WABENTANK

# „ DLR Modular-Free-Shapeable CNG Tank – A Hybrid, Composite Intensive Design“
## Current State

Dipl.-Ing. Diego Schierle
Prof. Dr. Horst E. Friedrich
DLR Institute of Vehicle Concepts
Stuttgart


DLR

WABENTANK

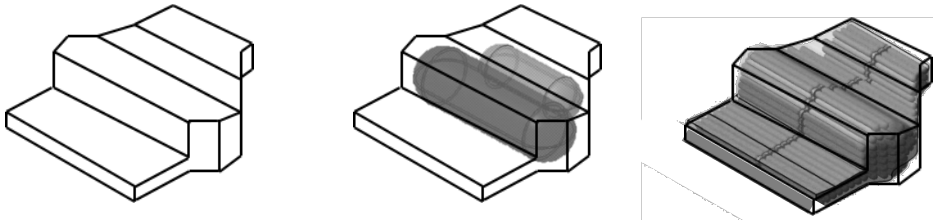
# Contents



WABENTANK

# 1. Social Challenge

- **Social Challenge**
  - ➢ Demand for alternatively fueled vehicles [Ulk13]
- **Compressed Natural Gas as an alternative**
  - ➢ Emissions are lower than petrol or diesel
  - ➢ Medium-term transitional solution [Sta12]; [Gei12]; [Pet11]
- **State of the Art CNG storage system**
  - ➢ Natural gas as CNG in vehicles is stored in cylindrical tanks[Gru12][GM08]



100% Ca. 30% Ca. 60%

WABENTANK

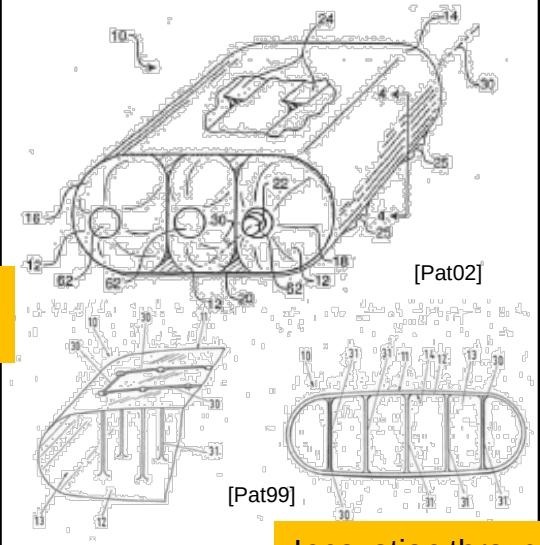
# 2. State of the Art for CNG-Tanks

## Industry

Innovation through
**Lightweight material**

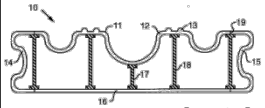
| Hersteller | Ansatz | Quelle |
|---|---|---|
| CNG Cylinders International | CNG 3 | www.cng.us.com |
| Dynetek Industries Ltd. | CNG 3 | www.dynetek.com |
| ENK | CNG 3 | www.enkcf.com |
| Faber Industrie | CNG 3 | www.fiber-italy.com |
| Gastank Sweden | CNG 3 | www.gastank.se |
| Lincoln Composites | CNG 3/4 | www.lincolncomposites.com |
| Luxfer Gas Cylinders | CNG 3 | www. luxfercylinders.com |
| Quantum Technologies | CNG 4 | www.qtww.com |
| Ragasco | CNG 4 | www.hexagonragasco.com |
| Xperion | CNG 4 | www.xperion.energy.de |
| 3M | CNG 4 | www.3m.com |

## Patents



[Pat02]

[Pat99]

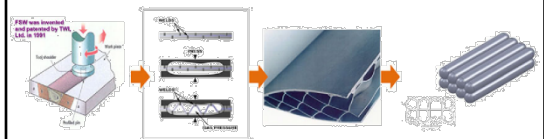


[Pat94]

