The Power Transforming the Automotive Industry from Below: NEV Battery Value Chains and Specialized Manufacturing Cluster in South China

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I. The Big Question

What will be future structure of auto industry? Who will dominate the sector?

New Value Chains in Auto	New Players in Auto
Autonomous vehicles and smart mobility	ride hailing firms, self-driving vehicle firms, independent car and NEV makers, digital car and new start-ups, incumbent carmakers, electronics, semi-conductor, telecommunication, software and internet firms
Electrification of cars and new energy components	oil producers, mining and chemical firms, battery makers, incumbent carmakers, integrated new energy providers
Digitalization of manufacturing system	car suppliers, electronics contract manufacturers

Three predicted scenarios

1. Refurbishing of the vertically-integrated mass production through integration of battery manufacturing by carmakers.

- Brand-name carmakers keep control of their hierarchical supplier pyramids, integration of battery makers as specialized suppliers (e.g., Panasonic, LG or CATL) but not controlling norms of production and technology.

2. Vertically disintegrated mass production with battery makers as core component suppliers with open interface to car assemblers.

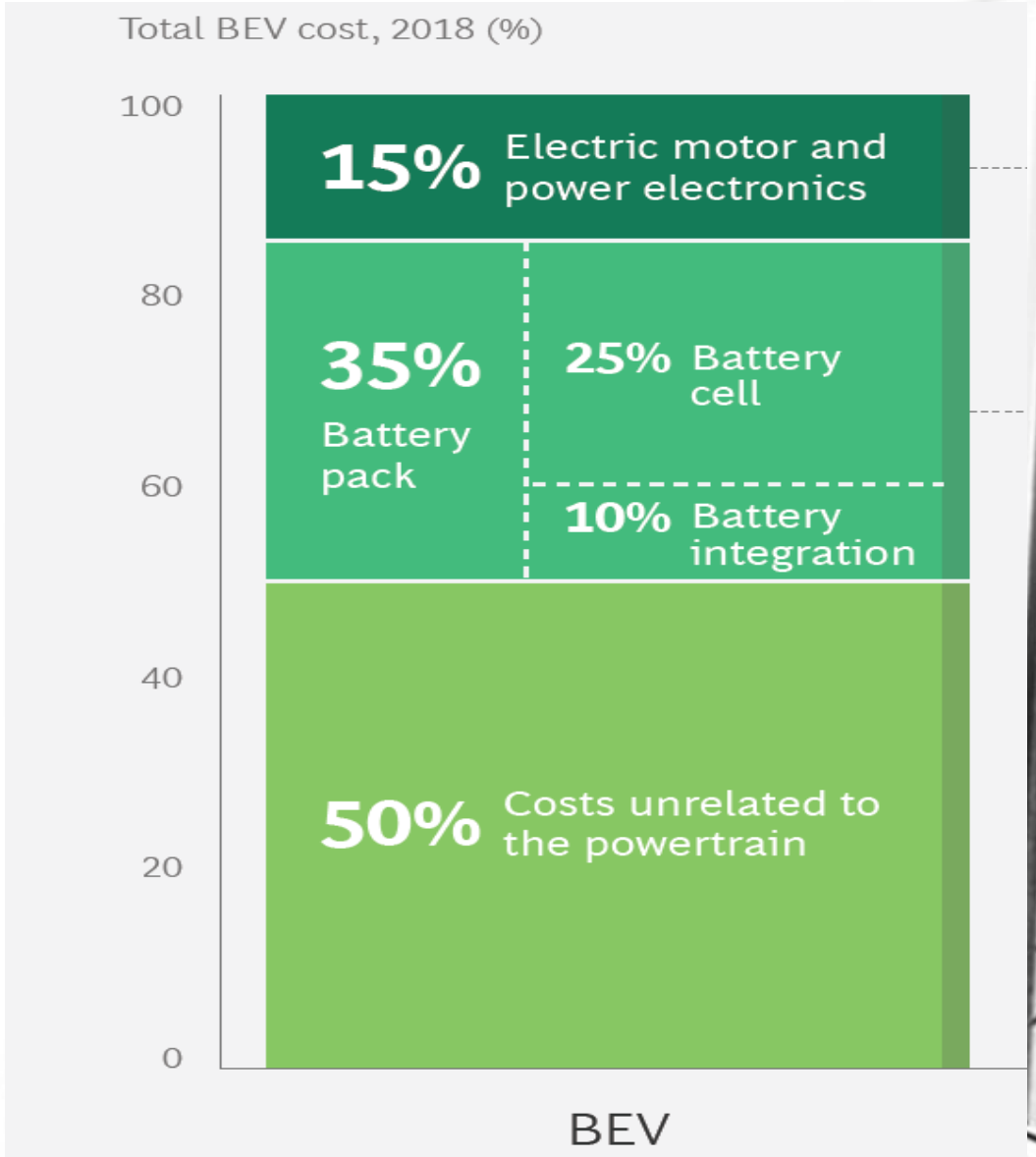
- Battery makers controlling norms of technology and manufacturing competencies along the Li-battery supply chain – open interfaces with car brands complemented by independent makers of digital drive trains.

3. Flexible specialization of battery manufacturing clusters as core component suppliers of EV.

- Integrated supply chains with co-development of core technological innovations and transfer into quality manufacturing, based on smaller to medium-sized innovative firms using industry 4.0 technologies for local markets, mobility systems and communities.

