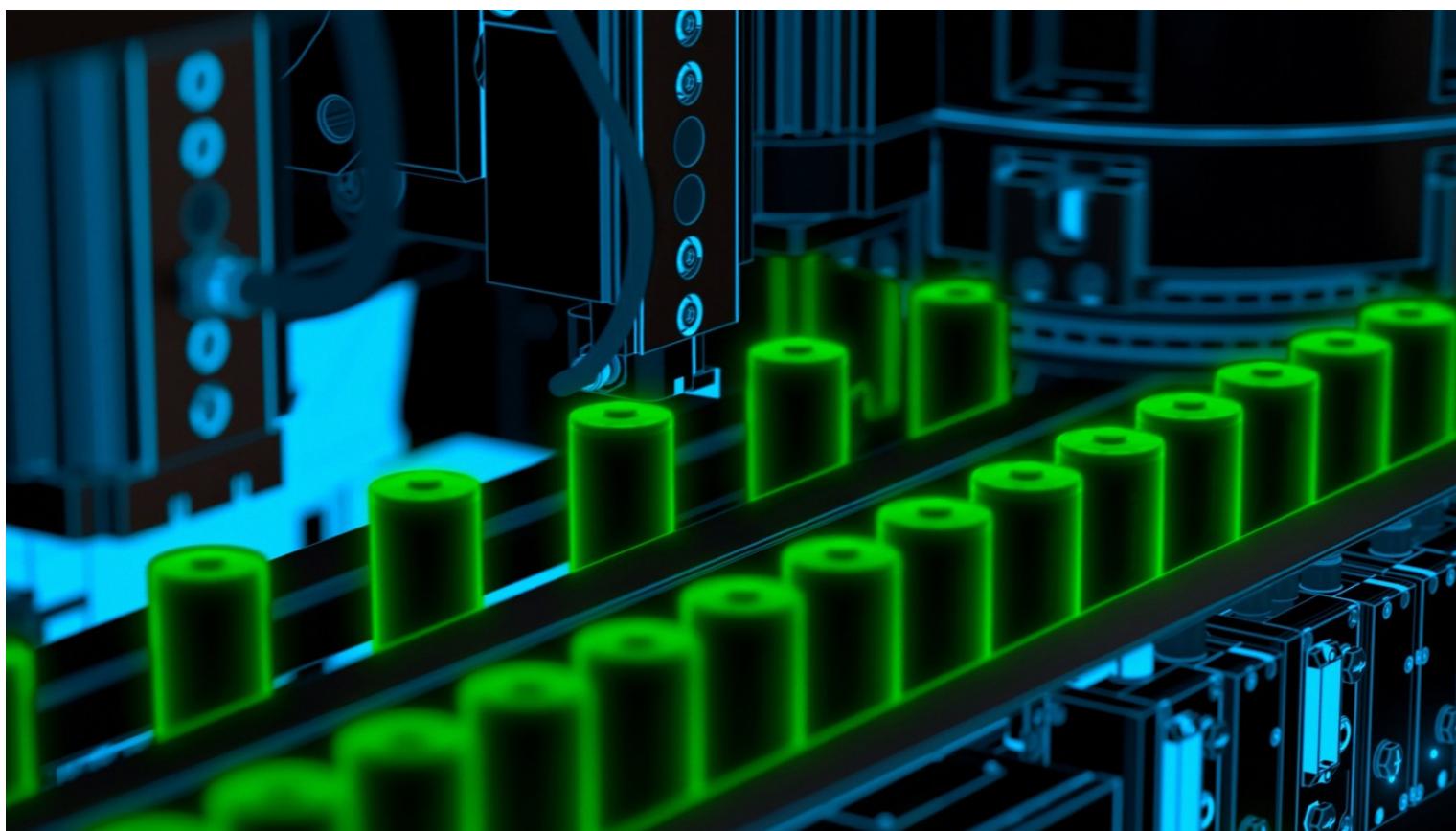


June 23, 2022 09:00 PM GMT

China Industrials

Lithium Battery Equipment – Seeking Alpha Through Cycles

In this report we highlight three trends – technology iteration, overseas tailwinds, and client decentralization – that we believe will bring long-term structural opportunities to Chinese players. We see Wuxi Lead and Hangke as best positioned, and we initiate on Hangke at OW.



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Lithium Battery Equipment – Seeking Alpha Through Cycles

China's lithium battery equipment industry has underperformed battery makers in the last four years due to weaker bargaining power and high cyclical. However, we believe three structural changes will generate more alpha among leading players going forward:

INDUSTRY VIEW

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In-Line

(1) Technology iteration will set a higher threshold. The increased application of

stacking machines, rising penetration of 4680-spec cells, and emergence of newly formed cells will help maintain the competitiveness of leading names in terms of market share and margins.

Technology reform involves contribution of technical breakthroughs from equipment suppliers in multiple processes.

(2) International markets to become another growth driver.

Following capacity expansion in China, global lithium battery makers have announced their own large-scale expansion plans. Emerging cell makers provide an opportunity for equipment suppliers to penetrate the overseas market, since new entrants will likely have little experience in cell manufacturing and hence will depend on equipment suppliers. Compared with their global peers, China's leading equipment suppliers have prominent advantages in R&D, production/after-sales service capacity, and cost effectiveness. Overseas expansion would provide broader market potential and help offset the domestic demand slowdown.

Exhibit 1: What's changed?

		Rating	PT
Wuxi Lead	MS new	OW	CNY 90.0
	MS old	OW	CNY 93.0
	% change		
Hangke	Initiation	OW	CNY 115.0

Source: Morgan Stanley Research estimates.

(3) Benefiting from a decentralized cell manufacturing market.

The lithium battery manufacturing industry is becoming crowded, with new entrants from both emerging cell makers and OEMs. The market will become more fragmented in the next few years, especially in view of increasing LFP battery adoption. We think this will push cell makers to focus more on product differentiation instead of existing technology duplication, where new equipment can contribute greater value and enjoy stronger bargaining power.

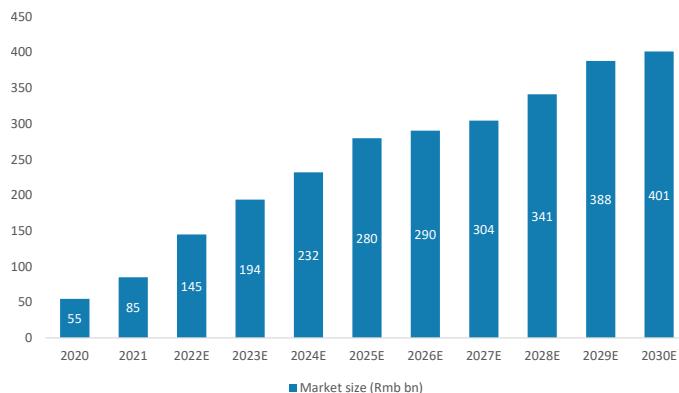
We believe most investors are fully aware of a potential domestic capacity expansion slowdown in 2024. In light of the potential positive surprises with alpha emergence in the long term, we prefer **Wuxi Lead** and **Hangke** due to their advanced technology, high margins, and quality clients.

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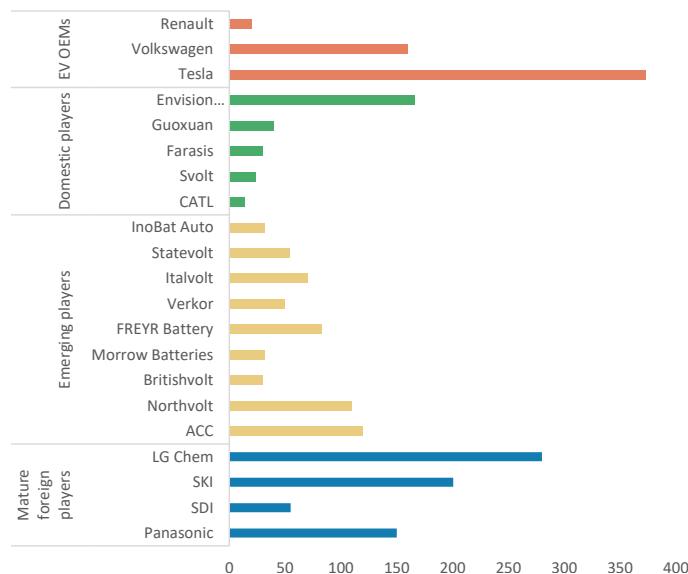
Key Exhibits

Exhibit 2: We estimate global lithium battery equipment sales will reach Rmb280bn by 2025 and Rmb400bn by 2030



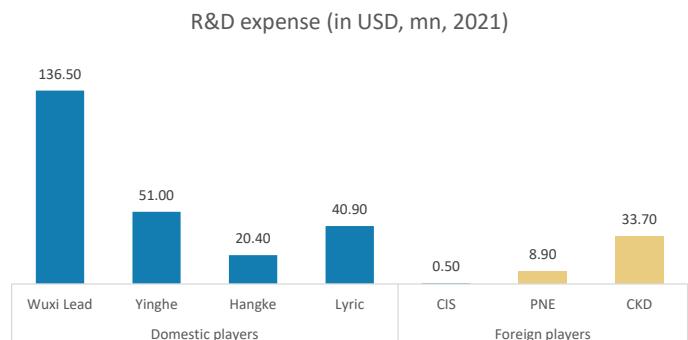
Source: Morgan Stanley Research estimates.

Exhibit 4: We estimate over 2TWh of new capacity is planned within 2022-30 in overseas markets



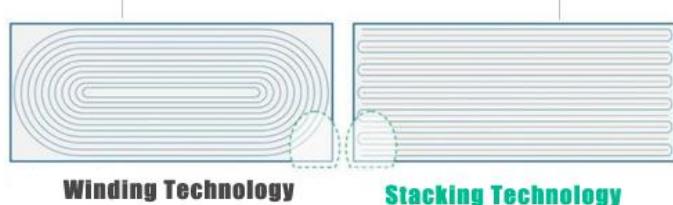
Source: Morgan Stanley Research estimates. Note: Tesla announced plans to independently produce battery cells at 100GWh scale by 2022 and 3TWh by 2030.

Exhibit 6: R&D investment from Chinese equipment suppliers is much higher than foreign peers



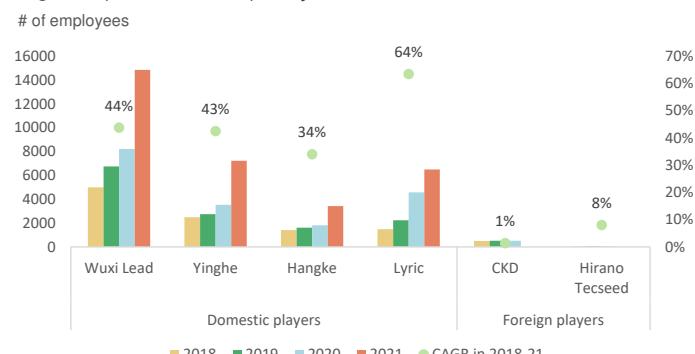
Source: Company data, Morgan Stanley Research.

Exhibit 3: Cells made by stacking machines enjoy lower internal resistance, high capacity density, and high discharge platform



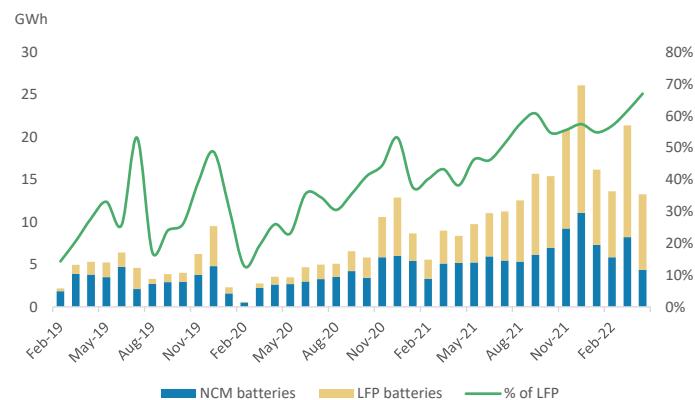
Source: Grepow.

Exhibit 5: Chinese equipment suppliers have prominent advantages in production capacity



Source: Company data, Morgan Stanley Research.

Exhibit 7: Increasing LFP battery adoption lowers technical entry barriers, which is likely to result in the decentralization of the battery manufacturing market, benefiting equipment suppliers



Source: GGII, SNE, Morgan Stanley Research.

Executive Summary

During the aggressive lithium battery capacity expansion in 4Q20-2021, the share prices of equipment makers almost tripled before encountering a major pullback this year. Apart from short-term macro uncertainty caused by the lockdowns in China, we think the de-rating is attributable to market concerns about a capacity expansion slowdown in 2022-24. Overall we expect the global equipment market to reach Rmb280bn in 2025 and Rmb400bn in 2030, up from Rmb85bn in 2021. In this report we will focus more on the industry's long-term trends instead of the industry's cyclicalities. We note that equipment names have shown little alpha and have always underperformed battery makers in the past. From this viewpoint, we see current valuations as attractive despite the recent rebound, and highlight three trends that will generate structural change in the industry.

(1) Technology iteration

The market is concerned that competition among equipment suppliers will intensify as more players join the industry. We think iteration will help the leading names maintain their competitiveness in terms of market share and margins. Equipment suppliers have been pursuing greater precision and consistency in manufacturing, even as they expand capacity. We see three major trends emerging in this area – including the increased penetration of stacking machines, 4680-spec cells, and solid batteries – that will lift the manufacturing threshold for equipment makers.

- Cells made by **stacking machines** enjoy lower internal resistance, stable cell structure, and less dead space, resulting in higher energy density. However, they are currently used less than winding machines due to their lower consistency and production efficiency. As larger and thinner cells are launched by cell makers, we believe the advantages of stacking machines will become more apparent and they will gain share.
- **4680-spec cells** have higher energy density, a simpler production process with lower costs, and better resistance to the swelling of silicon anodes. Multiple OEMs have announced plans to adopt this format from 2022 at the earliest. Given

that 4680 production lines are not compatible with those of 2170-spec cells, the increasing penetration of 4680 cells is likely to generate extra equipment demand. Also, entry barriers will be raised in a number of processes, such as coating, rolling, laser cutting, and tab welding.

- **Solid state cells** replace the liquid electrolyte solution with a solid electrolyte, which also acts as a separator. The solid electrolyte eliminates the risk of explosions and fires, saving space that would otherwise be used by safety components and thereby increasing energy density. That said, solid state cells are a longer-term story as they are currently expensive and multiple technical issues remain unsolved.

(2) Overseas tailwinds

Following the aggressive capacity expansion in China since 4Q20, a massive expansion overseas has started this year, with plans for new capacity of over 2TWh by 2030. This will mainly be contributed by leading global cell makers (i.e., LG and SKI), emerging international cell makers (i.e., Northvolt and ACC), Chinese cell makers (i.e., CATL, Envision, etc), and global OEMs (i.e., Tesla, Volkswagen, etc). This provides an opportunity for Chinese cell equipment suppliers to expand internationally. The global market is currently dominated by Korean/Japanese equipment names, especially at the higher end of the market. However, limited by their capacity scale in terms of both production and after-sales service, global equipment peers are unable to fulfill overseas expansion demand, leaving room for China's leading suppliers.

New and emerging cell makers provide an opportunity for equipment suppliers to penetrate the overseas market, since new entrants will likely have little experience in cell manufacturing and hence will depend on equipment suppliers. The overseas expansion plans of their existing domestic clients provide another opportunity for the leading China equipment suppliers to penetrate the overseas market, particularly given the stickiness of their relationships. We think overseas demand may alleviate order cyclicalities in the Chinese market, which has been a concern of investors for several months.

(3) Diversified client market landscape

OEMs are actively participating in cell manufacturing these days. Second-tier battery makers are also aggressive on market share, with massive capacity expansion plans. As increasing LFP cell adoption lowers the technical entry barriers, we foresee intensifying competition among cell makers and a more fragmented cell supply landscape. This will favor equipment suppliers in that they will be less dependent on a single client. Furthermore, the aggressive capacity expansion currently underway in China uses existing technology. We think cell makers will be more focused on seeking product differentiation via technology upgrades and iterations once capacity expansion slows and competition heats up. This is where the importance of iteration contributed by equipment suppliers will come into play. We think leading equipment makers with strong R&D capabilities will enjoy greater bargaining power and higher customer loyalty.

Stock ideas: Based on the three major trends mentioned above, we prefer **Wuxi Lead** and **Hangke**, which have proved themselves to

quality clients with solid products and enjoy high margins. We think the keys to staying in the front rank will be strong R&D capabilities and quality management. Wuxi Lead and Hangke should benefit from overseas tailwinds and stand a higher chance of maintaining their leading positions in technology with strong profitability in the long term. Current valuations look attractive, as Wuxi Lead is trading at 25x 2023 P/E and 0.5x PEG in 2021-24, well below its 7-year historical average of 34x. Hangke's 18x 2023 P/E also looks compelling compared to its 3-year historical average of 37x.

Where could we be wrong?

- Worse-than-expected NEV sales volume, which would lead to weaker capacity expansion.
- Further consolidation in the lithium battery market, which would result in stronger bargaining power for cell makers.
- Slower-than-expected technology iteration with intensified equipment market competition.
- Geopolitical tensions constrain equipment exports.

Exhibit 8: We initiate coverage on Hangke and revise our price target for Wuxi Lead

		Rating	PT	Revenue			Net Profit		
				2022E	2023E	2024E	2022E	2023E	2024E
Wuxi Lead	MS new	OW	CNY 90.0	16,223	24,240	29,359	2,550	4,065	5,223
	MS old	OW	CNY 93.0	17,883	23,168	26,568	2,844	3,719	4,403
	% change			-9.3%	4.6%	10.5%	-10.3%	9.3%	18.6%
	Initiation	OW	CNY 115.0	4,366	7,364	9,249	689	1,563	2,214

Source: Morgan Stanley Research. E = Morgan Stanley Research estimates.

Missing Alpha in the Past

Over the past three years, the share price movements of lithium battery equipment stocks can be roughly divided into five periods:

- **September 2020 – January 2021:** In September 2020, the central government announced an aim to hit peak emissions before 2030 and reach carbon neutrality by 2060. Also, NEV sales recovered from the Covid-19 pandemic and leading domestic lithium battery makers started their aggressive capacity expansions, which together drove up the share prices of lithium battery equipment players across the industry.
- **January 2021 – March 2021:** There was a pullback in share prices, which we think was mainly due to concerns over weak NEV sales and some progress on solid-state cell development.
- **April 2021 – December 2021:** More Chinese cell makers started expanding capacity. On the back of a bullish market view for NEV demand in the next five years, some further

raised their mid-term targets in a bid to gain market share. Meanwhile, global cell makers also announced large-scale expansion plans to accelerate their energy transitions. This signaled the start of the second capacity expansion cycle, and share prices surged in response.

- **December 2021 – April 2022:** The lithium carbonate price surge concerned the market in terms of both NEV demand and the margins of lithium battery makers in the near term. Investors worried margin pressure would gradually be passed on to equipment suppliers. The share prices of lithium battery equipment players corrected notably together with the cell makers.
- **May 2022 – present:** Share prices recovered slightly as NEV sales rebounded in May as daily Covid-19 cases in China decline and on the oil price surge. Concerns about EV demand and the interruption of the auto manufacturing supply chain were slightly eased.

Exhibit 9: Historical stock price performance (peers vs index)

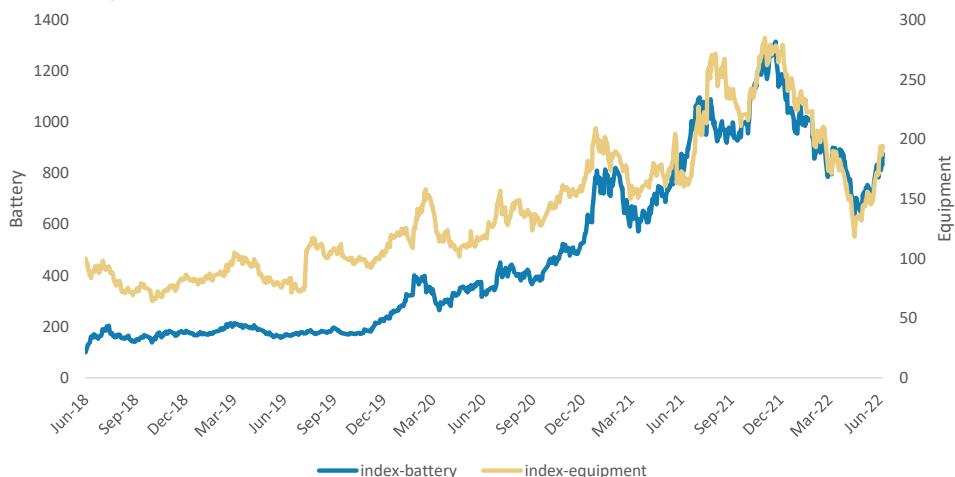


Source: Refinitiv, Morgan Stanley Research.

Lack of alpha and underperformance versus battery makers

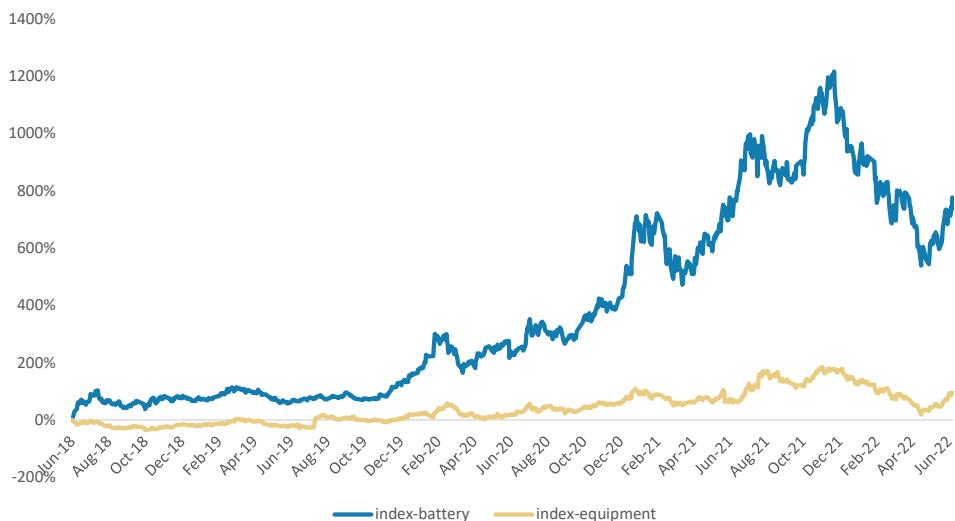
Over the past four years, the share prices of China's lithium battery equipment makers have underperformed battery makers, regardless of whether the battery industry was pulling back or surging. We have seen little alpha generation by equipment stocks, even amid the strong capacity expansion plans announced domestically in 2021. We think investors paid less attention to equipment stocks than the battery-making names due to the much smaller market size, weaker bargaining power, and cyclical caused by battery makers' capacity expansion plans. Prior to 2021, most of the capacity expansion was from CATL, and equipment orders were limited to around Rmb40bn/year on average in 2018-20, compared with a lithium battery market worth Rmb156bn/year in the same period. Investors have been treating the leading equipment maker, Wuxi Lead, more as a proxy for battery maker CATL. Most of Wuxi Lead's equipment peers are relatively small and had only recently joined the EV battery industry. As a result, the Morgan Stanley equipment index (weighted by market cap) has underperformed the Morgan Stanley lithium battery index for four years despite the respective industries sharing similar trends.

