

# The Challenging Process: Series Production of Laser-welded Bipolar Plates



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## Facts and figures 2023

**1.027**

customers worldwide

**4.359**

finished projects

**35**

years of experience

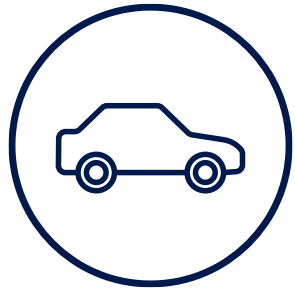
**250**

employees

**60 Mio. €**

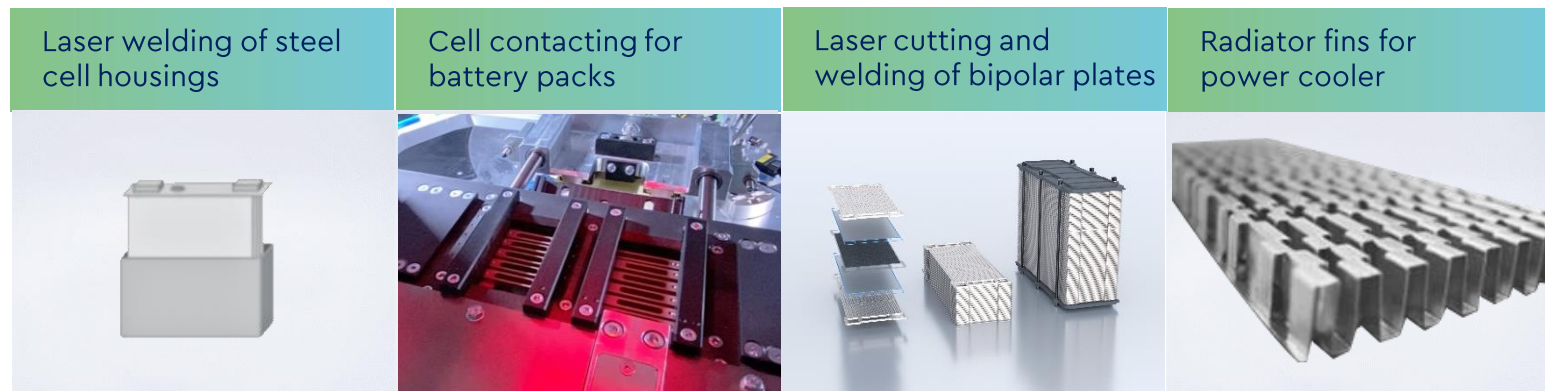
turnover

# Innovative manufacturing solutions for the mobility industry



**Mobility**

With our machines and systems, we support the requirements of the automotive industry to identify potentials, optimize production and face the key challenges in the changing industry.





