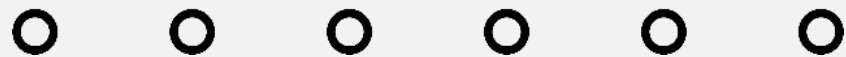


# HEGGEMANN



Digital. Efficient. Sustainable.

Simulation possibilities in the innovative aerospace supply industry.

Dr. Thomas Meyer

DYNAmore Infoday Automotive and Aerospace Applications, December 1, 2022 - Berlin

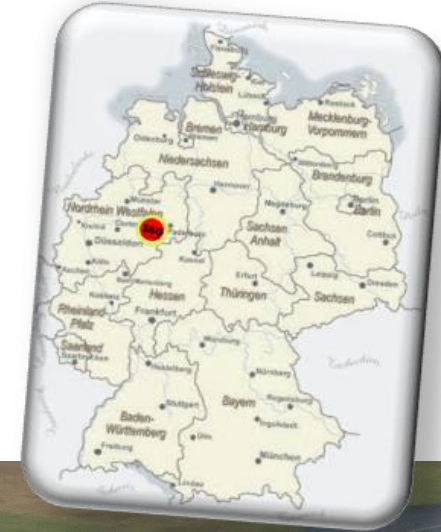


- Facts & Figures HEGGEMANN AG
- Aerospace Trends & Challenges
- Simulation Applications & Possibilities at HEGGEMANN
- Conclusion



## Company Overview

Year of Foundation	1962 (by Paul Heggemann)
Employees	230 (includes 15 Apprentices)
Managing Board	Dr. Christian Howe (CEO) • Jan Wesendahl (CTO) • Sven Breustedt (CCO)
Supervisory Board	Robert Heggemann





### Development and qualification of lightweight structures as well as ready-to-install systems!



**Aerospace**

Aerospace technology



Automotive efficiency



Automotive  
&  
Industrial

### Digitized industrialization and highly efficient production of small and medium quantities in high quality!



Certifications

DIN EN 9100 / AS 9100

DIN EN ISO 9001

EASA Part 21G

EASA Part 145

Certified and Qualified Welders DIN ISO 24394

Nadcap™ AC 7110/5 Welding

Nadcap™ AC 7114/1 and /2 NDT (FPI and MPI)

