

Key Factors of the Power Battery Development in 2013 : E-Motorcycle & EV

2013 EV Market Trends Seminar

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Outline

E-Motorcycle Battery Demand and Supply

- E-bikes
- Pedelec
- E-scooter

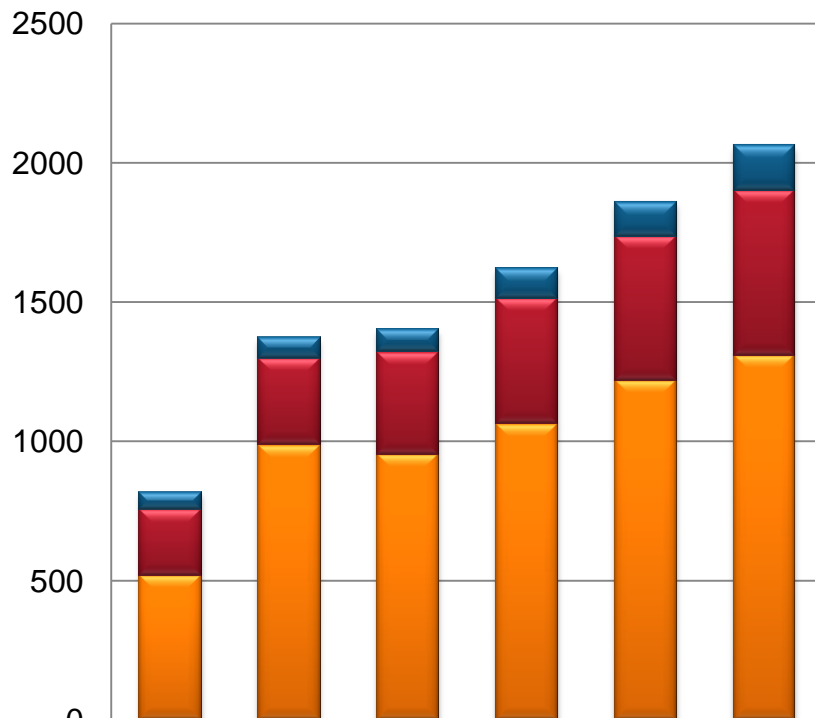
xEV Battery Recent Development

Conclusions

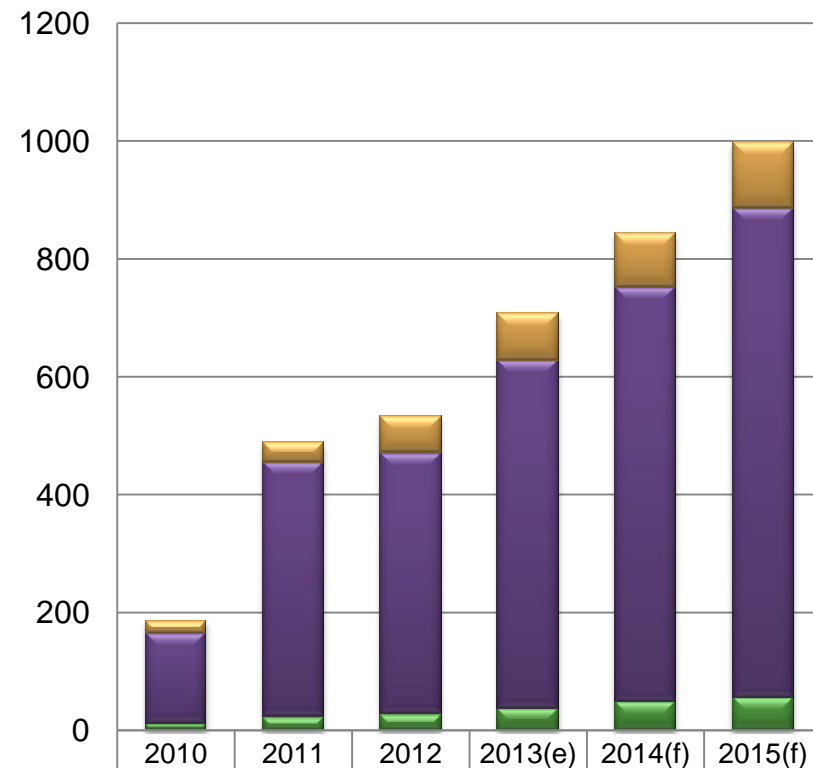
Electrification of Engine-type Motorcycles is Making Rapid Progress

- ❑ LIB shipment capacity for E-Motorcycles in 2012 was 1,401MWh
- ❑ E-buses and E-trucks was 533MWh
- ❑ China is the biggest market for E-bus. The pace of expansion in the E-truck market is not rising.

MWh/Year



■ E-Scooter	63	73	81	107	125	164
■ E-Pedelec	237	311	368	452	519	591
■ E-Bike	518	987	952	1062	1216	1308



■ E-Truck	22	35	62	80	93	111
■ E-Bus China	153	431	444	589	702	830
■ E-Bus	11	23	27	38	49	56

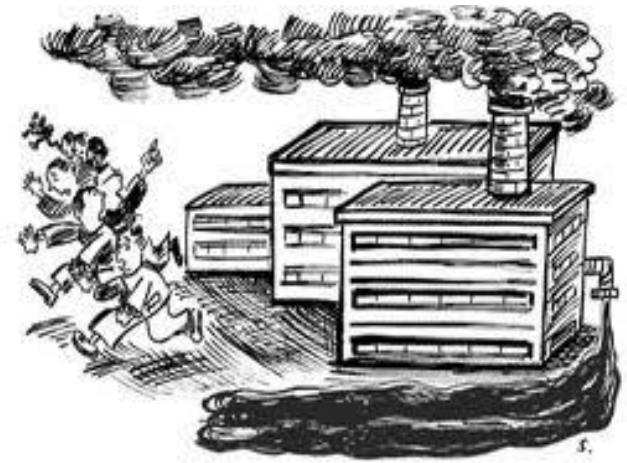
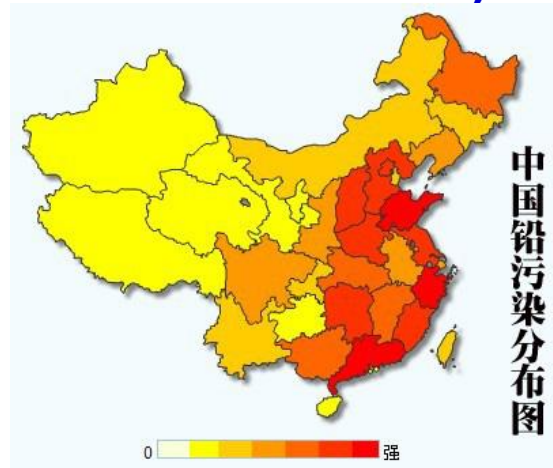
Over 95% E-Motorcycle Market belongs E-bike

- ❑ E-Motorcycles can be divided into 3 products:
- ❑ E-bikes are almost all produced in China, and do not require driving license.
- ❑ Pedelec (Pedal Electric Bicycles) use a motor to supplement the power of the rider.
- ❑ E-scooters require a driving license and have higher motor output.
- ❑ Total shipments of these three types in CY12 more than 35 million units, over 95% were E-bikes.

分類	主要特性	電池主要需求				
		24V	36V	48V	60V	電容量(Wh)
Pedelec 	以電力輔助人力踏行運作 →人力為主；電力為輔 (具踏板可踩踏前進) 最高時速25km以下 車重40kg以下	◎				100~600
E-bike 	可完全切換由電力為運作主體 最高時速25km以下 車重60kg以下		◎	◎	◎	300~600
E-scooter 	最大輸出馬力1.34~5HP 馬達功率超過600W 最高時速需低於45km			◎	◎	500以上

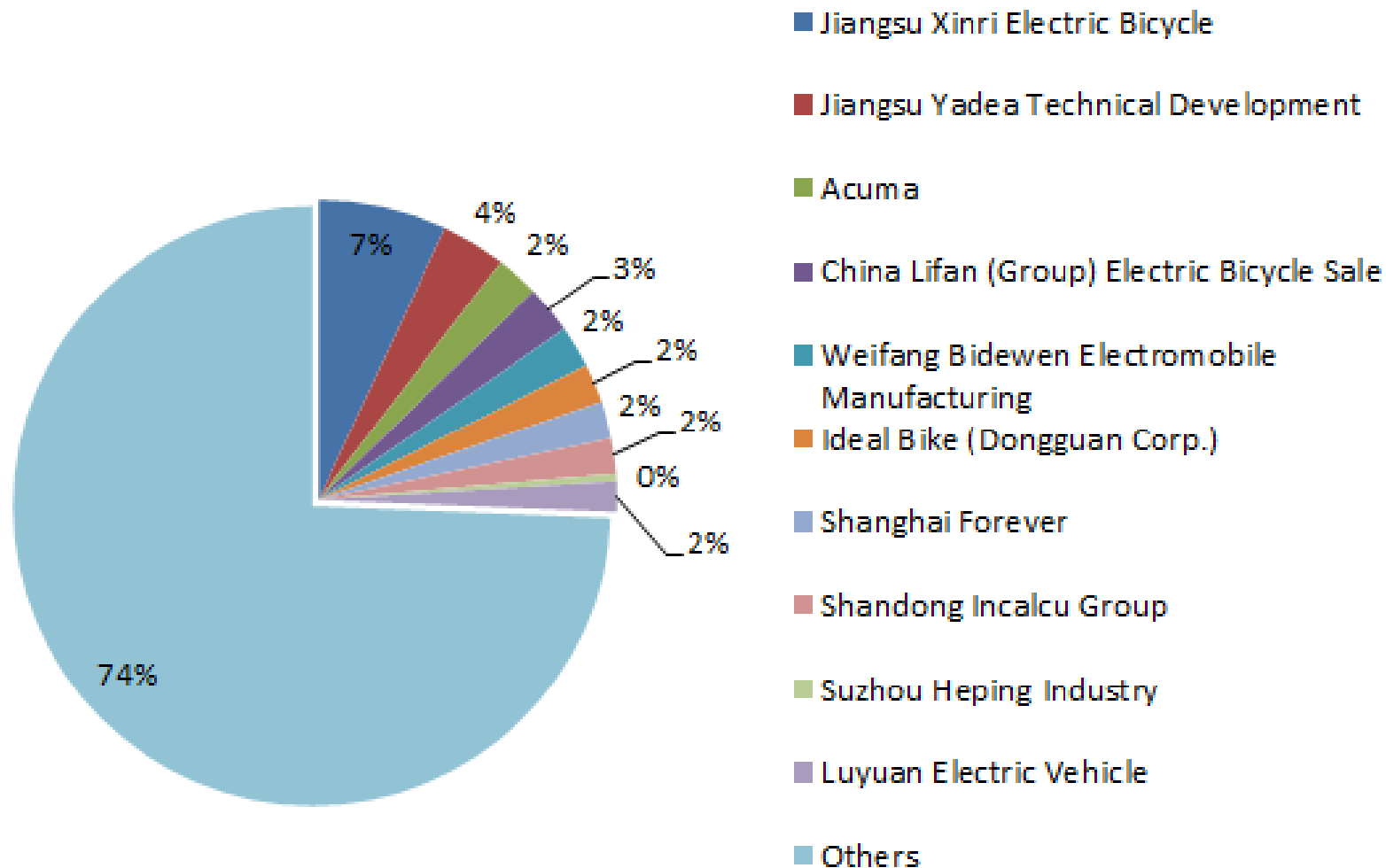
Chinese E-bikes Continue to Use Lead-acid Battery

- ❑ Users would like to switch if they had enough income, so all they want from E-bike is the price.
- ❑ The chances to replace to LIB are to set prices that undercut lead-acid battery, or wait for lead-acid battery to be affected by production restrictions or price rises.
- ❑ From 2011, 1,600 small and medium manufacturers of lead-acid battery have been ordered to suspend operations or close.
- The State Administration of Taxation and the Ministry of Finance are planning to introduce a 5% tax on lead-acid battery (taxation on a 48V, 12Ah lead acid battery is expected to be 15-20RMB).



