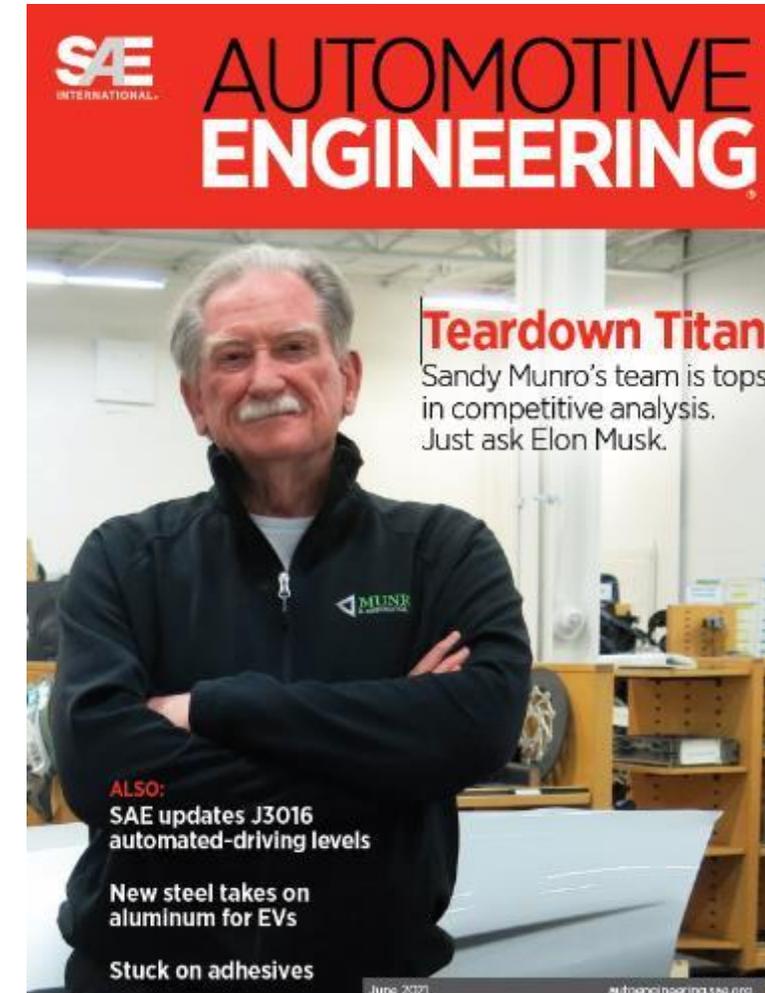


# *Short Bio: Sandy Munro*

**Honored as LTU's Innovator of the Year. Titled a visionary and master innovator by NASA, Sandy is a frequent speaker and advisor to some of the world's top executives on implementing change and innovative development strategies.**

**SAE June 2021 cover story**



# Who Is Munro?



**Munro & Associates Inc.**  
**1140 Centre Dive**  
**Auburn Hills, MI**  
**48326**  
[www.leandesign.com](http://www.leandesign.com)  
[www.designprofit.com](http://www.designprofit.com)



# Standard For Automotive NPD



# Truck of the Year 2019, 20 & 21



## No Pick-up EVER WON!!!



# *Find the Car!*



**Photo: Fifth Ave NYC Easter 1900 Source US National Archives**

# Find the Car!



**Photo: Fifth Ave NYC Easter 1900 Source US National Archives**

# *1913 Find the Horse*



**Photo: Fifth Ave NYC looking N 1913 Source US National Archives**

# 1913 Find the Horse



**Photo: Fifth Ave NYC looking N 1913 Source US National Archives**

# When a Paradigm Shifts

- **When a Paradigm shifts...everyone goes back to ZERO**
- **Your past success means nothing when the Paradigm changes.**
- **No one goes back to the old Paradigm.**
- **Steam engines, stone tools, kerosene lamps, women's whale bone corsets...all gone forever.**
- **Success in a dead or dying Paradigm WILL block your vision to the Future.**

# When a Paradigm Shifts

- This process is not new, and Psychiatrists gave it a name, it is called “Scotoma” which means “blind spot in the brain”.

- Here is an example:



# When a Paradigm Shifts

- Now what happens when you have strongly held rules that are not tangible but are deeply engrained.
- When expectations don't match the results, people are