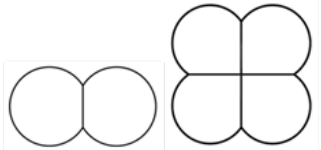
Innovation through
**Lightweight shape**
**→unsolved technical challenges**
**→no real shape adaptivity**

[Pat02] DE69622022T2, 2002
[Pat99] DE19749950A1, 1999
[Pat95] EU 0633422A1, 1994

## Research



[Sim13]



[Kim05]

[Sim13] Simmons, K.: Low-Cost Efficient manufacturing of pressurized conformal compressed natural gas storage tanks, Pacific Northwest National Laboratory, 2013
[Kim05] Kim Y.H. et.al.: A conceptual design and structural efficiency evaluation of 20ft container shape CNG tank, Journal of Society of Naval Architects of Korea, 2005

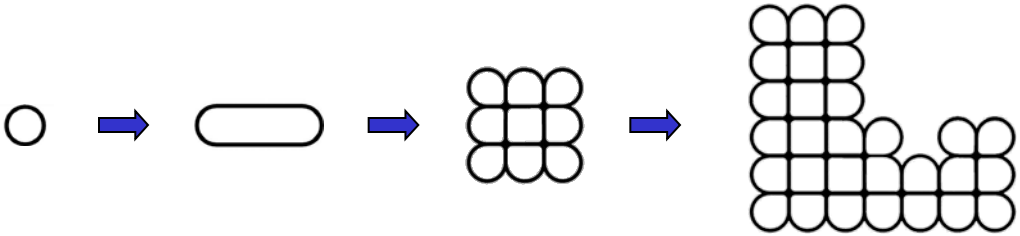
DLR

WABENTANK

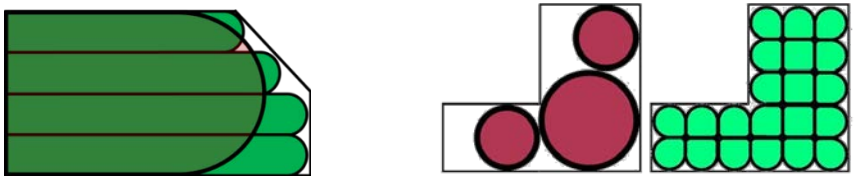
# 3.Technology – DLR-Wabentank

## Tanks with a wide range of packaging possibilities are an enabler for CNG-Vehicles

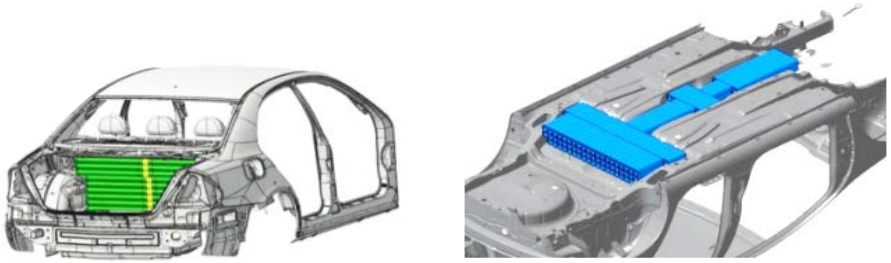
**Basic Concept – DLR-Patent**



**Variability in the use of the available space**



**Mercedes Benz E-Class: ca. + 38% demonstrated**

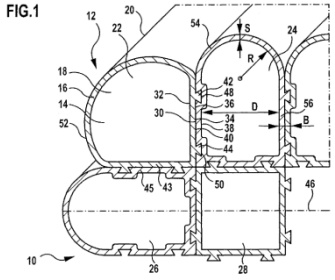


DLR

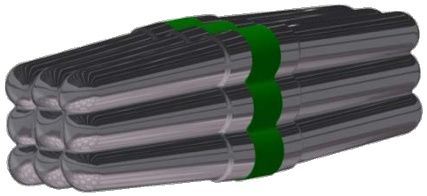
WABENTANK

# 4. History of the DLR-Wabentank

- DLR-Wabentank as an idea ca. 10 Years old
- Different stages of development:




[Kö03]

