



Solutions for a Better Tomorrow

# NEV megatrend in China and US driving LYB solutions

**Material Meets Engineering @ Frankfurt, Germany**

15<sup>th</sup> June 2023

**Feng Wang – Sr. Manager, New Business Development & Application Development Technical Service (APAC)**

**John Walling – Business Development Manager, EV Technology (USCAN)**

**Gavin Qu – PPC Product Application Development Manager (APAC)**



Solutions for a Better Tomorrow

# China EV (Electric Vehicle) Mega Trend

Wang Feng - New Business Development, Advanced Polymer Solutions, Asia Pacific

June 2023

## Today's Topics

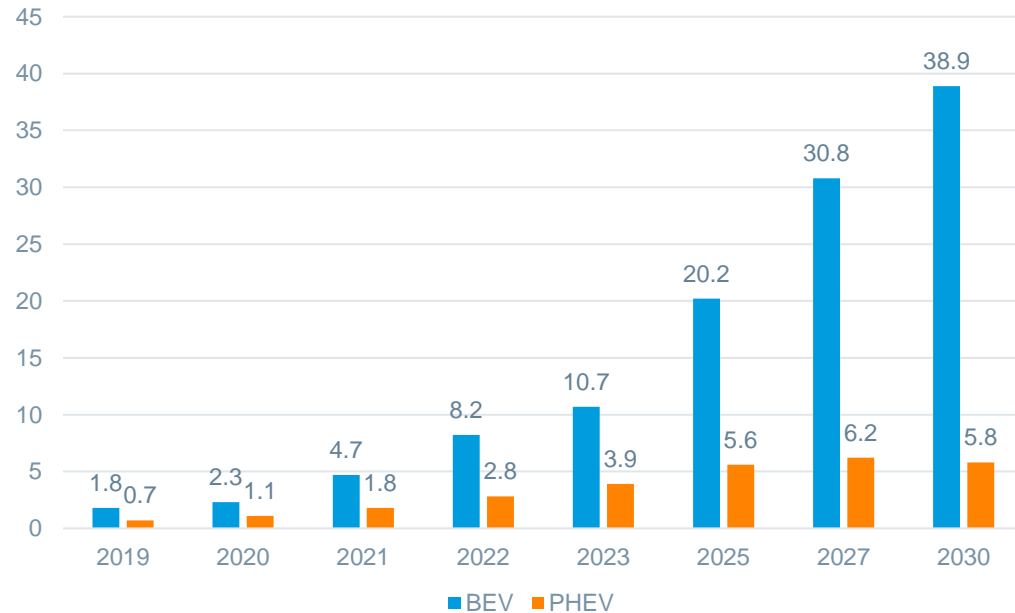
---

- **Electric Vehicle Growth Trend in Numbers**
- **China Auto Market Dynamics**
- **EV Design Trends**
- **APS Solutions for EV's**

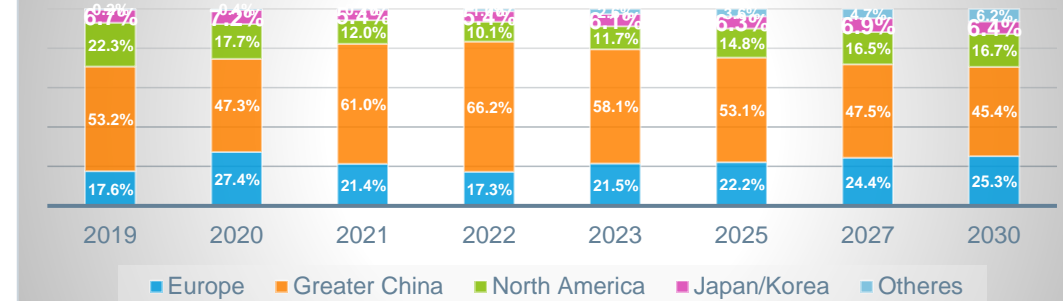
# Global EV Market Overview

- Over **11 millions** EVs were sold in 2022, up 60% relative to 2021 and more than 4 times in 2019
- Half of the world's EVs are in China
- In 2022, BEV sales in China reach to 5 million, and PHEV to 1.3 million
- China is expected to continue **leading** EV sales in 2030