# Wide range Hydrogen applications



Picture: Airbus

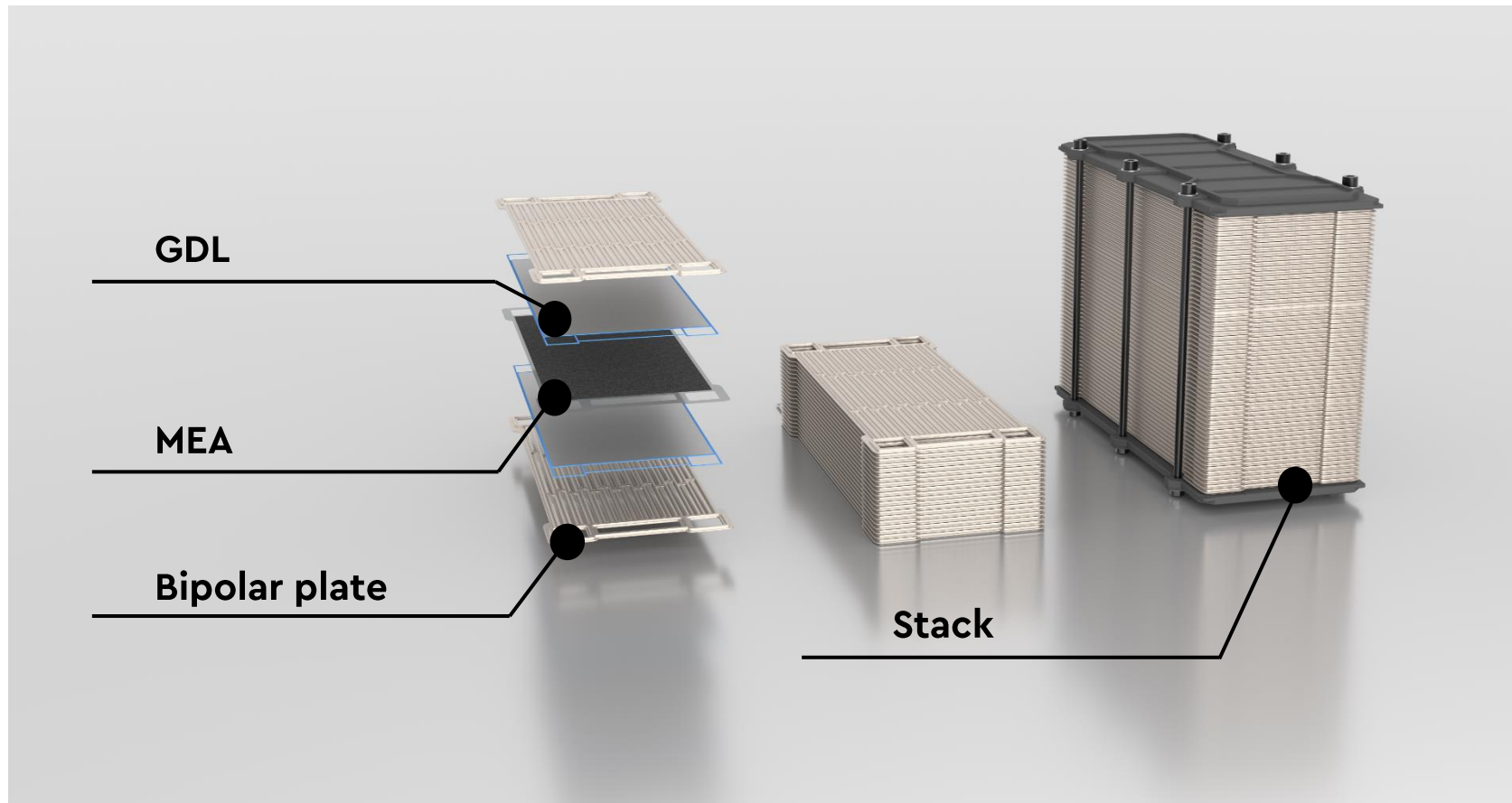


Picture: Havyard



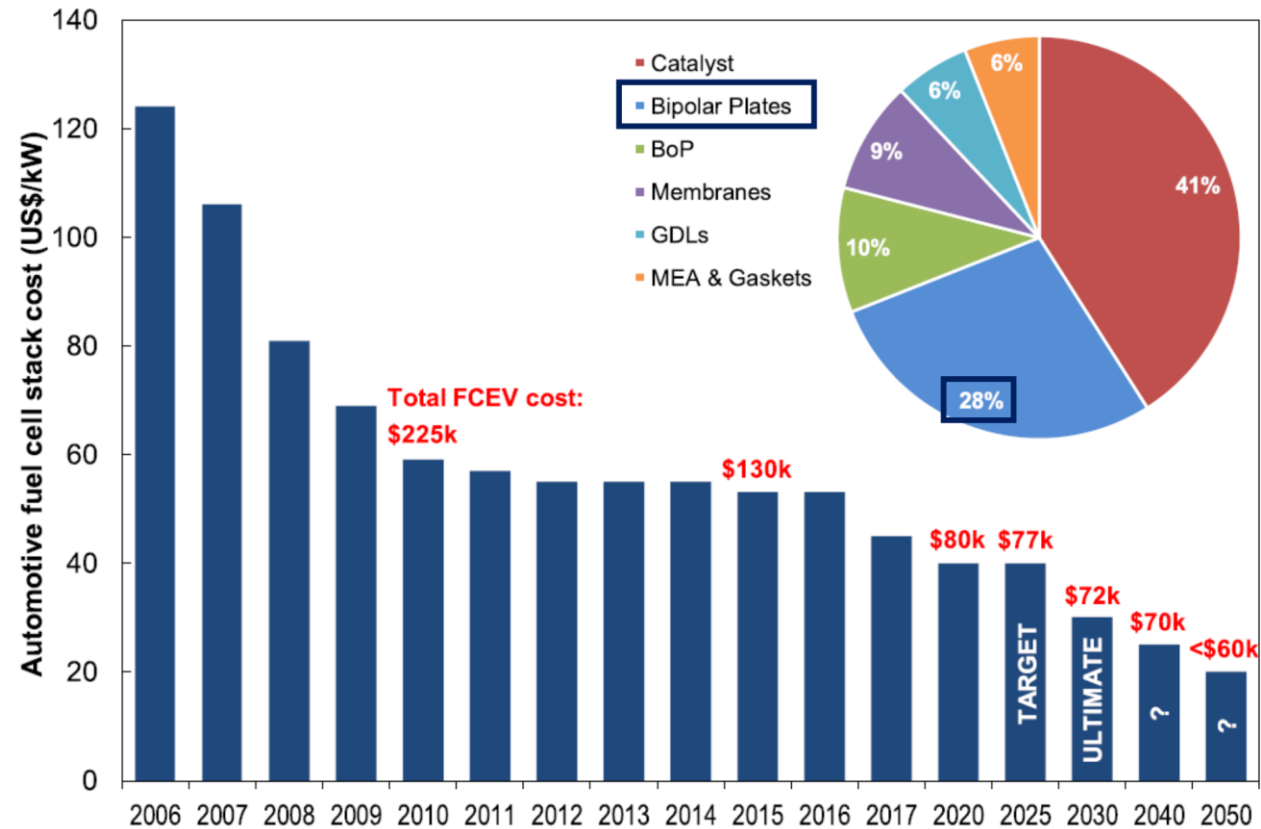
Picture: Stellantis

## Structure of a PEMFC stack and the individual cell

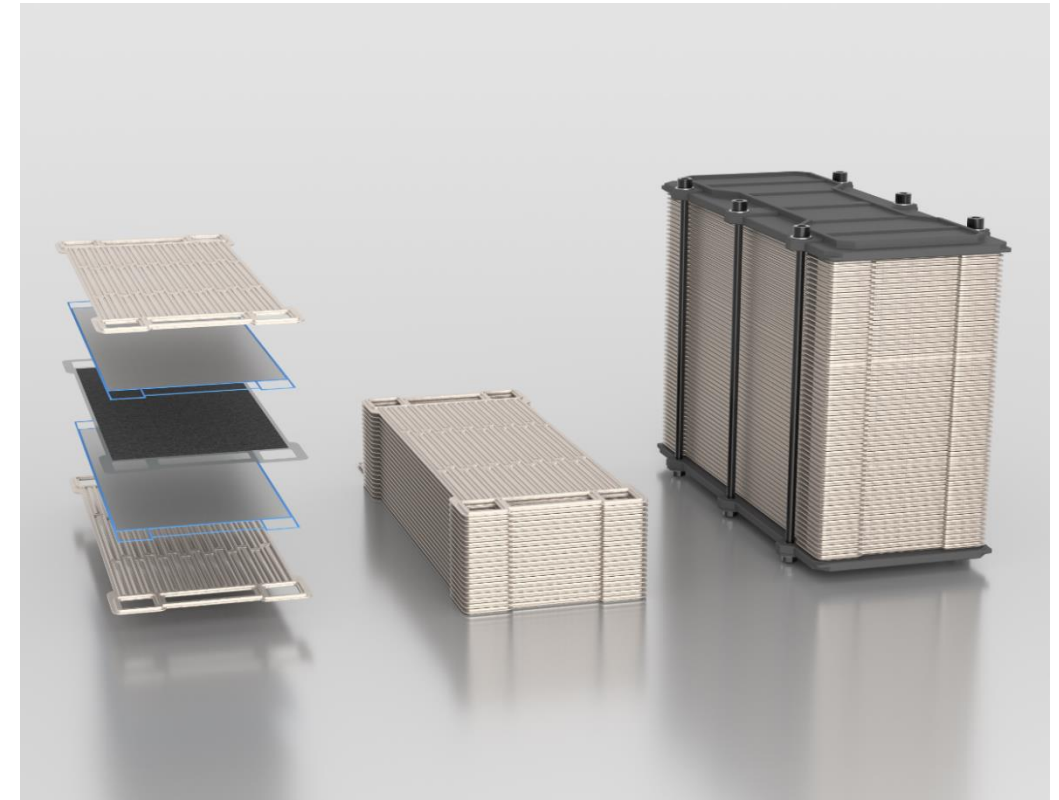


- A single cell typically consists of two bipolar plates (**BPP**), two gas diffusion layers (**GDL**) and the membrane electrode assembly (**MEA**)