DIN EN ISO 3834-2; DIN 2303 BK1, Q 1,2 & 4

Customer Approval: Airbus, GE Aviation

Customer Approval: MTU, Rolls-Royce

AIRBUS





Portfolio / References



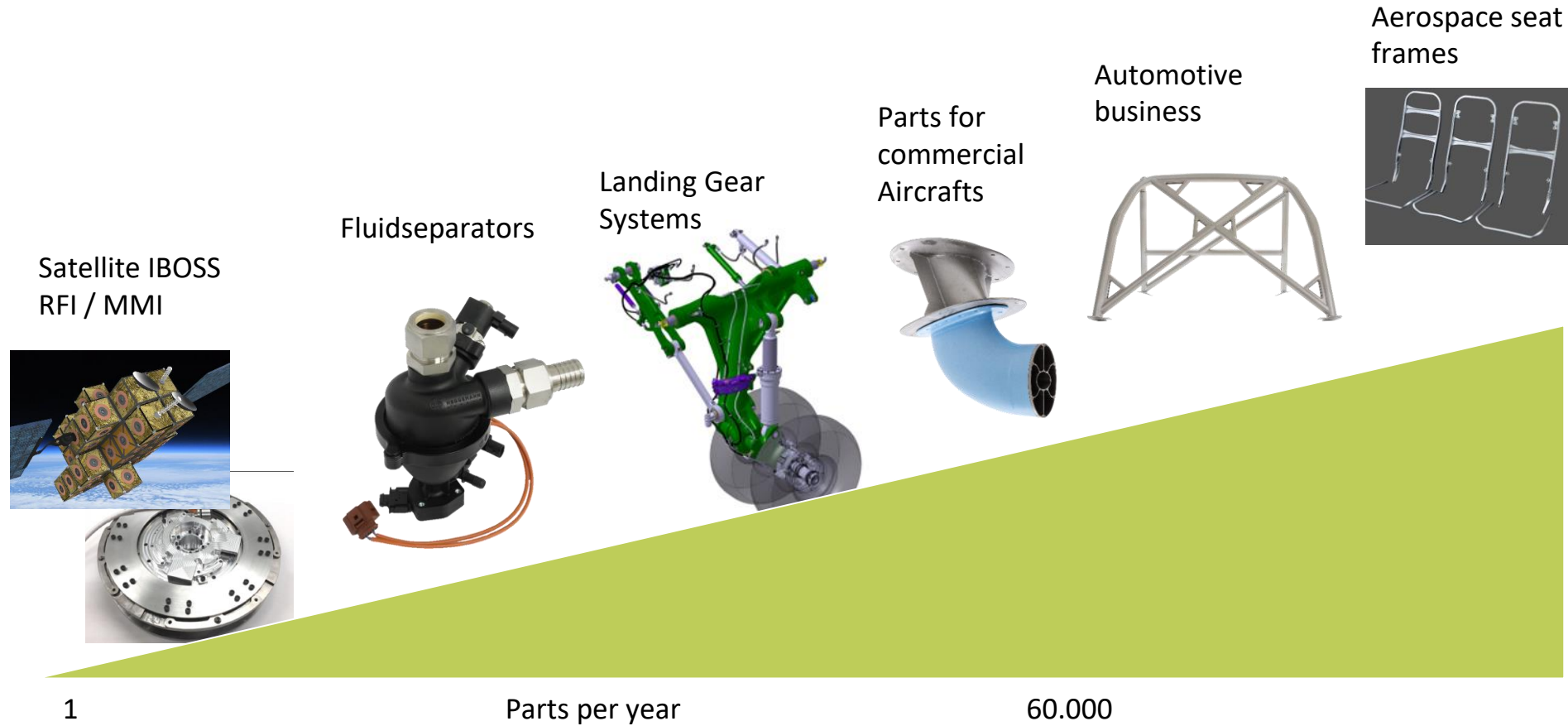
DEUTSCHE AIRCRAFT



Audi

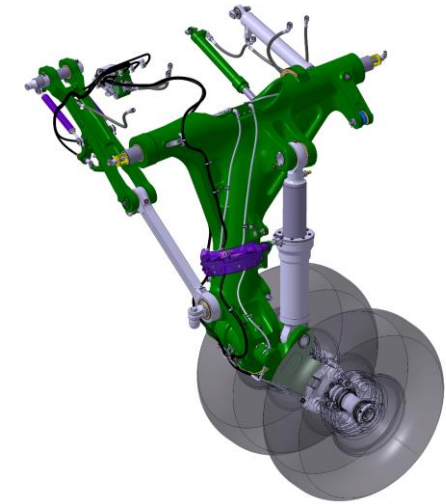


From small to large scale production





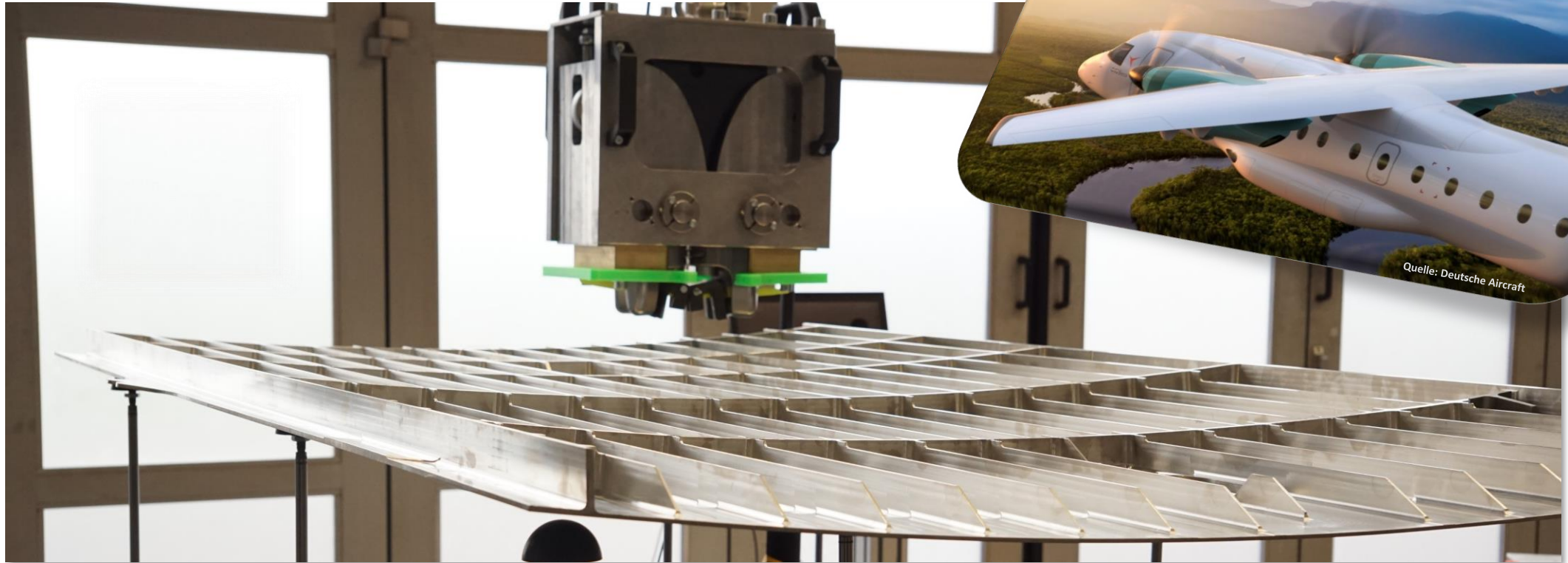
## D328eco Landing Gear System:



### Technical data Drop Test Bench:

- Max. Drop Mass: 15.000 kg
- Height: 9.70 m
- Drop speed: 8 m/s (at 3.3 m free drop height)
- Electric wheel rotation up to 300 km/h
- High Speed Video Camera!

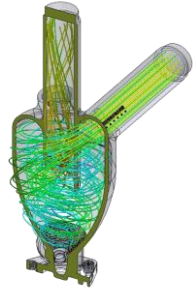




**Scope of Work  
HEGEMANN**

- >>> D328eco Wingbox: Total length approx. 21 m; approx. 4,000 individual parts; SAF suitable
- >>> Process development for semi-automated production of the Wing-Box with digitized end-to-end process according to "Industry 4.0" standard
- >>> Construction of the production line and series production from 2025

Forming simulation  
with LS-DYNA



### Layout & Design

- Design adapted to installation space
- Scalable volume
- Flow simulation
- Custom interface & mounting options
- Separation efficiency of up to 99% with low pressure losses
- Optional: integrated level sensor




### Test & Validation

- In-house test stand for static operating points
- Design & function validation incl. transparent fluid separator
- Climatic chamber tests ( icing!)



### Manufacturing

- Quantity 1 to xxxx
- Rapid Prototyping (Short Time to Market)
- Number of pieces depending on design to cost & industrialization
- High quality through established quality management
- Ready-to-install, tested system incl.
- Purge & Drain valves (Strategic partner: 



Source: AIRBUS





Co-Operation with Technology R&D-Institutes and Universities





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**About 80% of the world's population  
have never flown in their lives (2019).**

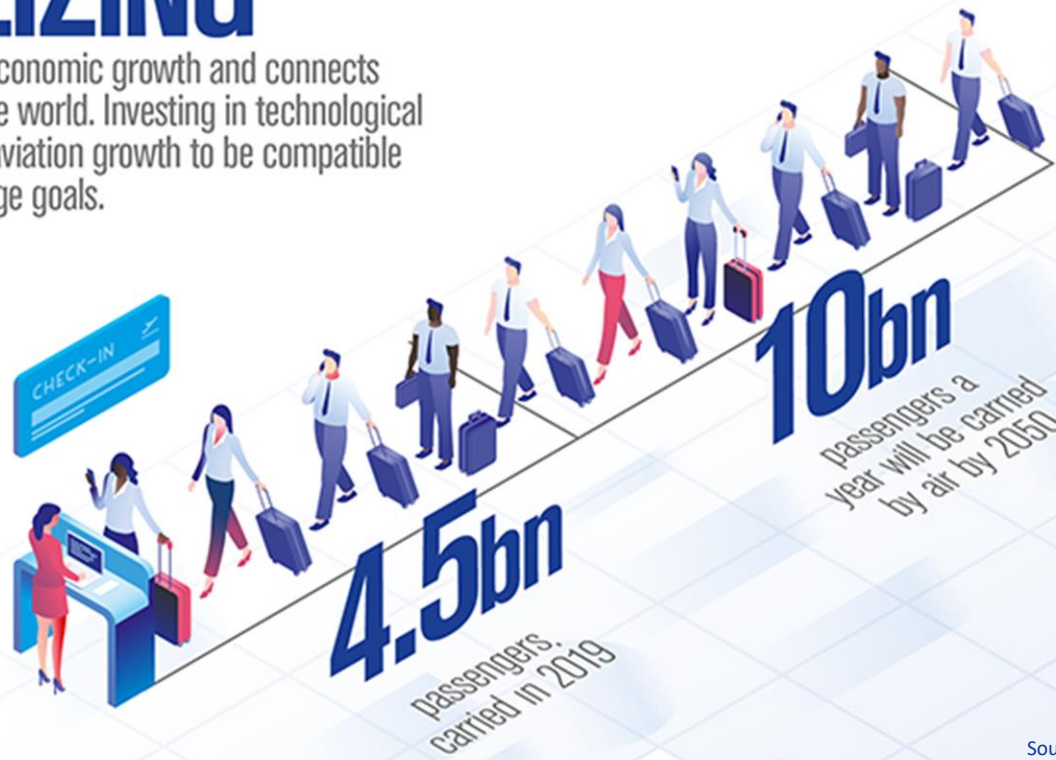
Source: [www.aero.de](http://www.aero.de)