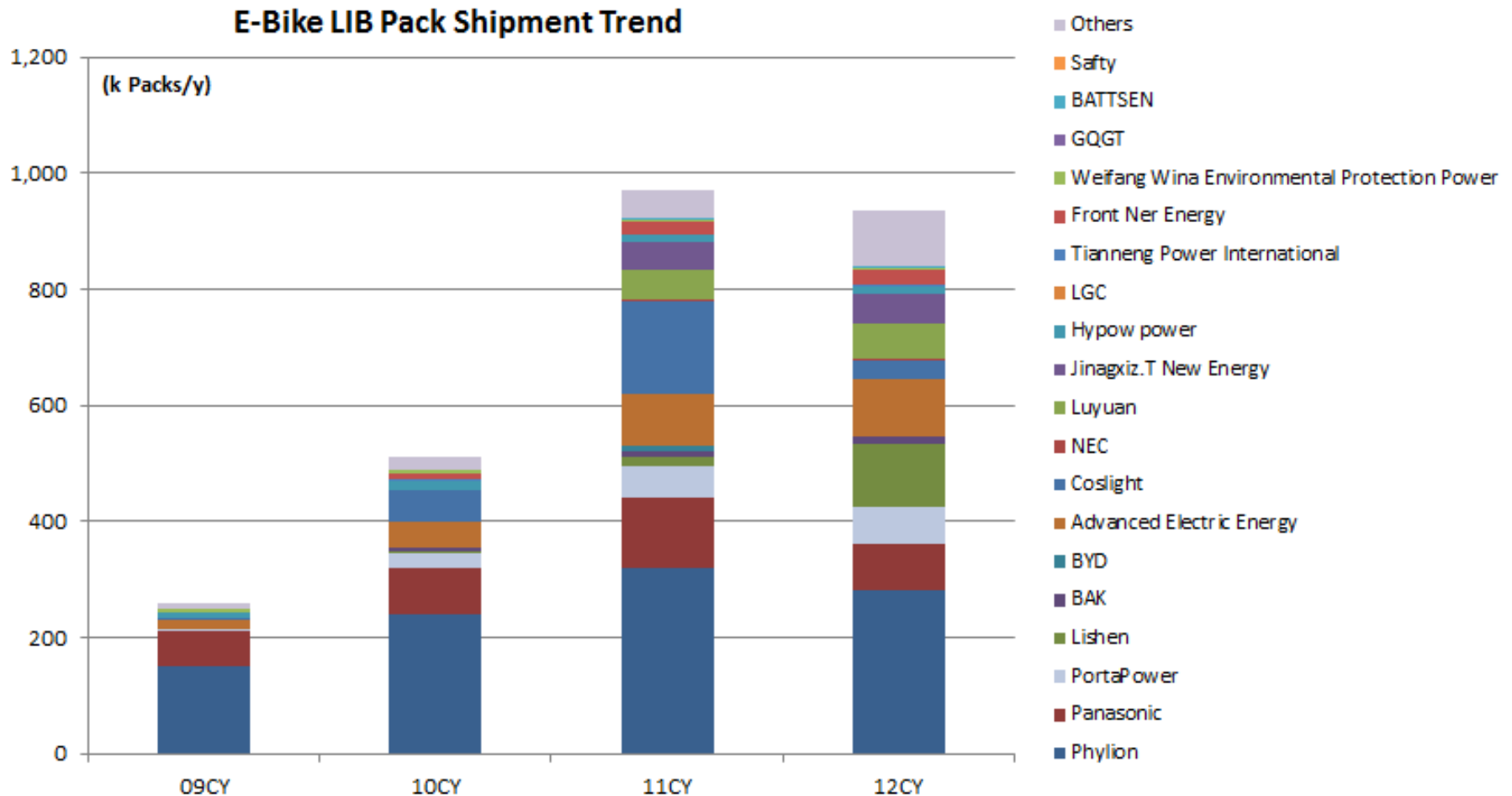
E-Bike Shipment almost a “Perfect Competition”

- The share for the top 10 is approximately 25%.
- 700+ E-bike manufacturers
- Jiangsu Xinri Electric Bicycle, the top manufacturer, shipped 2.2M units.



Just 3% Use LIB for E-Bike

- Around 950k packs were shipped in CY12.
- Phylion are keeping the top share, but Lishen are increasing supplies to local Chinese manufacturers
- Of around 33M E-bikes produced, approximately 2.9% used LIB in CY12.



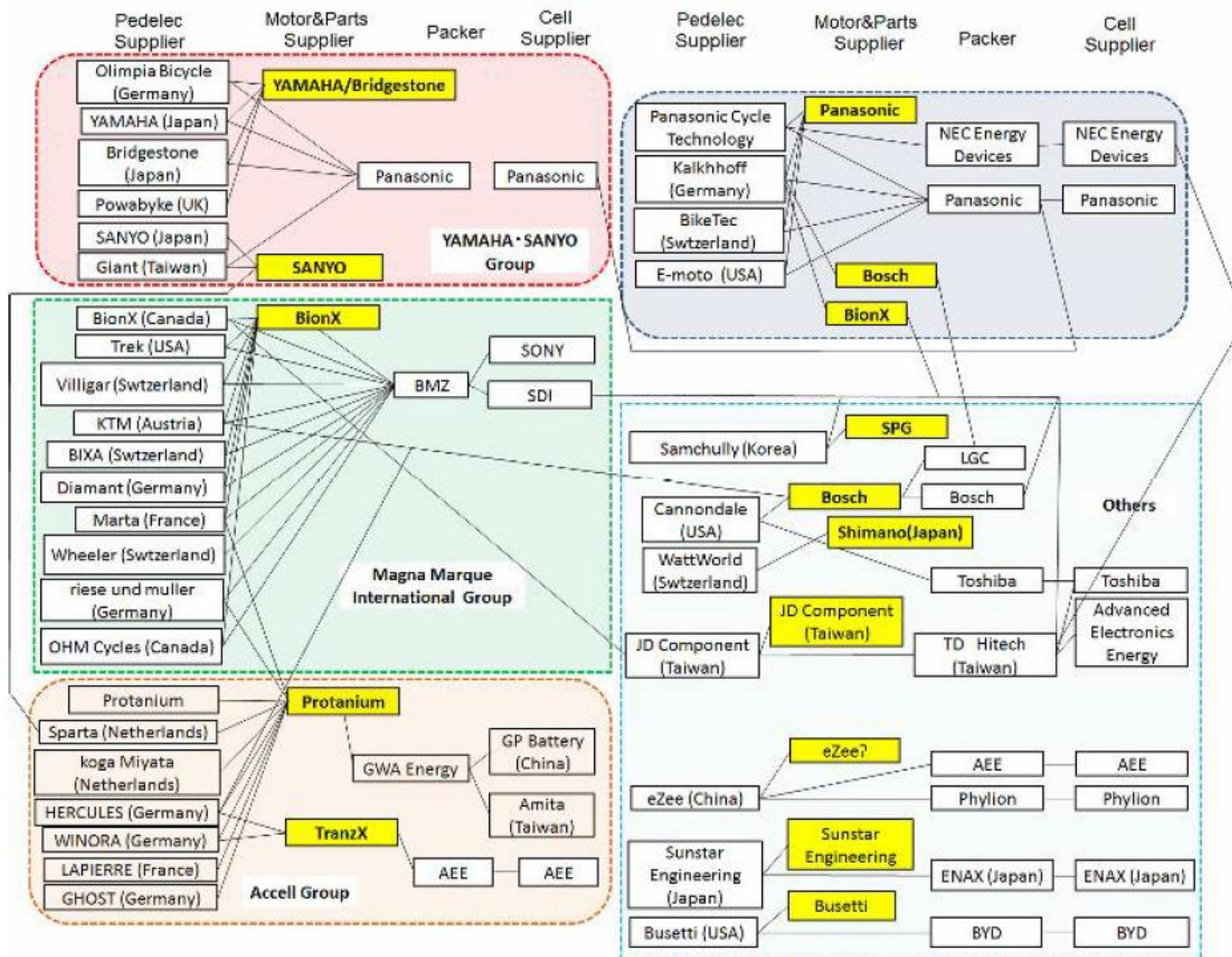
Pedelec Shipments Growth was Slow in CY12

- Market remains limited to Japan and Europe, but Europe is rising.
- The average capacity in Japan exceeded 8Ah in CY12
- In Europe, the average has exceeded 10Ah.
- 25.2V for a 7-cell series pack in Japan
- 36V for a 10-cell series pack in Europe.
- Rapid shift from 2.2Ah to 2.6Ah 18650 cy-cells

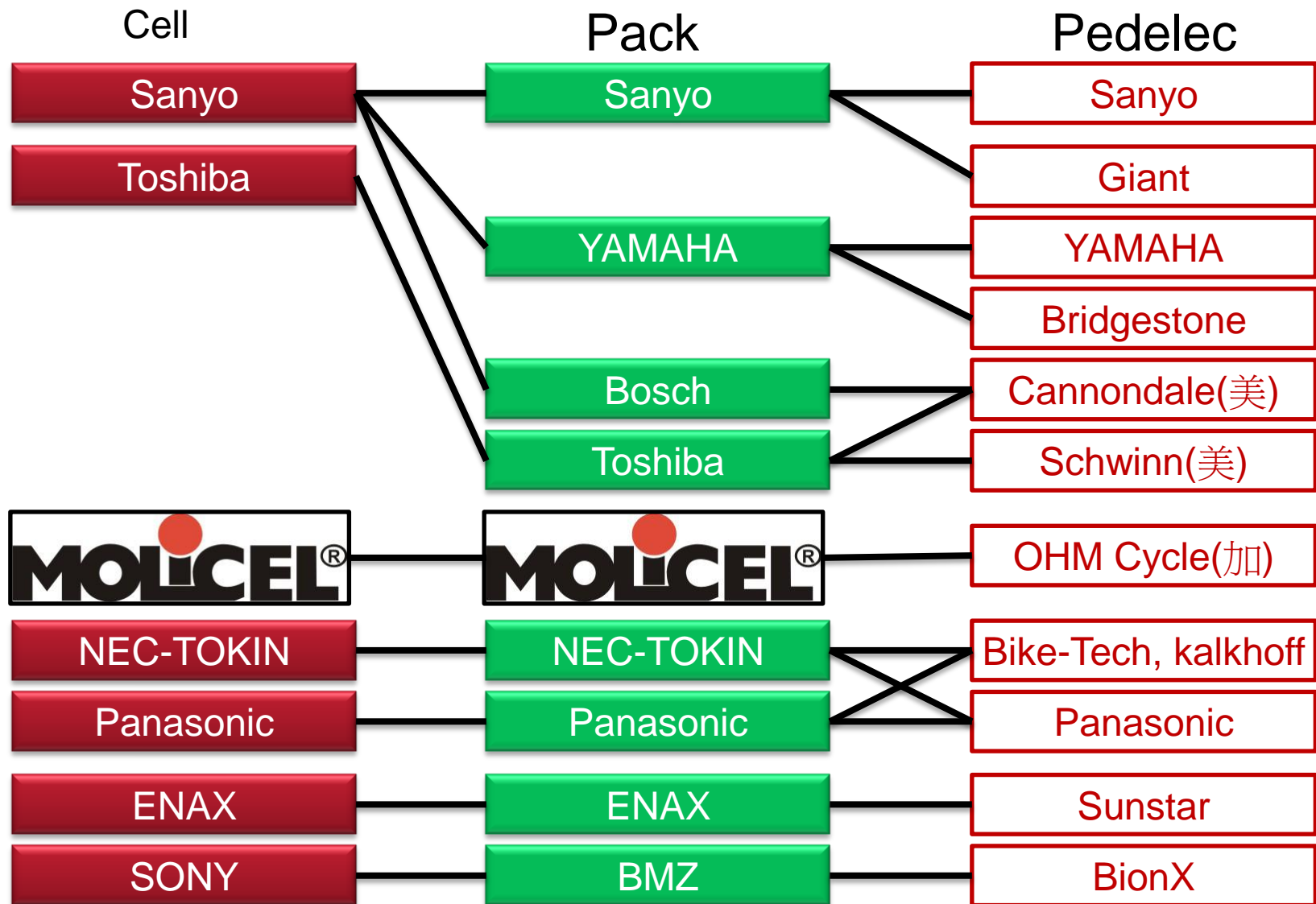


Cell Maker can Directly Provide Service

- Cell maker can direct provide for pack: increase the profit rate and uniform all the R&D activities

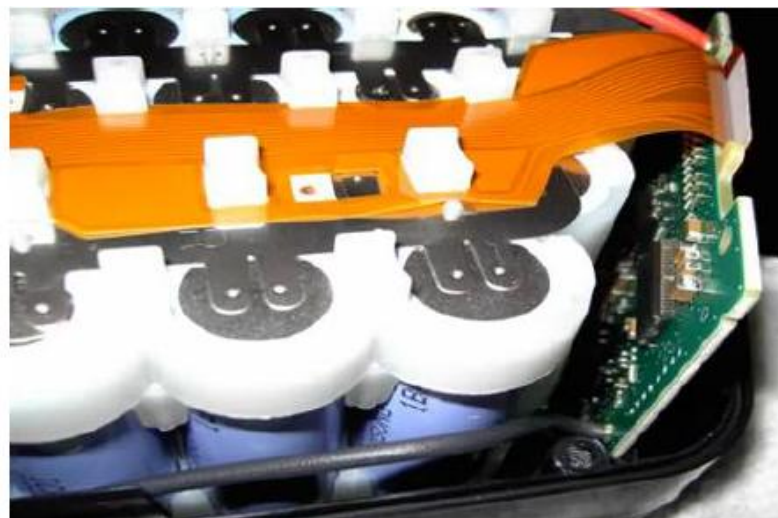
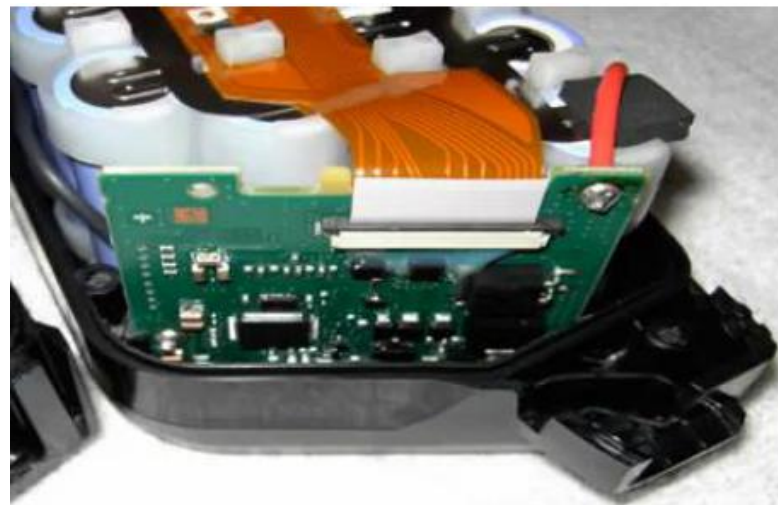


Main Supply Chain for Pedelec



Bosch Battery Pack for a Pedelec

- Bosch battery pack for a Pedelec.
- SDI and LGC supply cells to Bosch.