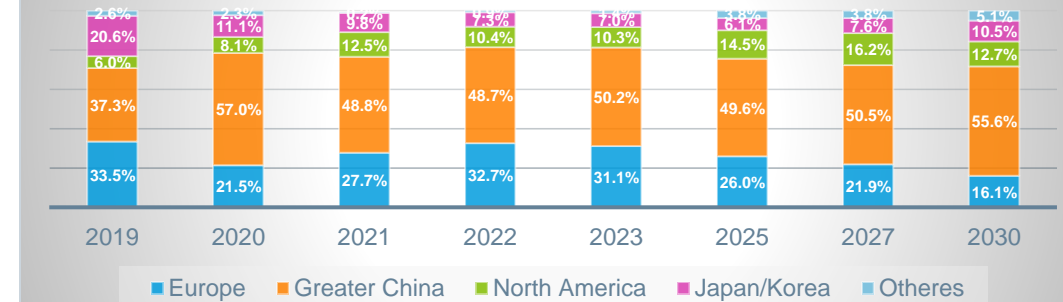
Global EV Production



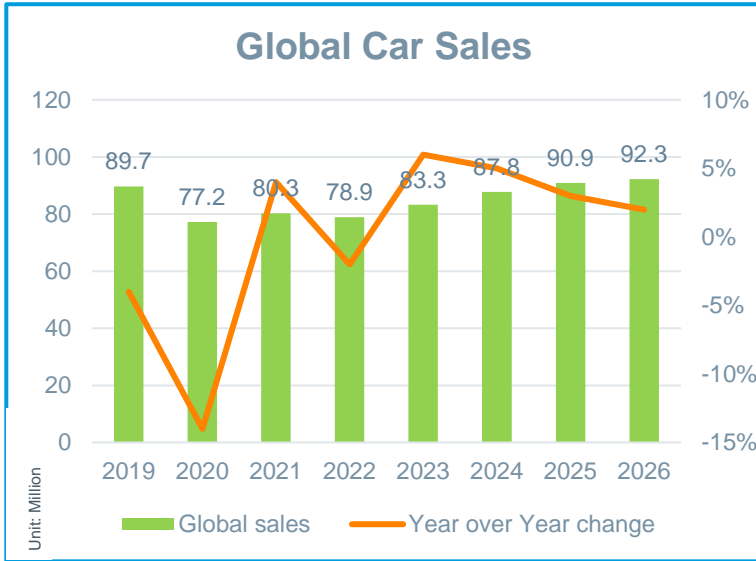
BEV Production by Region



PHEV Production by Region



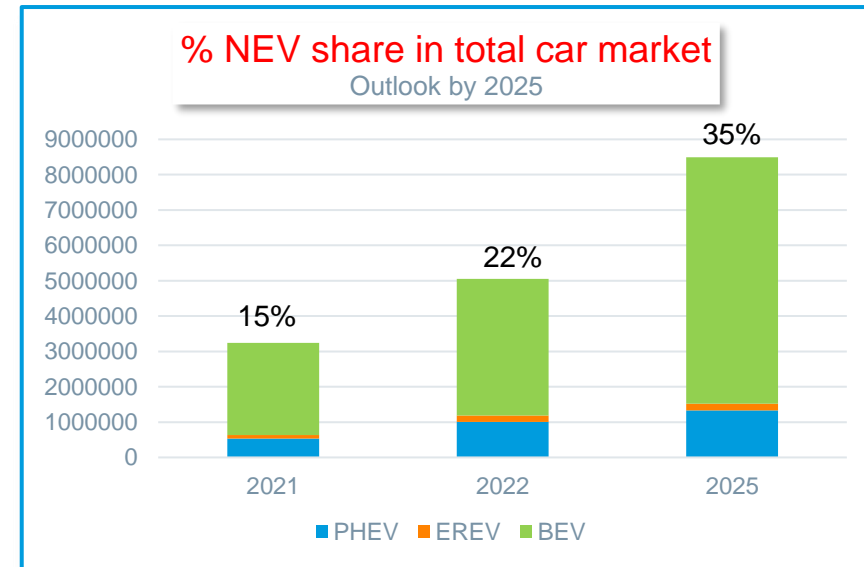
# China auto sales scope 2022



OEM	Dec 22	Dec 22/21	Dec/Nov 22	YTD 22	YTD 22/21
Volkswagen	0.25	-26.6%	↓ 22.3%	↑ 2.87	↑ 10.1%
<b>BYD</b>	<b>0.22</b>	<b>122.2%</b>	<b>↑ -4.9%</b>	<b>↓ 1.64</b>	<b>↑ 151.5%</b>
Geely	0.18	-0.7%	↓ 10.0%	↑ 1.53	↑ 14.5%
Toyota	0.17	-16.0%	↓ 31.8%	↑ 1.69	↑ 16.7%
SAIC-General Motors-Wuling	0.16	-28.2%	↓ 8.0%	↑ 1.45	↑ 0.3%
Changan	0.14	17.3%	↑ 44.2%	↑ 1.43	↑ 3.6%
Honda	0.12	-26.1%	↓ 42.2%	↑ 1.34	↓ -2.7%
General Motors	0.12	-25.3%	↓ 14.1%	↑ 1.08	↓ -7.8%
Renault-Nissan-Mitsubishi	0.11	-22.3%	↓ 60.1%	↑ 1.02	↓ -5.1%
Great Wall	0.10	-36.3%	↓ 17.2%	↑ 1.02	↓ -7.8%
Chery	0.10	-10.1%	↓ 9.4%	↑ 0.97	↑ 24.8%
<b>Tesla</b>	<b>0.09</b>	<b>36.1%</b>	<b>↑ -6.7%</b>	<b>↓ 0.68</b>	<b>↑ 61.5%</b>
SAIC	0.08	-36.1%	↓ 22.4%	↑ 0.92	↑ 1.1%
Dongfeng	0.08	-17.3%	↓ 10.5%	↑ 0.74	↑ 10.5%
<b>GAC</b>	<b>0.07</b>	<b>18.3%</b>	<b>↑ 4.7%</b>	<b>↑ 0.61</b>	<b>↑ 55.3%</b>
BMW	0.06	-23.5%	↓ 48.4%	↑ 0.59	↓ -4.3%
Mercedes-Benz	0.06	20.4%	↑ 10.4%	↑ 0.58	↑ 3.9%
BAIC	0.04	-9.1%	↓ 5.7%	↑ 0.43	↓ -19.9%
Hyundai	0.04	-35.4%	↓ 3.9%	↑ 0.37	↓ -15.8%
FAW	0.03	-27.2%	↓ 5.6%	↑ 0.36	↓ -10.2%
Ford	0.03	-38.1%	↓ 6.0%	↑ 0.33	↓ -10.5%
Jianghuai	0.03	-6.0%	↓ 4.8%	↑ 0.32	↓ -9.8%
<b>Hozon EV</b>	<b>0.02</b>	<b>108.7%</b>	<b>↑ 16.4%</b>	<b>↑ 0.15</b>	<b>↑ 148.1%</b>
Jiangling	0.02	-31.1%	↓ 4.5%	↑ 0.18	↓ -24.3%
<b>NIO</b>	<b>0.02</b>	<b>22.6%</b>	<b>↑ 3.8%</b>	<b>↑ 0.12</b>	<b>↑ 47.5%</b>
Lixiang Auto	0.01	-1.3%	↓ 0.0%	→ 0.12	↑ 53.7%
Mazda	0.01	-29.7%	↓ 4.8%	↑ 0.09	↓ -41.9%
Brilliance Auto	0.01	-51.7%	↓ 4.7%	↑ 0.14	↓ -32.4%
Leapmotor	0.01	22.0%	↑ 0.0%	↑ 0.11	↑ 187.0%
<b>Total</b>	<b>2.46</b>	<b>-13.6%</b>	<b>15.5%</b>	<b>23.62</b>	<b>8.7%</b>

Region: China

- Yearly Sales:
  - Global: 80~90 millions
  - China: 25~28 millions (30%~32%)
- Volume share growth: BYD, Tesla, Other Chinese EV OEMs
- Traditional OEM China JV Companies Experiencing Volume Share Loss



