HUSUM WIND 2023: Modellregion der Energiewende – Von der Lausitz lernen

Polymerbasierter Leichtbau (PbL)

Funktionsintegrative Leichtbautechnologien für die nachhaltige und dezentrale Energieversorgung, Marcello Ambrosio, M.Sc.

Prof. Dr.-Ing. Holger Seidlitz

Leiter des Fachgebietes Polymerbasierter Leichtbau

Fraunhofer IAP/PYCO

Arbeitskreis Kunststoffe und Leichtbautechnologien Cottbus

Husum, 12.09.2023

Polymer-based Lightweight

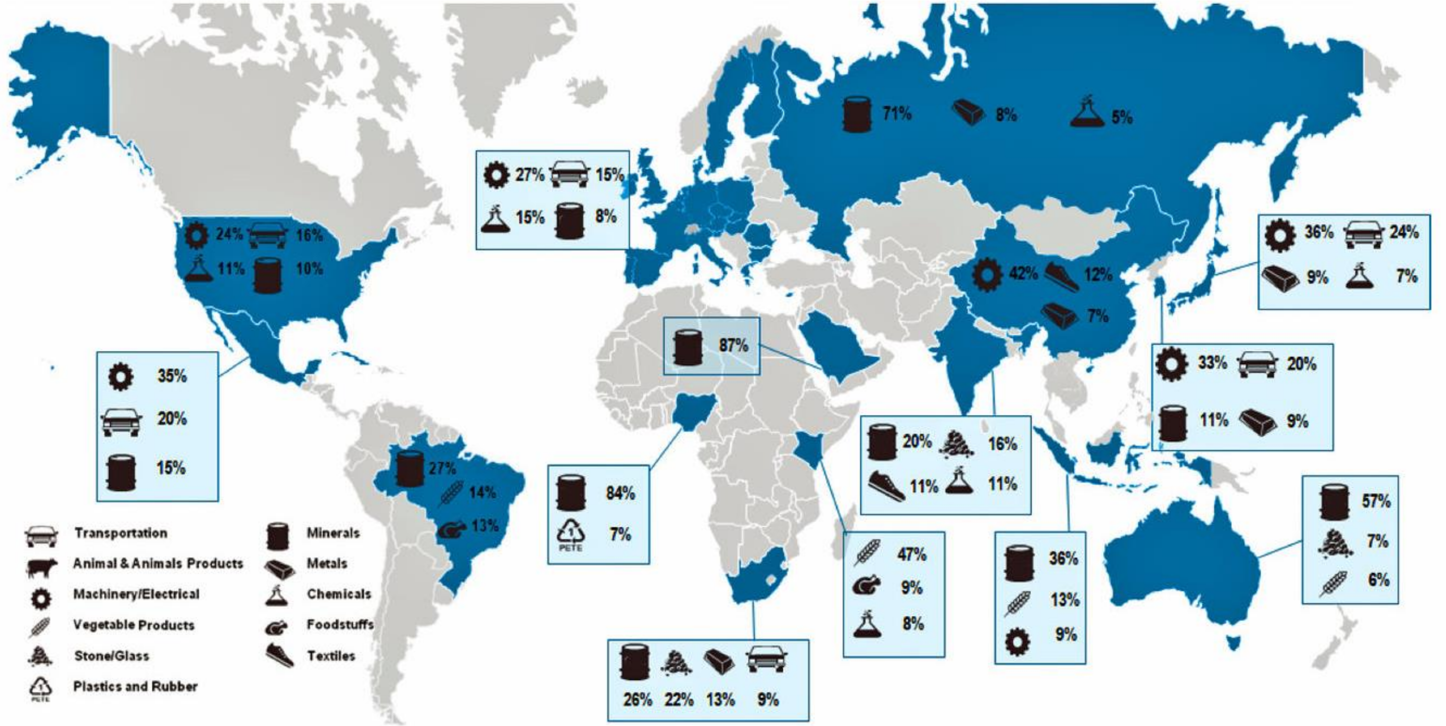
- Interdisciplinary research: 150 employees (PbL, IAP/PYCO).
- Customized polymers and composites
- Design of high-performance composites
- Multi-material design with composites and metals
- Plastics processing and recycling technologies
- Additive manufacturing