Summary of LIB Pedelec Pack for Yamaha



Application	Pedelec	YAMAHA
Li-ion battery	Product code	X73-21
	Capacity	5.7Ah (7S3P)
	Nominal Voltage	25.2V
	Cell	SANYO (18650 Cylindrical) 1.9Ah
BMS board	Size	55(H) × 140(W) mm



防水対策: セルはビニールで覆い, BMS基板は樹脂モールド



Cell Label: R1112



BMS for Gas gauge, Temperature Monitor

Panasonic Cycle Technology for E-bike/Pedelec

Part		Pack : Sanyo
LIB	Capacity	11.4Ah · 25.2V
	Single cell	1.9Ah · 7S6P
		Sanyo 18650Cy
BMS	Size	58*137mm
	Block	五階機能GG
		μP monitors : RENESAS
		AFE(analog front end) : Sanyo Semiconductors

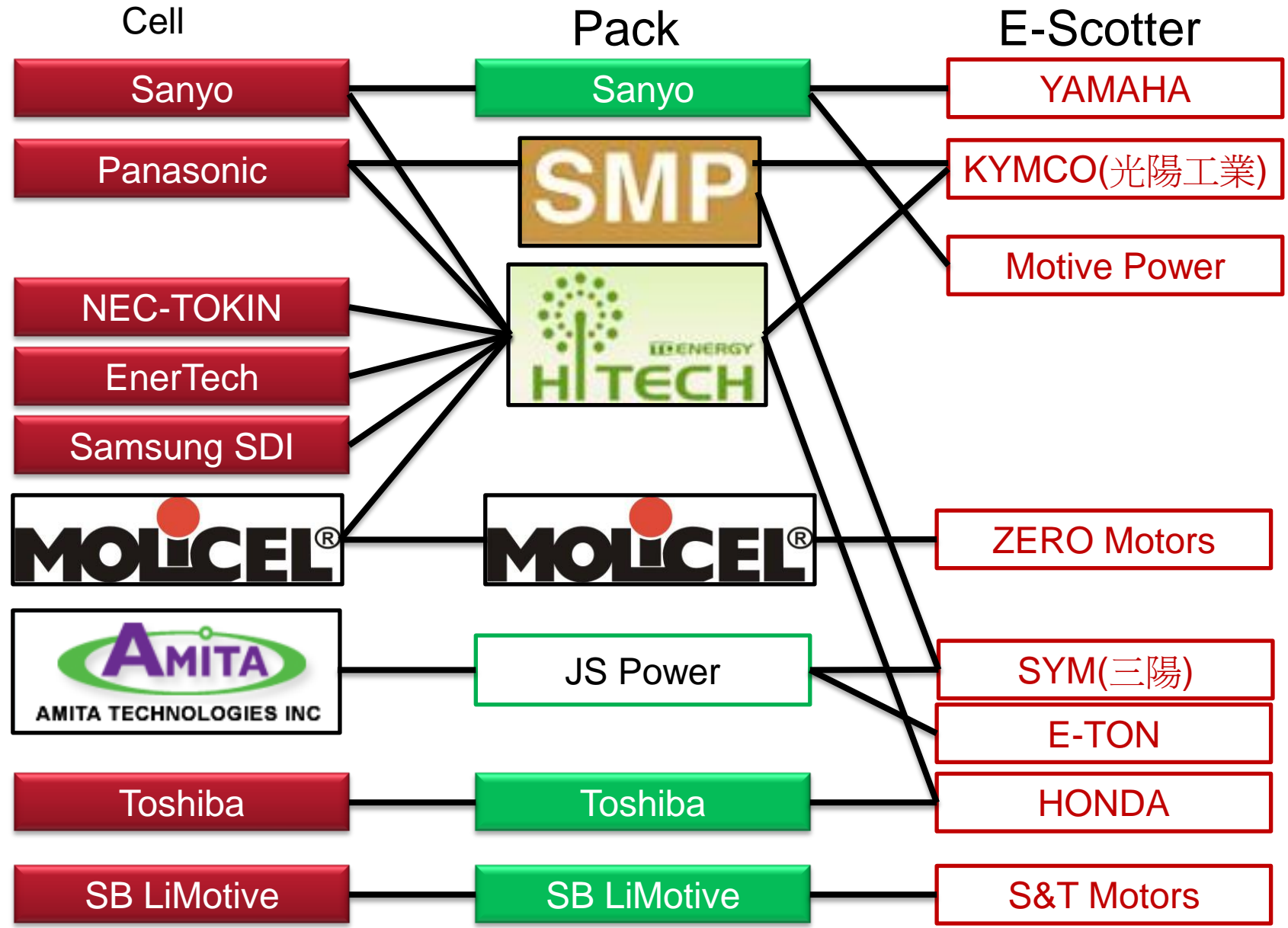


BMS Circuit Board

- ❑ Panasonic Cycle Technology : Sanyo 、 NEC Energy Device cell

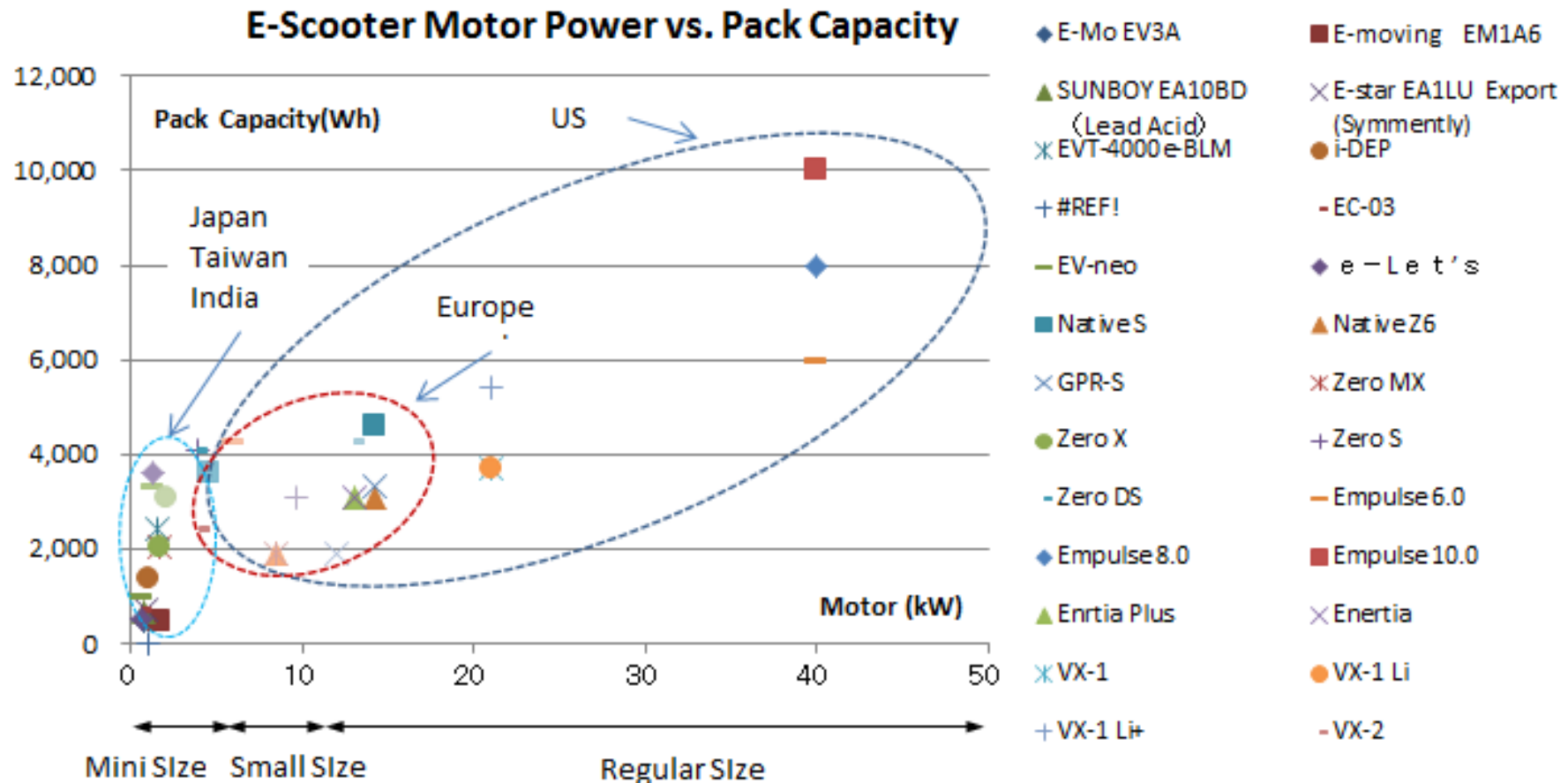


E-Scotter Main Player Supply Chain



E-scooters Around 30,000 units shipped worldwide in 2012

- Low-power motors are the mainstream in Japan and Taiwan
- American products have high motor power. While the markets are small, the E-scooters demanded in each country are completely different