Data Source: S&P monthly data update and S&P global webinar reports

# Leading OEMs in China EV Market

## 2022 CHINA EV TOTAL SALES

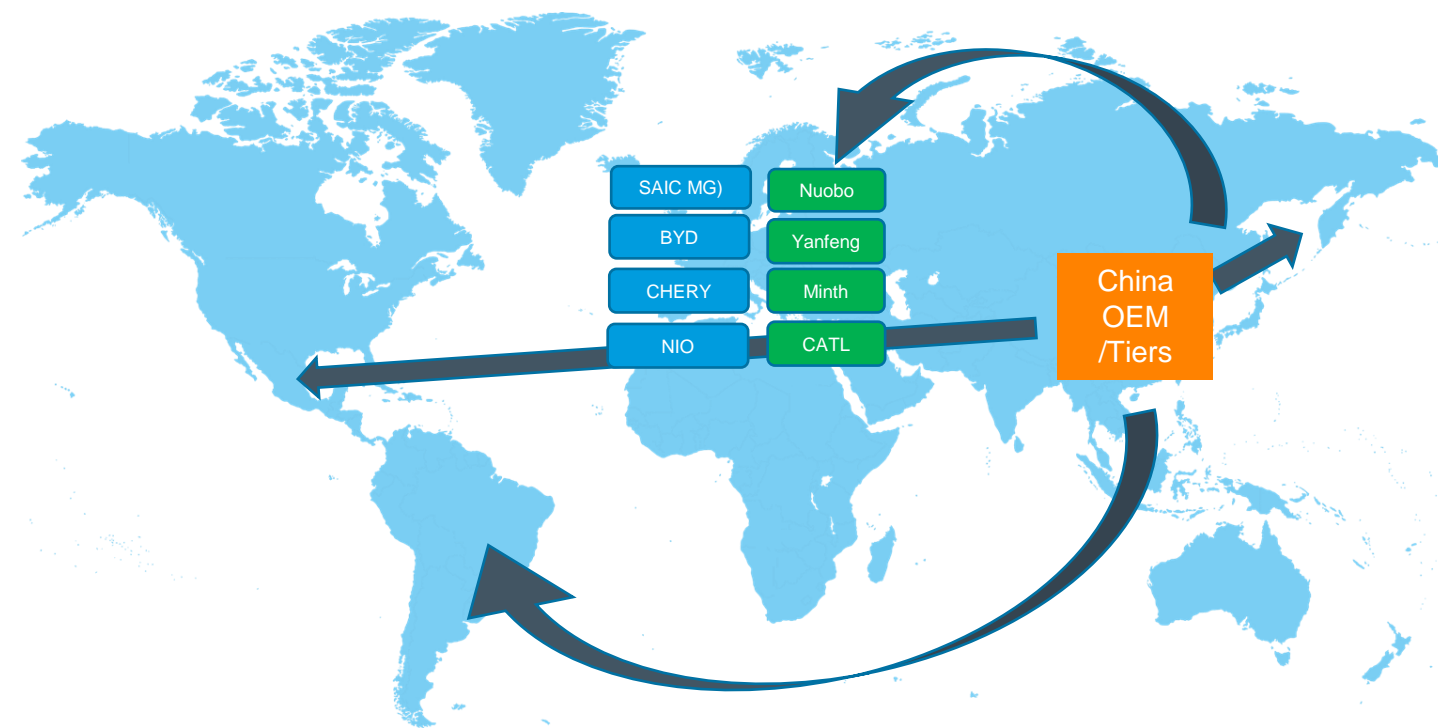


Data Source: S&P monthly data update

- TOP 10: BYD, Tesla, GM Wuling, Guangqi Aion, Chang an, Chery, Neta, Li Auto, XPeng, NIO
- EV market means higher value and higher growth rate in China

# China OEM and Tiers Globalization

Export trade → Overseas factory construction, production and sales



## Chinese OEMs Expansion Plan in EU

OEM	Export EU Status	Expansion Plan
SAIC (MG)	113k car sold in 2022, Germany, France, UK, Italy, Spain, Norway, Sweden	plan to expand in overseas markets using SAIC overseas facilities
Geely (Lynk&Co., Zeekr)	26k car sold in 2022	Released European strategy, starting from Sweden and Netherlands
BYD	4k car sold in 2022	Enters the markets of Japan, Europe, Brazil and Mexico. EU site building plan to be declared
NIO	1.5k car sold in 2022, Germany, Norway, Netherlands, Sweden	2022 Launch "Norway Strategy" to grow in EU market

## Chinese Tiers Expansion Plan in EU

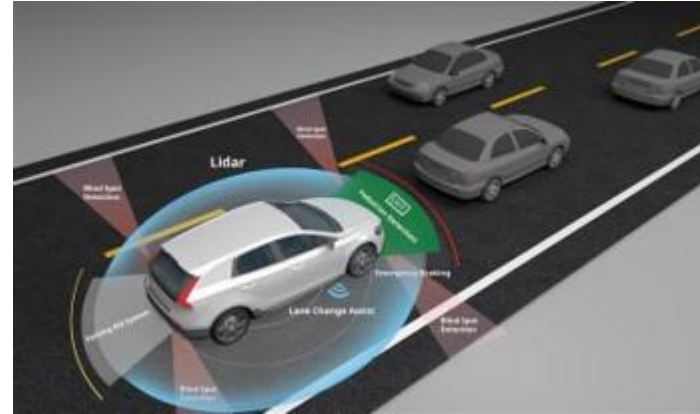
Tiers	Plant Status	Target OEMs
Yangfeng	Germany(1), Spain(1), Hungary(1), Czech(1), Slovakia(1), Serbia(1), Italy(1)	MB, VW, BMW, Ford, Volvo
CATL	Germany(1+1), Hungary(1)	BWM, MB, Stellantis, VW
Minth	Serbia(1)	VW, SKODE
Nobo	Germany(2+1)	MB, BMW

# EV Design Trends: Electrification / Intelligent Driving / Connection / Sharing

## Frunk 'Front Trunk' Storage



## ADAS (Advanced Driving Assistant System)



### ▪ Electrification:

- More FRs demands
- Less working temperature requirement
- More orange color demands
- Light-weight demands

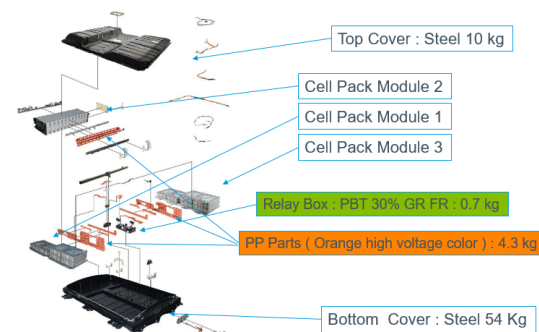
### ▪ Intelligent:

- More autonomous sensor demands
- Radar transparency demands
- LW demands



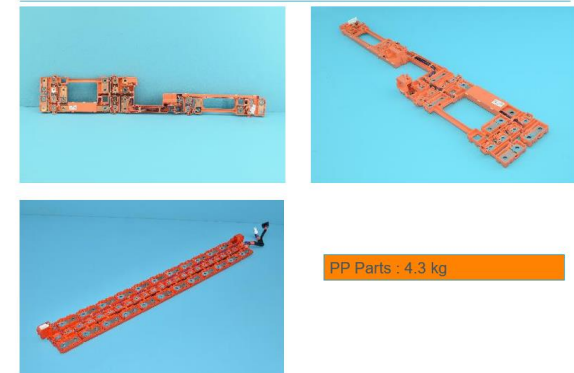
## Supercharger network

### Battery Pack



Top and Bottom Battery covers and module Pack in Steel . Battery weight : 304 kg

### Battery Bus Bars in PP



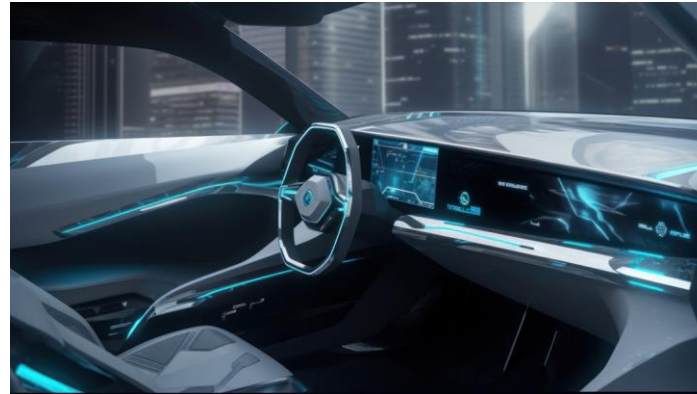


# EV Design Trends: Intelligence/Light weight/Personalization

Smart Bumper/Face



Smart Cabin



Big screen / Artificial intelligence



Body Panel functionalized with Radar

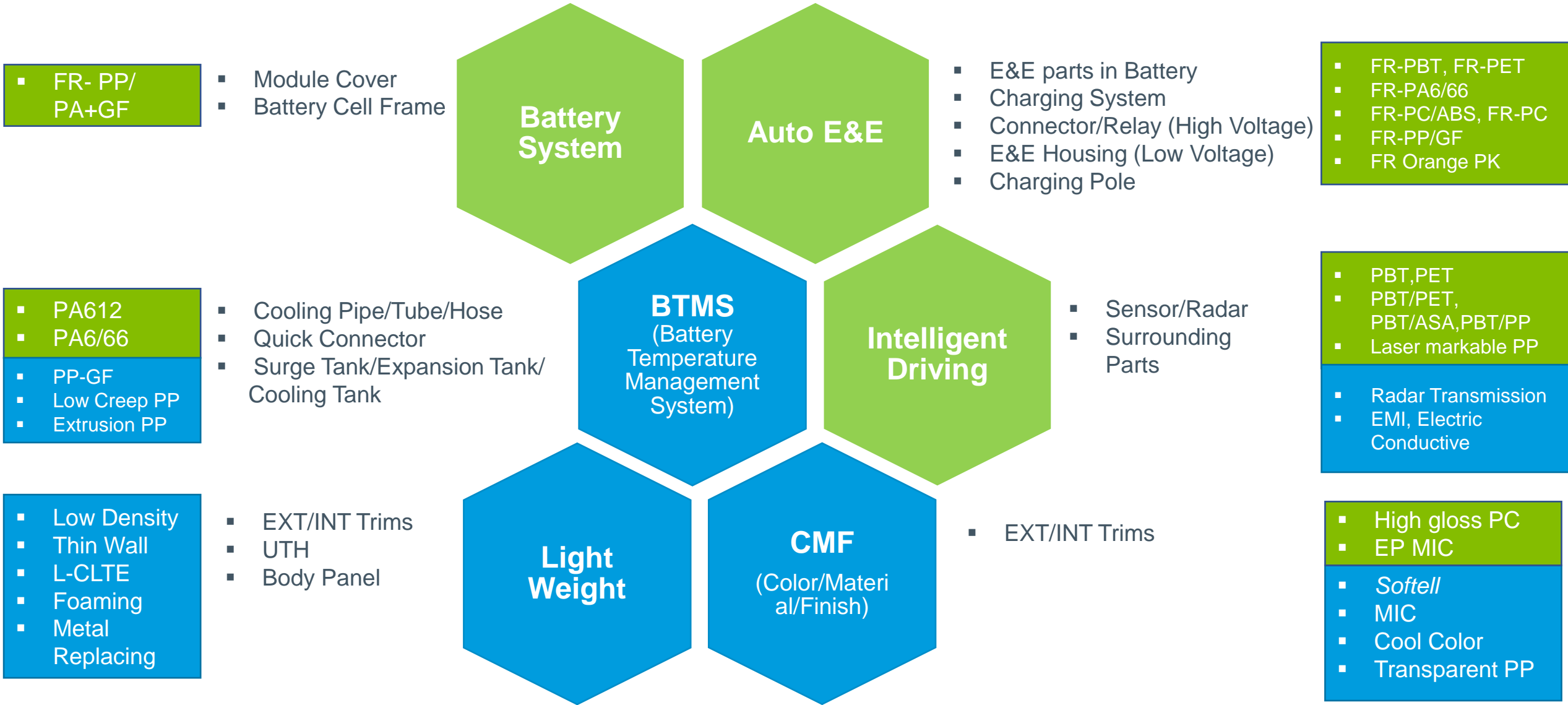


Plastic Tailgate provide design freedom and lightweight



# LYB APS Solutions to Capture EV Growth

EP Focus  
PPC Focus





Solutions for a Better Tomorrow

## US EV Megatrends

**John Walling – Business Development Manager, EV Technology, USCAN**

June 2023

# US EV OEM Leaders – BEV market share (2022) and some popular models for 2023-24

65%

**Tesla**



Model 3 / Model Y



Cybertruck

7.6%

**Ford**



Mustang Mach-E



F-150 Lightning

7.1%

**Hyundai**



Kona



Ioniq 5

6%

**GM**



Chevy Bolt



GMC Hummer

- Tesla still dominates, but lost share from 71% in 2021, as legacy OEMs launch new models
- VW, Nissan, BMW, Stellantis, and others rolling out new BEV models to compete for share

Source: [Wall Street Journal](#) 1/6/2023  
Data from Motor Intelligence.

All images reproduced with permission from Automotive News, (2022-2023).

- New BEV Start-ups

- Luxury
- Performance
- Utility

**Rivian**



R1T

**Lucid**



Air

**Lordstown**



Endurance

# US Heavy Truck and Fleet Vehicles - New players enter market with BEV platforms

## Tesla



Semi

## Nikola



TRE



Publicly announced orders of over-the-road Class 2-8 BEVs rose **640%**, from **4,500** in **2021** to more than **33,000** in 2022.



**75% of fleets** that have never used leading clean drivetrain technologies plan to increase use in the next 5 years - a first in survey results.

Source: 2023 The State of Sustainable Fleets Market Brief by GNA Clean Transportation and Energy Consultants

All images reproduced with permission from Automotive News, (2022-2023).

## Rivian



Amazon Delivery Van

## Ford



E-Transit Van

## Oshkosh



USPS Delivery Van

# US EV Charging Network - Expanding to serve the market

## Public charging today

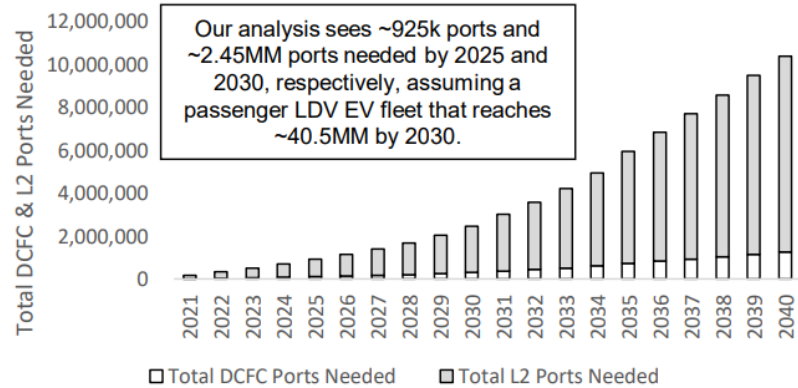
- ~46.7k public EV charging station locations and ~116k EVSE ports total in U.S (April 2022)
- ~6k stations / ~23k ports were DCFC (direct current fast charging)
- Year-over-year increase of ~30% for DCFC ports and ~17% for Level 2 public ports.
- Tesla Superchargers ~55-60% overall DCFC ports
- Chargepoint leading market share in Level 2

