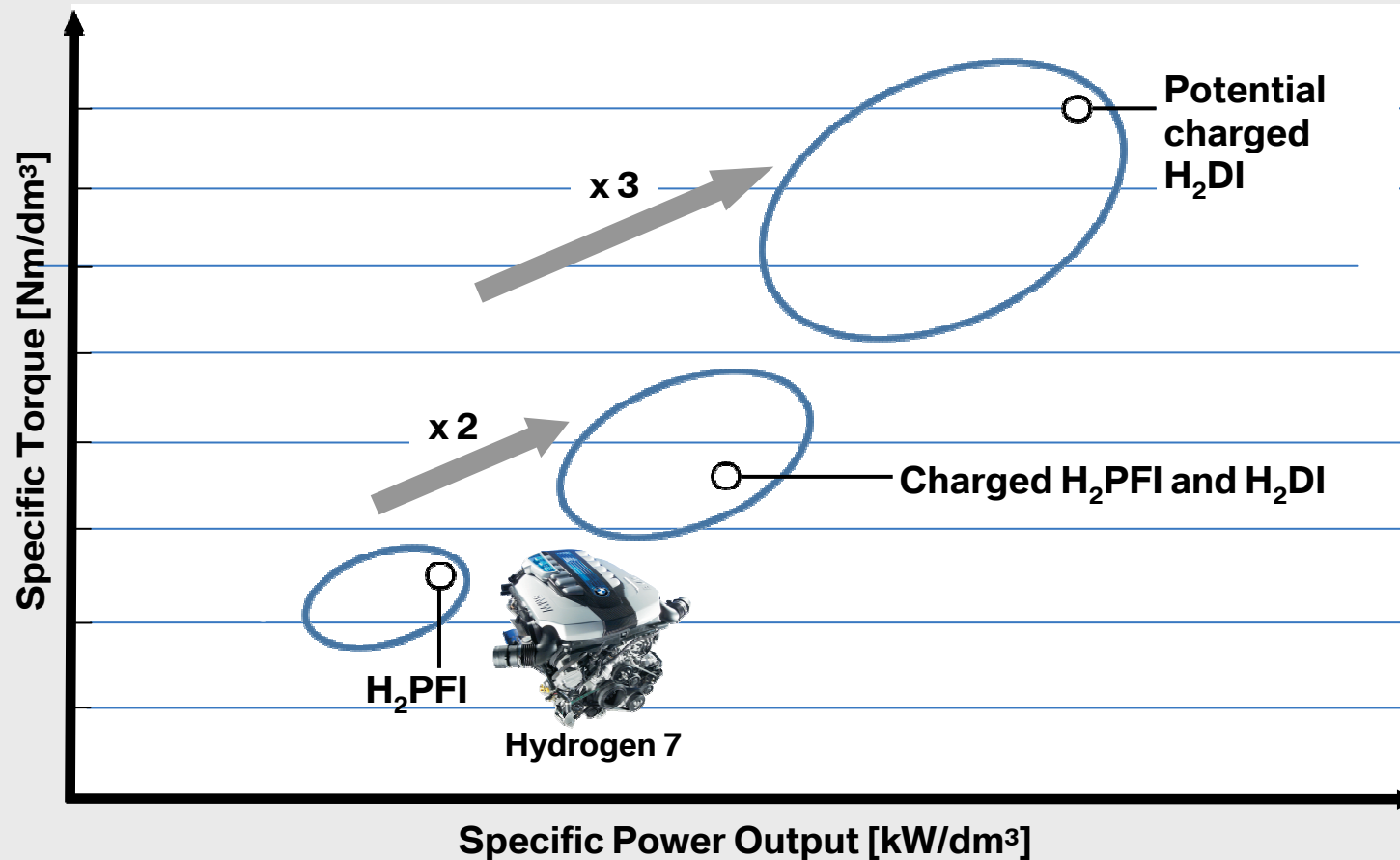
- high power density
- near zero emission (NZEV)
- high partial and full load efficiency
- robust, lifetime durability
- costs like conventional engines
- utilization of existing production / maintenance infrastructure
- flexible to all fuels
- low efficiency in idle and under low load

Potentials:

- increased power density
- optimized efficiency in advanced hybrid powertrain

H₂ ICE Powertrain. ICE Potentials.

