

THE MARKET DEVELOPER



Market Research

- Global Al / Mg Foundry, Forging Extrusion Databases for M&A, Supplier / Customer Localization or Competitor Analysis, ...
- Automotive & Industrial Application Research, Material & Process Trend Analyses
- Lightweight Technology Outlook in Aluminum, Carbon, Steel Composites & Magnesium
- Customized Market Intelligence
- European Automotive Forecast



Market Development

- Access & Build-Up of new Markets in Automotive, Truck [Tractor], Trailer & Bus Industries Mainly
- Analysis, Development & Execution of Market Trade-Offs & Opportunities of New Technologies
- Manage new Product Launches
- Accelerate Market Penetration & Establish a Sales Force
- Interim Sales Management



Roadshows / Events

- Organization of Technical, Commercial Roadshows & Events Globally
- Host In-House Events & Presentation Globally
- Common Technology Booth at Leading Exhibitions
- Supply-Chain Automotive Lightweight Symposium [SCALS] In EUROPE, ASIA & N.AMERICA



Strategic Localization

- Green & Brown Field Localization, from Site Selection to Foundation & Ramp-Up
- Warehousing, Distribution, Supplier & Tie-Up Localization
- Foreign Market Business Cases & their Realization
- M&A Target Research & Pre Due Diligence
- Interim CTO / COO & Plant Manager

ALUMAG[®] is “The Market Developer” that successfully penetrates new markets, creates business and localize leading suppliers for your company. ALUMAG[®] access any promising markets, open doors for your business in emerging and booming regions, markets, applications, materials, processes or products. ALUMAG[®] makes you successful - worldwide!

MARKET RESEARCH | MARKET DEVELOPMENT | ROADSHOWS / TECH-EVENTS | STRATEGIC LOCALIZATION

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TEASER - REPORT

EU27+ ANALYSIS: BEV MARKET INTELLIGENCE : AL PROCESSES - APPLICATIONS - SUPPLY CHAIN

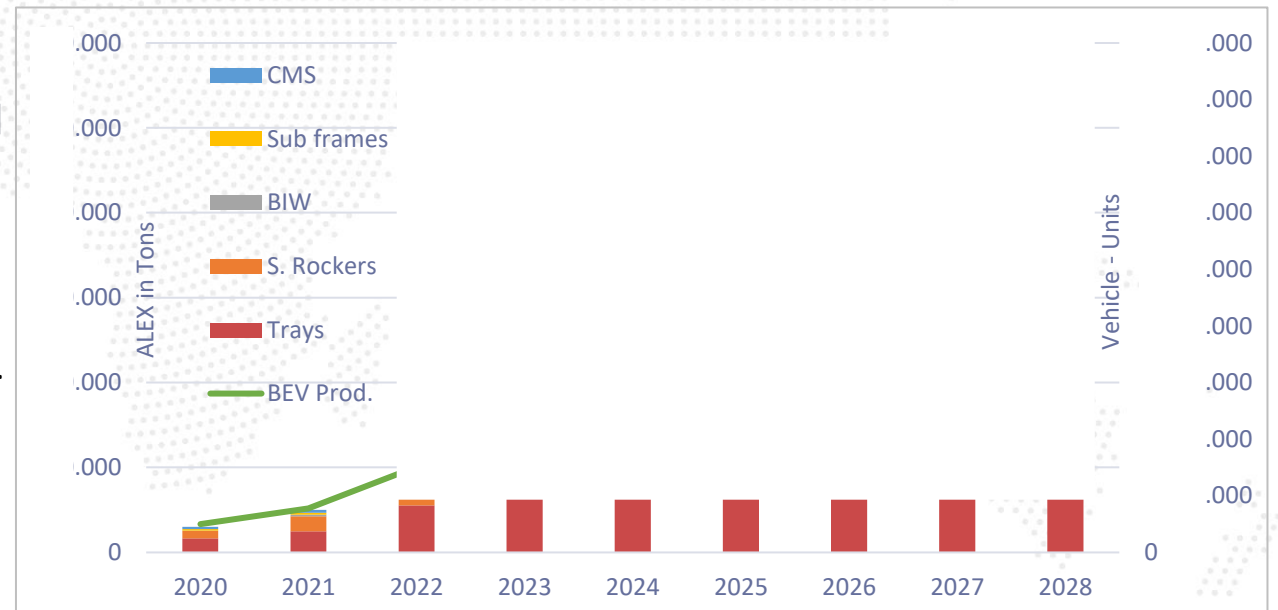
EU27+ ANALYSIS: BEV MARKET INTELLIGENCE : AL PROCESSES - APPLICATIONS - SUPPLY CHAIN

ALUMAG[®] Automotive recent analysis foresees a shift away from aluminum in key BEV applications!