Exhibit 10: The lithium battery and equipment industries have seen similar trends over the past four years



Source: Wind, Morgan Stanley Research. The Morgan Stanley equipment index include Wuxi Lead, Yinghe, Hangke, Lyric, HNAC Technology, United Winners, Nebula Electronics and Kanhoo; The Morgan Stanley battery index include CATL, Guoxuan High-tech and EVE Energy.

Exhibit 11: The Morgan Stanley equipment index has underperformed the Morgan Stanley battery index since mid-2018. Its only period of outperformance was in 1Q21.



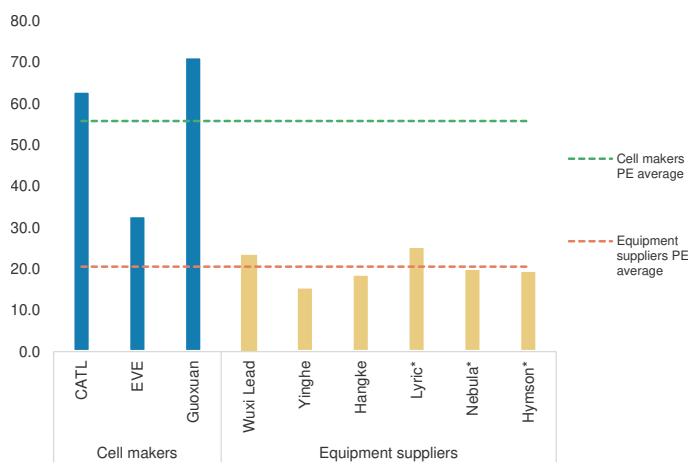
Source: Wind, Morgan Stanley Research. The Morgan Stanley equipment index include Wuxi Lead, Yinghe, Hangke, Lyric, HNAC Technology, United Winners, Nebula Electronics and Kanhoo. The Morgan Stanley battery index include CATL, Guoxuan High-tech and EVE Energy.

What concerns the market at this point?

Investors are worried that the equipment industry new orders will peak in 2023 and the equipment suppliers' margins will be squeezed due to the lithium carbonate price surge. Whether orders peak in 2023 or not will depend on the level of overseas orders Chinese equipment makers can attain. In the meantime, we see a limited impact on equipment margins from the lithium carbonate price surge, as battery makers usually separate their budget for material purchases from that for capacity expansion. We do not think battery makers will sacrifice potential market share gains for short-term profitability so long as the strong EV outlook remains intact.

In this report, we will focus more on the long-term trends than on the equipment industry's cycles. We think concerns of a new order growth slowdown and margin pressure are fully priced in. We believe the industry will deliver more alpha in the medium to long term based on three major trends – global growth, technology iteration, and the decentralization of cell manufacturing.

Exhibit 12: 2023 P/E estimates

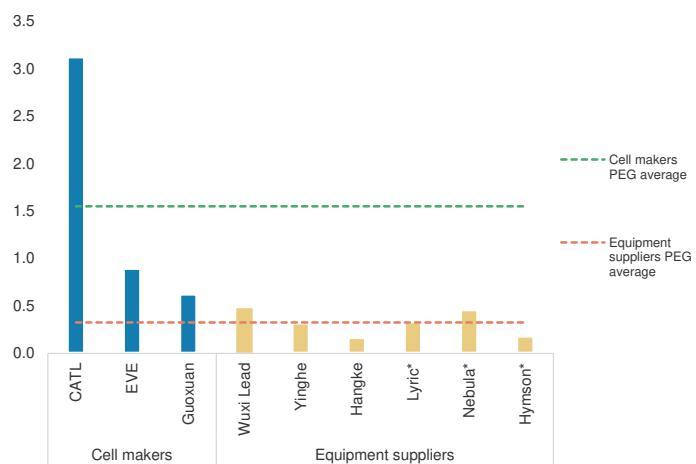


Source: Refinitiv, Morgan Stanley Research estimates. *Denotes stocks not covered by Morgan Stanley Research, using data from Refinitiv consensus estimates.

Why are we writing this note now?

The share prices of both cell makers and equipment suppliers have dropped sharply over the past six months, despite a mild rebound in recent weeks. We believe this creates an attractive entry point for equipment suppliers. In the near term, equipment suppliers should enjoy stronger sales growth and a better margin outlook than cell makers, yet they are trading at below-average discounts to cell makers in terms of both P/E and PEG in 2021-24. Leaving aside the probability of a near-term market peak in 2024 and margin pressure from material price hikes, we believe the equipment market as a whole will see a notable expansion over the next few years.

Exhibit 13: 2023 PEG estimate

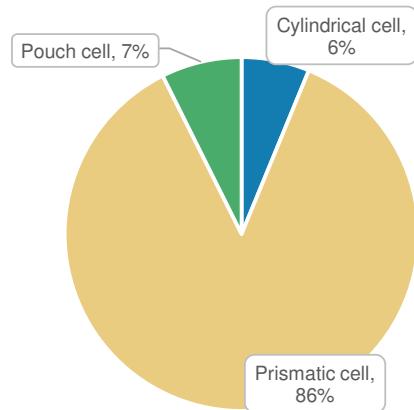


Source: Refinitiv, Morgan Stanley Research estimates. *Denotes stocks not covered by Morgan Stanley Research, using data from Refinitiv consensus estimates.

Trend #1: Technology Iteration to Help Maintain Leading Position

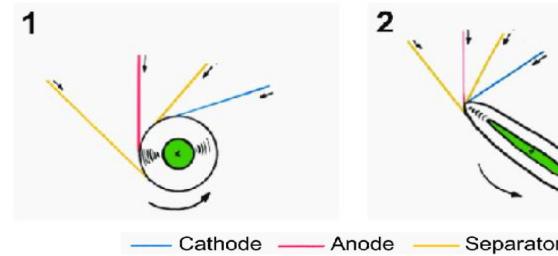
It is widely known that equipment suppliers start to face pricing pressure once a technology is widely adopted, typically within 2-3 years after launch. Lithium battery manufacturing techniques have seen limited iteration in recent years. This explains a major concern in the market regarding depressed margins in the long term. However, we believe several technology iterations – 4680-spec cells, the greater use of stacking machines, and the application of solid state cells – will help maintain the competitiveness of leading equipment names, alleviate pricing pressure, and create extra equipment demand over the next few years.

Exhibit 14: Prismatic cells are the major EV cell type in China, representing 86% of total cell installations in 2021



Source: GII, Morgan Stanley Research.

Exhibit 16: Winding machines to make cylindrical cells and prismatic cells

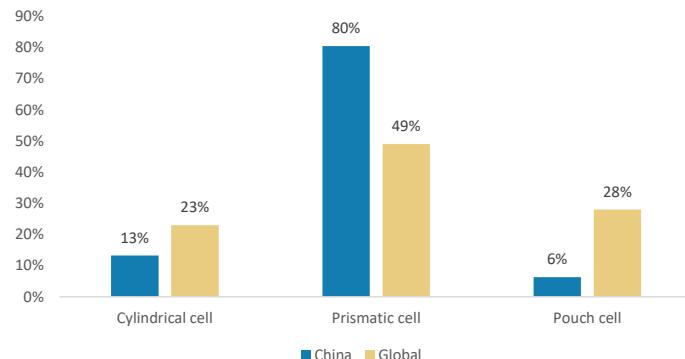


Source: ResearchGate. Note: 1. round winding; 2. prismatic winding.

(1) Stacking machines

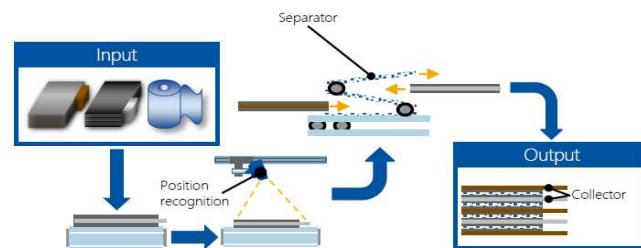
Thanks to better production efficiency, higher accuracy and lower costs, winding machines continue to dominate prismatic cell manufacturing, while stacking machines are used more for making EV pouch cells, as they are coated by aluminum plastic film, which has weaker mechanical properties than cylindrical and prismatic cells' steel or aluminum shells. In 2021, prismatic cells made up 86% of China's EV cell installations, up from 80% in 2020. Globally, prismatic cells have a relatively low share at nearly half of the market. Pouch cells are more popular internationally, with a 28% global share versus 6% in China. Hence, winding machines are still the major production technology used for cell assembly worldwide.

Exhibit 15: Globally, prismatic EV cells accounted for nearly half of total cell installations in 2020



Source: SNE Research, Morgan Stanley Research.

Exhibit 17: Stacking process



Source: VDMA.

Exhibit 18: Comparison of Wuxi Lead's stacking and winding machines

	Products	Capacity	Electrode end face alignment	Laminating alignment (between Ca&An)	Overall alignment	Winding alignment	Accuracy of electrode cutting position
Stacking Machine	Stacking Machine	0.45-0.6s/pcs/station	±0.2mm	±0.4mm			
	Stacking & Slitting Machine	0.45-0.8s/pcs/station	±0.2mm	±0.4mm			
	Continuous Thermal Lamination Stacking Machine	0.125s/pcs		±0.5mm	±0.6mm		
	Heat Laminating Machine (Stacking, Separator Cutting Type)	0.2s/pcs		±0.3mm	±0.6mm		
Winding Machine	Prismatic Aluminum Shell Cell Winding Machine	6PPM, electrode length ≤7000mm			±0.3mm	±0.5mm	
	18650/21700 Cylindrical Cell Winding Machine	Max45PPM			±0.2mm	±0.2mm	
	Digital Cell Integrated Welding and Winding Machine	Max20PPM			±0.15mm	±0.2mm	

Source: Wuxi Lead, Morgan Stanley Research.

What are the benefits of cells made by stacking machines? (1)

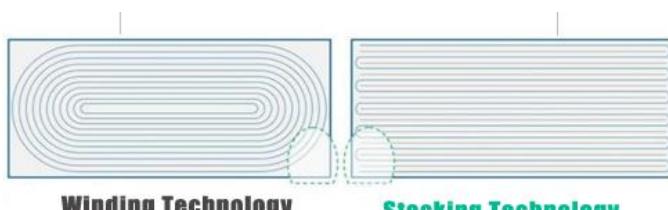
Lower internal resistance due to its parallel structure among many small electrode pieces; (2) higher consistency of stress areas between the electrode and separator, with no significant stress points; and (3) higher energy density due to better utilization of a

cell's internal space. Even so, applications for using stacking machines in prismatic manufacturing are limited owing to low productivity and stability. For the same production line, a stacking machine costs at least 30% more.

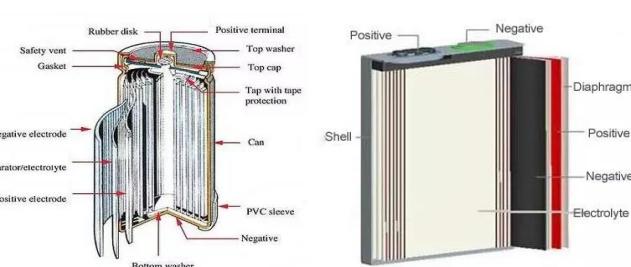
Exhibit 19: Comparison of winding and stacking technologies

		Winding technology	Stacking technology
Internal resistance	High	Normally, there is only a single tab for both the positive and negative electrodes.	Low It is equivalent to a plurality of small pole pieces connected in parallel, which reduces the internal resistance.
Discharge rate	Low	It is difficult for a single-pole to fully discharge at large currents.	High The multi-pole parallel connection makes it easier to discharge large currents in a short time.
Discharge platform	Low	Due to the high internal polarization and high polarization, a part of the voltage is consumed in the internal polarization of the battery, so the discharge platform is slightly lower.	High The lower internal resistance is less polarized, so the discharge platform will be higher than the wound battery and closer to the material's self-discharge platform.
Capacity density	Low	Due to the thickness of the tabs, the circular shape on both sides of the cell, and the two layers of the closed film to occupy the thickness in vain, the internal space is not fully utilized, and the volume-specific capacity is thus slightly lower.	High The internal space of the battery is fully utilized, and thus the volumetric specific capacity is higher than that of the winding process.
Energy density	Low	Due to the low volumetric capacity and the low discharge platform, the energy density is not as good as the stacking technology battery.	High The discharge platform and volume-specific capacity are higher than the winding technology battery, so the energy density is also relatively high.
Scope of application	Narrow	For ultra-thin batteries, the thickness of the tabs takes up too much space and affects the battery capacity.	Wide Whether it's an ultra-thin battery or an ultra-thick battery, the stacking technology can do the job.
Thickness		Application to narrow thickness, the thickness is difficult to control.	Thickness is easy to control and not easy to deform.
Battery shape		Only cylindrical battery	Flexible size, suitable for high-ratebattery, shaped battery, etc.

Source: Grepow, Morgan Stanley Research.

Exhibit 20: Cells made by stacking machines have less dead space and stable cell structures after cycles

Source: Grepow.

Exhibit 21: Stacking technology's key advantages lie in the effective use of space

Source: Battery-Lab.

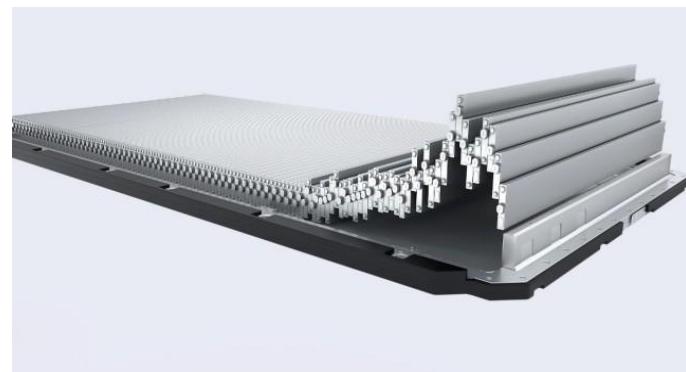
Stacking machines taking share from winding machines. The industry has reached a consensus that prismatic cells at larger and thinner sizes provide higher energy density and better heat dissipation. BYD and Svolt have successively launched the blade battery and L600 battery, respectively. BYD's blade battery is strong enough to support the whole battery pack, thanks to the composition and strength of integrated cells. When making large and thin cells, stacking machines have a prominent advantage in terms of force deformation. Along with their increasing production efficiency and better quality control, we believe stacking machines will gain more share in prismatic cell manufacturing.

Exhibit 22: Svolt L600 cell



Source: GGI.

Exhibit 23: BYD blade cell



Source: EVupdates.

(2) 4680-spec cells

4680 to become the next technology

In the past, the need for battery management system (BMS) simplicity on the OEM side led prismatic and pouch cells to gain market share from cylindrical cells. Prismatic cells have advantages in the effective use of shape with better design flexibility and high structural strength. Our China EV battery supply chain analyst Jack Lu believes 4680 cells (developed by Tesla and existing battery makers, to be launched in 2022) are the next technology iteration, as (1) they are better suited to combat the swelling issue of silicon anodes

(which is likely to be the next generation of anodes) given a circle enclosing maximum area for a given arc length. A rectangular shape would be deformed when the anode expands; (2) they have higher energy density, dry electrodes, and a tableless structure that reduces production complexity, eliminates manufacturing speed bottleneck, and enables some savings on material and energy costs; (3) the larger cylinder is able to simplify BMS with more OEMs to use the technology. Refer to [EV Battery Supply Chain: Charging Ahead – Positioning for Battery Tech's Next Iteration \(4 Jan 2022\)](#) for more details. Jack is positive on the 4680-spec cell kick-off in 2022 and believes it will gradually ramp-up over the next 3-5 years, reaching 50% penetration in the global EV battery market by 2025.

Exhibit 24: Cylindrical cells evolving from 1865 to 4680



Source: Tesla.

Exhibit 25: Tesla's 4680 design unveiled on Battery Day 2020



Source: Tesla.

Higher entry threshold for equipment

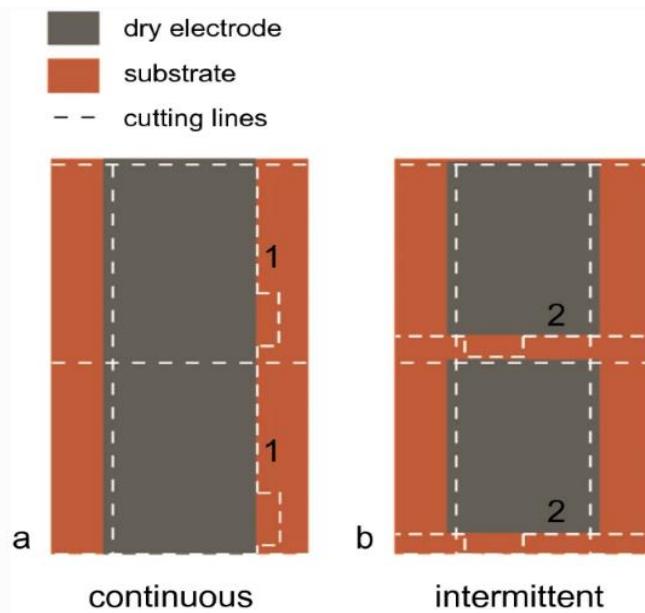
The application of large cylindrical cells sets a higher threshold for equipment and requires technology upgrades in multiple processes – coating, rolling, and laser cutting/welding.

1. The manufacturing of 4680-spec cell needs to left blank when coating the cathode. The width of the blank space is not fixed, indicating much higher consistency requirements for the coating machine.
2. Tabless technology directly cuts blank foil to form tabs, rather than welding external tabs onto the foil. It requires a technology upgrade to laser machines for speed and precision. For the welding step, the number of welding spots for 4680-spec cells is over 5x that of 2170-spec cells, increasing

the welding workload. Laser strength and focal length are hard to control and can easily cause incomplete fusion or burn-through to the cell.

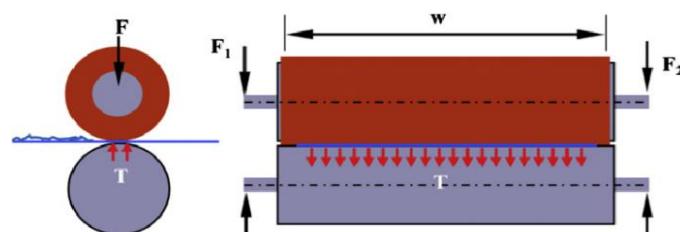
3. Extra heat and annealing treatment is needed when rolling – continuous coating can easily cause warped tabs because the coated foil will extend when it is subject to rolling force but blank foil (tabs) will stay unchanged. In order to make both types of foil extend at the same time, a heat and annealing treatment is adopted when rolling the foil.
4. Formation – 4680-spec cells' thicker rolls and higher energy density raise the difficulty level of temperature control and test consistency. The temperature of the inside roll can easily rise above that of the outside, which may cause fire or an explosion.

Exhibit 26: Continuous coating vs intermittent coating



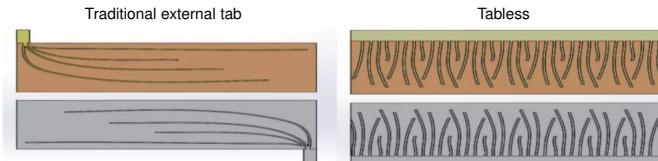
Source: Springer.

Exhibit 28: Electrode calendering pressure force diagram



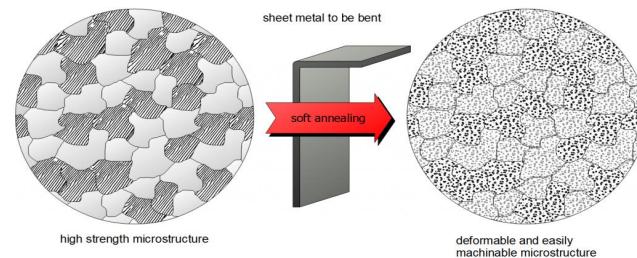
Source: Researchgate.

Exhibit 27: Traditional external tab vs tabless



Source: GGII.

Exhibit 29: Annealing treatment helps to maintain metal ductility, which solves the problem of warpage phenomenon

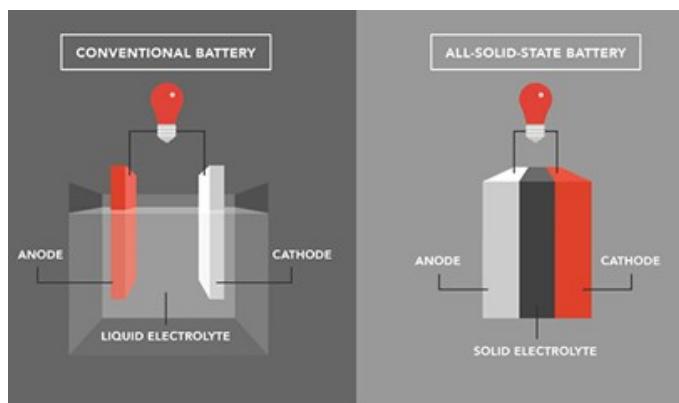


Source: Win.

