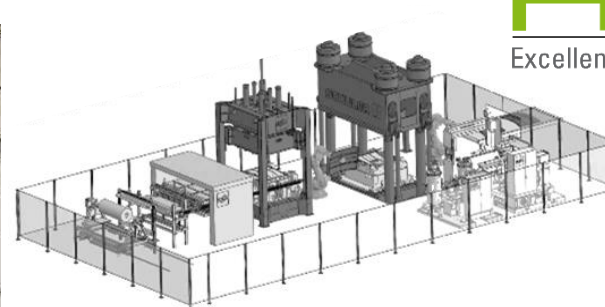
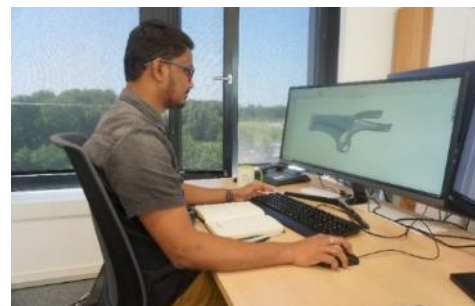


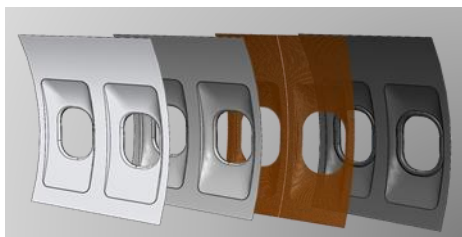
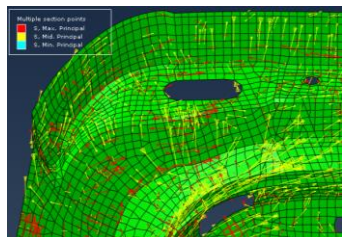
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# AZL Engineering and Service Portfolio

Business Development | Technology Development | Lightweight Production

In cooperation with:



# Know-how and Networks for Excellence in Lightweight Production

## Our Assets for Business Development and Technology Development



Our systematics for combining **Market and technology intelligence**

Our technology know-how: **Composite-based multi-material technologies**



Our international cross-industry network: **80+ companies from 21 countries**



Our high-tech ecosystem: **RWTH Aachen Campus**



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# AZL Service Approach

Diving from Market into Technology – and raising back to Market

We analyze target markets and applications for composite-based multi-material technologies,

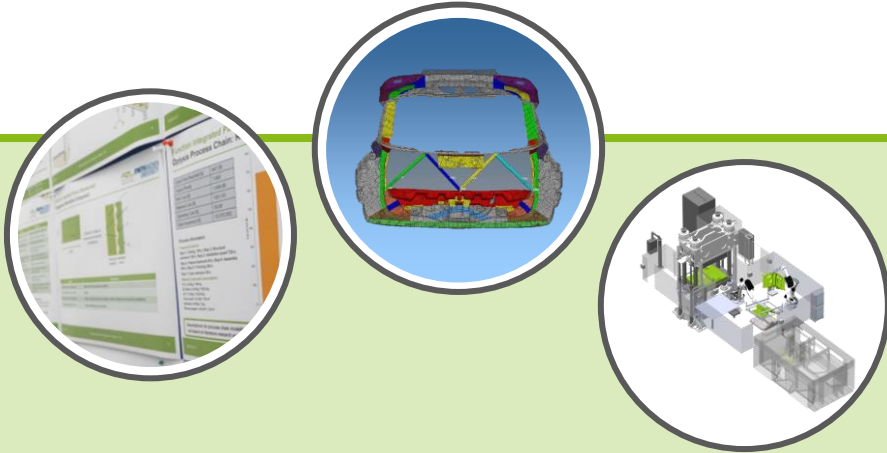
**BUSINESS  
DEVELOPMENT**

... and find the right partners for industrial implementation and establishment in the market.

**TECHNOLOGY  
DEVELOPMENT**

... to identify economically relevant technology improvements.

Thus we develop competitive innovations for economically highly relevant market segments,



### ENGINEERING AND SERVICES

- Market & business opportunity identification
- Component design and production concepts
- System and process development
- Support for industrial implementation



### AZL PARTNERSHIP

- Pre-competitive, trusting collaboration along the entire value chain
- Regular meetings in workgroups
- Joint projects
- Cross-industry networking and matchmaking



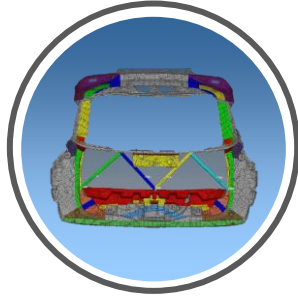
# AZL Engineering and Service Portfolio

## Services for Business Development and Technology Development



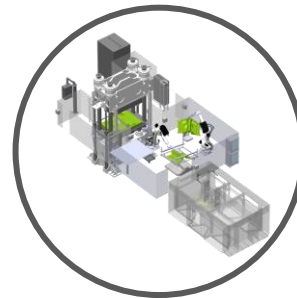
### MARKET AND BUSINESS OPPORTUNITY IDENTIFICATION

- Technological and economical benchmarking analysis
- Market and technology analysis
- Technology screening, identification and monitoring



### COMPONENT DESIGN AND PRODUCTION CONCEPTS

- Specification definitions
- Concept design
- CAE
- Production layout
- Prototyping, process validation
- Testing



### SYSTEM AND PROCESS DEVELOPMENT

- Concepts and design
- Proof-of-principle and prototyping
- Integration in existing productions



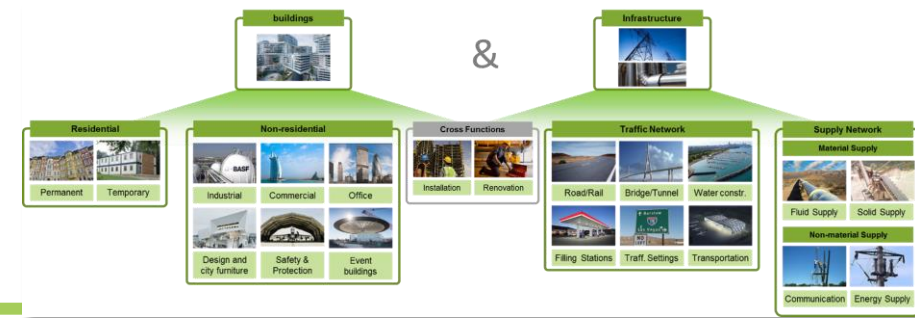
### SUPPORT FOR INDUSTRIAL IMPLEMENTATION