Sanyo DCV-101 Standardize Pack



14S6P

Pack需求內容齊備

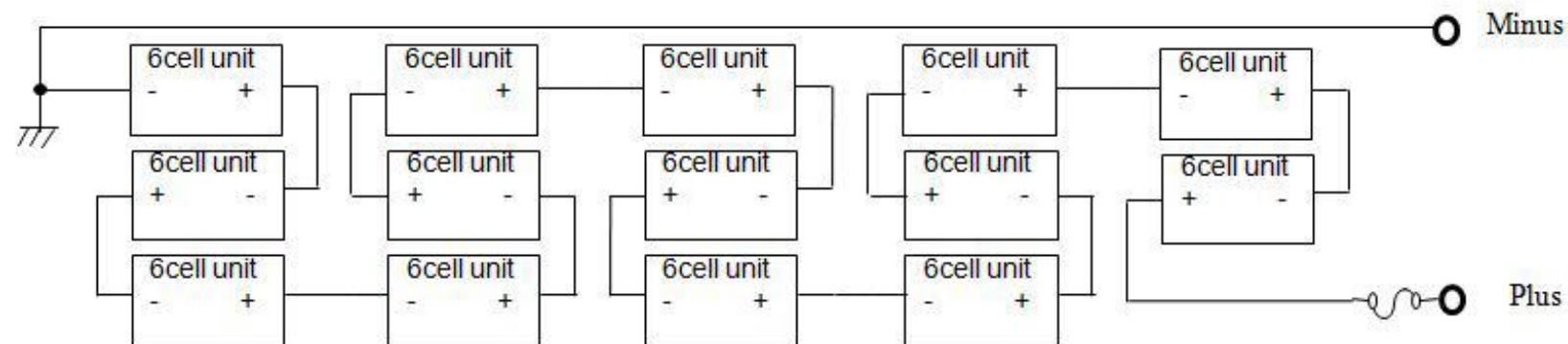
Voltage detection

2nd protection

charge/discharge current
monitoring, temperature

Detection

CAN communications

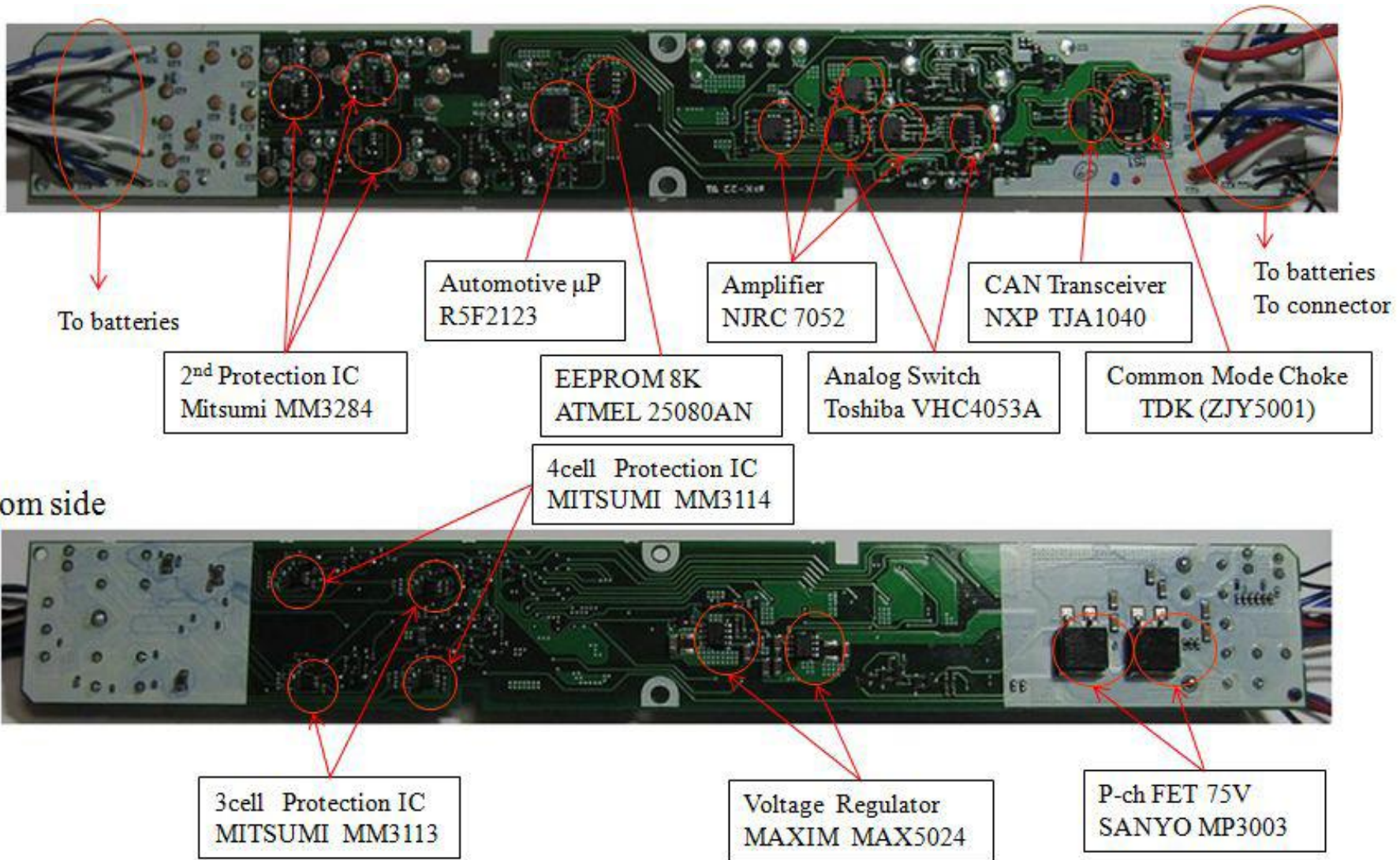


❑ Total production cost : NTD\$11,100

❑ Capacity : 0.544kWh

❑ NTD\$20.4/Wh

BMS- Sanyo DCV-101



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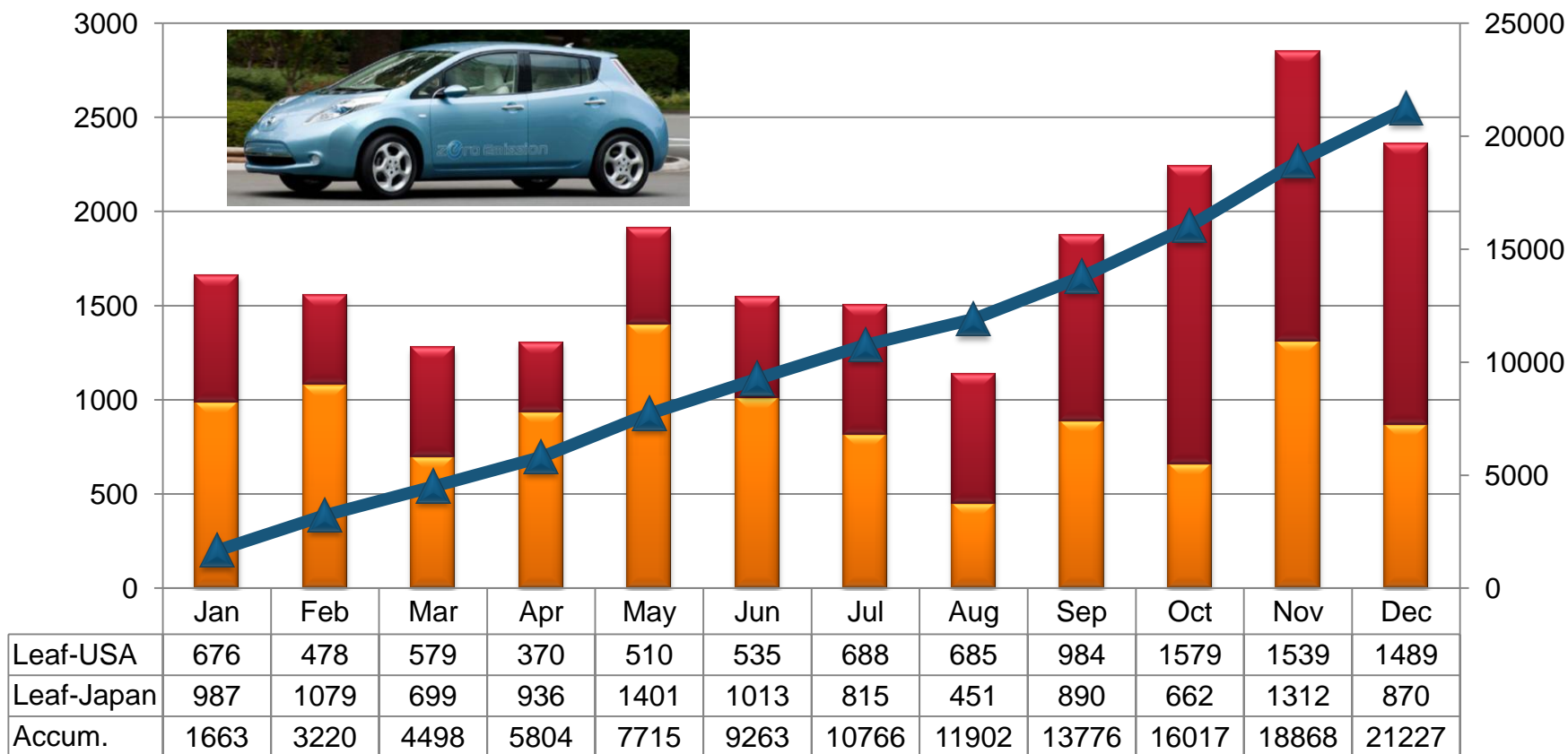
Conclusions

EV Market is Slow. Should be Turn Back in Reality


































- ❑ HEV has longer developing timeline, accumulated more know-how
- ❑ PHEV/BEV are in the beginning stage to promote, still have smoothly growing
- ❑ 「 Pessimistic viewpoint 」 ?! 「 Realistic viewpoint 」 !
- ❑ Compare with the IT battery Wh usage, total xEV market =11%, AESC=5%!

2012 Nissan Leaf BEV Shipment in JP/USA

Leaf-Japan Leaf-USA Accum.



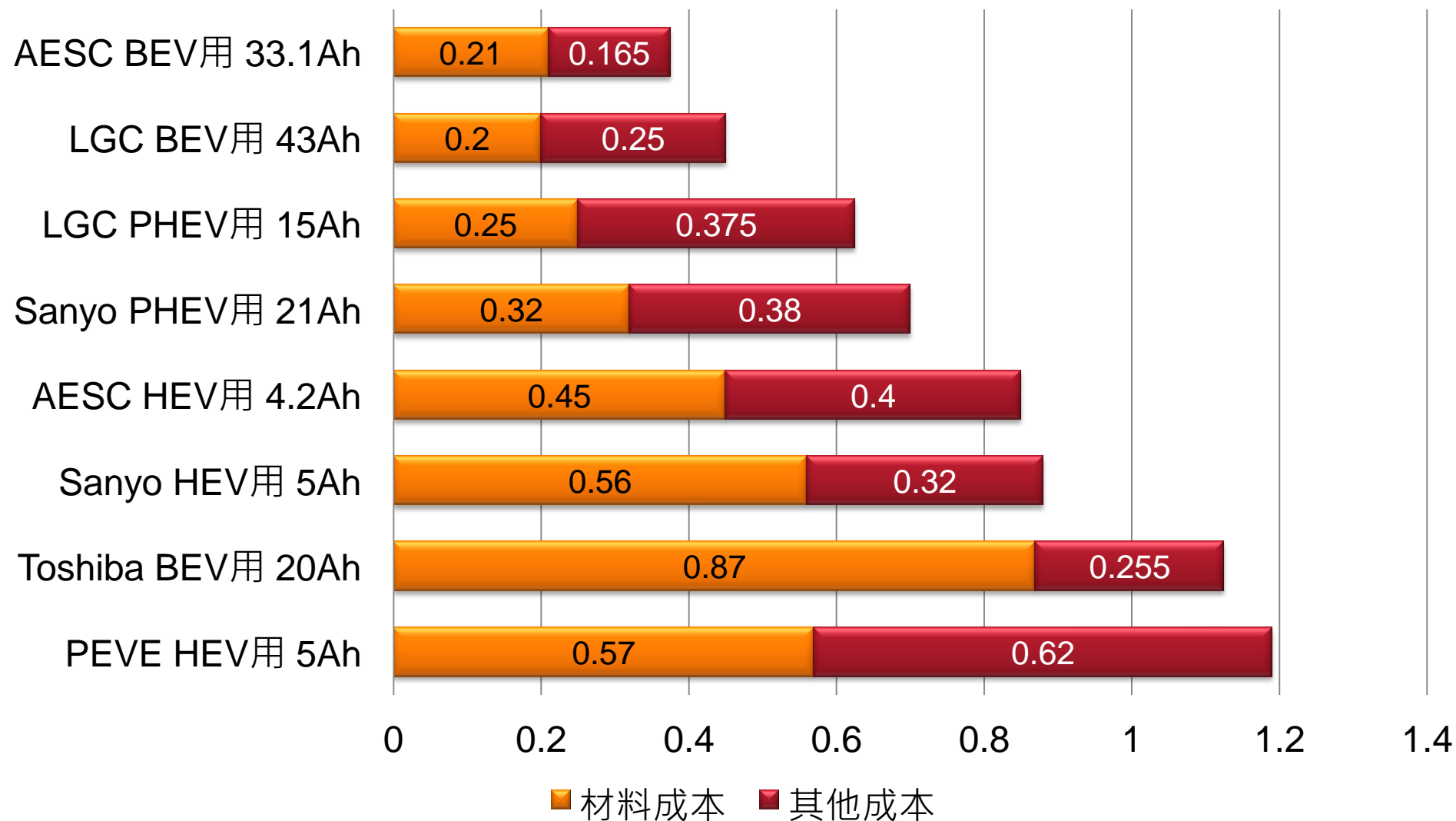
xEV Alliances Effect the Technology and Format

	HEV		PHEV		BEV			
		Panasonic	Panasonic		Panasonic			
		Hitachi						
	Blue Energy Company				Panasonic	TOSHIBA		
	TOSHIBA	 LG Chem				TOSHIBA		
	Hitachi		 LG Chem			 LG Chem		
	Panasonic		Panasonic		 LG Chem			
	 LG Chem		 LG Chem		 LG Chem	(SK)		
	Panasonic		Panasonic		Panasonic			
	Panasonic		Panasonic		Panasonic			
								

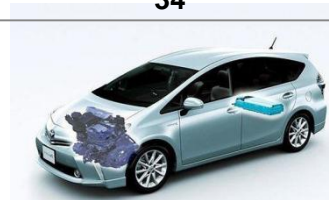
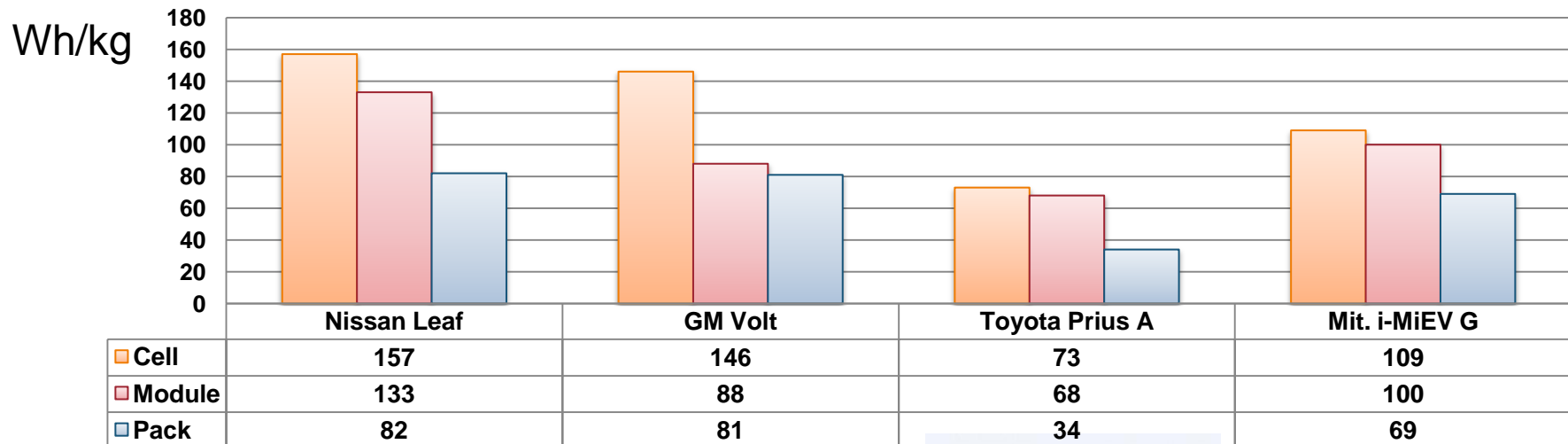
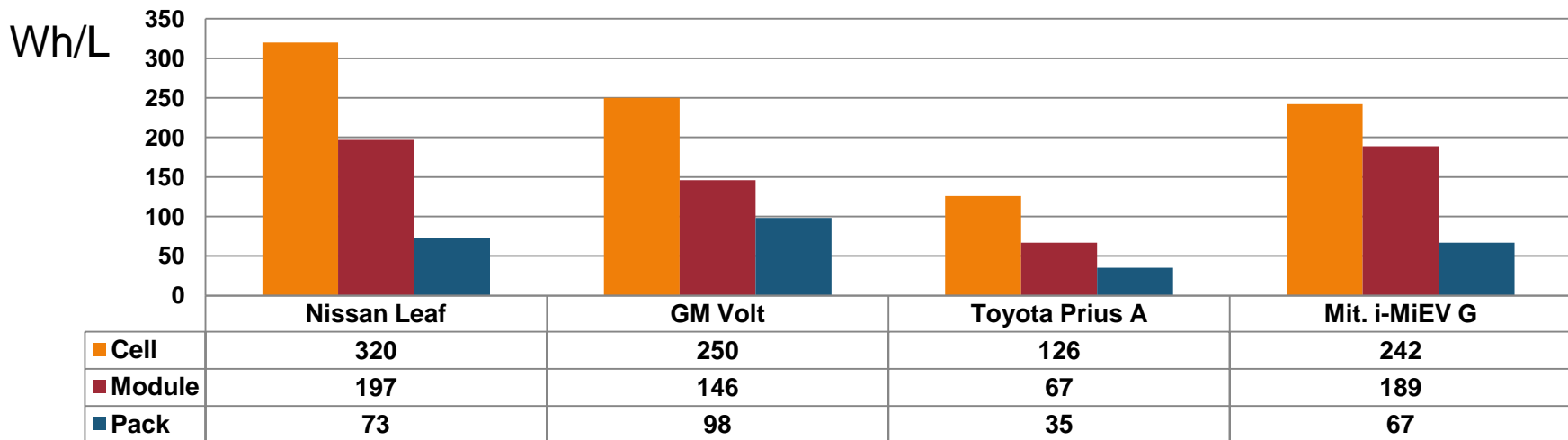
The Average Cost is about USD\$0.5/Wh