(3) Solid-state batteries

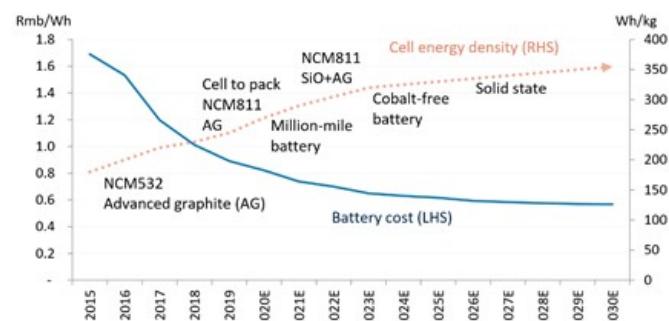
Solid-state batteries use solid electrodes and electrolytes instead of a liquid electrolyte solution. This design increases the capacity of EV batteries through higher energy density without the risk of explosion or fire, so the space reserved for safety components can be used for more active materials. That said, the manufacturing process will no longer require electrode production and refilling. In the meantime, stacking machines will be needed for inorganic electrolyte (sulfide or oxide electrolytes) solid-state battery manufacturing, given its lower mechanical hardness.

Exhibit 30: Comparison between lithium and solid-state batteries



Source: Samsung SDI.

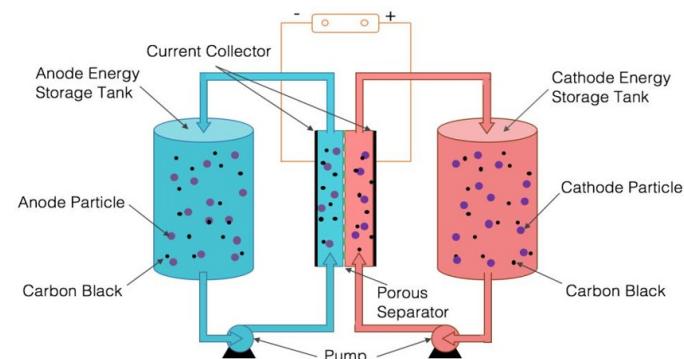
Exhibit 32: The future of batteries



Source: Company data, Morgan Stanley Research. E = Morgan Stanley Research estimates.

The market believes the industrialization of solid-state batteries will take at least 5-10 years. SNE Research has pointed out two major obstacles: multiple technical issues regarding solid electrolytes (including sulfide-based, oxide-based, and polymer-based) and high costs. Hence, OEMs have broken ground by launching semi-solid-state batteries first, and these have already entered mass production. These keep the diaphragm and electrolyte at a lower usage proportion, such that the manufacturing process is not significantly different from liquid electrolyte lithium batteries.

Exhibit 31: A typical semi-solid flow battery design



Source: Journal of Vacuum Science & Technology B.

Exhibit 33: Comparison of solid state and conventional cells

	Solid State Cell	Conventional Cell
Anode(+)	NCM, LiFe	NCM, LiFe
Cathode(-)	Lithium metal	Graphite, SiC
Separator	✗	✓
Electrolyte	Liquid electrolyte (Organic solution)	Solid electrolyte (Solid ionic conductor)
Types	Prismatic, pouch	Cylindrical, prismatic and pouch
Copper foil	✗	✓
Aluminum foil	✓	✓

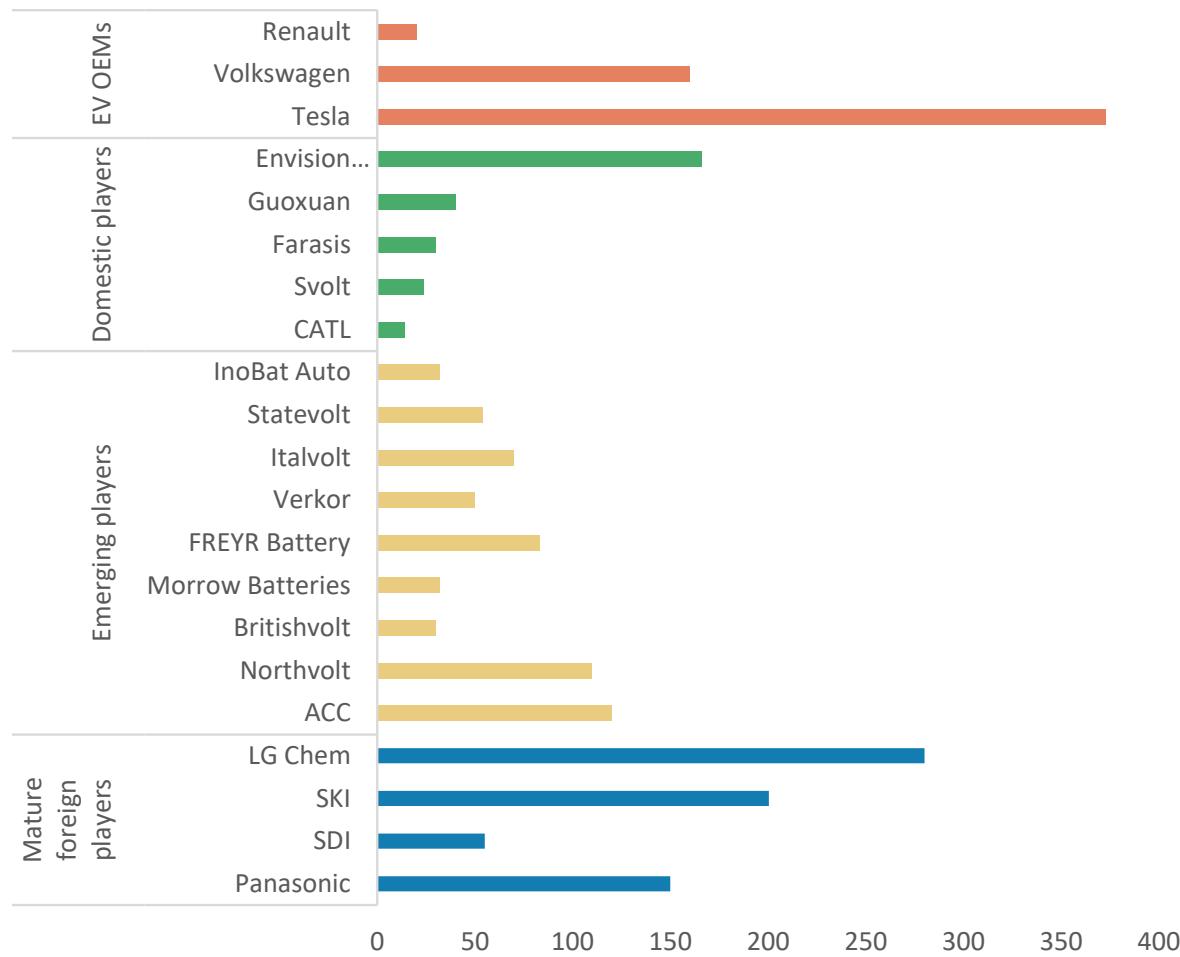
Source: Huacan.com, Morgan Stanley Research.

Trend #2 Overseas Expansion is Another Growth Driver

There are market concerns that the slowdown in domestic capacity will limit the size of the lithium battery equipment market in the next 3-5 years. We believe that overseas expansion will help offset this slowdown and be another growth driver for the industry. Following the aggressive capacity expansion in China since 4Q20, lithium battery makers including existing leading players, OEMs, and new entrants announced plans for large-scale expansion overseas in late 2021. We estimate over 2TWh of new capacity overseas has been planned for 2021-30, with most aiming to start production by 2025. This implies a total equipment market size of Rmb400bn in 2022-25, assuming the average value of a production line overseas is Rmb200mn/GWh, which we derive by taking the average value in the domestic market (Rmb160-180mn/GWh) and overseas (Rmb220-250mn/GWh).

At present, around 60% of global lithium battery capacity comes from China, where localization has reached as high as over 80% in all front-to-back-end machines. While the overseas market is dominated by foreign equipment suppliers, we think the leading domestic players are well-positioned to gain share in the upcoming overseas expansion. This is backed by their improving product quality at better prices as well as their broader product coverage, especially for the emerging battery makers that are more dependent on the equipment suppliers. We believe overseas demand will become another major growth driver for domestic equipment players going forward.

Exhibit 34: Overseas capacity expansion plans announced since 2021 at a total of over 2TWh (mostly by 2025), ranked by OEMs, domestic players, emerging players, mature foreign players)



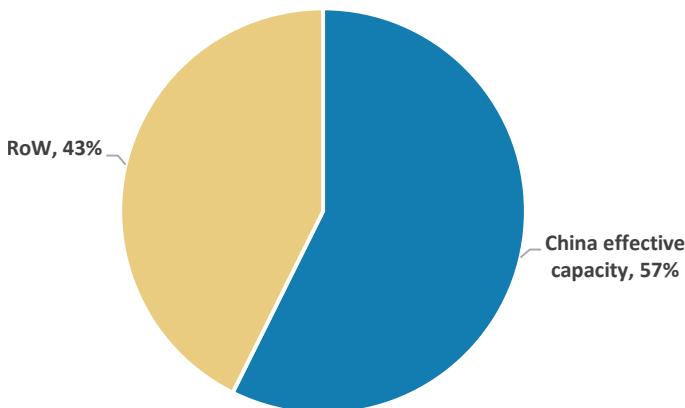
Source: Various materials, Morgan Stanley Research. Note: Tesla announced plans 3TWh cell production capacity by 2030. Here we use the outlook from our US auto team's forecast.

Current competition landscape

Foreign lithium battery makers are mainly using Japanese/Korean equipment suppliers

Japanese and Korean brands (such as PNT, PNE and CKD) have been in the market since 2000-05, growing alongside local cell makers such as LG Chem, Samsung SDI, etc. The Japanese and Korean names

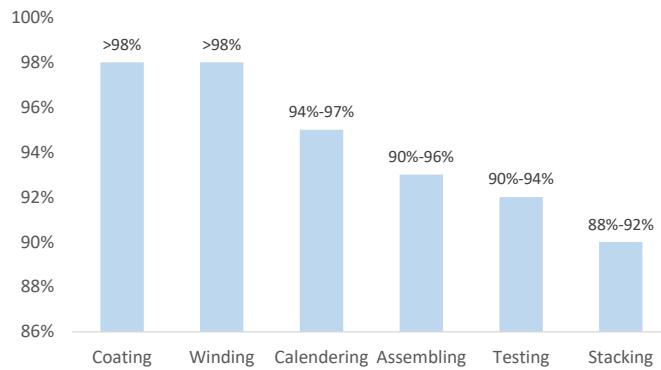
Exhibit 35: 57% capacity from the domestic market in 2021



Source: Morgan Stanley Research.

continue to dominate the overseas market, especially in the front-end. In contrast, China's equipment companies were mostly established around 2010 and enjoyed rapid development amid the capacity expansion by domestic cell makers. Many domestic equipment companies focused on the 3C businesses (computer, communication and consumer electronics) until the electric vehicle (EV) opened a bigger market. In China, equipment manufacturing has already realized import substitution with a localization rate of over 90% in most key processes.

Exhibit 36: China's localization rate



Source: GGI, Morgan Stanley Research.

Exhibit 37: A brief introduction of overseas lithium battery equipment suppliers

	Company name	Country	Founded	IPO	Main products	Revenue (21FY, in USD mn)
Front-end	PNT	Korea	2003	2012	Coating machine, rolling machine, slitting machine	330.1
	CIS	Korea	2002	2015	Coating machine, rolling machine, slitting machine	116
	Hirano Tecseed	Japan	1935	1962	Coating machine	243.4
Mid-end	CKD	Japan	1943	1979	Automatic machine (Winding machine)	1006.6
	KOEM	Korea	1987	unlisted	Winding machine	-
	Youil	Korea	2012	2021	Stacking machine, tab welding machine, modules and packlines	25.66
	Manz	Germany	1987	2006	Winding machine, stacking machine	268.4
Mid & Back-end	DA	Korea	1996	2014	Winding machine, welding machine, formation and grading system	39.68
Back-end	PNE	Korea	2004	2011	Formation and grading system, testing machine, battery assembly	154.2
	NS	Korea	1999	2015	Packing line, degassing line	40.39
	A-pro	Korea	2000	2007	General charges, high temperature pressurized chage	53.78
	KATAOKA	Japan	1968	unlisted	Rechargeable battery inspection systems	-

Source: Company websites, Refinitiv, Morgan Stanley Research.

At present, the domestic equipment suppliers are at the same technology level as their foreign peers in the mid-end and back-end processes, yet they have limited exposure to foreign clients. As one of the leading back-end companies in China, Hangke is the only domestic name that has penetrated the large traditional foreign bat-

tery makers (i.e., LG, SDI, SKI, etc). For the front-end process, we still see a gap between the domestic and international players mainly in terms of equipment reliability and machine stability.

Exhibit 38: Foreign clients' equipment supplier landscape (LG, SDI, SKI, Panasonic-Tesla, Tesla, ACC, Inobat Auto)

Company name	Front-end				Middle-end				Back-end		
	Mixing machine	Coating machine	Rolling machine	Slitting machine	Winding machine	Stacking machine	Filling machine	Welding machine	Formation and grading system	Testing machine	PACK assembly line
LG Chem		Korean and Japanese players			Wuxi Lead, Yinghe, Korean players	Korean players			Hangke, A-Pro, PNE		Korean players
SKI		Korean and Japanese players			-	Korean players			Hangke, A-Pro, PNE		Korean players
SDI		Korean and Japanese players							Hangke, A-Pro, PNE		Korean players
Panasonic-Tesla	Japanese players										
Tesla	Putailai				Wuxi Lead	-	Wuxi Lead	-	Wuxi Lead	-	Wuxi Lead
ACC	TSI and Yinghe	Yinghe			Wuxi Lead						
Inobat Auto	Wuxi Lead										
Northvolt	CIS				Wuxi Lead and Korean players				Wuxi Lead, PNE	Wuxi Lead	
Volkswagen	Volkswagen and Bosch established a JV to supply integrated battery production systems										

Source: Company data, GGI, Yicai Global, Ofweek, Morgan Stanley Research.

Exhibit 39: Technical parameters comparison - coating machine

Company name	Product	Speed (m/min)	Width (mm)	Thickness	Density accuracy
Wuxi Lead	Electrode Coating Machine	Max 100	Max 1500	$\geq 4\mu\text{m}$	$\leq \pm 1.0\%$ (Both sides)
Yinghe	Double slit extrusion coater machine	Max.110	Max 1600	NA	$\pm 1.0\%$
PNT	Double-sided coating machine	Max 100	Max 1450	$\geq 6\mu\text{m}$	$\pm 1.5\%$
CIS	Slot Die Coater 2F/L	Max 5-70	Max 1320	NA	$\pm 1.5\%$

Source: Company websites, Morgan Stanley Research.

Exhibit 40: Technical parameters comparison - winding machine

Company name	Product	Tension fluctuation	Speed /Capacility	Winding alignment	Accuracy of electrode cutting position	Laminating alignment (between Ca&An)
Wuxi Lead	Prismatic aluminum shell cell winding machine	$\leq \pm 3\%$	3m/s	$\pm 0.3\text{mm}$	$\pm 0.5\text{mm}$	
Yinghe	Prismatic power model winding machine		3m/s			
Greensun	Prismatic model auto winding machine		$\geq 3\text{PPM}$	$\pm 0.5\text{mm}$		$\pm 0.5\text{mm}$
Wuxi Lead	Cylindrical Cell Winding Machine		Max 45 PPM	$\pm 0.2\text{mm}$	$\pm 0.2\text{mm}$	
Greensun	Electrode making and winding machine		$\geq 12\text{PPM}$	$\pm 0.3\text{mm}$	$\pm 0.3\text{mm}$	$\pm 0.3\text{mm}$
CKD	Lithium-ion battery winding machine		1m/s			

Source: Company websites, Morgan Stanley Research.

Exhibit 41: Technical parameter comparison - formation and grading system

Company name	Product	Current resolution	Current accuracy	Voltage resolution	Voltage accuracy
Wuxi Lead	Formation and Grading system	0.1mA	± (0.05%FS+0.05%RDG)	0.1mV	± (0.05%FS+0.05%RDG)
Hangke	Formation System For Cylindrical Li-ion cells	0.1mA	±0.05%FS	0.1mV	±1mV
Hangke	Grading System For Cylindrical Li-ion Cells	0.1mA	±0.05%FS	0.1mV	±2mV
PNE	Formation system	16bit	± (0.05%FS+0.05%RDG)	± 0.04%FS	± 0.04%FS

Source: Company websites, Morgan Stanley Research.

Well-positioned for overseas expansion

Cost advantages

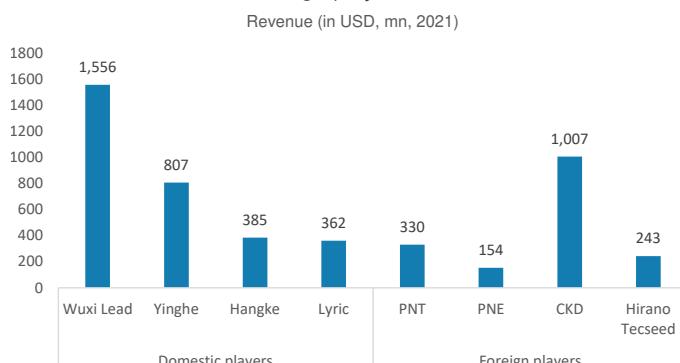
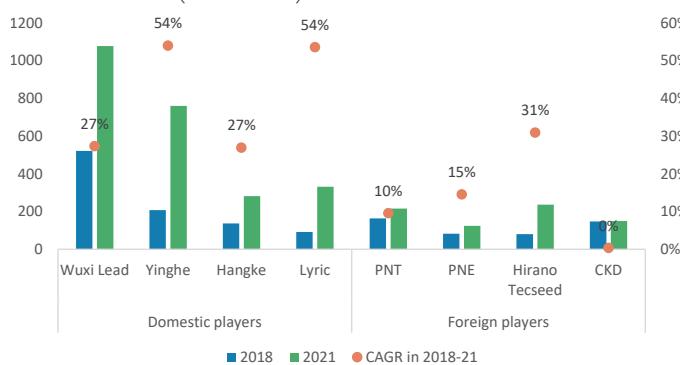
Lower cost is one of the most common advantages in the domestic manufacturing industry. China's lithium battery equipment suppliers enjoy lower raw material costs, especially non-standard components. This results in a much higher gross margin compared to the foreign brands, even after providing an over 20% price discount.

Thanks to lower labor costs, capacity sufficiency is another advan-

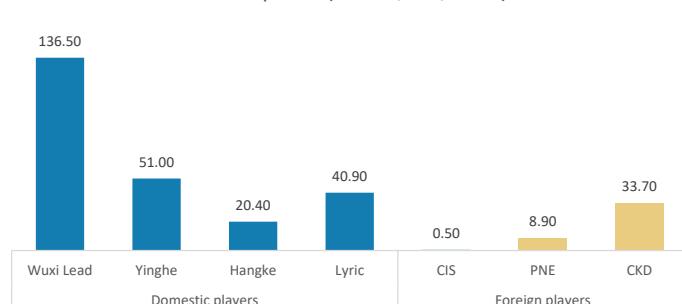
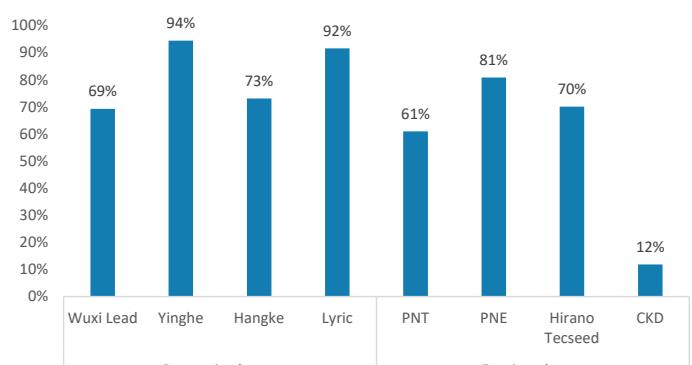
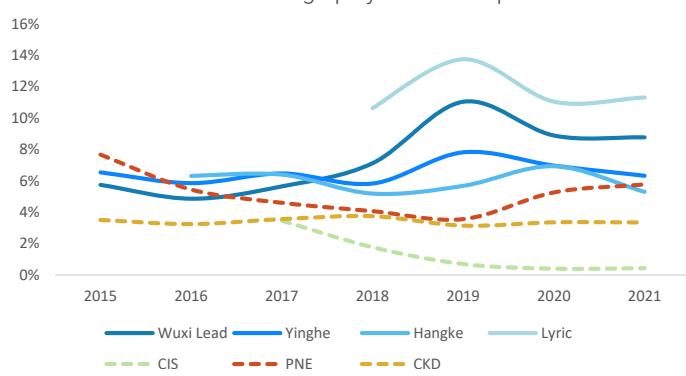
tage for domestic players amid the current aggressive capacity expansion overseas. The domestic cell makers started mass recruitment in 2020 in anticipation of the upcoming capacity growth domestically. Wuxi Lead increased its headcount from 6,759 at end-2019 to 14,858 at end-2021. In contrast, foreign equipment names have been more cautious on their capacity expansion plans and have a relatively low headcount, with a focus on one single machine or one specific process instead of the whole production line. Hence, because their business scale and production capacity are smaller than those of the Chinese players in general, more overseas orders will likely flow to the domestic players.

Exhibit 42: Domestic players enjoy higher gross margin than the foreign names, thanks to lower labor costs and raw material costs

Source: Company data, Morgan Stanley Research.

Exhibit 43: Chinese vs foreign players: Revenue scale**Exhibit 45:** Chinese vs foreign players: Growth of lithium battery-related revenue (in USD mn)**Strong R&D investments**

The strong R&D investments in the domestic lithium battery industry particularly in the past six years have supported the domestic players' competitiveness in the global market. In 2021, Wuxi Lead invested US\$137mn for R&D, higher than the combined amount invested by CIS, PNE, and CKD for R&D.

Exhibit 47: Chinese vs foreign players: R&D expense**Exhibit 44:** Chinese vs foreign players: Number of employees**Exhibit 46:** Chinese vs foreign: Percentage of lithium battery-related revenue in 2021**Exhibit 48:** Chinese vs foreign players: R&D expense ratio

Broader machine coverage favored by emerging cell makers

Among the domestic players, both Wuxi Lead and Lyrics are able to provide their clients with turnkey solutions. Yinghe can also manufacture both front-end and mid-end equipment as well as part of the back-end equipment. This turnkey solution service is a key advantage of China's leading equipment suppliers as the emerging cell makers and OEMs rely more on equipment suppliers given their limited experience in manufacturing techniques compared to the mature battery makers. Wuxi Lead has won a turnkey project order from Inobat and mid-back end orders from Northvolt. We believe the current capacity expansion plans of OEMs and emerging battery makers overseas will provide significant opportunities for domestic equipment suppliers to penetrate the global market.