- Customer, partner, supplier analyses and matchmaking
- Consulting during ramp-up of production

# Market and Business Opportunity Identification

## An Example: Market And Technology Studies

Structuring and analysis of  
**trend markets and market segments**



Systematic analysis of  
**attractive applications**



Identification and benchmarking of  
**technologies and enablers**



Analysis of  
**business cases**



Systematic and  
established approach

Market analysis  
through the eyes of  
technology experts

# Market and Business Opportunity Identification

## Examples of Market And Technology Studies

### Example joint studies:

- Mass Production for Lightweight Composite Structure
- Composites in Buildings and Infrastructure
- Energy Storage Systems
- Composites in the Furniture Industry
- Next Generation Mobility Solutions
- High-Performance SMC
- Potentials and Challenges of Thermoplastic Tapes for SME Injection Molders



“The AZL study on Buildings and Infrastructure provided us a **great networking with key players** and gave us a **proper market understanding** including market size/volume in numbers to prove the value of this technology to building industry.”

**Justin Jin, CEO of AXIA Materials**

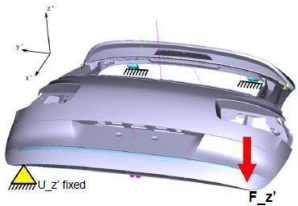


# Component Design and Production Concepts

## The Design Process – from Concept to Tested Prototype

AZL covers complete design chain: **with focus on lightweight, composites and part cost**

### Specification sheet



1. ....
2. ....
3. ....
- .....

Typical  
requirement  
studies

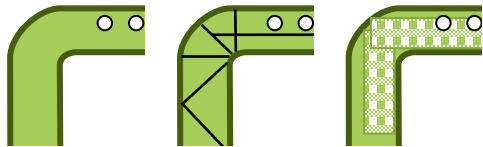
### Concept design



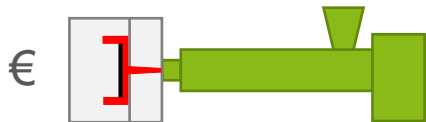
Material options



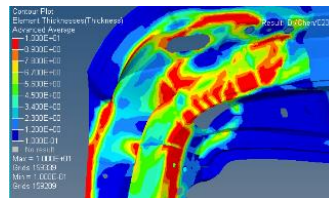
Structural layouts



Production options & Cost



### CAE

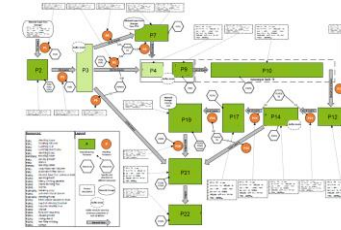


Mechanical &  
process

### Detail CAD



### Manufacturing layout



### Prototypes



- Tape laying
- Press forming
- Drape forming
- Overmoulding
- Thermoset & thermoplastic



