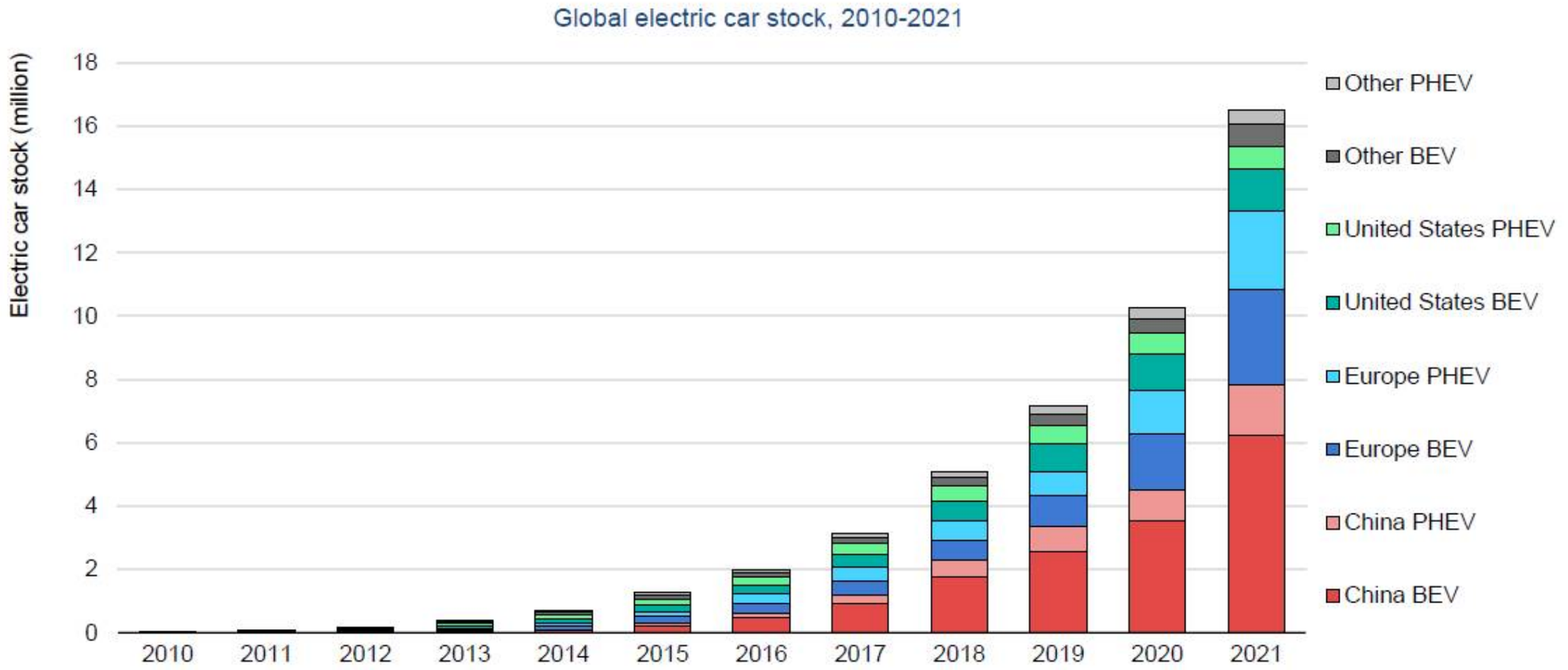
โอกาสในห่วงโซ่คุณค่าของแบตเตอรี่สำหรับอุตสาหกรรมยานยนต์

พิมพา ลิ้มทองกุล
ศูนย์เทคโนโลยีพลังงานแห่งชาติ
สำนักงานพัฒนาวิทยาศาสตร์และเทคโนโลยีแห่งชาติ
4 ธันวาคม 2566

ELECTRIC VEHICLES SALE is ON THE RISE

Over 16.5 million electric cars were on the road in 2021, a tripling in just three years



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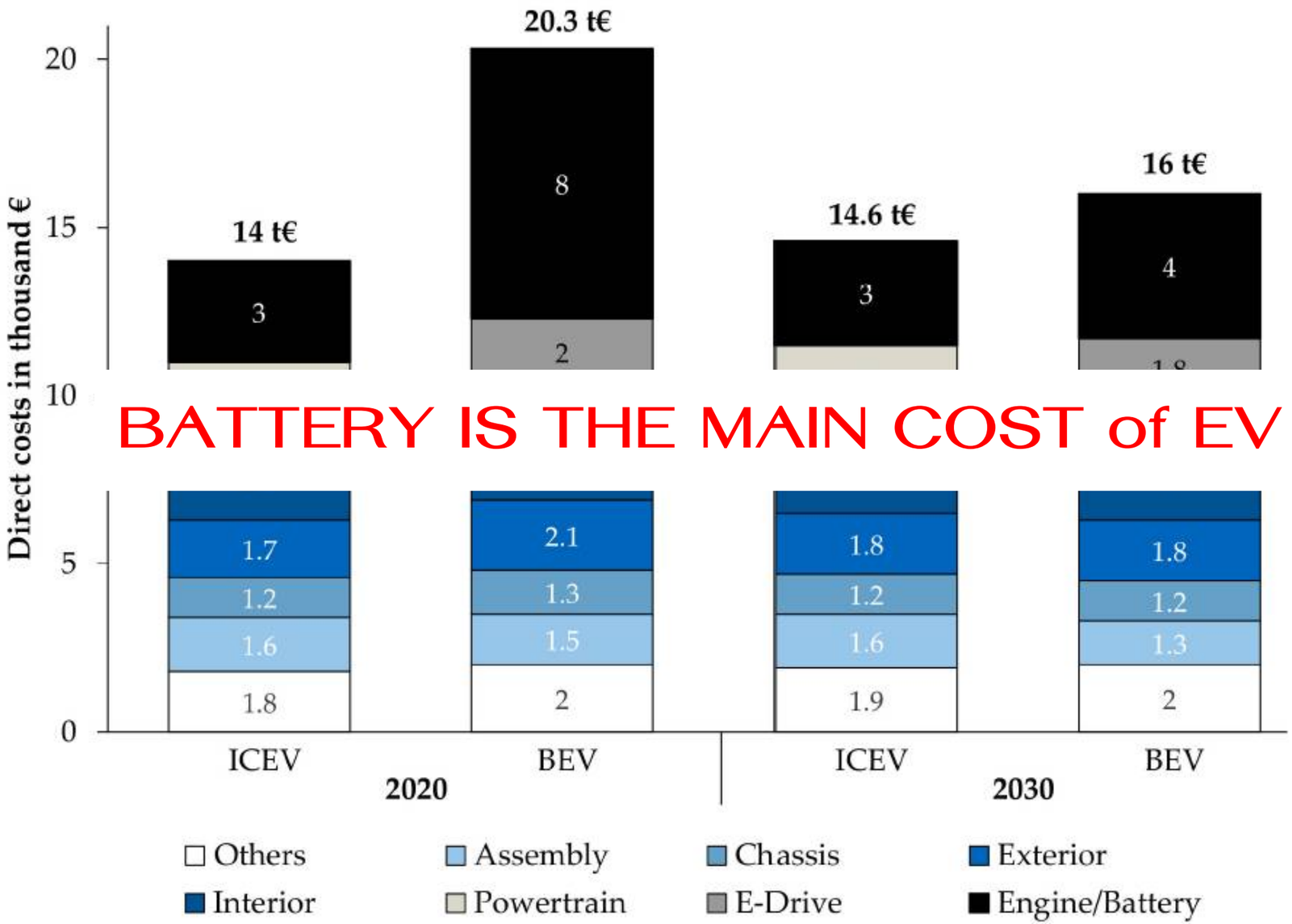
Notes: BEV = battery electric vehicle; PHEV = plug-in hybrid electric vehicle. Electric car stock in this figure refers to passenger light-duty vehicles.
"Other" includes Australia, Brazil, Canada, Chile, India, Japan, Korea, Malaysia, Mexico, New Zealand, South Africa and Thailand. Europe in this figure includes the EU27, Norway, Iceland, Switzerland and United Kingdom.
Sources: IEA analysis based on country submissions, complemented by ACEA; CAAM; EAFO; EV Volumes; Marklines.