As mentioned above, Korean and Japanese equipment companies are more focused on a single machine or one specific process instead of the whole production line. For other foreign brands, PNT and CIS focus on some front-end machines (coating, rolling, and slitting) and Manz mainly makes mid-end machines (die cutting, rolling, stacking, welding).

Penetrating overseas together with the domestic battery makers

In pursuit of greater market opportunities, China's leading cell makers have been mapping out their global strategy, especially in the European market. Farasis is establishing its third cell workshop in

Germany with an initial capacity of 6GWh. In the meantime, it signed an agreement with TOGG on a 20GWh cell investment plan in Turkey. CATL has invested EUR1.8bn to expand its European production and research base, targeting 14GWh capacity as of 2022. It eventually plans to build an 80GWh capacity in the US with a total investment of US\$5bn, according to Bloomberg (March 19, 2022). Solt, Guoxuan, and AESC also plan to build capacity overseas. Considering China's equipment localization rate of over 90% in most of key processes, leading domestic equipment suppliers have established relationships with battery makers in the past few years. As China's cell makers expand overseas, we think the equipment suppliers will expand overseas together with them.

Will geopolitical tensions negatively impact the Chinese equipment suppliers?

Cell makers appeared to turn bearish when US-China tensions on the new energy business intensified last year ([link](#)). Hangke lost orders from LG's procurement in the US market. However, it retained orders from both cell makers LG and SK for their US capacity expansion plans this year, when the latter two companies determined that the situation was not as bad as they had expected. We think that, as long as US-China tensions do not worsen, the domestic players will remain the preferred equipment suppliers.

Exhibit 49: Product coverage by domestic and overseas equipment suppliers

	Company name	Whole-line	Front-end				Middle-end				Back-end		
			Mixing machine	Coating machine	Rolling machine	Slitting machine	Winding machine	Stacking machine	Filling machine	Welding machine	Formation and grading system	Testing machine	PACK assembly line
Domestic players	Wuxi Lead	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Yinghe			✓	✓		✓	✓	✓	✓			✓
	Lyric	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Hangke										✓	✓	✓
Overseas players	PNT		✓	✓	✓								
	CIS		✓	✓	✓								
	KOEM						✓						
	Youil							✓	✓	✓			
	DA							✓	✓	✓	✓		
	PNE								✓	✓	✓	✓	
	NS								✓	✓	✓	✓	
	A-pro									✓	✓	✓	
	Hirano Tecseed		✓					✓					
	CKD												
KATAOKA											✓	✓	
	Manz							✓	✓	✓			✓

Source: Company websites, Morgan Stanley Research.

Trend #3: Benefiting from a Decentralized Cell Manufacturing Market

The lithium battery manufacturing industry is becoming crowded. New entrants from both emerging cell makers and OEMs are expanding their business scope into downstream cell manufacturing in order to secure their cell supply and customize their own cells to enhance their competitiveness. In the past two years, multiple cell makers have announced aggressive expansion plans that would more than double the global EV battery manufacturing capacity by 2025. That said, as increasing LFP cell adoption lowers the technical

entry barriers, we think more players will emerge and try to establish their own footprint to improve EV battery properties such as driving range, cycle life, and safety performance, etc. We think this decentralized battery manufacturing market and diversified products will benefit the leading equipment suppliers given their bargaining power and less dependence on a single battery maker.

Exhibit 50: CATL remains the largest lithium battery maker in the world, with a 32.1% market share in terms of new battery installations in 2021, followed by LG Chem (20.6%) and Panasonic (16.0%)

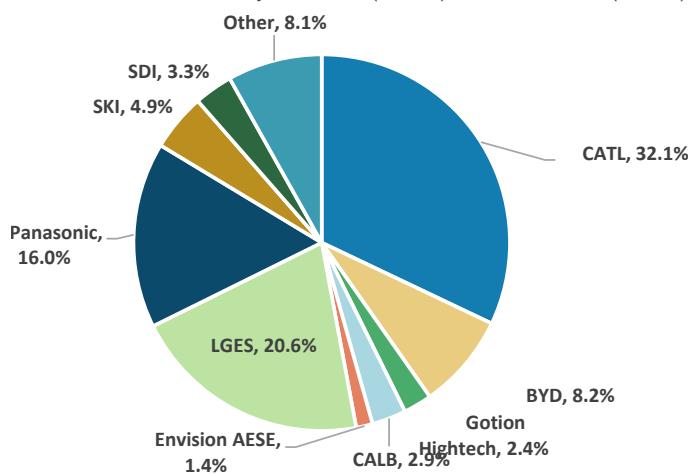
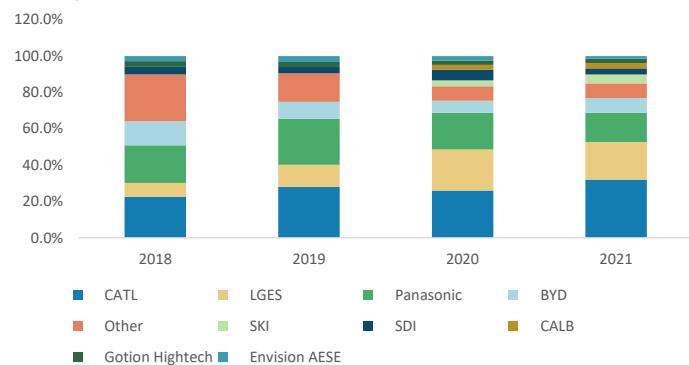


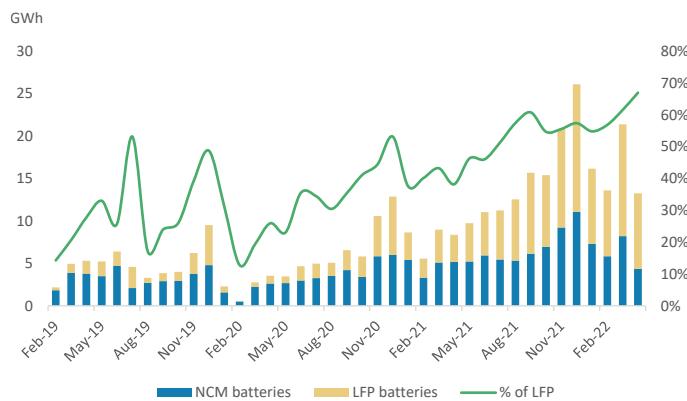
Exhibit 51: The market has become more fragmented in the past three years.



Cell makers' diversification

If given a choice OEMs would naturally prefer to diversify their suppliers to enhance their own bargaining power. Foreign OEMs such as Tesla and Volkswagen have also started to actively manufacture their own battery. This would make global/China battery supply market more fragmented. Our China EV battery supply chain analyst Jack Lu attributes this trend to increasing LFP battery adoption and intensified market competition, which have resulted in lower technical barriers to entry. He expects the learning curve to accelerate at secondary battery suppliers and new entrants. In our view, this more fragmented downstream landscape will benefit the leading equipment suppliers, as they would enjoy a diversified client base that is less dependent on a single client.

Exhibit 52: Percentage of LFP battery among total ePV battery installation in China

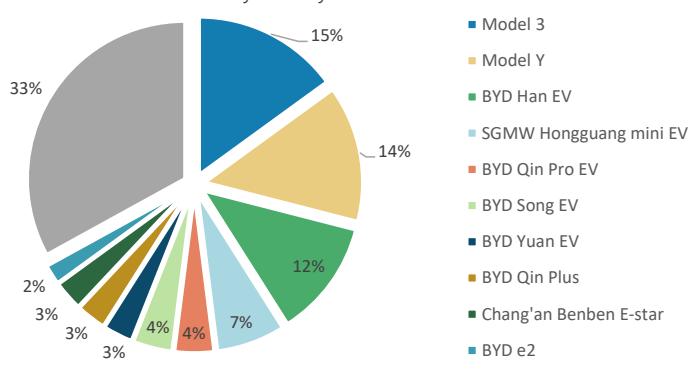


Source: Wind, GII, Morgan Stanley Research.

Stronger bargaining power amid fragmented client landscape

Newly expanded capacity in the domestic market uses existing technology instead of focusing on technology upgrades. This is evidenced by their aggressive expansion to gain market share in the near term. Once capacity expansion slows and competition heats up, we think cell makers will focus more on seeking product differentiation via technology upgrades and iterations, where equipment suppliers will play a bigger role. Leading equipment makers with strong R&D capabilities will enjoy greater bargaining power and greater customer loyalty.

Exhibit 53: LFP battery mix by ePV models in 2021



Source: GII, SNE, Morgan Stanley Research.

Stock Implications

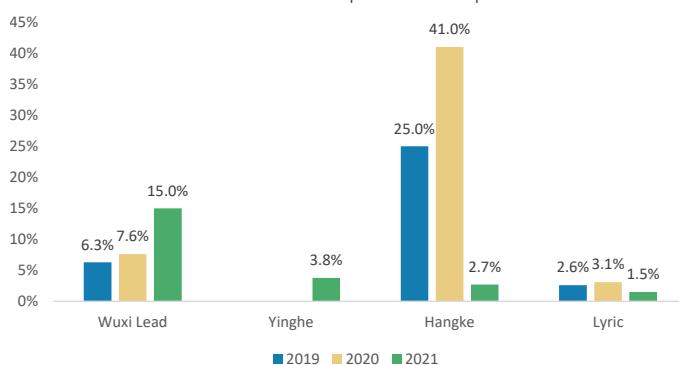
In order to identify the mid- to long-term opportunities within the lithium battery equipment space, we have analyzed the three major trends mentioned above – overseas expansion, technology iteration, client market fragmentation – and find that Wuxi Lead and Hangke are best positioned. We think both companies will outperform their peers in terms of sustainable earnings growth and higher profitability on the back of their advanced technology, proven track record, and stronger bargaining power.

Exhibit 54: Historical gross margin comparison



Source: Company data, Morgan Stanley Research.

Exhibit 55: Overseas revenue exposure comparison



Source: Company data, Morgan Stanley Research.

Wuxi Lead

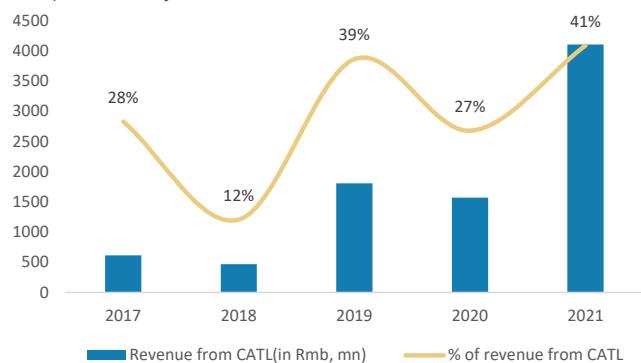
Targeting emerging overseas capacity expansion opportunities

Wuxi Lead is the only equipment maker in the world that can make its own machines and supply them for the whole new energy equipment production line. This turnkey solution capability can help those emerging battery makers and OEMs that have limited experience in cell manufacturing. New and emerging entrants would need to heavily rely on the equipment suppliers and will likely prefer to create relationships with those equipment makers that have a good track record. We believe this is one way that Wuxi Lead can penetrate the foreign market. Wuxi Lead won a turnkey solution project from InoBat (a European battery maker) in December 2021, wherein the whole pouch cell production line will be designed, manufactured, and assembled by Wuxi Lead. Meanwhile, Northvolt, ACC (a JV between Stellantis, Total Energies, and Mercedes-Benz), and Volkswagen have started the procurement process for their capacity expansion plans in 1H22. We estimate the total designed capacity from these three clients will reach over 400GWh by 2030, and see opportunity for Wuxi Lead to gain substantial share from the capacity expansion plans from these emerging battery players.

Stronger bargaining power from a diversified client base

Wuxi Lead is regarded by investors as a proxy for CATL, especially after the latter signed an agreement in 2021 to procure no less than 50% of key equipment from Wuxi Lead. When CATL expanded capacity in the domestic market in 2020-21, Wuxi Lead was its largest winding machine supplier. Hence, Wuxi Lead's share price was positively correlated with CATL's share price. However, it has underperformed CATL in the past three years, and we think this is partly because of its high dependence on CATL; one-third of Wuxi Lead's revenue in 2019-21 came from CATL. We view the current aggressive capacity expansion plans of multiple battery makers as an opportunity for Wuxi Lead to diversify its client base. We note that Wuxi Lead won new orders from CALB in 2021 and Eve Energy in 1Q22, supporting our view that the company can gain share from non-CATL clients on account of its advanced technology and sufficient capacity.

Exhibit 56: One-third of Wuxi Lead's revenue came from CATL in the past three years.



Source: Company data, Morgan Stanley Research.

Technology iteration

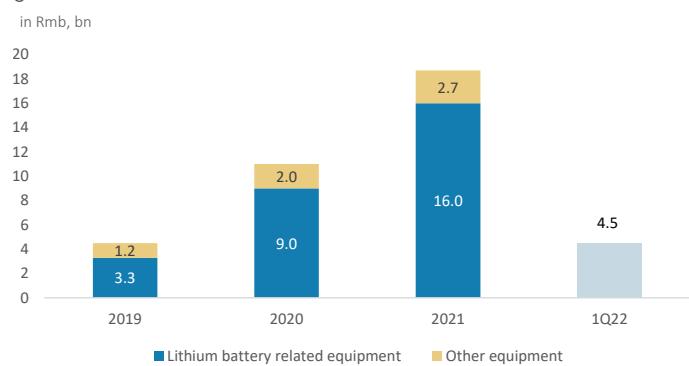
There are concerns in the market that competition among equipment suppliers will intensify as more players join the industry. We think technology iteration will help the leading names maintain their competitiveness in terms of market share and margins. We believe Wuxi Lead will benefit from the major trends emerging in this area, including 4680-spec cell and stacking machine applications on the back of its advanced technologies especially in mid-end equipment (i.e., winding and stacking machines).

Exhibit 58: Technical parameters comparison - stacking machine

Company name	Product	Capacity	Material speed	Laminating alignment (between Ca&An)	Total alignment of cell
Wuxi Lead	Heat Laminating Machine (Stacking, Separator Cutting Type)	300pcs/min	15m/min	±0.3mm	±0.6mm
Wuxi Lead	Continuous Thermal Lamination Stacking Machine	480pcs/min	24m/min	±0.5mm	±0.6mm
Yinghe	Double Location Full Auto Stacking Machine	120-150pcs/min			
Greensun	Double Location Full Auto Stacking Machine	150-200pcs/min			±0.4mm

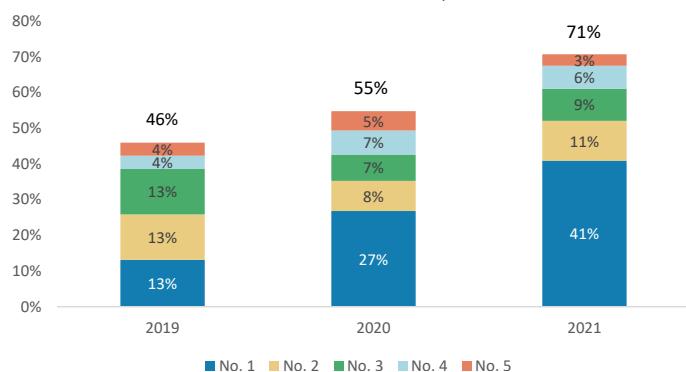
Source: Company websites, Morgan Stanley Research.

Exhibit 59: Wuxi Lead: Strong new order growth secures its sales growth



Source: Company data, Morgan Stanley Research.

Exhibit 57: Revenue contribution from top 5 clients

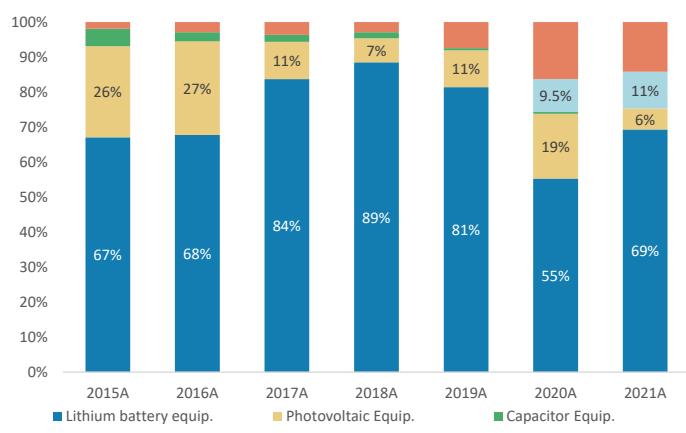


Source: Company data, Morgan Stanley Research.

Diversified businesses to lessen the impact of cyclicity

Wuxi Lead's new order contribution from the lithium battery-related business increased from 73% in 2019 to 85% in 2021 due to the aggressive lithium battery capacity expansion starting in 4Q20. Besides the lithium battery-related business, the company also manufactures solar equipment, 3C equipment, cell module pack equipment and automation, hydrogen cell equipment, laser machines, etc. We think this business diversity will help the company to overcome the ups and downs of the lithium battery capacity cycle going forward.

Exhibit 60: Wuxi Lead: Revenue mix has become more diversified



Source: Company data, Morgan Stanley Research.

Changes to our earnings estimates: We lower our earnings estimate for Wuxi Lead by 10% in 2022, to factor in weaker gross margin given higher raw material prices and increasing revenue contribution from low-margin intelligent logistics orders signed in 4Q20. We raise our earnings estimates by 9% in 2023 and by 19% in 2024, reflecting

higher revenue given our expectations that Wuxi Lead will gain new high-margin overseas orders as well as market share in non-CATL cell makers. As a result, we project a 43% revenue CAGR (versus 38% previously) and a 49% net profit CAGR (versus 41% previously) in 2021-24.

Exhibit 61: Wuxi Lead: Earnings estimate revisions

	2022E			2023E			2024E		
	New	Old	Chg%	New	Old	Chg%	New	Old	Chg%
Revenue									
Lithium Battery Equip.	12,164	13,824	-12.0%	19,051	17,979	6.0%	23,144	20,551	12.6%
Photovoltaic Equip.	660	660	0.0%	858	858	0.0%	1,116	1,116	0.0%
Intelligent logistics	1,689	1,689	0.0%	2,364	2,364	0.0%	2,837	2,837	0.0%
3C and others	1,710	1,710	0.0%	1,967	1,967	0.0%	2,262	2,065	9.5%
Total	16,223	17,883	-9.3%	24,240	23,168	4.6%	29,359	26,568	10.5%
Gross Profit									
Selling exp.	(405)	(465)	-12.9%	(581)	(580)	0.2%	(704)	(665)	5.9%
Admin exp.	(847)	(933)	-9.3%	(1,266)	(1,210)	4.6%	(1,533)	(1,387)	10.5%
R&D exp.	(1,428)	(1,574)	-9.3%	(2,060)	(1,969)	4.6%	(2,525)	(2,285)	10.5%
Operating Profit	2,840	3,172	-10.5%	4,648	4,258	9.2%	6,019	5,091	18.2%
Net Profit	2,550	2,844	-10.3%	4,065	3,719	9.3%	5,223	4,403	18.6%
EPS	1.63	1.82	-10.4%	2.60	2.38	9.2%	3.34	2.82	18.4%
Gross Margin									
Selling exp as % of Rev	2.5%	2.6%	-0.1%	2.4%	2.5%	-0.1%	2.4%	2.5%	-0.1%
Admin exp as % of Rev	5.2%	5.2%	0.0%	5.2%	5.2%	0.0%	5.2%	5.2%	0.0%
R&D exp as % of Rev	8.8%	8.8%	0.0%	8.5%	8.5%	0.0%	8.6%	8.6%	0.0%
Operating Margin	17.5%	17.7%	-0.2%	19.2%	18.4%	0.8%	20.5%	19.2%	1.3%
Net Margin	15.7%	15.9%	-0.2%	16.8%	16.1%	0.7%	17.8%	16.6%	1.2%

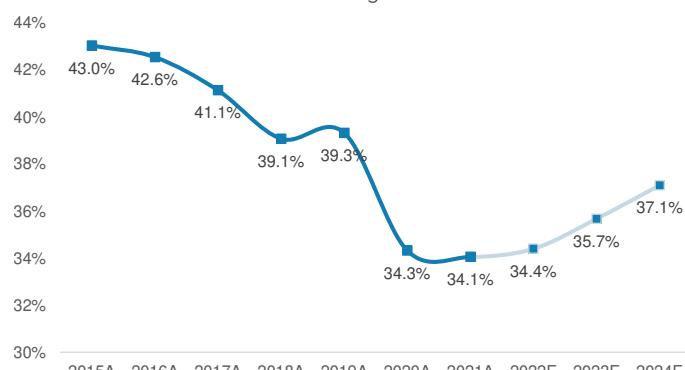
Source: Morgan Stanley Research. E = Morgan Stanley Research estimates.

Exhibit 62: Wuxi Lead: Annual revenue



Source: Company data, Morgan Stanley Research. E = Morgan Stanley Research estimates

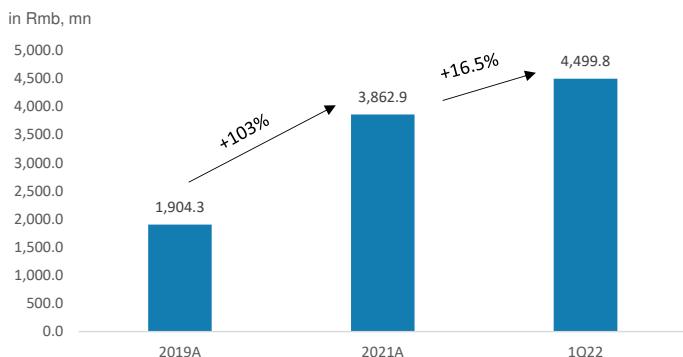
Exhibit 63: Wuxi Lead: Gross margin



Source: Company data, Morgan Stanley Research. E = Morgan Stanley Research estimates

Exhibit 64: Wuxi Lead: Net profit

Source: Company data, Morgan Stanley Research. E = Morgan Stanley Research estimates.

Exhibit 65: Wuxi Lead: Contract liability

Source: Company data, Morgan Stanley Research.

What's in the price? (1) Strong new order growth and high penetration of winding/stacking machines in major cell makers; (2) considerable orders from Northvolt and ACC this year; (3) near-term margin recovery on better profitability of orders signed since 2021.

What's not in the price? (1) Penetration into traditional foreign cell makers; (2) notable progress in new orders for coating machines; (3) resilient revenue growth given more diversified businesses and stronger bargaining power due to technology iteration and a fragmented downstream landscape.