# Component Design and Production Concepts

## Focus on Manufacturability and Profitability in Early Concept Designs

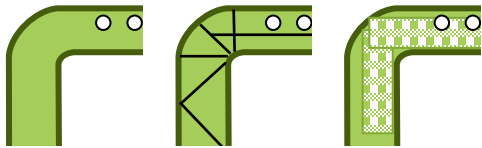
### Concept design



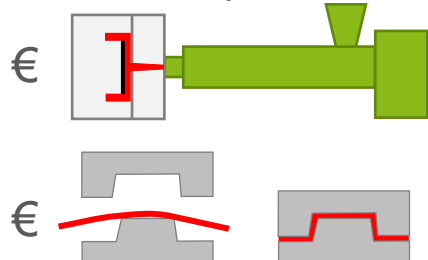
### Material options



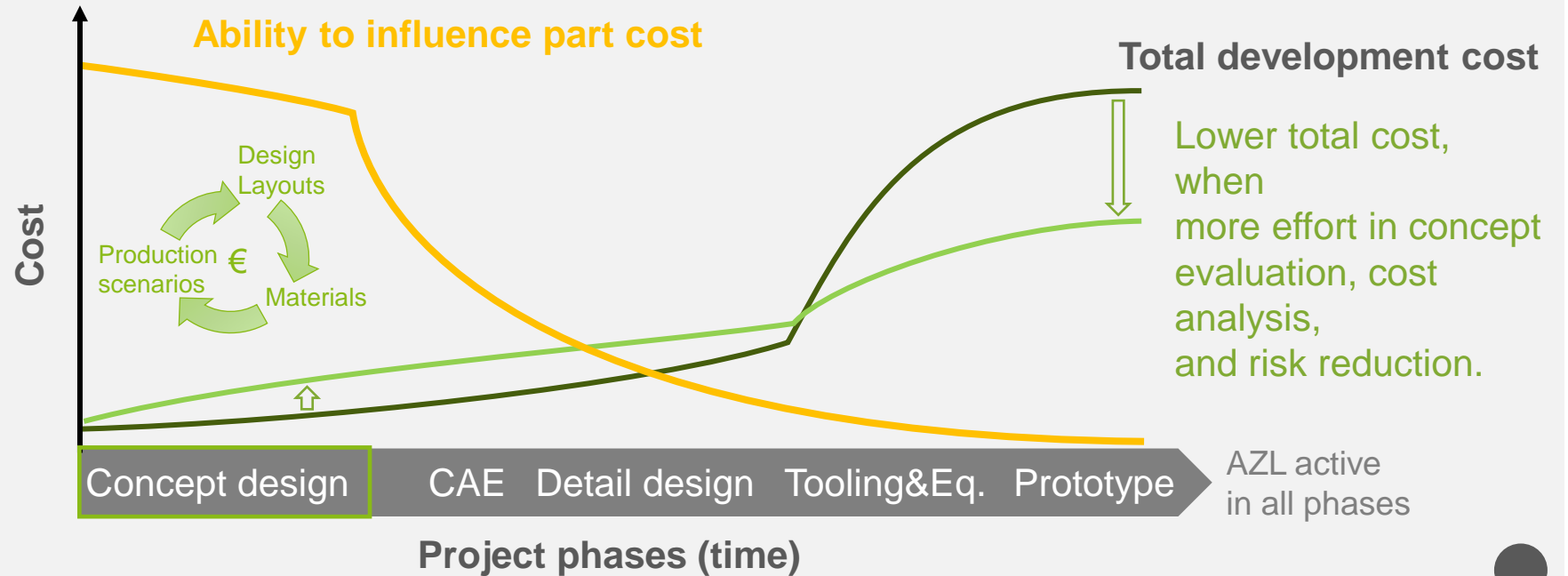
### Structural layouts



### Production options & Cost



### Typical development cost timeline



### AZL focus on design to profitability in early concept stages yields:

- Lower total development cost
- Lower part production cost
- Lower risk

# Component Design and Production Concepts

## Design Services Listing

### OUR SERVICES

- Specification definitions
- Concept design
  - Multiple concepts, multiple materials
  - Cost & weight analysis
- CAE
  - Mechanical, optimization
  - Process design and parameter optimization
- Production layout
- Prototyping, process validation
- Testing
- Senior expert consulting

### WHY WORK WITH US?

Professional team with:

- Design knowledge
- Production focus
- Cost & business insight
- Hands-on prototyping
- Aachen Campus network
- Partner network
- Material & technology neutral

### YOUR BENEFITS:

- Lighter components
- Cheaper components,
- which are competitive
- Reduced risk and support towards production

Use a design brain storming session at AZL, to learn what would be possible in your case.

# Component Design and Production Concepts

## An Example: Concepts Studies for Lightweight Components

Substructures,  
material selection,  
topology optimization



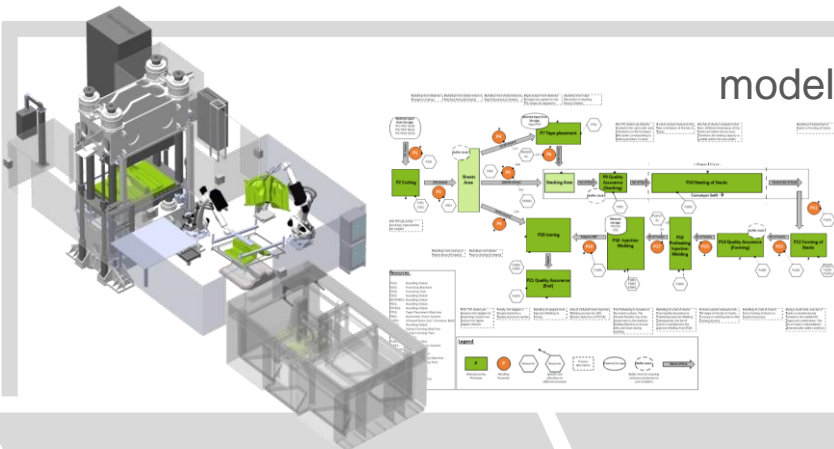
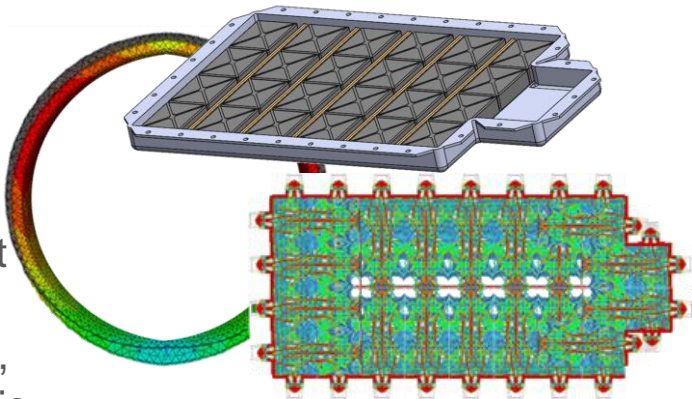
Component requirement  
analysis

Multi-material  
component concept  
design and  
simulation

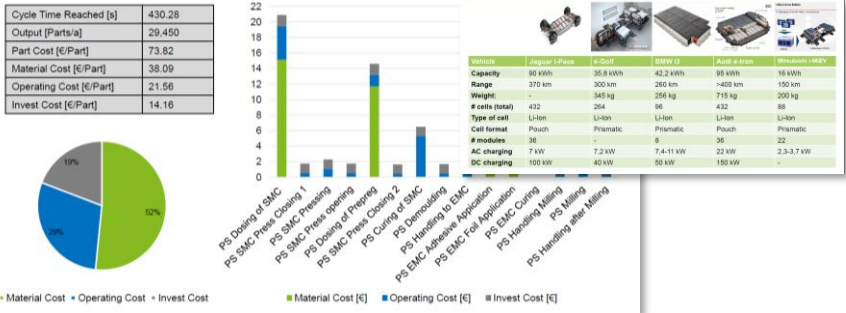
Identification and  
evaluation of  
production  
concepts

Cost analysis and  
sensitivity analysis of  
production-related  
KPIs

Material- and  
process-independent  
design concepts,  
detailed CAD design,  
finite element analysis



Process chain  
modelling and benchmark





# Component Design and Production Concepts

## An Example: Concepts Studies for Lightweight Components

Component requirement analysis

Multi-material component concept design and simulation

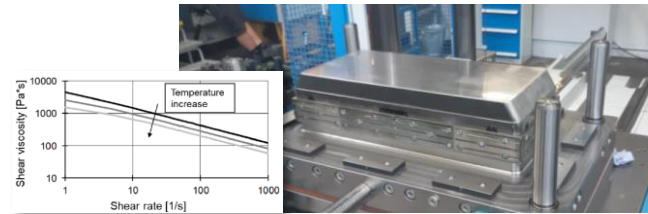
Identification and evaluation of production concepts