- PEMFC stack for mobile applications consists of approx. **200 to 500 individual cells**
- **Successful Industrialization is a matter of high automated processes**

# Automotive fuel cell cost evaluation and projection

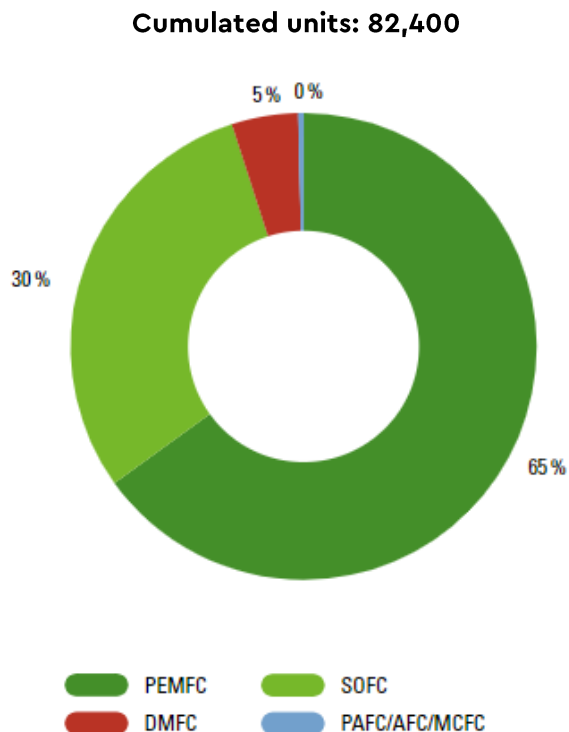


Source: Pollet BG, Kocha SS, Staffel I: Current status of automotive fuel cells for sustainable transport