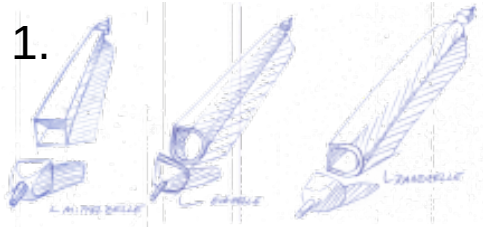


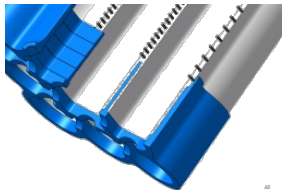
[LLBT09]

[Str11]

metal thermoplast thermoset

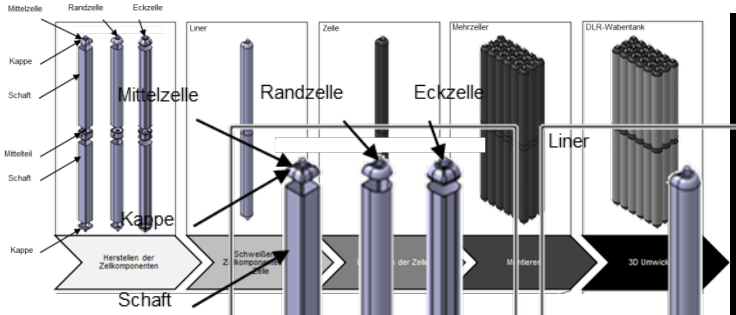
- Project to develop the automated production steps for a thermoset „DLR-Wabentank“
- Dividing the complexity in 3. subsystems:

1. 

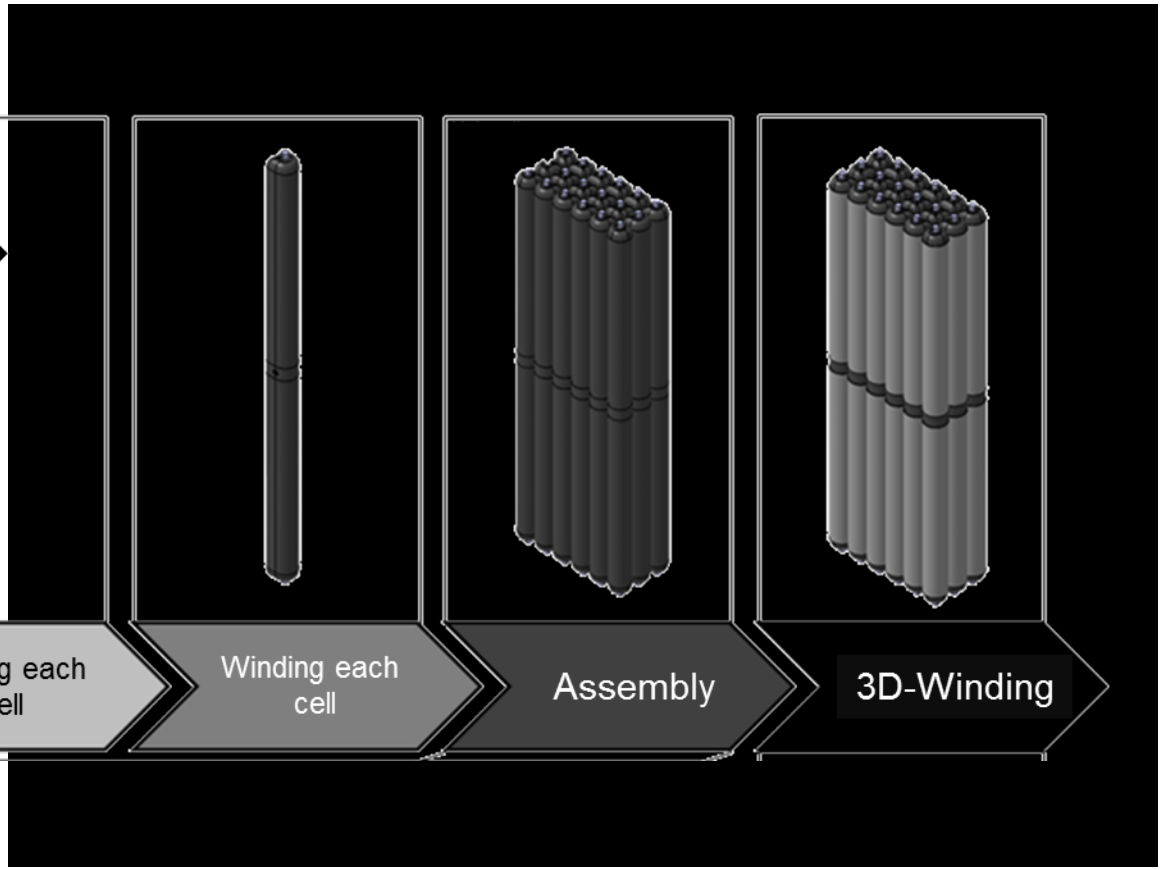
2. 