Valuation

We change our valuation method from a DCF model to a P/E approach, as the lithium battery equipment market has become more cyclical and has expanded notably. In determining our target P/E, we have considered (1) peers' P/E multiples, (2) Wuxi Lead's historical trading band since 2015, and (3) the impact that earnings growth has on the P/E multiple in which Wuxi Lead trades.

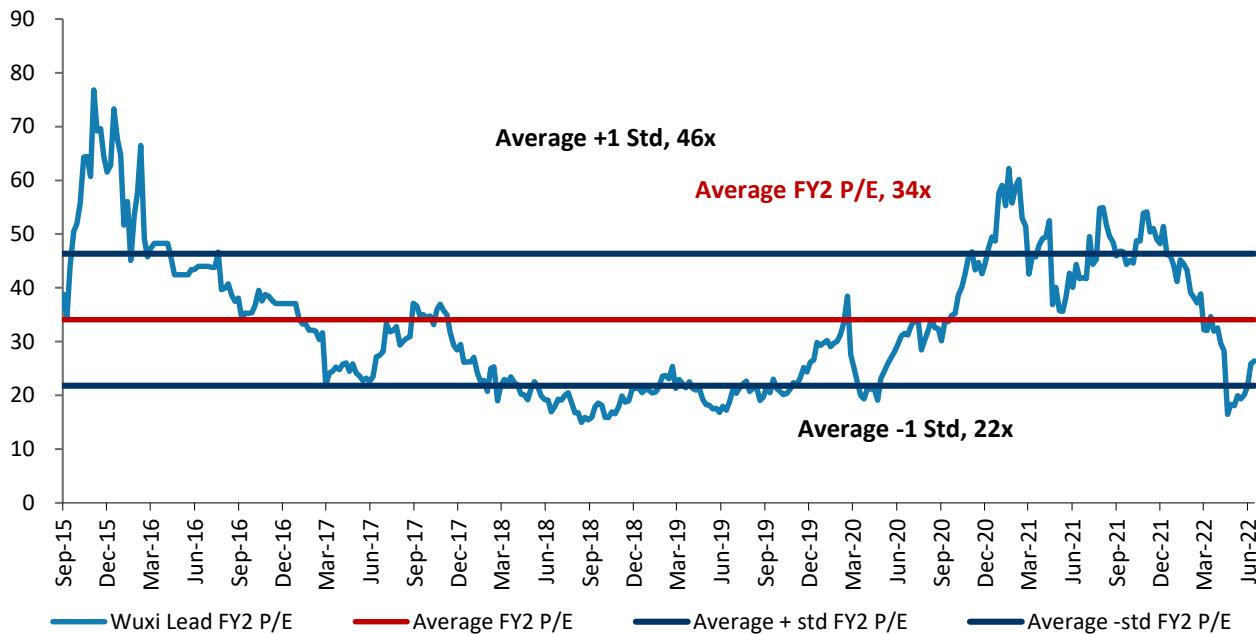
Wuxi Lead's FY2 P/E in the last growth peak (2017) was 30x, indicating a 2.3x PEG in the last growth moderation cycle (2017-20). Our new price target (which is also our base case scenario value) of

Rmb90.0 (down from Rmb93) implies 40% upside potential, 35x 2023e P/E, and 0.7x PEG in 2021-24. We think the premium versus the previous growth peak is reasonable due to (1) the higher 49% earnings CAGR in 2021-24 versus a 13% CAGR in 2017-20, and (2) Wuxi Lead's currently more diversified businesses than in the past as well as potential alpha emergence despite a lower gross margin than during the last cycle.

Bull and bear case scenario values

Bull case (Rmb125, down from Rmb130): In this scenario we now assume (1) NEV sales accelerate significantly in 2023, encouraging continuous strong downstream capacity expansion, and (2) the company successfully penetrates into LG's supply chain and more emerging cell makers. Our bull case scenario value implies 48x bull case 2023e P/E.

Bear case (Rmb39, down from Rmb40): In this scenario we now assume (1) China's NEV sales fall short of Morgan Stanley's estimates, (2) the company makes little progress in the market for coating machines and other equipment, and (3) gross margin deteriorates with an increasing number of competitors and more specialized jobs. Our bear case scenario value implies 15x bear case 2023e P/E.

Exhibit 66: Wuxi Lead: FY2 P/E band chart

Source: Refinitiv, Morgan Stanley Research.

Hangke

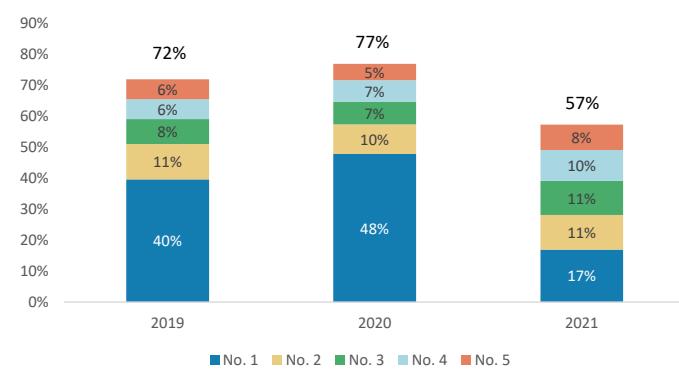
Largest beneficiary of overseas capacity expansion among the domestic equipment names

Hangke mainly focuses on the back-end process of lithium battery manufacturing. It has successfully penetrated traditional overseas clients including LG, Samsung, SKI, etc, since 2004. The company is currently the major back-end machine supplier for both LG and SKI, evidence of its strong competitiveness versus foreign peers. Given the strong stickiness between equipment suppliers and cell makers, we think Hangke will be a preferred equipment maker in the

upcoming aggressive capacity expansion of the traditional foreign cell makers, and will thus enjoy strong revenue growth as well as high gross margin.

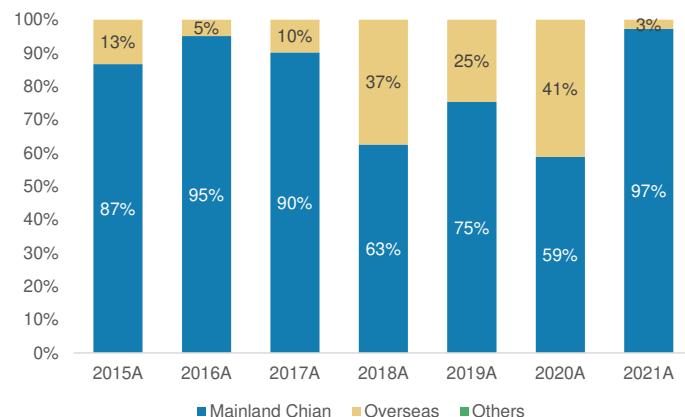
Orders from overseas typically generate over 50% gross margin, much higher than orders from the domestic market, which has averaged 37% in the past three years. Hangke's overseas revenue contribution dropped from 34% on average in 2018-20 to 3% in 2021 due to the strong capacity expansion in the domestic market in 2H20. We believe the robust overseas expansion in 2022-25 will optimize Hangke's revenue mix with margin recovery from a record low of 26.2% in 2021.

Exhibit 67: Hangke: Revenue contribution from top 5 clients: More fragmented client base



Source: Company data, Morgan Stanley Research.

Exhibit 68: Hangke: Overseas exposure



Source: Company data, Morgan Stanley Research.

Technology iteration to create a better competitive landscape; the strong will stay strong

Hangke has a clear advantage in high-end formation machines globally; it is one of very few suppliers covering all back-end equipment (cylindrical, prismatic, and pouch cell). Its accuracy of voltage control and current control can reach as high as 0.02% and 0.05%, respectively, the highest levels globally. The back-end process determines the consistency and stability of the cell and therefore greatly affects the safety and performance of the cell pack. Back-end machines are customized based on the different projects and uses, and the cooperation between equipment maker and battery maker typically

involves a large amount of technology secrecy. That said, battery makers can not easily replace existing equipment suppliers given product safety concerns, setting a solid moat for back-end equipment makers, especially for high-end products. Meanwhile, technology iteration involves establishing higher standards of formation and testing machines. This can only be achieved with collaborative R&D between the battery makers and their equipment suppliers. We think continuous technology iteration will further enhance Hangke's leading position in the back-end market and help alleviate margin pressure amid rising raw material costs.

Exhibit 69: Technical parameter comparison between Hangke and China Electric Institute

Technological type	Indicators	Hangke	China Electric Institute	Domestic industry average	Foreign industry average
High-precision linear charge-discharge technology	Voltage accuracy	0.02%	0.02%	0.04%-0.1%	0.04%-0.1%
	Currency accuracy	0.05%	0.05%	0.05%-0.1%	0.05%-0.1%
Fully automatic calibration technology	Calibrated simultaneously	Up to 400 channels	Up to 256 channels	Up to 256 channels	Up to 256 channels
Energy efficiency technology	Voltage accuracy	0.02%	0.04%	0.1%- 0.2%	0.04%- 0.1%
	Currency accuracy	0.05%	0.04%	0.1%-0.2%	0.05%-0.1%
	Charging efficiency	≥80%	Series: ≥90% Parallel: ≥75%	≥65-78%	≥75%
	Discharging efficiency	≥80%	Series: ≥85% Parallel: ≥70%	≥65-75%	≥70%

Source: Hangke prospectus, China Electric prospectus, Morgan Stanley Research.

Exhibit 70: LG is aggressively expanding its battery capacity on its own and via JV, and targets to have ~520GWh capacity by 2025

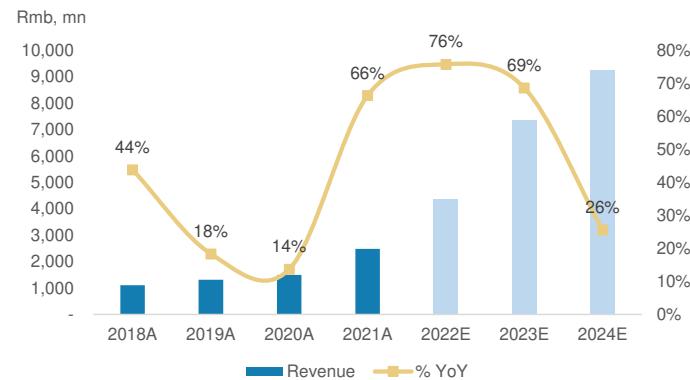
Location	Scale (GWh)	Description
LGES self-own		
Arizona, America	11	LGES plans to invest \$1.39bn in a new factory for cylindrical lithium-ion batteries, with 11GWh capacity, mass production is slated in the second half of 2024
Michigan, America	20	LGES plans to invest \$1.7bn to expand its existing wholly-owned lithium-ion battery plant to 25GWh from 5GWh
Wroclaw, Poland	15	LGES plans to expand its Wroclaw plant capacity from 70GWh to 85GWh in 2025
Europe	15	LGES plans to increase its capacity in another region in Europe to 15GWh in 2025. The region is likely to be France or Germany
Nanjing, China	48	LGES plans to increase Nanjing factory's capacity from 62GWh to 110GWh in 2025
Korea	4	LGES plans to expand its Korea plant's capacity from 18GWh to 22GWh in 2025
Via JV		
GM	America	160
		There are three locations under construction. The Ohio plant will begin production in this August, the Tennessee plant is set to follow in 2023, and the Michigan plant begins in 2024. The fourth plant whose location has not yet to be announced will be up and running in 2025. Production capacity of the four plants is expected to 160GWh
Stellantis	Canada	45
		LGES and Stellantis to invest \$4.1bn in JV for a battery production plant, with annual production capacity over 45GWh. Plant construction activities are scheduled to begin later 2022 with production operations planned to launch in the first quarter of 2024
Hyundai Motor	Indonesia	10
		LGES and Hyundai Motor have formed a JV to build a battery factory with a capacity of 10GWh that is expected to start operation in 2024

Source: Various materials, Morgan Stanley Research.

What's in the price? (1) Investors expectations that Hangke will win most back-end formation orders from traditional Korean cell makers this year; (2) near-term margin recovery due to improved product mix; (3) new orders to peak in 2023-24.

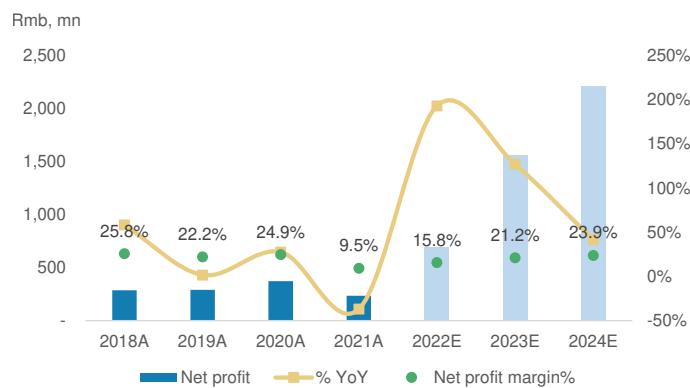
What's not in the price? (1) Share gains in the domestic market owing to the 4680-spec cell tailwind; (2) resilient margins in the mid-to long-term given Hangke's advanced technologies.

Exhibit 71: Hangke: Annual revenue



Source: Company data, Morgan Stanley Research. E = Morgan Stanley Research estimates.

Exhibit 73: Hangke: Net profit



Source: Company data, Morgan Stanley Research. E = Morgan Stanley Research estimates.

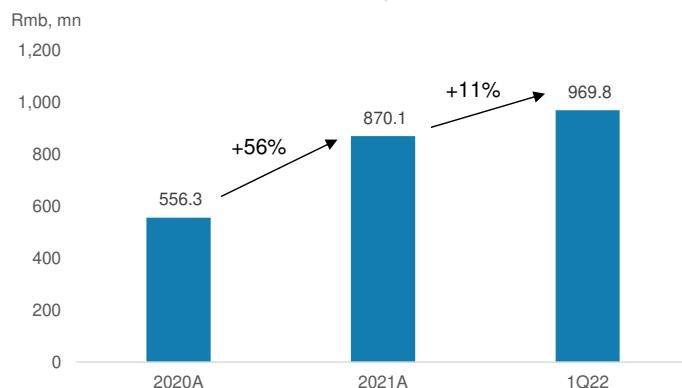
Hangke's share price fell 70% in December 2021-April 2022. The share price has rebounded ~80% since then, and we think this is driven mainly by the loosened Covid-19 restrictions particularly in Shanghai, where most auto supply chain participants are located.

Exhibit 72: Hangke: Gross margin



Source: Company data, Morgan Stanley Research. E = Morgan Stanley Research estimates.

Exhibit 74: Hangke: Contract liability

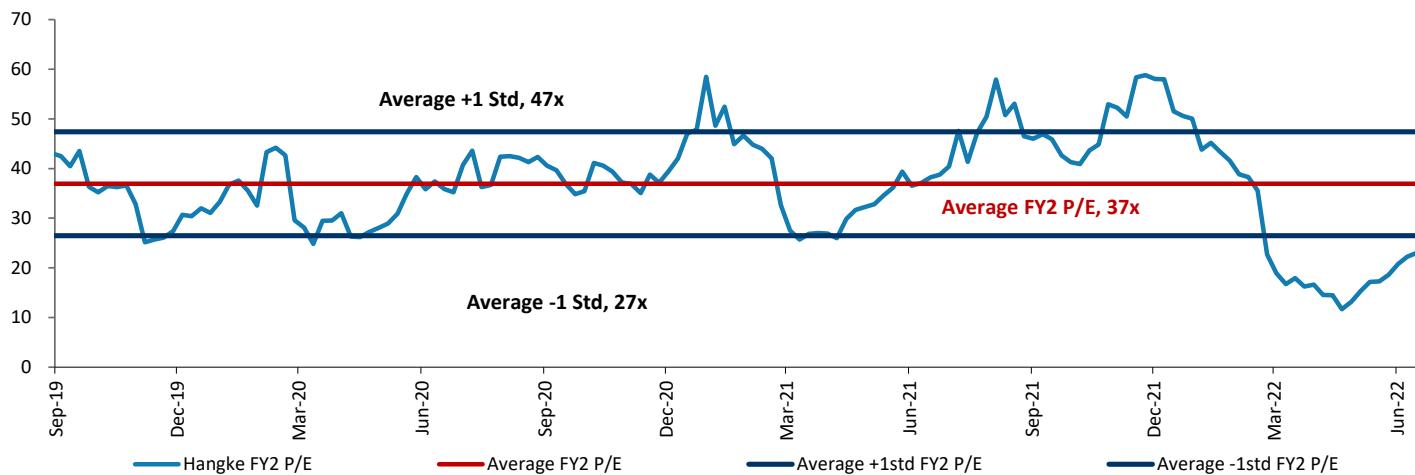


Source: Company data, Morgan Stanley Research.

Valuation

We initiate coverage on Hangke with an Overweight rating and a price target of Rmb115, implying 30x 2023e P/E and 0.3 PEG in 2021-24. Our target P/E is derived from its historical average PEG of 0.3 and 111% earnings CAGR estimates in 2021-24. Hangke is currently trading at 19x 2023e P/E, indicating 64% upside potential.

Exhibit 75: Hangke: FY2 P/E band chart



Source: Refinitiv, Morgan Stanley Research.

Valuations comps

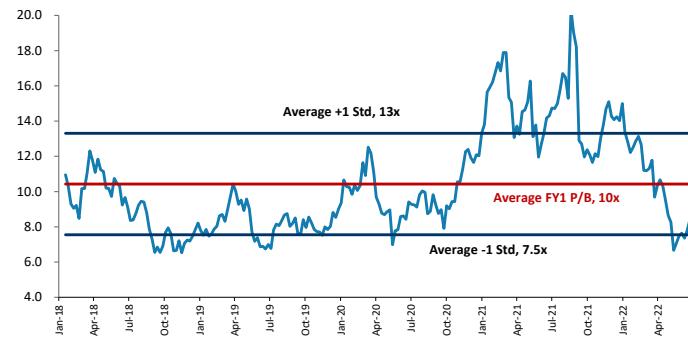
Exhibit 76: Valuation comps

Company Name	Closing 21/6/2022	Mkt Cap. CNY (Mn)	EPS Growth			P/E (x)			P/B (x)			EV/EBITDA			Div Yield (%)			ROE (%)		
			2022E	2023E	2024E	2022E	2023E	2024E	2022E	2023E	2024E	2022E	2023E	2024E	2022E	2023E	2024E	2022E	2023E	2024E
Lithium Battery Equip. and Laser																				
300450.SZ Wuxi Lead	61.30	95,487	61%	59%	28%	37.6	23.6	18.4	8.5	6.7	5.4	30.8	18.8	14.3	1.1%	1.7%	2.2%	22.7%	28.5%	29.2%
300457.SZ Yinghe	25.34	16,396	37%	13%		30.8	27.2	NA	2.8	2.6	NA	19.7	16.0	NA	0.4%	0.6%	NA	9.8%	10.2%	NA
688006.SS Hangke	72.40	29,189	193%	127%	42%	42.6	18.8	13.3	8.9	6.7	4.9	37.7	15.9	10.9	0.7%	1.6%	2.3%	20.8%	35.5%	37.2%
688499.SS Lyric*	235.09	20,608	123%	66%	47%	42.2	25.5	17.3	8.4	6.4	4.8	42.8	24.5	16.9				19.8%	25.3%	27.9%
688559.SS Hymson*	79.50	15,838	155%	129%	52%	45.2	19.7	13.0	8.5	6.0	4.3	34.5	17.4	13.0	0.3%	0.7%	1.0%	18.8%	30.7%	32.9%
688518.SS United Winners*	35.50	10,580	191%	82%	32%	34.6	19.0	14.4	5.9	4.6	3.6	28.2	16.0	12.8	0.6%	1.2%	1.3%	17.0%	24.3%	25.3%
002008.SZ Han's Laser	31.55	33,054	9%	15%	26%	15.7	13.7	10.9	2.6	2.3	2.0	9.9	8.5	6.7	1.9%	2.2%	2.8%	18.8%	19.0%	21.2%
Average			110%	70%	38%	35.5	21.1	14.5	6.5	5.1	4.2	29.1	16.7	12.4	0.8%	1.3%	1.9%	18.2%	24.8%	28.9%
Median			123%	66%	37%	37.6	19.7	13.8	8.4	6.0	4.5	30.8	16.0	12.9	0.7%	1.4%	2.2%	18.8%	25.3%	28.5%
Lithium Battery Makers																				
300750.SZ CATL	506.52	1,176,052	13%	24%	24%	78.5	63.1	51.0	11.6	10.0	8.9	32.9	25.8	21.1	0.4%	0.8%	1.0%	17.8%	18.4%	19.7%
300014.SZ EVE	101.25	191,504	31%	49%	31%	49.1	33.0	25.1	8.8	7.0	5.5	44.9	30.6	20.6	0.0%	0.1%	0.1%	21.6%	26.8%	27.9%
002074.SZ Guoxuan	46.50	77,109	207%	165%	20%	189.0	71.4	59.3	4.0	3.8	3.6	24.1	16.3	13.0	0.2%	0.4%	0.5%	2.1%	5.5%	6.4%
Average			84%	79%	25%	105.5	55.8	45.1	8.1	6.9	6.0	34.0	24.2	18.2	0.2%	0.4%	0.5%	13.9%	16.9%	18.0%
Median			31%	49%	24%	78.5	63.1	51.0	8.8	7.0	5.5	32.9	25.8	20.6	0.2%	0.4%	0.5%	17.8%	18.4%	19.7%

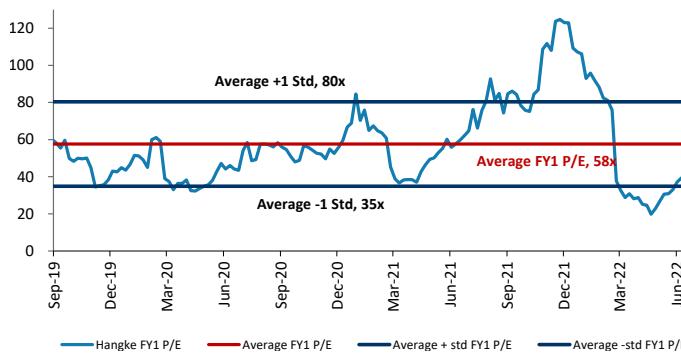
Source: Refinitiv, Morgan Stanley Research Note: Stocks with * are not covered by Morgan Stanley Research, and their data are Refinitiv estimates. Others are covered by Morgan Stanley, and their data are Morgan Stanley Research estimates.

