

# Steel components for battery housings

at CBMM & Partners Mobility Tech Workshop

Berlin, 24<sup>th</sup> of May 2019



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# The voestalpine group

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Headquartered in Linz, Austria

voestalpine is a leading technology and capital goods group with combined material and processing expertise, holding global top positions in its business units. The Group focuses on product and system solutions based on steel and other metals of the highest quality in technology-intensive industries and niches.



# voestalpine divisions

As a publicly listed holding company, voestalpine AG manages four divisions that are each **world market leaders or one of the leading global suppliers.**



## STEEL DIVISION

**Worldwide  
quality leadership**  
36% share of Group  
consolidated revenue



## HIGH PERFORMANCE METALS DIVISION

**Global  
market leader**  
22% share of Group  
consolidated revenue



## METAL ENGINEERING DIVISION

**World  
market leader**  
22% share of Group  
consolidated revenue



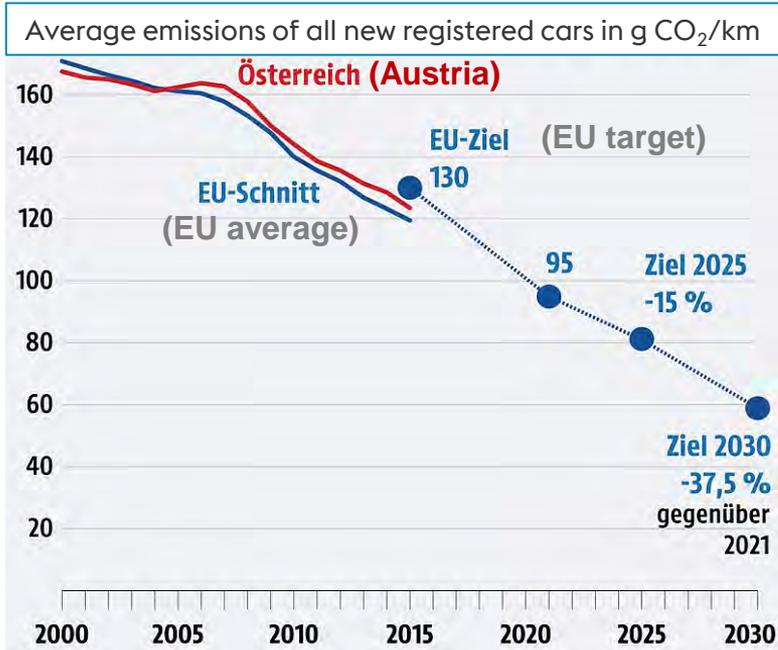
## METAL FORMING DIVISION

**World's  
leading supplier**  
20% share of Group  
consolidated revenue



# Electro mobility

## Aims of the European Union



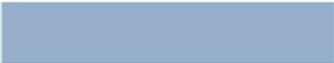
- » 95g CO<sub>2</sub>/km: 3,6l diesel or. 4,1l petrol /100km
- » For every additional gram: 95 € penalty / PKW
  - » Billions of € fines for car manufactures possible (FCA/Tesla)
- » Future regulations also for trucks and coaches (2025: -15 % CO<sub>2</sub> 2030: -30 % CO<sub>2</sub>)

Targets can not be reached without electrification of the drive train!



# Electro mobility

## Manufacturers 2021

Country	Expected production EV and PHEV until 2021 ['000 cars']	Top 3 models per country
	 6.843	BAIC EU260 EV; SAIC Roewe 550 PHEV; BAIC EV200
	 3.058	Tesla Model 3; Tesla Model S; Chevrolet Bolt
	 2.247	Audi etron, Mercedes C PHEV, BMW i3
	 1.023	Nissan Leaf; Toyota Prius PHEV, Mitsubishi Outlander PHEV
	 763	Renault ZOE Z.E., Peugeot 208 EV, Renault Kangoo Z.E.
	 632	Hyundai Ioniq EV, Kia Niro PHEV; Kia Soul EV

Source: Index Elektromobilität, Roland Berger & fka Aachen, 2018



# Electro mobility

## Why steel?

- » What have a high volume **VW Golf 7 TSI Blue Motion 1.2** and a **Carinthian Drautaler cheese** in common?