IEA Global EV Outlook 2022

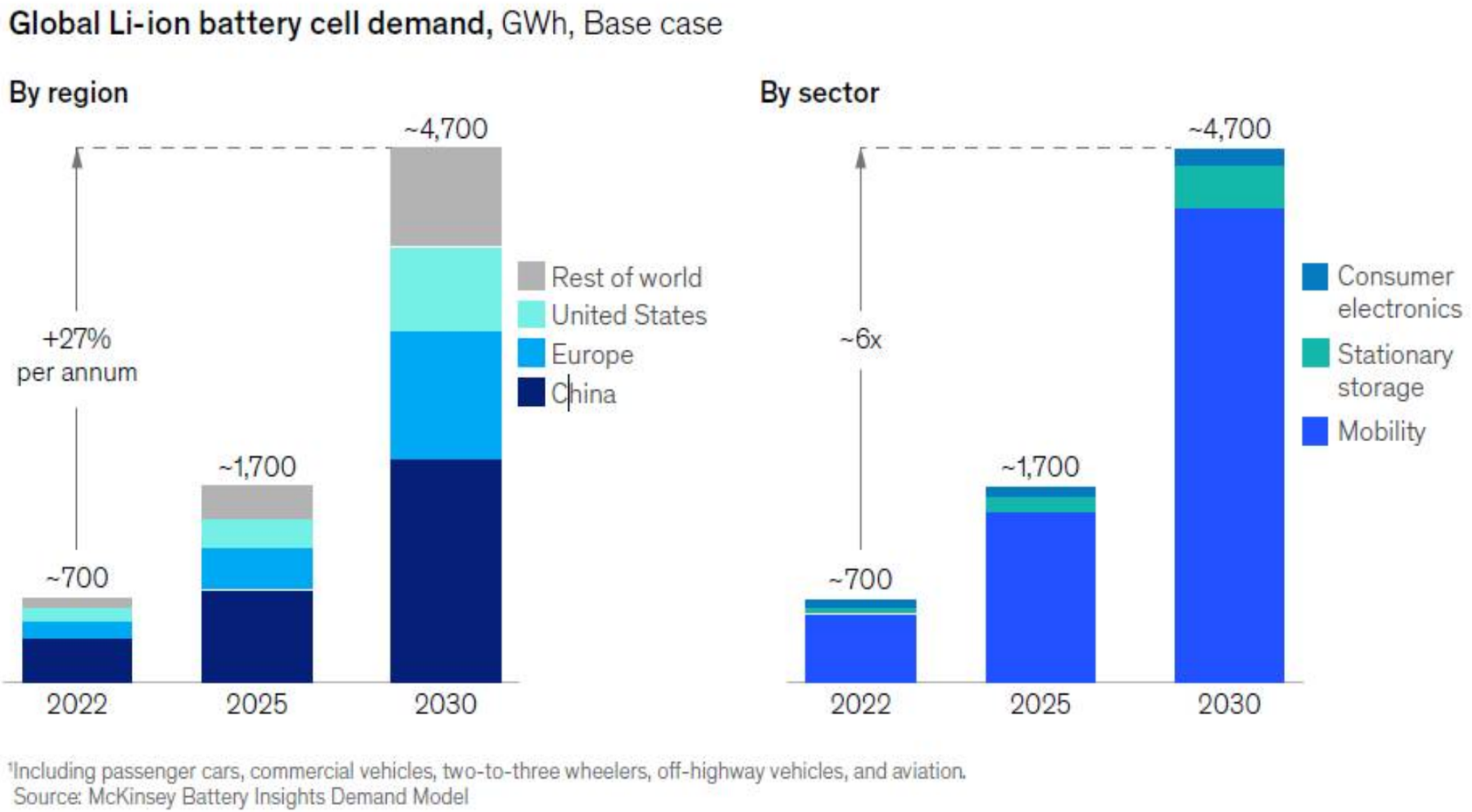
COST COMPONENT IN ELECTRIC VEHICLES



A. Konig, et. Al, 2021, World Electr. Veh. J. 2021,12, 21. http://doi.org/10.3390/wevj12010021

RISE IN EV CAUSE HIGHER DEMAND FOR BATTERIES

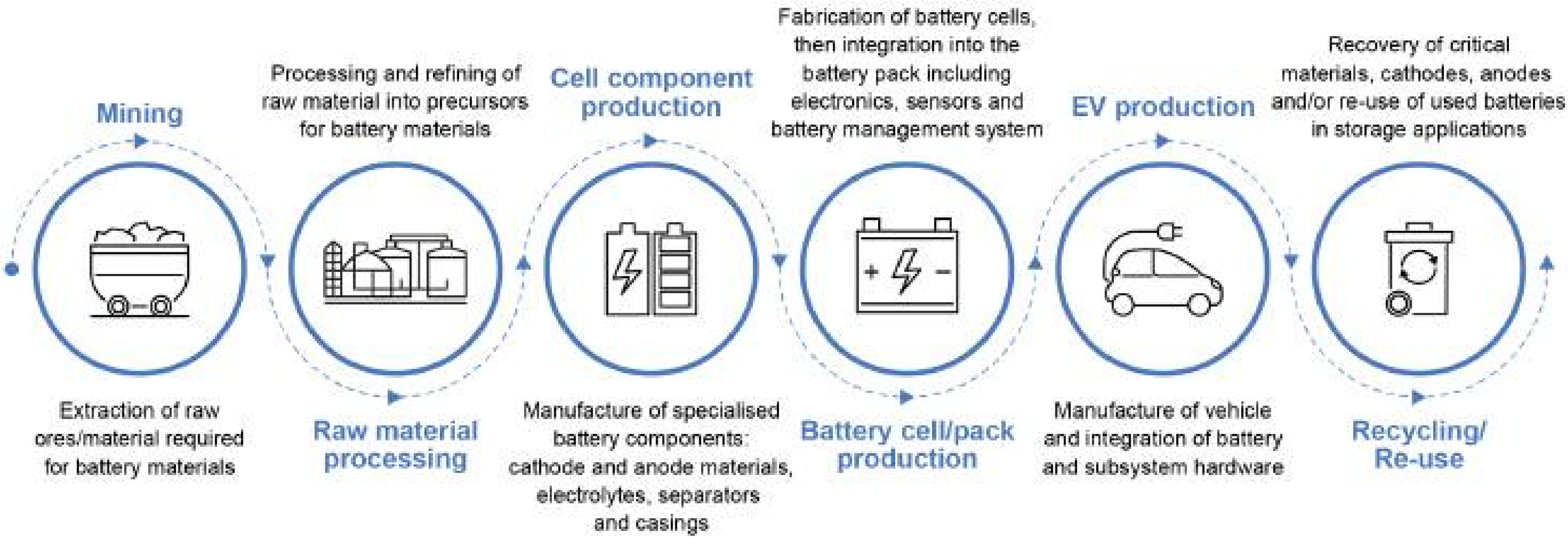
- Li-ion battery market growth worldwide is 27% CAGR with volume increase from the value from ~700GWh in 2022 to ~4700GWh in 2030.
- Expected total value will increase from $85B (2022) to ~ $400B (2030)



[1]Including passenger cars, commercial vehicles, two-to-three wheelers, off-highway vehicles, and aviation.
Source: McKinsey Battery Insights Demand Model

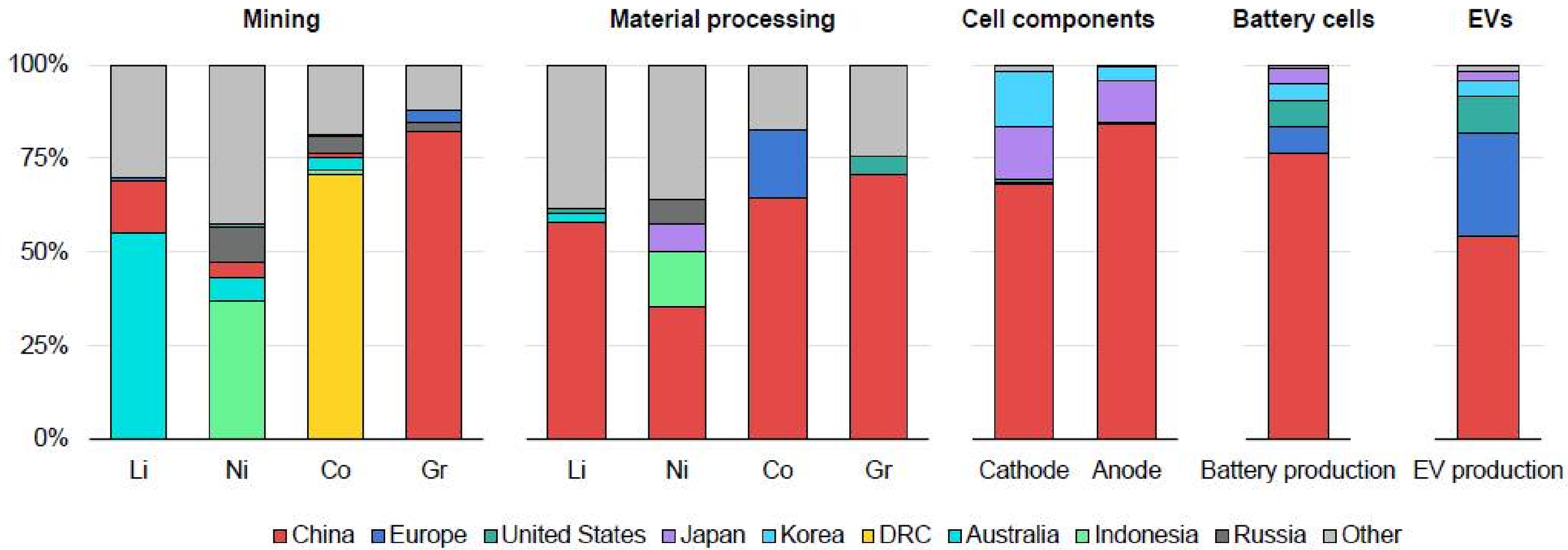
Source: Global Battery Alliance 2023, Battery 2030: Resilient, sustainable, and circular

BATTERY VALUE CHAIN



IEA Global Supply Chain of EV Batteries 2022

WHO IS WHO IN THE VALUE CHAIN?