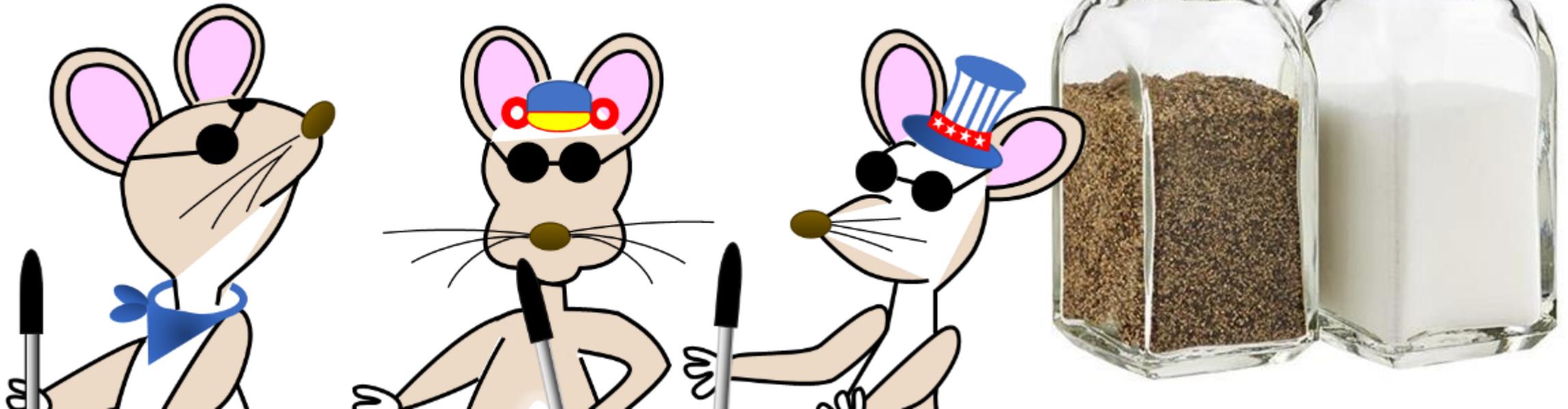


**Blind To The Data!!!**

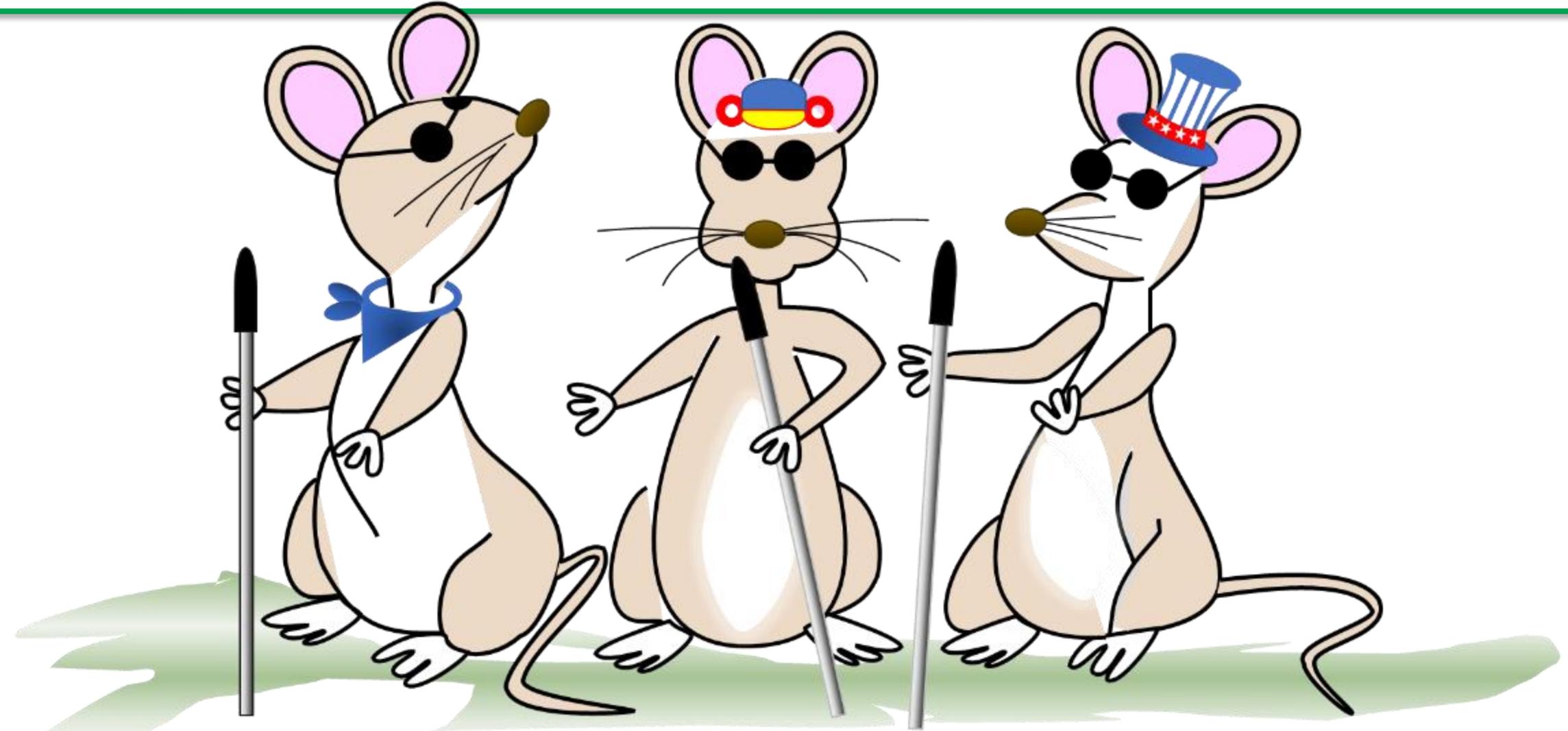
# When a Paradigm Shifts

And now for a little Slightly Modified  
Nursery rhyme singalong to the tune of

## Three Blind Mice



# Three Blind Mice...Three Blind Mice...



**EURO**

**NIPPON**

**NA**

## ***Checklist***

- MBA
- Squeeze Suppliers
- Risk Averse
- Second & Better Dressed
- Labor is Always the Problem
- Giant Bonus for Bad Behavior
- Bring Back the Diesel!!!
- Cheating the EPA & Public is OK

**The ICE Age  
will be here  
Forever.  
Singed  
HPC**



# They All Ignored the Warning Bell...

**2017/2018**

**2019**

**2020**

**2021**



# They All Dropped into Paradigm Hell...

**A-Teams on ICE**



**ANXIETY RANGE**

**Ford Behind GM in  
EV Development**

**GM BEHIND FORD IN  
EV DEVELOPMENT**



**Chip Shortages!!!**

**NA AUTO MAKERS  
HAVE NO EV DEPTH**

**BATTERY  
FIRES!!!**

**GM TOO LATE WITH  
TOO LITTLE**

**EVs are too Expensive**

# Got Tired of Hearing Elon Musk is Swell...



# Can't Even Get Help from a Wall Street Short Sell...

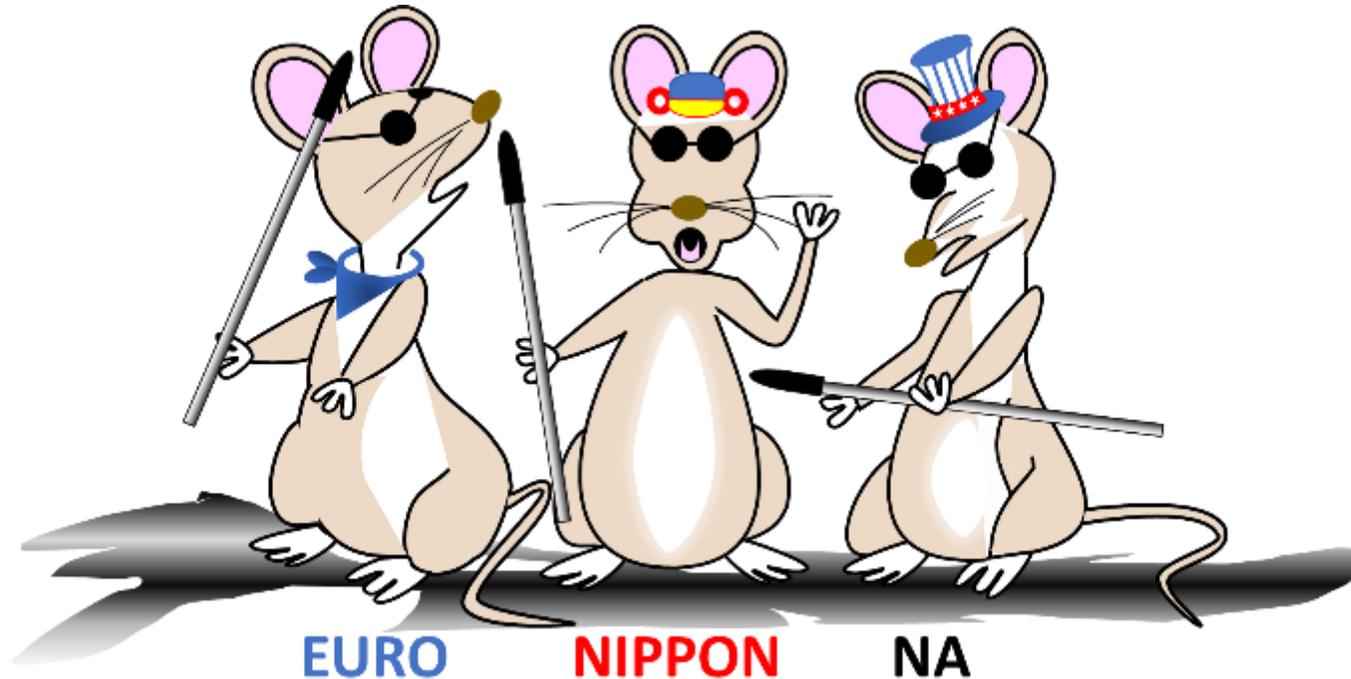


***THREE BLIND MICE...***

# Rivian, Tesla, and Faraday, Arcimoto, Aptera, and More Await ...



## What More Could get in the Way, of Three Blind Mice...



# *I was Ringing the Bell in 2017 but...*

- **Wil Joosten was trying to awaken Bosch in 2004**
- *Already in 2004 when I was working for Bosch Automotive as Battery Product Manager Worldwide Aftermarket, colleagues in China informed me of the Chinese Government's strategy to become an EV market leader by 2030.*
- *Unfortunately, Bosch decided to start together with some German car manufacturers to promote diesel ICE as an environmentally friendly solution in reaction to the growth of hybrid vehicles in the USA. This went well for about 10 years!"*

## China Will Dominate EV's For A Decade

- **Chairman Xi Jinping** announced that China will endeavor to reduce its carbon emissions to reach **carbon neutrality by 2060**
- **China 75% EV's 2030**
- **100% EV's by 2035**
- **Total stop** to manufacturing of **ICE** (gas) **2040**



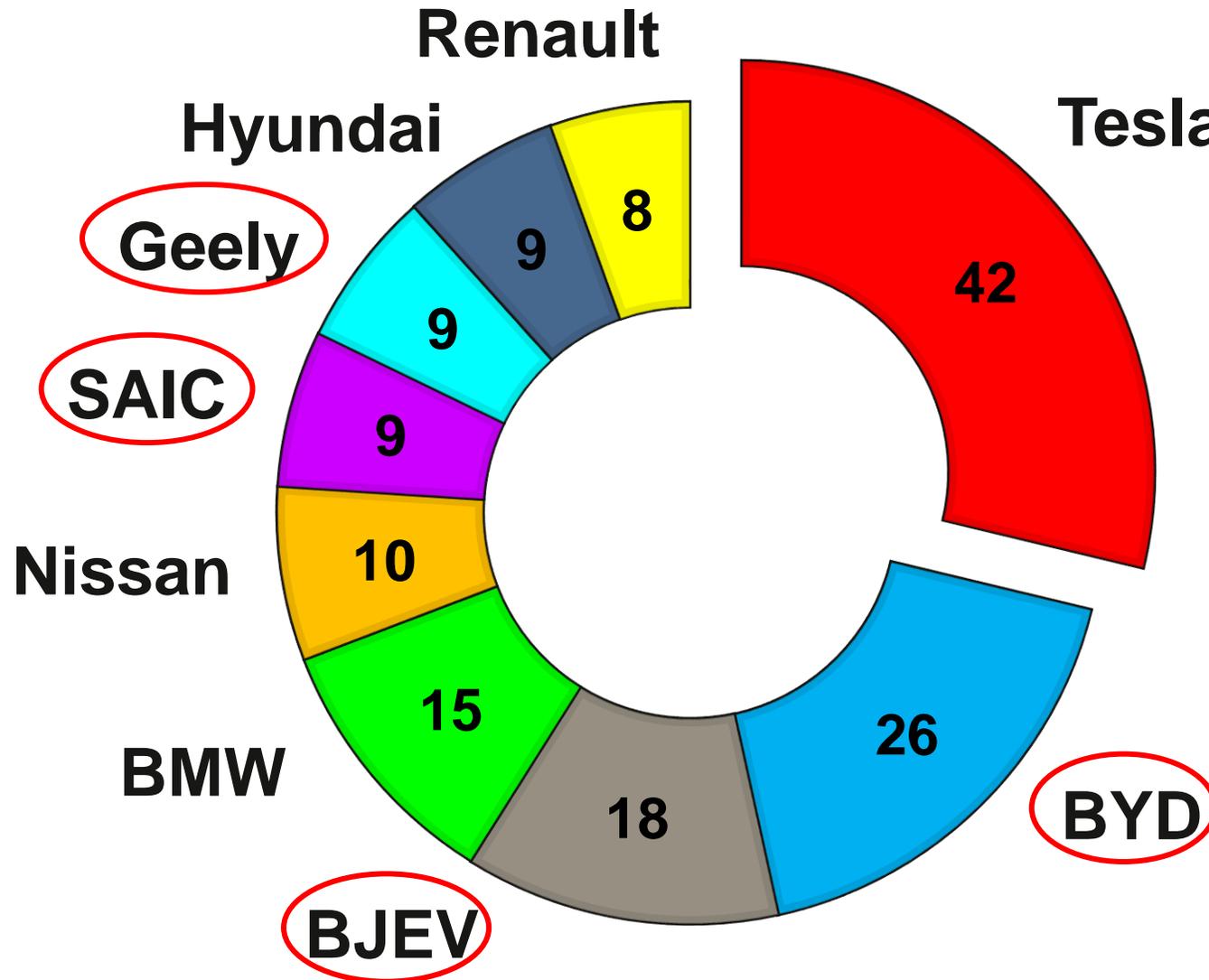
# How China is driving the future of EV/HEV