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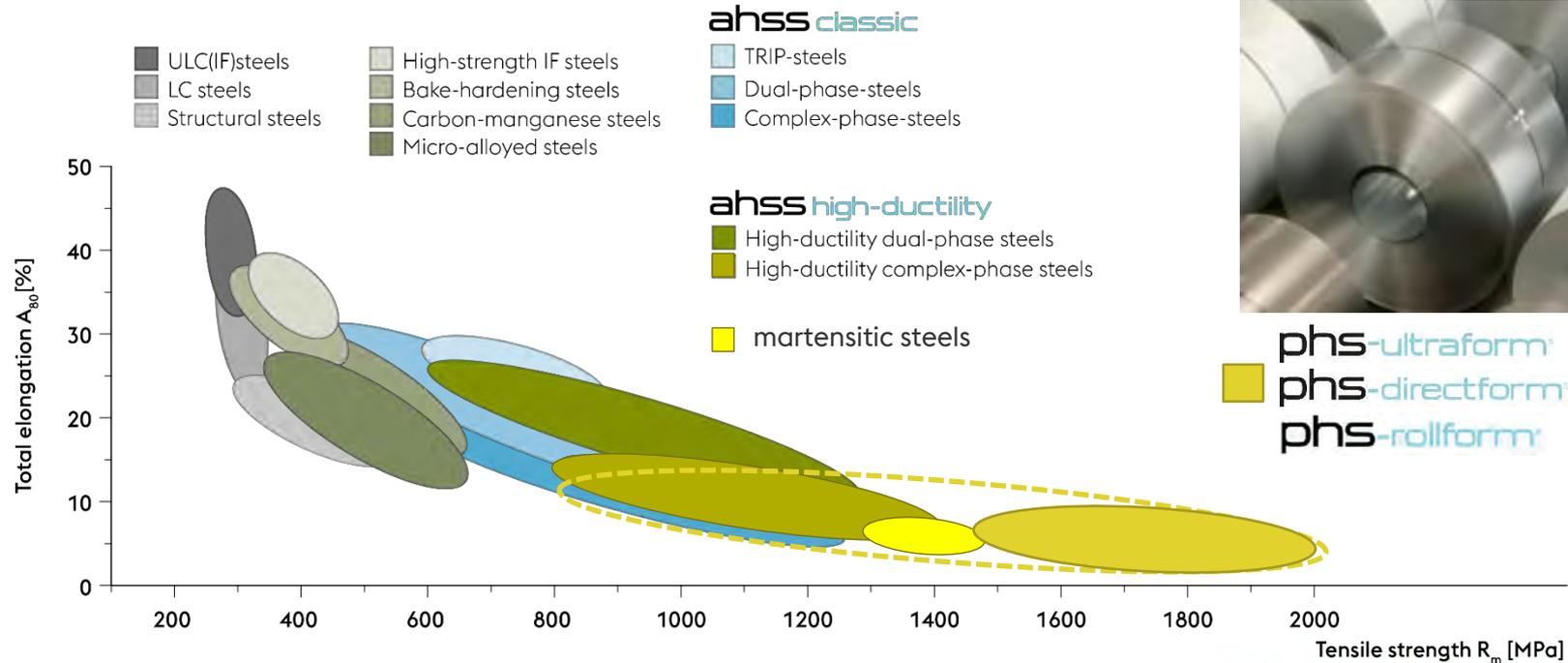
€ / kg