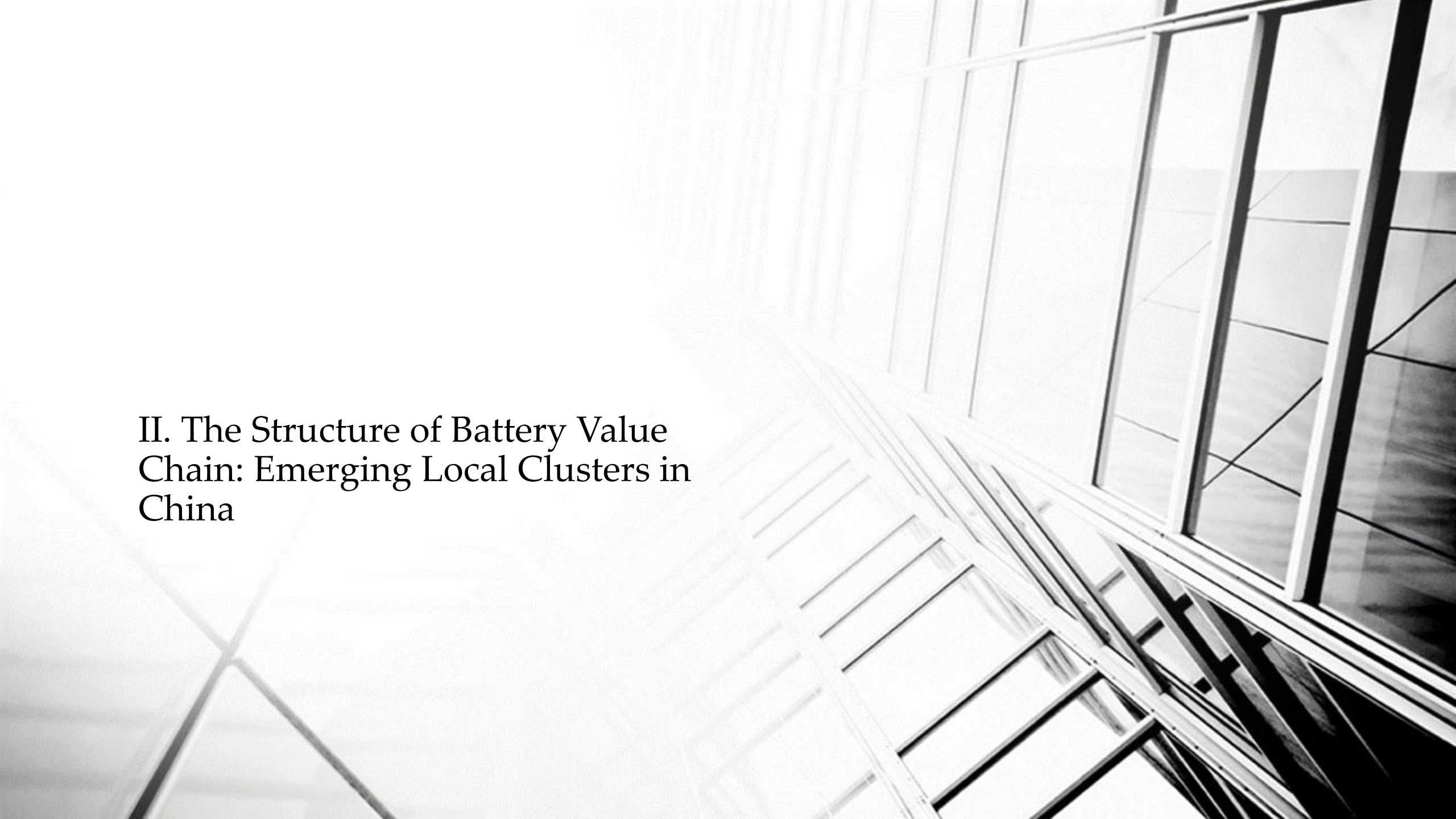
Battery production/producer plays a key role in EV industry restructuring

[3] Roland Berger 2015 turnover, note that $7 billion out of $217 billion is hybrid and BEV related

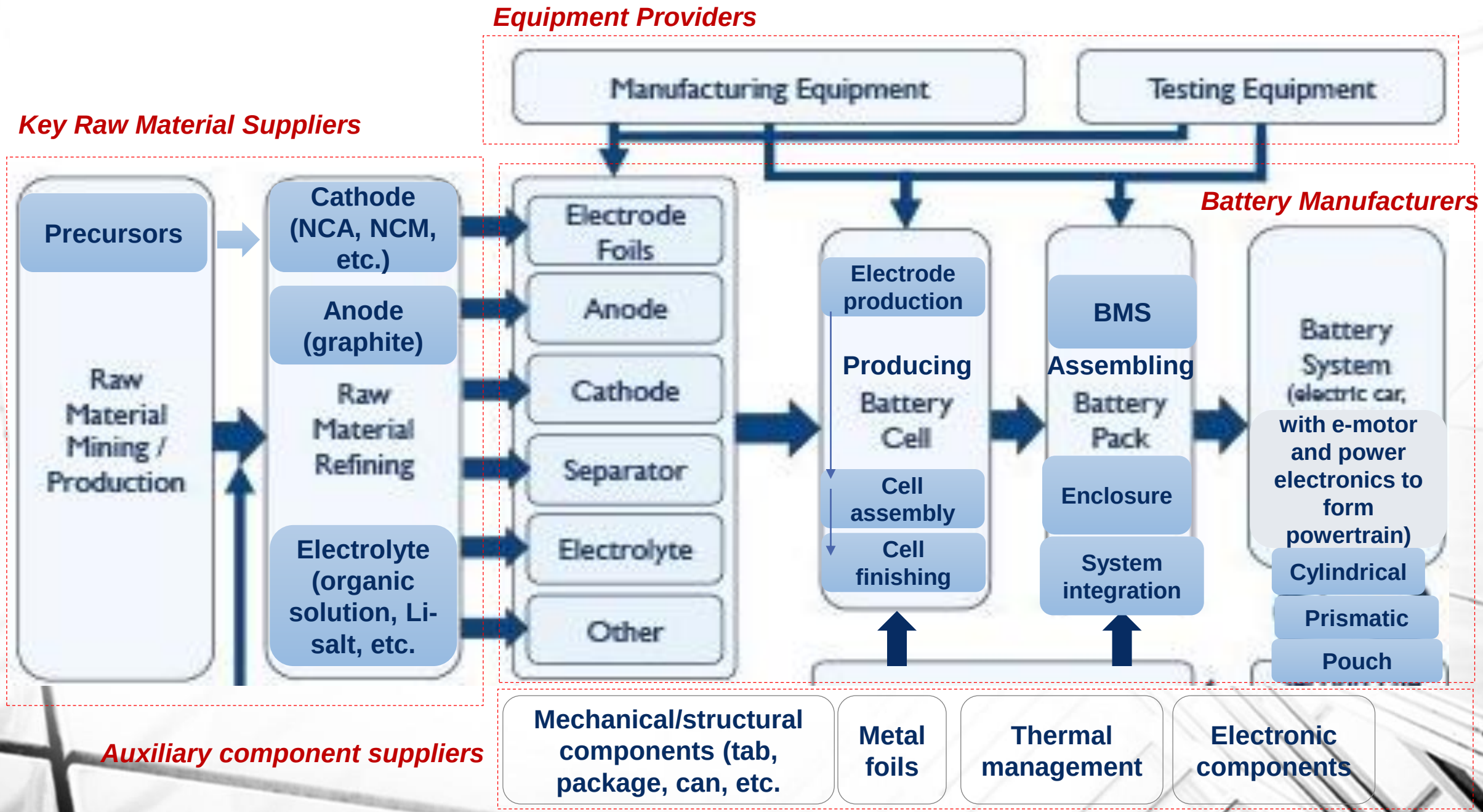


Sources: JPMorgan Chase; BCG analysis.