Wildau

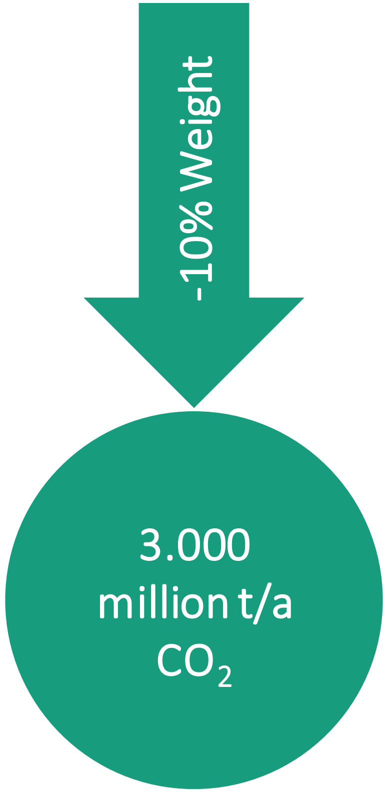
Cottbus

- Scalable and flexible production lines, globally organized, distributed value chains
- Adaptive processes and products corresponding to local needs and framework conditions
- Flexibility, sustainability and economic affordability of all parameters, process elements and steps

Exports by products



Source: IMF DOTS, Standard Chartered Bank, 2012



Source: Lothar Kroll, TU Chemnitz, 2018

UN Sustainability Goals

#No European Green deal, without Lightweight Technology

I. **Optimise energy and resource efficiency**

II. **Create sustainable value circles**

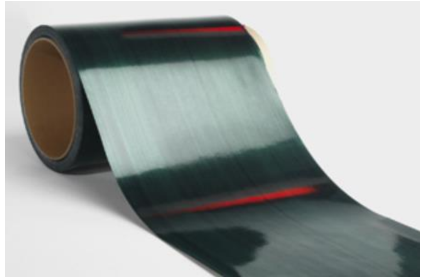
III. **Boost lightweight integration in more areas**

Rademacker, T., "Lightweight Technology, on the Way to Circular Economy", Brussels, 2023.05.04

Ramberg, C., "Lightweight Technology Impact on Climate Protection and Efficient use of Energy & Resources", Brussels, 2023.05.04

Value Chain Thinking

material development → semi-finished products → plastics processing → design, simulation, test



Customized materials → **Design & Manufacturing technologies**

From monomer to structural part and manufacturing process

Lightweight solutions from a single source

Univ.-Prof. Dr.-Ing. Holger Seidlitz
Head of the department Polymer materials und composite PYCO
BTU Cottbus – Senftenberg, Chair of Polymer-based lightweight construction

Customized materials

Prof. Dr. Christian Dreyer, deputy Head of department PYCO,
TH Wildau - Professur Faserverbund-Materialtechnologien

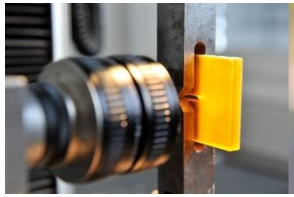
Design & Manufacturing technologies

Univ.-Prof. Dr.-Ing. Holger Seidlitz










Polymer development

Prof. Dr. Christian Dreyer

- alternative curing methods (UV, microwaves, IR)
- recycling and repair
- high performance polymers
- Microelectronics, photonics (function integration)

Semi-finished products

Dr. Sebastian Steffen

- SMC, BMC
- bio-based thermosets
- natural fiber reinforced plastics
- biofunctional surfaces (functional integration)
- prepregs
- fire protection systems

Simulation & Design

Marcello Ambrosio, M.Sc.

- Design (CAD)
- Structure and process simulation (FEM)
- Design of manufacturing processes
- AFP, Additive Manufacturing
- Injection molding, extrusion
- Tools and demonstrators