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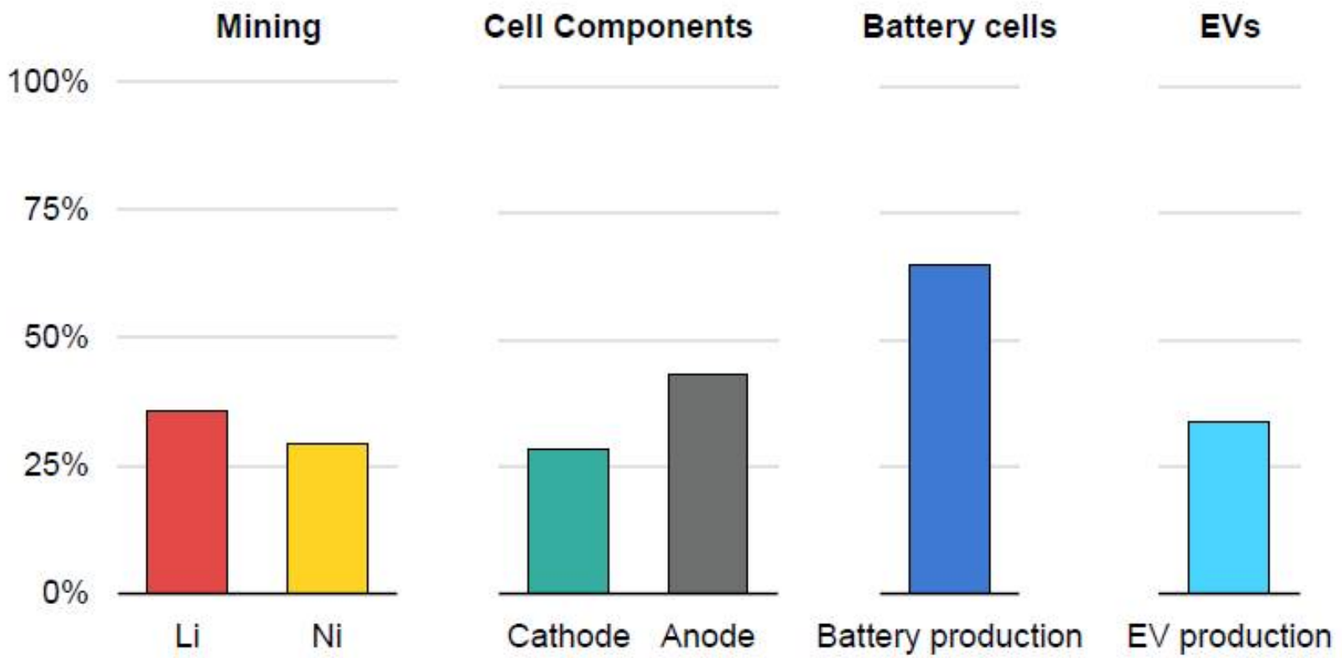
IEA Global Supply Chain of EV Batteries 2022

WHO IS WHO IN THE VALUE CHAIN?

- **Top 3 Producers – some capture over 50% of value in the value chain**

Share of total production of top-three companies at each stage of the EV battery supply chain, 2021



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Notes: The figure shows production percentages of top-three companies for 2021: EV production by sales; battery production by MWh produced; cathode and anode by production capacity; mining by production capacity. Top-three companies by production (country where headquartered): *lithium* - Sociedad Química y Minera de Chile (Chile); Pilbara Minerals (Australia); Allkem (Australia); *nickel* - Jinchuan Group (China); BHP Group (Australia); Vale SA (Brazil); *cathode* - Sumitomo (Japan); Tianjin B&M Science and Technology (China); Shenzhen Dynanonic (China); *anode* - Ningbo Shanshan (China); BTR New Energy Materials (China); Shanghai Putailai New Energy Technology (China); *battery production* - CATL (China); LG Energy Solution (Korea); Panasonic (Japan); *EV production* - Tesla (United States); VW Group (Germany); and BYD (China).

Sources: IEA analysis based on Benchmark Mineral Intelligence; Bloomberg NEF; S&P Global.

- *Source: IEA Report 2022 "Global Supply Chiang of EV Batteries"*

BATTERY SUPPLY CHAIN COMPETITIVENESS

2022

Country	Raw Materials	Battery manufacturing	ESG	Industry, innovation and infrastructure	Downstream demand	Overall ranking
China	1	1	17	9	1	1
Canada	3	8	6	4	10	2
US	6	4	16	5	2	3
Finland	9	15	2	1	11	4
Norway	18	10	1	3	7	5
Germany	21	6	4	7	2	6
South Korea	17	2	10	6	5	6
Sweden	21	9	3	2	8	8
Japan	13	3	8	12	8	9
Australia	2	15	9	13	11	10
France	24	10	5	10	5	11
UK	26	15	7	8	4	12
Czechia	23	10	11	11	18	13
Poland	24	5	15	16	15	14
Hungary	26	6	13	14	20	15
Chile	7	18	14	23	19	16
Turkey	15	18	21	15	13	17
India	13	10	26	21	13	18
Vietnam	20	10	20	18	17	19
South Africa	8	18	19	17	26	20
Brazil	4	18	23	22	20	21
Indonesia	5	18	22	27	25	22
Argentina	11	18	12	19	26	23
Slovakia	26	18	18	25	24	24
Thailand	26	18	24	20	16	25
Philippines	10	18	29	28	22	26
Mexico	16	18	27	26	23	27
Morocco	19	18	25	24	28	28
DRC	11	18	30	29	30	29
Bolivia	26	18	28	30	28	30

2020

	Country	2020 rank	Raw material	Cell & component	Environ.	RII	Demand	2025 rank	Raw material	Cell & component	Environ.	RII	Demand
1	China	1	1	1	16	11	1	1	1	1	15(▲1)	11	1
2	Japan	2	12	2	6	7	6	2	8(▲4)	3(▼1)	7(▼1)	7	8(▼2)
3	S. Korea	3	17	2	9	5	2	8(▼5)	16(▲1)	2	13(▼4)	5	9(▼7)
4	Canada	4	4	10	4	10	11	5(▼1)	3(▲1)	12(▼2)	4	10	6(▲5)
5	Germany	4	17	6	12	2	2	6(▼2)	22(▼5)	6	9(▲3)	2	3(▼1)
6	U.S.	6	15	4	13	6	2	3(▲3)	13(▲2)	3(▲1)	7(▲6)	6	2
6	U.K.	7	17	6	9	4	6	8(▼1)	17	8(▼2)	10(▼1)	4	4(▲2)
8	Finland	8	11	13	5	3	13	7(▲1)	10(▲1)	8(▲5)	6(▼1)	3	17(▼4)
9	France	8	17	13	1	9	5	10(▼2)	17	12(▲1)	1	9	5
10	Sweden	10	22	13	3	1	8	4(▲6)	17(▲5)	7(▲6)	3	1	7(▲1)
11	Australia	11	2	13	21	12	8	11	2	12(▲1)	19(▲2)	12	11(▼3)
12	Brazil	12	3	13	2	24	23	12	7(▼4)	18(▼5)	2	24	15(▲8)
13	Poland	12	22	5	11	13	14	13(▼1)	22	5	12(▼1)	13	19(▼5)
14	Hungary	12	22	6	8	14	15	15(▼3)	22	8(▼2)	11(▼3)	14	18(▼3)
15	Czech Rep.	15	17	10	17	8	17	16(▼1)	17	12(▼2)	17	8	21(▼4)
16	India	16	9	13	19	18	11	16	13(▼4)	18(▼5)	21(▼2)	18	10(▲1)
17	Chile	17	6	13	18	16	20	14(▲3)	4(▲2)	12(▲1)	15(▲3)	16	23(▼3)
18	Vietnam	18	16	6	22	20	10	23(▼5)	17(▼1)	12(▼6)	23(▼1)	20	12(▼2)
19	S. Africa	19	5	13	23	17	19	20(▼1)	4(▲1)	18(▼5)	19(▲4)	17	22(▼2)
20	Argentina	20	12	13	6	22	24	16(▲4)	8(▲4)	18(▼5)	5(▲1)	22	25(▼1)
21	Indonesia	21	7	13	25	21	15	20(▲1)	4(▲3)	18(▼5)	24(▲1)	21	13(▲2)
22	~~Mexico~~	~~22~~	~~12~~	~~13~~	~~15~~	~~19~~	~~22~~	~~16(▲6)~~	~~12~~	~~18(▼6)~~	~~13(▲2)~~	~~19~~	~~16(▲6)~~
23	Thailand	23	22	10	19	15	17	22(▲1)	22	8(▲2)	21(▼2)	15	20 (▼3)
24	D.R.C.	24	8	13	14	25	24	25(▼1)	10(▼2)	18(▼5)	18(▼4)	25	24
25	Philippines	25	9	13	24	23	20	24(▲1)	13(▼4)	18(▼5)	25(▼1)	23	14(▲6)
26													
27													
28													
29													
30													

- Battery supply chain competitiveness is mainly driven by demand

Source: BNEF 2022, 2020

THAILAND IS ALL THE DEMAND IN SOUTHEAST ASIA FOR BEV

* Note: The total percentage may vary from 100% due to rounding

Source: https://www.thailand-business-news.com/en/business/99313-thailand-leads-southeast-asia-bev-sales

PASSENSOR CARS ARE NOT THE ONLY OPPORTUNITY

- SEA – potential for PV, 2 wheelers and batteries

5 or more countries | 1-4 countries | No countries

	Solar PV	Electric 2-wheelers	Batteries
Current manufacturing capability across value chain	Polysilicon ✓ > Wafer ✓ > Cell ✓ > Module assembly ✓	Component ✓ > Vehicle assembly ✓	Mining & refining ✓ > Cathode ✓ > Cell ✓ > Pack –
Perspectives on demand and manufacturing	**~16** Technical solar potential, TW: Myanmar, Thailand, Indonesia (75%)	**23%** Share of global ICE 2W sales (2021): Vietnam, Indonesia (~66%)	**25%** Share of global nickel reserves: Indonesia (21%), Philippines (4%)
	9-10% Share of global cell and module production: Thailand, Vietnam and Malaysia (90%)	**6-10%** Share of global E2W assembly capacity: Estimated global capacity: 25-30mn[1]	**<0.5%** Share of global battery cell production: Global: 745 GWh; Southeast Asia: ~3GWh

Source: https://www.eco-business.com/news/a-us200-billion-opportunity-in-southeast-asia-lies-in-solar-two-wheeler-evs-batteries-mckinsey-report