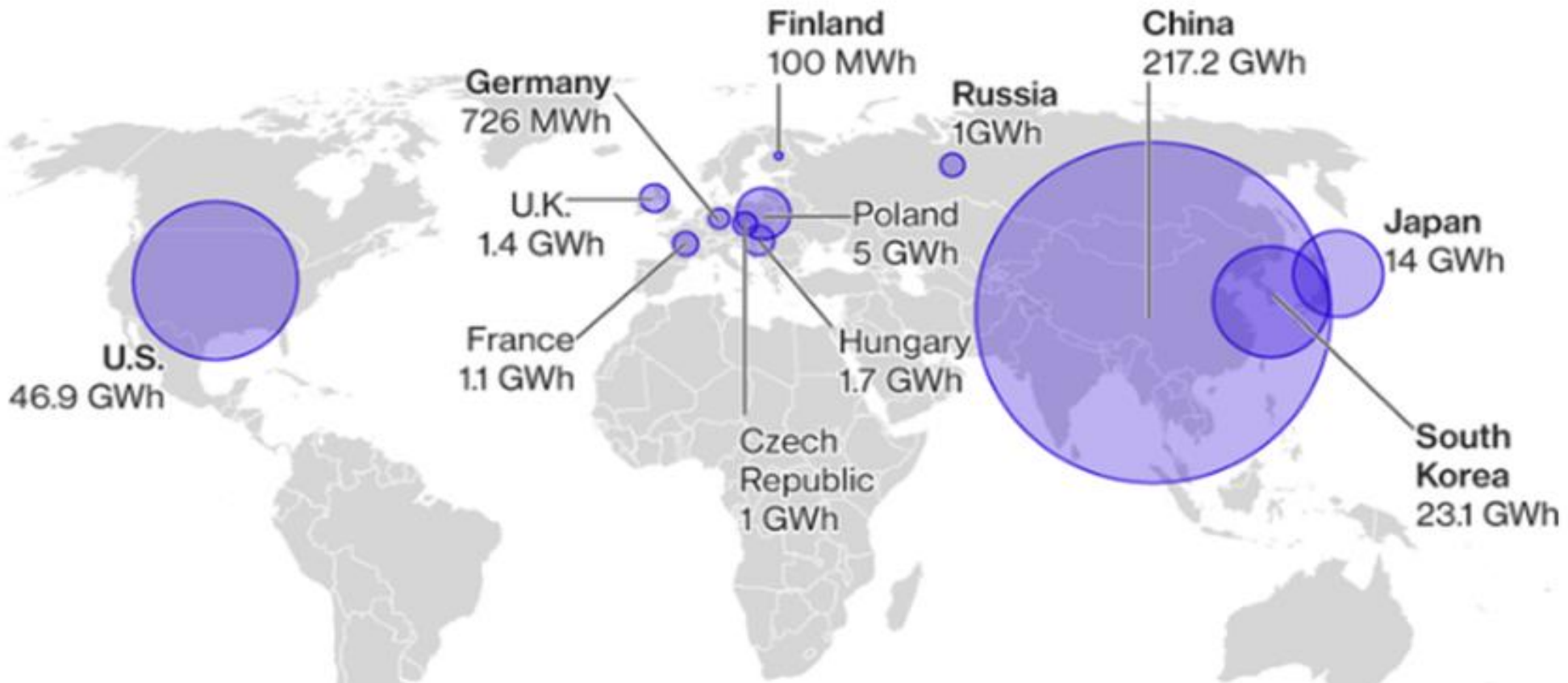
II. The Structure of Battery Value Chain: Emerging Local Clusters in China



(Source: Status of the Rechargeable Li-ion Battery Industry, July 2017, Yole Développement)



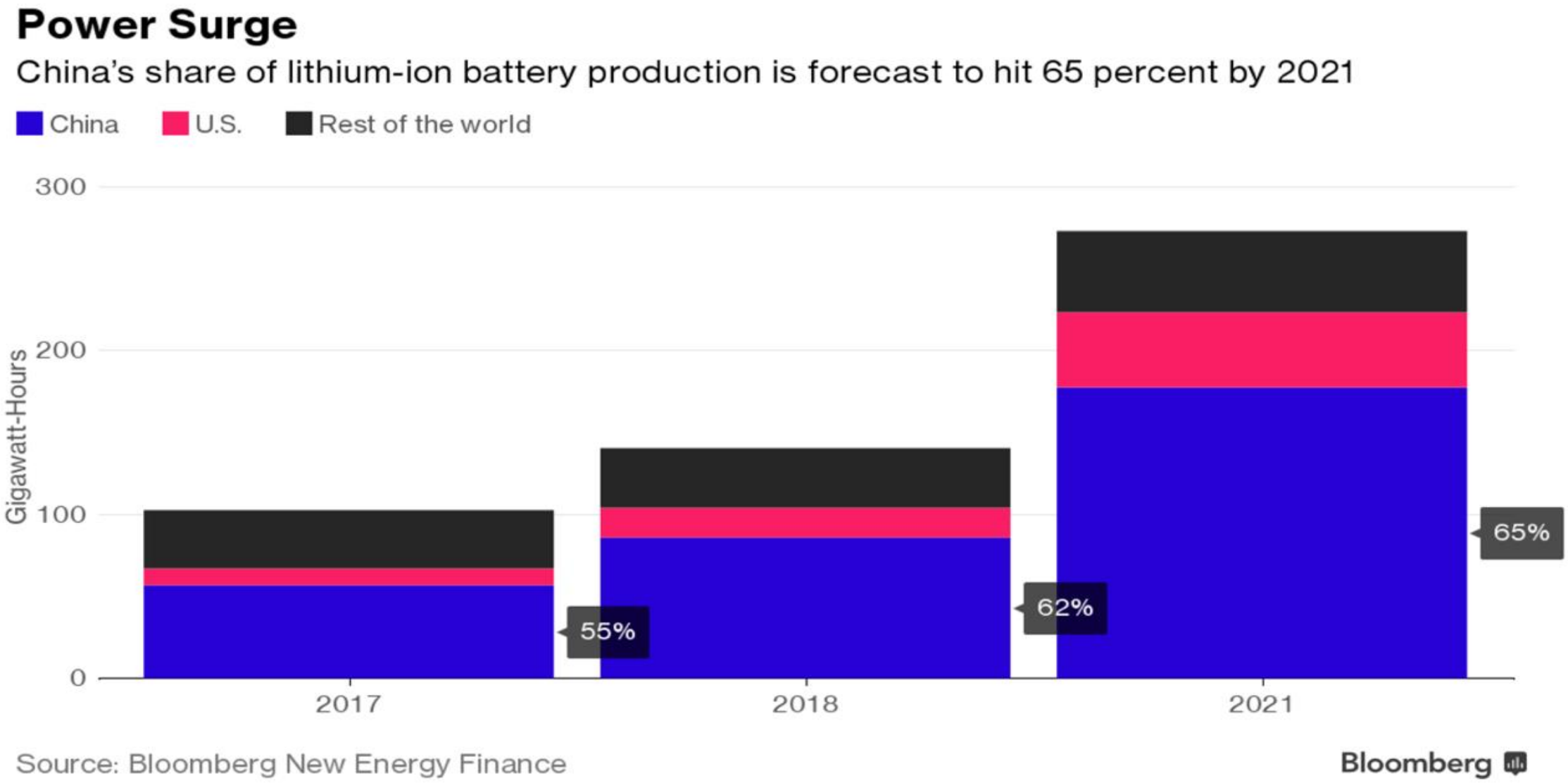
Li-ion Battery Production Capacity in 2020



China is now a huge producer of batteries and wants to be the biggest in the world, in the same way that it has become the dominant provider of solar panels. Chinese battery makers are growing rapidly and signing deals with lithium producers around the world.