» Demand for cost effective **steel solutions!**



# voestalpine Stahl GmbH

## Range of products - Cold rolled steel sheets





# Component production

## Deep drawing - Exp. B-Pillar Dual phase steel

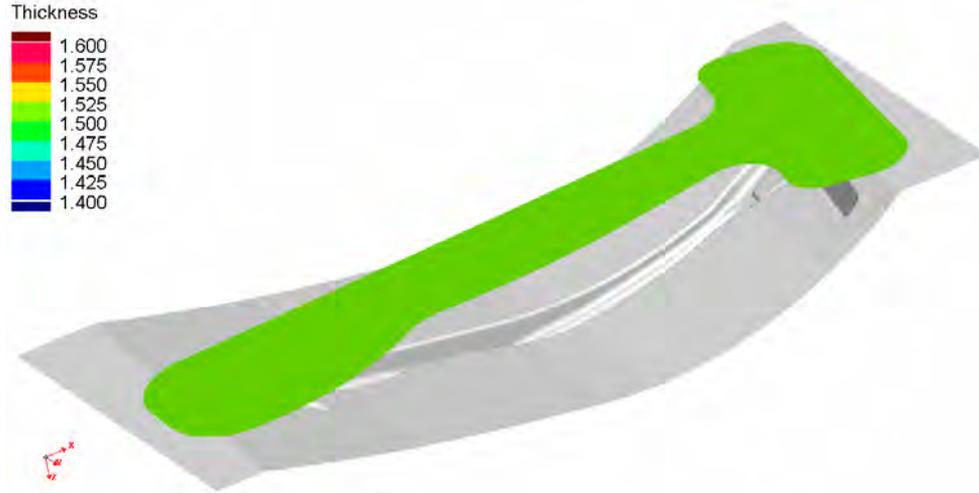




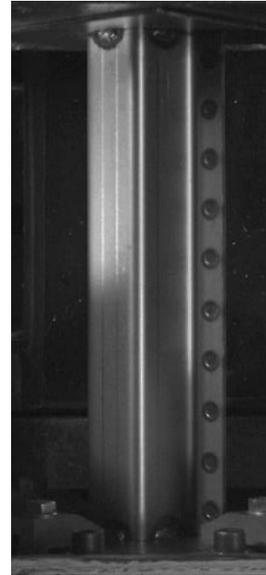
# Component production

## Dual phase steel - deep drawing and crash test simulation

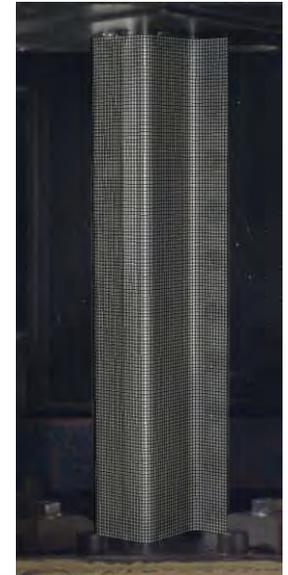
Deep drawing simulation



Crash test



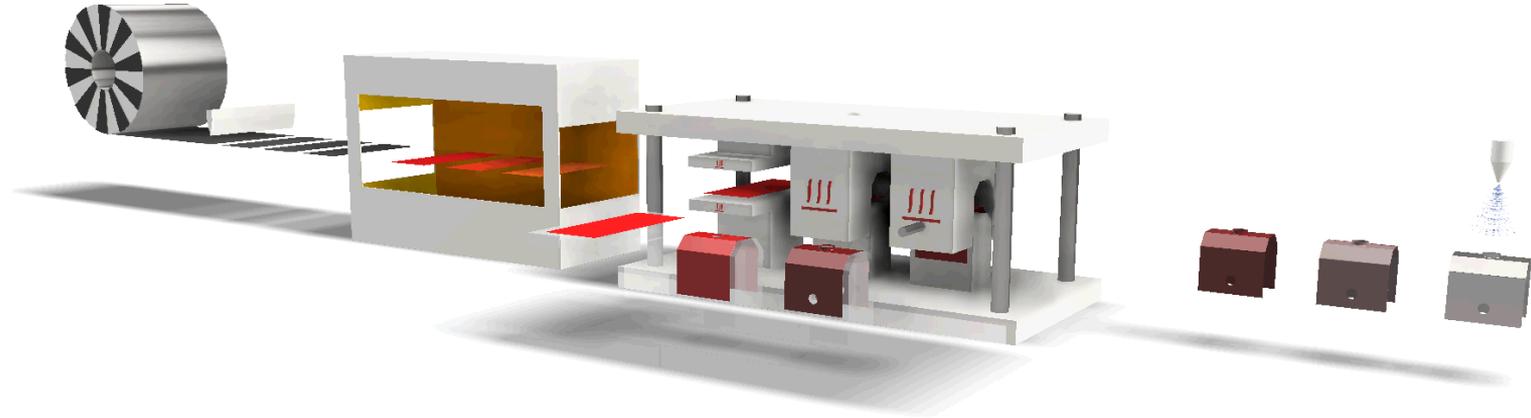
Crash simulation





# Component production

phs - directform/multiform – direct press hardening process

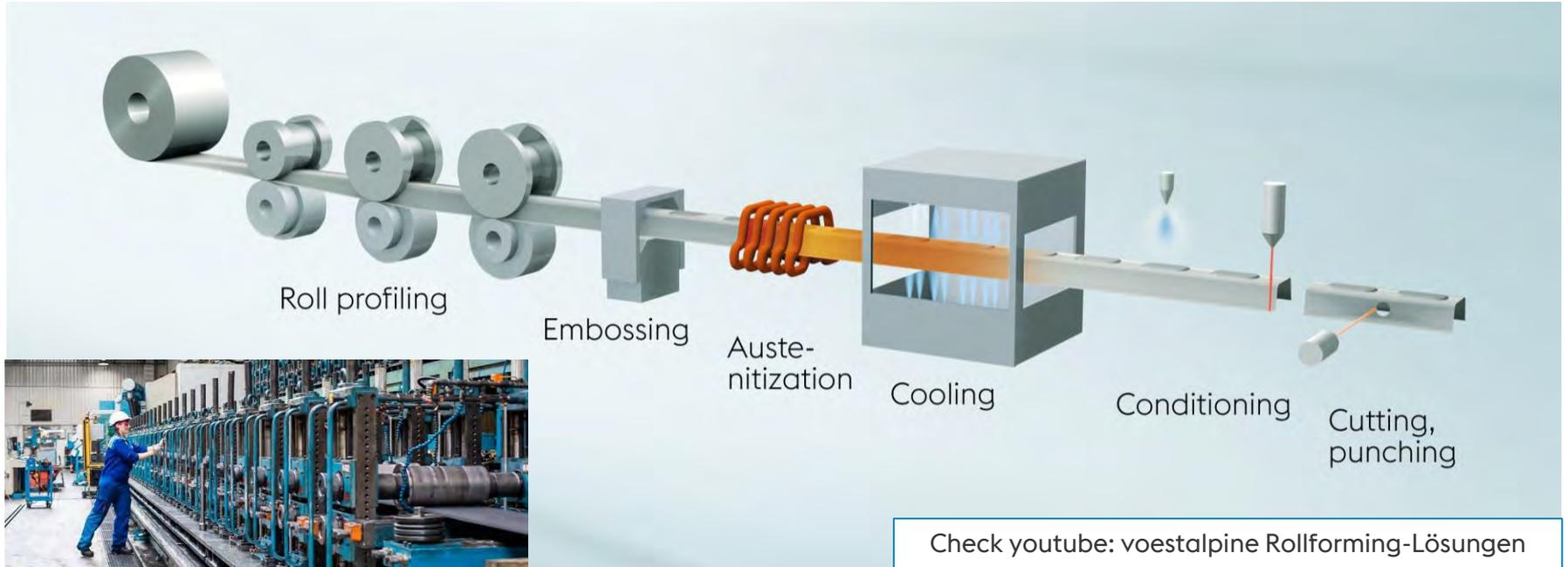


Check youtube: pbs-directform Prozess: Eine Weltneuheit für den Leichtbau