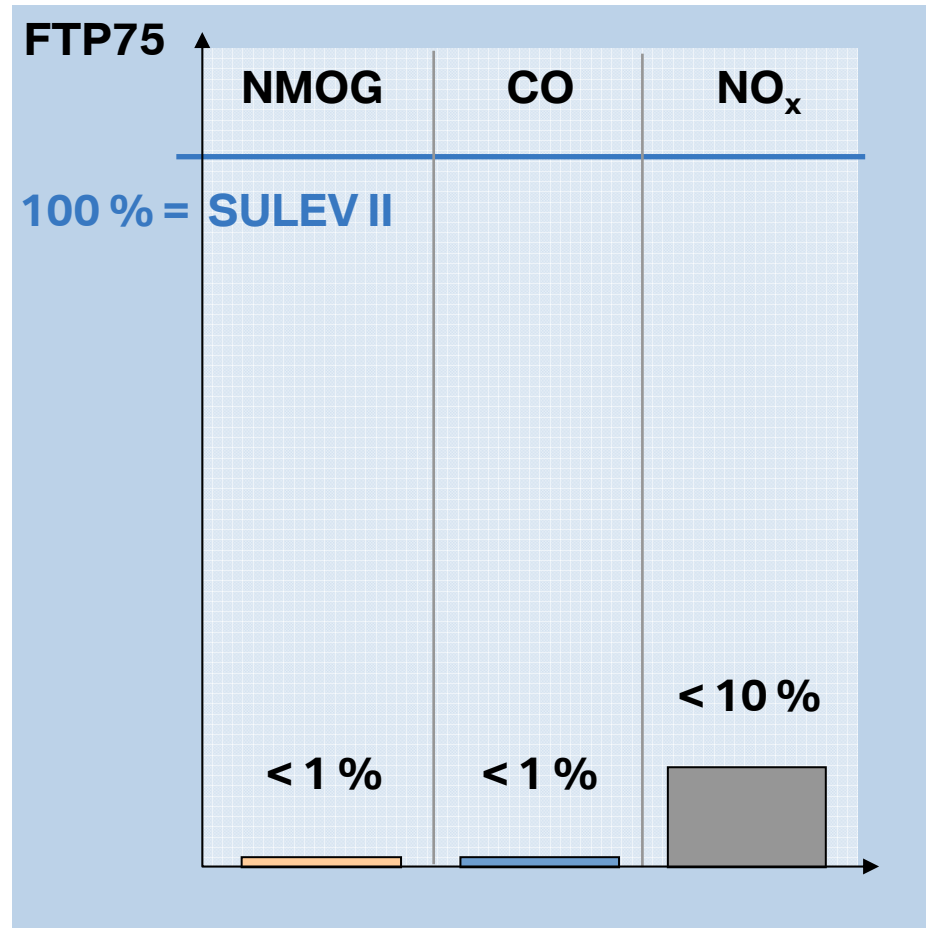
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➔ “Combustion Analysis of a Hydrogen DI-Engine” by Hermann Rottengruber

H₂ ICE Powertrain. Emissions Strategy.