## Federal support

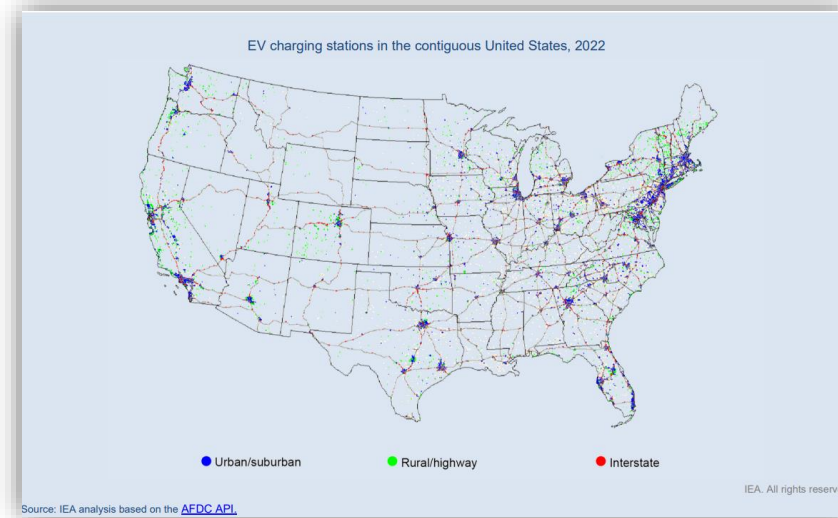
- \$7.5B allocated (2022-2026) to build network of ~500k charge points
- ~2.5M charge points needed by 2030, and 10M by 2040



## TPH Public Charging Demand Forecast (Base Case)



Source: Energy 101 Primer, Tudor Pickering Holt & Company, June 2022



# US EV Megatrends – Consumer demands driving material innovation

## ■ Larger vehicles

- Passenger – light trucks, SUVs
- Commercial – fleet, heavy truck

## ■ Longer driving range

- Bigger batteries
- Higher energy density
- Access to fast-charging

## ■ Utility and Durability

- Recreation (towing, off-road)
- Work/construction
- Backup power to home

## ■ Low Maintenance

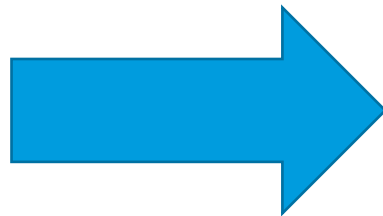
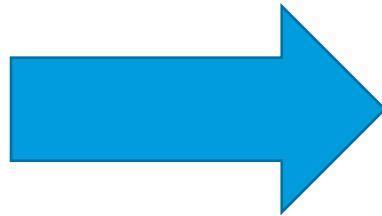
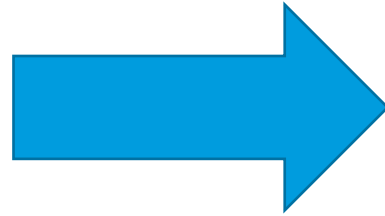
- Simple to operate, recharge
- Reliable, easy to service

## ■ Safety / Security

- Crash avoidance
- Passenger protection (impact, fire)

## ■ Cost of ownership

- Battery cost decrease
- Vehicle life, resale value increase



## Material & Design considerations

### EV Battery (range & safety):

- Larger housings
  - Structure vs. weight
  - Production method
- Modular vs. Cell-to-pack configuration
- More electrical connections, high voltage
- Higher capacity/run-time cooling system
- Thermal runaway containment (FR, venting)

### EV Charging (ease-of-use):

- Level 2 charger at home, work
- DCFC charger for travel, retail stops
- High voltage cable insulation and cooling
- Weatherable electrical enclosures
- OEM accessory - brand aesthetics

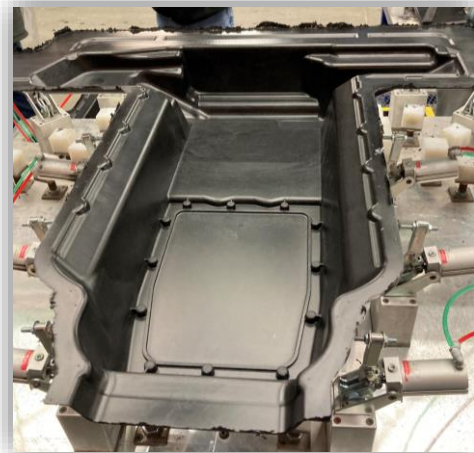
### EV Battery (cost):

- Cell size/shape (cylinder, prism, pouch)
- Chemical environment inside & out
- Automated assembly for quality & scale
- Solvent vs. dry process for efficiency
- Sustainable reuse, recycle options

# EV Battery Enclosure – Multiple solutions for customer challenges

## Engineered Composites

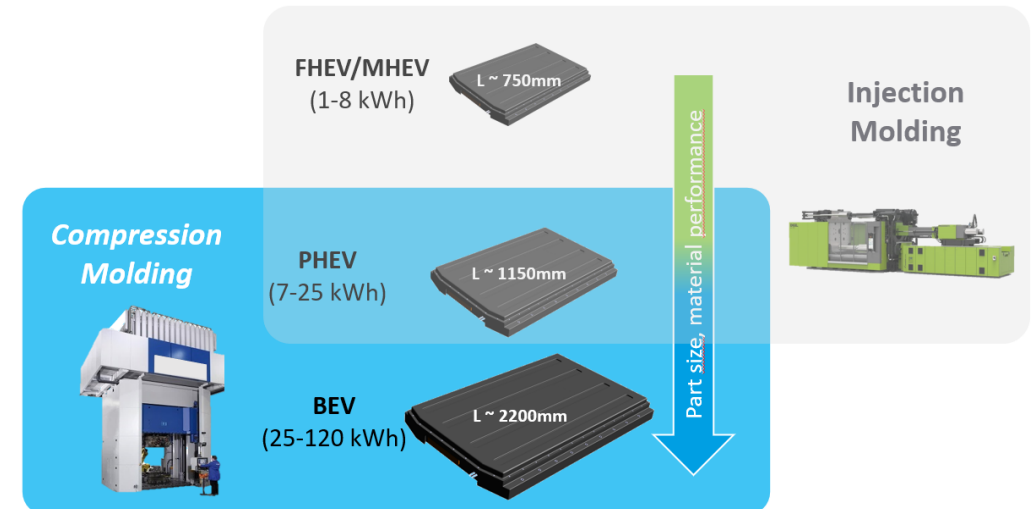
- SMC (Sheet Molding Compound)
- Compression molding
  - High strength to weight ratio
  - Lightweight
  - Chemical resistance
  - Engineered fire resistance
  - Low shrink
  - Lower cost tooling