ALUMAG[®] has successfully finalized the market intelligence “EU27+ ANALYSIS: BEV MARKET INTELLIGENCE : AL PROCESSES - APPLICATIONS - SUPPLY CHAIN”, which is now ready to market. The market intel provides a basic understanding, technical / cost insights and demand overview of the market for multi hollow extruded aluminum sections. In course of the market intel around 150 current and future BEVs were analysed in regards to material use in key structural applications such as BIW parts, CMS, HV battery frames/trays, side collision rocker and sub frames. And, with the EU27+ BEV penetration forecasted to grow from 10% in 2022 to 41% in 2028, prospects for BEV applications are looking good. Though only HV battery frames and side collision rockers are obvious BEV components, BIW, sub frames and CMS are equally interesting in this context as their specs are partly redefined in BEVs.

The bottom-up intelligence of the 150 BEV models revealed some interesting but not expected facts. Extruded aluminum is and will play a dominant role within structural BEV applications [CAGR of 64%] in the timeframe 2020 - 2025. And while the MEB 1 platform by VW Group accounts for almost 50% of the entire AL-extruded demand in 2022, 65% of the market demand will be split by 10 major BEV platforms in 2028.

In general BEV HV battery frames are material and/or process hybrids. [Roll] formed AL / ST and AL / ST sheet, AL extrusions with AL HPDC nodes, assembled by FSW or other welding processes, representing the vast majority. And almost every BEV is fitted with massive AL extruded side collision rockers [intrusion beam/members /rails], up to 22kg per piece. Steel and composites engineered side collision rockers are still rare.



AL Extrusion Market Growth By Application

EU27+ ANALYSIS: BEV MARKET INTELLIGENCE : AL PROCESSES - APPLICATIONS - SUPPLY CHAIN

ALUMAG[®] Automotive recent analysis foresees a shift away from aluminum in key BEV applications!

BMW is in pole position when it comes to utilizing extruded AL [Close to XX,000 tons in 2025] for the analyzed BIW applications and the overall penetration of front extruded AL subframes is higher than for rear subframes during the entire analyzed timeframe.

But not everything that shines is aluminum. At least not in the middle run. Steel is already the predominant material used for BEV's CMS . But the study also revealed high penetration of steel, in for example, battery trays - especially in two upcoming BEV platforms [architectures].

These and much more market intel are available in the 200 pages PPT report incl a detailed excel database with bottom up analyses of all BEVs in EU27+. Incl. in dept analysis of all applications in regards to market overview, market players, technical insight & demand by group, brand, platform, material, process, and alloys. Next step for ALUMAG[®] is to include North America and Asia in the market intell.

THE ENTIRE "EU27+" MARKET INTEL BY ALUMAG[®] CAN BE ACQUIRED FOR THE NET SUM OF 99,990 EUR OR PURCHASED IN BITS IF REQUESTED.

PACKAGE I - Summary page 6 – 51: [PREFACE / INTRODUCTION , MARKET PERSUASIONS & TAKE-AWAYS , AL EXTRUDED MULTI HOLLOW SECTION , EU27+ NON-PROSPECTIVE APPLICATIONS SUMMARY , ESTIMATION OF MARKET SHARE EXTRUDED 6082] - **19,998 EUR or USD**

PACKAGE II - Summary page 52 – 97: [EIGHT LEADING OEM BEV PLATFORMS & AL EXTRUSION NEED , NINE LEADING EXTRUDER AUTOMOTIVE ALLOYS FOR MULTIHOLLOW SECTIONS & THREE HYDRO CALIBRATOR , PROCESS & COST] - **19,998 EUR or USD**

PACKAGE III - Appendix 98 – 198: 100 PAGES WITH DETAILED DESCRIPTION AND PICTURES OF ANALYSED APPLICATIONS - **19,998 EUR or USD**

PACKAGE IV – Excel Database: IN DEPT ANALYSIS OF ALL APPLICATIONS IN REGARDS TO MARKET OVERVIEW, MARKET PLAYERS, TECHNICAL INSIGHT & DEMAND BY GROUP, BRAND, PLATFORM, MATERIAL, PROCESS, AND ALLOYS. - **39,996 EUR or USD**

The study is based on interviews with industry experts and secondary information incl. limited BOMs [bill of materials] and quotes. All researched market intel has carefully been validated, confirmed, benchmarked, structured and allocated into excel & PowerPoint databases. ALUMAG[®] is specialized in the execution of customized market analysis. Please do not hesitate to contact us with your specific request. As your provider of automotive research and forecasting studies, ALUMAG[®] offer you and your business, the market intelligence you need to make the best strategic decisions and makes you successful worldwide!