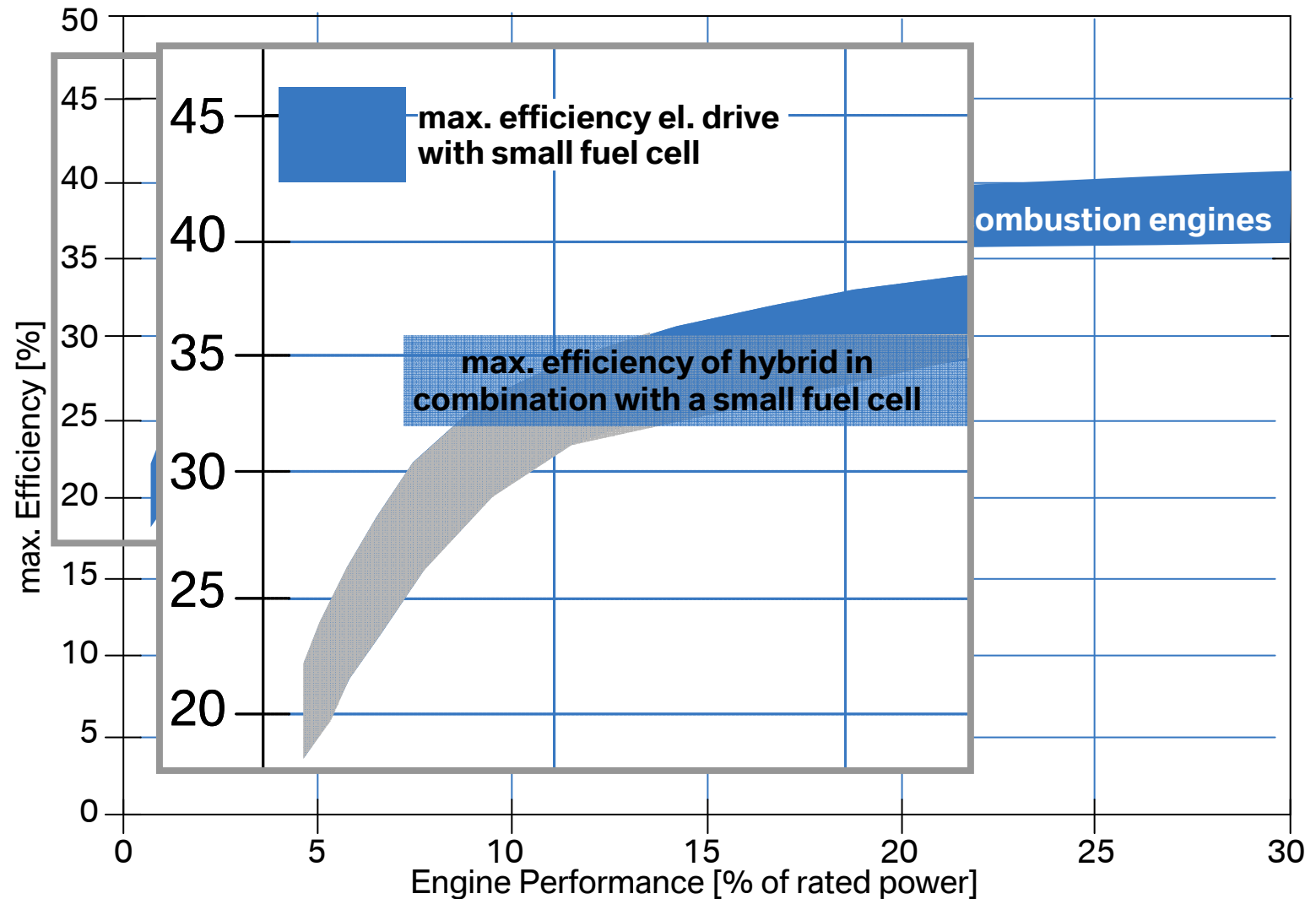
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H₂ ICE Powertrain.