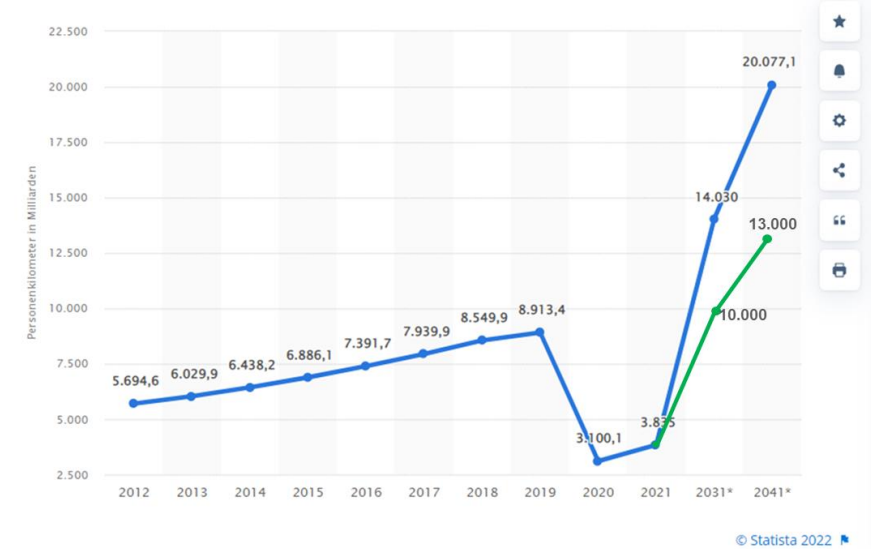
### Sustainable Growth

# MOBILIZING

Aviation drives global economic growth and connects communities across the world. Investing in technological innovation will enable aviation growth to be compatible with vital climate change goals.



Development of global passenger air traffic from 2012 to 2041 (in billion passenger kilometers)





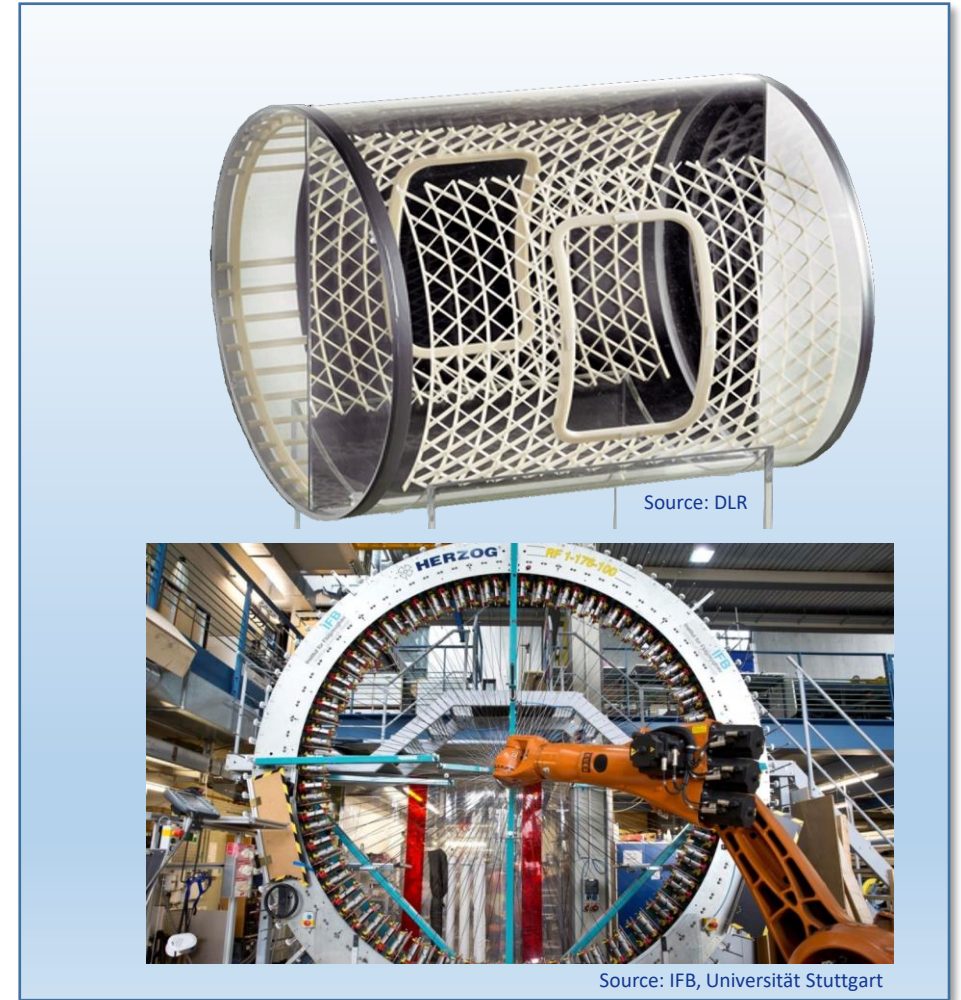
## Need for disruptive manufacturing technologies