## and associated power electronics\*



(Source: Power Electronics for Electric & Hybrid Electric Vehicles 2020 report, Yole Développement, 2020)

# USA; Get Ready for the Chinese Invasion



**China Makes  
62 cars/hour**  
-v-  
**Tesla at  
42 cars/hour**

# Here is Some Data from Years Ago

## *Public Opinion has turned against ICE*

Z E T A

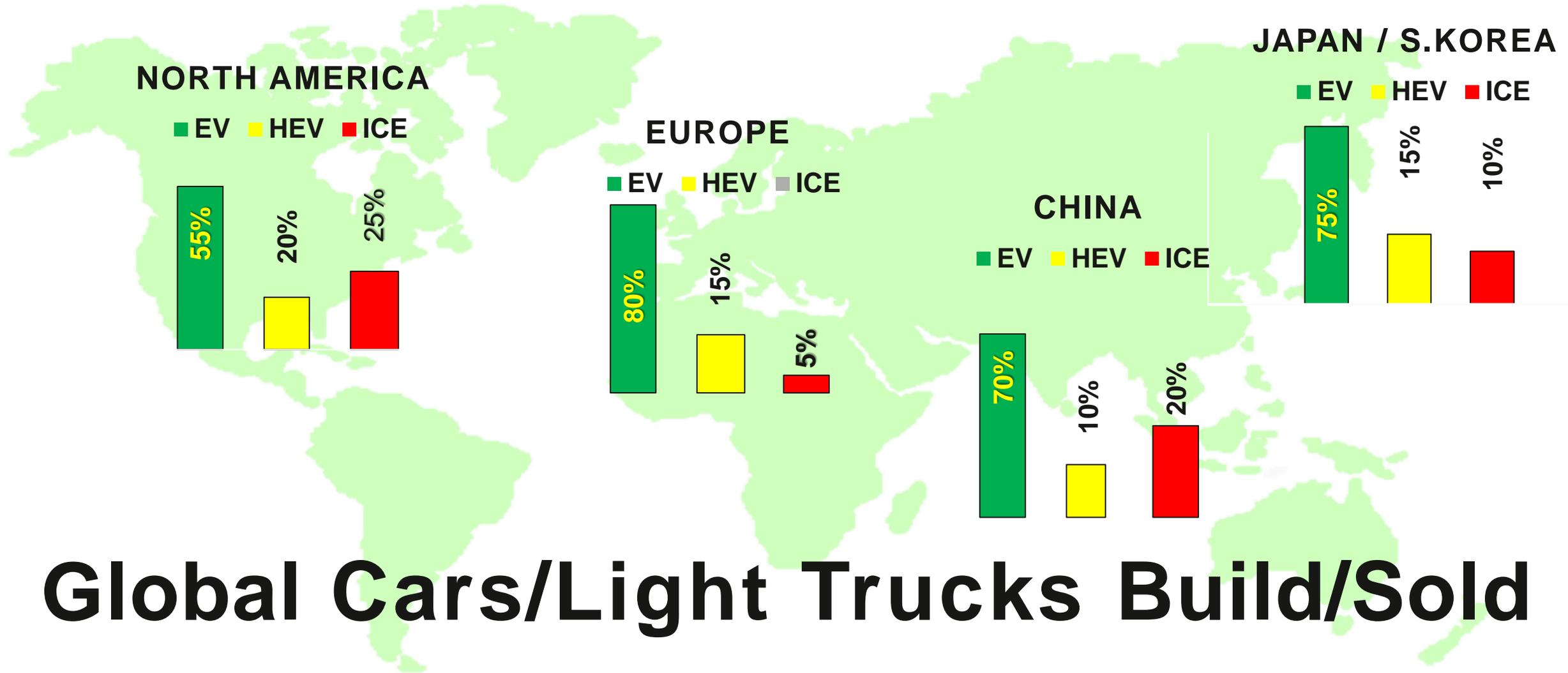


ZERO EMISSION  
TRANSPORTATION  
ASSOCIATION



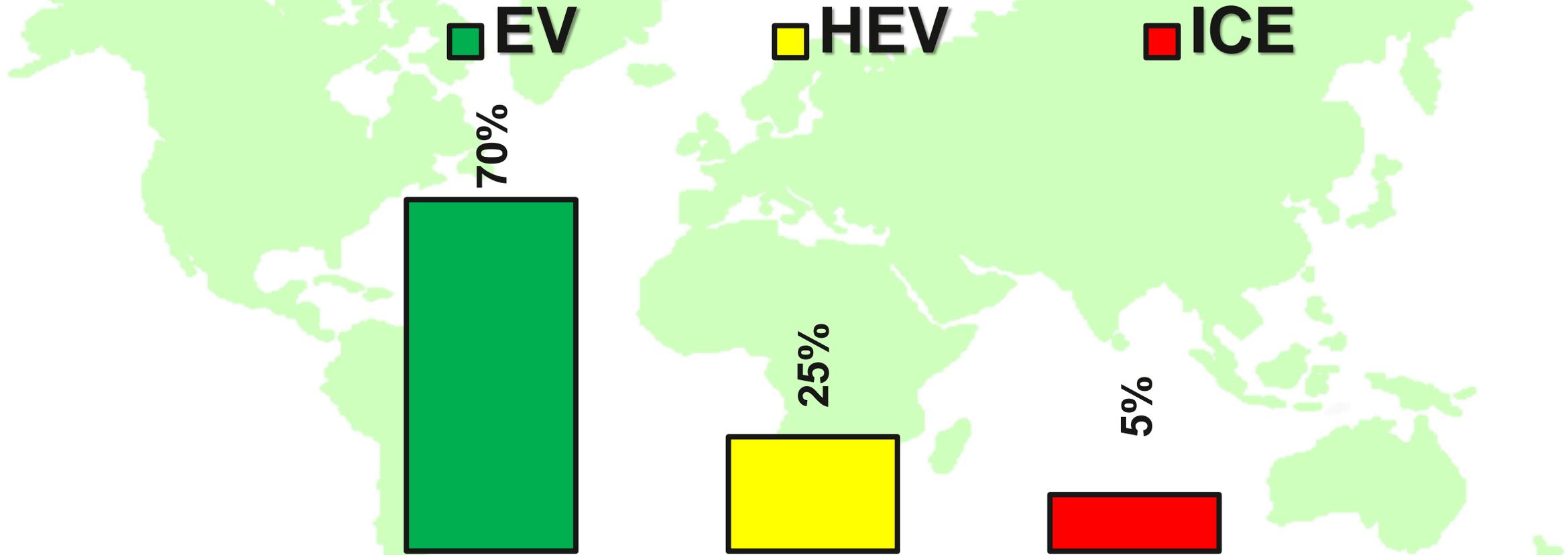
Landmark IEA Report  
Outlines Roadmap for  
Net-Zero Emissions,  
Urgency for Accelerated  
EV Adoption