USD\$/Wh

EV Battery Bare Cell Cost



Energy Density Still need to Improved



The Safety Issue Still Effects the xEV Market

2012.04 : China Taxi

2012.05.26 : BYD

GM Volt Lab

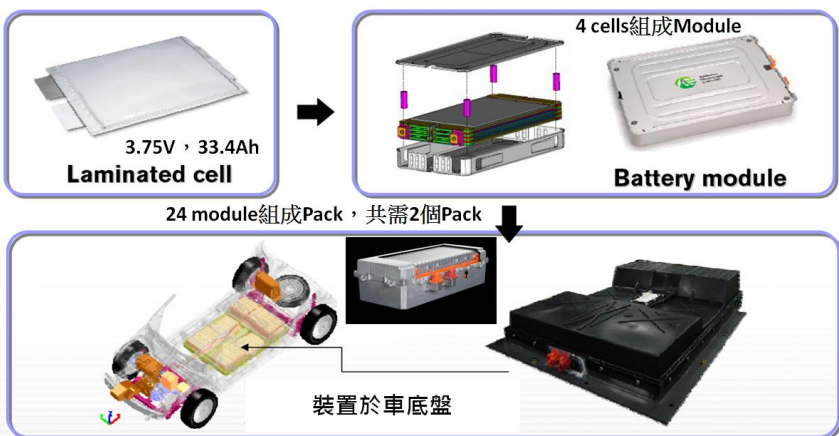


2012.05.25 : Paris

2012.07.18 : Shan-hai E-bus

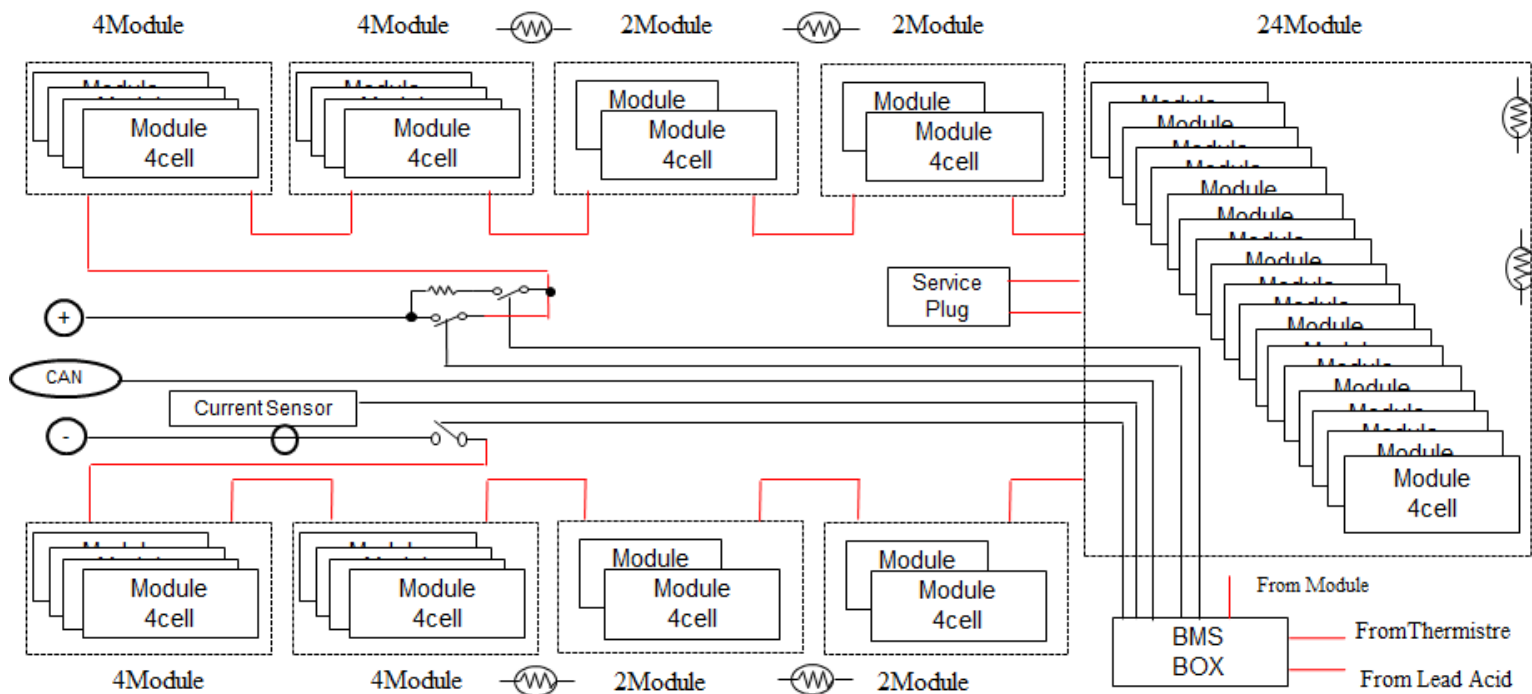


Nissan Leaf/AESC may possibly the Lowest Cost

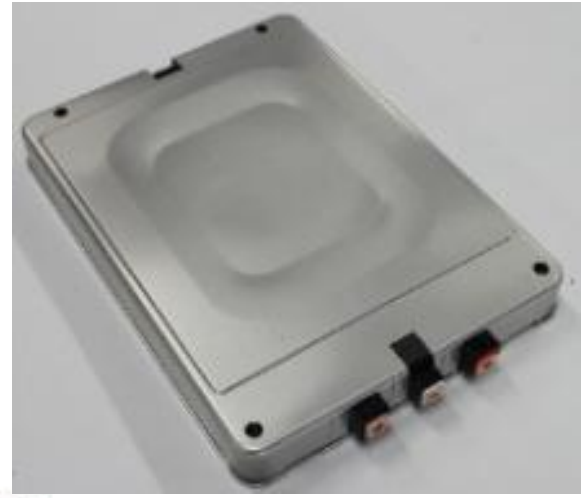
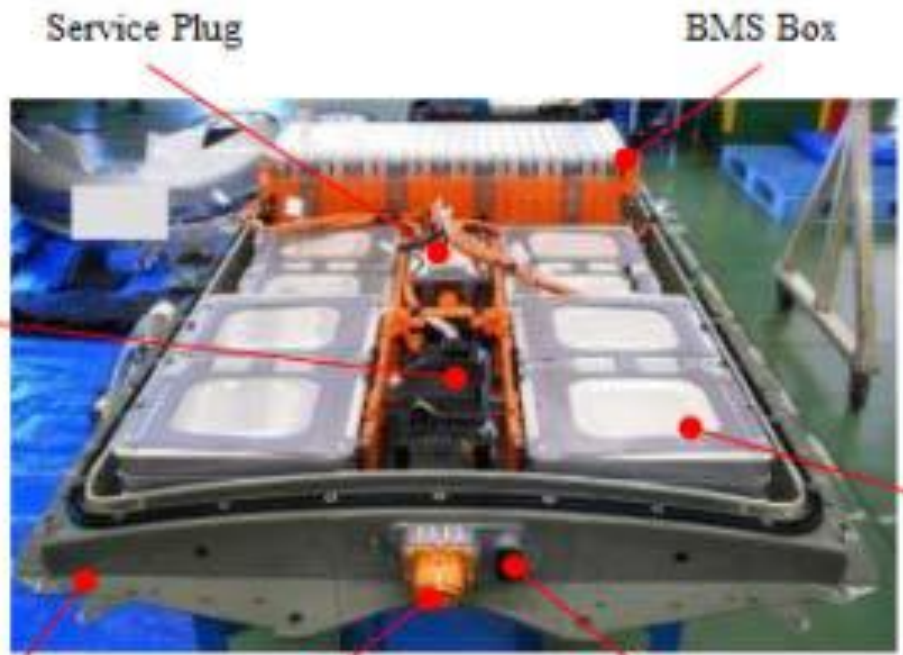


AESC		
電池芯規格	3.8V、33.1Ah	
	用量	
正極材料-LMO	231.7g	100mAh/g(70%)
正極材料-LNO	49.7g	200mAh/g(30%)
PVDF-12% NMP比例	158.1g	PVDF 6wt% of cathode
碳黑	15.8g	5wt% of cathode
負極-NG Core	120.4g	330mAh/g
Anode-PVDF 12% NMP	52.8g	Binder 5wt% of anode
電解液	120g	EC+DEC+LiPF ₆
Al/PP laminate foil	0.12m ²	261x216x2 sides
其他部件-極耳	2 pcs	
鋁箔	0.72m ²	217x196x17pcs
銅箔	0.43m ²	220x199x18pcs
PP單層隔離膜+mono layer	0.95m ²	229x202x34pcs
每瓦時材料成本		USD\$0.21

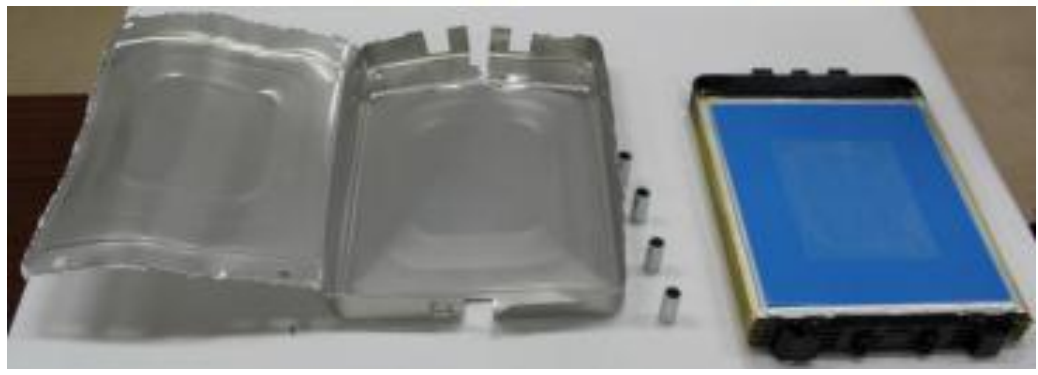
Nissan Leaf PACK



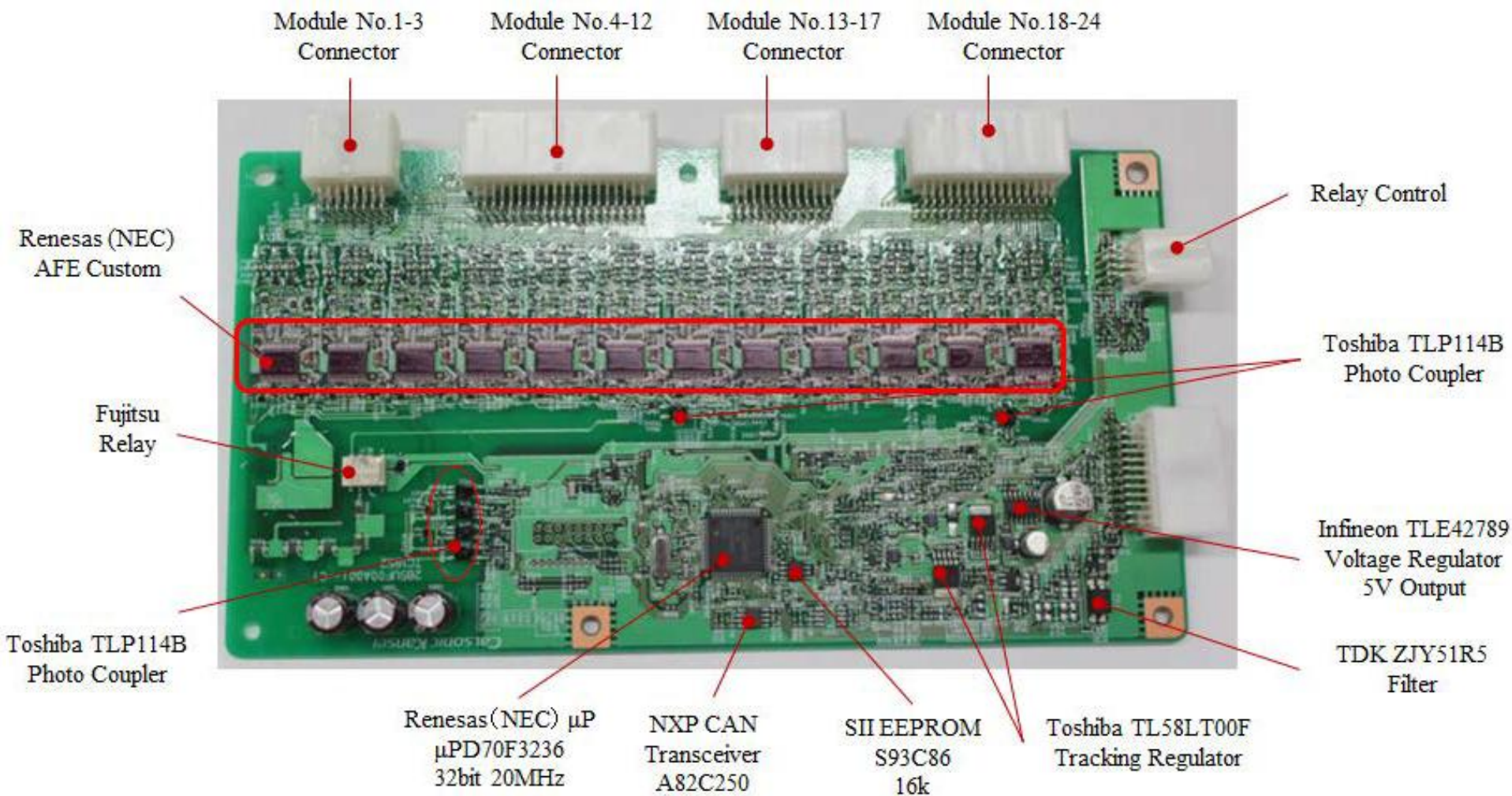
Nissan Leaf -Module



Module



Nissan Leaf-BMS(Cell voltage monitoring circuit + CPU)