Source: Bloomberg New Energy Finance, CATL IPO prospectus

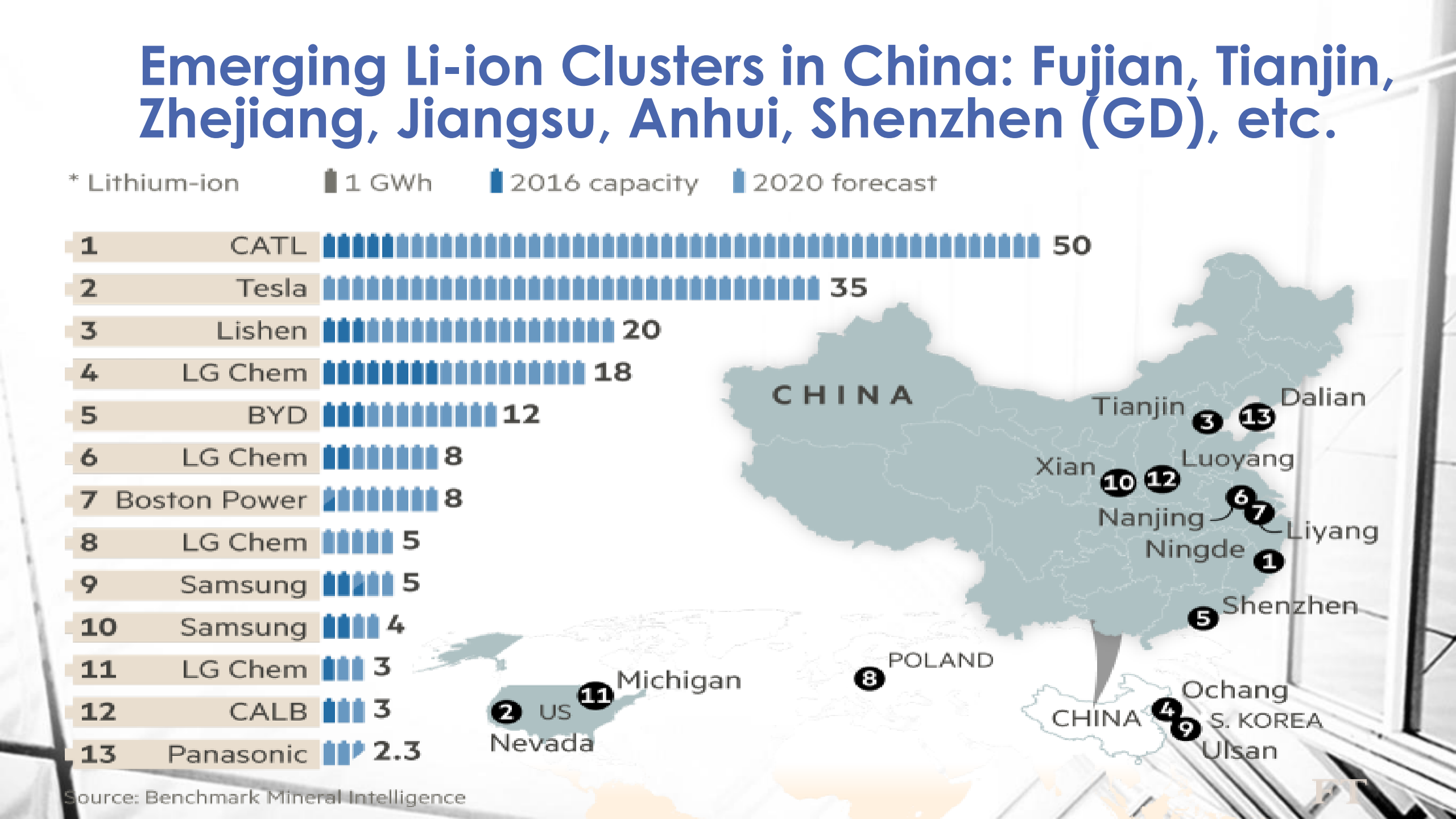
Bloomberg



China's total planned battery-making capacity is three times that which the rest of the world will construct

BCG estimated that annual demand of battery capacity will increase from 70 Gwh (2017) to 900 Gwh (2030)

Emerging Li-ion Clusters in China: Fujian, Tianjin, Zhejiang, Jiangsu, Anhui, Shenzhen (GD), etc.



China now has the most complete supply chains of NEV battery, geographically concentrated in industrial clusters

Global Opportunity:

- 1) annual battery demand increase from 70 giga watt hours (2017) to 800-900 Gwh (2030);
- 2) manufacturing costs reduction (50% electric powertrain; 35% pack+BMS for powertrain; and 70% cells for pack system).

Global Threat:

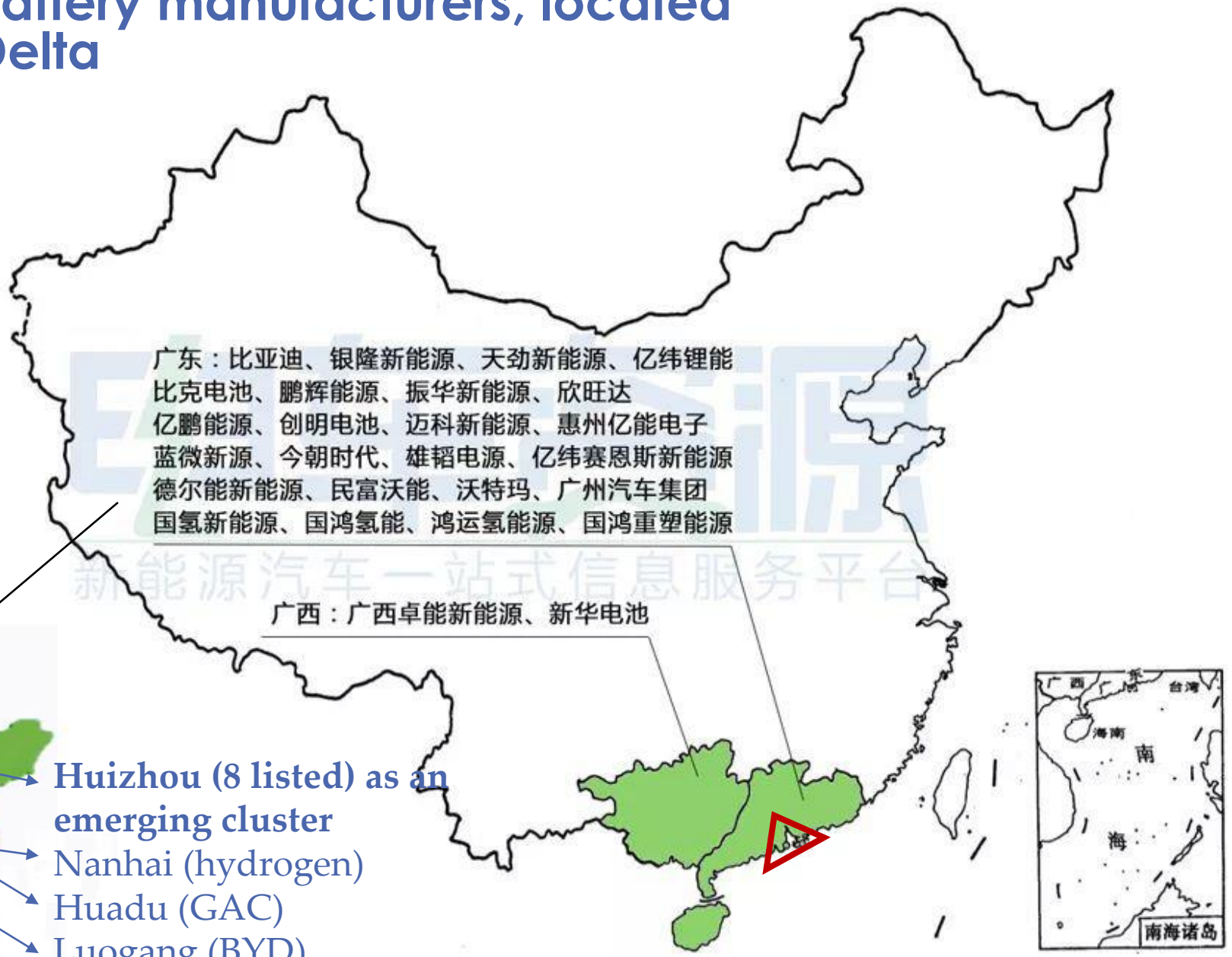
- 1) global overcapacity, double capacity but 40% overcapacity in 2021;
- 2) Chinese overcapacity of 60% in 2021, cost must be at 153 $ /Kwh to keep profit. (cf. solar panel industry story)