# Industrialization is a crucial success factor for PEMFC



Development of FCEV sales based on governments fleet targets



Source: E4tech: The Fuel Cell Industry Review 2020 /  
NOW - GmbH: WERTSCHÖPFUNGSKETTE BRENNSTOFFZELLE  
Center Fuel Cell Industrialization 2021

- Approximately **82,000** fuel cell systems sold in 2020
- Polymer electrolyte membrane fuel cell (PEMFC) is the dominant technology with **65%**
- High market development of PEMFCs in mobile applications
- In Addition to political goals, the **technical and economic development** of the technology is crucial for success
- **Successful Industrialization is a matter of building up the right competences in short time**

# Transition from ICE to Fuel Cell: Laser is one Key Technology

## Conventional ICE



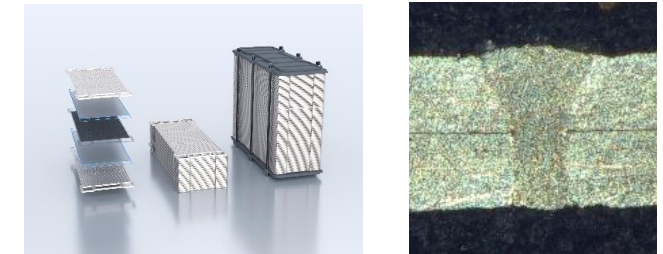
~ 1mm Thickness of Parts  
10 to 50mm of Weld  
lengths