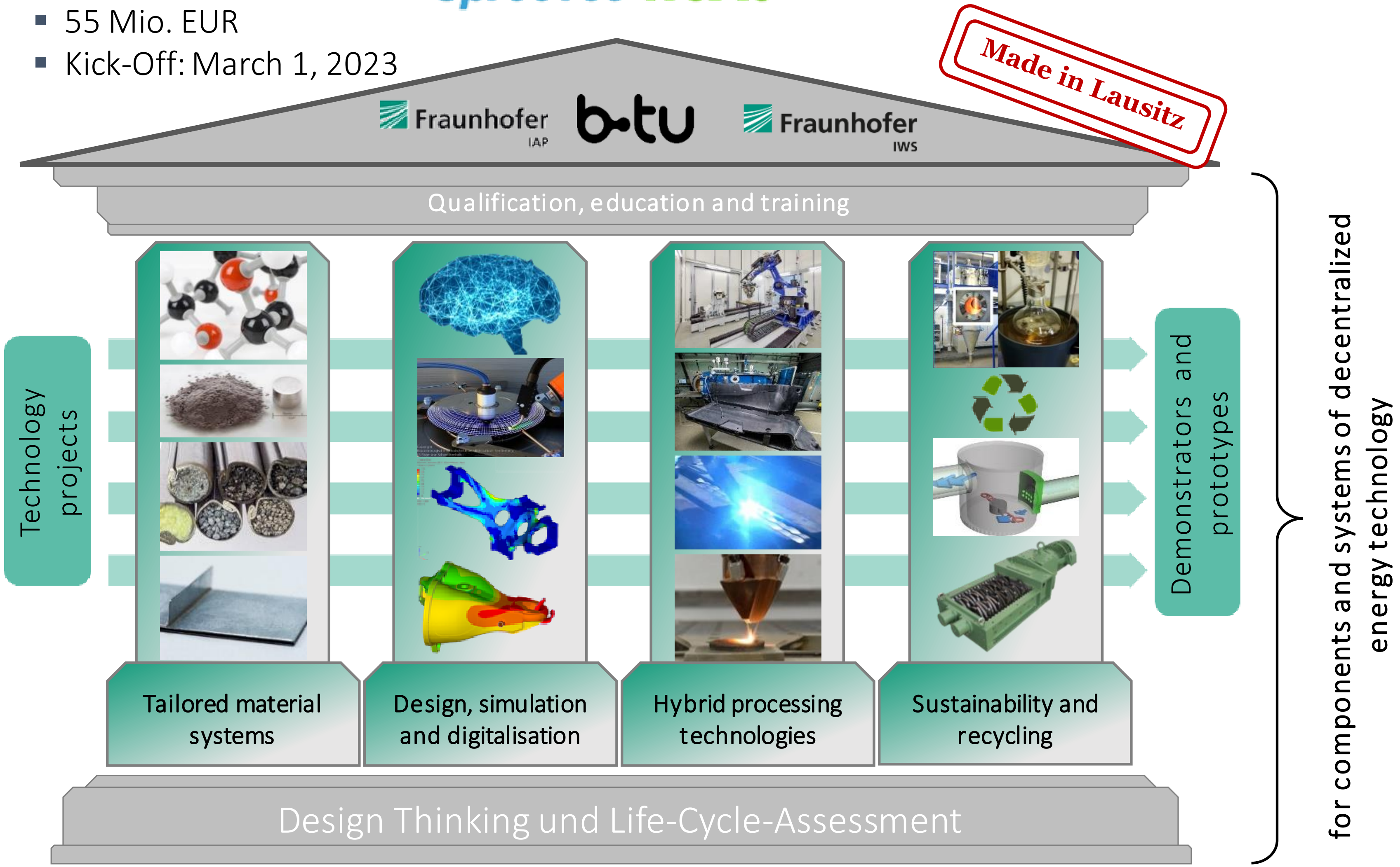
Structural testing & Analytics

Dr. Mathias Köhler

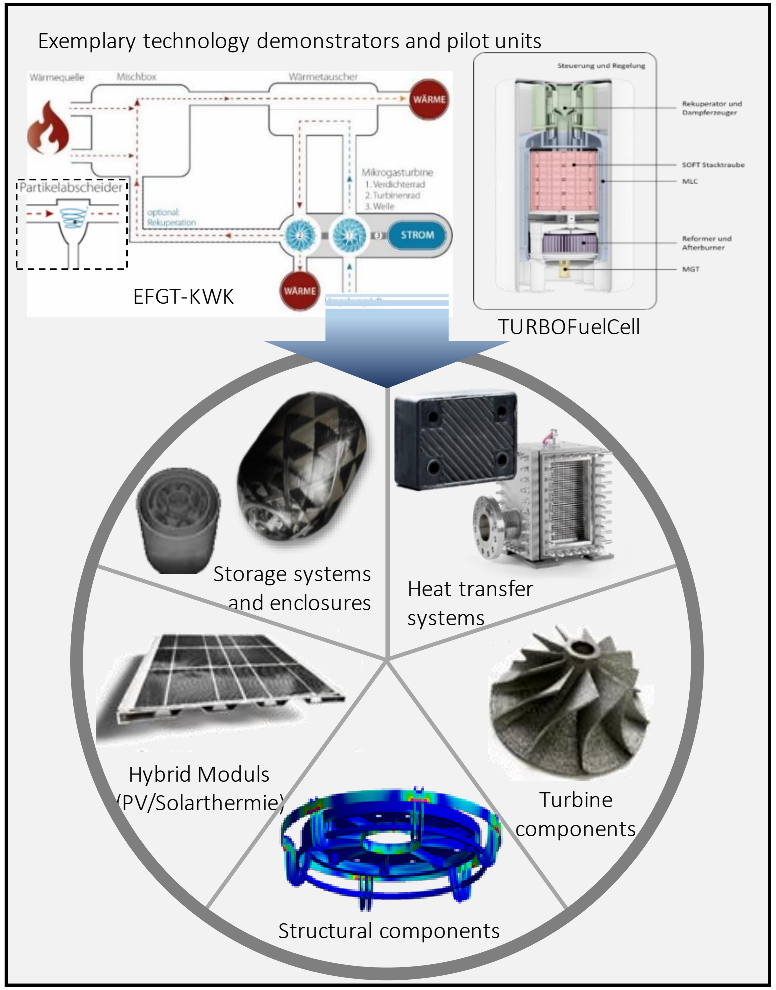
- Analytics
- Thermomechanical characterization
- Mechanical testing
- Optical characterization
- fatigue strength
- non-destructive testing
- fire protection