PASSENSOR CARS ARE NOT THE ONLY OPPORTUNITY

POWER THEM UP

Thailand's EV Production and Use Targets

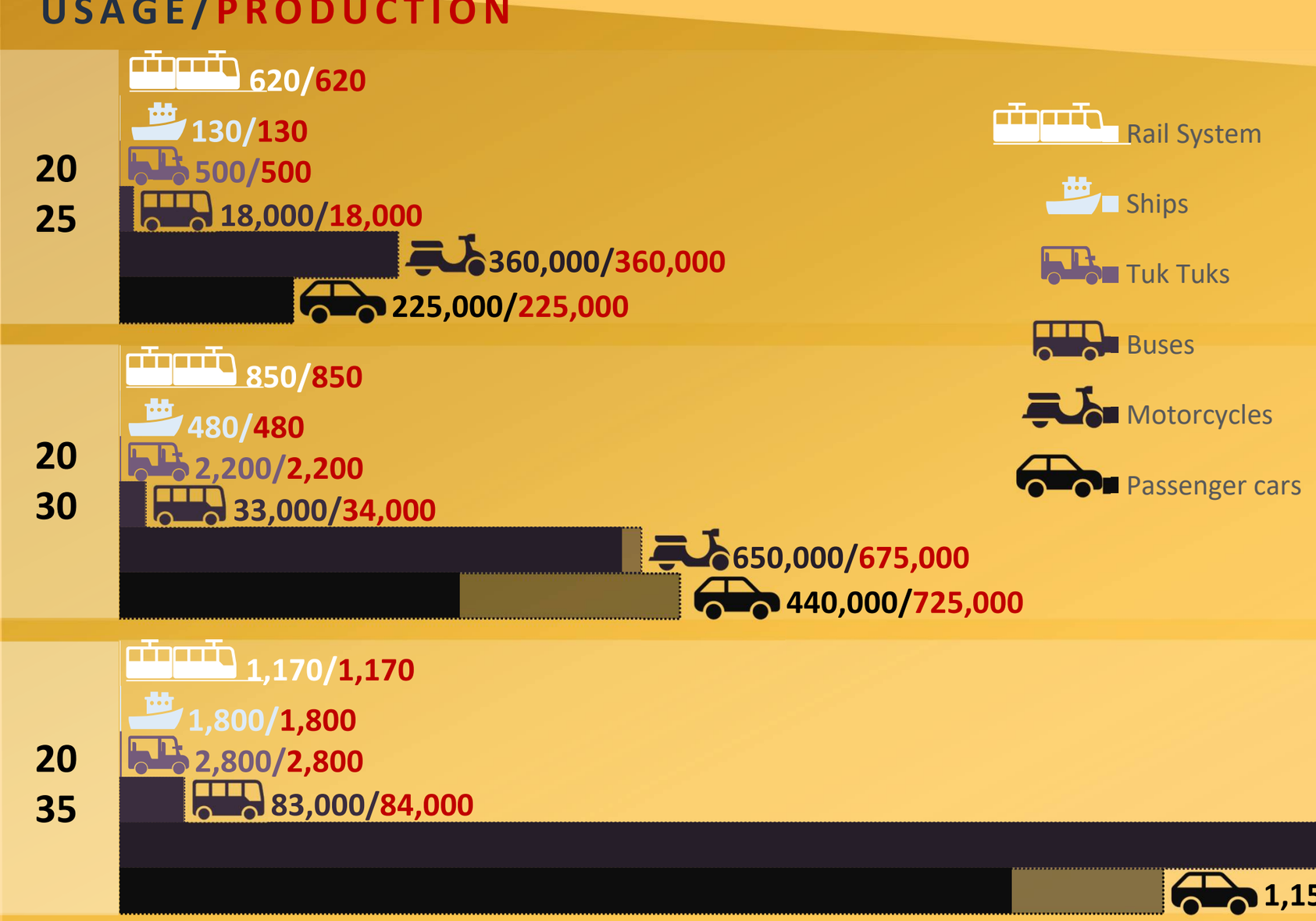
Target	Types of Veicles	2025	2030	2035
Use	Cars/pickup trucks	402,000	2,050,000	6,400,000
	Motorbikes	622,000	3,200,000	8,750,000
	Buses/trucks	31,000	160,000	430,000
	Total	**1,055,000**	**5,410,000**	**15,580,000**
Production	Cars/pickup trucks	400,000	2,935,000	8,625,000
	Motorbikes	620,000	3,133,000	9,330,000
	Buses/trucks	31,000	156,000	458,000
	Total	**1,051,000**	**6,224,000**	**18,413,000**

Source: Industry Ministry BANGKOK POST GRAPHICS

Source: BangkokPost March 25 2021

Thailand's ZEV 30@30 Target

TESTA
Thailand Energy Storage Technology Association



Target: Raise the proportion ZEVs to 30% of all domestic vehicle production by 2030

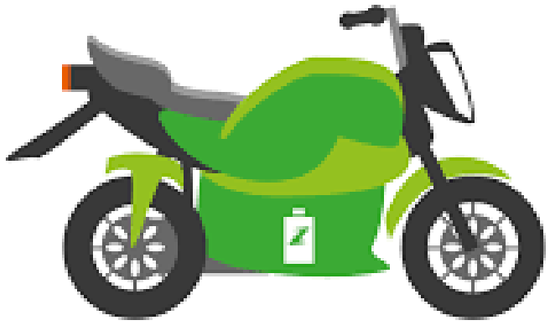
Milestone: By 2035, all new registered vehicles should be ZEVs

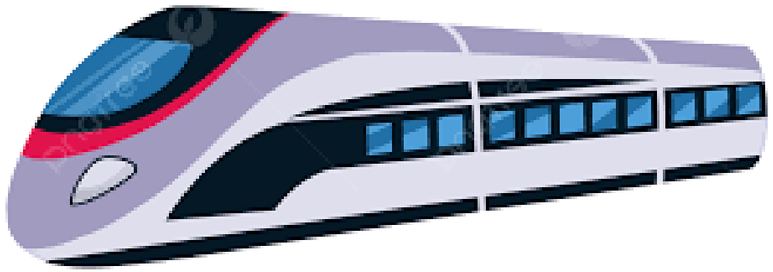
30%
of Production

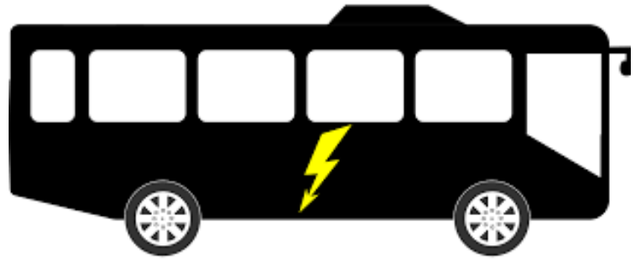
100%
of Usage

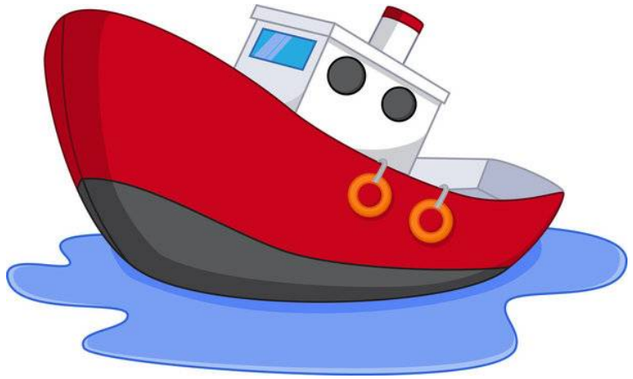
Source: National EV Policy Committee

PASSENSOR CARS ARE NOT THE ONLY OPPORTUNITY







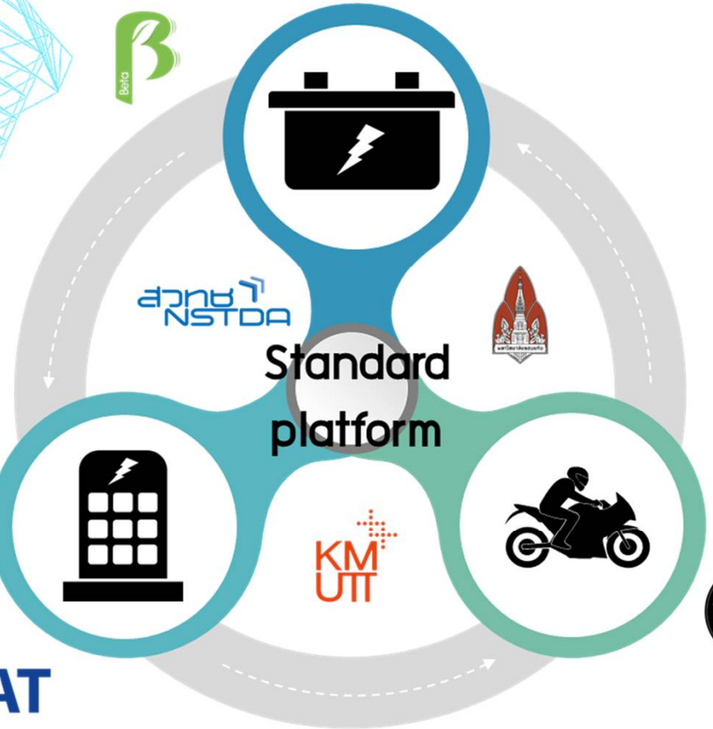


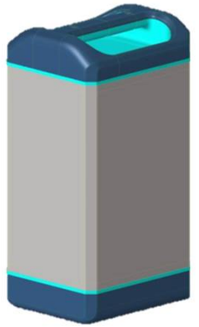
Source: https://www.eco-business.com/news/a-us200-billion-opportunity-in-southeast-asia-lies-in-solar-two-wheeler-evs-batteries-mckinsey-report