Volt LIB Pack

Service Plug

72cell Module
Voltage Monitor

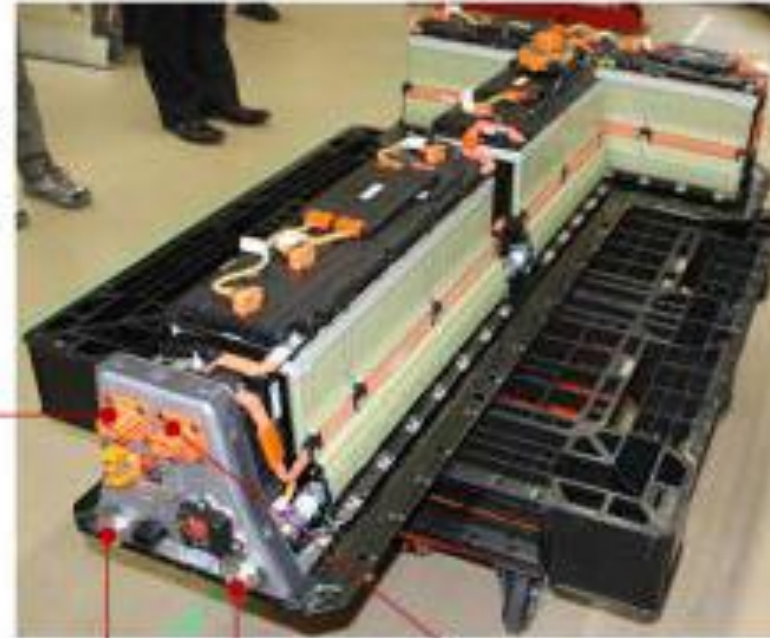
94cell Module
Voltage Monitor



94cell Module

72cell Module

Power
Output
Terminal



54cell Module

72cell Module

72cell Module
Voltage Monitor

Water Inlet/Outlet

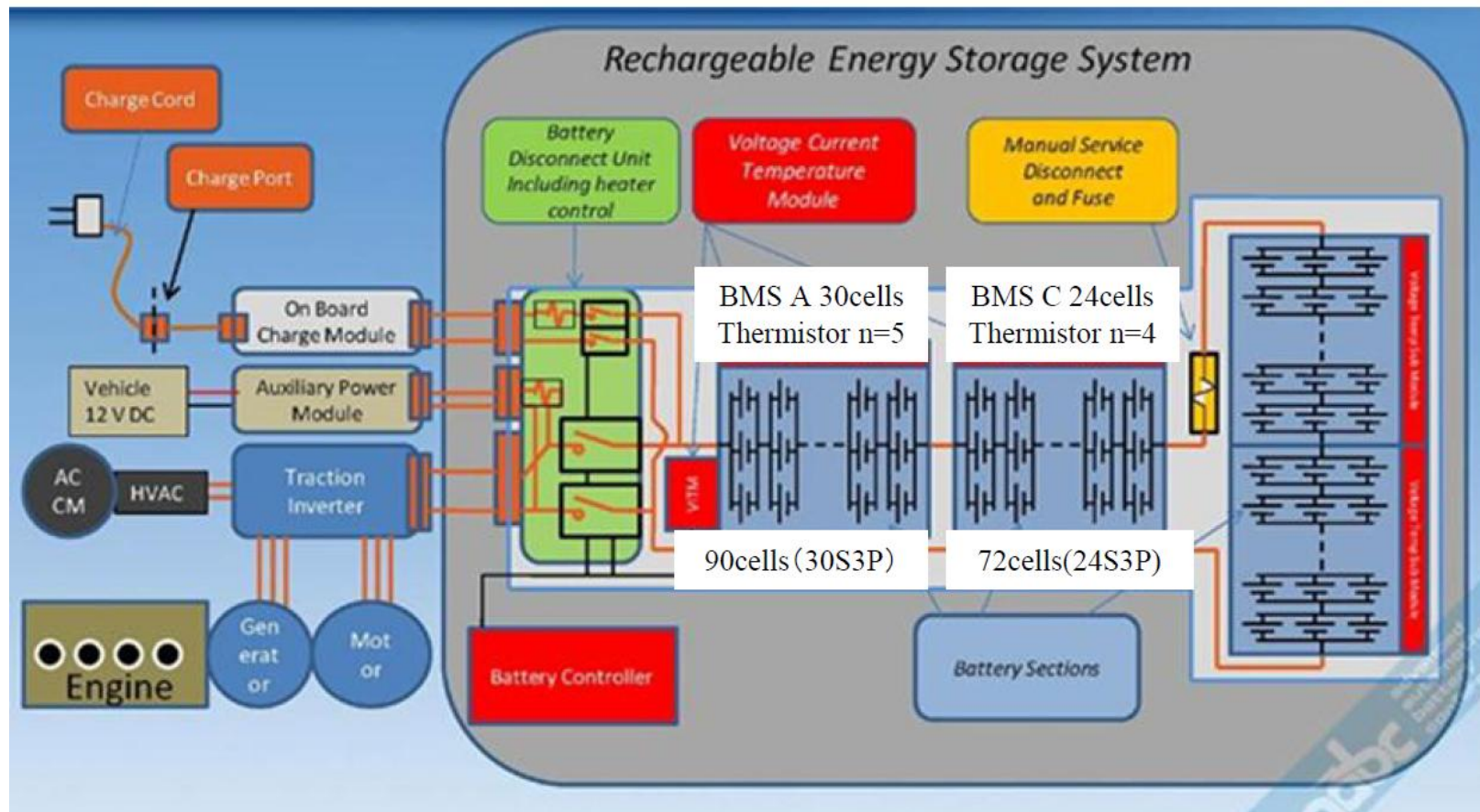
Power Output
Terminal

54cell Module
Voltage Monitor

Water cooling



Electrical Connection Diagram for the Volt LIB Pack



BMS C 24cells
Thermistor n=4
72cells
(24S3P)

BMS B 18cells
Thermistor n=3
54cells
(18S3P)

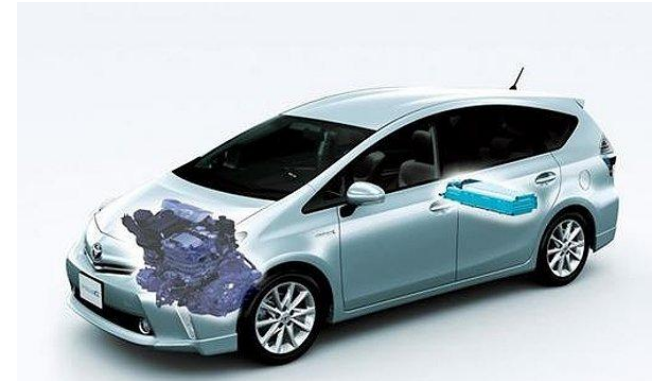
Toyota Prius PHEV



Sanyo		
電池芯規格	3.7V、20Ah	
	用量	
正極材料-NCM-523	132.3g	155mAh/g
PVDF-12% NMP比例	38g	PVDF 3wt% of cathode
碳黑	15.2g	10wt% of cathode
負極-Soft Carbon+MAGX	14.9+59.6g	330mAh/g
MBS/CMC	3.9g	Binder 5wt% of anode
電解液	75g	PC+DMC+LiPF6
鋁外裝罐	1 pcs	
上蓋	1 pcs	
其他部件-極耳	2 pcs	
鋁箔	0.41m ²	130x3000mm
銅箔	0.43m ²	130x3200mm
PE多層隔離膜+陶瓷塗佈	0.95m ²	135x3500mmx2
每瓦時材料成本		USD\$0.32

Toyota Prius α

- Pack Cost=USD\$2,040
- Less than 10% :
 - HEV small capacity
 - Less serial design
 - No design cost

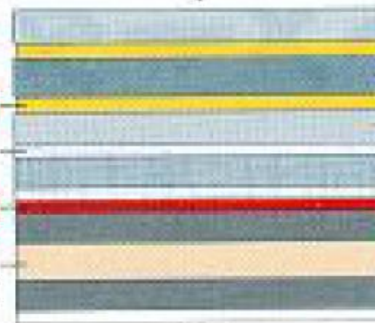


Polymer PTC layer

Organic electrolyte

Heat-resistant
ceramics layer

Copper foil

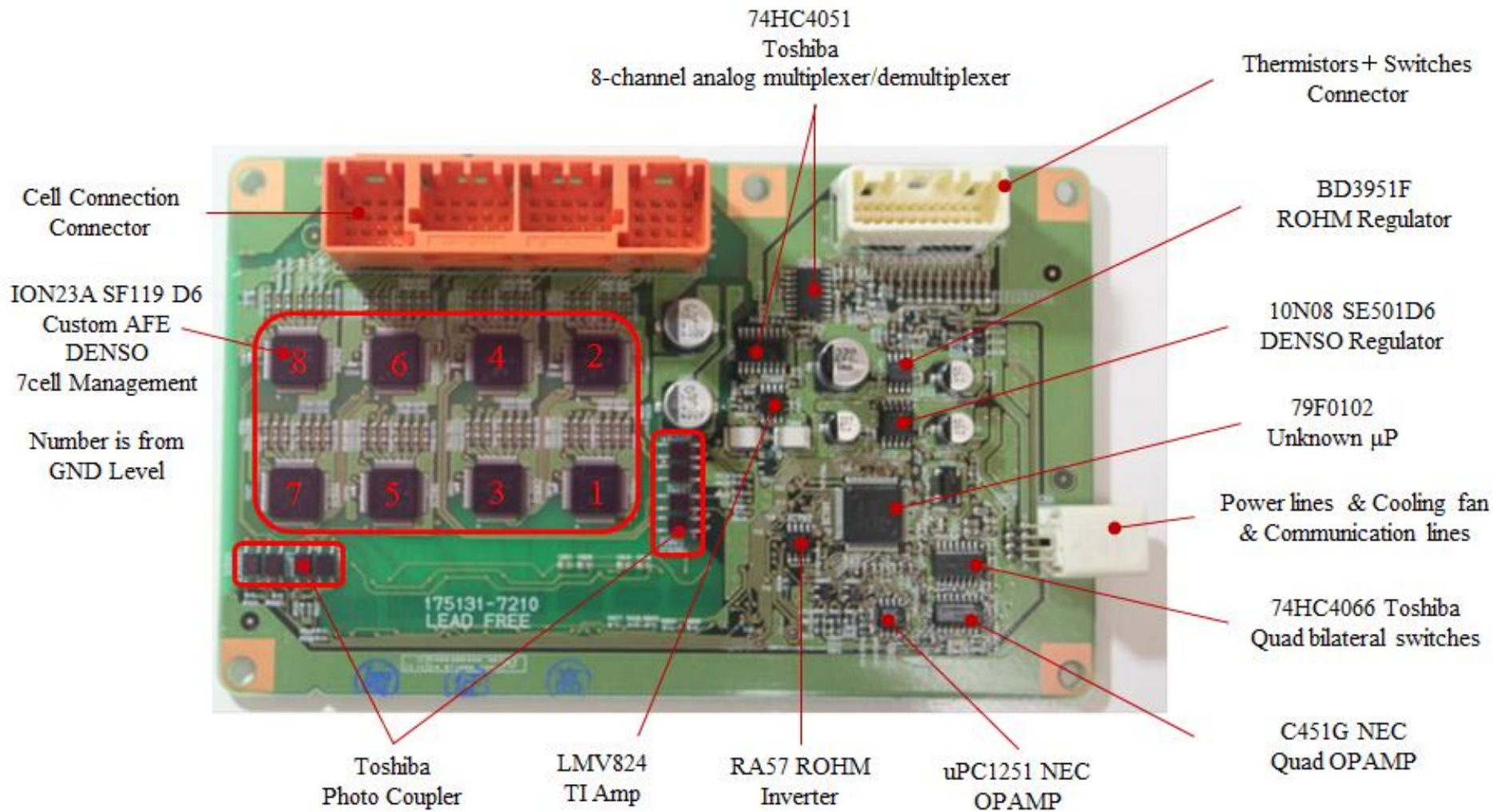


Aluminum foil

Positive-electrode material
(NCA type)
Separator (PE/PP/PE)

Negative-electrode material
(carbon material)