# OEM's Blinded: ICE Age over in 2028



## Global Cars/Light Trucks Build/Sold

## Global Cars/Light Trucks Build/Sold



*(Excludes Africa, Middle East, South America, and India)*

# August 2021 Norway Passenger Auto Registrations

Data from OFV

**Petrol**

4.6%

**Diesel**

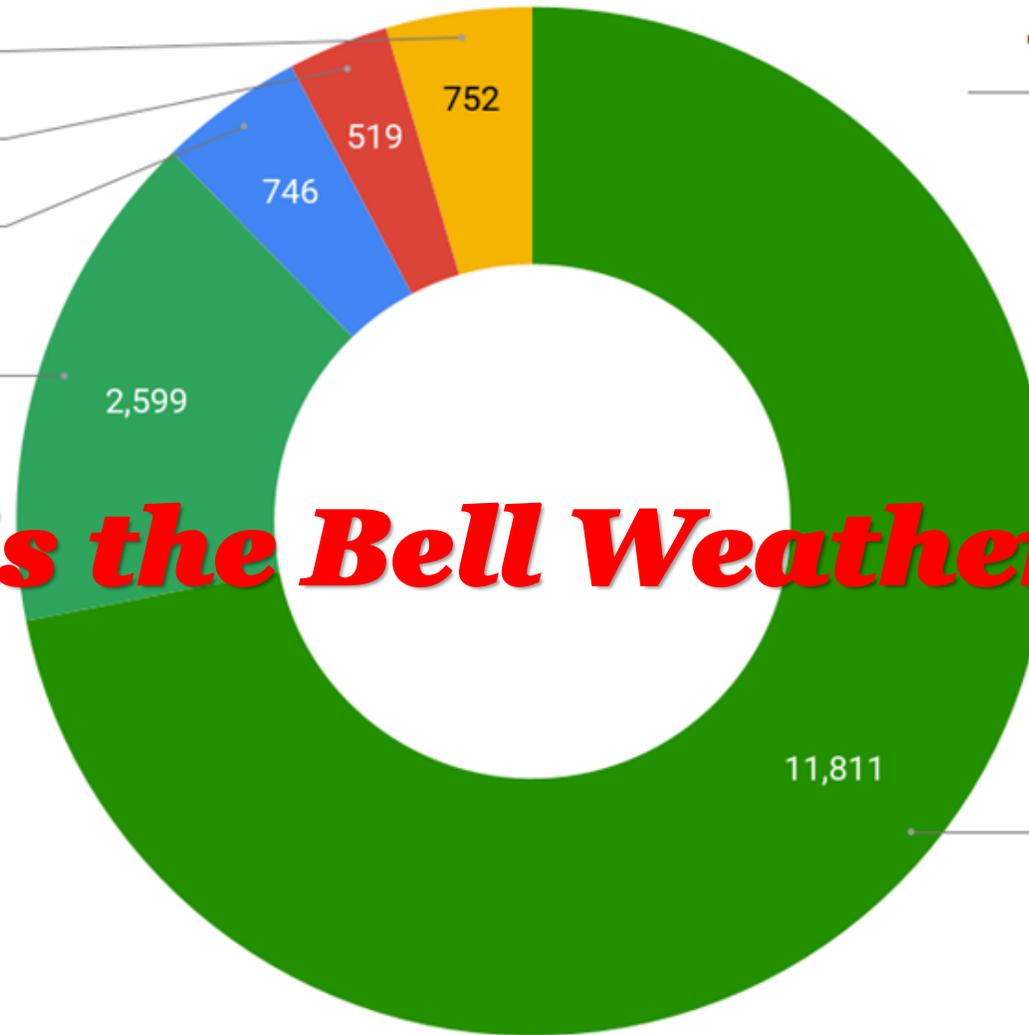
3.2%

**Hybrids (plugless)**

4.5%

**PHEV**

15.8%



**Total PEVs**

**87.7%**

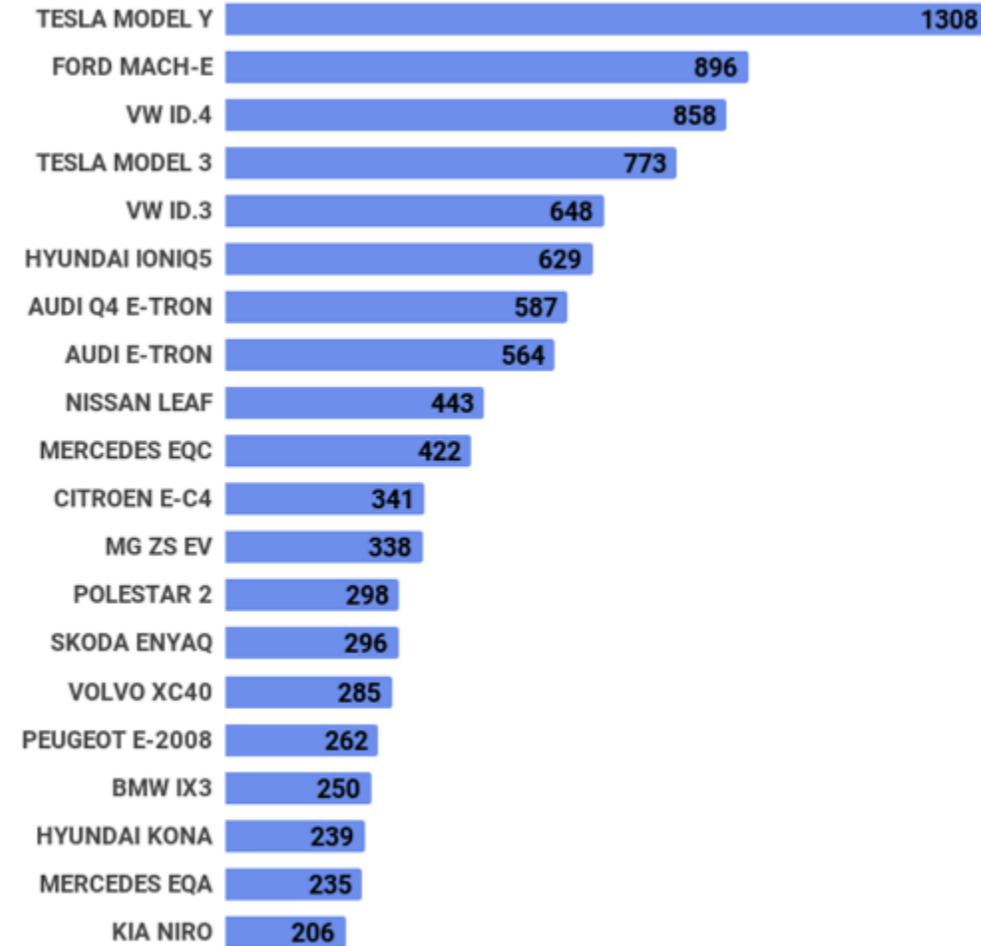
**BEV**  
**71.9%**

***Norway is the Bell Weather to the Future***

© Max Holland / CleanTechnica

# Norway Top BEVs – August 2021

Data from eu-evs.com, accurate +/- 1%, excludes grey imports etc.



© Max Holland / CleanTechnica

# Bigger Battery Means More Range!... Right???

YEAR	MAKE	MODEL	MSRP	RANGE	MPGe AVG	MPGe City	MPGe Hwy	COST TO DRIVE 100MI	ANNUAL OPERATING COST*	kWh / 100 mi
2021	Tesla	Model S Plaid	\$129,900	390	101	102	99	\$3.68	\$550	33
2021	Bentley	Continental GT	\$202,500	380	19	16	26	\$20.04	\$8,500	0
2021	Tesla	Model Y Standard	\$41,190	326	129	140	119	\$2.88	\$450	26
2021	BMW	530e (hybrid)	\$57,200	21 both / 340 total	64			\$6.88 / \$14.64	\$1,550	49
2021	BMW	530i (gas)	\$54,200	504	28	25	33	\$13.60	\$3,250	0
2021	Cadillac	XT4 AWD	\$39,795	391	24	22	29	\$15.88	\$3,150	0
2021	Mercedes	GLB 250	\$38,050	413	26	23	31	\$14.64	\$3,200	0
2021	Tesla	Model 3 Standard	\$39,990 - \$56,990	263	142	150	133	\$2.60	\$400	24
2021	Volkswagen	ID.4	\$39,995 - \$48,175	250	97	104	89	\$3.84	\$600	35
2021	Porsche	Taycan Turbo S	\$185,000	212	73	71	75	\$4.96	\$750	45
2021	Porsche	Taycan Perf		200	79	76	84	\$4.52	\$700	41
2021	Ford	Mustang Mach-E AWD	\$42,895 - \$59,900	211	93	100	86	\$4.00	\$600	36
2021	Audi	e-tron	\$65,900 - \$79,100	222	78	78	77	\$4.76	\$700	43
2021	Polestar	2	\$59,900	233	92	96	88	\$4.04	\$600	37

**ICE**

\* Operating Costs include fuel, change oil & filter, rotate tires, fluids, and lubrication