OPPORTUNITIES FOR EV & BATTERIES

Source: https://urbancreature.co/one-day-with-sira-leepipattanawit/

PASSENSOR CARS ARE NOT THE ONLY OPPORTUNITY





Item	Specification
Overall system	
Dimension W x L x H (mm)	145 x 180 x 340
Total Weight	TBD
Storage temperature	0-35‡C
Operating temperature	Charge: 0-45°C, Discharge: -20-60°C
1. Battery packs	
total number of cell	140
number of cell in series	20
number of cell in parallel	7
Cell specifications	HDCNR18650-2600-3.6V 2.6Ah
Connection	2 modules 7P10S in series (7P10S*2)
pack capacity (Ah)	18.2
pack nominal voltage (V)	72
pack minimum voltage (V)	55
pack maximum voltage (V)	84
pack Energy (kWh)	1.31
Normal discharging current (A)	18.2A (1C)
max cont. discharge current (A)	54.6A (3C)
max pulse discharge current (A), 20 seconds	72A (@ 20-100% SOC), 120 A (@40-100%C)
Normal charging current (A)	9.1A (C/2)
Max charging current (A)	18.2A (1C)
total cells weight (kg)	6.44
1. BMS	
Maximum continuous current	Discharge 150A Charge 75A
Connections	1 Centralized system
Cell balancing method	Passive
Cell balancing current	30 +/-5 mA @ cell voltage >3.8V
Cell balancing guarantee voltage	Δ Vcell ≤ 50 mV
Rated supply voltage	No (ใช้พลังงานจากแบตเตอรี่เท่านั้น)

100 KM
3 KW

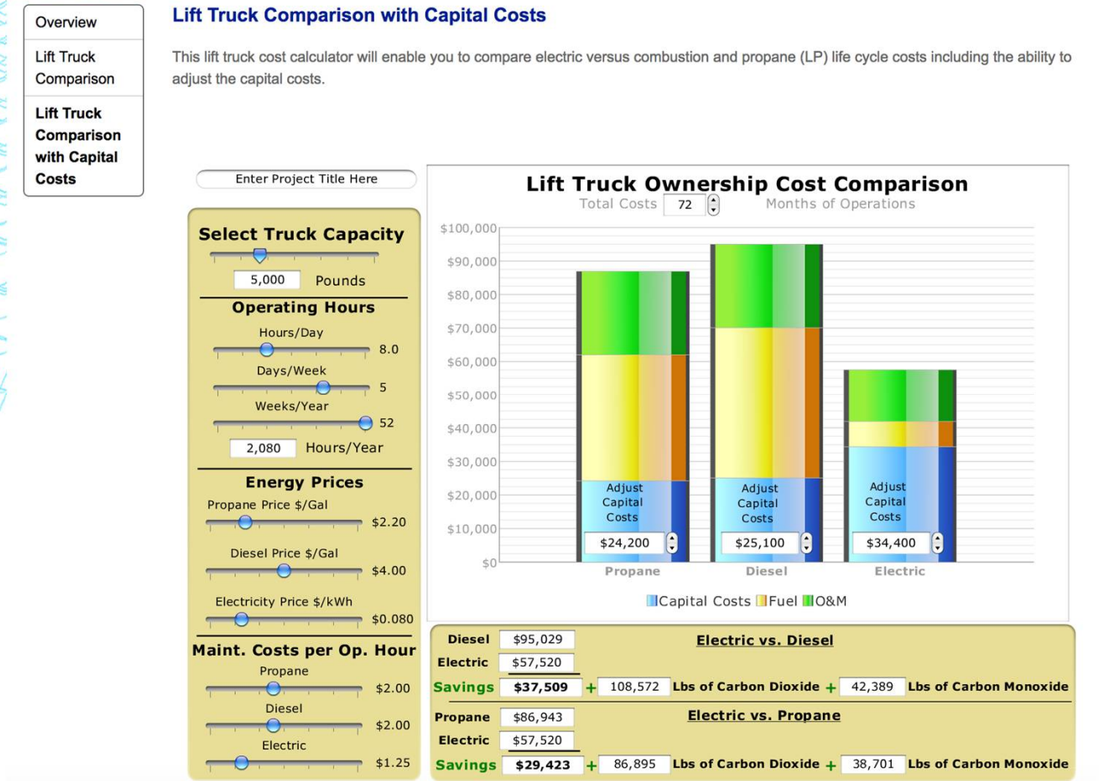
100 KM
4 KW

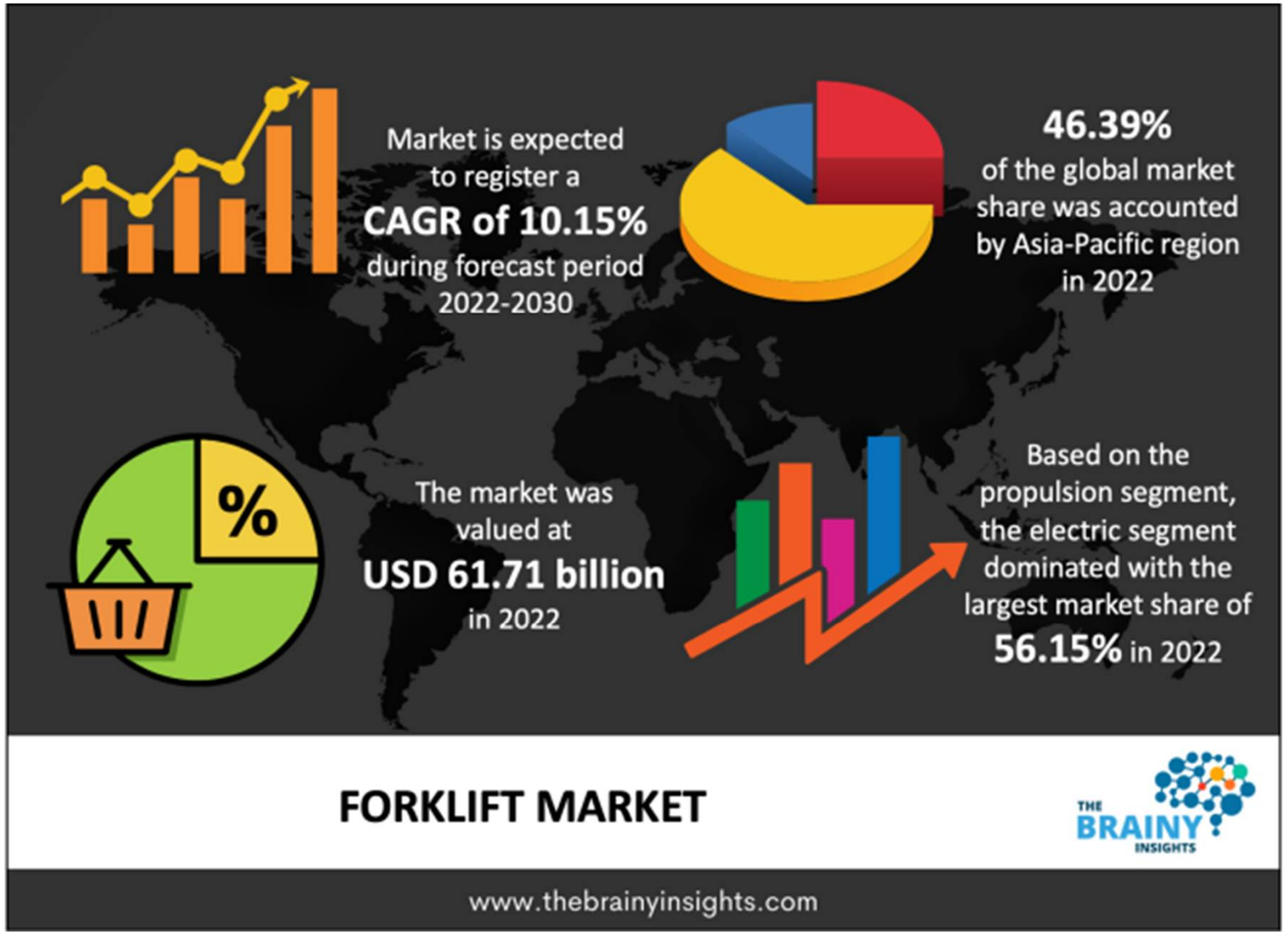
- A collaborative project between research institute, universities, battery pack producer, E-motorcycle producers and charging service providers
- Target to create standardized battery packs which can be used in various motorcycle providers, and charging operators

Source: https://www.eco-business.com/news/a-us200-billion-opportunity-in-southeast-asia-lies-in-solar-two-wheeler-evs-batteries-mckinsey-report

OTHER MARKET EXAMPLE: Forklift

- Global market = 61.71 Billion USD in 2022; CAGR of 10.15% (2022-2030)
- 46.39% in Asia Pacific (2022)
- 56.15% Electric (2022)