TABLE OF CONTENT

PART I - ANALYSIS: BEV LIGHT WEIGHTING KEY APPLICATIONS

Source: ALUMAG[®]

1.	<u>PREFACE / INTRODUCTION</u>	006 - 006
2.	<u>MARKET PERSUASIONS & TAKE-AWAYS</u>	007 - 014
1.	<u>RECOMMENDATION</u>	007 - 009
2.	<u>MACRO TRENDS IMPACTING DEMAND</u>	010 - 014
3.	<u>AL EXTRUDED MULTI HOLLOW SECTION :</u>	015 - 046
1.	<u>HELICOPTER OVERVIEW & KEY TAKE-AWAYS</u>	015 - 021
2.	<u>BEV HV BATTERY FRAME</u>	022 - 026
3.	<u>BEV HV BATTERY SIDE COLLISION ROCKER</u>	027 - 031
4.	<u>BIW STRUCTURE</u>	032 - 036
5.	<u>CMS</u>	037 - 041
6.	<u>SUB FRAME</u>	042 - 046
4.	<u>EU27+ NON-PROSPECTIVE APPLICATIONS SUMMARY</u>	047 - 050
1.	<u>AIRCON / HEAT TRANSFER</u>	047 - 048
2.	<u>MOTOR & TRANSMISSION [E.DRIVE]</u>	049 - 049
3.	<u>TRIM INTERIOR / EXTERIOR</u>	050 - 050

TABLE OF CONTENT

PART II - ANALYSIS: TARGET OEM & LEADING EXTRUDER

Source: ALUMAG[®]

5.	<u>ESTIMATION OF MARKET SHARE EXTRUDED 6082</u>	051 - 051
6.	<u>EIGHT LEADING OEM BEV PLATFORMS & AL EXTRUSION NEED</u>	052 - 074
1.	<u>PERFACE - INTRODUCTION - OVERVIEW</u>	050 - 055
2.	<u>BMW</u>	056 - 057
3.	<u>FORD</u>	058 - 058
4.	<u>JLR {TATA}</u>	059 - 060
5.	<u>MB GROUP</u>	061 - 063
6.	<u>RENAULT NISSAN</u>	064 - 064
7.	<u>STELLANTIS</u>	065 - 069
8.	<u>TESLA</u>	070 - 070
9.	<u>VW GROUP</u>	071 - 074
7.	<u>NINE LEADING EXTRUDER AUTOMOTIVE ALLOYS FOR MULTIHOLLOW SECTIONS & THREE HYDRO CALIBRATOR</u>	075 - 075

TABLE OF CONTENT

PART II - ANALYSIS: TARGET OEM & LEADING EXTRUDER

8.	<u>PROCESS & COST</u>	076 - 097
1.	<u>EQUIPMENT, PROCESS LAYOUT, INVESTMENTS, CYCLE TIMES</u>	076 - 086
2.	<u>COST FACTSHEET : METAL, CONVERSION REVENUE, POST EXTRUSION, HYDRO CALIBRATION</u>	087 - 087
3.	<u>ALTERNATIVE PROCESSES</u>	088 - 097
9.	<u>APPENDIX & GENERAL MARKET INFORMATION BY OEM & SUPPLIER</u>	098 - 195
10.	<u>ABBREVIATIONS</u>	196 - 197
11.	<u>OEM & BRANDS</u>	198 - 198
	<u>CONTACTS</u>	199 - 199

Source: ALUMAG[®]

SAMPLE PAGE – PACKAGE I

03.02 AL EXTRUDED MULTI HOLLOW SECTION : BEV HV BATTERY FRAME 2020 - 2025+

The BEV propulsion system consists of sub-systems such as an HV battery system [energy storage device], electric machine, divers power electronics incl onboard charger. BEVs HV battery system does contain several battery modules with battery packs to maintain a suitable range which increases the weight of the vehicle. The HV battery system contain several different sub-systems like BMS, thermal management and further to deliver performance for the electrified vehicle.

The tray incl the frame are made from extruded, cast & sheet AL as a process hybrid. Further ST is playing a runners-up role.

▪ ALLOYS : EN AW-6005A, EN AW-6061, EN AW-6063,

▪ SPEC

▪ CIRCUMFERENC

▪ WEIGHT /CAR

▪ COST

▪ VOLUME YEAR 2

▪ VOLUME YEAR 2 Mill. BEV

Source: BENTELER & ALUMAG[®]