Neue Fertigungstechnologien für Komponenten und Systeme der dezentralen Energietechnik

- 2022 – 2039
- 55 Mio. EUR
- Kick-Off: March 1, 2023



Exemplary technology demonstrators and energy systems *(EFGT-KWK/TurboFuelCell)*



Prof. Dr.-Ing. Holger Seidlitz

- 2023 – 2026
- 19 Mio. EUR

Wasserstoff Leitprojekte *Grün. Groß. Global.*

Leitprojekt TransHyDE

GEFÖRDERT VOM Bundesministerium für Bildung und Forschung

Subproject Mukran

Development of a spherical hydrogen high pressure tank

Part of overall "TransHyDe" goal to develop a suitable hydrogen transport infrastructure

Applications:

- Transport via ship, rail, truck
- Stationery storage

Object of the Mukran:

- Structure mechanical design of the intended systems
- Development of a manufacturing process
- Integration of sensors as part of monitoring system
- Experiment of operation (filling, transportation, draining) on prototype
- Scale up to larger tank measures

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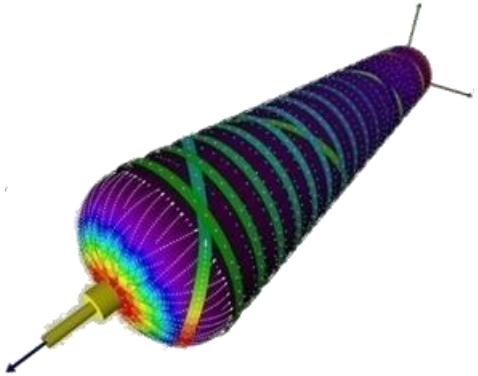
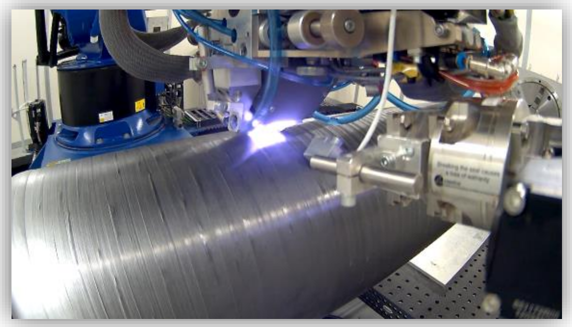
NASA Artemis programme: World's largest LH2 tank (1.25 M gal = 4.730 m³)
https://twitter.com/NASAGroundSys/status/1645510449071357959





Why composite pressure vessels

Types according to DIN EN ISO 11439

Type I:
monolithic metal tank

Type II:
perimeter reinforced metal tank

Type III:
fully reinforced metal tank

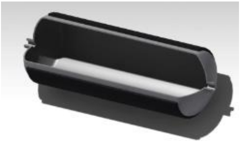
Type IV:
fully reinforced composite tank

Type (V):
linerless tank made of
fiber reinforced plastics

Lightweight potential

Tank wall thickness **steel**: t_{steel} = 25.5 mm

Strength: 1.000 MPa



Tank wall thickness **CFRP**: t_{CFRP} = 17.4 mm

Fiber tensile strength: 2.090 MPa

Pressure 700 bar; Volume: 250 L

$$m_{\text{steel}}^{1000} \approx 611 \text{ kg}$$

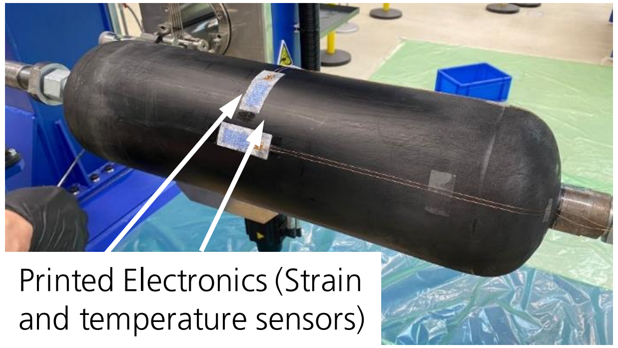
$$m_{\text{CFRP}} \approx 95.5 \text{ kg}$$