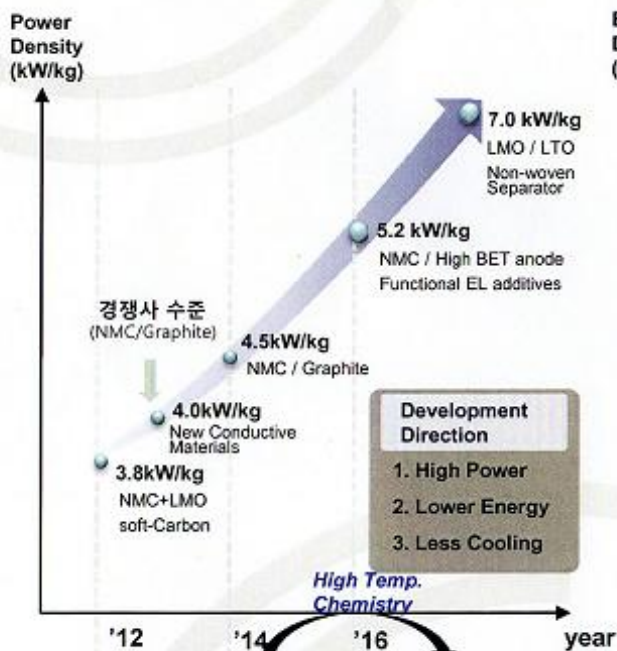
Prius Alfa Cell Voltage Monitoring Circuit Board



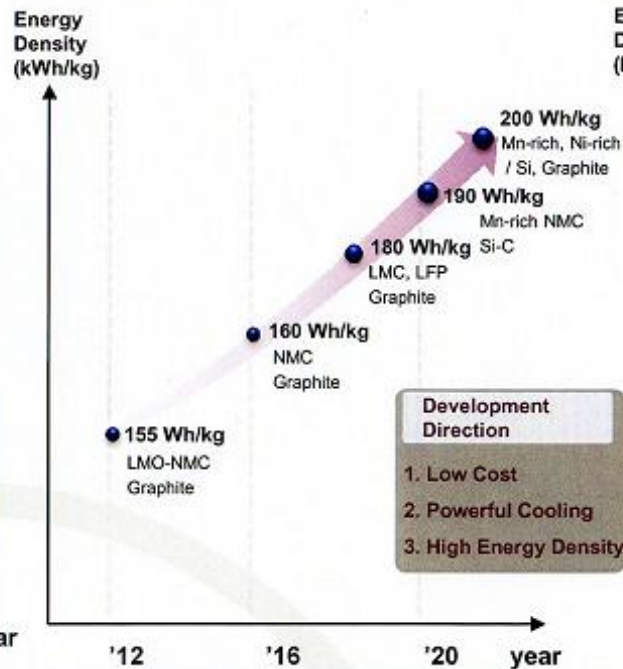
LGC's Road Map for xEV LIB Technology

Battery Technology Road-map

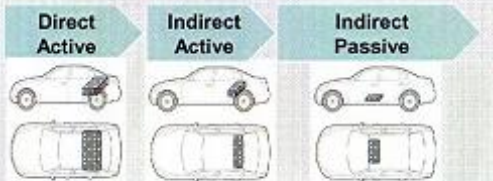
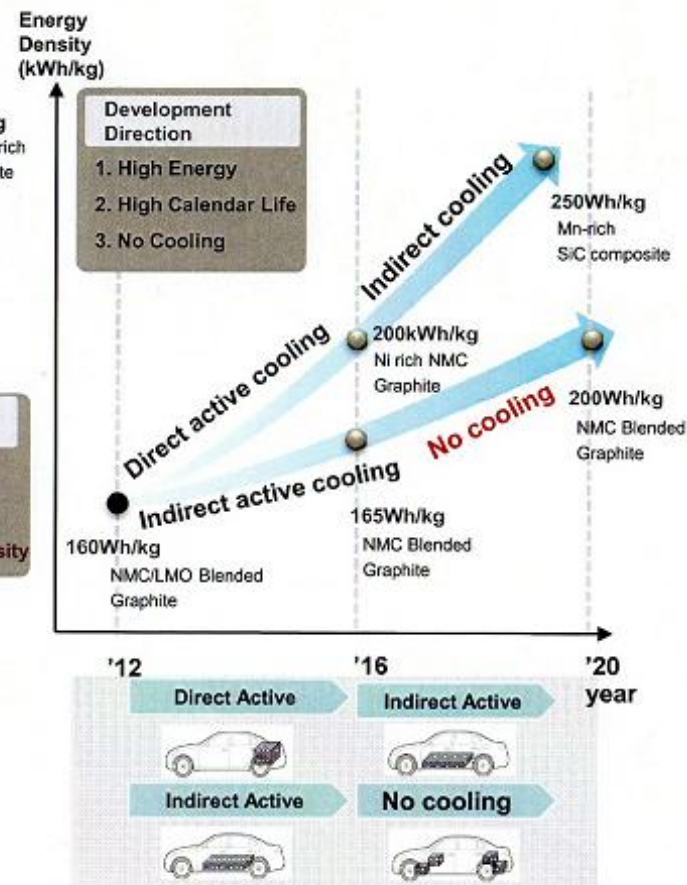
HEV Road-map



PHEV Road-map



EV Road-map



BYD Still has Positive Attitude for EV



20 e6 taxi in Baoji, Shanxi, from 2012

50 K9 in Xi'an, Shanxi

12 e6 for the State of Council, China



50 K9 in Chang Sha, Hunan

650 e6 for Shenzhen public transit system

200 K9 for public transit in Shenzhen
Another 500 K9 are planned to put into operation in 2013.

55 e6 run more than one year in Shenzhen public security system

Basic Parameters

Cell	Capacity	200	Ah	
	Weight	5.95	kg	
	Max. Power	2000	W/kg	
e6	Energy	60	kWh	General Profile
	Range	300	km	
	Max. Speed	140	km/h	
K9 (Bus)	Energy	320	kWh	40km/h City Road
	Range	≥400	km	
	Max. Speed	≥250	km	
		≥70	km/h	

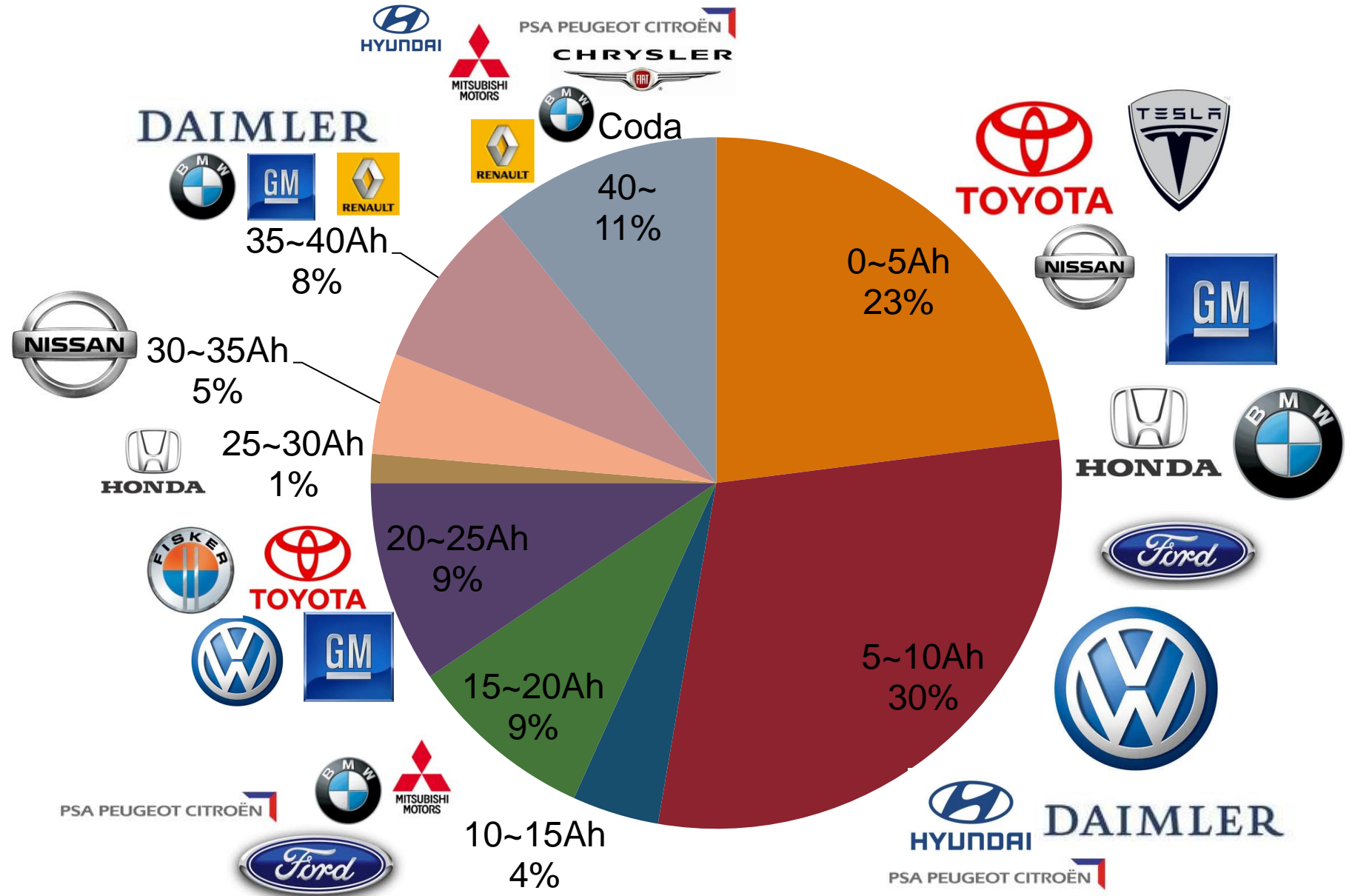


The maximal odometer of single e6 is over **260,000** kilometers;
The total odometer is over **32 million** kilometers (in Shenzhen).

The maximal odometer of single K9 is over **100,000** kilometers;
The total odometer in Shenzhen is over **10 million** kilometers (in Shenzhen).



148 models of EV Battery Capacity



Material Compositions and Suppliers for EV LIB-Pr



	Sanyo HEV/PHEV用 5Ah/20.5Ah	PEVE HEV/PHEV 5Ah	LEJ BEV 50Ah	BEC HEV 4.7Ah	SBL xEV 5.2	HVE HEV 4.4/4.8Ah	Toshiba HEV 20Ah
極板結構	Winding	Winding	Winding x2P	Winding	Winding x1~4P	Winding	Winding
外包裝	鋁質方罐 Fuji Exceed	鋁質方罐 Fuji Exceed	SUS合金方罐 Kuno Metal	鋁質方罐 Fuji Exceed	鋁質方罐 Fuji Exceed	鋁質方罐 Power Precision	鋁質方罐 IMI/Ozawa
正極材料	NCM Nichia	LNO Sumitomo MM	LMO/NCM Mitsubishi Chem.	NCM Mitsubishi Chem.	NCM/LMO Umicore/Mitsui	LMO/NCM Mitsubishi Chem.	LNMO Honjo FMC
負極材料	Gr/SC Hitachi Chem.	Gr Mitsubishi Chem.	Gr mixture Nippon Graphite+ Showa	HC Kureha	Gr Nippon Carbon	HC-SC Kureha/Hitachi Chem.	LTO Titanium Industrial
電解液	EC Type Ube	EC Type Mitsubishi Chem.	EC Type Mitsui Chem.	PC Type Mitsui Chem.	EC Type Panax-Etec	PC Type Ube	PC Type Mitsui Chem.
隔離膜	多層乾式 Ube	多層乾式 Ube	PE 濕式 Asahi	PE 濕式 Asahi	PE 濕式/多層乾式 Tonen/Celgard	多層乾式 Ube	Celrose Nippon Kodoshi
銅箔	電解 Furukawa	壓延 Hitachi Cable	電解 Furukawa	電解 Furukawa	電解 Ijjin	壓延 Hitachi Cable	壓延Al Nippon Foil
Shut down	No	Yes	Yes	Yes	Yes	Yes	Yes
陶瓷塗佈	HRL	HRL	No	No	SFL	No	No