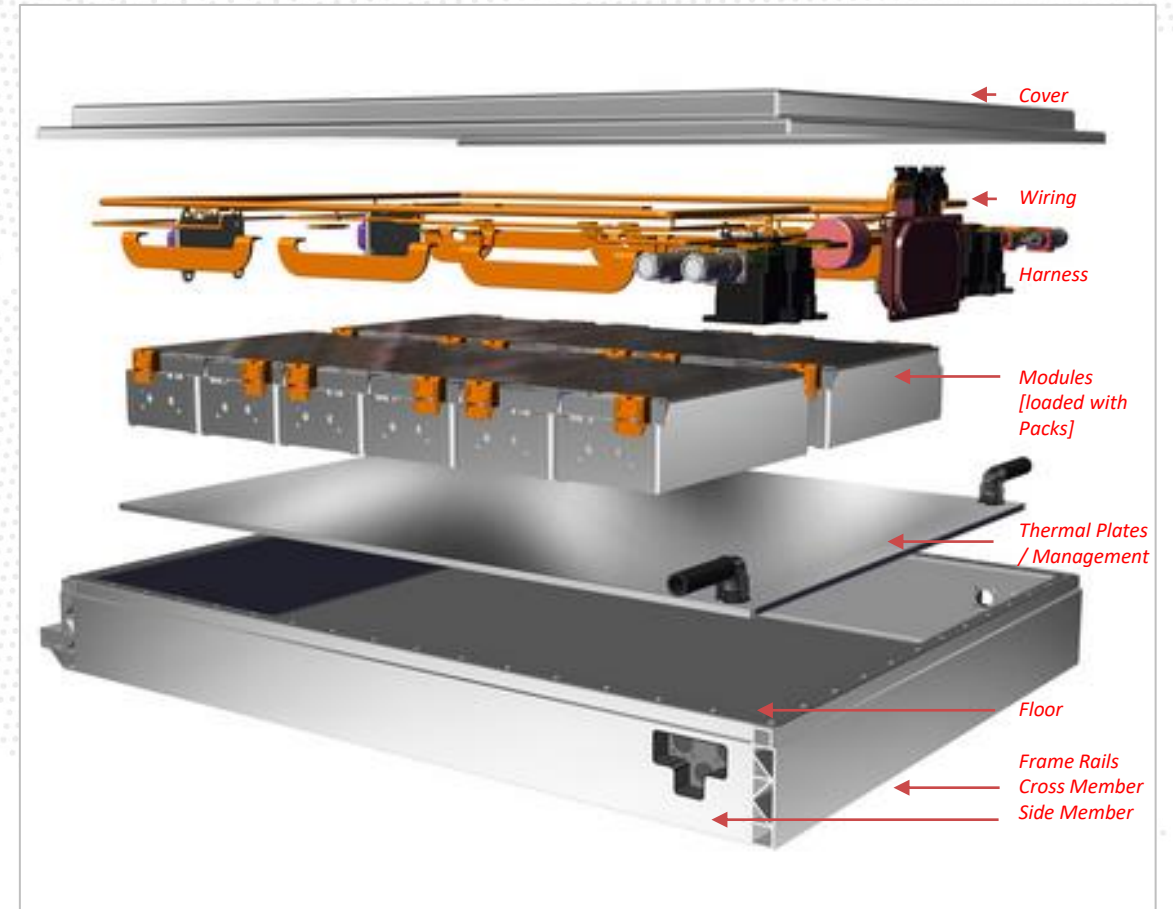
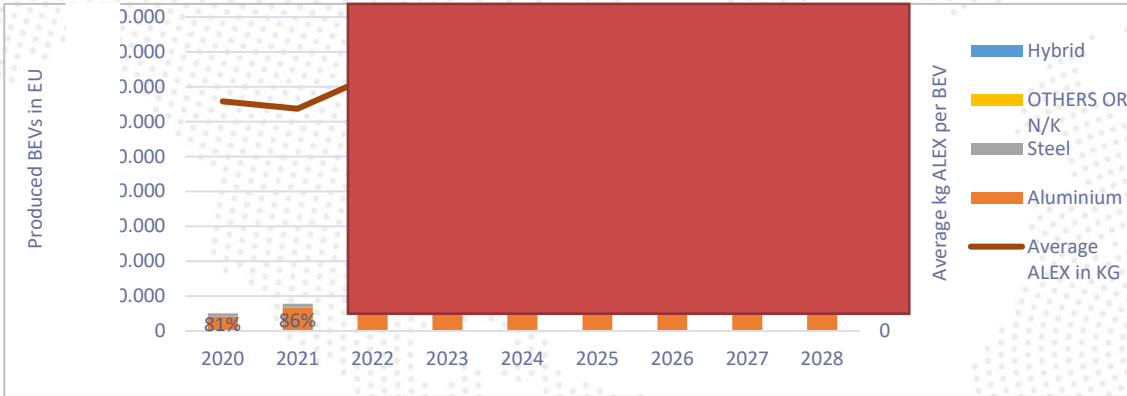