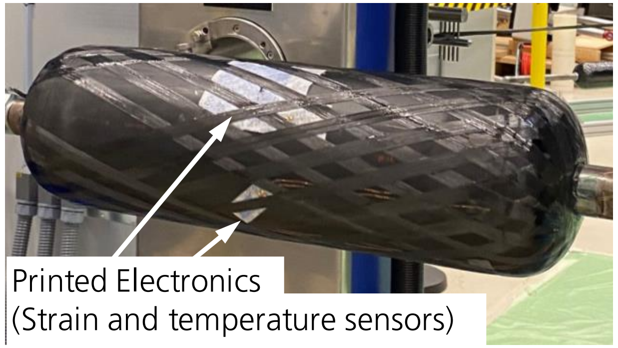
INSTITUT FÜR LEICHTBAU UND WERTSCHÖPFUNGS-MANAGEMENT

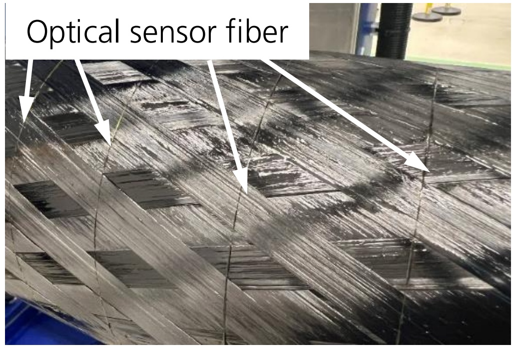
Structural Health Monitoring for pressure vessels

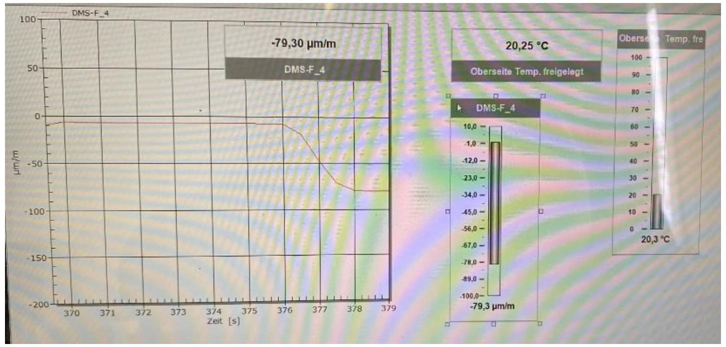
Brandenburg University of Technology Cottbus - Senftenberg