Source: Bundesarchiv Bundesarchiv Bild 146-1976-097



Source: www.aero.de



Source: DLR

Source: IFB, Universität Stuttgart

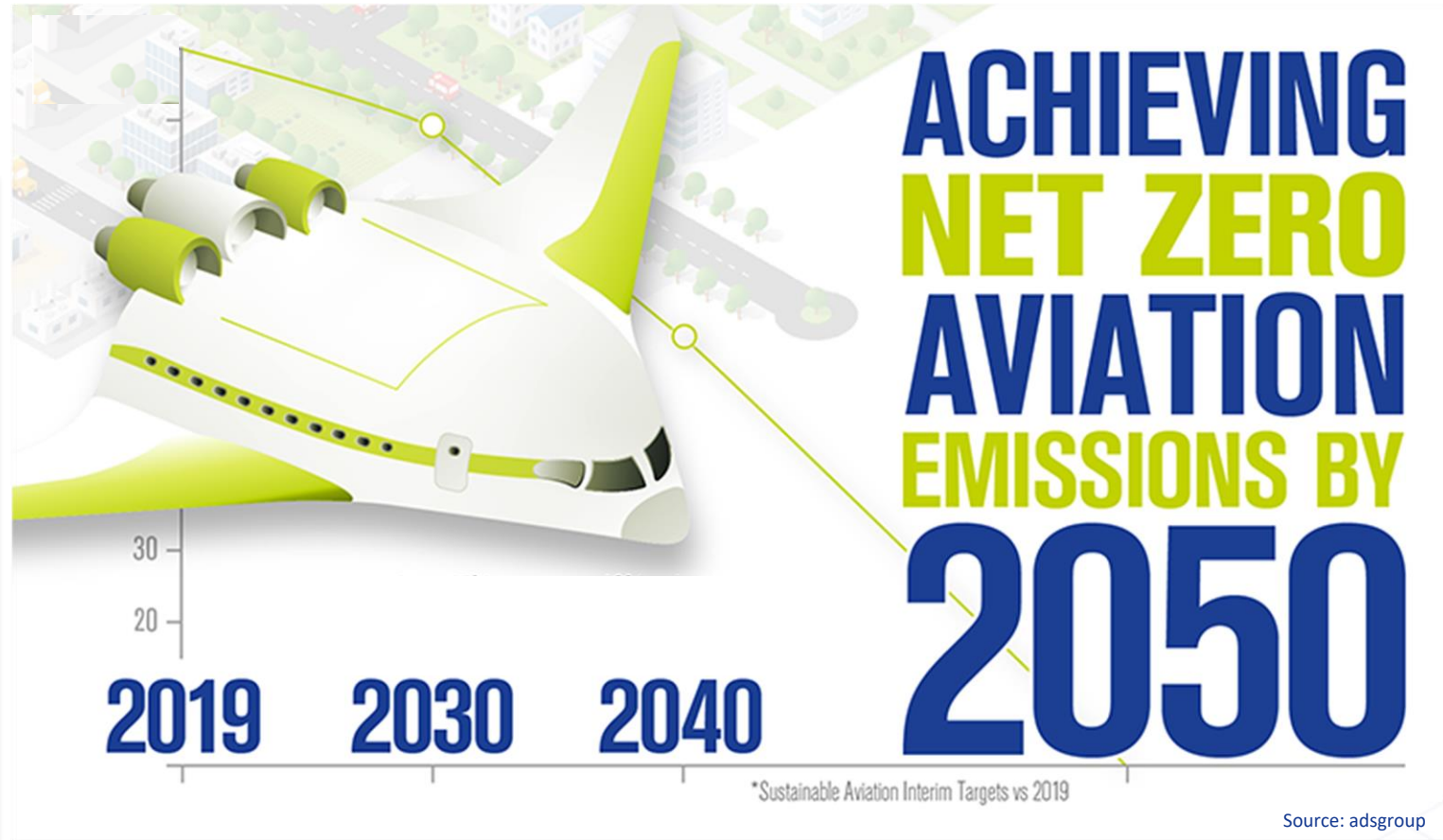


### Reduction of the environmental impact

- ✈ 2,5% of global CO2 emissions from aviation\*
- ✈ Aviation contributes 3.5% to global warming\*



Source: dpa



\* DLR Study, 3.9.2020





## Reduction of the environmental impact

**\$150bn**  
global investment into efficiency research and development in the last decade

**INNOVATING**  
Investment in accelerating technology development will drive future emission reductions.

**£1.5bn**  
awarded by Aerospace Technology Institute in the UK to 327 R&D projects since 2013

**15% - 20%**  
more fuel efficiency with each new generation of aircraft

**IMPROVING CORE TECHNOLOGIES**  
Ongoing development of aircraft design, engine performance, fuel efficiency and weight reduction deliver ever-improving emissions reduction.