Illustration Of AL Intensive HV Battery System

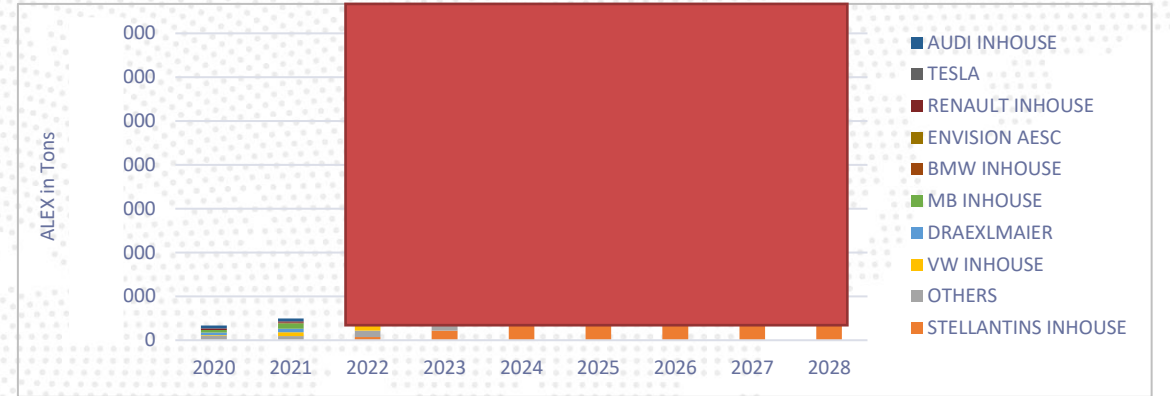
SAMPLE PAGE – PACKAGE I

03.02 AL EXTRUDED MULTI HOLLOW SECTION : BEV HV BATTERY FRAME 2020 - 2025+

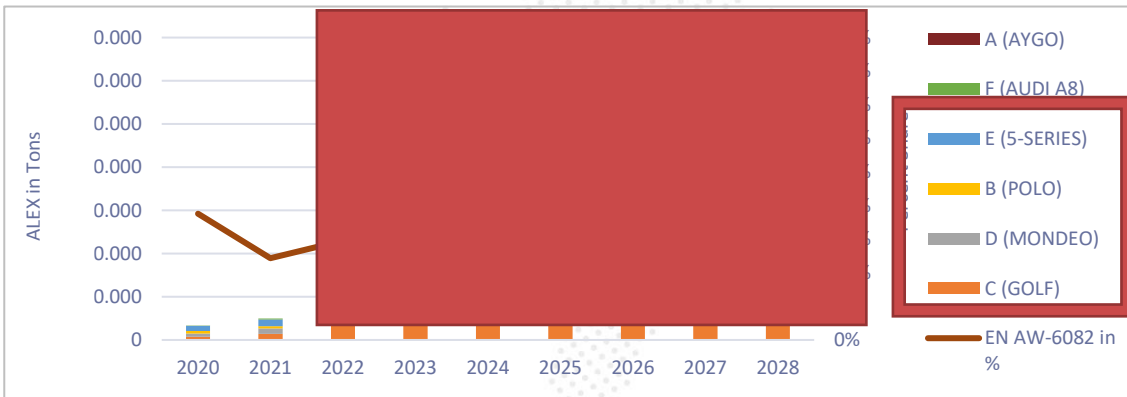
Source: ALUMAG[®]