Battery Pack Cover  
made with *Premi-Glas 3406*

## Thermoplastics

- PP, PA resins & compounds (glass fiber)
- Injection molding or Compression molding D-LFT
  - Design freedom (ribs, detail features)
  - Lightweight
  - Chemical resistance
  - Flame retardant
  - Fast cycle time
  - Recyclable





# EV Charging Systems – Translating proven solutions

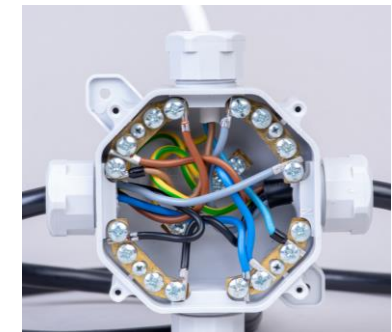
## GM Ultium Level 2 Charging System

- **Charger Surround and Holster Cover**
- **Hifax TYC 2137P (High gloss TPO)**
  - Molded in color with painted appearance
    - Exterior weatherability (color / gloss retention)
    - UL Yellow Card registered (HB)
  - Cost savings – exceeds \$3 per part by paint elimination
  - Sustainability – VOC reduction
  - Aesthetics - Ultium brand styling and appeal



## Other EV Charging Applications

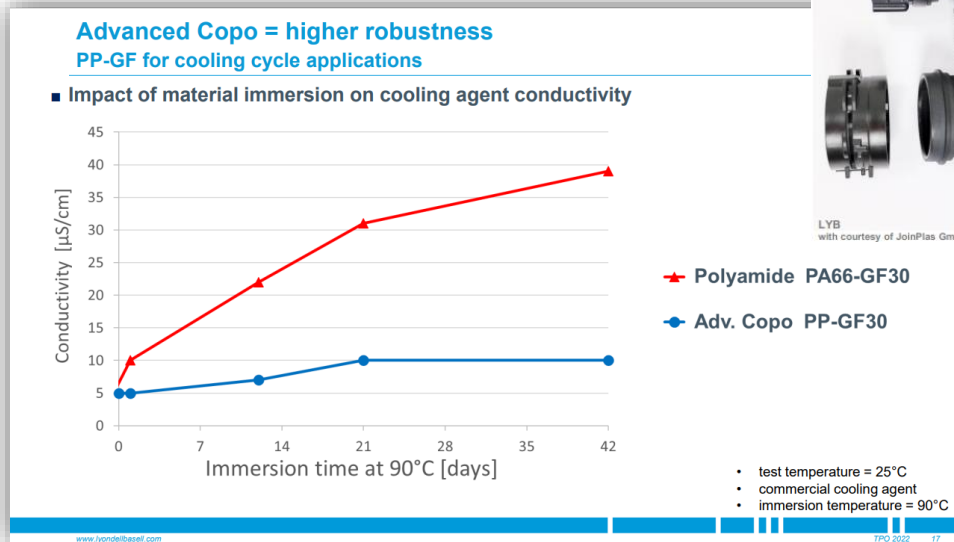
- **DCFC Charger Enclosure**
- **Electrical housing**
- **Structural frame**
- **Charge port, plug & cable assembly**



# EV Thermal management cooling systems – Differentiated performance

## BEV Cooling Fluid Connector

- PP GF Advanced Copolymer
- **Hostacom EKG 2087T**
  - Alternative to replace PA66-GF30
  - Life usage 25,000 hours
  - Air temp: -40°C to 125°C / Fluid temp: -28°C to 104°C
  - Fluid pressure from 0-30 psi
  - Chemical resistance to glycol

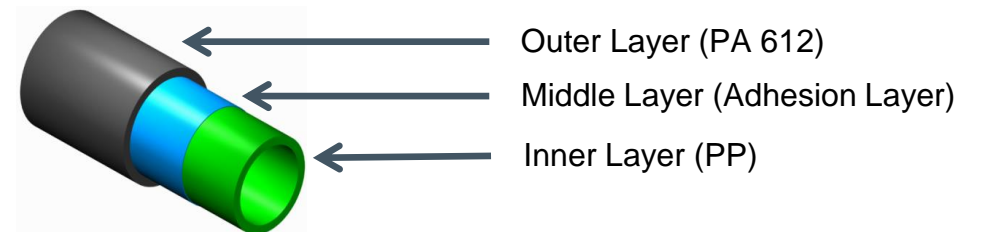


## BEV Cooling Tube Inner Layer

- PP High Impact Copolymer
- **Pro-fax PP resin**
  - Materials Category Winner, SPE Innovation Awards 2022
  - Cooper Standard's *PlastiCool* 2000 solution
  - Multi-layer thermal cooling tube (pipe) for Hybrid and BEV
  - Featured on several of GM's current BEV platforms.



Source: [Plastics Engineering](#), April 2023



Source: Advanced Copo = higher robustness: Opening new applications for glass fiber reinforced polypropylene. Dr. Sven Nietzel, Oct. 2022



Solutions for a Better Tomorrow

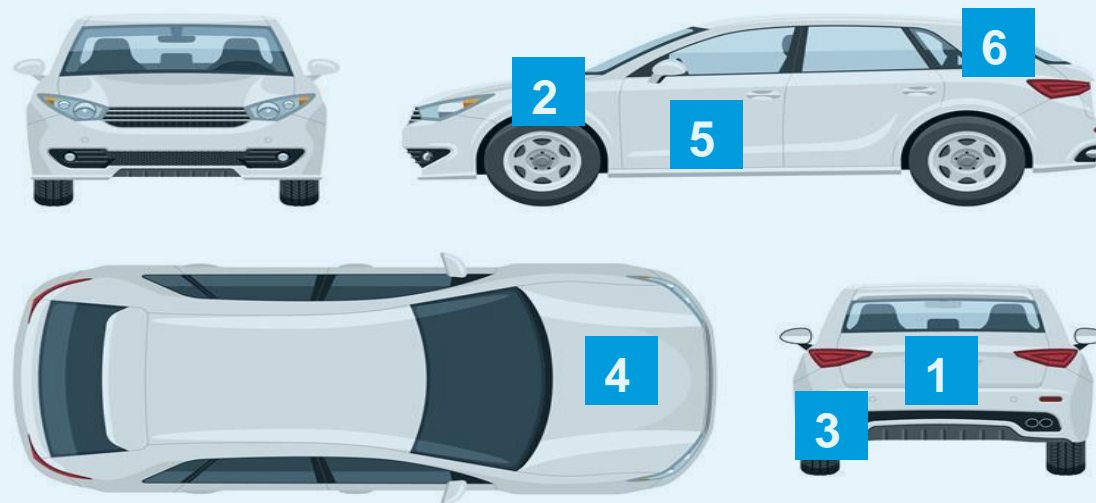
# **Plastic Body Panels New Innovation for Automotive Light Weight Solution**