**Notes: Gas Reg \$3.29, \$0.11/kWh, 1 gal gas = 33.7kWh, 15k miles/yr, 55% stop and go**

# Battery Size **Doesn't** = More Range

**75 kWh**

**88 kWh**

**82 kWh**

**95 kWh**

2021 Tesla Model Y  
Long Range AWD



Electric Vehicle



Automatic (A1)

2021 Ford Mustang  
Mach-E RWD California  
Route 1



Electric Vehicle



Automatic (A1)

2021 Volkswagen ID.4  
1st



Electric Vehicle



Automatic (A1)

2021 Audi e-tron



Electric Vehicle



Automatic (A1)

Electricity

**125** MPGe  
131 117  
combined city highway  
City/Highway  
27 kWh/100 mi

Electricity

**101** MPGe  
108 94  
combined city highway  
City/Highway  
33 kWh/100 mi

Electricity

**97** MPGe  
104 89  
combined city highway  
City/Highway  
35 kWh/100 mi

Electricity

**78** MPGe  
78 77  
combined city highway  
City/Highway  
43 kWh/100 mi

Electricity

326 miles  
Total Range

Electricity

305 miles  
Total Range

Electricity

250 miles  
Total Range

Electricity

222 miles  
Total Range

Courtesy of John Neff <https://www.motor1.com/features/503234/make-cars-out-of-fabric/>

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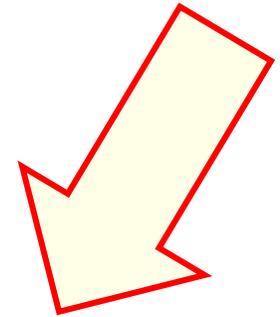
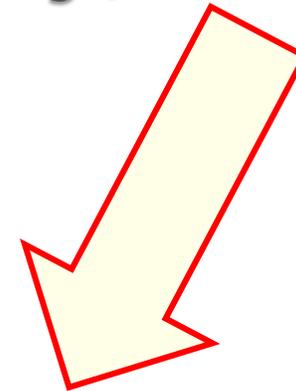
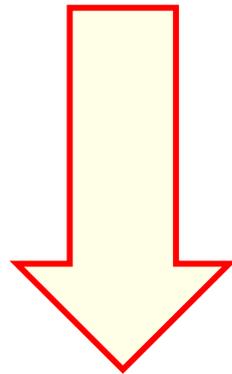
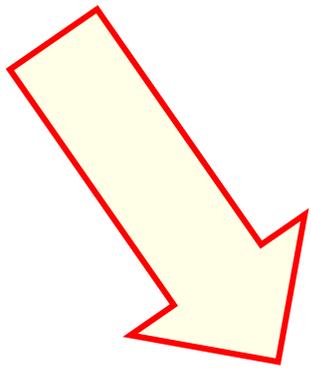
# ***What Enables EV's Growth?***