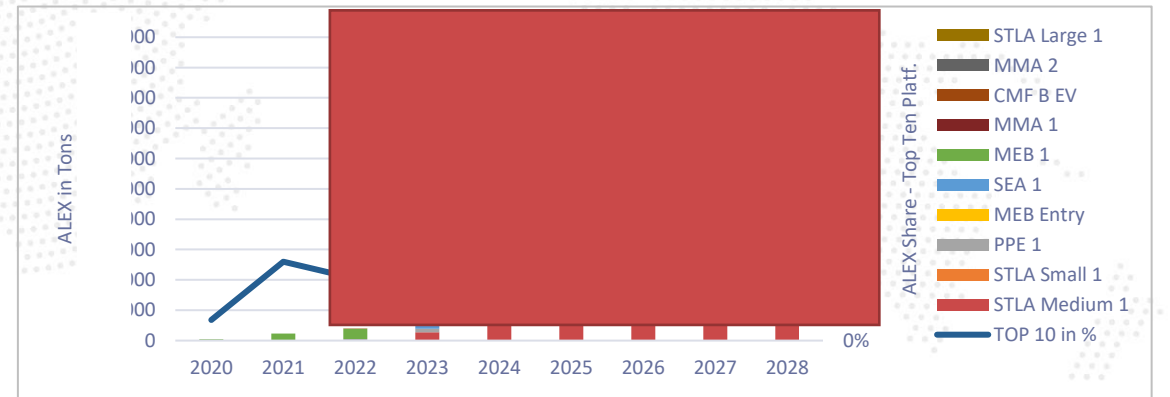
BATTERY TRAYS BY MATERIALS IN UNITS



SYSTEM SUPPLIER SHARE - ALEX DEMAND



CAR SEGMENT SHARE - ALEX DEMAND



PLATFORM TOP 10 SHARE - ALEX DEMAND

SAMPLE PAGE – PACKAGE II

08.03 PROCESS & COST : ALTERNATIVE PROCESSES : ROLL FORMING

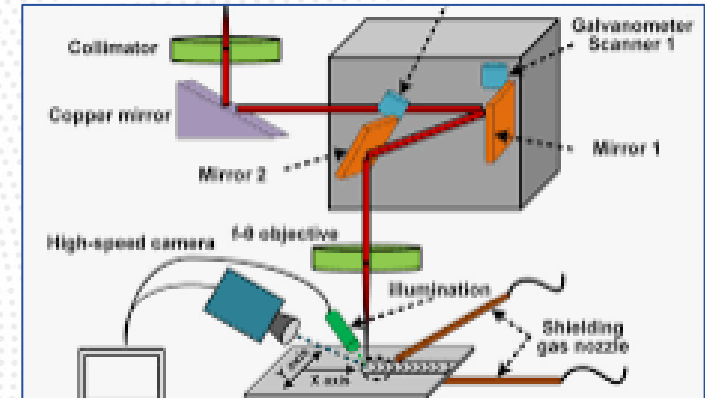
Advanced multifunctional roll forming is a highly flexible sheet metal production cell by placing roll forming, embossing, punching, stamping, bending, welding, hemming, adhesive, inserting and quality check points modules at any position within the line [please note the next page with the matrix. It is :

- Flexible integration by mobile units for additional operations are fast and easy to placed inside the line
- 6XXX T4 alloys well roll formable with inner radii <1x wall thickness e. g. for side rocker than T82 HT with 345 Mpa yield strength. Roll forming speed of simple hollow sections with HFI welding go at up to 100 m/min, a 3-hollow section is estimated with 20 m/min
- UHSS and 6XXX/7XXX aluminum roll formable without waves in the flanges
- Part shape tolerance deviation below +/-0.8 mm

Roll forming limitations in regards of shapes and alloys are:

- 7XXX high strength alloys are difficult to roll form with restricted inner radii of 3x wall thickness, which is for many applications not acceptable and have limited corrosion resistance for outer applications
- In regards of speed, laser welding with added material is one of the bottle net, laser oscillating welding could be one solution as well as adhesive

Source: Science Direct & NOVELIS & ALUMAG[®]



Scheme Of Oscillating Laser Welding

	Design	Estimated cost*	weight (kg)	\$/kg saved	Tooling Investment
	Novelis Battery Enclosure (Aluminum Sheet)	127%	70	\$2.29 ±20%	\$ 6-8 M
	Novelis Design, in steel, (Steel Gauges/Grades)	100%	113	--	\$ 6-8 M
	Existing Aluminum Extrusion Intensive Design	147%	107	>\$10	\$ 8-10 M
	Chevy Bolt (SMC/Steel) – scaled to 90 kWh (1.39x)	117%	114	N/A	\$ 7-9 M

Includes Structural Weight & Cooling Plates

SAMPLE PAGE – PACKAGE II

08.03 PROCESS & COST : ALTERNATIVE PROCESSES : LARGE HIGH PRESSURE DIE CAST [HPDC] CELLS & CLAMPING FORCES [CF]

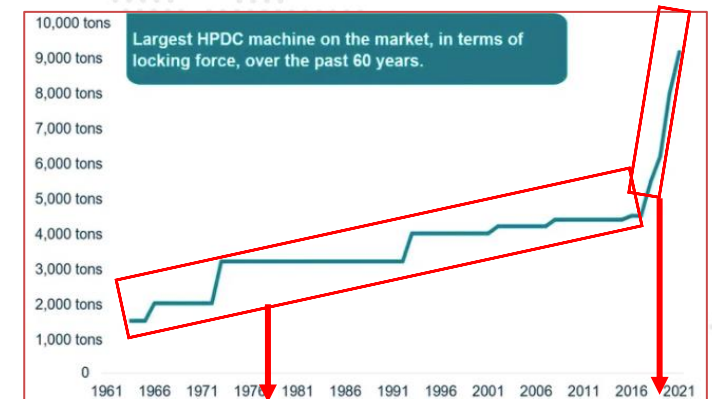
Source: BÜHLER & IDRA & LK & TESLA & ALUMAG[®]

TESLA has taken the path and overtaken the German premium OEM, which have directed the engineering and processes of BiW components into a new era, 20 years ago. AUDI, BMW and MB GROUP have transited a shock tower [also called suspension dome] from 18 single stamped and weld steel parts into one shot single HPDC component. The result was and is still: less parts, less joining, less weight, less cost and shorter “bill of materials”. Large / giga HPDC parts could be a risk for extruded and assembled aluminum.