# Component production

phs-rollform – roll forming with subsequent martensitic hardening

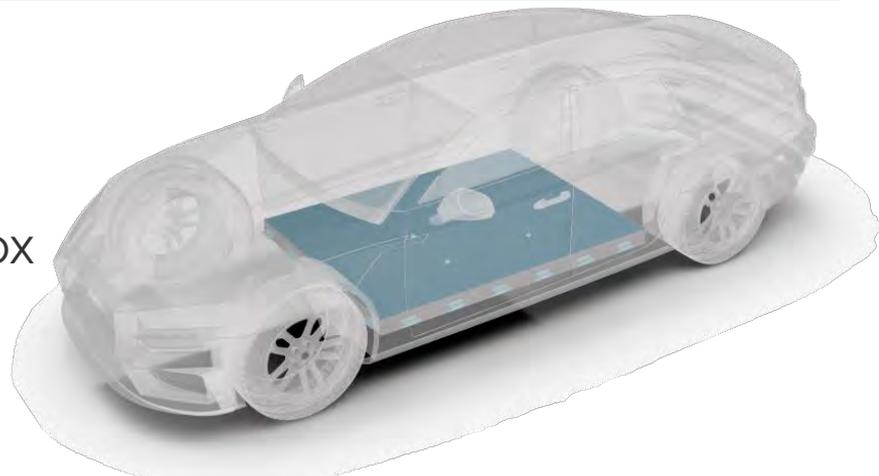


## The new modular battery box system for efficient e-mobility

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### » Target:

Development and production of a modular, scalable battery box including configurable and integrable functions in a TOOLBOX



### » Requirements:

Regulatory standards (GB/T, ECE R100), Bottom impact 20kN,

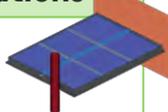
Battery capacity >70kWh, module height 80mm

Dimensions: 2.000mm x 1.500mm x 120mm, parts production/a: 150.000



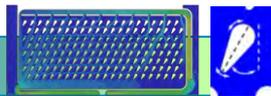
### 1. Analysis of relevant regulations

- Thermal requirements
- Crush & shock tests
- Supplementary industrial standards



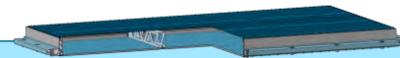
### 4. Optimization

- Matching of functional solutions with degree of target fulfilment
- Alternation of set targets (e.g. focus on lightweight design, tightness, ...)



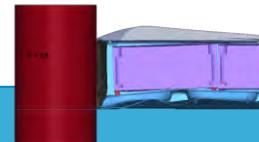
### 2. Conceptual Design

- Generation of possible solutions
- Draft and discussion of ideas
- Detailed constructive elaboration



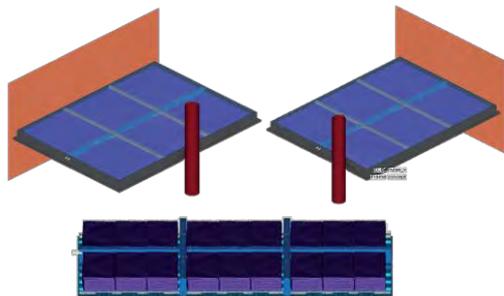
### 3. Validation

- Analysis of elaborated designs
- Simulations and hardware testing
- Evaluation of test results