***It Must Be Battery Size!***

***Wrong!!!***

***Range Is Mostly Determined 4 Ways.***

***Weight, Engineered Efficiency, Friction, Drag***



***Composites Can Help In All These Criteria***

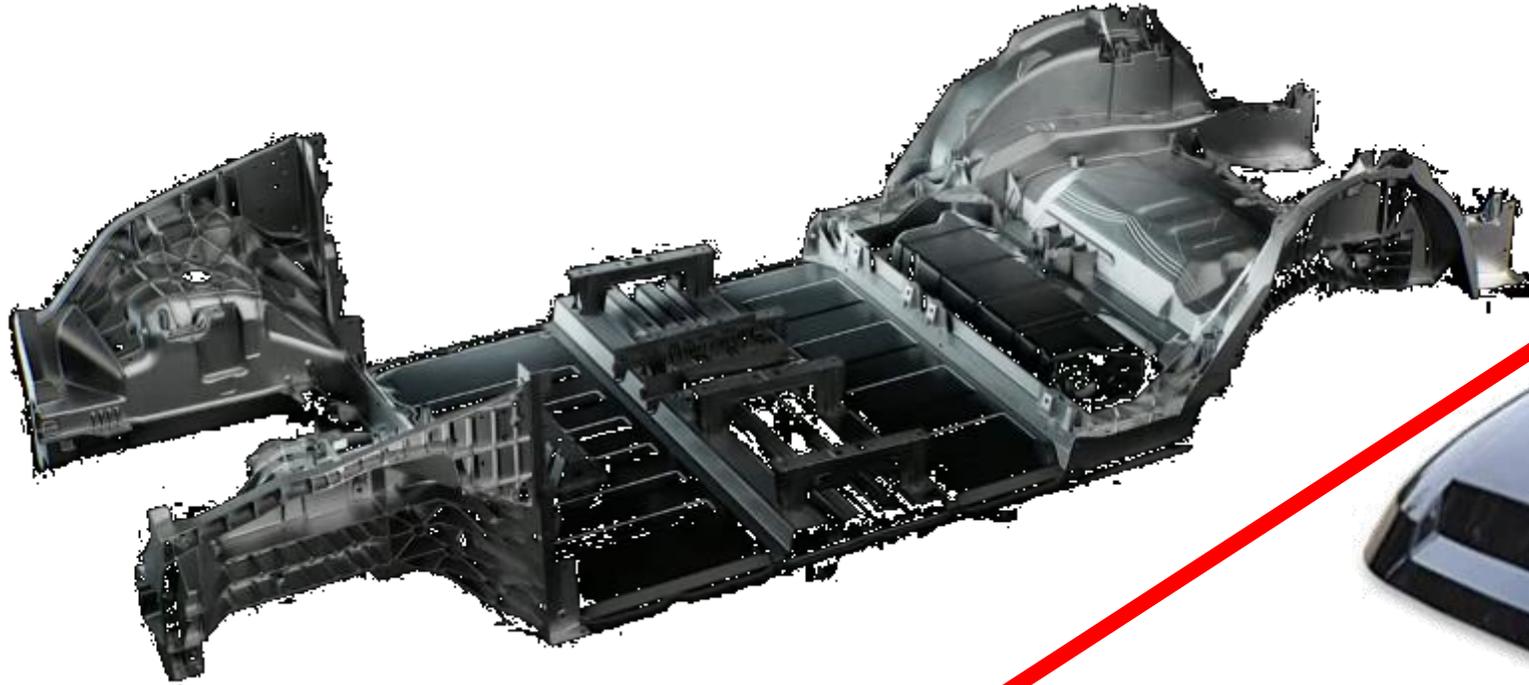
# BMW i3 Changed the Rules



***BMW i3 Life Module  
148 Kilos!***

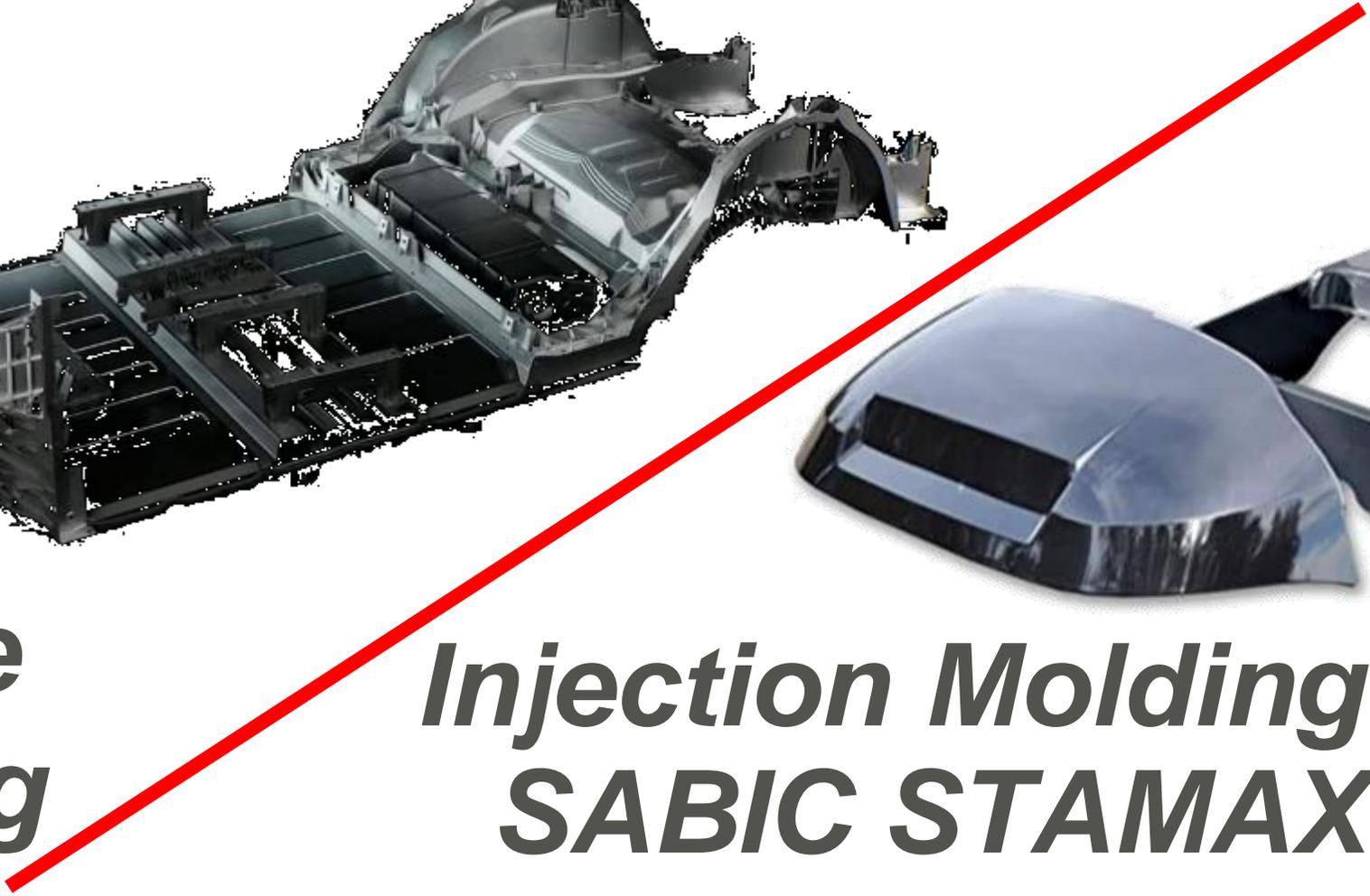
***Equivalent Steel BIW 349kg!!***

# *Two Choices for Volume Production*



***HP Die  
Casting***

***Injection Molding Using  
SABIC STAMAX FR***



# Tesla Megacasting

2019 Model Y... This was just the beginning!



70parts vs 1

Increased Piece Cost Reduced Investment Cost

# 2020 Tesla Model Y Megacasting Data



**This 1 New Part On  
Model Y replaces 17**



**Reduced Piece Cost Reduced Investment Cost**

**6,000 Tons And Growing**  
**3 Parts Replace 400 Parts**

**Parts and Operations from 450 to 20**  
**Weight For The Model Y Casting Is 130 Kg**  
**Weight In Steel For This Design 215 Kg**

**Reduced Piece Cost Reduced Investment Cost**  
**Increased Range Due to Less weight**

<https://techau.com.au/tesla-is-about-to-make-cars-very-differently-faster-cheaper/>

# Tesla in March **8000 Ton** Megacasting!!



**Riccardo Ferrario, Idra General Manager,  
announced:**

**“IDRA on March 16, 2021, “we have been able to  
secure the first order for an **8,000-ton die casting  
machine!!!” *Tesla has ordered 12 more units!!! WHY?*****