Printed Electronics



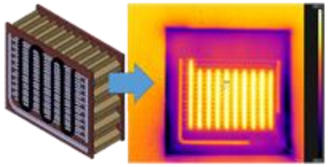


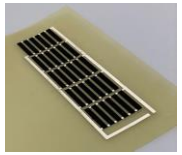




Printed Electronics

Piezo-, Ink-Jet Printing

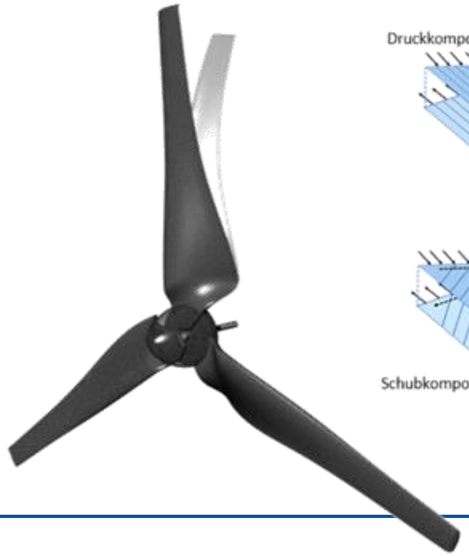


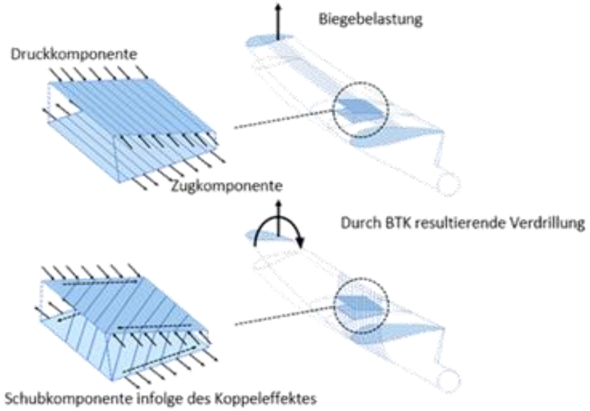


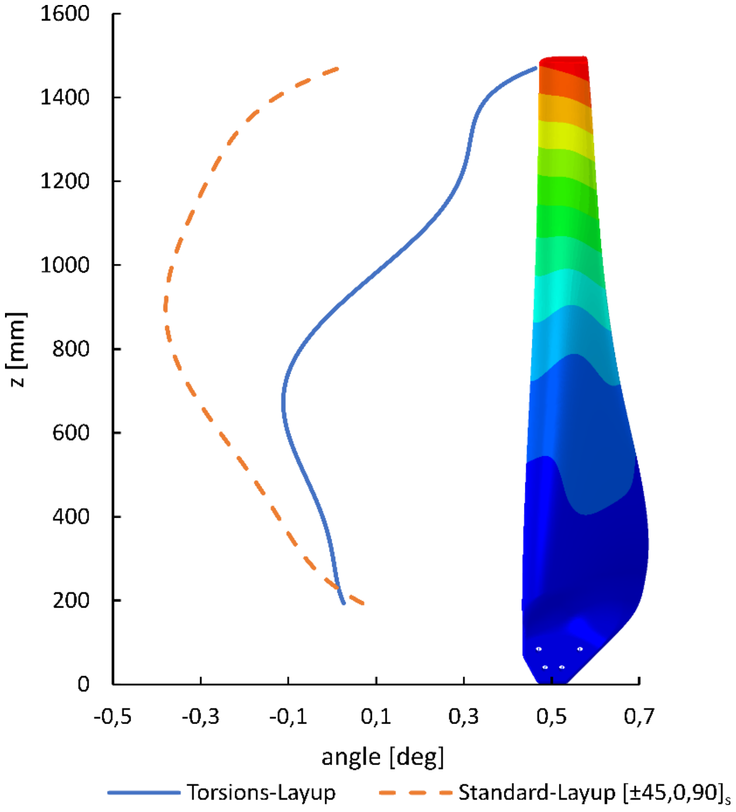
Potential for small wind turbines (KWEA)

- Start-up at low wind speeds: no power below 3 m/s (10 km/h)
- passive throttling at high speeds (12 m/s)
- reduced noise emission (in investigation)

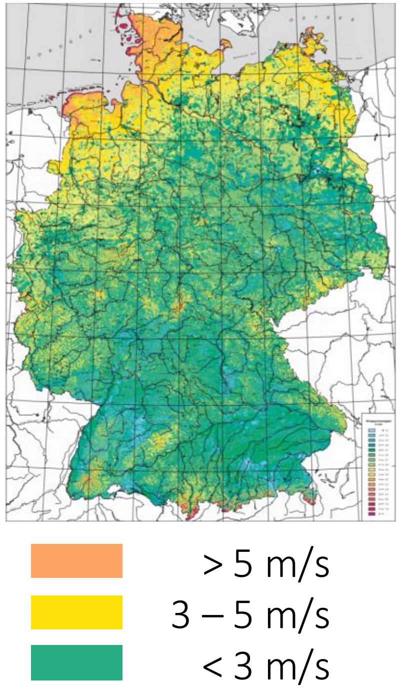
→ Adaptive lightweight rotor blade with bending-torsion coupling