3. 

# 5. New Production Approach DLR-Wabentank




- DLR-Wabentank Stand 2013:
  - Automated Production
  - Modular Expansion
  - 18% > Volumen
  - Automated Production starts at 201

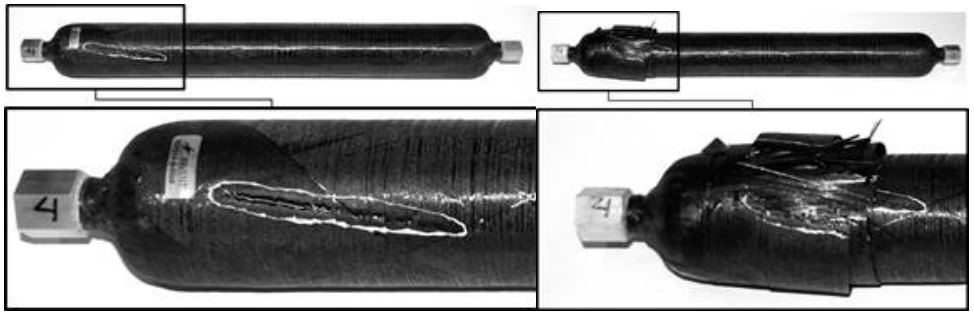


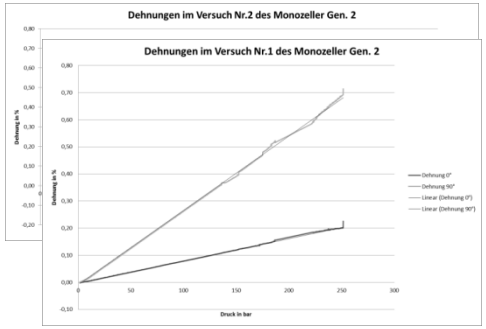

WABENTANK

# 5. Subsystems: Cell

- 0,5mm Aluminum Liner
- **Non-rotation-sym. Liner** full winding

- Burst pressure tests on rotationally symmetrie liners

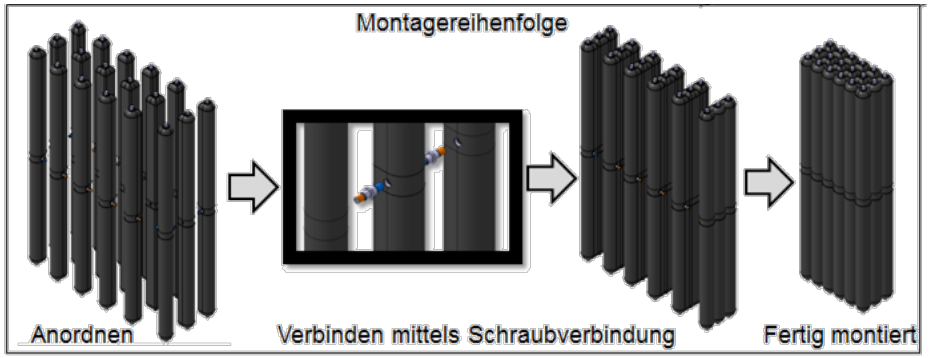


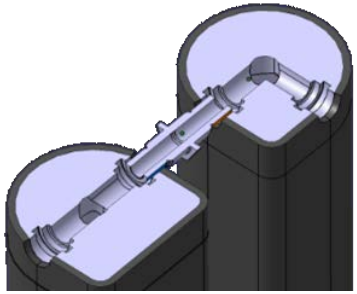


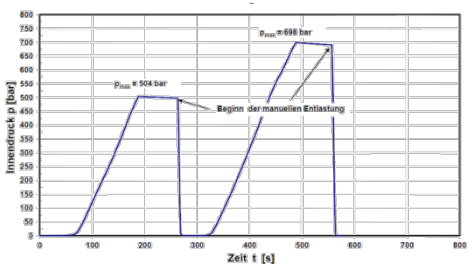

DLR

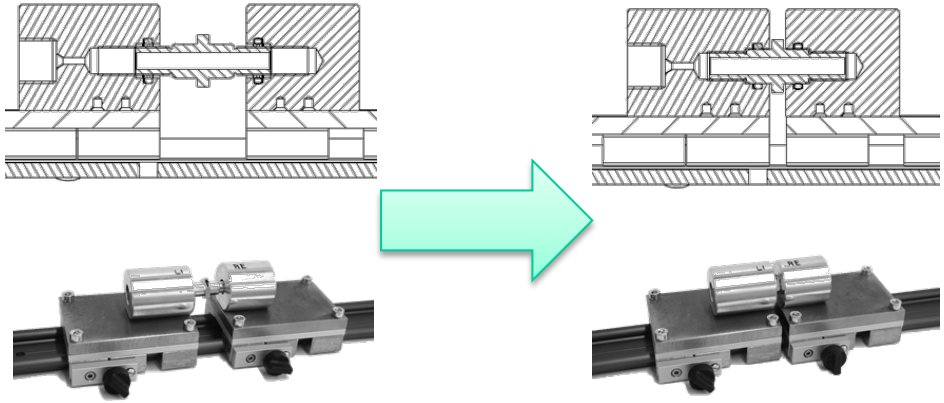
WABENTANK

# 5. Subsystem: Gas-Connecter





Validated:

- Burst pressure (500bar & 700bar)
- Pressure cycles

  (10bar-250bar→500 000cycles)

DLR

WABENTANK

# 5. Subsystem: 3D-Winding




- Tool with a max. width of 2mm and a length of 500mm
- Undergoing trials

DLR

WABENTANK

# 6. DLR-Wabentank Potential

- The production of a “Modular-Free-Shapeable CNG Tank” as the DLR-Wabentank could enable further CNG-Vehicles