**Much Reduced Piece Cost!!!**

**Much Reduced Investment Cost!!!**

**Floor Space Needed is 1/3 of a Normal Site!!!**



# Munro/SABIC Redesign of VW ID4 Tray

VW ID.4 Battery Tray - 53% Weight Reduction

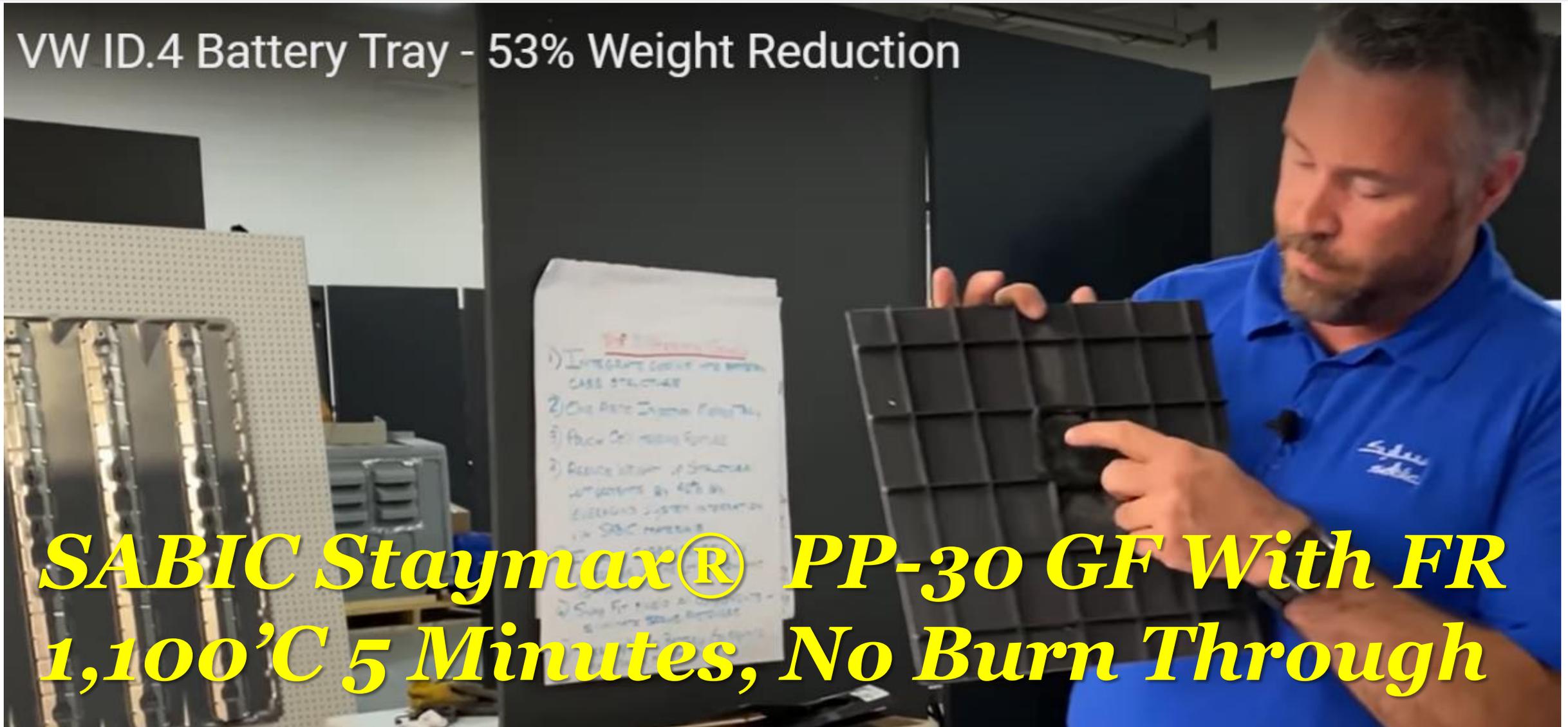


**See the video on MunroLive YouTube**

<https://www.youtube.com/watch?v=cjJUpqo1YDM&t=372s>

# Munro/SABIC Redesign of VW ID4 Tray

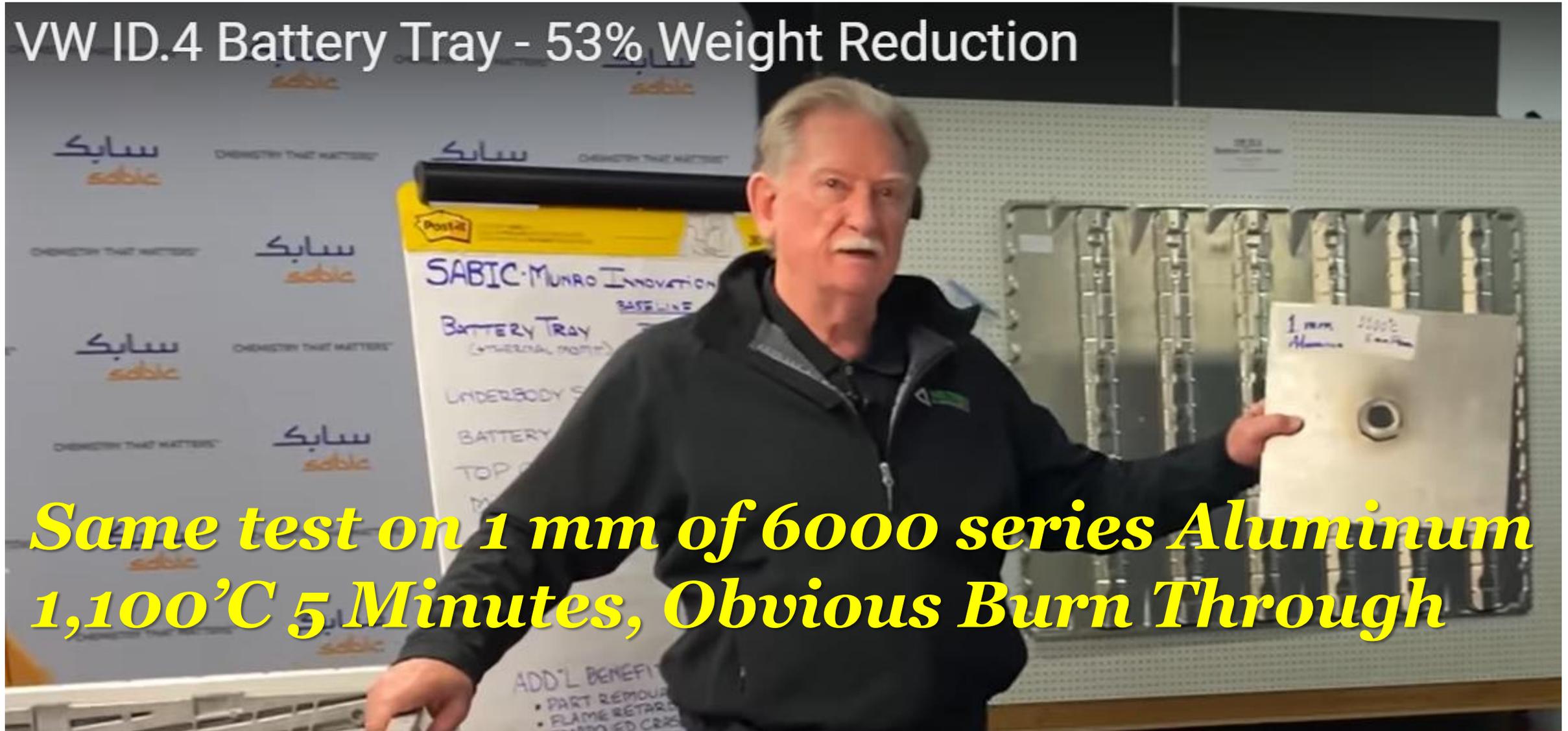
VW ID.4 Battery Tray - 53% Weight Reduction



***SABIC Staymax® PP-30 GF With FR 1,100°C 5 Minutes, No Burn Through***

# Munro/SABIC Redesign of VW ID4 Tray

VW ID.4 Battery Tray - 53% Weight Reduction



*Same test on 1 mm of 6000 series Aluminum  
1,100°C 5 Minutes, Obvious Burn Through*

# SABIC Battery Tray Redesign for the VW ID4



## System Weight & Cost Breakdown

	VW ID.4 Battery Pack		FeatherVolt Battery Pack	
	Weight (kg)	Total Cost	Weight (kg)	Total Cost
Top Cover	8.38	\$105.00	8.55	\$54.70
Cell Module Housing	57.19	\$811.47	41.19	\$554.92
Main Housing / Tray	92.08	\$708.72	44.54	\$232.93
Electronics / Misc	11.05	\$36.56	11.05	\$36.56
<b>Total</b>	<b>169</b>	<b>\$1,662</b>	<b>105</b>	<b>\$879</b>

- The chart above represents the comparison of baseline to redesign by system level breakdown of the battery pack
- The Electronics / Misc is the same on both the baseline and redesign
- Total cost includes material cost + production cost + Q Burden + SG&A + Profit
- Detail breakdown of each system is given in the following slides



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1



# SABIC Battery Tray Redesign for the VW ID4



## System Weight & Cost Breakdown



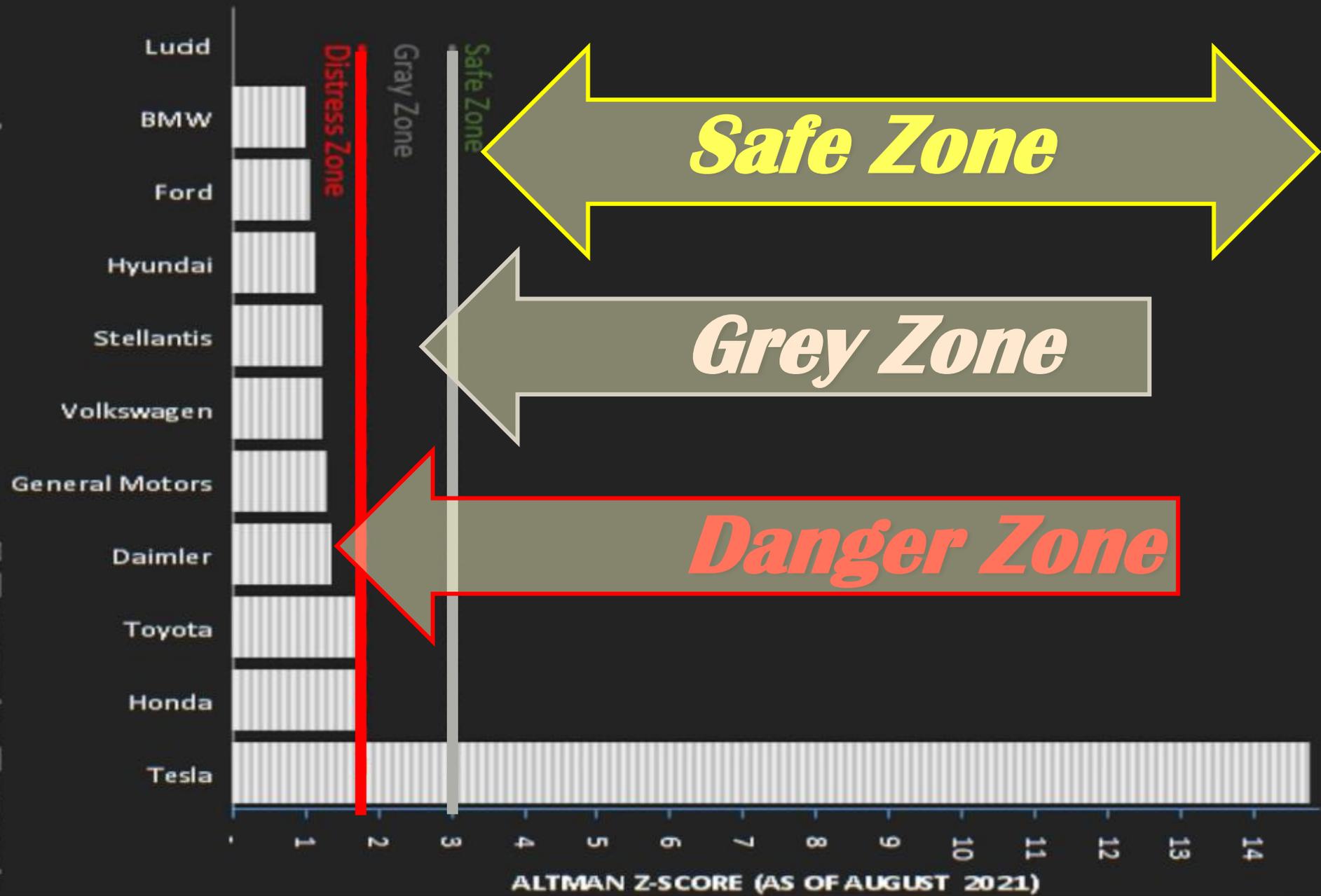
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Source: gurufocus.com