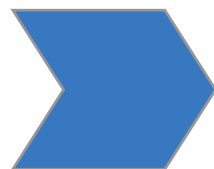
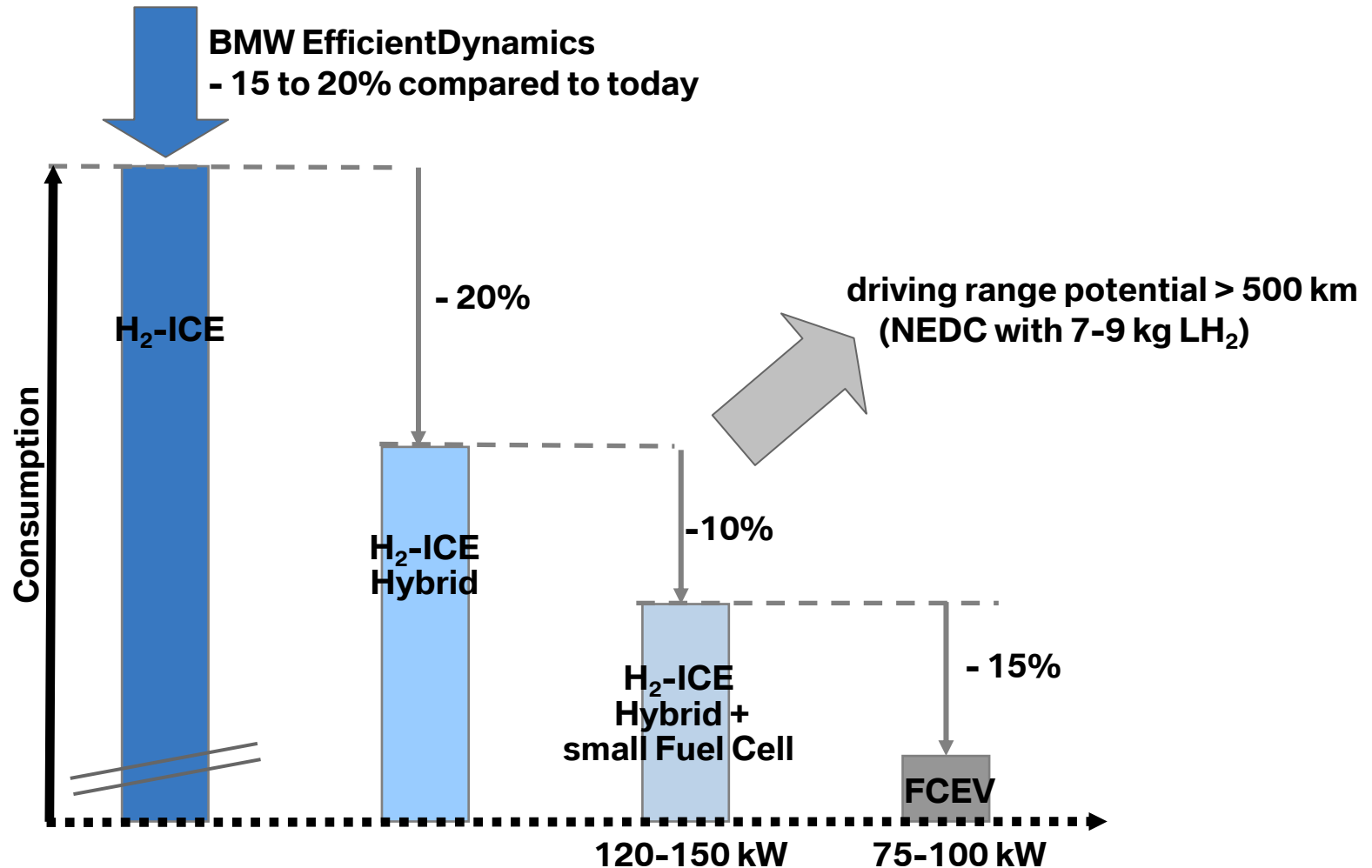
Efficiency Potential ICE Hybrid.

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H₂ Advanced Powertrain. Consumption Potential ICE Hybrid.