Exhibit 77: Wuxi Lead: P/E band chart

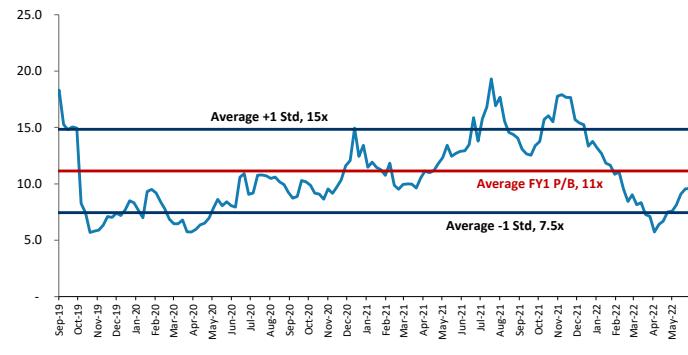
Source: Refinitiv, Morgan Stanley Research.

Exhibit 78: Wuxi Lead: P/B band chart

Source: Refinitiv, Morgan Stanley Research.

Exhibit 79: Hangke: P/E band chart

Source: Refinitiv, Morgan Stanley Research.

Exhibit 80: Hangke: P/B band chart

Source: Refinitiv, Morgan Stanley Research.

Wuxi Lead: Financial Summary

Exhibit 81: Wuxi Lead: Financial summary

Income Statement						Financial Analysis					
(Rmb Mn)	2020A	2021A	2022E	2023E	2024E	(Rmb Mn)	2020A	2021A	2022E	2023E	2024E
Revenue	5,858	10,037	16,223	24,240	29,359	Growth (%)					
Cost of sales and services	(3,848)	(6,619)	(10,642)	(15,592)	(18,465)	Turnover	25.1%	71.3%	61.6%	49.4%	21.1%
Gross profit	2,011	3,418	5,581	8,649	10,894	Operating Profit	5.1%	80.4%	68.8%	63.7%	29.5%
Business Tax and plus	(44)	(39)	(62)	(93)	(113)	Net Profit	0.3%	106.5%	60.9%	59.4%	28.5%
Selling exp.	(181)	(275)	(405)	(581)	(704)	Margins (%)					
Admin exp.	(315)	(524)	(847)	(1,266)	(1,533)	Gross Margin	34.3%	34.1%	34.4%	35.7%	37.1%
R&D exp.	(538)	(898)	(1,428)	(2,060)	(2,525)	Selling expenses	3.1%	2.7%	2.5%	2.4%	2.4%
Operating profit	932	1,682	2,840	4,648	6,019	Admin expenses	5.4%	5.2%	5.2%	5.2%	5.2%
Asset impairment Loss	(270)	(298)	(593)	(997)	(1,274)	R&D expenses	9.2%	8.9%	8.8%	8.5%	8.6%
Investment Gains	31	59	59	59	59	Operating Margin	15.9%	16.8%	17.5%	19.2%	20.5%
Non-operating profit	190	264	433	646	783	Net Margin	13.1%	15.8%	15.7%	16.8%	17.8%
Non-operating loss	(1)	(5)	(5)	(5)	(5)	Efficiency					
Financial expenses	(43)	2	10	22	38	Asset Turnover (X)	0.5	0.4	0.6	0.6	0.6
Profit before tax	839	1,705	2,744	4,374	5,620	Inventory Days	272.7	428.8	300.0	310.0	320.0
Tax	(71)	(120)	(194)	(309)	(397)	Account Receivables Days	168.8	147.6	160.0	180.0	190.0
Net profit	768	1,585	2,550	4,065	5,223	Account Payable Days	212.1	247.1	220.0	230.0	230.0
Minority	0	0	0	0	0						
Net profit to shareholders	768	1,585	2,550	4,065	5,223						
EPS (Rmb)	0.54	1.01	1.63	2.60	3.34						
Balance Sheet						Return (%)					
(Rmb Mn)	2020A	2021A	2022E	2023E	2024E	ROA	6.1%	6.6%	8.7%	10.0%	10.7%
Non-current assets	2,349	3,350	3,242	3,337	0	ROE	13.7%	16.7%	22.7%	28.5%	29.2%
PPE	791	1,065	963	1,068	1,183	Gearing (X)					
Intangible assets	157	303	297	286	272	Asset/Equity	2.2	2.4	2.6	2.7	2.8
Other current assets	1,401	1,982	1,982	1,982	(1,455)	Total Liabilities/Equity	1.3	1.5	1.6	1.8	1.7
Current assets	10,314	20,650	26,008	37,266	45,567	Total IB Debt/Equity	0.1	0.0	0.0	0.0	0.0
Cash	2,201	1,397	2,269	3,493	5,085	Net Cash	1,852.7	1,363.9	2,236.2	3,460.4	5,052.4
Cash Deposits and Equivalents	537	1,468	1,468	1,468	1,468	Valuation					
Notes Receivable	288	683	667	996	1,207	P/E	118.3	63.4	39.4	24.7	19.2
Account Receivable	2,709	4,060	7,111	11,954	15,283	P/BV	16.2	10.6	8.9	7.0	5.6
Prepayments	105	237	381	558	661	EV/EBITDA	86.4	54.1	32.3	19.8	15.0
Other Receivables	27	48	383	572	693						
Inventory	2,874	7,776	8,747	13,242	16,189						
Other Current Assets	1,571	4,983	4,983	4,983	4,983						
Total Assets	12,662	24,000	29,250	40,603	45,567						
Current liabilities	6,987	14,154	17,636	25,944	30,748						
Short-term borrowing	348	33	33	33	33						
Notes Payable	1,740	4,789	4,956	7,262	8,600						
Account Payable	2,236	4,481	6,414	9,825	11,636						
Prepayments	1,904	3,863	5,245	7,837	9,491						
Salary payable	263	420	420	420	420						
Tax payable	140	87	87	87	87						
Other current assets	356	481	481	481	481						
Non-current liabilities	60	377	377	377	377						
Debt and long term bond	0	0	0	0	0						
Other Non-current Liabilities	60	377	377	377	377						
Non-controlling interests	0	0	0	0	0						
Shareholders' equity	5,615	9,469	11,237	14,282	17,879						
Share Capital	907	1,564	1,564	1,564	1,564						
Additional Paid-in Capital	2,272	4,321	4,321	4,321	4,321						
Retained Earnings	2,435	3,584	5,352	8,397	11,994						
Total Liabilities and Equity	12,662	24,000	29,250	40,603	49,004						

Source: Company data, Morgan Stanley Research. E = Morgan Stanley Research estimates.

E = Morgan Stanley Research estimates

Source: Company data, Morgan Stanley Research

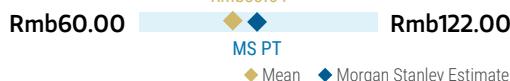
Risk Reward – Wuxi Lead Intelligent (300450.SZ)

Targeting emerging overseas capacity expansion opportunities

PRICE TARGET Rmb90.00

- Base case, derived from P/E multiple approach, as the equipment market has become more cyclical.
- Our price target of Rmb90.0 implies 35x 2023e P/E, higher than the previous growth peak P/E of 30x in 2017 due to the higher earnings growth of 49% CAGR in 2021-24 versus 13% CAGR in 2017-20, as well as its more diversified businesses and potential alpha emergence.

Consensus Price Target Distribution



Source: Refinitiv, Morgan Stanley Research

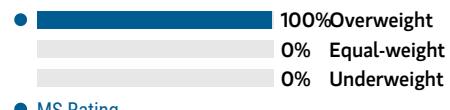
RISK REWARD CHART



OVERWEIGHT THESIS

- We see the company as one of the best proxies for the new lithium battery capacity cycle, with high conviction on strong sales growth in 2022-24.
- We expect the industry's new orders to continue to grow in the double-digits percentage in 2022-24, in view of stronger NEV sales globally.
- We expect GPM to rebound, thanks to growing economies of scale and a back-end business management reshuffle.
- We expect Wuxi Lead to benefit from technology iteration and a fragmented downstream client landscape.

Consensus Rating Distribution



Source: Refinitiv, Morgan Stanley Research

Risk Reward Themes

Contrarian:	<i>Positive</i>
Disruption:	<i>Positive</i>
Electric Vehicles:	<i>Positive</i>

View descriptions of Risk Rewards Themes [here](#)

BULL CASE

48x bull case 2023e EPS

NEV sales accelerate significantly in 2023, encouraging continuous strong downstream capacity expansion. The company successfully penetrates into LG's supply chain and more emerging cell makers.

Rmb125.00

BASE CASE

35x base case 2023e EPS

The company's existing and potential customers add 450GWh of new capacity in 2022, and its share in non-CATL clients slightly increases. GPM improves in 2022, thanks to economies of scale and greater bargaining power.

Rmb90.00

BEAR CASE

15x bear case 2023e EPS

China's NEV sales fall short of Morgan Stanley's estimate. The company makes little progress in the market for coating machines and other equipment. Gross margin deteriorates with an increasing number of competitors and more specialized jobs.

Risk Reward – Wuxi Lead Intelligent (300450.SZ)

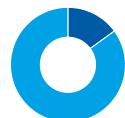
KEY EARNINGS INPUTS

Drivers	2021	2022e	2023e	2024e
Lithium Battery Equipment revenue growth (%)	114.8	74.9	56.6	21.5
Gross Margin (%)	34.1	34.4	35.7	37.1

INVESTMENT DRIVERS

- Battery makers' capex growth
- Other battery-related business (such as battery pack assembly, factory logistics) to boost its revenue scale

GLOBAL REVENUE EXPOSURE



- 10-20% Europe ex UK
- 80-90% Mainland China

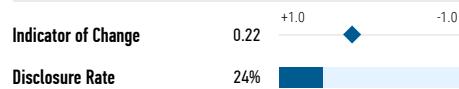
Source: Morgan Stanley Research Estimate
View explanation of regional hierarchies [here](#)

MS ALPHA MODELS



Source: Refinitiv, FactSet, Morgan Stanley Research; 1 is the highest favored Quintile and 5 is the least favored Quintile

SUSTAINABILITY & ESG



RISKS TO PT/RATING

RISKS TO UPSIDE

- Stronger-than-expected EV sales throughout 2022-23 - this would help to boost battery makers' plant utilization rates and increase equipment demand
- Faster-than-expected progress of overseas expansion
- Strong penetration increase of 4680-spec cell.

RISKS TO DOWNSIDE

- Weak execution and delivery, resulting in lower profitability and market share
- Limited progress in overseas expansion

OWNERSHIP POSITIONING

Inst. Owners, % Active

Source: Refinitiv, Morgan Stanley Research

MS ESTIMATES VS. CONSENSUS

FY Dec 2022e

Sales / Revenue (Rmb, mn) 14,425 16,223 17,883 16,309

EBITDA (Rmb, mn) 2,655 2,990 3,322 2,977

Net income (Rmb, mn) 1,818 2,550 2,958 2,593

EPS (Rmb) 1.16 1.63 1.89 1.66

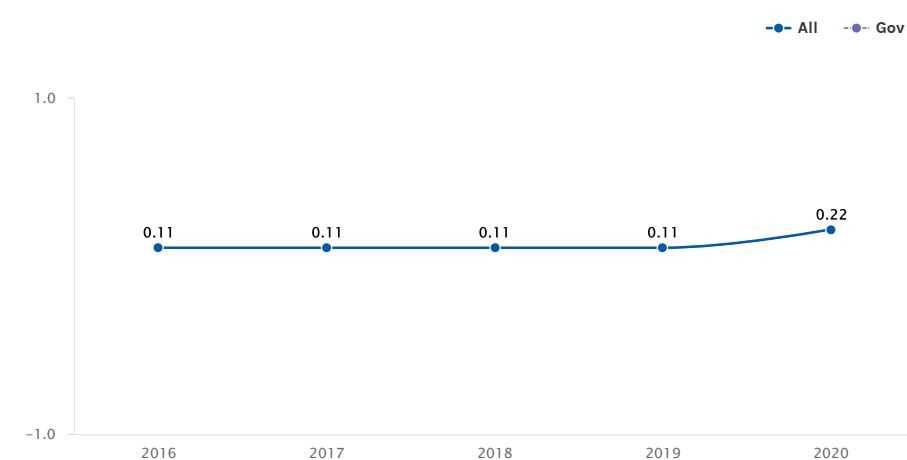
♦ Mean ◆ Morgan Stanley Estimates

Source: Refinitiv, Morgan Stanley Research

Risk Reward – Wuxi Lead Intelligent (300450.SZ)

SUSTAINABILITY AND ESG

INDICATOR OF CHANGE OVER TIME



Governance	Unit	Dec '18	Dec '19	Dec '20
Avg tenure of the board	Years	3.87	4.87	5.87
Female board members	Percentage	14.29%	14.29%	14.29%
Independent board members	Percentage	42.86%	42.86%	42.86%
Shares owned by board members	Percentage	0%	0%	0%

Indicator of change chart is plotted using the fiscal aligned methodology. View explanation of 'Indicator of Change' methodology [here](#)

Source: Company Data, Morgan Stanley Research

SUMMARY

ESG Data/Indicator of Change

In 2020, Wuxi Lead had an ESG Indicator of Change of 0.22, which signals that the majority of the ESG data points in our database improved YoY.

Sustainable Solutions

Wuxi Lead generates 90% of revenues/EBITA from products that are exposed to the Energy Storage Sustainability theme(s).

SUSTAINABLE SOLUTIONS

Theme	Exposure
Energy Storage	90% (EBITA)
Green Mobility	90% (EBITA)

Exposure is presented for top four Sustainability themes
View explanation of Theme/Exposure methodology [here](#)

Hangke (688006.SS): Beneficiary of Overseas Capacity Expansion

We initiate coverage on Hangke Technology with an Overweight rating and a price target of Rmb115. Hangke is a leading global supplier of back-end cell manufacturing equipment (mainly formation machines), which accounts for ~30% of the total lithium battery production line.

Highly customized with high entry threshold. Formation machines are customized based on the specific project that they are or will be used for. Any slight change in cell design to adjust the equipment will lead to additional expenses. This explains the sticky relationship between equipment suppliers and cell makers.

Robust overseas expansion to drive strong revenue growth mix with margin recovery. Hangke has established close business agreements with leading overseas cell makers LG and SKI, supplying over 70% of their back-end machines. We believe their robust overseas expansion will drive Hangke's strong revenue growth in the coming years.

We also expect Hangke's gross margin to recover from a record low of 26% in 2021 to 34% in 2024, owing to margin improvement in domestic orders and greater revenue contribution from high-margin overseas clients. Hangke's new orders signed in the past two years have seen better profitability due to an equipment shortage. Overseas orders can generate a 20% gross margin premium to domestic orders, given foreign clients tend to accept higher prices.

Stock incentive schemes to align interests of management, staff, and shareholders. Hangke has introduced three share incentive plans in the past three years with 11.2mn shares (2.8% of total shares outstanding) in total, mainly for senior management and technical staff.

Exhibit 82: Hangke: Key metrics

Reuters:688006.SS / Bloomberg:688006.SS

China Industrials				
Price target (Rmb)				115.00
Up/downside to price target (%)				64%
Shr price, close (June 21, 2022)				70.18
52-Week Range				Rmb 136.36 - 38.08
Sh out, dil, curr (mn)				405
Mkt cap, curr (Rmb, mn)				28,449
EV, curr (Rmb, mn)				26,508
Avg daily trading value (Rmb, mn)				223

Fiscal Year Ending	12/21	12/22e	12/23e	12/24e
ModelWare EPS (Rmb)	0.58	1.70	3.86	5.46
Consensus EPS (Rmb)§	0.58	1.79	3.29	4.34
Revenue, net (Rmb, mn)	2,483	4,366	7,364	9,249
EBITDA (Rmb, mn)	308	727	1,736	2,540
ModelWare net inc (Rmb, mn)	235	689	1,563	2,214
P/E	185.5	42.6	18.8	13.3
P/BV	15.4	8.9	6.7	4.9
ROA (%)	4.1%	9.3%	14.9%	17.1%
ROE (%)	8.3%	20.8%	35.5%	37.2%
EV/EBITDA	135.4	37.7	15.9	10.9
Div yld (%)	0.2%	0.7%	1.6%	2.3%
FCF yld ratio (%)	-2.6%	0.5%	1.3%	2.4%
Asset/Equity	1.8	2.2	2.3	2.3

Unless otherwise noted, all metrics are based on Morgan Stanley ModelWare framework

§ = Consensus data is provided by Thomson Reuters Estimates

e = Morgan Stanley Research estimate

Company description

Hangke Technology is a China-based company committed to the design, research and development, production and sales of back-end lithium battery equipment. Hangke's main product includes charging and discharging equipment and test system, which sold at home and exported to Japan, South Korea, Poland and other international markets. Hangke is trusted by global players in the industry like LG Chem, SKI, SDI, CATL, BYD, EVE, CALB, Guoxuan High-tech, ect. Founded in 1984, Hangke was successfully listed on SSE STAR Market in 2019. The company has over 500 R&D engineers and 6 research institutes.

Source: Company data, Refinitiv, Morgan Stanley Research. E = Morgan Stanley Research estimates.

Valuation: Our price target of Rmb115 is derived from a P/E multiple approach. We use a target 30x 2023e P/E, implying 0.3x PEG (in-line with its 3-year historical average PEG of 0.3x).

Key downside risks: Higher export tariffs or other unfavorable cross-border policies depress overseas demand; slower-than-expected technology development; increasing bad debt if supply exceeds demand.

Hangke: Financial Summary

Exhibit 83: Hangke: Financial summary

Income Statement						Financial Analysis					
(Rmb Mn)	2020A	2021A	2022E	2023E	2024E	(Rmb Mn)	2020A	2021A	2022E	2023E	2024E
Revenue	1,493	2,483	4,366	7,364	9,249	Growth (%)					
Cost of sales and services	(770)	(1,831)	(3,063)	(5,008)	(6,077)	Turnover	13.7%	66.3%	75.8%	68.7%	25.6%
Gross profit	723	652	1,303	2,356	3,172	Operating Profit	-1.2%	-34.1%	147.4%	145.7%	44.6%
Business Tax and plus	(11)	(7)	(13)	(21)	(36)	Net Profit	27.7%	-36.8%	193.0%	126.9%	41.6%
Selling exp.	(66)	(48)	(76)	(120)	(147)	Margins (%)					
Admin exp.	(142)	(201)	(354)	(328)	(339)	Gross Margin	48.4%	26.2%	29.8%	32.0%	34.3%
R&D exp.	(104)	(131)	(207)	(283)	(329)	Selling expenses	4.4%	1.9%	1.7%	1.6%	1.6%
Operating profit	400	264	653	1,604	2,320	Admin expenses	9.5%	8.1%	8.1%	4.5%	3.7%
Financial expenses	10	(42)	15	15	15	R&D expenses	6.9%	5.3%	4.7%	3.8%	3.6%
Impairment loss	(55)	(20)	(14)	(23)	(34)	Operating Margin	26.8%	10.6%	15.0%	21.8%	25.1%
Investment Gains	8	8	8	8	8	Net Margin	24.9%	9.5%	15.8%	21.2%	23.9%
Other income	62	45	49	54	60	Efficiency					
Non-operating profit	1	4	79	133	167	Asset Turnover (X)	0.4	0.4	0.6	0.7	0.7
Non-operating loss	(1)	(1)	(2)	(4)	(5)	Inventory Days	378.1	283.5	250.0	260.0	260.0
Profit before tax	425	257	787	1,787	2,530	Account Receivables Days	85.4	145.3	130.0	130.0	150.0
Tax	(53)	(22)	(98)	(223)	(316)	Account Payable Days	178.3	499.3	180.0	180.0	180.0
Net profit	372	235	689	1,563	2,214	Return (%)					
Minority	0	0	0	0	0	ROA	9.6%	4.1%	9.3%	14.9%	17.1%
Net profit to shareholders	372	235	689	1,563	2,214	ROE	14.5%	8.3%	20.8%	35.5%	37.2%
EPS-Basic (Rmb)	0.93	0.58	1.70	3.86	5.46	Gearing (X)					
EPS-Diluted (Rmb)	0.92	0.58	1.70	3.86	5.46	Asset/Equity	1.6	1.8	2.2	2.3	2.3
Balance Sheet						Total Liabilities/Equity	0.5	1.0	1.2	1.4	1.2
(Rmb Mn)	2020A	2021A	2022E	2023E	2024E	Total IB Debt/Equity	-	-	-	-	-
Non-current assets	677	976	1,340	1,868	2,395	Net Cash	1,753.7	1,941.6	1,905.1	1,778.7	1,703.5
PPE	496	694	1,036	1,544	2,052	Valuation					
Intangible assets	97	138	160	180	199	P/E	89.3	185.5	41.3	18.2	12.8
Other current assets	85	144	144	144	144	P/BV	12.9	15.4	8.6	6.5	4.8
Current assets	3,198	4,791	6,081	8,619	10,560	EV/EBITDA	72.4	135.4	36.5	15.4	10.5
Cash Deposits and Equivalents	1,754	1,942	1,905	1,779	1,703	Cashflow Statement					
Notes Receivable	38	38	72	121	152	(Rmb Mn)	2020A	2021A	2022E	2023E	2024E
Account Receivable	349	988	1,555	2,623	3,801	Operating cash flow	292	482	609	1,003	1,336
Prepayments	54	50	84	138	168	Investing cash flow	(75)	(306)	(438)	(660)	(747)
Other Receivables	9	19	36	61	76	Financing cash flow	(88)	(95)	(207)	(469)	(664)
Inventory	797	1,423	2,098	3,567	4,329	Increase in cash	129	81	(37)	(126)	(75)
Other Current Assets	197	330	330	330	330	FX changes	(17)	(55)	0	0	0
Total Assets	3,876	5,766	7,420	10,487	12,955	Cash beginning	1,663	1,754	1,942	1,905	1,779
Current liabilities	1,290	2,917	4,089	6,061	6,979	Cash ending	1,754	1,942	1,905	1,779	1,703
Short-term borrowing	0	0	0	0	0	E = Morgan Stanley Research estimates					
Notes payable	228	977	1,594	2,607	2,997	Source: Company data, Morgan Stanley Research					
Account payable	370	956	1,511	2,470	2,997						
Prepayments	0	0	1	1	2						
Contract liability	556	870	870	870	870						
Salary payable	31	13	13	13	13						
Other current assets	104	101	101	101	101						
Non-current liabilities	18	24	24	24	24						
Debt and long term bond	0	0	0	0	0						
Other Non-current Liabilities	18	24	24	24	24						
Non-controlling interests	0	0	0	0	0						
Shareholders' equity	2,567	2,825	3,307	4,401	5,951						
Share Capital	401	403	403	403	403						
Additional Paid-in Capital	1,271	1,426	1,426	1,426	1,426						
Retained Earnings	896	995	1,477	2,572	4,122						
Total Liabilities and Equity	3,876	5,766	7,420	10,487	12,955						

Source: Company data, Morgan Stanley Research. E = Morgan Stanley Research estimates.