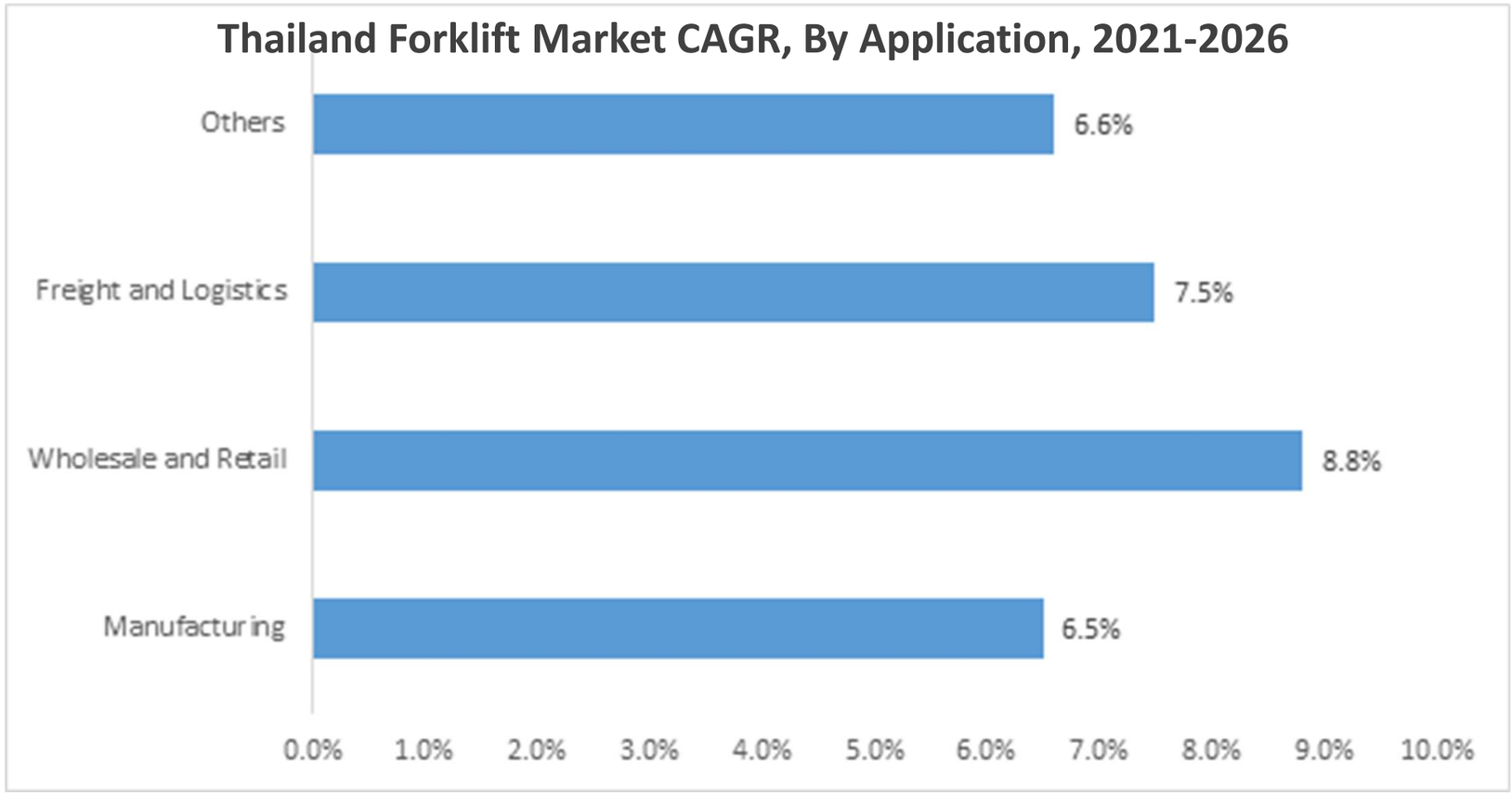




Source: https://www.thebrainyinsights.com/report/forklift-market-13025; https://www.lantech.com/understanding-forklift-costs-capital-maintenance-and-fuel/

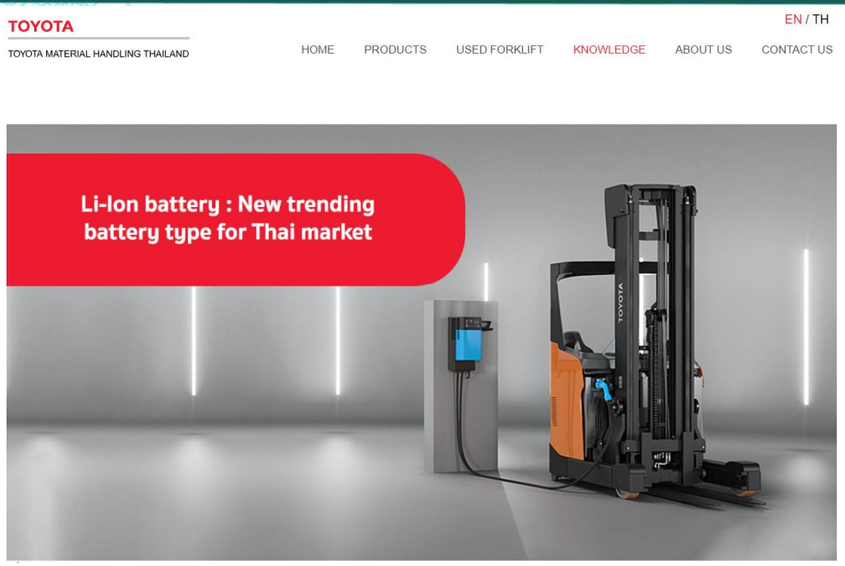
OTHER MARKET EXAMPLE: Forklift

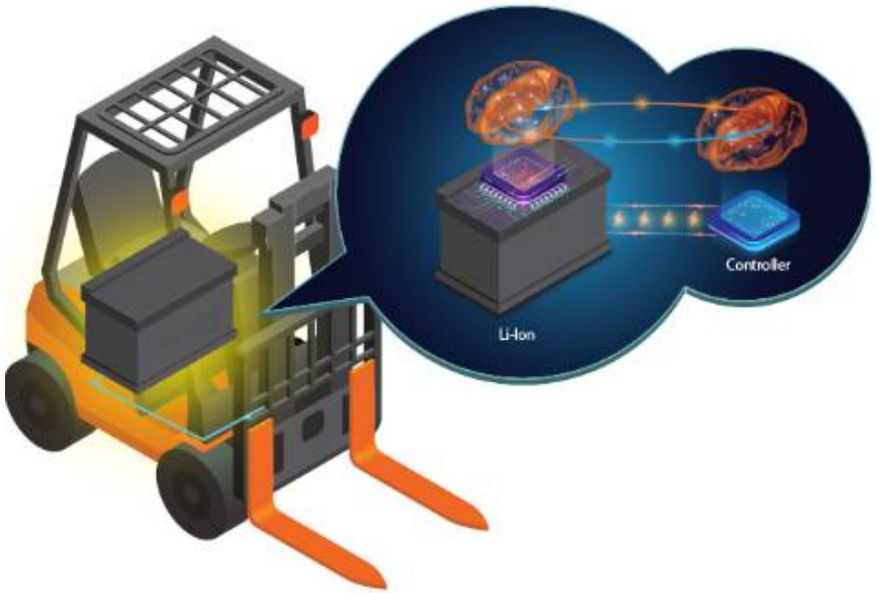
- Thailand Forklift Market driven by e- commerce segment and advanced logistics and environment
- CAGR of 7.2% (2021-2026)
- $341 M by 2026
- Seeing a trend in switch from Pb-acid to Li-ion batteries



Source: https://www.industryarc.com/Report/19151/thailand-forklift-market

OTHER MARKET : Forklift





BENEFITS

COST REDUCTIONS
– 3 times longer lifecycle than a lead-acid battery

MAINTENANCE FREE
– No watering
– No special charging rooms or space for spare batteries

EFFICIENT OPERATIONS
– Improved charging efficiency for reduced energy costs
– Quick recharge during breaks
– No need for battery swapping
– Suitable for intense operations; single & multi shifts

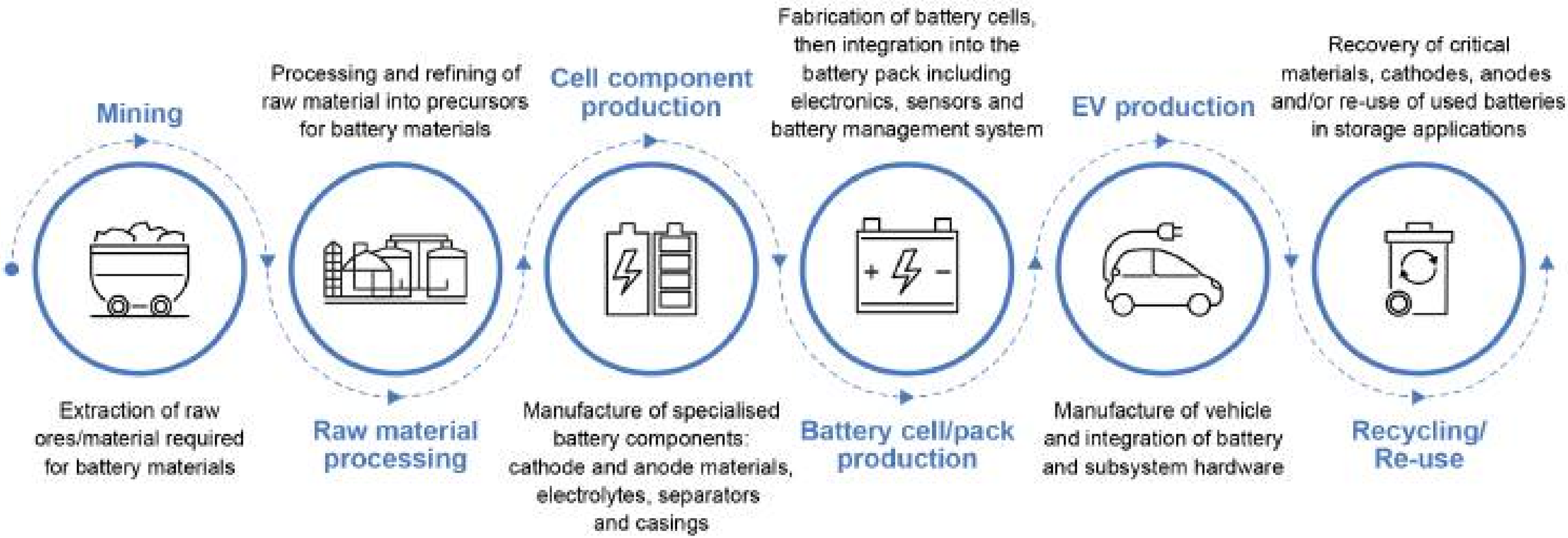
CLEAN WORK ENVIRONMENT
– No hazardous gases or exposure to acids

Customer's Case

Segment : Food & Beverage
Working Hours : 24 Hours (3 Shifts)
Level of Operation : Intense
Length of Use : 2 Years

https://toyota-material-handling.co.th/en/li-ion-battery-new-trending-battery-type-for-thai-market/