## Battery / E-Powertrain



0.2mm to 0.5mm  
Thickness of Parts  
1mm to 1000mm of Weld  
lengths

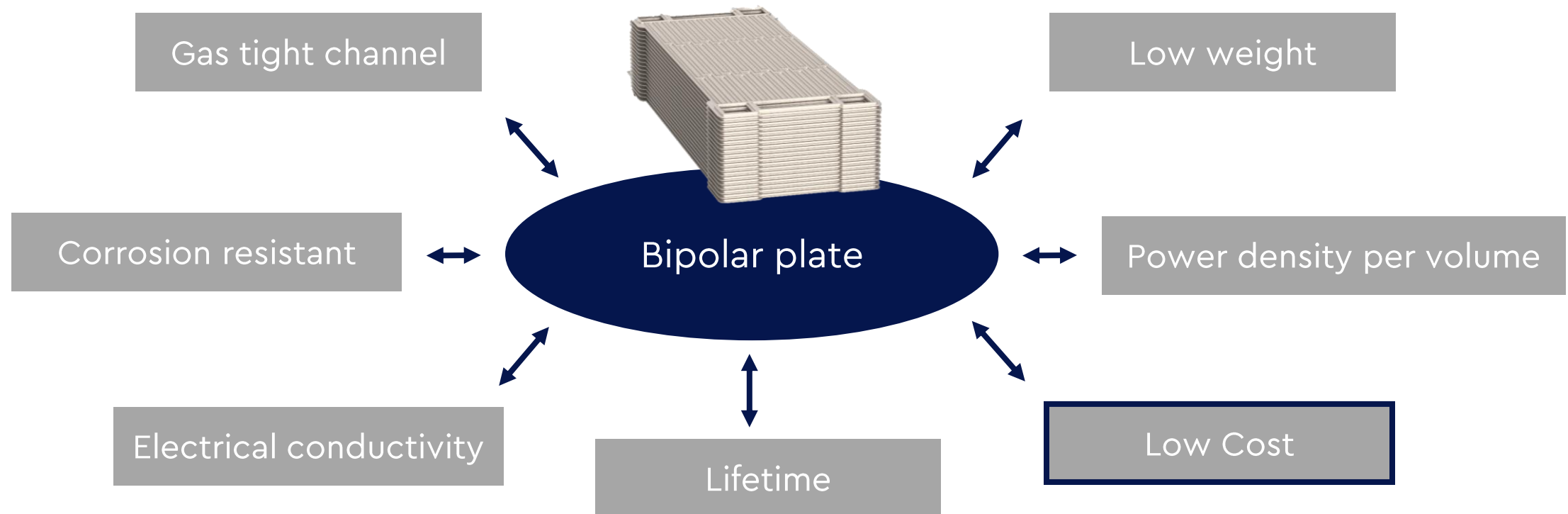
## Fuel Cell Stack



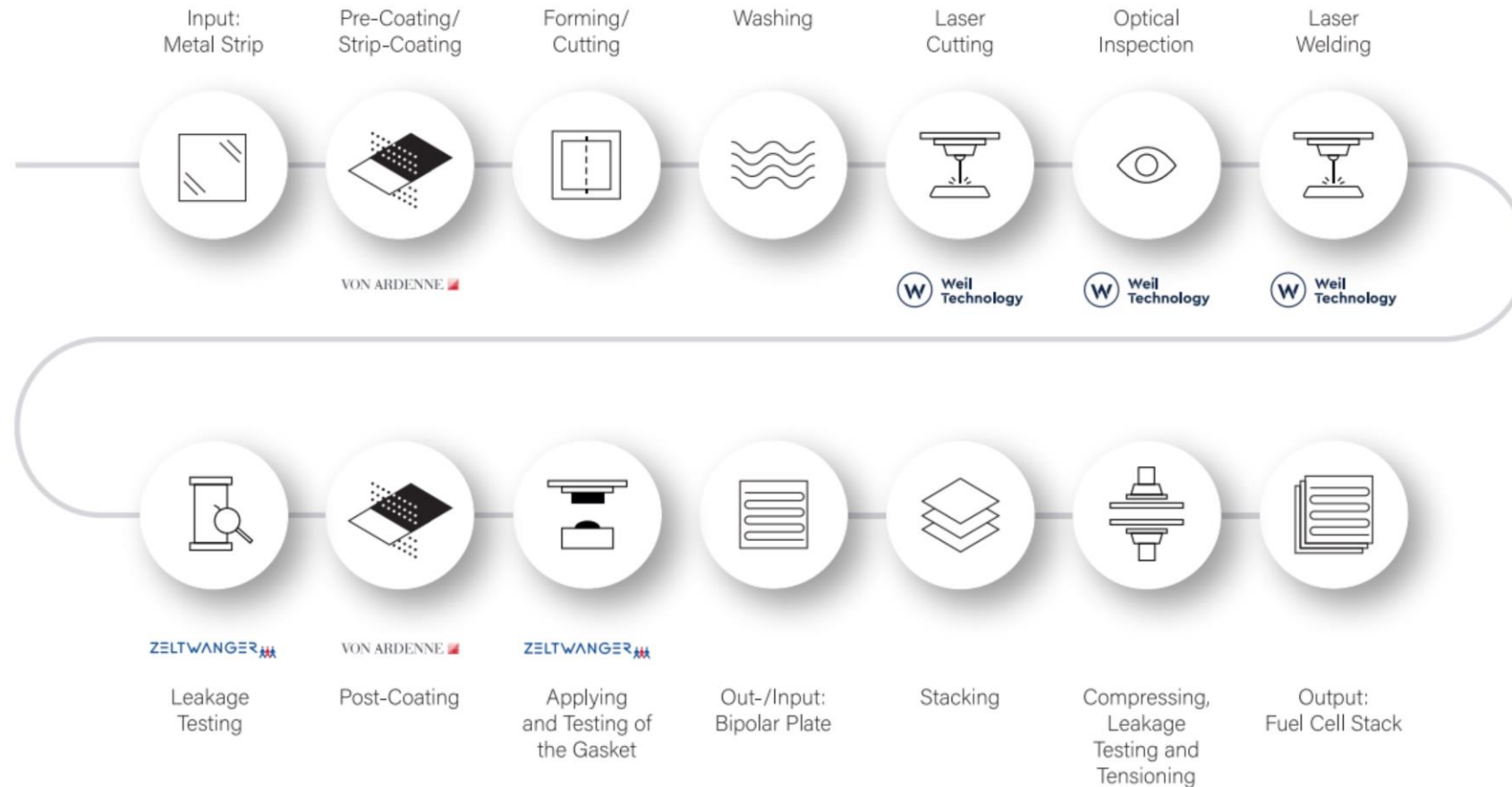
40 $\mu$ m to 100 $\mu$ m  
Thickness of Parts  
800m of Weld lengths