**Gavin Qu - Suzhou Technical Center, Advanced Polymer Solutions, Asia Pacific**

June 2023

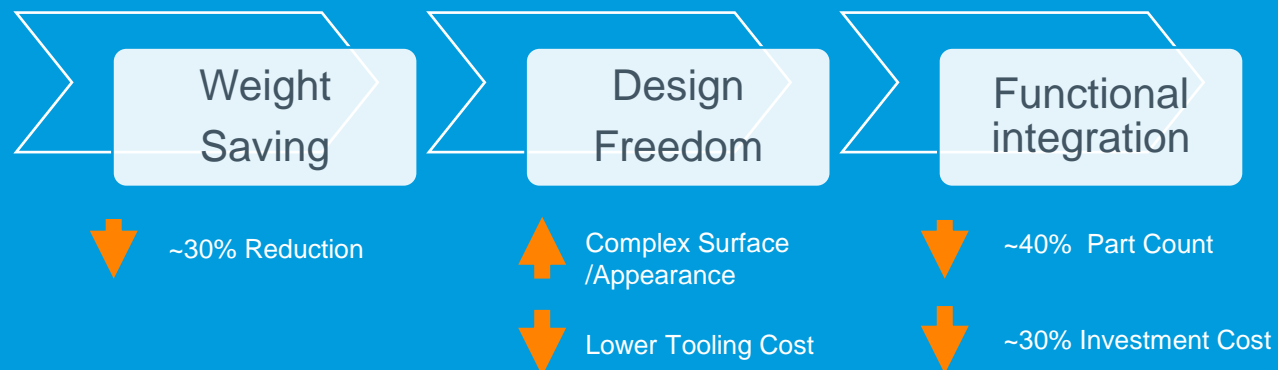
## EV Market Trend: Heavier vehicles drive more metal replacement

NO	Potential Applications
1	Plastic Tailgate
2	Plastic Fender
3	Plastic Side Wall
4	Plastic Hood
5	Plastic Side Door
6	Plastic Body Structure



### Successful Application Keys:

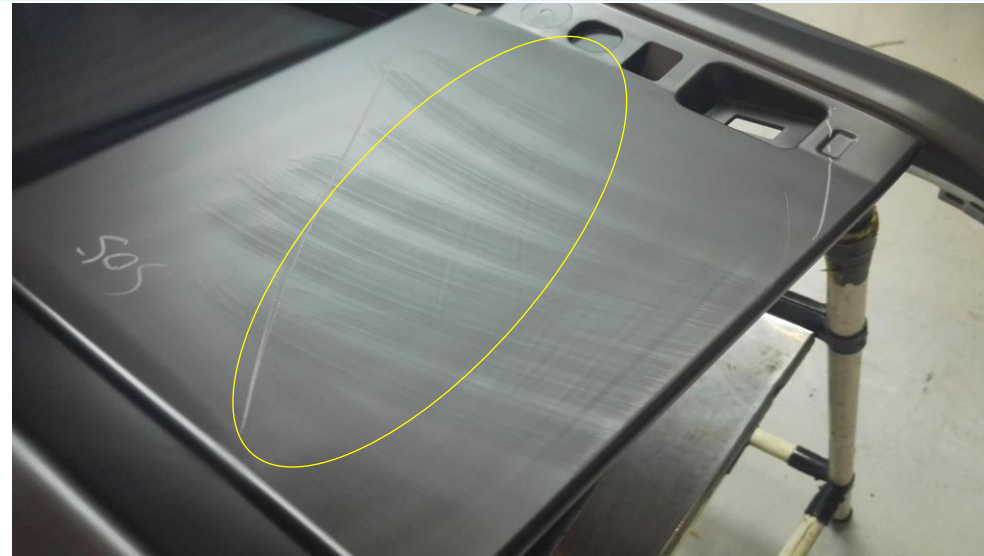
- Design
- Performance
- Manufacturing
- Cost



**Plastic tailgates have great potential for large-scale commercial applications**

## Large plastic part molding challenge - pressure line

- The pressure line problem at large parts molding, such as the tailgates, is a common industry manufacturing problem.
- Pressure lines are not visible after molding, but they will appear after painting or polishing, effecting painting performance.



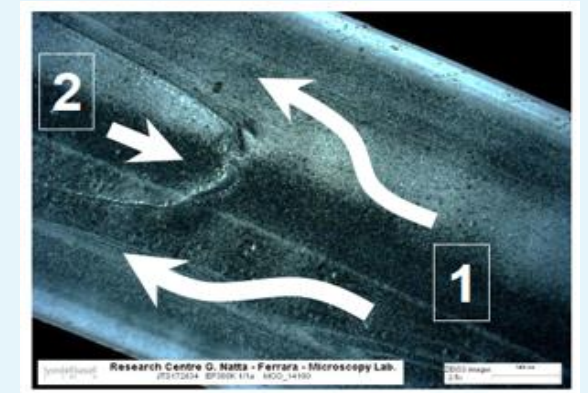
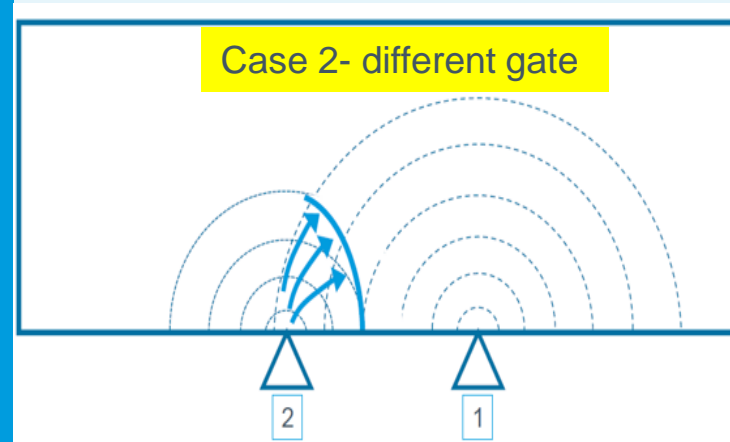
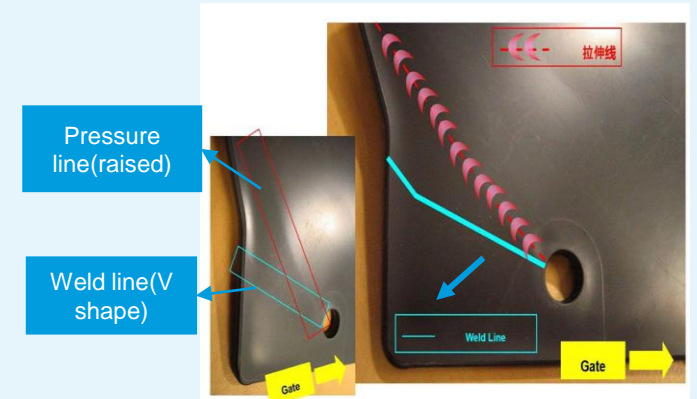
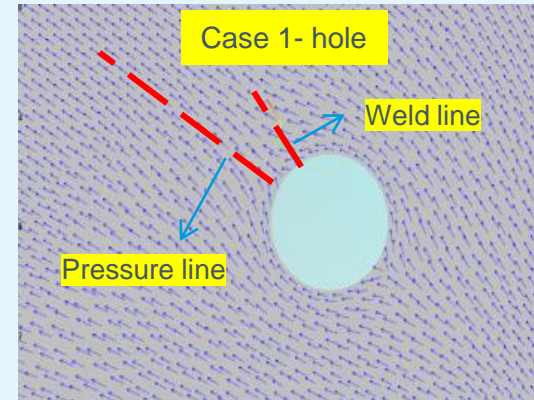
## Pressure line and the root cause

### Root cause

- When flow fronts from two directions meet at hole or different injection gates, one of the fronts reverses direction and flows back in the middle of the outer frozen layers. Then pressure lines appear on the melt flow edges.