BATTERY VALUE CHAIN

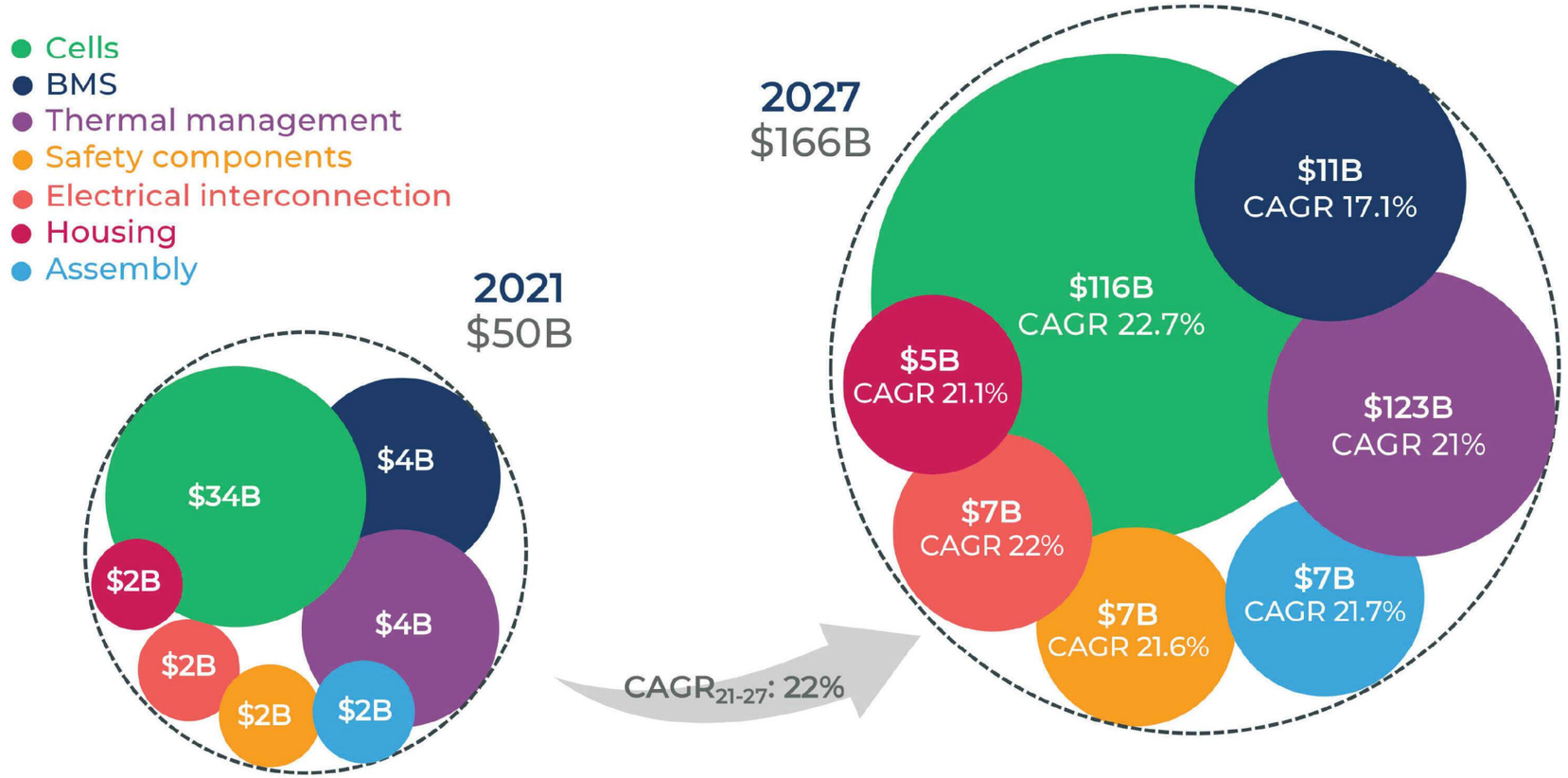


IEA Global Supply Chain of EV Batteries 2022

COMPONENT VALUES – BATTERY PACK

2021 – 2027 BATTERY PACK MARKET VALUE IN $B – SPLIT BY PACK COMPONENTS

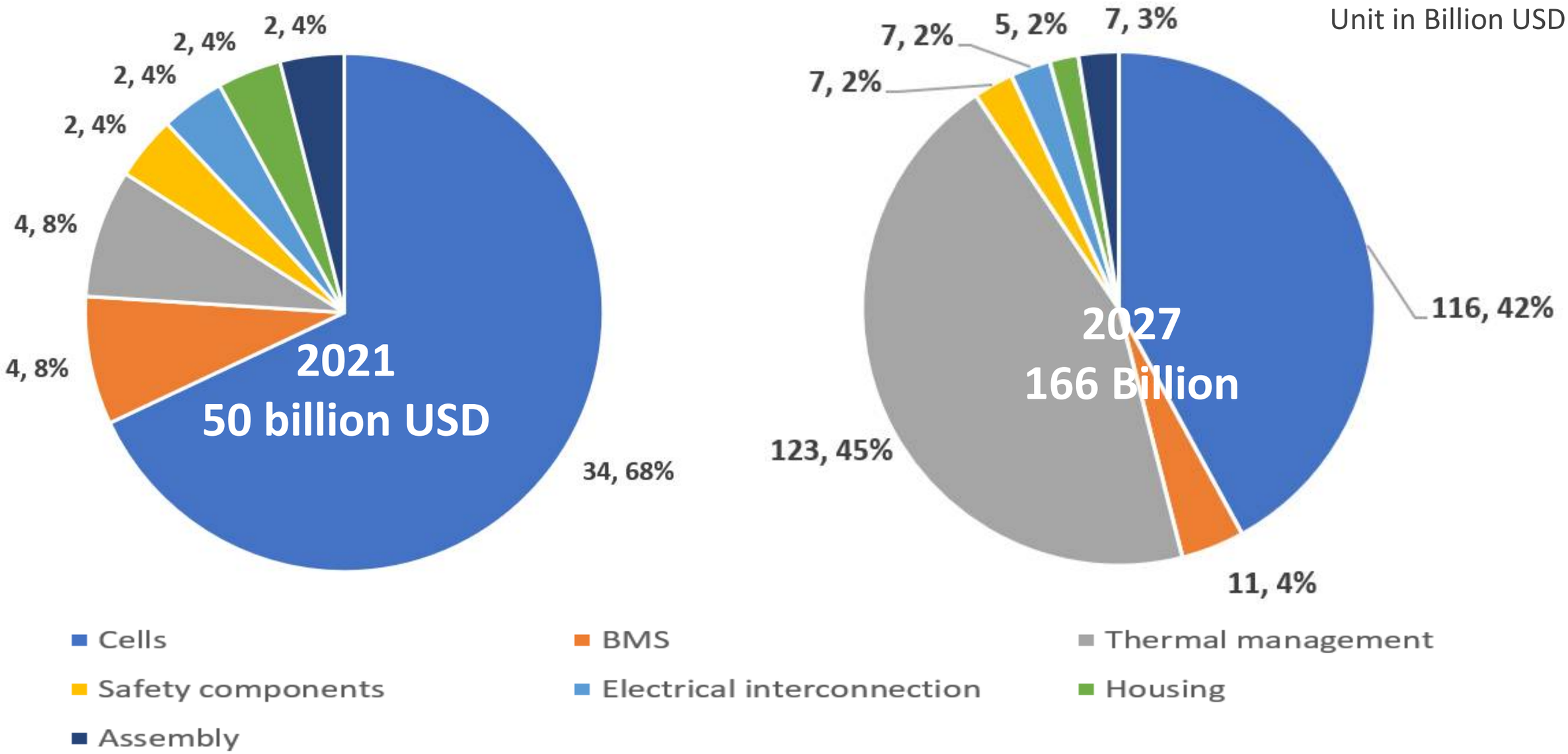
Source: Battery pack for Automotive, e-buses and e-trucks 2022 report, Yole Intelligence, 2022



Source: Yole Nov 2022, https://www.yolegroup.com/press-release/automotive-battery-pack-attractions-improvements/

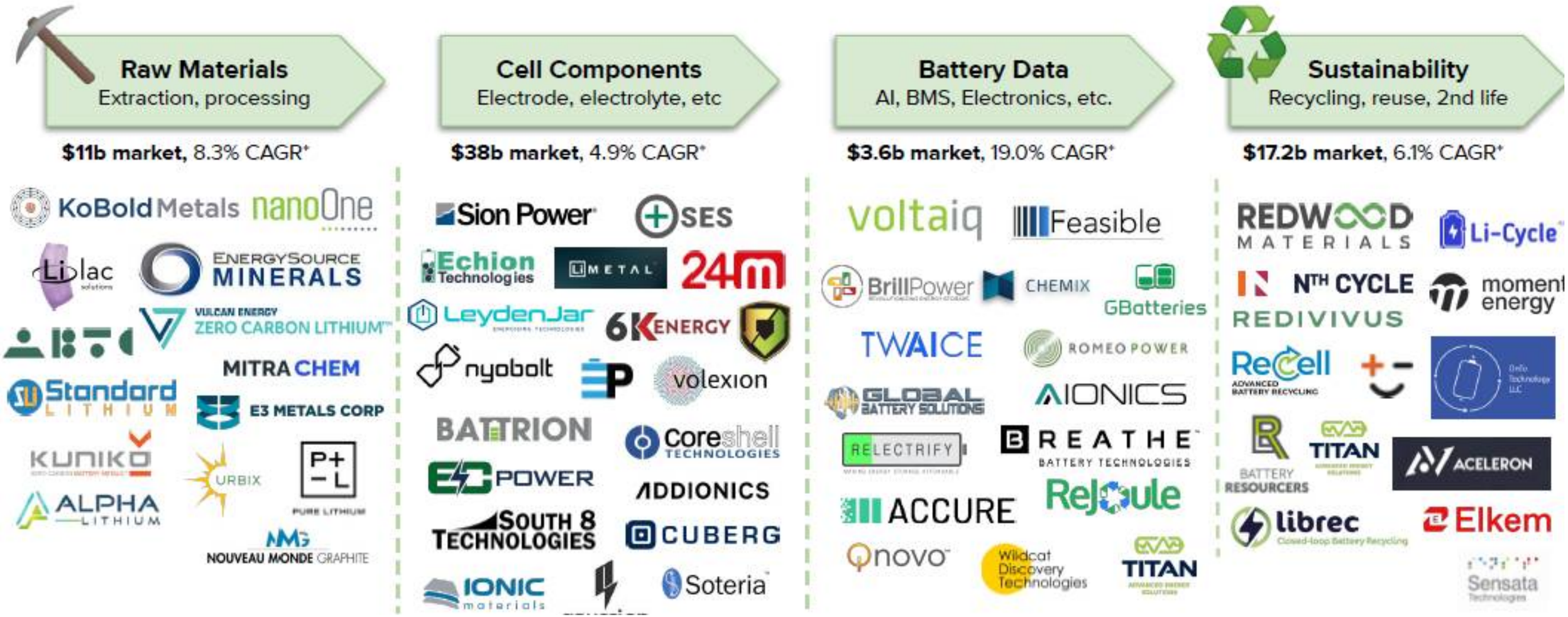
www.yolegroup.com | ©Yole Intelligence 2022