## Diverse requirements for machine technology



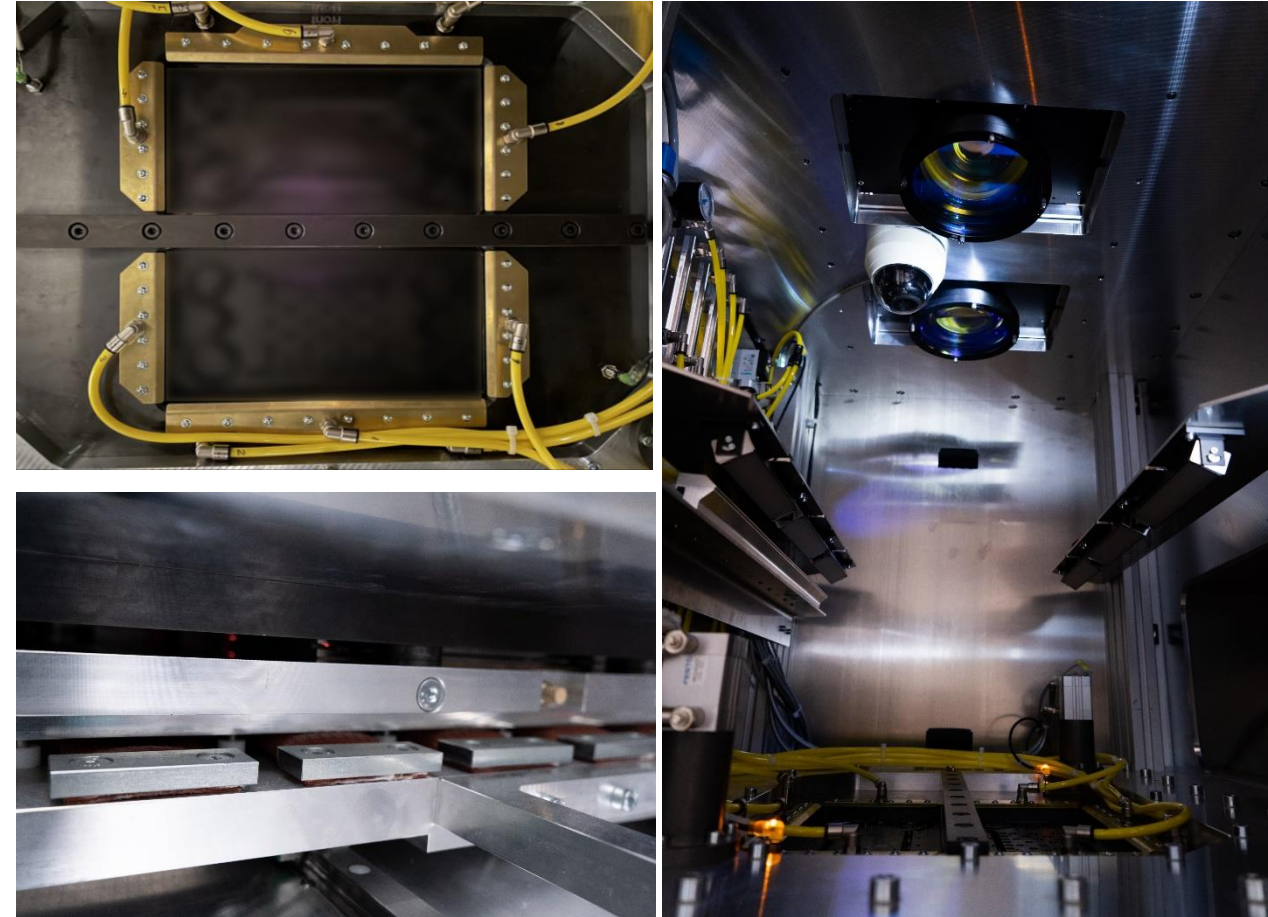
# Process chain for metallic bipolar plate production



## Laser- and fixture technology developed for bipolar plate

### One system with two scanner optics in simultaneous processing

- Doubling of the absolute welding speed to 1000 mm/s with large usable working range of 550 x 450 mm
- Butterfly-Weld: Symmetrical heat input due to intelligent welding sequence
- Static overall system for high contour accuracy and reproducibility
- New developed clamping technology especially for the demands of the thin half plates



Weil Technology Laser Welding Module

# The dual field scanner technology achieved high absolute welding speeds with necessary process reliability

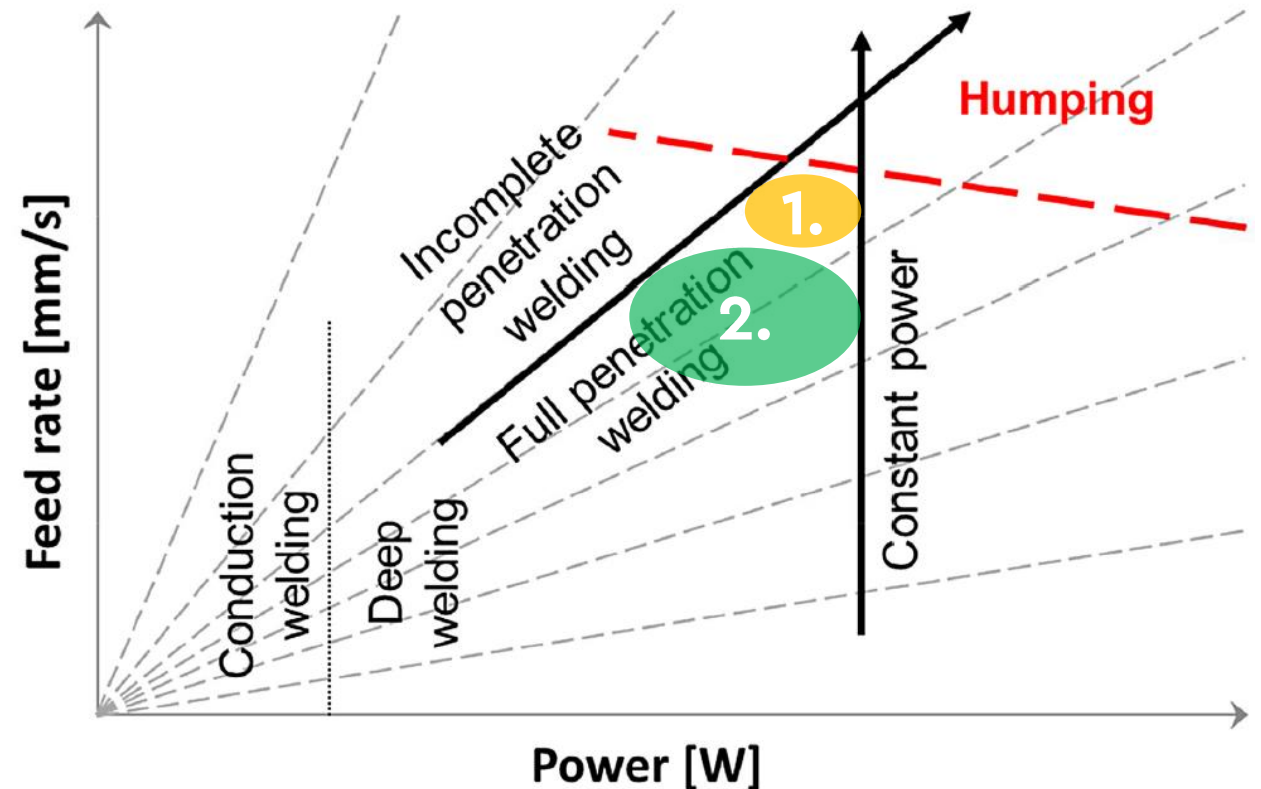
Welding speeds for formed material in series up to 600mm/s per scanner