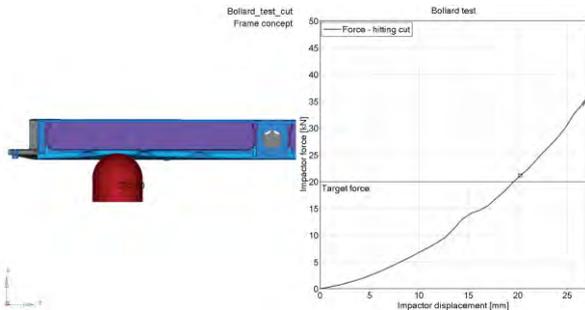
## Agile Development Process

## Boundary conditions - Crash requirements & Thermal Management



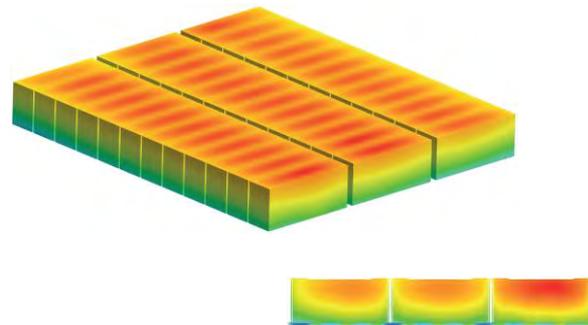
### ➤ Crush test in x- / y- direction

- GB/T 31467.3 / ECE R100
- 100 kN
- Quasi static
- No fire / no explosion



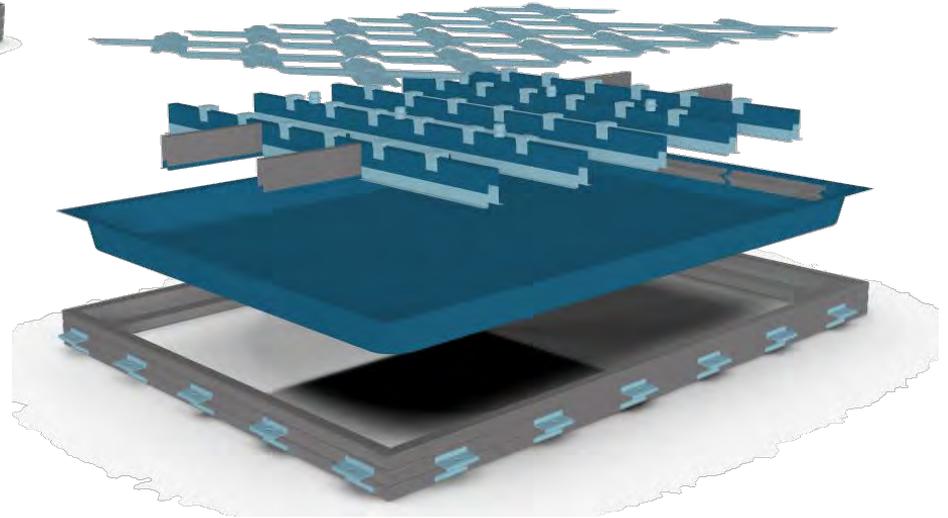
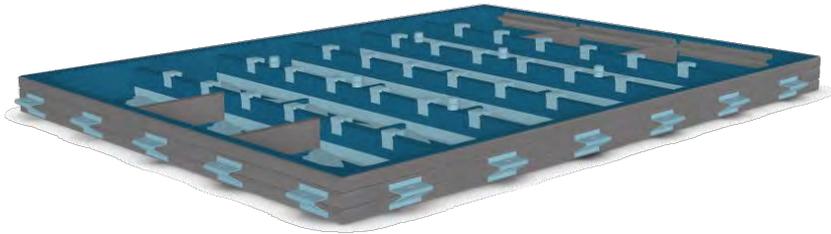
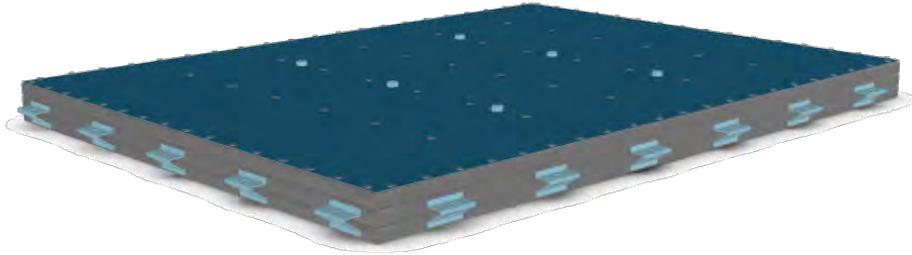
### ➤ Vertical crush (pole) test

- 20kN bottom impact
- Quasi static
- No fire / no explosion
- Accord. customer requirements



### ➤ Analysis of temperature homogeneity on cell level

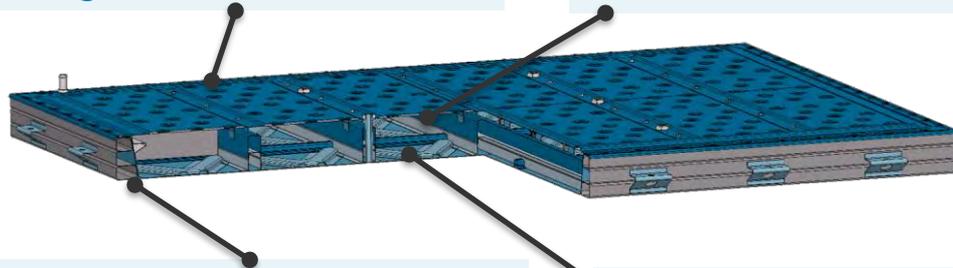
- $T = 15^{\circ}\text{C}-40^{\circ}\text{C}$ ,  $\Delta T < 5 \text{ K}$
- Low pressure loss in the integrated cooling system