**30%**  
improvement in efficiency by 2030 compared to 2005

**42%**  
predicted reduction in global aviation emissions through aircraft technology innovation

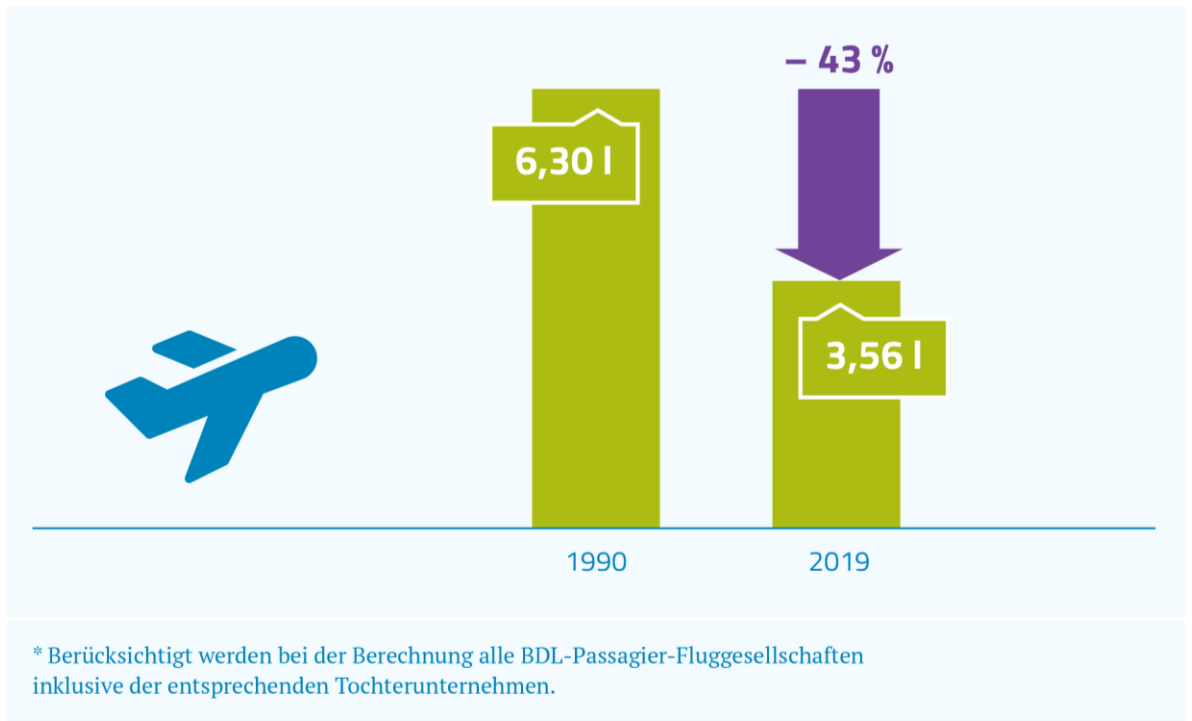
Next Generation Engines

System Electrification

Composite Materials

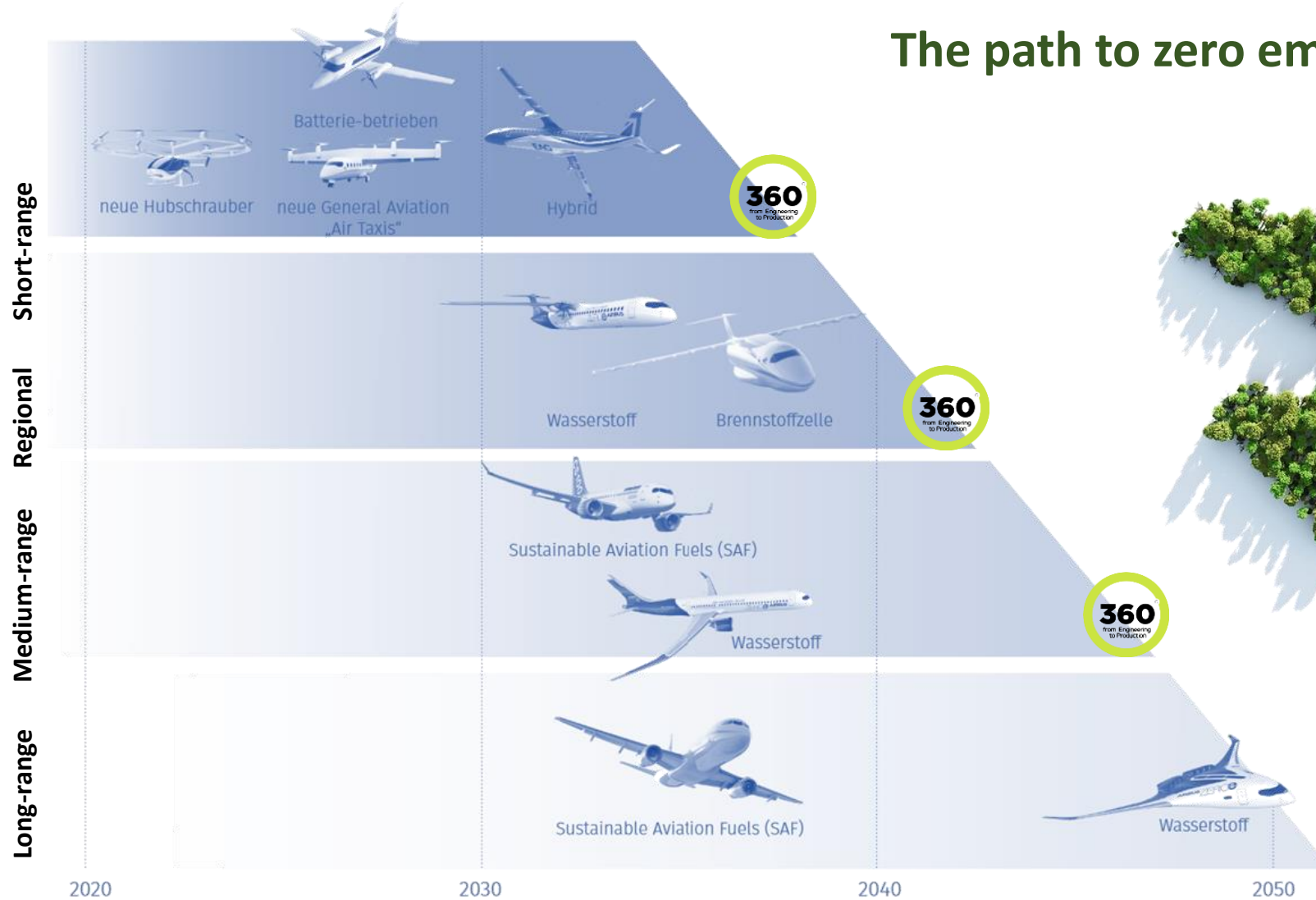
Source: adsgroup

## Average kerosene consumption of the German aircraft fleet in liters per passenger per 100 km



Quelle: Bundesverband der Deutschen Luftverkehrswirtschaft (BDL) auf Grundlage von Unternehmensangaben

Source: Klimaschutz-Portal.aero



## The path to zero emission flying!

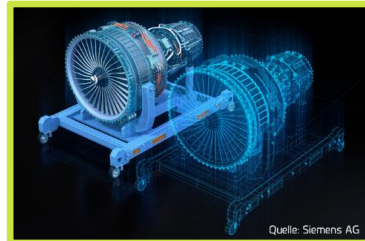
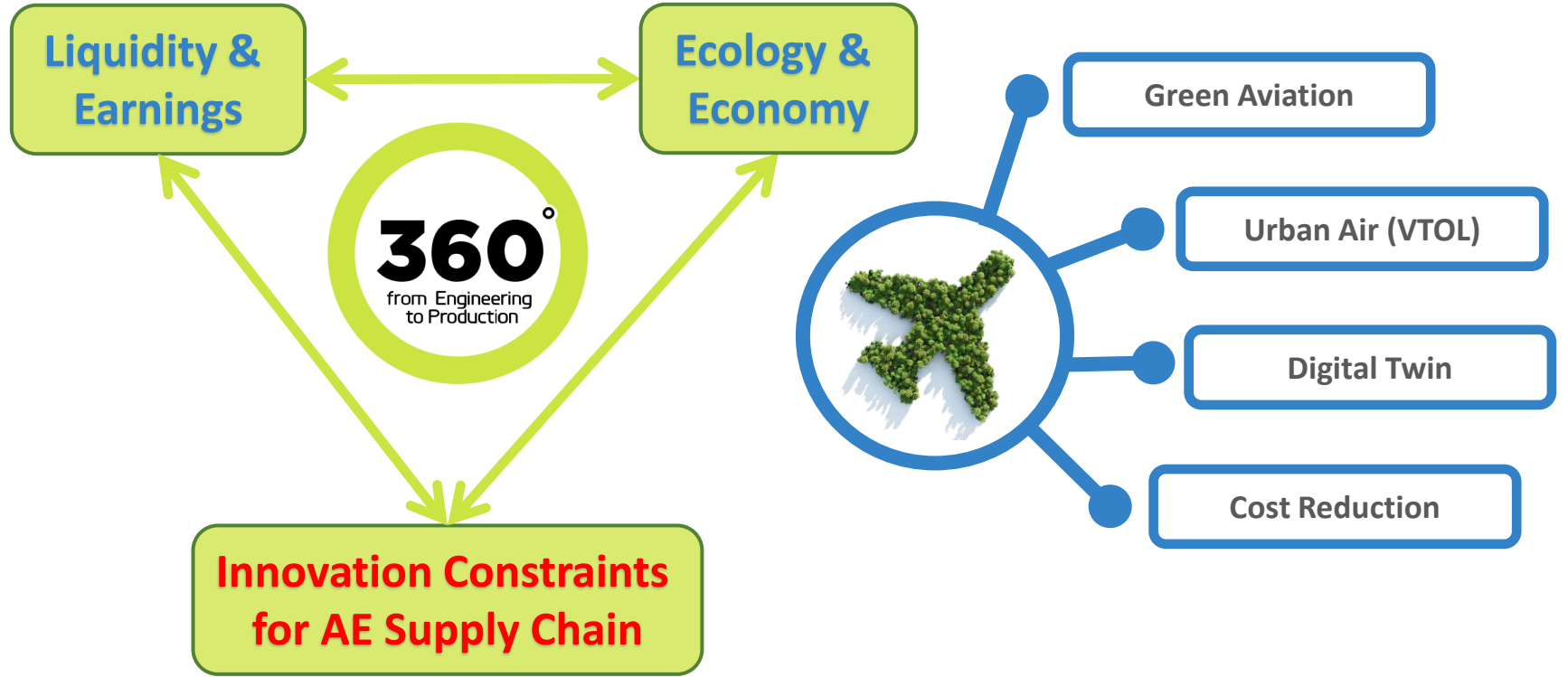
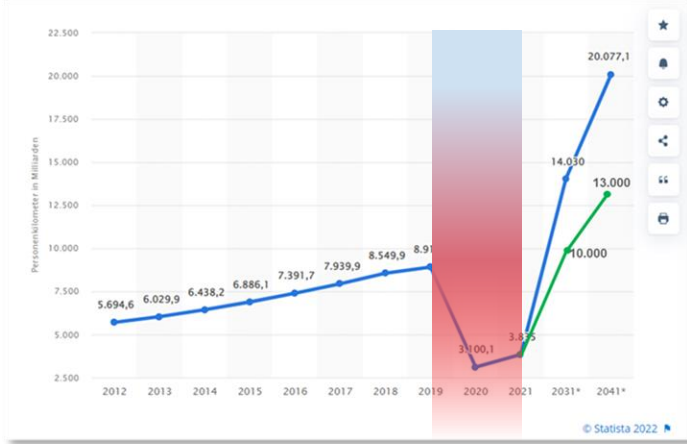


Source: Altair Advisory

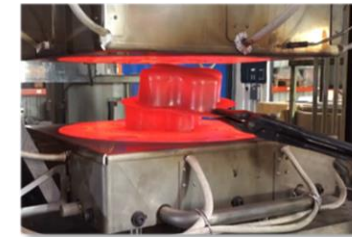
Source: BDLI, 2020



## AE supply industry in the area of tension



Quelle: Siemens AG





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Determination of characteristic values for material model at temperatures up to 850°C