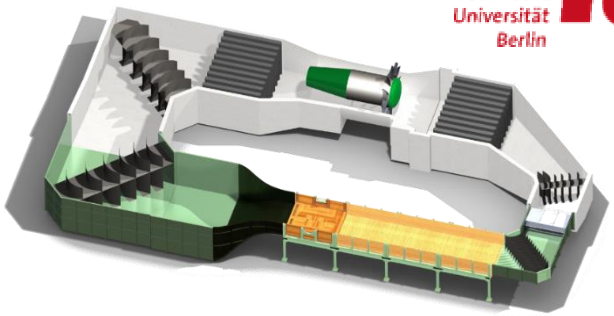


Wind speed 10 m above ground



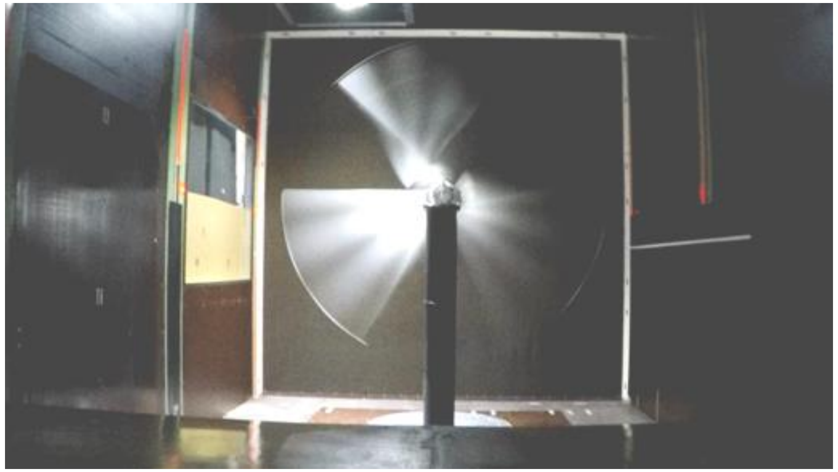
Quelle: Deutscher Wetterdienst, Klima- und Umweltberatung

Acceleration of the wind turbine



- Acceleration of rotor blades using wind speeds up to 10 m/s in 0,5 m/s steps
- Recording of power supply data, windspeed, rpm of blades, air temperature
- Calibration of the power inverter and adjustment of the electrical system
- Optimization of noise emmission through calibration of electrical system

Wind speed: 0-5 m/s



Wind speed: 8 m/s

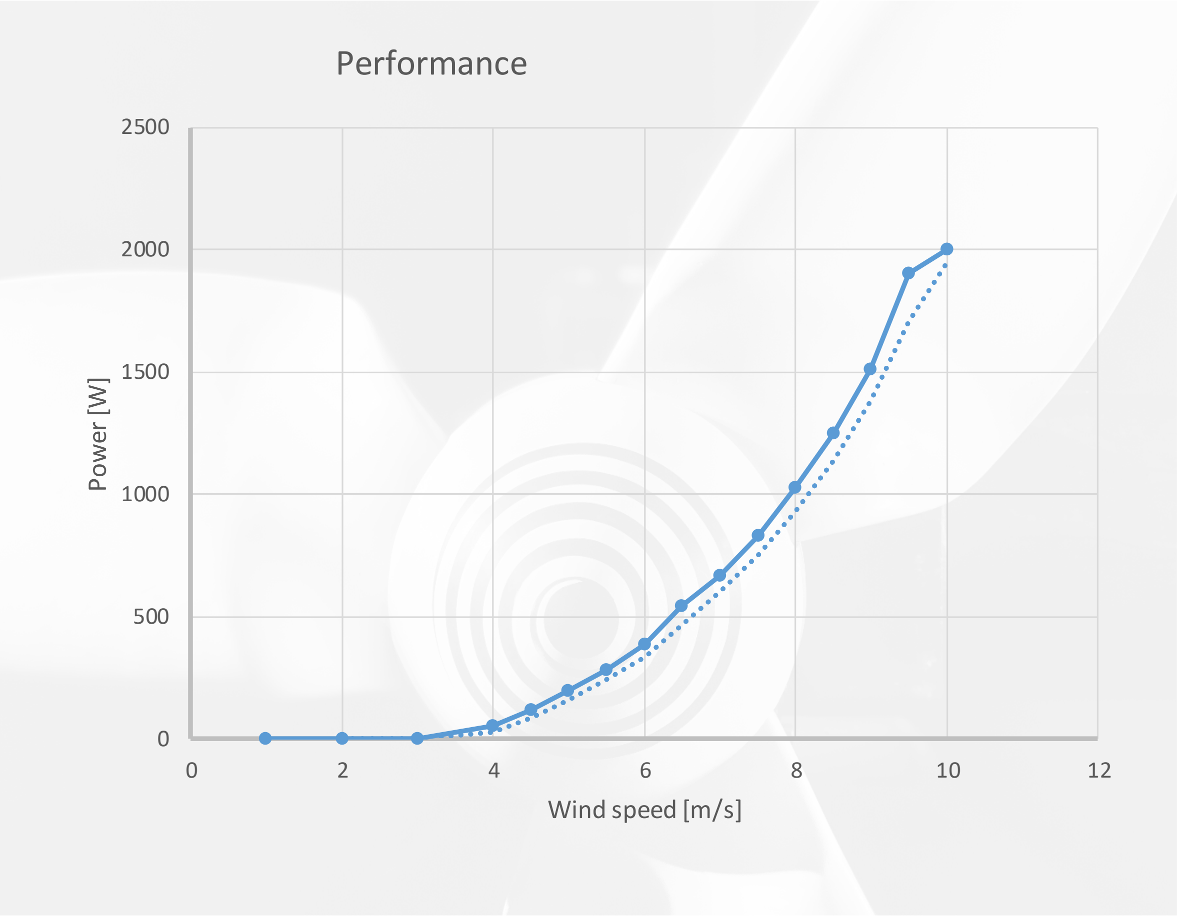
Wind speed: 10 m/s

Results

- Start of blade rotation: 2,7 m/s
- Cut-out at 10 m/s
- Up to 450 rpm
- Max. efficiency: 53%
- Max. power: 2000 W at 10,0 m/s
- annual yield:
  - 2030 kWh/a (ø 4,1 m/s, Brandenburg)
  - 3600 kWh/a (ø 5,0 m/s, Brandenburg)