Cost analysis and sensitivity analysis of production-related KPIs

- Practically any technology can be realized with equipment and expertise in the Aachen Ecosystem

- Interdisciplinary teams

Process parameter identification



Construction and sampling of tools, damage analyses

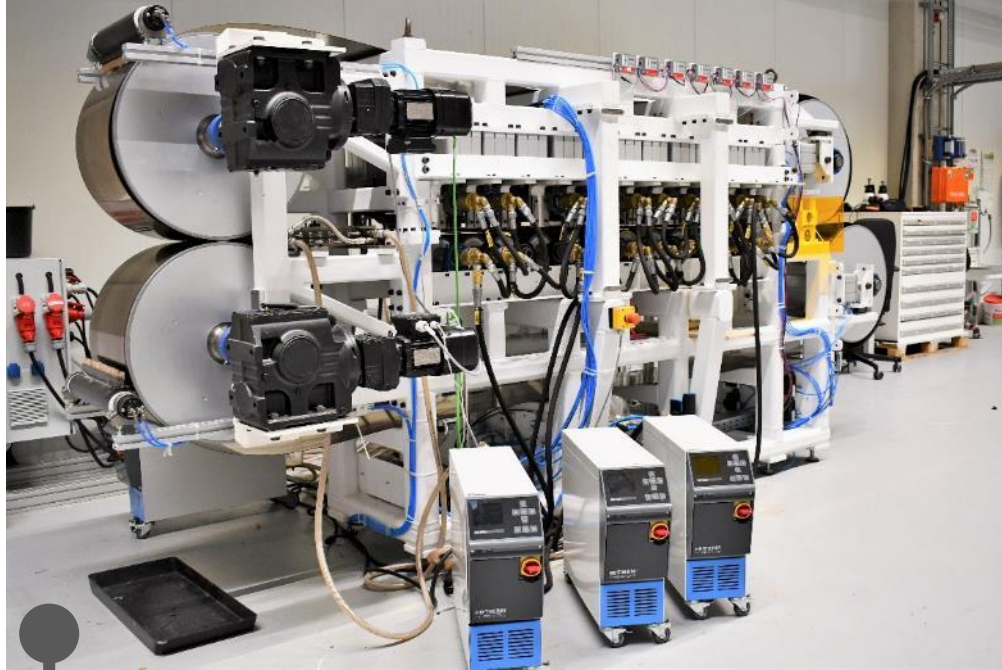
Realization and validation of lightweight component

Specimen production and material testing

Prototype production and testing

# System and Process Development

Systems for continuous Production of FRP semi-finished products developed at AZL



## Scalable double-belt press

- Energy- and cost-efficient
- Consolidating and impregnating a wide variety of composite materials
- Highly flexible: all parameters adjustable within minutes (e.g. pressure, temperature, speed)

## Ultra-fast consolidator machine system

- Mass-production of individual tailored blanks
- Laser-assisted thermoplastic tape placement
- In-situ consolidation
- Modular production system





# Large-scale Lightweight Production Systems at AZL Tech Center

One of 9 Composite Tech Centers at RWTH Aachen Campus





An aerial photograph of the RWTH Aachen University campus. The image shows a dense cluster of modern university buildings, including lecture halls, laboratories, and administrative offices, interspersed with green lawns and trees. A major highway and railway lines are visible on the left side of the campus. The surrounding area includes residential neighborhoods and more green space.

# Our high-tech Ecosystem: RWTH Aachen Campus

**RWTH**AACHEN  
UNIVERSITY





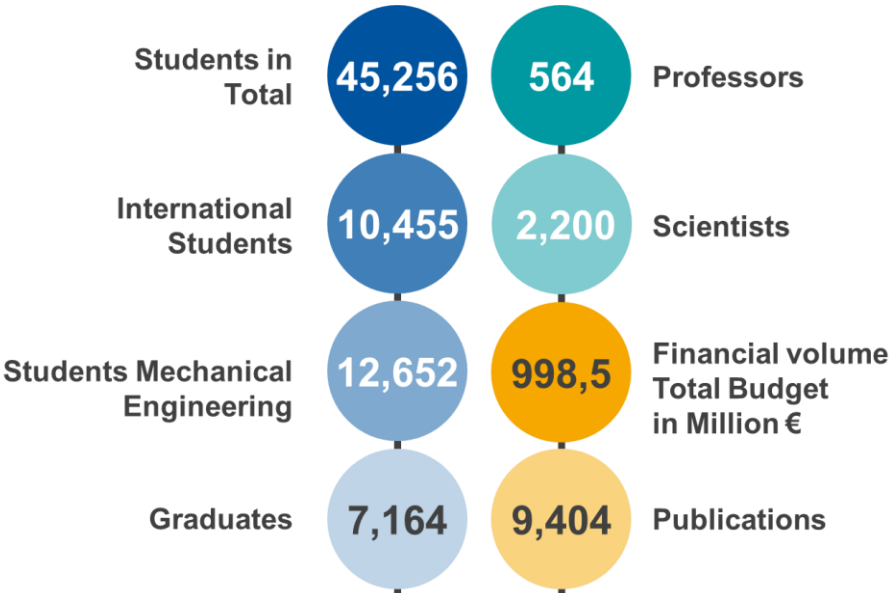
- 3 Clusters of Excellence:
- The Fuel Science Center
  - Internet of Production
  - Matter and Light for Quantum Computing