Ermittlung aller Kennwerte bis 850 °C

- Fließkurven
- Reibwerte
- Umformtests
- Wärmeübergangskoeffizient
- Emissionskoeffizient

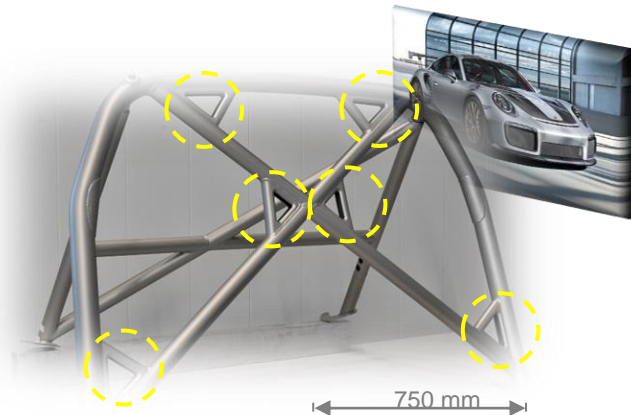
Numerical process simulation, verification of characteristic values and validation of material properties

**DYNA MORE**

TI-AIG-V4  
T = 800 °C  
t = 60 s

10 µm

Validation of the simulation with industrialized manufacturing technology and quality assurance



## Project "Titanium roll cage"

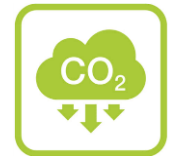
# Component: "Ti gusset plate"  
# Alloy: Ti-6Al-4V,  
# Quantity: 18,000 pcs.



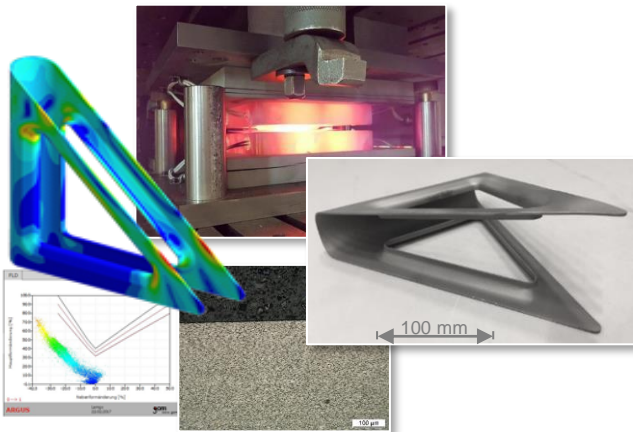
Material saving:  
23.7 t titanium in series production  
(1.32 kg per component)



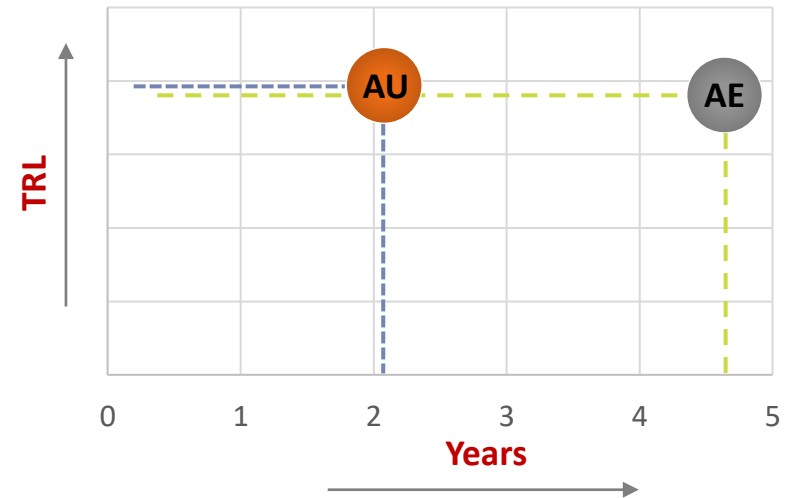
Energy saving:  
2.6 GWh in series production



CO2 savings:  
> 72 t CO2 in series production



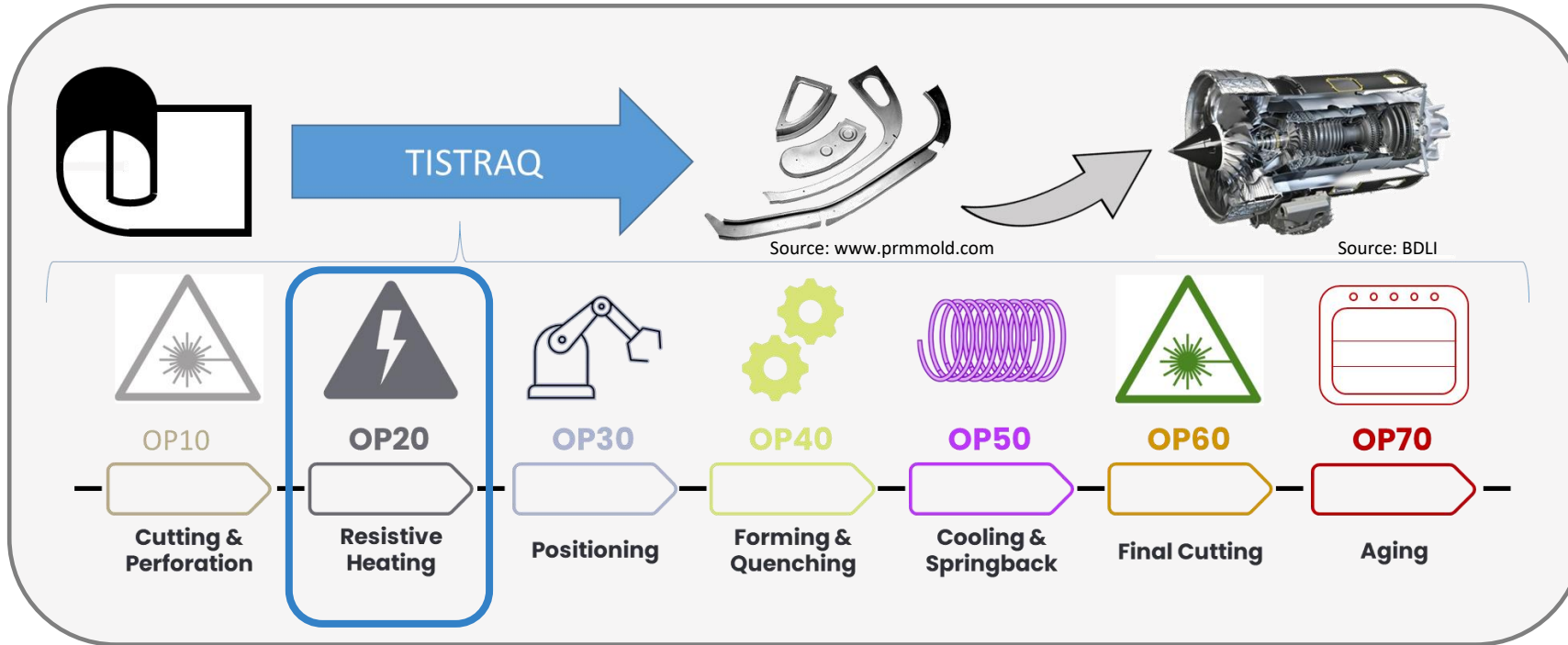
## TRL\* Ti Hotforming: AU vs. AE



\*TRL = Technology Readiness Level  
International Standard for the Assessment of Development new technologies based on systematic analysis.  
☐ TRL 1 (basic research) to TRL 9 (ready for series production)



### TISTRAQ: Titanium Solution Treated and Rapid Quenching



New efficient and resource saving process for sheet metal forming of Ti-6AL-4V with additional potential for increasing the technological mechanical properties!