COMPONENT VALUES – BATTERY PACK



Source: Plotted from Yole Nov 2022, https://www.yolegroup.com/press-release/automotive-battery-pack-attractions-improvements/

OTHER OPPORTUNITIES IN VALUE CHAIN

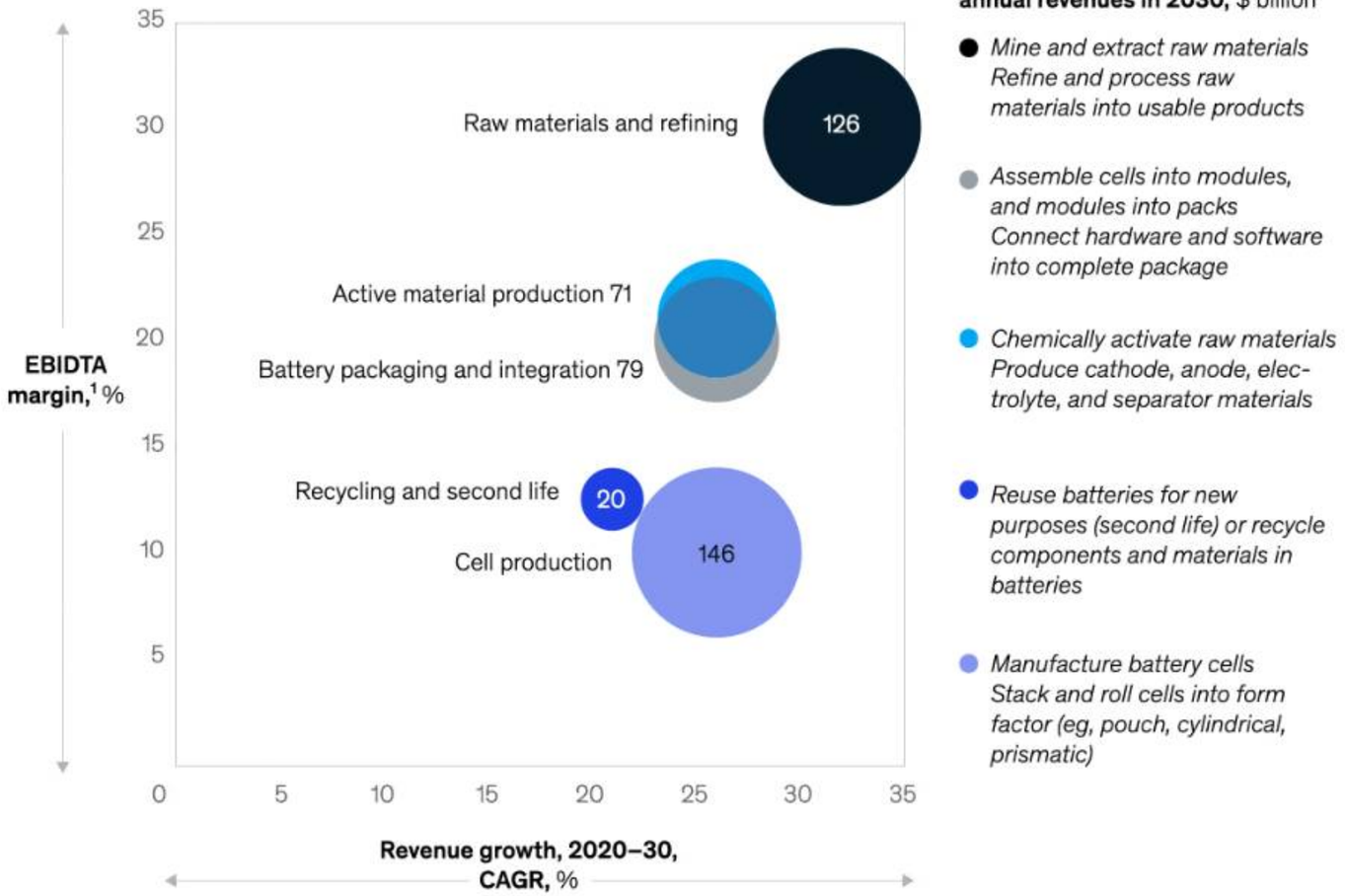


IEA Global Supply Chain of EV Batteries 2022

OTHER OPPORTUNITIES

All aspects of the battery value chain are expected to grow rapidly through 2030.

Growth in revenue and margin for battery value chain



[1]Based on 2020 EBITDA figures for select companies in value chain step. High volatility seen in recent years because of surging demand, making estimates of long-term margins uncertain.
Source: McKinsey analysis

- Cell production maybe important and whole the largest value
- BUT other opportunities also lie in the value chain w/ higher margin: pack management and component manufacturing, sustainability & recycling + testing and manufacturing equipments

Source: Source: https://www.mckinsey.com/featured-insights/sustainable-inclusive-growth/chart-of-the-day/battery-boom

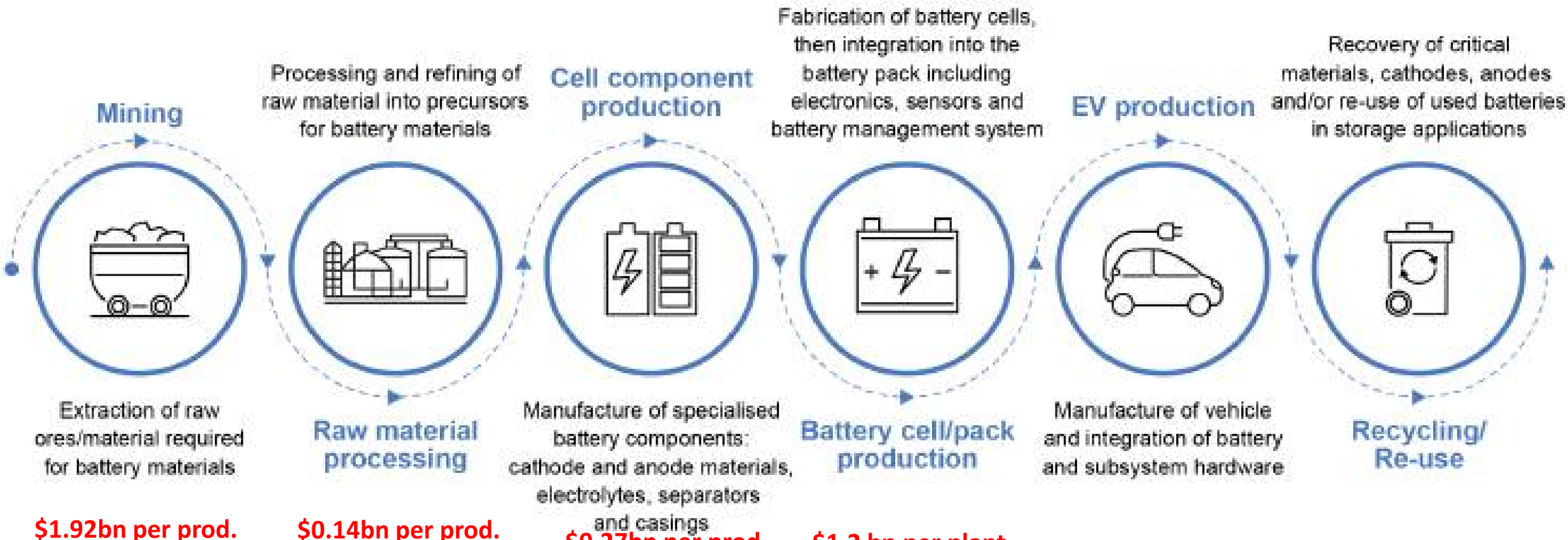
BATTERY VALUE CHAIN

CAGR 21.3%

Manufacturing Equipment

Testing Equipment

CAGR 4.7%



$1.92bn per prod. **$0.14bn per prod.** **$0.27bn per prod.** **$1.2 bn per plant**

IEA Global Supply Chain of EV Batteries 2022, https://www.mordorintelligence.com/industry-reports/battery-testing-and-inspection-equipment-market

https://www.businessresearchinsights.com/market-reports/lithium-battery-manufacturing-equipment-market-102938#:~:text=Lithium%20Battery%20Manufacturing%20Equipment%20Market%20Report%20Overview&text=The%20global%20lithium%20battery%20manufacturing,21.3%25%20during%20the%20forecasting%20period.

SUMMARY

- BATTERY will become an important part of the automotive industries taking up > 30% of the value of a vehicle
- Everywhere in the world is trying to capture the values along the battery value chain
- Opportunities NOT in just the cell and vehicle production BUT also battery pack components, management, recycling and raw materials processing.
- Thailand should explore the opportunities in the certain niche auto-market and along the value chain due to the already underlying good geography, fundamental infrastructure, and background in such industries.
- Support needs include demand creation, tax holidays. HR development support. low interest loan, monetary incentives, supply chain partner engagements.