## 1. Single scanner solution

Single scanner solution with lower process stability resp. low reserve to humping,  $v = 600\text{mm/s}$

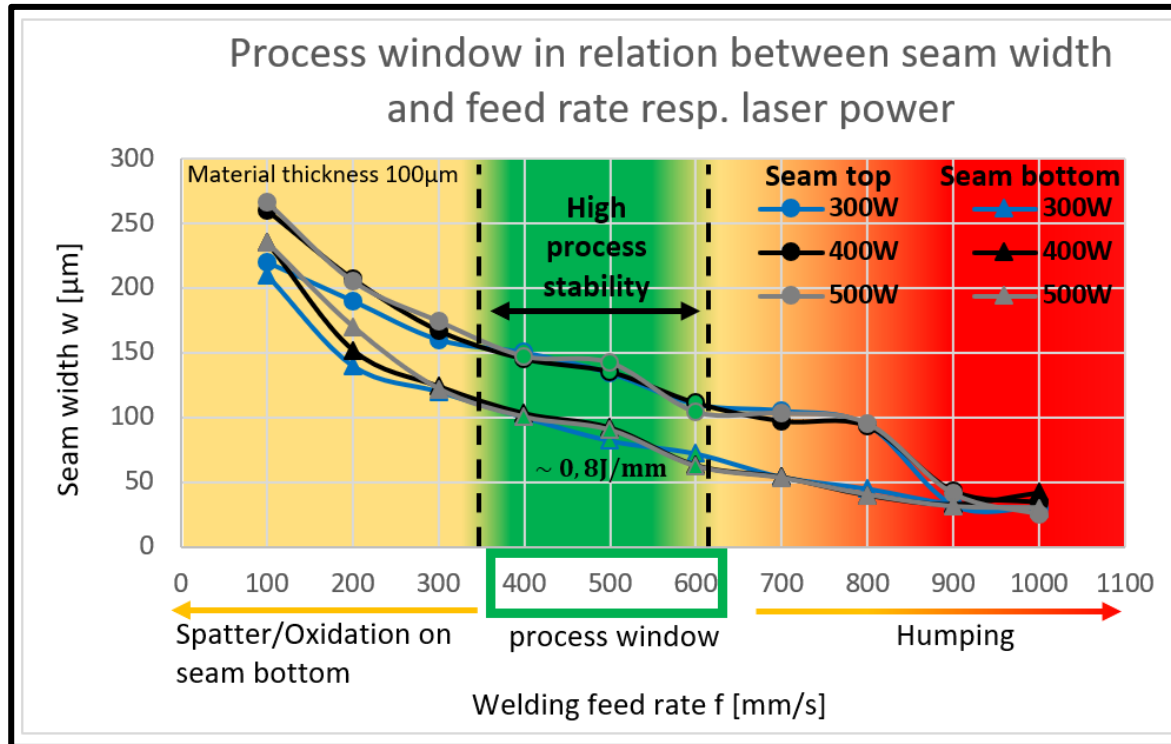
## 2. Dual field scanner solution

Higher process stability through targeted reduction of the welding speed to  $v = 500\text{ mm/s}$  per scanner