Risk Reward – Zhejiang Hangke Technology (688006.SS)

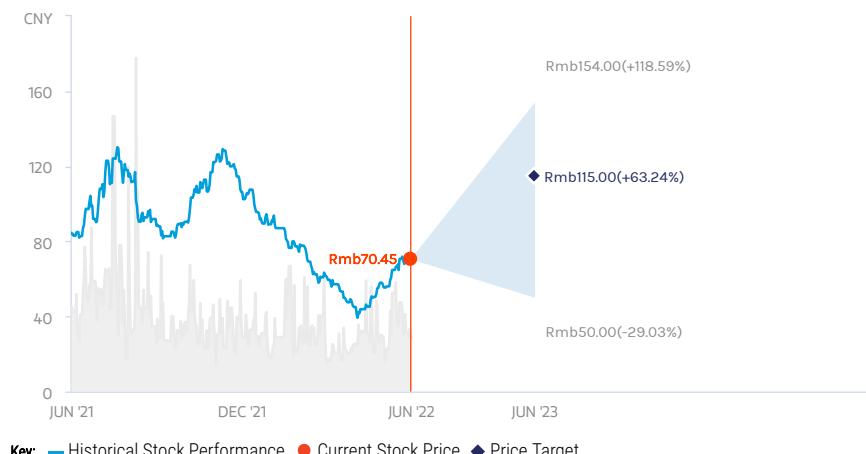
Beneficiary of overseas capacity expansion

PRICE TARGET Rmb115.00

Base case, derived from 30x 2023e P/E and 0.3 PEG in 2021-24. Our target P/E is lower than Hangke's 3-year historical average FY2 P/E of 37x, which we think this is reasonable given its lower gross margin level than in 2018-21. However, we think Hangke should trade at a premium to the peer average of 24x 2023e P/E, given its higher margins, quality clients, and high exposure to the overseas market.



RISK REWARD CHART



BULL CASE

40x bull case 2023e EPS

Massive overseas expansion in 2022 and surging demand for back-end equipment. The company penetrates into more foreign clients.

Rmb154.00

BASE CASE

30x base case 2023e EPS

The company's existing and potential clients add massive expansion in 2022. Margin improves in 2022, thanks to margin improvement in domestic orders and greater revenue contribution from high-margin overseas clients.

Rmb115.00

BEAR CASE

13x bear case 2023e EPS

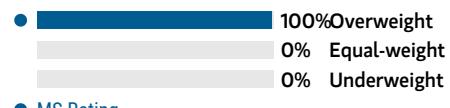
Overseas expansion falls short of Morgan Stanley's expectations. The company loses market share because of the intense competition landscape in the back-end equipment market.

Rmb50.00

OVERWEIGHT THESIS

- As it is a leading global supplier of back-end cell manufacturing equipment, with high conviction on Hangke's strong sales growth in 2022-24.
- We believe the robust overseas expansion will drive Hangke's strong revenue growth in the coming years.
- We expect gross margin to recover from a record low of 26% in 2021 to 34% in 2024, thanks to margin improvement in domestic orders and greater revenue contribution from high-margin overseas clients.
- Hangke is trading at an attractive 18x 2023x P/E, which is well below its 3-year historical average of 37x P/E.

Consensus Rating Distribution



Source: Refinitiv, Morgan Stanley Research

Risk Reward Themes

Contrarian:	Positive
Disruption:	Negative

View descriptions of Risk Rewards Themes [here](#)

Risk Reward – Zhejiang Hangke Technology (688006.SS)

KEY EARNINGS INPUTS

Drivers	2021	2022e	2023e	2024e
Charging and discharging equipment growth (%) (%)	64.3	75.7	75.9	24.1
Gross Margin (%)	26.2	29.8	32.0	34.3

INVESTMENT DRIVERS

- Battery makers' capex growth
- Equipment transformation, which would determine Hangke's stickiness with cell makers and expands its revenue scale

GLOBAL REVENUE EXPOSURE



● 100% Mainland China

Source: Morgan Stanley Research Estimate
View explanation of regional hierarchies [here](#)

RISKS TO PT/RATING

RISKS TO UPSIDE

- Higher-than-expected overseas expansion demand
- Better-than-expected pouch battery procurement by Chinese OEMs
- Better-than-expected cost reduction of new technologies, leading to stronger demand

RISKS TO DOWNSIDE

- Higher export tariffs or other unfavorable cross-border policies depress overseas demand
- Slower-than-expected technology development
- Increasing bad debt if supply exceeds demand

MS ESTIMATES VS. CONSENSUS

FY 2023e



♦ Mean ♦ Morgan Stanley Estimates

Source: Refinitiv, Morgan Stanley Research

Hangke: Operational Review And Investment Positives/Concerns

Key operational review

Hangke listed on the Shanghai Stock Exchange (SSE) STAR Market in 2019. Since 1Q20, Hangke's share price performance has trended inline with other lithium battery equipment companies such as Wuxi Lead and Yinghe Technology given increasing demand for EVs and ongoing capacity expansions by lithium battery makers. Because of the Covid-19 pandemic in 2020, Hangke's overseas expansion was sluggish in 2Q20-3Q20 and most of its orders came from the domestic market, which generates lower gross profit margin. This put pressure on net profit in 1H21 and led to a share price pullback in 3Q21. Hangke's share price pulled back 70% from Rmb128 on December 3, 2021, to a low of Rmb39 on April 26, 2022, mainly due to the softened economic environment globally and weak EV demand on the Covid-19 pandemic resurgence in mainland China.

Key financial metrics and earnings estimates

Revenue – Owing to capacity expansions by the domestic battery makers, Hangke's revenue increased from Rmb1,313mn in 2019 to Rmb2,483mn in 2021, a two-year CAGR of 37.5%. Charging and discharging equipment were the major revenue contributors, repre-

senting 77% of total revenue on average in 2019-21. Hangke has strong overseas customer resources, however. Due to the Covid-19 pandemic, its overseas orders' revenue contribution decreased from 40.5% in 2020 to 2.7% in 2021. On the back of the capacity expansions by overseas battery makers in the post-pandemic era, we estimate revenue will rise at a 55% CAGR in 2021-24.

Gross margin – Hangke's gross margin declined from 48% in 2020 to 26% in 2021, mainly due to the significant drop in revenue contribution from overseas orders, which generate higher gross margin. Recently, overall gross margin has increased from 17% in 4Q21 to 30% in 1Q22, and we forecast it will recover to the ~40% level in 2022-23, within which we expect charging and discharging equipment to recover to ~50% when overseas expansion plans resume.

SG&A – Hangke's SG&A expense increased from Rmb232mn in 2019 to Rmb381mn in 2021, a two-year CAGR of 28%, which is slower than the 37% revenue CAGR in the same period. SG&A expense ratio decreased from 20.9% in 2020 to 15.3% in 2021 (17.7% in 2019), indicating effective cost control. R&D expense ratio declined slightly, from 5.7% in 2019 to 5.3% in 2021.

Exhibit 84: Hangke's share price performance since its IPO



Source: Refinitiv, Morgan Stanley Research. Note: SSEC = Shanghai Stock Exchange Composite Index.

Net margin – Hangke's net margin narrowed from 24.9% in 2020 to 9.5% in 2021 (22.2% in 2019) on greater revenue contribution from low-margin domestic orders.

Dividend – Hangke has distributed Rmb293mn in dividends since it listed in 2019, implying a 33.3% payout on average.

Balance sheet – Hangke had a net cash of Rmb1,620mn as of 1Q22, implying a net cash-to-equity ratio of 55%. We expect the company's gearing to remain healthy in 2022-24.

Investment positives

(1) Beneficiary of aggressive lithium battery capacity expansion in the overseas market since 2022: We estimate over 2TWh new capacity expansion overseas will be launched mostly by 2025. As the major back-end equipment supplier to traditional foreign cell makers, we believe Hangke will greatly benefit from this overseas tailwind.

(2) Margin recovery, thanks to higher gross margin from domestic clients and better revenue mix: The gross margin erosion in 2Q21-1Q22 was mainly due to greater revenue contribution from low-margin domestic orders. Orders from overseas typically generate over 50% gross margin, much higher than orders from the domestic market, which generated an average of 37% gross margin in the past three years. We believe the robust overseas expansion in 2022-24 will optimize Hangke's revenue mix. Together with increasing profit-

ability of domestic orders, we forecast its gross margin will recover from 26% in 2021 to 34% in 2024.

(3) Riding the 4680-spec cells tailwind: On back of our bullish view on 4680-spec cell demand in the next few years, we think Hangke will gain market share supported by its strong presence in formation equipment in cylindrical cell manufacturing. The 4680-spec cell production put forward much higher requirements on temperature, current, voltage controls. Hangke has successfully tackled these technical difficulties in its back-end process and has successfully delivered its production line to clients.

Investment concerns

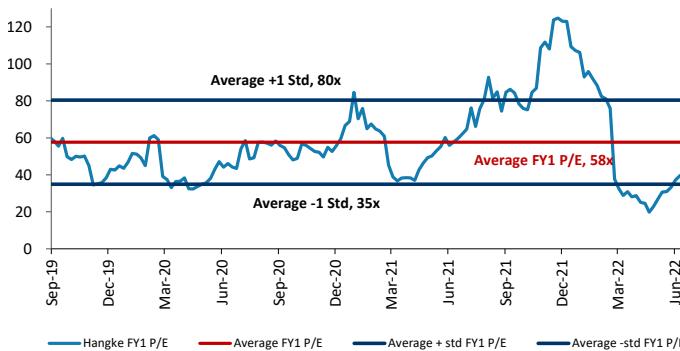
(1) Working capital to continue to grow rapidly: The payment structure between equipment suppliers and cell makers indicates that equipment suppliers need to be able to support clients with working capital, which usually needs to increase together with revenue. The inventory and accounts receivables can accumulate quickly if cell makers delay their payments.

(2) Escalation of geopolitical tensions may negatively impact new orders: There may be concerns that rising geopolitical tensions may greatly impact Chinese equipment suppliers' overseas expansion plans. Hangke lost orders from LG in the Korean battery maker's US capacity expansion plans last year, although it gained new orders from SKI in the Korean battery maker's US workshop.

Hangke: Valuation

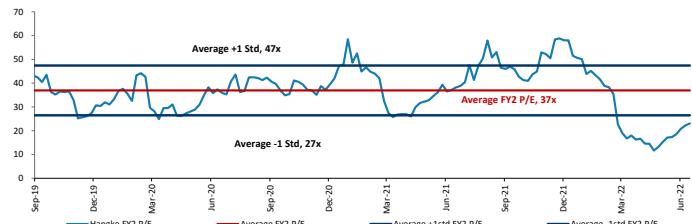
We use a P/E multiple approach to arrive at our Rmb115 price target, implying 64% upside potential and a FY2 P/E multiple of 30x. We adopt P/E multiple due to cyclical nature of the lithium battery equipment industry. In determining our target P/E, we have considered (1) peers' multiples; (2) Hangke's historical trading band since 2019; and (3) the impact that earnings growth has on the P/E multiple in which Hangke trades. Our 30x target P/E multiple is lower than its 3-year historical average FY2 P/E of 37x. We think this is reasonable, given its lower gross margin level than in 2018-21. However, we think Hangke should trade at a premium to the peer average of 24x 2023e P/E, given its higher margins, quality clients, and high exposure to the overseas market at 23% in 2019-21 on average. Our price target is also our base case scenario value.

Exhibit 85: Hangke: FY1 P/E band chart



Source: Refinitiv, Morgan Stanley Research.

Exhibit 86: Hangke: FY2 P/E band chart



Source: Refinitiv, Morgan Stanley Research.

Exhibit 87: Hangke: Valuation comps

Company Name	Closing 21/6/2022	Mkt Cap. CNY (Mn)	EPS 2022E	Growth 2023E	2024E	P/E (x) 2022E	2023E	2024E	P/B (x) 2022E	2023E	2024E	EV/EBITDA 2022E	2023E	2024E	Div Yield (%) 2022E	2023E	2024E	ROE (%) 2022E	2023E	2024E
Lithium Battery Equip. and Laser																				
300450.SZ Wuxi Lead	61.30	95,487	61%	59%	28%	37.6	23.6	18.4	8.5	6.7	5.4	30.8	18.8	14.3	1.1%	1.7%	2.2%	22.7%	28.5%	29.2%
300457.SZ Yinghe	25.34	16,396	37%	13%	30.8	27.2	2.8	2.6	19.7	16.0	0.4%	0.6%	9.8%	10.2%						
688006.SS Hangke	72.40	29,189	193%	127%	42%	42.6	18.8	13.3	8.9	6.7	4.9	37.7	15.9	10.9	0.7%	1.6%	2.3%	20.8%	35.5%	37.2%
688499.SS Lyric*	235.09	20,608	123%	66%	47%	42.2	25.5	17.3	8.4	6.4	4.8	42.8	24.5	16.9	19.8%	25.3%	27.9%			
Average			104%	66%	39%	38.3	23.8	16.3	7.1	5.6	5.0	32.8	18.8	14.0	0.7%	1.3%	2.2%	18.3%	24.9%	31.4%
Median			92%	63%	42%	39.9	24.5	17.3	8.4	6.6	4.9	34.3	17.4	14.3	0.7%	1.6%	2.2%	20.3%	26.9%	29.2%

Source: Refinitiv, Morgan Stanley Research Note: Stocks with * are not covered by Morgan Stanley Research, and their data are Refinitiv estimates. Others are covered by Morgan Stanley, and their data are Morgan Stanley Research estimates.

Bull and bear case scenario values

Bull case (Rmb154): In this scenario we assume higher-than-expected overseas expansion demand, and the company becomes the leading back-end equipment supplier globally. Our bull case scenario value implies 40x bull case 2023e P/E.

Bear case (Rmb50): In this scenario we assume a slowdown in overseas expansion, and the company loses share in charging and discharging equipment. Our bear case scenario value implies 13x bear case 2023e P/E.

Key risks

Upside risks to our price target include: (1) Higher-than-expected overseas expansion demand; (2) better-than-expected pouch battery procurement by Chinese OEMs; and (3) better-than-expected cost reduction of new technologies leading to stronger demand.

Downside risks to our price target include: (1) Higher export tariffs or other unfavorable cross-border policies depress overseas demand; (2) slower-than-expected technology development; and (3) increasing bad debt if supply exceeds demand.

Hangke: Company Background

Hangke Technology is a China-based company committed to the design, research and development, production, and sale of back-end lithium battery equipment. Hangke's main products include charging and discharging equipment and test systems, which are sold domestically and internationally to Japan, South Korea, Poland, and other international markets. Hangke is a global player whose customers include LG Chem, SKI, SDI, CATL, BYD, EVE, CALB, Guoxuan High-Tech, etc.

Founded in 1984, Hangke listed in the SSE STAR Market in 2019. The company has over 500 R&D engineers and six research institutes in China.

Key products

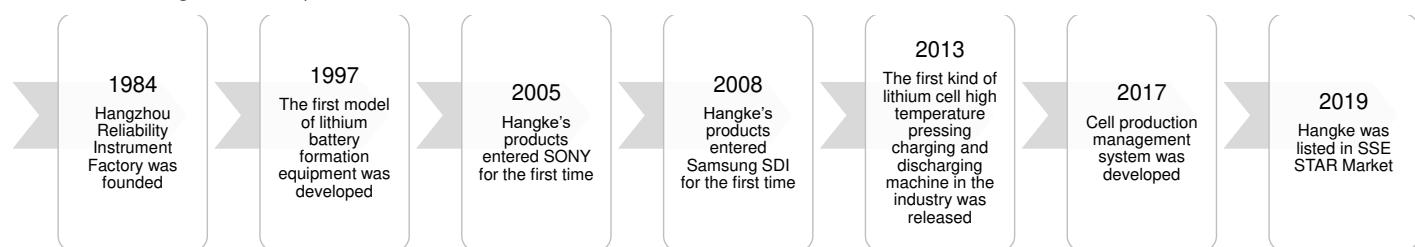
The back-end process accounts for more than one-third of the total cost of the lithium battery manufacturing process. The accuracy of current and voltage control during the first charging and discharging process largely determines the reliability of the finished battery's

consistency control. The current and voltage distribution used during the back-end process are required to be strictly controlled and monitored. Formation and grading systems play important roles in improving the performance of the battery and shortening the battery production cycle. As a leading back-end equipment company in the industry, Hangke produces formation and grading systems for pouch batteries, prismatic batteries and cylindrical batteries, test systems, and logistics software systems.

Shareholding structure

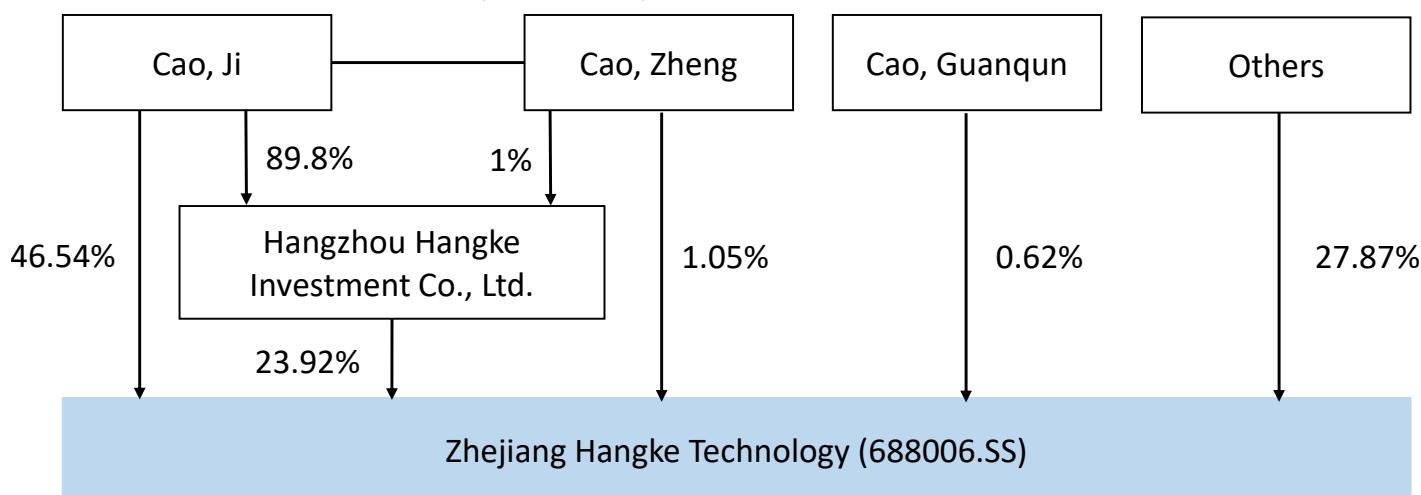
Cao Ji and his son, Cao Zheng, are persons acting in concert. As of end-2021, they directly held 187.62mn and 4.24mn shares of the company, accounting for 46.54% and 1.05% of total shares, respectively. They also indirectly control 23.92% of the company through Hangzhou Hangke Investment Co., Ltd. Hence, they hold 71.51% of the company in total, and are the controlling shareholders of and run the company.

Exhibit 88: Hangke's development milestones



Source: Company website, Morgan Stanley Research.

Exhibit 89: Hangke's shareholding structure (as of end-2021)



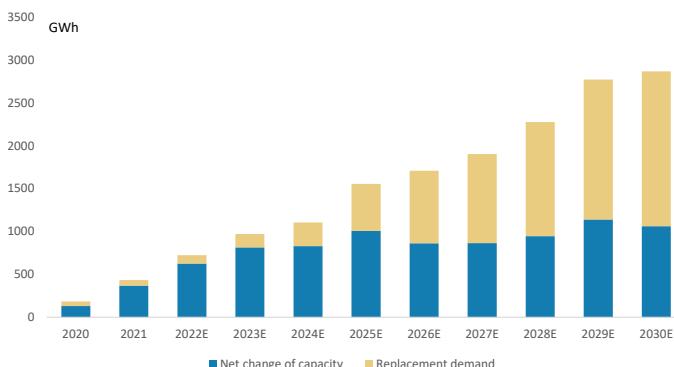
Source: Company data, Morgan Stanley Research.

Industry Forecasts

Overall, we estimate the lithium battery equipment market to grow from Rmb85bn in 2021 to Rmb280bn in 2025 and further to Rmb400bn in 2030. Growth drivers include rising global EV sales as well as strong demand for energy storage systems (ESS). We assume a replacement cycle of 3.5 years and project a 5% ASP decline per year in 2022-30.

From the demand side: Governments worldwide have recently instituted initiatives that have been supportive of the lithium battery equipment industry. These initiatives range from ICE bans, BEV subsidies, and carbon emissions targets, and will support BEV penetration,

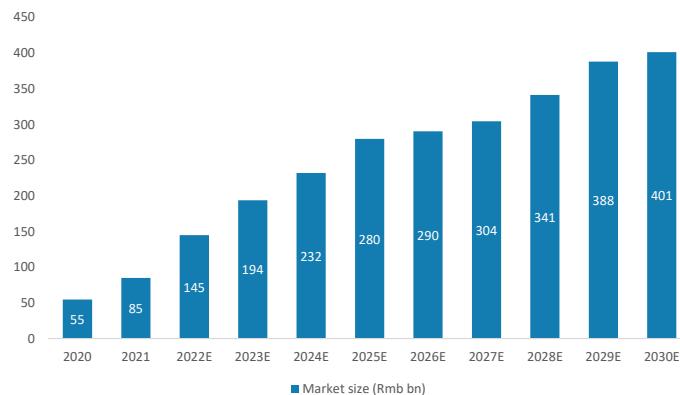
Exhibit 90: Replacement demand will drive equipment demand growth from 2026



Source: Company data, Morgan Stanley Research. E = Morgan Stanley Research estimates.