Project Partner:



Supported by:



on the basis of a decision by the German Bundestag

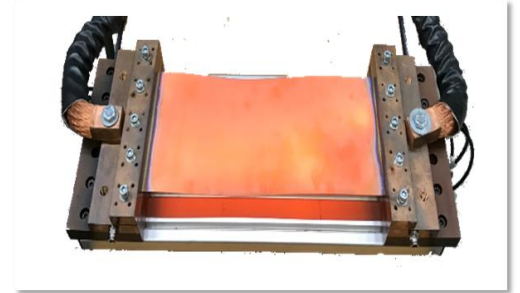


## Process: resistive heating of metal blanks for complex geometries

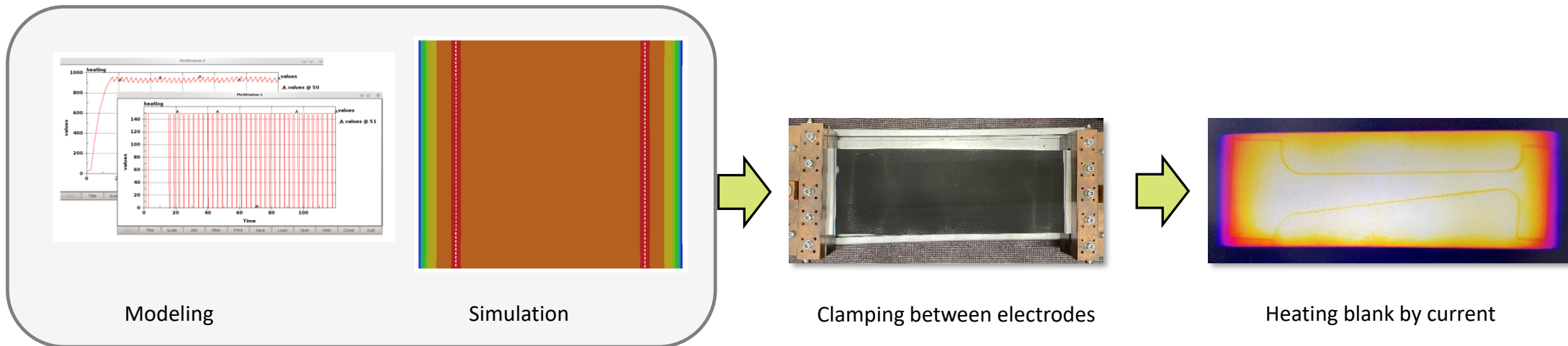
- Rectangular cut is necessary for a uniform heating by current
- Integration of complex contours through perforation by laser cutting
- Perforated contour cracks during forming from rectangular blank → Forming process as usual

## Advantages:

- Very quick heating ( $T > 950\text{ °C}$  in few seconds, scale reduction, optimization of material properties)
- Very homogeneous heating pattern despite perforation
- Furnace replacement → Cost reduction (purchase, maintenance, energy, space requirements)



In co-operation with **DYNA MORE**





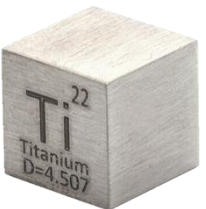


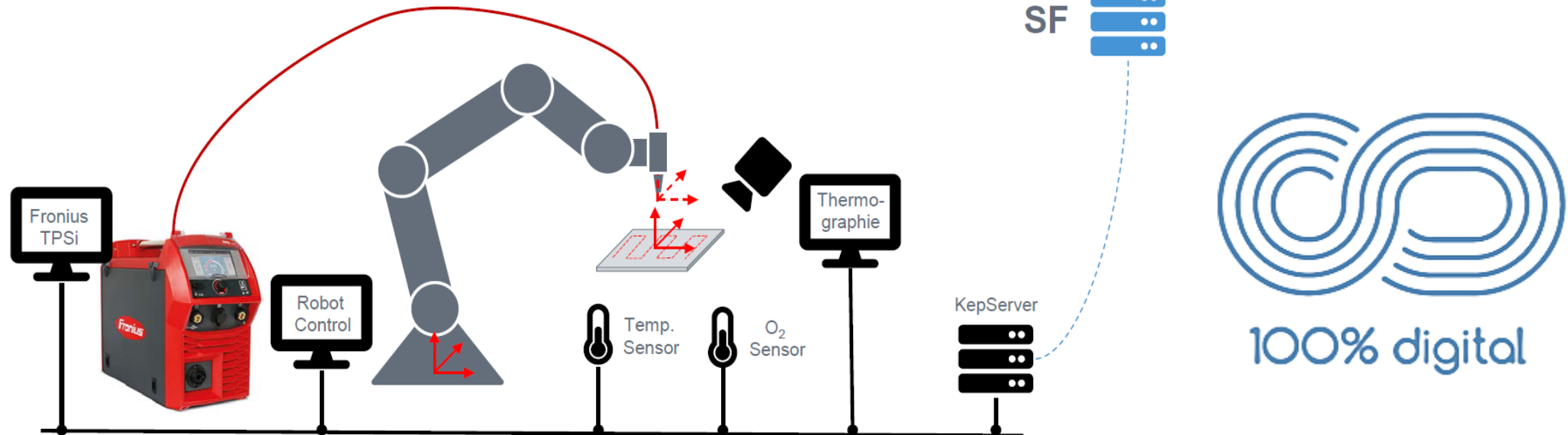
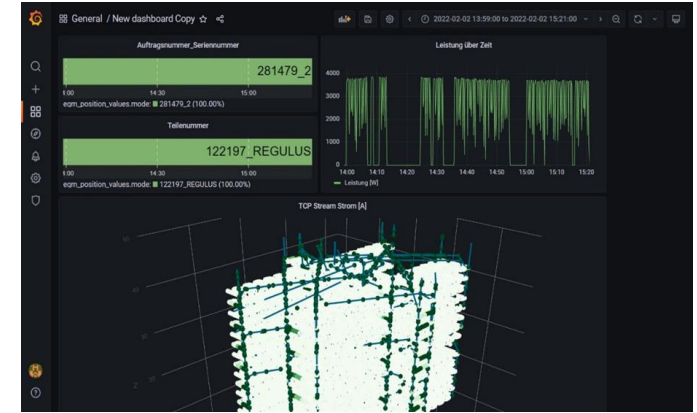
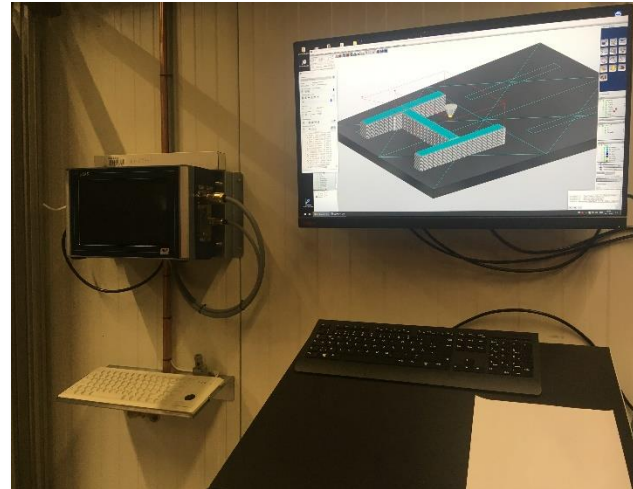
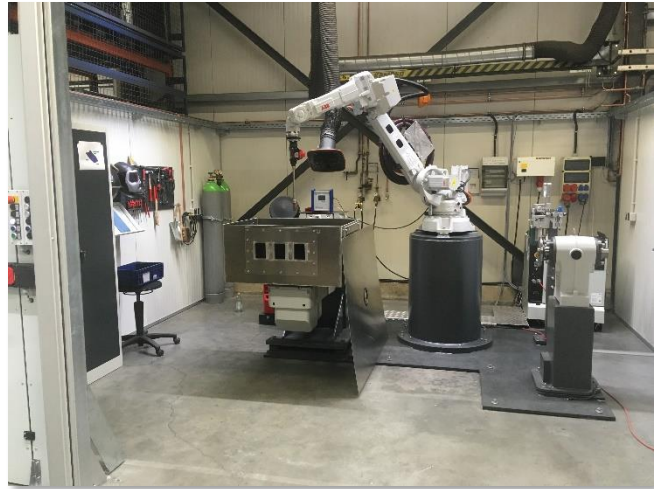
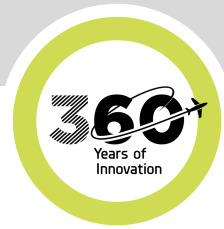
Material- & energy efficient additive manufacturing of titanium structural components according to aerospace quality standards and with a digital component twin in the entire process chain!