In year 2018, clamping forces [CF] between 3,500 to 4,400 tons HPDC cells were an exception. And in an interview by Jost GAERTNER with BUEHLER and IDRA, both have very clearly expressed, 7,000 tons will be the maximum. Today, with the demanding client TESLA, light weighting, function integration, simplification of parts and processes, digitalization, im-proved press technics, -tooling, -release agents, -non hardening and semi solid alloys, ... the casting industry has moved ahead and pushed the borders. Further OEM have detected mega/giga casting such as HYUNDAI, HIPHI, NIO, POLESTAR, TOYOTA, VOLVO, XPENG, ..., ZEEKR. FORD US is doing examinations and for the Trinity, VW has backtracked

LATEST INSTALLMENTS & ORDERS* SINCE 2018

1. 15,000 t & 12,000 t CF HAITAIN by MILLISON in Chongqing China [presses under development]
2. 12,000 t CF N.K. [redacted] [highly confidential]
3. 12,000 t CF & 11 [redacted] - UAT Serbia with installment 2023/2024
4. 12,000 t & 9,000 [redacted] an & Guangdong in 2022 for NIO & XPENG
5. 9,200 t CF BUE [redacted]
6. 9,000 t CF IDRA [redacted] lment for Cybertruck
7. 9,000 t & 8,000 [redacted] hejiang China expected in 2022 for Rail & Road
8. 9,000 t & 6,600 [redacted] hina expected in 2022/2023 for front & rear body structur housings
9. 9,000 t CF LK 3 [redacted] hina in 2022
10. 9,000 t CF LK 2 [redacted] nd Tianjin China in 2022



Over The 55Years A Trend Of Larger Clamping Forces. Last 5Years A Jump

SAMPLE PAGE – PACKAGE III

09.00 APPENDIX & GENERAL MARKET INFORMATION BY OEM & SUPPLIER : BMW i4 G26 CLAR

- BMW i4 Based On Platform “CLAR”, same as for the 3’Series
- The i4 battery module count is a bit weird, on the base layer it has 4 huge modules and 1 small, and the top layer 2 small modules
- WALDASCHAFF is a HV Battery tray component supplier, AL extrusions. No hydro calibration
- Spec GS93047 [former WS2002], similar to C24
- **XXX** EUR/Kg Conversion revenue app.

Source: BMW & ALUMAG[®]



BMW i4



BMW i4 Battery System Is bolted Into The Modified Underpinning



BMW i4 Battery System With Integrated Small Side Collision Rocker



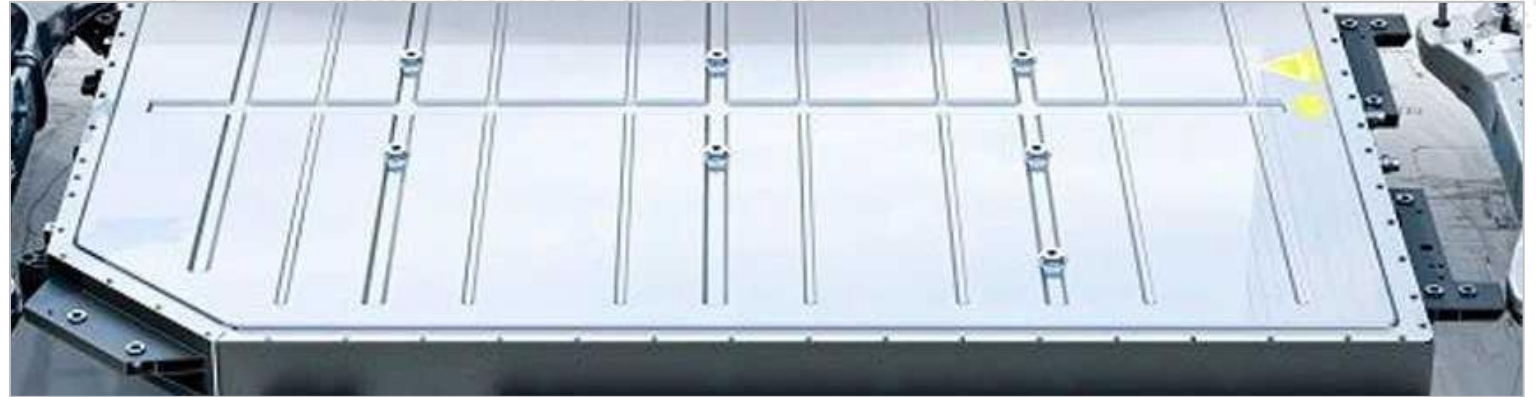
BMW i4 Battery Frame With Integrated Small Side Collision Rocker

SAMPLE PAGE – PACKAGE III

09.00 APPENDIX & GENERAL MARKET INFORMATION BY OEM & SUPPLIER : GEELY LEVC POLESTAR VOLVO CMA-1 & SEA & SPA-2

Source: cdnmotor.1 & VOLVO & ALUMAG[®]

- The HV Battery system is developed together with VOLVO and LOTUS. Internally, the drive train is called P10 with the 800V HV Battery system “intent [not confirmed]” to be used for VOLVO XC90, POLESTAR 3, POLESTAR 4 and POLESTAR 5
- The HV Battery frame as well as the floor is engineered AL extrusion intensive