### Pressure lines & weld lines

- Pressure lines usually appear with the occurrence of weld lines
- Pressure lines are close to the weld lines
- Pressure lines appear above the surfaces
- Weld lines sink on the surfaces



## Pressure line solution -- novel product *Hifax TYC 568X*

### Scope/Key Success Factors

- Excellent pressure line performance
- Low CLTE and balanced impact and FM
- For liftgate, commercialized in 2019
- For decklid, commercialized in 2021

LyondellBasell TYC 568X



Market benchmark



Property targets		Unit	Market benchmark	LyondellBasell <i>Hifax TYC 568X</i>
Mechanical properties	MFR	g/10min @ 230 °C, 2.16 Kg	14	23
	Flex. Modulus	MPa	2950	3050
	Notched Charpy	kJ/m <sup>2</sup>	25	20
Surface quality	Pressure line level	/	poor	<b>good</b>

# LyondellBasell technical support and service for plastic body panel design and manufacturing

- Materials Development
- Tailor made for customers
- Balanced Performance
- Experience in PPC



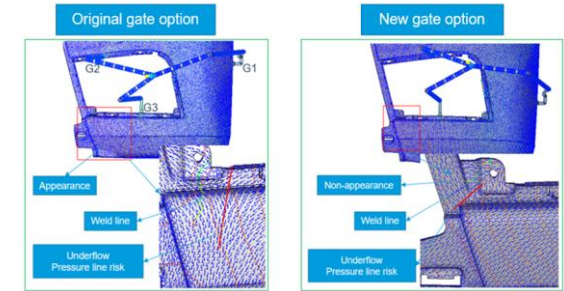
**Advancing  
possible  
together**



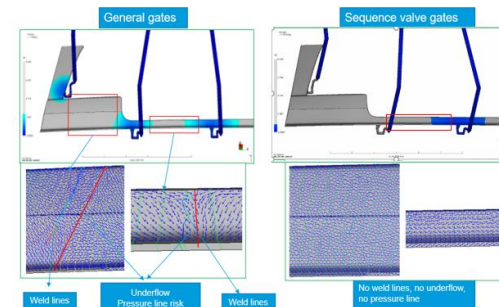
- Molding trial support
- Try out tool of LyondellBasell
- Tech. exchanging and training



- Structural analysis
- Mold flow



- Quick Response
- Test Capabilities
- Hot Issue Solutions





# Disclaimers

---

The statements in this presentation relating to matters that are not historical facts are forward-looking statements. These forward-looking statements are based upon assumptions of management which are believed to be reasonable at the time made, and are subject to significant risks and uncertainties. Actual results could differ materially based on factors including, but not limited to, the ability to comply with the terms of our credit facilities and other financing arrangements; the costs and availability of financing; the ability to maintain adequate liquidity; the ability to implement business strategies; availability, cost and price volatility of raw materials and utilities; supply/demand balances; industry production capacities and operating rates; uncertainties associated with the U.S. and worldwide economies; legal, tax and environmental proceedings; cyclical nature of the chemical and refining industries; operating interruptions; current and potential governmental regulatory actions; terrorist acts; international political unrest; competitive products and pricing; technological developments; risks of doing business outside of the U.S.; access to capital markets; and other risk factors. Additional factors that could cause results to differ materially from those described in the forward-looking statements can be found in our financial reports, which are available at [www.lyondellbasell.com](http://www.lyondellbasell.com) on the Investor Relations page.

This presentation includes industry data that we obtained from periodic industry publications. Industry publications generally state that the information contained therein has been obtained from sources believed to be reliable, but there can be no assurance as to the accuracy or completeness of included information. Additionally, the industry sources that we reference request or require that, if we reproduce the information they provide, we inform readers that they make no warranty, express or implied, as to the accuracy or completeness of, nor assume any liability for, such information. We believe that the industry data that we obtained from industry publications is reliable and is the data commonly and regularly used for analysis of our industry. However, we have made no independent verification of, and we make no representations regarding, the accuracy of these data.

Before using a product sold by a company of the LyondellBasell family of companies, users should make their own independent determination that the product is suitable for the intended use and can be used safely and legally. **SELLER MAKES NO WARRANTY; EXPRESS OR IMPLIED (INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY WARRANTY) OTHER THAN AS SEPARATELY AGREED TO BY THE PARTIES IN A CONTRACT.**

LyondellBasell prohibits or restricts the use of its products in certain applications. For further information on restrictions or prohibitions of use, please contact a LyondellBasell representative.

Users should review the applicable Safety Data Sheet before handling the product.

*Adflex, Adstif, Adsyl, Akoafloor, Akoalit, Alastian, Alathon, Alkylate, Amazing Chemistry, Aquamarine, Aquathene, Avant, Catalloy, Clyrell, CRP, Crystex, Dexflex, Duopac, Duoprime, Explore & Experiment, Filmex, Flexathene, Fueling the power to win, Glacido, Hifax, Hiflex, Histif, Hostacom, Hostalen, Hyperzone, Ideal, Indure, Integrate, Koattro, LIPP, Lucalen, Luflexen, Lupolen, Luposim, Lupostress, Lupotech, Metocene, Microthene, Moplen, MPDIOL, Nerolex, Nexprene, Petrothene, Plexar, Polymeg, Pristene, Prodflex, Pro-fax, Punctilious, Purell, Refax, SAA100, SAA101, Sequel, Softell, Spherilene, Spheripol, Spherizone, Starflex, Stretchene, Superflex, TBAC, Tebol, T-Hydro, Toppyl, Trans4m, Tufflo, Ultrathene, Vacido and Valtec are trademarks owned and/or used by the LyondellBasell family of companies.*

*Adsyl, Akoafloor, Akoalit, Alastian, Alathon, Aquamarine, Avant, CRP, Crystex, Dexflex, Duopac, Duoprime, Explore & Experiment, Filmex, Flexathene, Hifax, Hostacom, Hostalen, Ideal, Integrate, Koattro, Lucalen, Lupolen, Metocene, Microthene, Moplen, MPDIOL, Nexprene, Petrothene, Plexar, Polymeg, Pristene, Pro-fax, Punctilious, Purell, Sequel, Softell, Spheripol, Spherizone, Starflex, Tebol, T-Hydro, Toppyl, Tufflo and Ultrathene are registered in the U.S. Patent and Trademark Office.*



Solutions for a Better Tomorrow

**Thank you !**