Renowned for production technology and materials science



Aachen ecosystem:  
Interdisciplinary  
clusters of science  
and industry





# Our 9 RWTH partners

Research along the entire value chain of lightweight on 1000m



1987

today

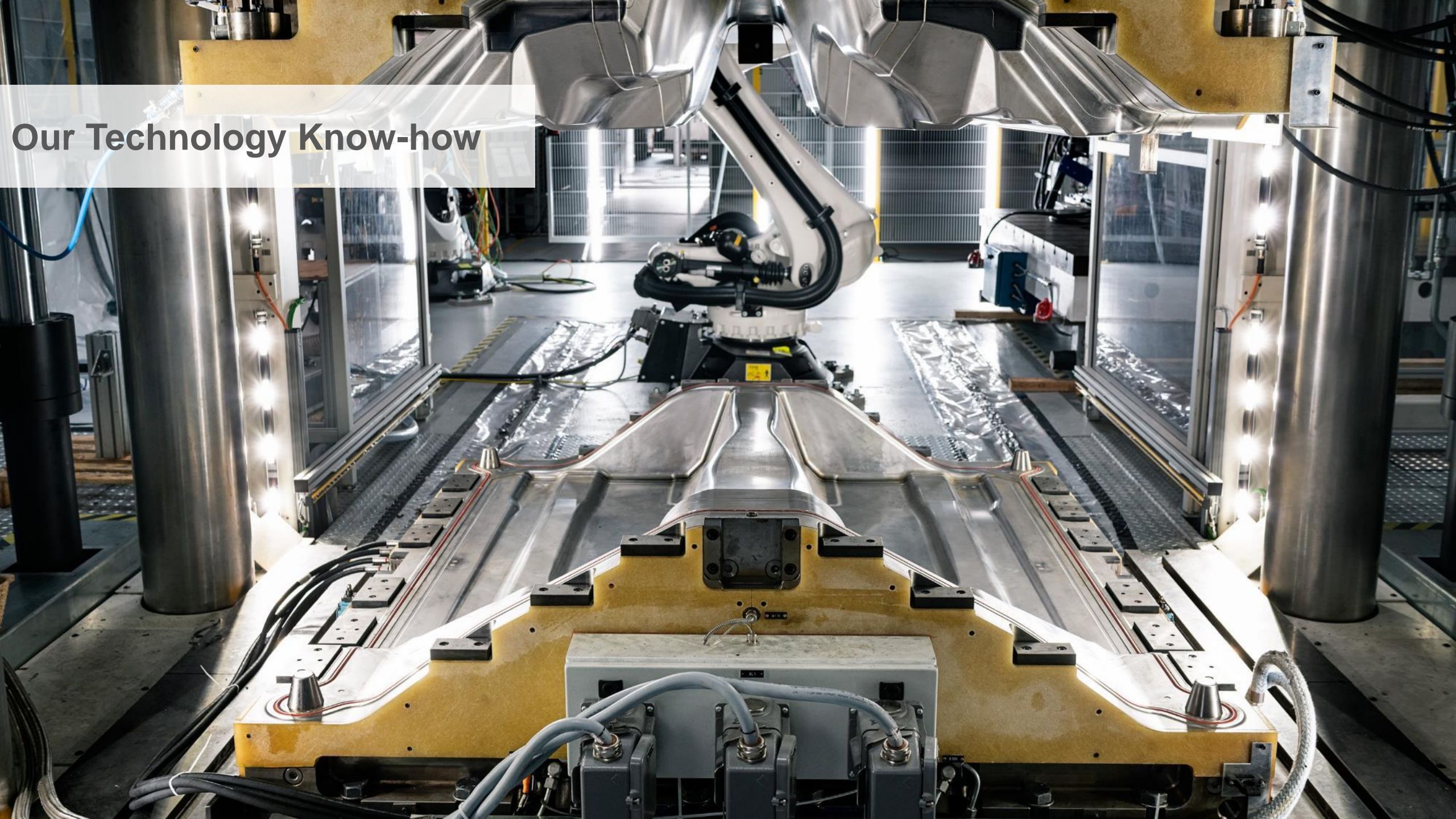
“AZL’s way to work internationally and open minded, makes me feel welcome every time I come to Aachen. I do appreciate the broad background available in Aachen and the effective and pragmatic approach of the Joint Partner Projects.”

Thierry Renault, Composite Technologies – Manager of Partnerships at Faurecia Clean Mobility





**Our Technology Know-how**





# Our technology know-how

## Integrative composite-based lightweight production



Expertise  
Prof. Hopmann

### Lightweight materials & design

- Material modelling
- Plastics processing
- Composite/ multi-material systems
- Product design



### Production technology

- Manufacturing technologies
- Production machines & tools
- Quality assurance
- Production- & cost planning



Expertise  
Prof. Brecher

### Integrative research on interdependencies:



## Integrated process combinations

Functionalization of CBPP lines for Automotive Body Light (BMBF)