GEELY SEA LYNK&CO Zero EV HV Battery Frame Extruded AL



VOLVO SPA-2 Is Planning Large



GEELY SEA LYNK&CO Zero EV HV Battery Frame Extruded AL

SAMPLE PAGE – PACKAGE IV

K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	
Modelo	Material Hybrid	Process Hybrid	Modelo Suppl.	Modelo Paquete	Modelo - Text Name	Material	Material Suppl.	Material Paquete	Main Process	Secondary Process	Alloy Range	Units per car	Weight/Part [Kg]	Weight/Meter [Kg]	Length [mm]	Circumference [mm]	Alloy	HT	
Battery Tray	NO	YES	WINHOUSE	25%	2022 Jan.: MEB Battery Frame Profil, VW does NOT specify the alloy, just the spec VW TL116 N24 to achieve f cover. There are two main cross-sections, with weights of 4.8 and 5.6 kg/m, each for the tunzide and cross frame profil. STEP-G does extrude in 6005a, does the machining and deliver	Aluminum	EDEM GESTAMP	100%	AL Extrusion	Extruded Profil	6000xx	1	32,73				150	EN AW-6082	T6
Battery Tray	NO	YES	WINHOUSE	50%	2022 Jan.: MEB Battery Frame Profil, VW does NOT specify the alloy, just the spec VW TL116 N24 to achieve f cover. There are two main cross-sections, with weights of 4.8 and 5.6 kg/m, each for the tunzide and cross frame profil. STEP-G does extrude in 6005a, does the machining and deliver	Aluminum	STEP-G	100%	AL Extrusion	Extruded Profil	6000xx	1	32,73				150	EN AW-6005A	T6
Battery Tray	NO	YES	MINTH	25%	2022 Jan.: MEB Battery Frame Profil, VW does NOT specify the alloy, just the spec VW TL116 N24 to achieve f cover. There are two main cross-sections, with weights of 4.8 and 5.6 kg/m, each for the tunzide and cross frame profil. STEP-G does extrude in 6005a, does the machining and deliver	Aluminum	MINTH	100%	AL Extrusion	Extruded Profil	6000xx	1	32,73				150	EN AW-6082	T6
Battery Tray	NO	YES	WINHOUSE	50%	Feb 2021: The battery having weight in at 53.8kg. In addition to that the cover weight 5.8kg and the underfloor protection 16.9kg. Source: FEV	Aluminum	HANDTMANN	100%	AL Casting	HPDC	OTHERS OR N/K	1	9,80					OTHERS OR N/K	
Battery Tray	NO	YES	MINTH	50%	2021 Feb.: The battery having weight in at 53.8kg. In addition to that the cover weight 5.8kg and the underfloor protection 16.9kg. Source: FEV	Aluminum	WENGAN	100%	AL Casting	HPDC	OTHERS OR N/K	1	9,80					OTHERS OR N/K	
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Battery Tray	NO		WINHOUSE	100%	2022 Feb. 24.: Assumption, SKODA, VW and SEAT/CUBRA model line, the HV battery tray/frames will be an ST intensive design	Steel	OTHERS OR N/K	100%	ST Sheet	Other Or N/K		1	1,00						
Battery Tray	NO		OTHERS OR N/K	100%	April 2022: The Toyota B24R based on the TNGA e1 platform has steel battery tray. Source: AluMag	Steel	OTHERS OR N/K	100%	ST Sheet	Stamping		1	70,00						
Battery Tray	NO		OTHERS OR N/K	100%	April 2022: The Toyota B24R based on the TNGA e1 platform has steel battery tray. Source: AluMag	Steel	OTHERS OR N/K	100%	ST Sheet	Stamping		1	70,00						
Battery Tray	NO		OTHERS OR N/K	100%		OTHERS OR N/K	OTHERS OR N/K	100%	OTHERS OR N/K	OTHERS OR N/K		1							
Battery Tray	NO		OTHERS OR N/K	100%		OTHERS OR N/K	OTHERS OR N/K	100%	OTHERS OR N/K	OTHERS OR N/K		1							
Battery Tray	YES	YES	TESLA	100%	2022 May 6.: According to a Suisse HPDC Sales Manager, TESLA will remain the AL Extrusion intensive HV Battery frame, combined with a ST stamped floor inner tray. This concept will / is considered to the Model S and Model Y. 2022 Feb. 23.: Non-confirmed information, TESLA Model 3	Aluminum	OTHERS OR N/K	100%	AL Extrusion	Extruded Profil	6000xx	1	44,00					EN AW-6061	T6
Battery Tray	YES	YES	TESLA	100%	2022 May 6.: According to a Suisse HPDC Sales Manager, TESLA will remain the AL Extrusion intensive HV Battery frame, combined with a ST stamped floor inner tray. This concept will / is considered to the Model S and Model Y. 2022 Feb. 23.: Non-confirmed information, TESLA Model 3	Aluminum	OTHERS OR N/K	100%	AL Sheet	Stamping		1	20,00						
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