» two-layer steel cover with integrated cooling in combination with overhead modules (functional integration in cover)

» No cooling fluid within the battery box (increased safety)



» Multi chamber –side section & tight tray (scalable crash-concept)

» deep-drawn & reinforced bottom structure (functional integration of underbody protection)

### Performance

- » highest safety & tightness
- » scalable crash-concept
- » high permissible intrusion length in pole test

### Weight

- » 103kg
  - 20 kg outer section
  - 27,5kg tray
  - 21,5kg framework
  - 17 kg cover & integrated cooling
  - 13 kg reinforced bottom



» integration of cooling hose system into long sections

» Multi chamber – Side section



» bottom with effective reinforcement for side & bottom-up forces

» variable & scalable bottom structure

### Performance

- » exceptional modularity
- » excellent Thermal Management
- » Good Performance in pole test

### Weight

- » 100kg
  - 23 kg outer section
  - 12,5kg framework
  - 34,5kg bottom and bottom framework
  - 13 kg cooling
  - 13 kg cover



» cover with stamping & integrated long sections w. load-bearing capacity

» PHS - outer section & multi chamber section for crash protection



» light weight - cross bar structure (weight optimized)

» Aluminum-Sandwich bottom plate: cooling integrated, effective reinforcement

### Performance

- » Ultra light weight variant
- » Steel → cost efficient light weight construction
- » Aluminum-bottom plate supports at impact of side crash
- » Functional integration of cooling in bottom plate

### Weight

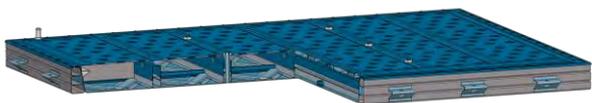
- » 55,55kg
  - 18,7 kg outer section
  - 4,2 kg crossbar
  - 8,1 kg cover
  - 19,0 kg bottom plate w. integrated cooling



# flextric

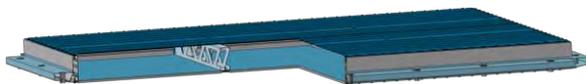
## Modular electric battery housing highlights

### Tray Design



➤ Maximum safety & strength

### St-Al Hybrid Design



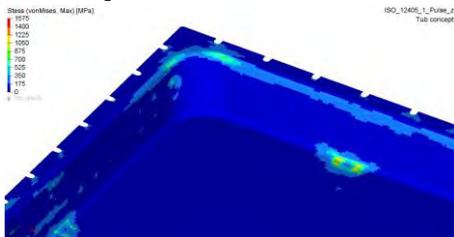
➤ Maximum weight savings

### Frame Design



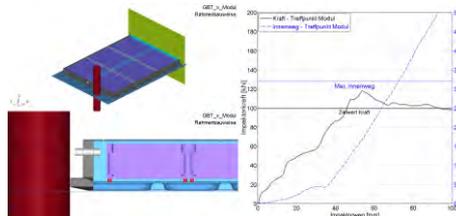
➤ Maximum modularity

### phs-ultraform ®



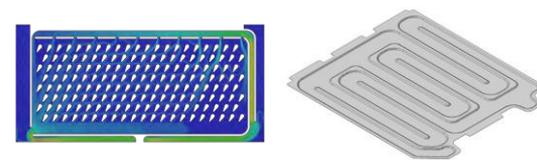
➤ Highest durability

### Crush-Performance



➤ Highly scalable

### Thermal management



➤ Smart cooling solutions





# Conclusion

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- » Steel in battery housings
  - » Cost effective for high production volumes
  - » voestalpine development support
    - » Know-how in production processes
    - » Know-how in steel (formability, crash behaviour, corrosion protection, joining)
      - » Material models for forming and crash freely available
- » flextric – modular battery housing
  - » Toolbox for concept design
  - » Supplier for concept design and manufacturing of battery housings

flextric

# Thank You!

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