Demonstrated 2017 at AZL of RWTH Aachen University

Integrated Process Combinations

## Hybrid production machines

Hybrid Production Machines

## Self-optimizing „intelligent“ process chains

Self-optimizing „intelligent“ Process Chains



# Our international cross-industry Network

**AZL**  
AACHEN  
EXCELLENCE IN  
LIGHTWEIGHT  
PRODUCTION  
PARTNERSHIP



# Our International Cross-Industry Network

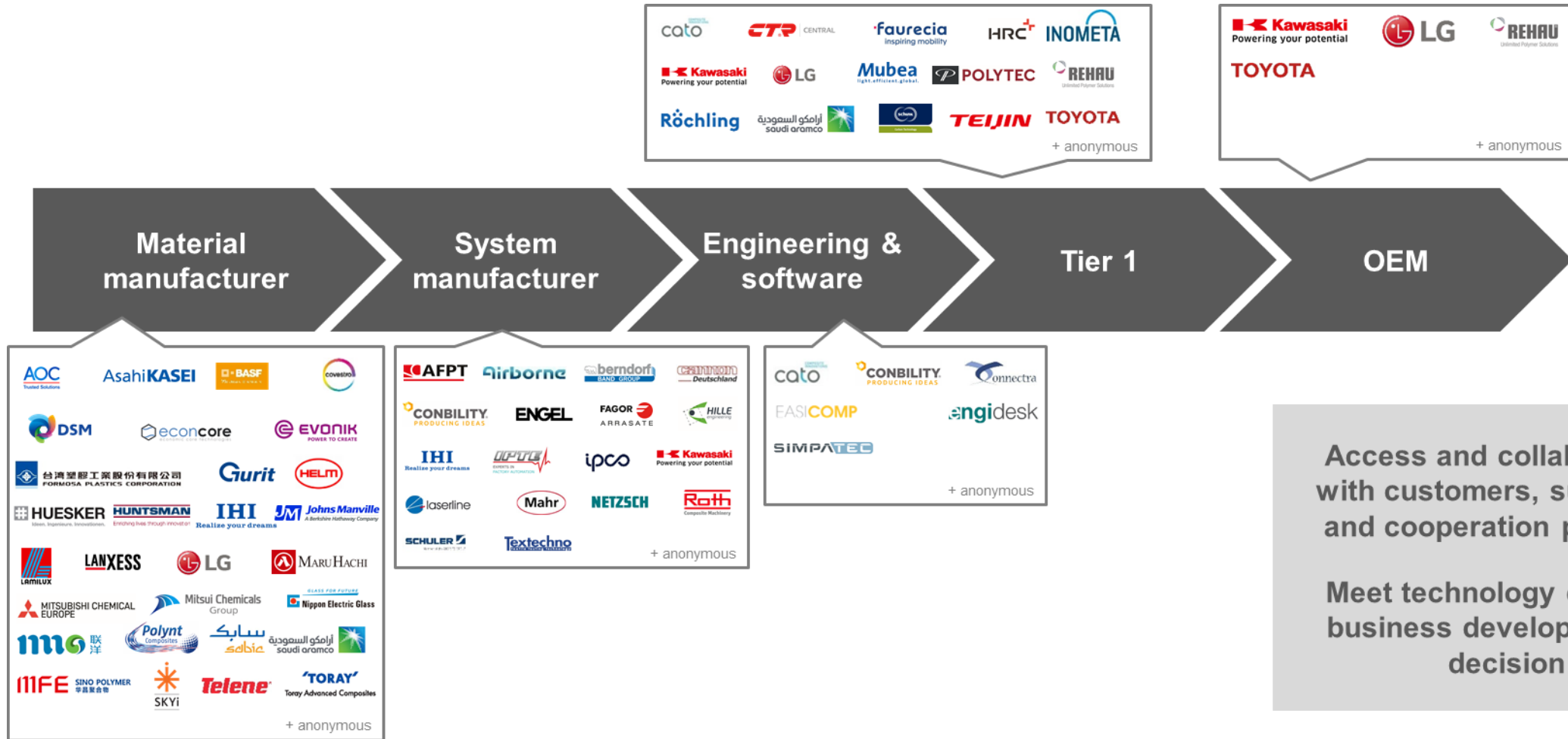
80+ AZL Partner Companies from 21 Countries





# AZL Partnership

## Collaboration of 80+ Companies along the entire Value Chain



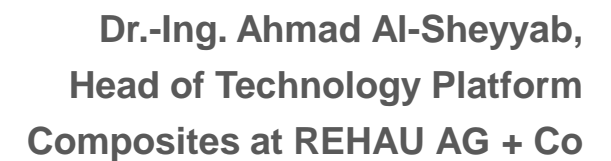
# AZL Partnership

Trusting, pre-competitive Cooperation in continuous Activities

**AZL**  
AACHEN  
EXCELLENCE IN  
LIGHTWEIGHT  
PRODUCTION  
PARTNERSHIP



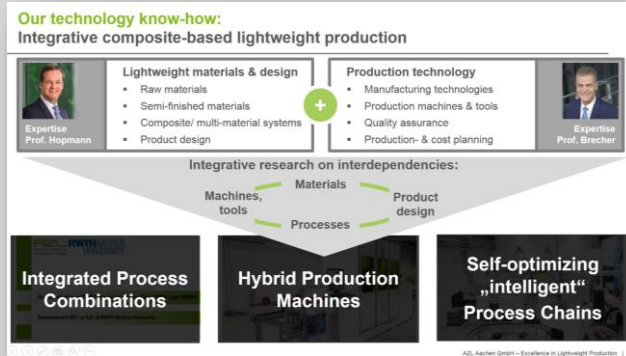




# AZL Innovation Strategy

We bring Industry and Academia together for efficient Industry Solutions

## Technology Push 9 RWTH institutes



# AZL

Innovation strategy  
of the AZL and its  
industrial partners

## Market Pull 80+ partner companies from 21 countries







**How the AZL Innovation Strategy leads to a cost- and energy-efficient Double Belt Press System**





**Belt width  
350 mm,  
scalable**

**Elastic rollers for  
areal pressure  
application  
(up to 23 bar)**

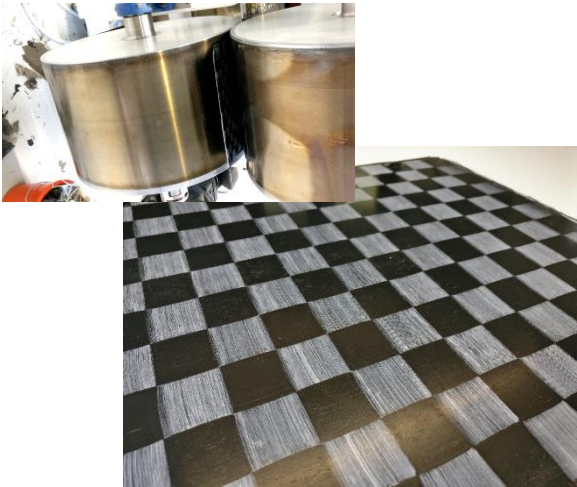
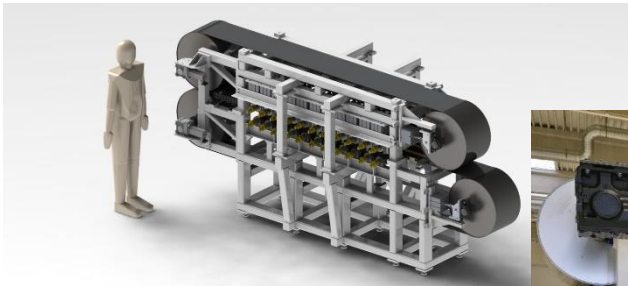
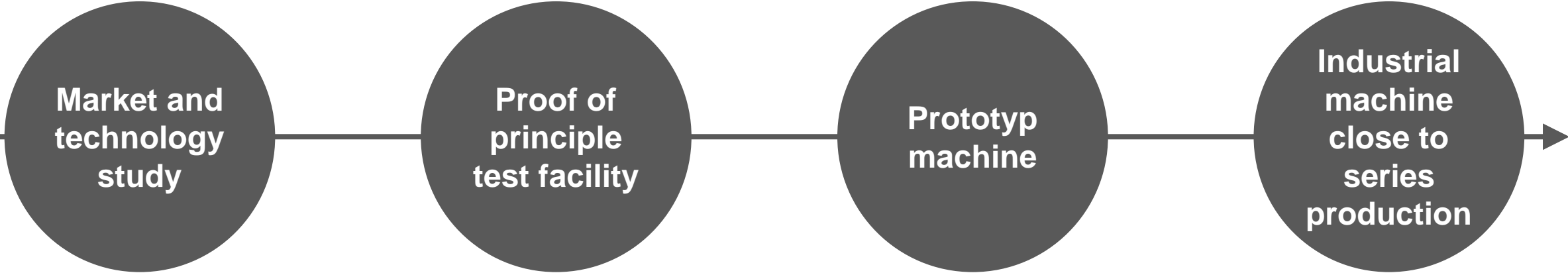
**Inductive  
heating of belts  
(up to 300°C)**