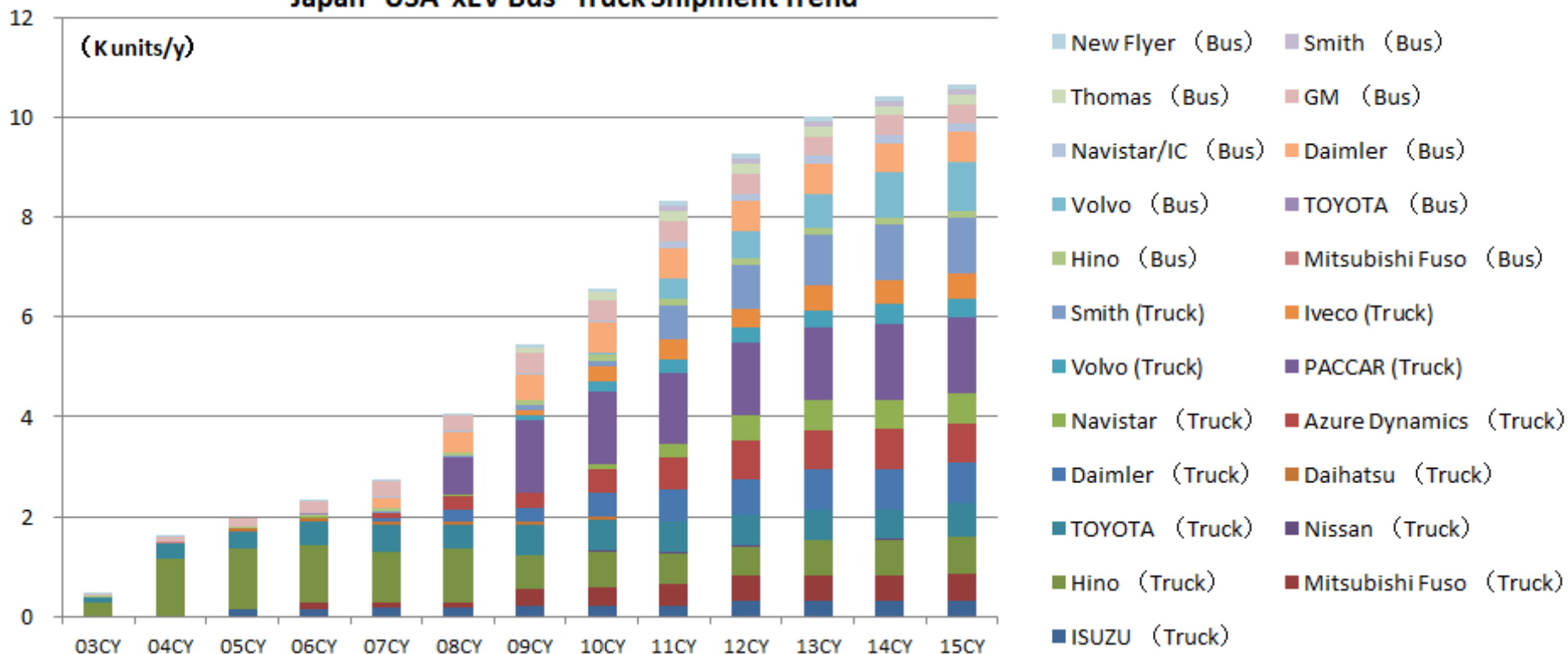
Material Compositions and Suppliers for EV LIB-Pouch

	AESC BEV 33.1Ah	AESC HEV 4Ah	LGC PHEV 15Ah	LGC HEV 5.3Ah	EnerDel BEV 20Ah	EnerDel HEV 5Ah	A123 BEV 20Ah	Litec BEV 40Ah
極板結構	Stacking	Stacking	Bi-cell rotation stacking	Bi-cell rotation stacking	Separator envelop type stacking	Separator envelop type stacking	Zigzag sacking	Satcking
外包裝	DNP	DNP	DNP	DNP	DNP	DNP	DNP	DNP
正極材料	LMO/LNO 日本電工/三井 金屬/戶田工業	LMO/LNO 日本電工/戶田 工業	LMO/NCM 戶田工業 /Umicore	LMO/NCM 戶田工業 /Umicore	NCM 戶田工業	LMO 戶田工業	LFP A123 in-house	NCM BASF
負極材料	Gr Hitachi Chem.	HC Kureha	Gr/HC Mitsubishi Chem./Kureha	SC Mitsubishi Chem.	HC Kureha	LTO Titanium Industrial	Gr ConocoPhilips	Gr
電解液	EC Type Mitsubishi Chem.	PC Type Mitsubishi Chem.	EC Type In-house	PC Type In-house	PC Type 富山藥品	PC Type Daikin	EC/PC Type 中國廠商	EC Type Evonik
隔離膜	PP乾式 Celgard	多層乾式 Ube	PP乾式 Celgard	PP乾式 Celgard	PE濕式 Asahi/Toray Tonen	PE濕式 Asahi/Toray Tonen	PP乾式 Celgard	PET Non- woven Evonik
銅箔	電解 Furukawa	電解 Furukawa	電解 LS Mtron	電解 LS Mtron	電解/壓延 Furukawa/Nip pon Foil/JX Nikko	壓延Al Nippon Foil/Toyo Alumi	電解 Furukawa	壓延 Hitachi Cable
Shut down	No	No	No	No	No	No	No	No
陶瓷塗佈	No	No	SRS	SRS	No	No	No	On Separator

E-Bus and E-Truck are another

日美兩地銷售之電動巴士/電動貨車年銷量與未來需求量

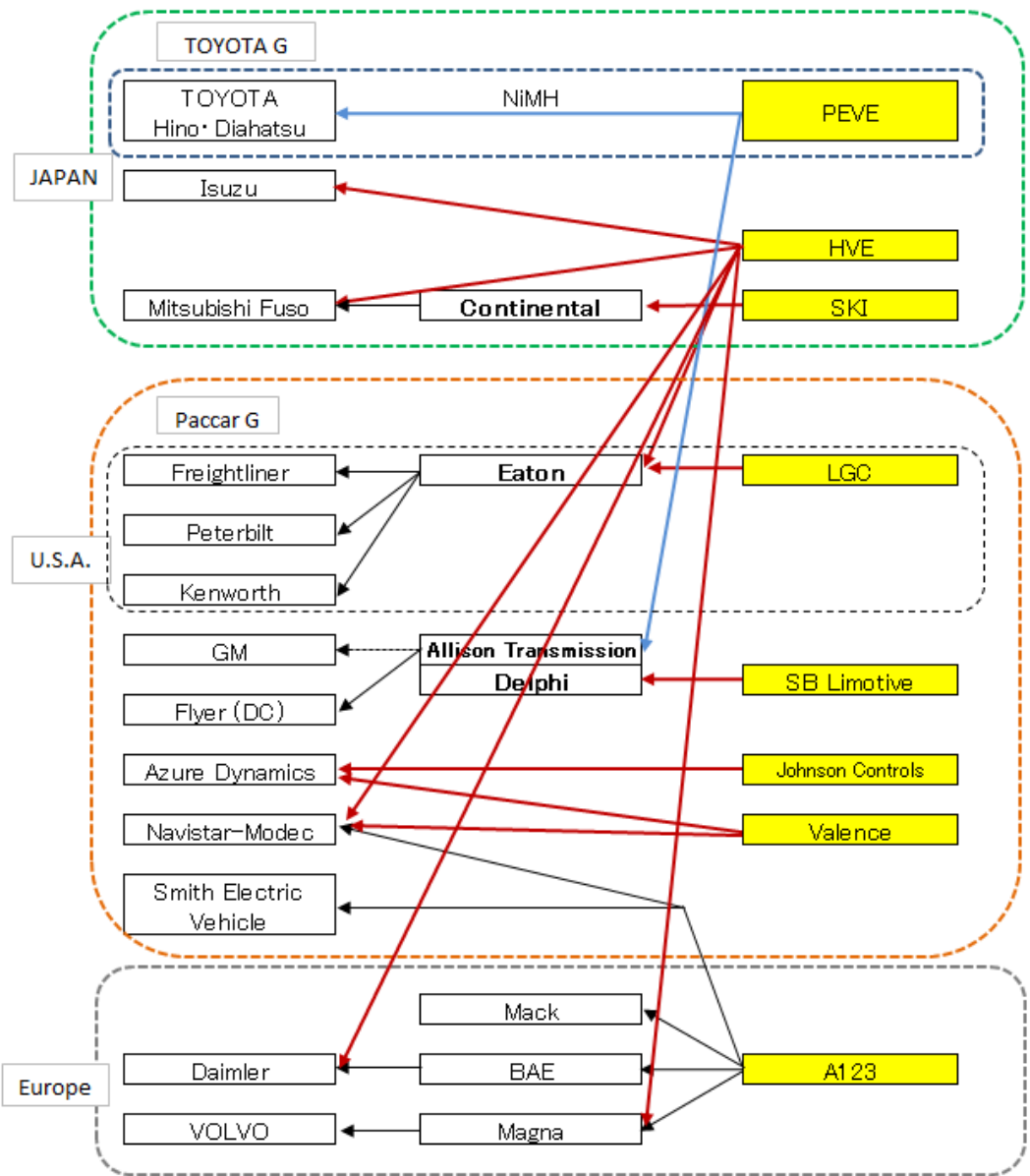
Japan- USA xEV Bus- Truck Shipment Trend



■ Most for HEV

■ Hino、TOYOTA: Ni-MH

The Supply Matrix is Beginning to Develop



Smith生產之純電動巴士/貨卡車



Outline

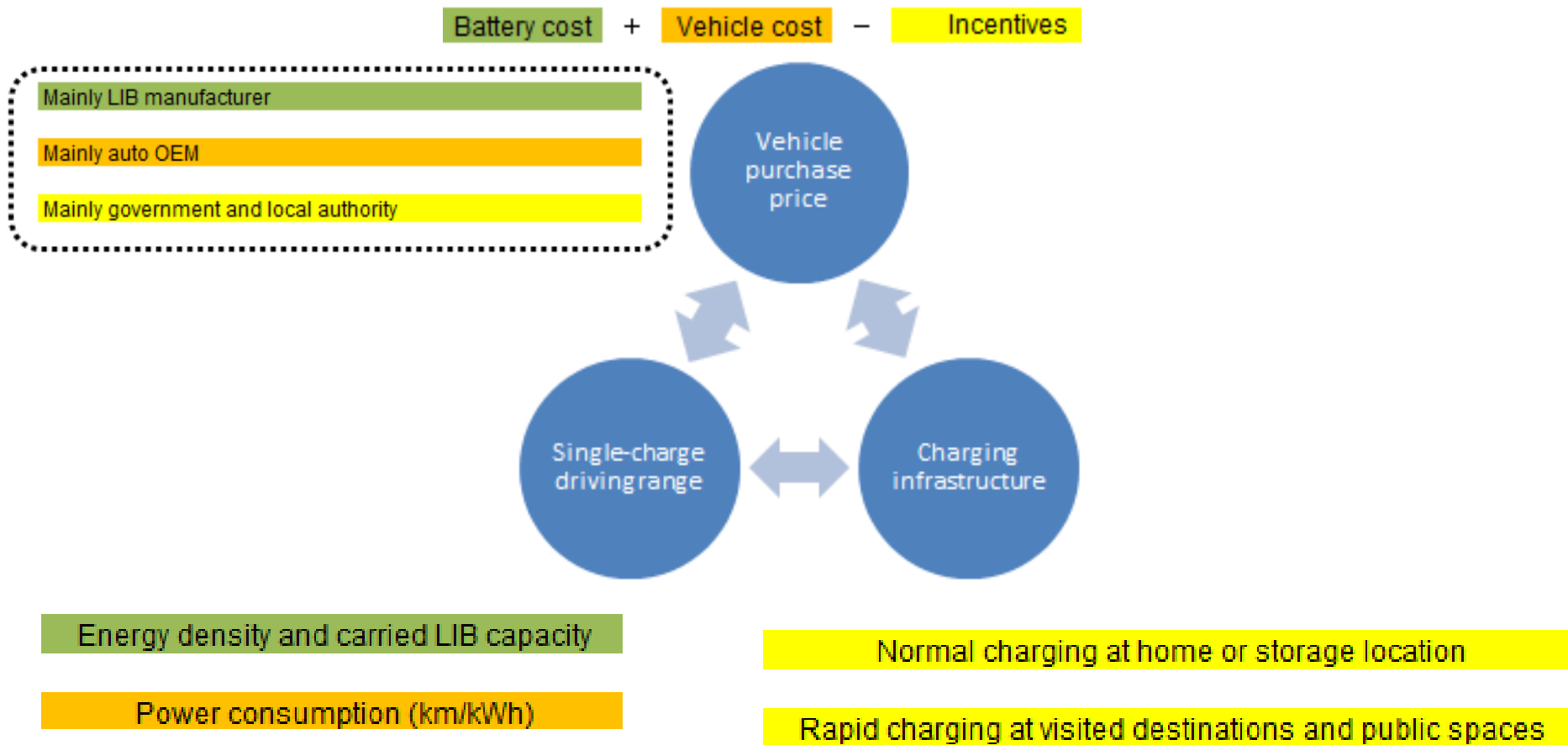
E-Motorcycle Battery Demand and Supply

- E-bikes
- Pedelec
- E-scooter

xEV Battery Recent Development

Conclusions

Battery is Important, but Anything Else?



- Still need other factors improve
- Recent material/supply chain may have the chance to restructure
- Both making the battery cost lower and improve the performance

Applications Demand Leads the Battery Tech



E-two-wheels

- Mainly Lead-acid, LIB begin to earn penetration
- China have special 「333」 : 30M, 3 years, 3%!
- Pedelec/bike can use cheaper energy 18650 directly
- China has more player use laminated cell



Power Tool

- Steady penetration from NiCd to LIB
- 18650/1.5Ah power cell mainly
- 2013 recall happened



ESS

- 2012 : 317MWh for the LIB
- Japan market finally small in 2012
- Emergency and special usage limits the market
- Light and smoothly growth in UPS, base station, PV/Wind power

Market Reality





xEV

- To be realistic thinking
- 10~30% annual growth
- Supply chain restructure and next generation material series

E-Bike/Scooter

- Engine-type motorcycles satisfy all attributes of price, performance and quality
- 18650 may be the answer to compete with Lead-acid
- China market still need time to get down the rule
- Euro/Japan market is smoothly growing

「Smiling Curve」 Concept for Battery Industry

	Up-stream : Material 	Cell manufacturing 	Pack/System supply 
Profit Rate	10%~50% (Depends on differ items)	<10%(energy cell for IT) <15%(power cell)	5~10%(OEM only) 5~15%(ODM service)
Value-added And Profit			
	Focus to the demand, make special characteristic and China High Voltage, energy density	18650?! Laminated growth	Always strive for keeping the ODM design capability and advantage New Market, new buyer,

Thank You

IEK View

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