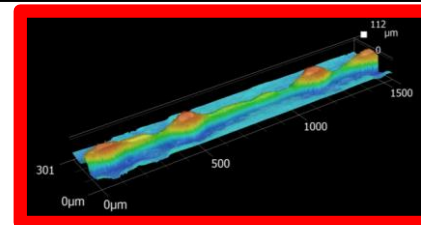
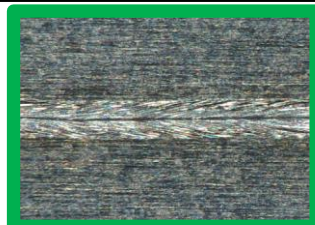
# Experimental studies: Process stability and seam irregularities



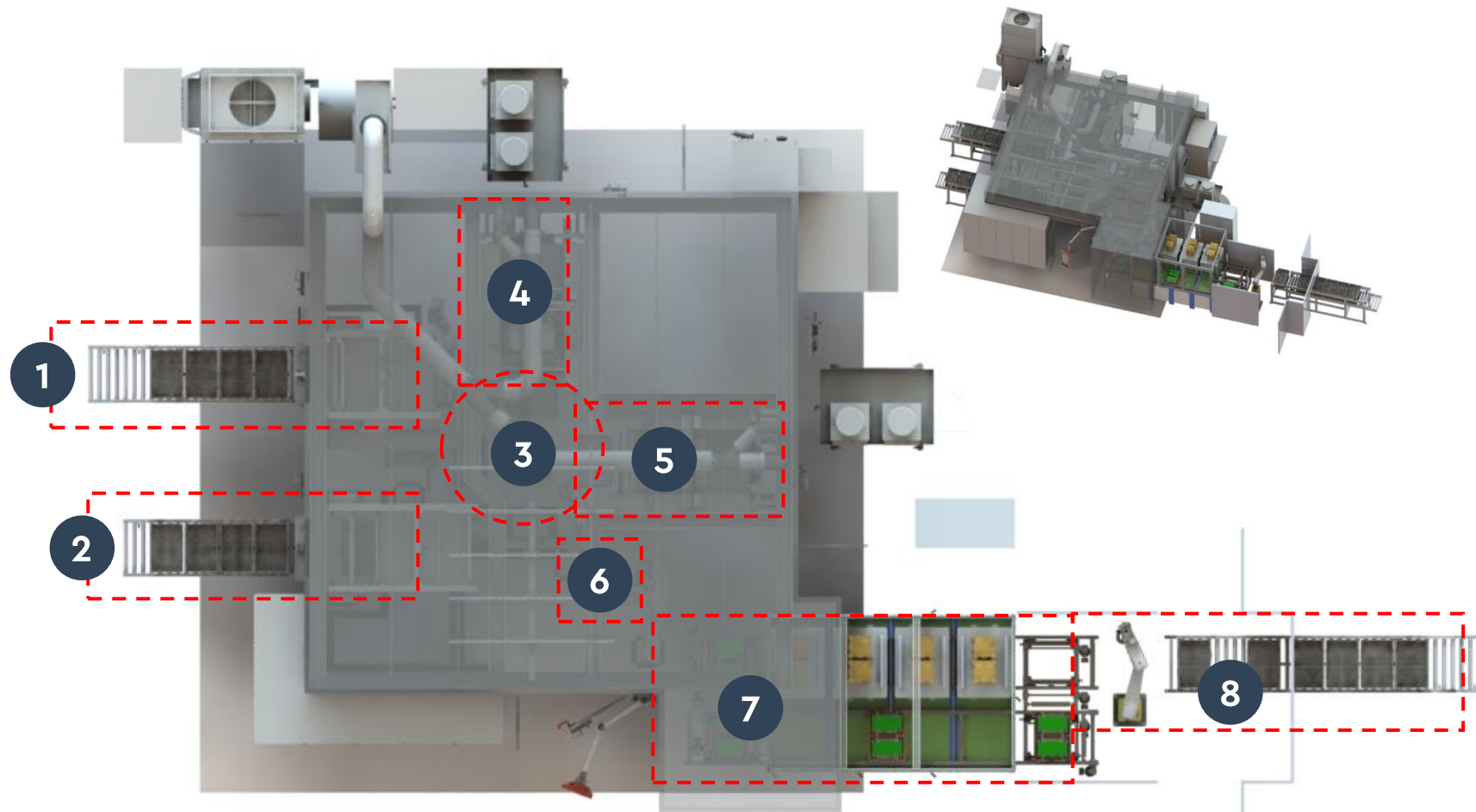
## High process stability with small focus diameter

- Process reliability with 500mm/s per scanner and welding feed reserve of 20%!
- Reduction of heat input through low melting volume and thermal management with dual field scanner
- Low influence of the laser power in the process window → high process stability in the whole scanner field

- ✓ Process stability
- ✓ 20% welding feed reserve
- ✓ Low heat input
- ✓ Thermal management



# Laser welding cell with integrated leak testing module



1. Material infeed of **cathode**
2. Material infeed of **anode**
3. 4-station turntable
4. Welding module 1
5. Welding module 2
6. DMC- marking station
7. Leaktesting unit
8. Unloading of welded and tested BPP

**Thank you!**



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**Realizing fascinating solutions**

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