Manufacturing Challenge:

- 1） cell design to increase energy density,
- 2) factory of future at Industrie 4.0

Source: BCG Report 2018

Guangdong has 24 battery manufacturers, located all in the Pearl River Delta



Huizhou (8 listed) as an emerging cluster

- Nanhai (hydrogen)
- Huadu (GAC)
- Luogang (BYD)
- …

III. Core Competence of NEV Battery Firms in South China (Huizhou)

Introduction of Huizhou Emerging Industries
惠州产业背景

- Huizhou is an important element of Guangdong Province's 13th "Five Year Plan" with focus on automobile industry and relevant disruptive technologies such as NEV, equipment, IoT, big data, etc., based on its strong foundation of electronics industry (TCL Group)
- 惠州是广东省先进制造业“十三五”总体空间布局“三带两区” 的重要城市, 致力于推动汽车与装备制造和大数据、物联网等新兴产业优势。

- Huizhou is the **No.1 city** in China in the field of automotive on-board information services and electronics products.
- 惠州车载信息服务和产品产销量全国第一.
- In 2017, Huizhou's sales of car navigation systems reached 6.6 million units, generated the revenue of more than 20 billion Yuan.
- 2017年，车载导航产量660万台，产值超200亿元

long history in electronics manufacturing, a distinct trajectory!

Current Development of Huizhou's Automobile Industry 惠州汽车行业发展情况

- In 2013, Huizhou was listed as one of the six key supported and developing industrial parks in Guangdong Province for automotive components.
- 2013年惠州被列入广东省六个重点支持发展的汽车零部件产业园区。

- In 2017, the automotive industry generated a total value of 57.994 billion Yuan, reached a growth rate of 12.9%.
- 2017年，汽车行业实现工业总产值579.94亿元，增长12.9%。
  - Incl.: the sector of **new-energy cars** generated value of 12.4 billion Yuan (rate: more than 35% annual growth since 5 yrs).
  - 其中新能源汽车产业产值124亿元。

There is no OEM passenger car firms locally.

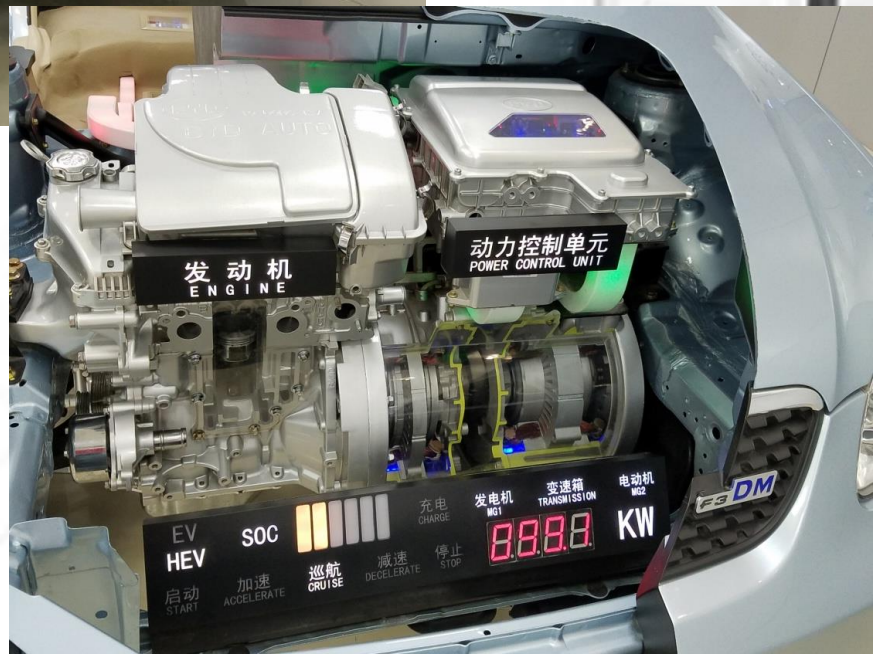
Cooperation Between China and Europe in Development of New Energy Car
中欧对于新能源汽车发展的合作

BYD was originally a supplier of Li-batteries for computers and smartphones to Foxconn and other large electronics manufacturers.

- In 2008, **BYD Auto Co., Ltd** of China acquired semi-conductor manufacturing company Ningbo Zhongwei for more than 200 million Yuan. Therefore gained the competency to develop and produce electric car motor.
- 2008年10月6日，比亚迪以近2亿元收购了半导体制造企业宁波中纬，拥有了电动汽车驱动电机的研发能力和生产能力。
- At the Geneva Car Exhibition in 2010, BYD Auto and **Daimler AG** signed a memorandum of understanding for the joint development of electric vehicles, and later formed a 50/50 joint venture—Denza as a specialized company in producing new energy vehicles.
- 在2010年3月日内瓦汽车展上，比亚迪与戴姆勒签订电动车和零部件领域合作备忘录，并在之后成立一家全面的双模混动车型—腾势合资公司。


快充口


发动机
ENGINE
动力控制单元
POWER CONTROL UNIT


发动机
ENGINE
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POWER CONTROL UNIT
EV
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TRANSMISSION
电动机
MG2
KW
启动
START
加速
ACCELERATE
巡航
CRUISE
减速
DECELERATE
停止
STOP
DM

Huizhou's Development of New Energy Vehicles 惠州新能源汽车的发展

- Huizhou's new energy automotive industry covers areas of complete vehicle production, batteries, motors and battery management systems.

惠州的新能源汽车产业涵盖了整车生产、电池、电机及电池管理系统等领域。

1/ In the development of EV **assembly**, Yiding New Energy Vehicles（logistics vehicles) is the top priority. The first stage has already started with the investment of 2.1 billion Yuan.

整车装配方面，正在推动亿鼎新能源汽车专用车。一期投资21亿元亿鼎新能源专用车项目已动工建设，项目立项已通过国家发改委备案。

2/ In **battery** segment, new energy vehicle groups' projects such as Xinwangda, KEDALI, and Battery NM 's II project are under construction.