**Potential energy  
saving > 50%**

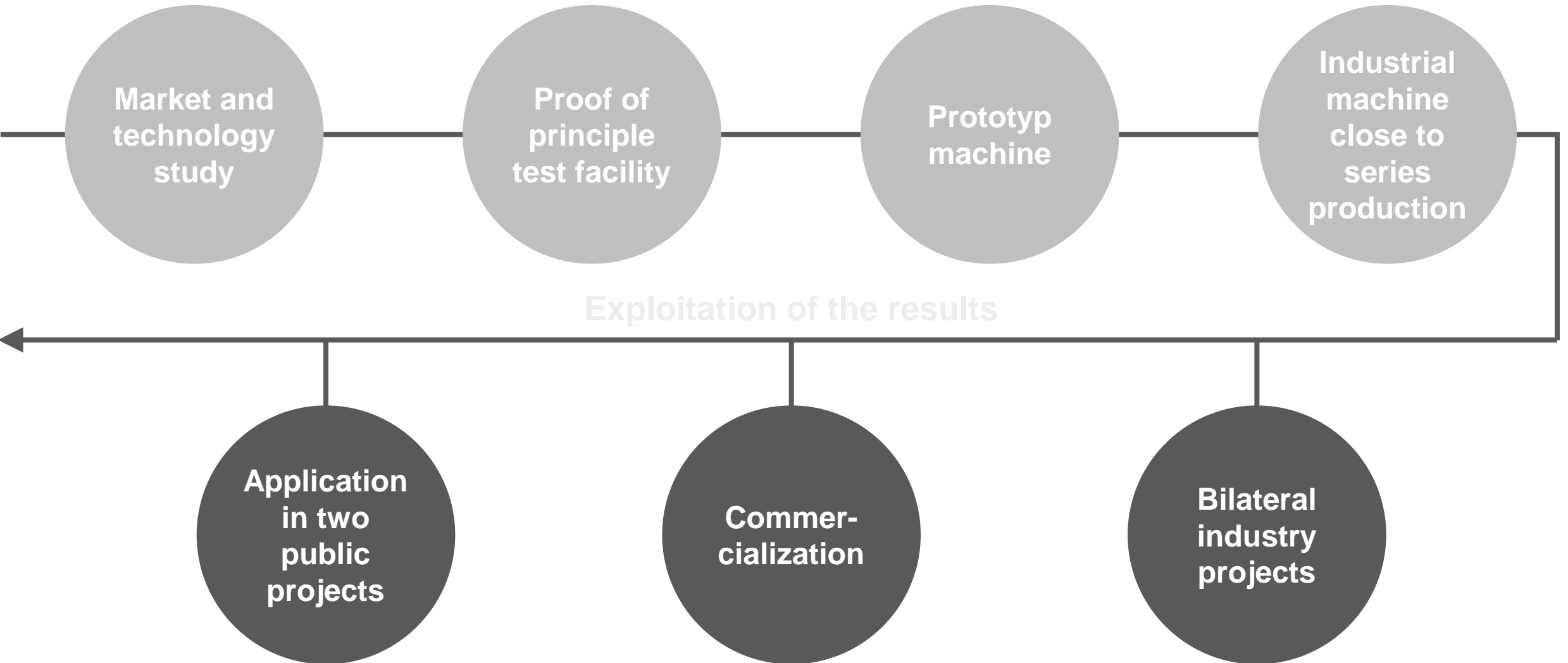
**Scalable system  
(speed, heat and  
pressure distribution)**