→ Quick acceleration due to lightweight design of rotor blades

→ 83% better performance compared to recent market solutions in average

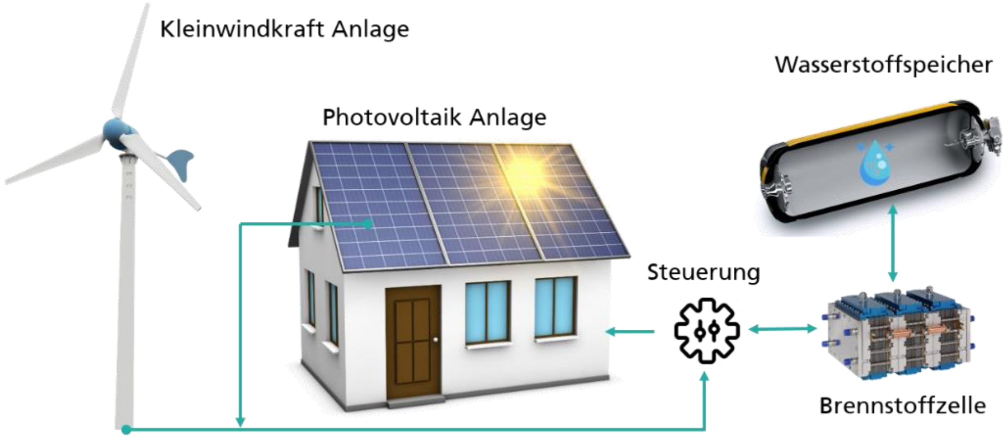


Development of a decentralized power-to-X pilot plant based on hydrogen using solar and wind energy

RIK Regionales Investitionskonzept Lausitz (Laufzeit 8/2020 – 2/2022)

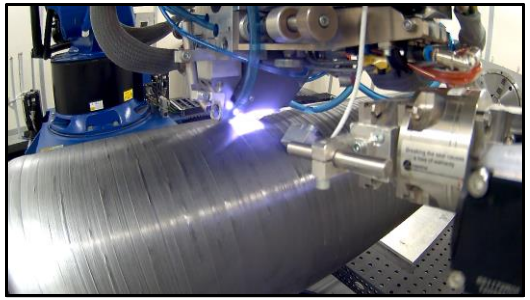
WIRTSCHAFTS REGION LAUSITZ
Bundesministerium für Wirtschaft und Energie

Consistent design of the overall system: Generation Storage Conversion



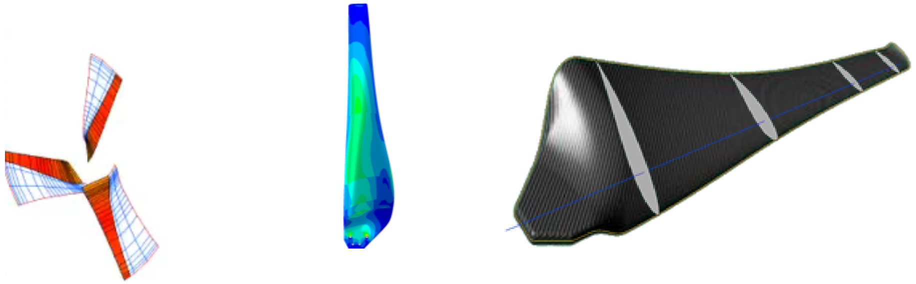
Function-integrative FKV high-pressure vessels

Automated Fiber Placement-Verfahren



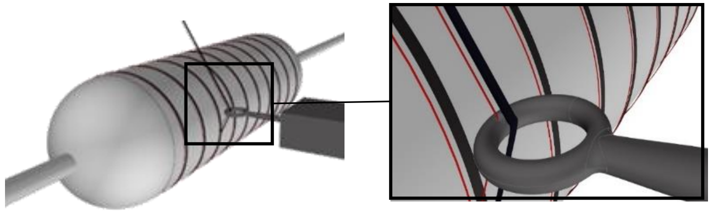
More resource-efficient rotor blades and sustainable manufacturing technologies

Utilization of the FKV material anisotropy



Rapid tooling of molds

In-situ Structural Health Monitoring



Thank you for your attention!

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