另有一批新能源汽车项目如新旺达、科利达、贝特瑞二期等正在建设中。

Huizhou's Development of New Energy Vehicles' Batteries 惠州新能源汽车电池的发展

- Huizhou battery value chain is complete, consisting of " **BYD Battery, EVE Lithium Energy, Yineng Electronics, Desay Blue Micro New Energy, E-Power Energy, Battery New Material , Xinwangda, Yinghe Technology, Haopeng Technology and Kedali**", all Chinese domestic NEV battery manufacturing companies, totally 10 (*we conducted interviews with all in 2016, 2018, 2019, and made some value chain analysis of these firms).*

惠州拥有比亚迪电池、亿纬锂能、亿能电子、德赛电池、贝特瑞新材料等生产企业。

Manufacturing part with HQ elsewhere

- EVE Lithium Energy has already started the first stage of their high-performance lithium-ion battery production with the initial investment of 630 million Yuan.

亿纬锂能正加大新能源汽车专用车和动力电池产业化布局，一期投资6.3亿元的高性能锂离子动力电池项目已投入生产。

Key Raw Material Suppliers

	Firm and positions in the value chain	Mass production and advanced manufacturing capabilities	Technology R&D and innovation capabilities	Customer and market conditions	Corporate development strategy	Business needs for local policies
电池材料	-**Battery NM** (mining ore, anode material, electrolyte, adhesive, binder) -**BYD** (cathode material, electrolyte) -**HaoPeng Technology** (cathode precursor)	-Reached mass-production and are expanding production capacity; -Automated production lines, import of key equipment.	Developed a silicon carbon anode material; The R&D base is headquartered in Shenzhen; Development of comprehensive lithium battery technology solutions (material application)	Domestic mainstream customers; Develop materials together with customers; Traditional cathode and anode materials markets are saturated	From the production of cathode or anode materials to the development and manufacture of all materials, including cathode and anode materials, electrolytes, separators, and binders.	Provide talent and financial support for production expansion; Speed up project approval and simplify approval procedures

	Firm and positions in the value chain	Mass production and advanced manufacturing capabilities	Technology R&D and innovation capabilities	Customer and market conditions	Corporate development strategy	Business needs for local policies
锂电设备	**Yinghe Technology** (Lithium battery front-end and back-end equipment, especially for laser cutting/ slitting, winder/ calendaring, electrode shaping, MES, complete intelligent assembly line, etc.)	Has reached mass-producion and is expanding production capacity; The overall level of automation of equipment production is not very high. Non-standard equipment products must be assembled by hand. Precision parts processing with automation	The only firm manufacturing intelligent production line solution for lithium battery production (turnkey project); Developed industry-specific manufacturing execution system (MES); Develop "digital factory" concept	Domestic mainstream customers; Products are customized for customers; Provide a lot of training support for customers, similar to robot manufacturers	Integrate equipment manufacturing for whole process of lithium battery production, from front-end electrode production, middle-stage cell assembly, to rear-end cell finishing, and promote intelligent manufacturing system	Help companies solve problems of talent attraction, training and maintenance

Equipment Provider

	Firm and positions in the value chain	Mass production and advanced manufacturing capabilities	Technology R&D and innovation capabilities	Customer and market conditions	Corporate development strategy	Business needs for local policies
精密结构件	**Kodali Precision** (automobile power battery structural parts, electric box structural parts for energy storage battery) **BYD** (battery cover)	Kodali plans to produce 30 million sets per year; it has reached mass production and is expanding its production capacity; Main equipment is imported. Equipped with automated production line. Pre-purchase of equipment suppliers' several years of production capacity	Take use of experience in the mold industry since many years to carry out product process innovation; Develop precision components for intelligent vehicle control systems	Domestic mainstream customers; The national market share is 50%, and the global market share is 20%; Keep up with the needs of mainstream car (OEM) companies	Niche strategy to become a first tier supplier of lithium battery precision structural parts and new energy automotive parts assembly	Develop a more complete local industrial chain to create conditions for the migration of corporate headquarters from Shenzhen to Huizhou

Auxiliary component supplier

Battery Manufacturers: Cell Production

	Firm and positions in the value chain	Mass production and advanced manufacturing capabilities	Technology R&D and innovation capabilities	Customer and market conditions	Corporate development strategy	Business needs for local policies
电芯	**EVE Lithium Energy** (batteries: cobalt acid lithium, NCM- nickel and manganese, with anode, phosphate Li-ion) **BYD** battery (ion battery, NCA, NCM) **E-Power Energy** (lithium acid manganate) **Haopeng Technology** (NCA) **Sunwoda** (NCA, NCM)	Mass production, and is expanding capacity on a larger scale; Realized fully automatic intelligent production line; But less automatic production line for pouch packs	Routine development of cell design; Research is mainly to extend battery life and increase capacity density; R&D associated with battery material research; There is a gap between the overall technological level with Japanese and Korean companies.	Supply to the producers for battery modules and battery packs assembly, some are local producers	Integrating into the production of the EV battery system, as the core technology foundation of the whole battery system	Permission of establishment of an industrial park and various related supportive policies

Battery Manufacturers: Modules, Pack Assembly, BMS

	Firm and positions in the value chain	Mass production and advanced manufacturing capabilities	Technology R&D and innovation capabilities	Customer and market conditions	Corporate development strategy	Business needs for local policies
电池管理系统与电池系统	**EVE Lithium Energy** (cylindrical, prismatic, pouch; EV power, energy storage) 20 Gwh **BYD** battery (prismatic design; EV power, energy storage) 40 Gwh **Desay Blue Micro New Energy** (prismatic, cylindrical; EV power, energy storage; now only BMS) **Yineng Electronics** (pouch pack; EV power; BMS) **E-Power Energy** (pouch; electric bus power; BMS) 2.8 Gwh **Sunwoda** (modules, packs, BMS) 50 Gwh in 5 yrs.	Mass production and large-scale expansion of production capacity; 12.1 GWh/year Semi-automatic, fully automated, intelligent manufacturing lines are used according to different products. The front-end equipment is mostly imported, and the battery pack assembly line and logistics line at the back end are developed by firms in-house.	Intensive development activities, including: Iterative development of software systems, multiple sets of BMS; Circuit system design, using active liquid cooling technology for battery systems; Battery system design optimization	Domestic mainstream customers, and international mainstream customers; Emphasize a rapid response to customer needs; Equipped with specialized professional after-sales service; The impact of the policy on the market demand is relatively large, felt by pressure on cost killing from clients (OEM)	Reduce costs through capacity expansion to increase market share; Development towards integration of whole vehicle production (BYD, but also EVE)	Provide financial support for technology research and development, and encourage enterprises to expand R&D centers; Attracting OEMs to set up; Tax incentives for innovative start-ups; Financial subsidies and loan facilities, etc.