McGraw-Hill



**Why  
 Invest  
 If you  
 know  
 there is  
 huge  
 risk?**

# China – Monthly Sales by Group, Top 25

Country	Total Sales Ranking	Group	2021-01	2021-02	2021-03	2021-04	2021-05	2021-06	First Half(Jan.-Jun.)	2021-07	2021-08	2021-09	2021-10	2021-11	2021-12	Second Half(Jul.-Dec.)	Total
China	1	VW Group	301,386	171,166	327,417	259,334	276,306	186,477	<b>1,522,086</b>	169,600	0	0	0	0	0	169,600	<b>1,691,686</b>
China	2	GM Group	222,779	141,988	279,078	215,319	205,350	178,149	<b>1,242,663</b>	200,017	0	0	0	0	0	200,017	<b>1,442,680</b>
China	3	Toyota Group	172,905	91,814	152,967	134,306	137,617	148,378	<b>837,987</b>	153,873	0	0	0	0	0	153,873	<b>991,860</b>
China	4	Changan/Chana (Changan Automobile (Group))	182,663	127,856	154,476	141,578	123,660	108,760	<b>838,993</b>	117,472	0	0	0	0	0	117,472	<b>956,465</b>
China	5	Honda	149,745	87,977	147,321	152,730	114,919	107,752	<b>760,444</b>	102,178	0	0	0	0	0	102,178	<b>862,622</b>
China	6	Geely Holding Group	176,455	86,938	115,872	117,599	114,632	117,244	<b>728,740</b>	117,046	0	0	0	0	0	117,046	<b>845,786</b>
China	7	Great Wall Motor Company Ltd. (GWM)	139,012	89,050	110,736	91,784	86,965	100,664	<b>618,211</b>	91,555	0	0	0	0	0	91,555	<b>709,766</b>
China	8	Dongfeng (Dongfeng Motor Corp.)	93,822	56,255	127,919	108,680	103,782	98,259	<b>588,717</b>	66,731	0	0	0	0	0	66,731	<b>655,448</b>
China	9	Renault-Nissan Alliance	123,261	58,624	84,865	94,237	87,245	93,140	<b>541,372</b>	92,938	0	0	0	0	0	92,938	<b>634,310</b>
China	10	FAW (China FAW Group Corp.)	120,353	59,029	104,090	88,303	84,986	79,273	<b>536,034</b>	50,795	0	0	0	0	0	50,795	<b>586,829</b>
China	11	SAIC (Shanghai Automotive Industry Corporation (Group))	83,074	43,903	86,768	83,414	81,069	74,419	<b>452,647</b>	71,605	0	0	0	0	0	71,605	<b>524,252</b>
China	12	BAIC Group	73,139	44,237	110,393	89,602	72,877	73,637	<b>463,885</b>	55,544	0	0	0	0	0	55,544	<b>519,429</b>
China	13	Chery Automobile	71,721	44,072	74,884	73,051	60,491	68,619	<b>392,838</b>	77,932	0	0	0	0	0	77,932	<b>470,770</b>
China	14	Small and Medium OEM	55,031	35,834	74,919	75,740	70,060	79,124	<b>390,708</b>	61,853	0	0	0	0	0	61,853	<b>452,561</b>
China	15	BMW Group	73,333	41,696	65,543	61,303	62,858	59,640	<b>364,373</b>	43,466	0	0	0	0	0	43,466	<b>407,839</b>
China	16	Daimler Group	68,871	43,274	63,792	63,300	53,748	44,248	<b>337,233</b>	33,968	0	0	0	0	0	33,968	<b>371,201</b>
China	17	Hyundai Kia Automotive Group	60,548	28,952	46,516	43,858	47,819	46,149	<b>273,842</b>	37,585	0	0	0	0	0	37,585	<b>311,427</b>
China	18	BYD Auto	42,401	20,927	40,817	45,234	46,295	51,015	<b>246,689</b>	57,410	0	0	0	0	0	57,410	<b>304,099</b>
China	19	China National Heavy Duty Truck Group	36,434	33,461	54,099	51,282	42,998	39,794	<b>258,068</b>	29,829	0	0	0	0	0	29,829	<b>287,897</b>
China	20	Anhui Jianghuai Automotive Group	49,949	28,365	47,054	44,889	37,579	32,673	<b>240,509</b>	30,433	0	0	0	0	0	30,433	<b>270,942</b>
China	21	Guangzhou Automobile Group	41,756	16,950	33,161	34,044	34,445	33,487	<b>193,843</b>	39,733	0	0	0	0	0	39,733	<b>233,576</b>
China	22	Tesla	15,484	18,318	35,478	25,845	33,463	33,155	<b>161,743</b>	32,968	0	0	0	0	0	32,968	<b>194,711</b>
China	23	Ford Group	33,975	13,111	26,871	19,968	24,185	26,893	<b>145,003</b>	30,201	0	0	0	0	0	30,201	<b>175,204</b>
China	24	Jiangling Motors Co. Group	23,361	15,484	33,791	29,214	25,901	26,552	<b>154,303</b>	19,851	0	0	0	0	0	19,851	<b>174,154</b>
China	25	Shaanxi Automobile Group	20,168	11,044	38,042	25,902	22,846	28,683	<b>146,685</b>	12,568	0	0	0	0	0	12,568	<b>159,253</b>

# *Is There Any Hope For Sight Again?*

*Ford, VW and GM Are Building Battery Plants,  
But They Will Not Be Ready For A Long Time.*



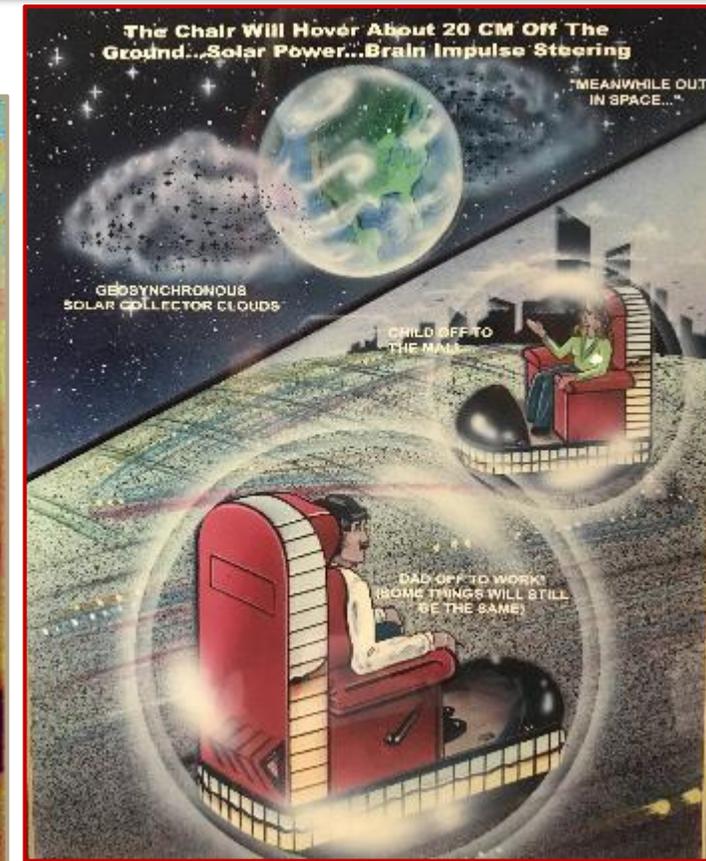
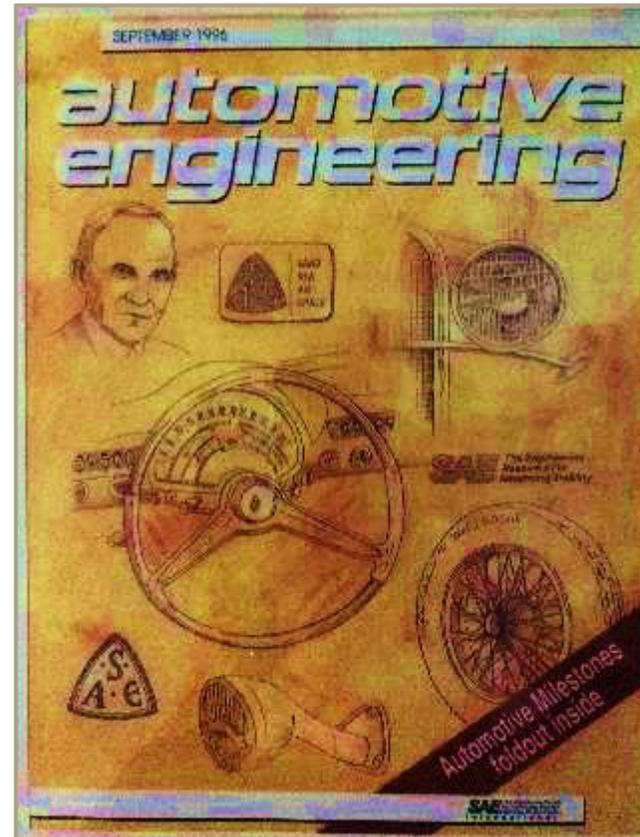
*In the USA Tesla #1, Ford #2*

# Personal Air Mobility is a Possibility

Just after WWII



1996



Uber, Volocopter, Ehang, Lilium, Joby Aviation and **MANY** others are in the game.

***I Hope So!!!!:***

- ***Speed & convenience***
- ***Personal space (COVID environment)***
- ***Air cargo / delivery solution***
- ***Emergency response***
- ***Cost of new Roads!!!***

***I Hope So!!!!:***

- ***Speed & convenience***
- ***Personal space (COVID environment)***
- ***Air cargo / delivery solution***
- ***Emergency response***
- ***Cost of new Roads!!!***

# ***China & Korea Are Not Blind***

**Hyundai;**  
**WE will have...**



- An air cargo version by 2026
- An intracity Urban Air Mobility unit by 2028
- Regional air mobility operating between cities by the 2030s

# ***VTOL, Will You make the right choice?***



***I Hope So!!!!:***

***Blatant Sales Warning!!!***

***If you are interested in a VTOL NPD Do what Boeing 787, Airbus, NG, Raytheon, and many other aircraft framers have done...***

***Call Munro for RFT***



Concept



Engineering



Manufacturing



Distribution



Operation



Maintenance



End of Life



Total Lifecycle Cost  
Prediction Quantification Reduction

Since 1988

Thank You For your Time

“Carpe Diem”