- 18% > Volume → increasing range of CNG-Vehicles

- Customer benefits

- DLR-Wabentank is able to be incorporated at any stage in the vehicle development process

WABENTANK

WABENTANK

# Source

*Ulken, M.:* Umweltauflagen: Deutschland darf keine Ausnahme bekommen. http://www.zeit.de/auto/2013-04/luftverschmutzung-deutschland-potocnik. Version: 04 2013

*Stan, C.:* Alternative Antriebe Für Automobile: Hybridsysteme, Brennstozellen, Alternative Energieträger. Springer Vieweg, 2012
*Geitmann, S.:* Alternative Kraftstoe: Erdgas & Flüssiggas  Biodiesel & Panzenöl  Wassersto & Strom - Womit fahre ich am besten? GRIN Verlag, 2012

*Peters, Christian A.;* et. Al.: Erdgas und Biomethan im künftigen Kraftstomix / Deutsche Energieargentur. 2011. Forschungsbericht

*Gruenweg, T.:* Autogramm VW Eco Up: Mit gutem Gewissen Gas geben. http://www.spiegel.de/auto/aktuell/vw-macht-den-kleinwagen-up-mit-einem-erdgasantrieb-zum-oeko-auto-a-871533.html. Version: 12 2012

*GM Global Operations*: Dicherheitsanordnung für Gastank eine Kraftfahrzeugs.2008

DLR