Emerging EV Battery Cluster in Huizhou: Summary

- **Manufacturing:** Huizhou's 5 automotive EV Battery Companies (Haopeng Technology, Xinwanda, BYD batteries, Yineng Electronics and EVE lithium energy) are all transforming to automatic large-scale manufacturing.
  - In 2017, the cluster's EV battery production capacity reached 12.1 Giga (GWH), annual production capacity of 196, 700 sets of EV battery parks, annual output of 31800 sets **(capacity usage rate:16%).**
- **Technology**: The performance of the developed products is leading in the industry, and the key technologies of the battery have made major breakthroughs. Some of the power battery products have even reached the international advanced level.
- **Sales and Market**: In 2017, the sales of new energy vehicles in China exceeded 800,000 units, and Huizhou EV and key component firms achieved sales revenue of 12.45 billion Y.
  - Huizhou local firms are almost all market champions in materials, equipment and structural parts at the front end of the battery industry chain, with market share having an absolute advantage.
  - The products of battery cells, battery systems and battery management systems of those firms at the downstream of the industrial chain have also entered the supply system of well-known domestic automobile OEMs.
- **Development Strategy**: All are emerging, high-growth enterprises, which have activities and impulses to promote the close interactions among power battery, materials, parts and components, and downstream vehicles. Investors and companies also have forward-and-backward integration in their own industry chain to enhance brand awareness and strengthen their core competitiveness.

Experienced Mass Manufacturing: Core Competence of Chinese NEV Battery Makers

1) **Core Technologies and Capabilities:** Li-battery cell production; capacity planning, fast building, and scaling up of investment for NEV battery production ; cost controlling; large quantity production with stabilized quality.

2) **Core Assets and Resources:** intelligent manufacturing system implementation (Battery production has seen a significant push for digital automation, related to Made in China 2025. Automation is mostly introduced to improve quality standards), using newest equipment imported from different places, continuous purchase of automated machines, forming fixed assets.

3) **Core skills and experience:** system integration and engineering, know-how in battery manufacturing; modularization of product design; adaptation to different market segments and speed to respond to customer requirement.

X company's mass production facilities of EV battery

EV Cell

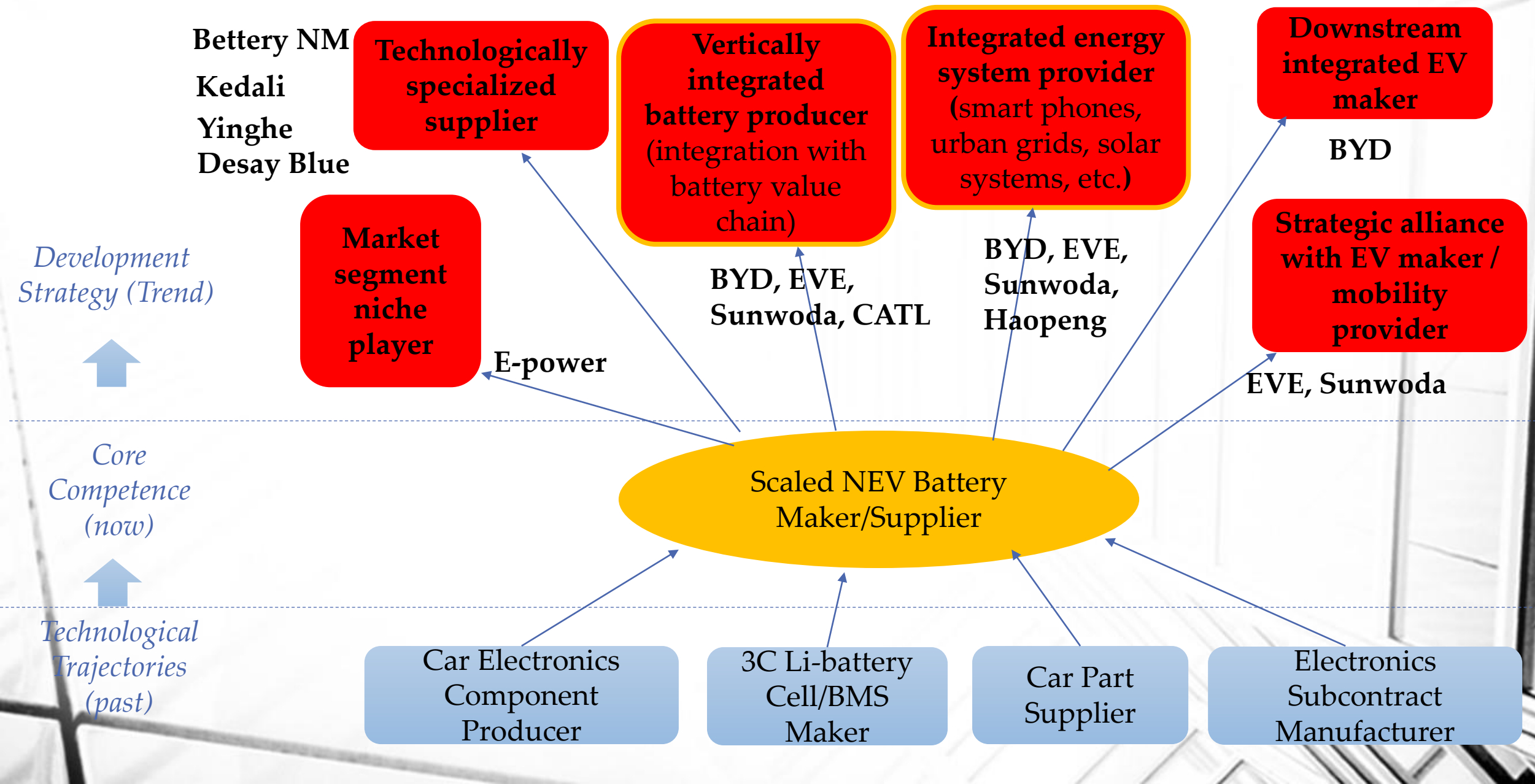
EV Module

BMS

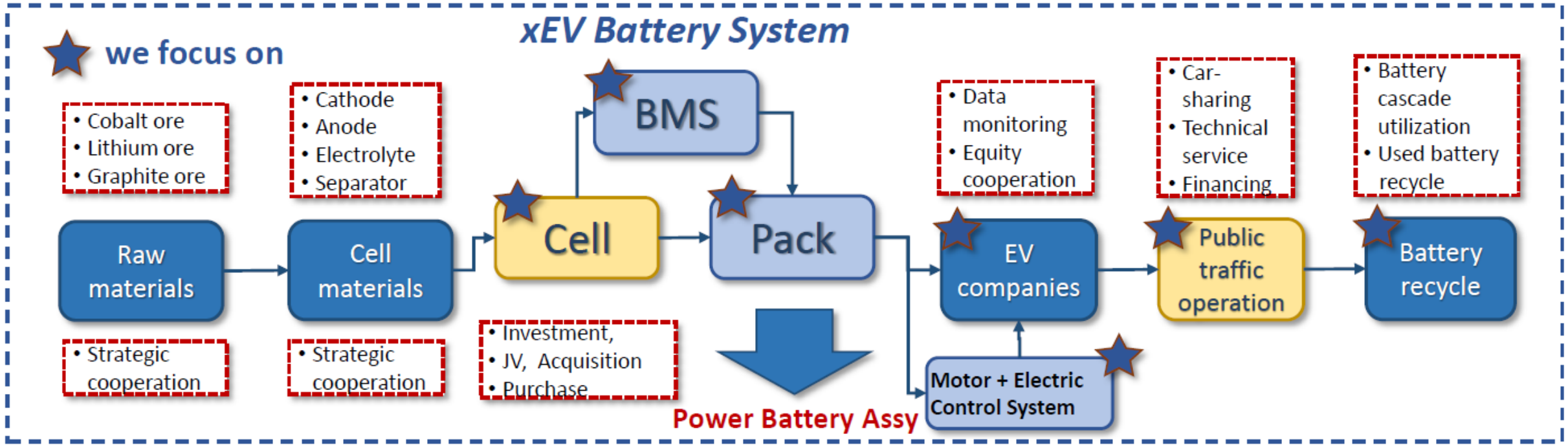
EV PACK

IV. Strategy of Vertical Specialization and Impact on the Future of NEV Supply Chain

Dominant Strategy: Vertically Specialized Integration



X company's power battery strategy: hidden champion with vertical specialization



- Full industrial chain involvement to enhance comprehensive competitiveness
- Full localized production capacity planning to develop strategic customers
- Full life cycle quality management to guarantee sustainable business growth