- Low buy-to-fly ratio (material)
- High Quality
- 100% Quality Assurance



Quelle: [www.all3dp.com](http://www.all3dp.com)

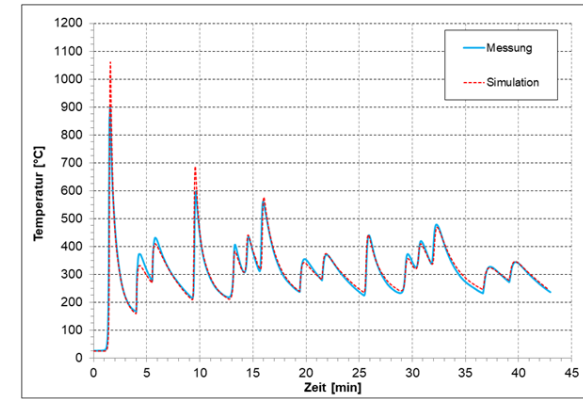
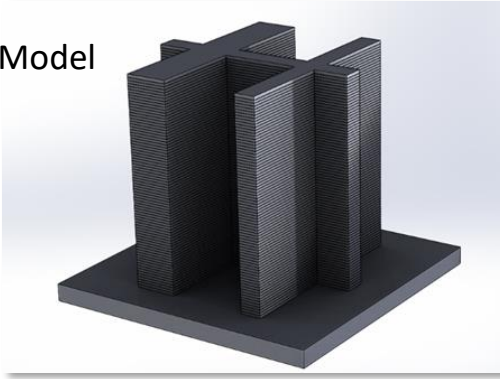




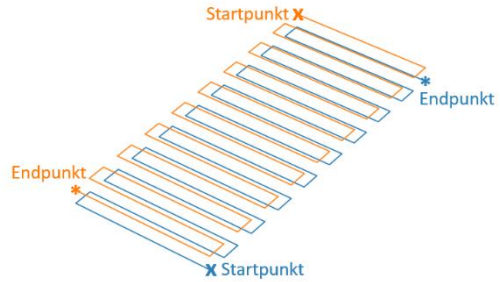
# WAAM Simulation (LS-DYNA)



## 1. CAD-Model



Experiment
Themische Validierung
Schweißsystem
Fronius TPS 500i
Schweißverfahren
CMT
Werkstoff - Substratplatte
S235JR
Werkstoff - Schweißzusatz
ISO 14341-A-G 46 5 M21 4Si1
Messort
Thermoelement 2



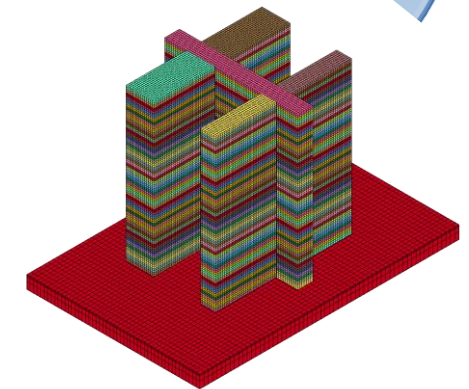
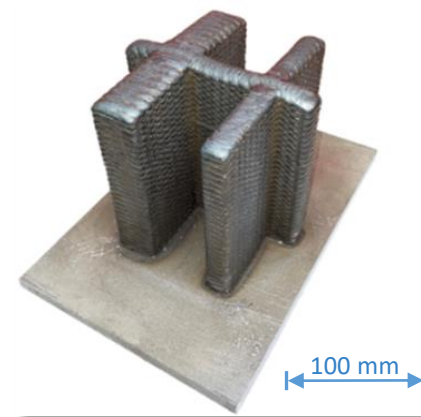
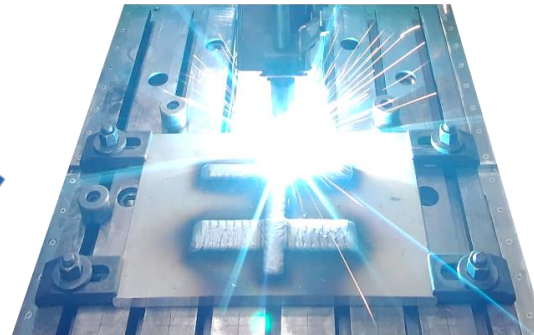
## 2. Buildup strategy in LS-DYNA regarding welding distortion



## 6. Measurement and simulation alignment



## 3. Automated buildup strategy with LS-DYNA regarding temp. management (material-dependent)



## 4. WAAM-Process

## 5. Hardware & digital twin



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- ✈ Corona consequences, price increases and uncertain material supply are the biggest challenges for AE suppliers - especially for SMEs
- ✈ Positive forecasts and at the same time the compulsion for significant CO2 reduction of commercial aviation require further and disruptive innovations along the whole supply chain
- ✈ End-to-end digitalization opens up further potentials to increase material and energy efficiency in the industrial production
- ✈ HEGGEMANN relies on LS-DYNA and the successful cooperation with DYNAmore in R&D projects for the simulation-based optimization of complex production processes to develop and industrialize innovative technologies (Hot Forming, WAAM etc.)



**The best way to predict the future is to invent it.**

Alan Kay