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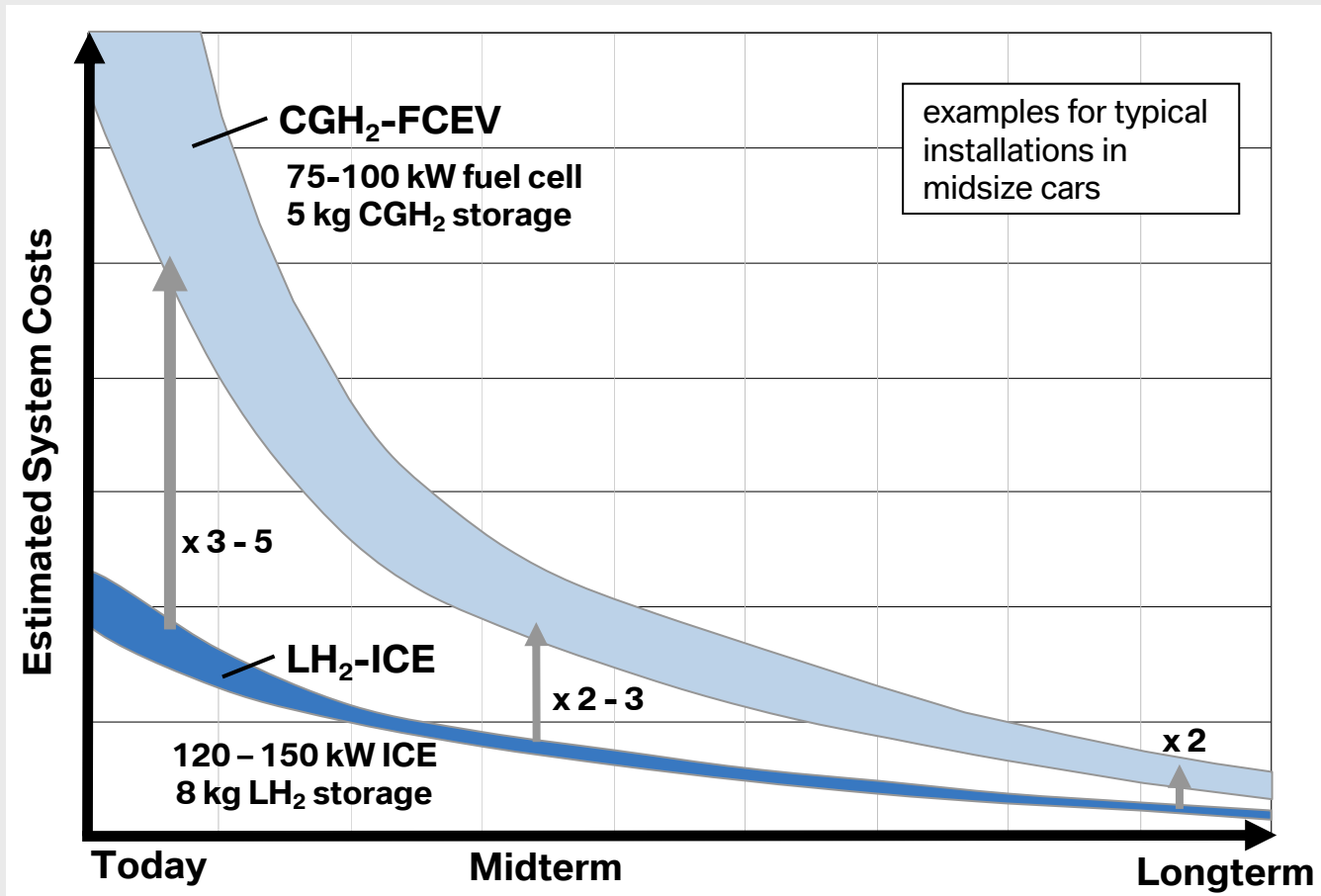
Advanced H₂ ICE powertrains:

- consumption potential of up to 30 % possible
- FCEV advantage with up to 15 % (on different performance level)

H₂ System Comparison.

Cost Comparison LH₂-ICE vs. CGH₂-FCEV.

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BMW CleanEnergy. Summary.

BMW Hydrogen 7

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H₂ Powertrain

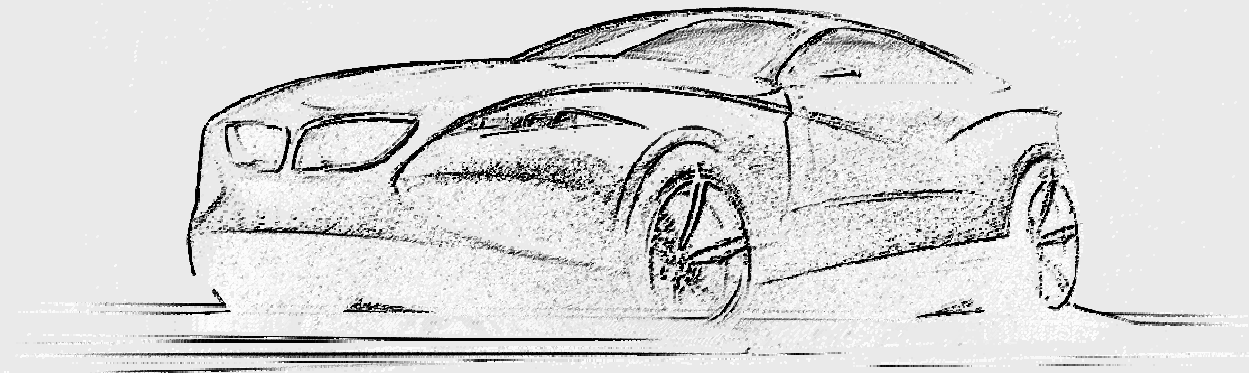
Future Potentials

H₂ ICE hybrid powertrain

- practically emission free
- high power density
- high fuel efficiency
- industrialized technology
- robustness

LH₂ storage

- high energy density
- minimized energy loss
- light weight
- cost effective



H₂ vehicle

- convincing H₂ advantages
- high customer value
- cost effective solution
- potential for industrialization

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Thank you for your Attention.



It's not a Sprint
It's a Marathon.

BMW CleanEnergy.
An Initiative of the BMW Group.