V. Conclusions and Implications

Future structure of Auto Industry: Vertically disintegrated with specialized integrated battery makers (Foxconnization of CATL)

- **Production for platforms:** brand-name carmakers VW, BMW, and other incumbent global carmakers have decided to source battery cells externally under large-scale contracts with CATL and other East-Asian producers, and to limit their own production activities to the assembly of battery cells into car frames. This model is already practiced in relevant factories in China. Also, Chinese local governments have habit to encourage large scale and leap-frogging champions to become suppliers to brand-name car OEM producers.
- **The perils of the CATL model:** battery makers become over-dependent on the car industry and risk to remain trapped as mass suppliers of cheap standard components with large numbers of low-wage manufacturing jobs under control of carmakers (like the Chinese solar panel industry before).

Implications to China

广东省人民政府关于加快新能源汽车产业创新发展的意见:

1. 加强关键核心技术研发
2. 建设产业创新平台
3. 组建产业技术创新联盟

1. Policy for Flexible Specialization Clustering

Consortia and alliances

Public technology centers

Industrial parks

Training centers

Adoption and diffusion centers

Incubators

Objective setting; Firm attracting and incubating (match zoning and section targeting; upstream activities promotion; investing in car assemblers; intelligent manufacturing diffusion; IoT project, etc.)

（一）做大做强新能源汽车产业集群

（二）建设粤东西两翼新能源汽车产业基地

（三）支持企业降低生产成本

Investment bureau

Professional fairs

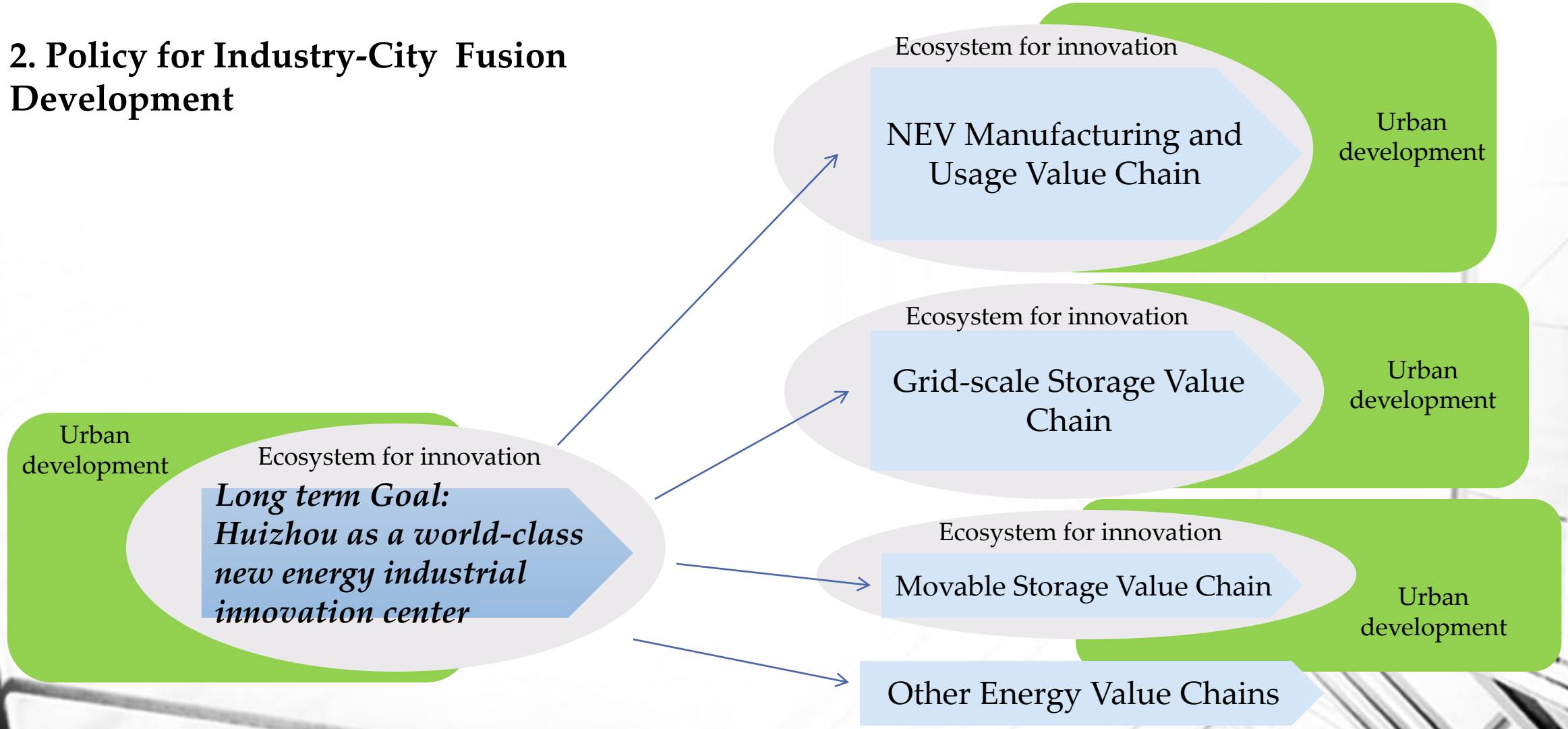
Overseas projects

Sectoral funds, leasing funds

Testing, standards, and service

Implications to China

2. Policy for Industry-City Fusion Development



Implication to EU

1. Relentless focus on cost and scale, China's battery makers are in the midst of technological catching up with their counterparts in Japan and South Korea and becoming dominant international suppliers.

2. Replication of experimental ecosystem created jointly by firm decisions and industrial policies is pushing Chinese battery makers to increase their production capacity, without paying attention to potential problems of overcapacity and technological locks-in, situation similar to that of solar panel industry.

3. Supported by local ecosystem and policies, China's emerging regional specialized clusters of NEV battery manufacturing stress more pragmatic integration into global networks than classic technonationalism (endogenous innovation). If more of the supply chain for electric vehicles is in China than any where else, Chinese-made power trains may become the global standard.

4. Western/EU car makers are now struggling with the investments required for scale up manufacturing of EV batteries. In face of Chinese firms' aggressive entry, they may have to decide: licensing technology, buying hardware, or building by their own?