# How the AZL Innovation Strategy leads to a cost- and energy-efficient Double Belt Press System



# How the AZL Innovation Strategy leads to a cost- and energy-efficient Double Belt Press System

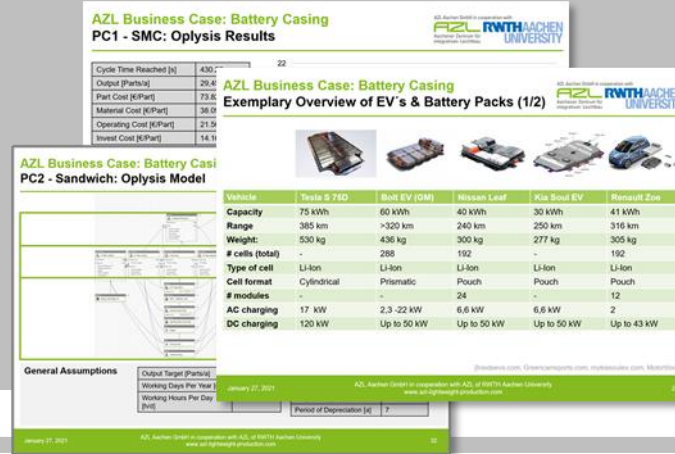




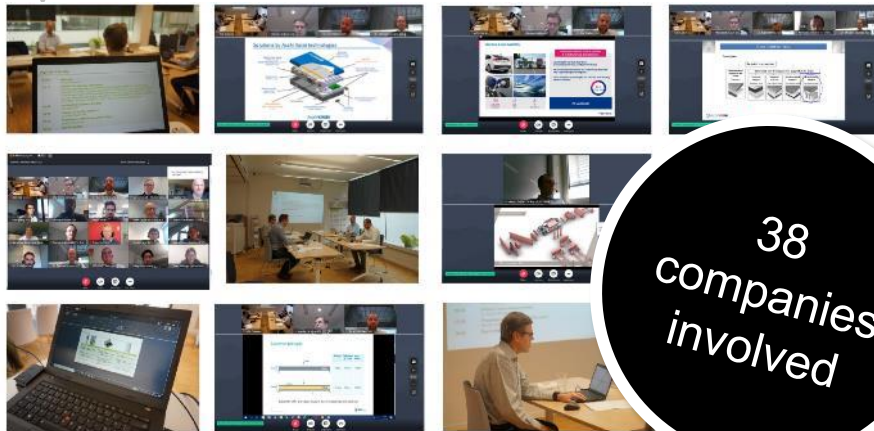
# Joint Product Development of a Multi-Material Battery Casing

As another Example

Demand identified in joint market and application analyses



Concept Study & Development of a  
Multi-material Battery Casing



38  
companies  
involved

Joint product development  
kicked-off with 38 companies



Follow-up project  
to realize a  
prototype



**For me personally as a business developer, the AZL partnership offers valuable market insights and sustainable cooperation with the entire value chain.**

**Arne Böttcher, Market Development Composites  
at Covestro Deutschland AG**



### ENGINEERING AND SERVICES

- Market & business opportunity identification
- Component design and production concepts
- System and process development
- Support for industrial implementation

### AZL PARTNERSHIP

- Pre-competitive, trusting collaboration along the entire value chain
- Regular meetings in workgroups
- Joint projects
- Cross-industry networking and matchmaking



### Business+ Partnership

- Easily join and set up projects with the included project budget
- Without administrative effort
- Definable budget, min. 15,000 €

# Lightweight production systems at AZL Tech Center

## From Meeting Room right into the Tech Center



### Schuler Composite Press

- Principle: Hydraulic short-stroke downstroke ram presses
- Closing force: 1.800 t
- Tool installation space
- Clamping area: 1.8 m x 2.8 m
- distance table UT - closing part OT: 2.400 mm
- distance table OT - closing unit UT: 600 mm
- T-slots: number 12; pitch 200 mm; width 28 mm



### ENGEL Injection Molding Machine

#### ENGEL duo combi M

- 2-component injection moulding machine with turning plate
- Clamping plate size: 2.42 m x 2.17 m
- clamping force: 17.000 kN



### Double-belt-press

- Inductive heating of the strips
- Elastic rollers for the flat application of pressure
- Pressure profiles within the pressure module
- Energy saving potential > 50% compared to the state of the art
- Max. Pressure 23 bar
- Production width up to 350 mm, scalable





# Lightweight production systems at AZL Tech Center

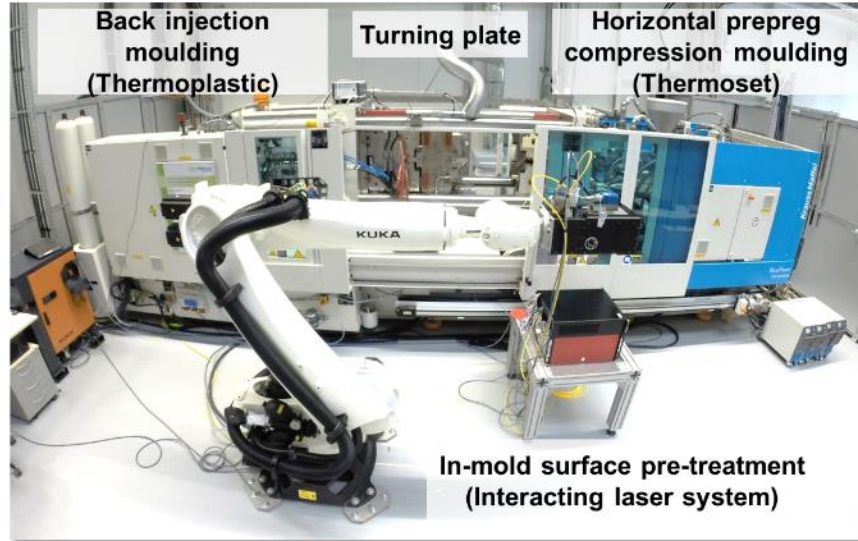
## One of 9 Composite Tech Centers at RWTH Aachen Campus



### GOM ATOS 5 non-contact optical measurement system

#### GOM ATOS 5

- Measuring range (700 mm x 530 mm x 520 mm) x 2
- Geometry measurement
- Measurement accuracy 47 µm
- Deformation and strain measurement



### KraussMaffei injection molding/RTM machine

#### CX200W

- Clamp force 2.000 kN
- Shot weight 180 g (SP380-D40)
- Control specialties: Embossing, 40°-50° plate position, extrusion mode

### Kuka KR90 R3100 HA

- Load capacity 90 kg
- Range 3,1 m
- Accuracy (Data sheet) ± 0,05 mm
- Euromap 67, Profibus and RSI



### Ultra-fast tape placement system

- Placement speed demonstrated up to 850 mm/s with full consolidation
- Cycle time demonstrated: 3.5 sec (cycles time < 3 sec feasible) > "Every 3 seconds a finished tailored blank"
- Business case analysis: < 1 €/kg of machine cost per kg produced part mass (CF-PP)
- Easy scalability of the system (applicators per station, stations per line) according to desired production scenario

### Arges 3D laser scanner

#### Arges Chameleon (3d)

- Pulsed NIR: 50 W, 100 ns, 1 mJ, 80 µm spot
- Cw NIR: 400 W, > 1 mm spot
- On-axis sensors
  - Pyrometer: 80 - 450°C, > 1 mm spot
  - LCI: Measure accuracy < 10 µm, 140 µm spot, measurement range 10 mm
- Mass 45 kg

# Many thanks!

## We are looking forward to working with you



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