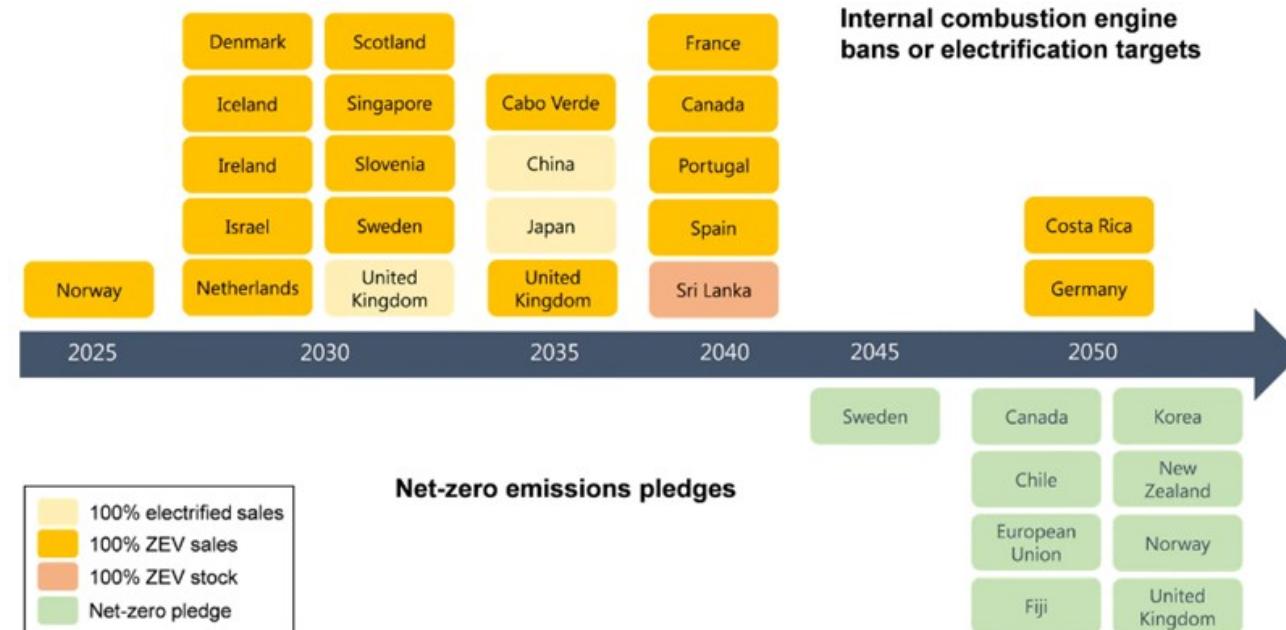
which, in turn, will support the EV battery industry's growth. We estimate the global EV penetration rate will be 25% in 2025 and 48% in 2030, up from 11% in 2021, implying EV battery installations of 1.2TWh in 2025 and 3.0TWh in 2030. In the meantime, we believe ESS demand will experience rapid growth during this decade, resulting in newly added installations of 108GWh in 2025 and 190GWh in 2030, up from 36GWh in 2021. Overall, we forecast total lithium battery installations will reach 1.3TWh in 2025 and 3.1TWh in 2030, up from 420GWh in 2021.

Exhibit 91: We estimate the market size of lithium battery equipment will almost triple in 2030 from 2022 levels

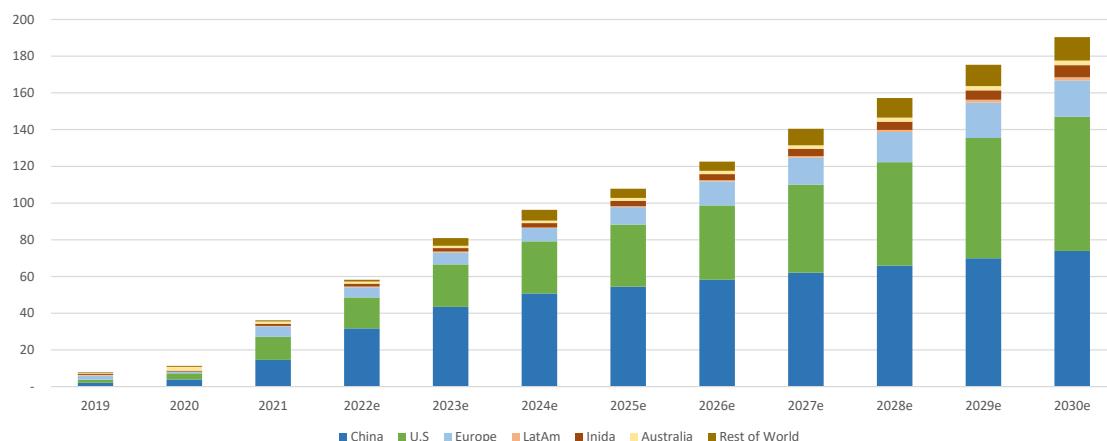


Source: Company data, Morgan Stanley Research. E = Morgan Stanley Research estimates.

Exhibit 92: Snapshot of electrification targets globally



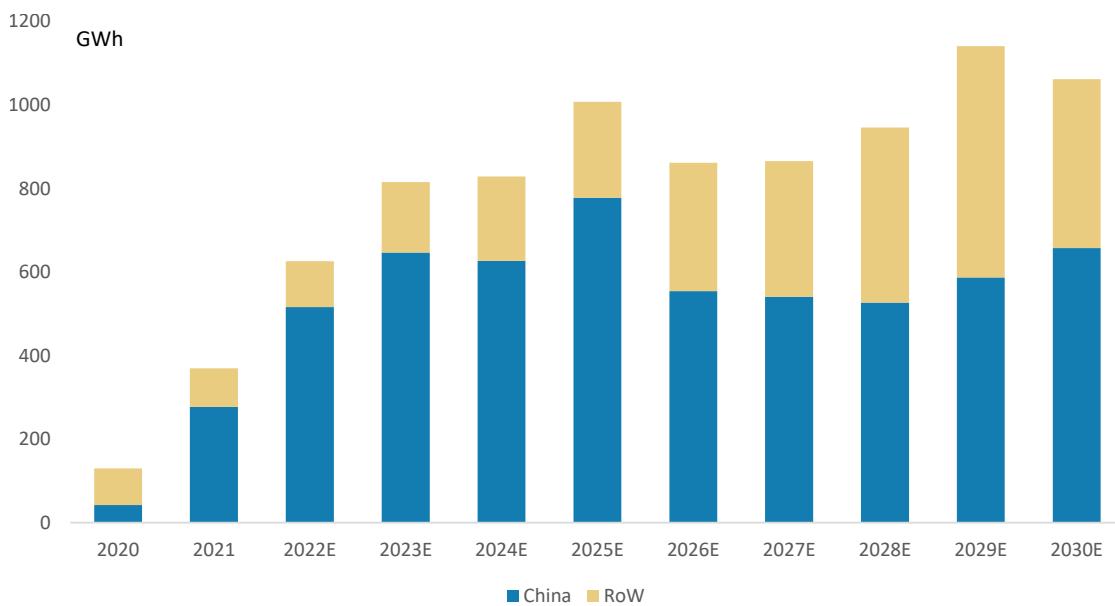
Source: IEA, Morgan Stanley Research.

Exhibit 93: Global ESS additions

Source: BNEF, IHS, Fluence, Tesla, NexEra, Morgan Stanley Research. E = Morgan Stanley Research estimates.

From the supply side: On the back of the aggressive capacity expansion planned by cell makers around the world, we estimate the global battery capacity to grow from ~800GWh in 2021 to ~4TWh in 2025 and further to ~9TWh in 2030.

Exhibit 94: Overseas capacity will take more market share along with massive capacity expansion from both traditional foreign cell makers and OEMs



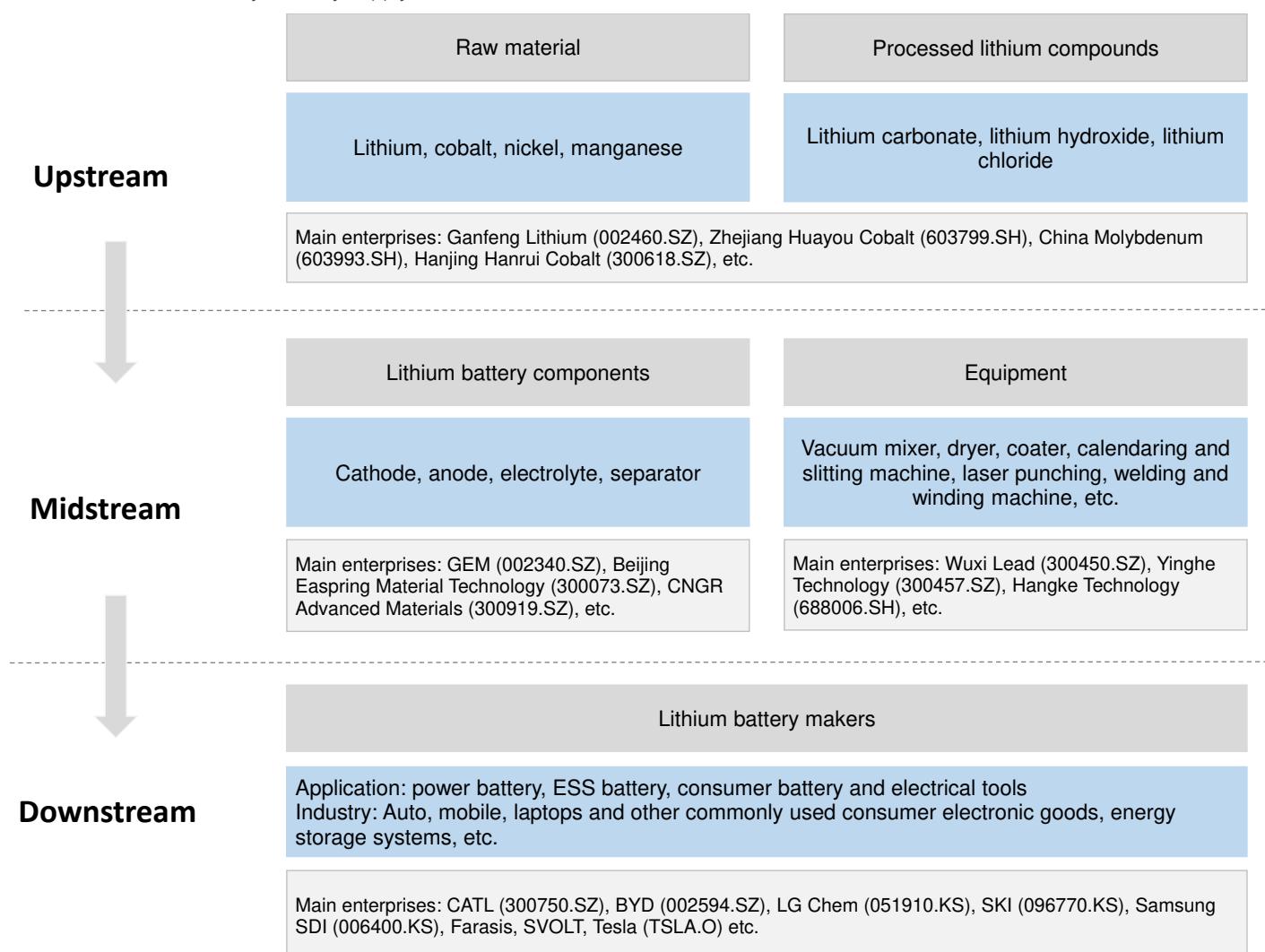
Source: Company data, Morgan Stanley Research. E = Morgan Stanley Research estimates.

Lithium Battery Industry Ecosystem

The upstream segment typically consists of raw materials and their processing. Given the growing demand for certain minerals such as lithium, cobalt, and nickel, the competitive landscape has consolidated via ongoing capacity expansions and acquisitions. In the mid-stream segment, various components such as cathodes, anodes, electrolytes, and separators are manufactured and assembled. The

downstream segment includes the assembly of those components and distribution to their end users such as EV OEMs, energy storage players, and 3C enterprises. In 2021, the world's battery supply was dominated by Chinese and Korean companies, of which Chinese battery makers had a ~48% market share in terms of new installations and South Korean companies took up ~30%.

Exhibit 95: Lithium battery industry supply chain



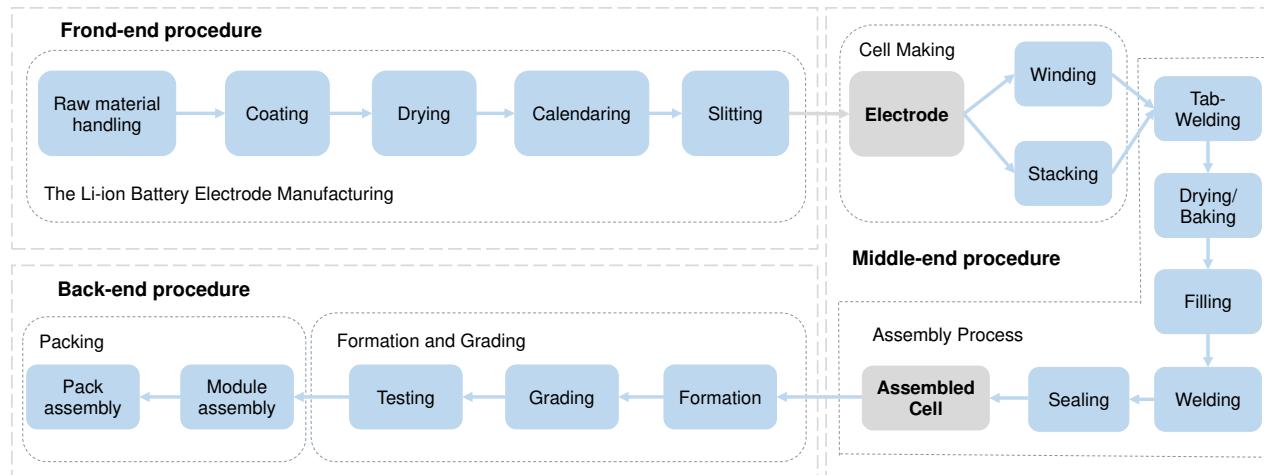
Source: Morgan Stanley Research.

Lithium Battery Equipment Industry 101

Lithium battery equipment chain

Lithium battery production can be divided into three stages: electrode manufacturing, cell making, and formation and grading. The lithium battery equipment chain corresponds to these three stages and are called front-end equipment, middle-end equipment, and back-end equipment, which accounted for approximately 35%, 35% and 30% of the value of the whole production line, respectively. Core equipment for these three production stages includes (1) **front-end**: mixer, coating machine, dryer, and calendaring and slitting machine; (2) **mid-end**: welding machine, winding machine and stacking machine; and (3) **back-end**: formation and grading system, and testing machine. Lithium battery equipment plays a critical role in determining the performance and cost of making the battery.

Exhibit 96: Lithium battery manufacturing processes



Source: Morgan Stanley Research.

Exhibit 97: Front-end equipment and main players

Process	Description	Effect	Equipments	Major players
Mixing	Active raw materials, binder and conductive agent are mixed together in specific mass ratios	Slurry stability	Vacuum mixer /Loading system of mixer	D: Naura/Wuxi Lead/G.M.W F: ASADA
Coating	Coating slurries on copper film for making anodes and aluminium film for making cathodes of lithium batteries	Density and viscosity	Coating machine	D: Wuxi Lead/Yinghe /Putailai/Kanhoo/Lyric F: PNT/CIS /Hirano Tecseed
Calendaring	Calendaring the dry electrode to increasing the energy density of cell	Density and viscosity	Integrated calendaring and slitting machine	D: Wuxi Lead/Yinghe /Naura F: PNT/CIS/Nishimura
Slitting	The finished electrode are cut or punched into strips of desired shape and size	Shape and size	Integrated calendaring and slitting machine /separator slitting machine /laser punching	D:Wuxi Lead/Naura /Yinghe/Kanhoo/Lyric F: PNT/CIS

Source: Morgan Stanley Research. Note: D=Domestic, F=Foreign.

Front-end

The electrode manufacturing stage involves a series of steps, including the formulation and selection of materials, mixing of the materials into a solvent to create an electrode slurry, coating of the slurry onto metal foil, drying the coated electrode to remove solvents, and calendaring the dry electrode to increase the energy density of the cell via a reduction in porosity, leaving sufficient porosity for lithium transport. The finished electrode can be cut to size and assembled into a cell.

Coating machine is the core equipment in the front-end, and its value accounts for about 75% of electrode manufacturing. Coating refers to the process of applying electrode slurries on copper film for making anodes and aluminum film for making cathodes. The quality of the coating process profoundly affects the energy density and viscosity of the electrode, affecting uniformity, consistency, safety and battery life. Thus, a coating machine's rolling speed, width, density and thickness must be precisely calibrated. Thanks to their strong R&D capabilities, leading domestic players are at the same technology level as their foreign peers.

Exhibit 98: Mid-end equipment and main players

Process	Description	Effect	Equipment	Major players
Winding	Winding raw materials in the order of the negative electrode, the separator, the positive electrode, and the separator, and directly roll into a cylindrical shape	Safety, energy density, process control	Winding machine/Integrated welding and winding machine	D: Wuxi Lead/Yinghe/Lyric F: CKD/KOEM/DA
Stacking	Relying on a "stack", such as a "z"-shaped stacking, first cutting the positive and negative materials into rectangular pieces of the same size, and then stacking them on the diaphragm, respectively	Safety, energy density, process control	Stacking machine	D: Wuxi Lead/Yinghe/Lyric F: Youil/DA/mPLUS/DA
Filling	Filling electrolyte into cell	Safety, electrochemical performance, cycle life	Rehydration machine /Electrolytic injection machine	D: Wuxi Lead/Yinghe/Lyric F: DA
Welding	Welding the injection port	Capacity	Laser welding machine	D: Wuxi Lead /Yinghe/Lyric/Han's Laser F: Youil/DA/mPLUS

Source: Morgan Stanley Research. Note: D=Domestic, F=Foreign.

Mid-end

The cell-making stage includes winding or stacking, welding, electrolyte filling, sealing, and packing. Winding machine and stacking machine have the highest value in the mid-end stage, which requires high-precision, efficiency, and consistency.

The winding process involves stacking the raw materials in the order of the negative electrode, the separators, the positive electrode, and the separators again, and rolling them into a cylindrical shape by a winding technology. One of the key advantages of the winding process is the winding speed, which is about 5x faster than that of the stacking process. The stacking process involves cutting the positive and negative materials into rectangular pieces of the same size, and then stacking them (like a Z shape) on the diaphragm. Stacking technology has a higher discharge capacity, better discharge platform, higher energy density, and a wider range of application because of its flexible size. However, these advantages come with higher costs and higher requirements for automated machines. Thus, a winding machine is more popular in today's lithium battery manufacturing industry and its value accounts for about 70% among mid-end equipment.

The winding machine market is highly concentrated, with a CR3 ratio of 60-70%. Wuxi Lead plays a leading role in the domestic market, followed by Yinghe and Chengjie Intelligent. Among the foreign brands, KOEM and CKD are leading brands. Domestic players enjoy market share expansion, driven by advanced technology. For example, Wuxi Lead's prismatic aluminum shell cell winding machine has precise tension fluctuation, which $\leq \pm 3\%$, comparing with

10-20% of domestic peers, while maximum design linear speed is 3m/s (versus ~1m/s of foreign brands), and winding alignment achieved $\pm 0.3\text{mm}$ (versus $\sim 0.3\text{mm}$ of foreign brands).

Three types of lithium battery

There are three major lithium battery forms: cylindrical, prismatic, and pouch. Each of these types have their own advantages and disadvantages. A cylindrical battery has mechanical stability. A prismatic battery's technology is in the mature stage and thus this type of battery is widely used in China's EV market, enjoying ~80% market share. A pouch battery can easily fit in the available space of a given chassis. According to *EV Volumes*, out of the 20 best-selling EV models (both pure EV and hybrids) globally in 2020, 14 models used pouch batteries.

As for technological process, the cylindrical and some prismatic batteries' technologies are based on the winding process, while the pouch battery is based on the stacking process. As mentioned above, the winding process is more popular nowadays, however, given the growing demand for pouch batteries, we expect continuous technology improvements and declining costs in the stacking process.

Exhibit 99: Three major types of lithium battery

Types	Pictures	Energy Density	Safety	Weight	Degree of Standardization	Technology Difficulty	Charge and Discharge Ratio
Cylindrical Battery		Middle	Middle	High	High	Easy	Low
Prismatic Battery		Middle	Middle	Low	Low	Moderate	Middle
Pouch Battery		High	High	Low	Low	Difficult	High

Source: Morgan Stanley Research.

Back-end

The back-end process includes formation and grading, testing, and packing, and accounts for ~30% of the total cost of the lithium battery manufacturing process. Formation and grading of the battery cell is the key step, achieved by precise control of the first charging and discharging process, which directly affect the product yield and quality of the finished battery.

Formation refers to activating the cell, with different charging currents, rest step and degassing step, which gives the battery the ability to store and release electrical energy. During the formation process, the electrode material reacts with the electrolyte at the solid-liquid phase interface. After the reaction, a thin film called SEI forms on the surface of the electrode material. The SEI film has a crucial impact on the performance and cycle life of the finished battery, while it is influenced by electrolytes, the first charging and discharging current and temperature. The battery cell grading involves sorting the characteristics of the finished battery such as discharge capacity, voltage, and

internal resistance, which can improve the consistency of the finished battery and optimize the system configuration.

The back-end equipment includes formation and grading system, testing machine and detection machine, which has realized over 90% localization, thanks to their high customization and good cost performance. Hangke is a leading back-end company in China, with a more than 60% market share in the top 10 battery makers. Wuxi Lead, Yinghe, Lyric, and Guangzhou Kinte Industrial are the other major back-end players in China. Among the foreign players, PNE and Kataoka are leading companies in the back-end process, thanks to their early mover advantage in battery equipment of the Japanese and Korean companies. These foreign players mainly focus on single machines. Although foreign machines are more precise and are more automated than the domestic machines, they also command higher prices. Hence, we see opportunity for the Chinese back-end players to penetrate the global market.

Exhibit 100: Back-end equipment and main players

Process	Description	Equipment	Major players
Formation	Activating the cell to performing initial charge/discharge operation, to enable the cell perform its electrical functionality	Formation and grading system	D: Hangke/Wuxi Lead/Lyric F: PNE/A-pro/Kataoka
Grading	Making the cell's electrochemical property settle down to obtain discharge capacity, voltage, and internal resistance	Formation and grading system	D: Hangke/Wuxi Lead/Lyric F: PNE/A-pro/Kataoka
Testing	Testing the appearance and internal structure of the battery	Airtightness tester /Detection equipment	D: Hangke/Wuxi Lead/Lyric F: PNE/A-pro/Kataoka
Packing	The finished batteries are already installed in the device they are designed for	Module assembly line /PACK assembly line	D: Wuxi Lead/Yinghe/Lyric F: DA

Source: Morgan Stanley Research. Note: D=Domestic, F=Foreign.

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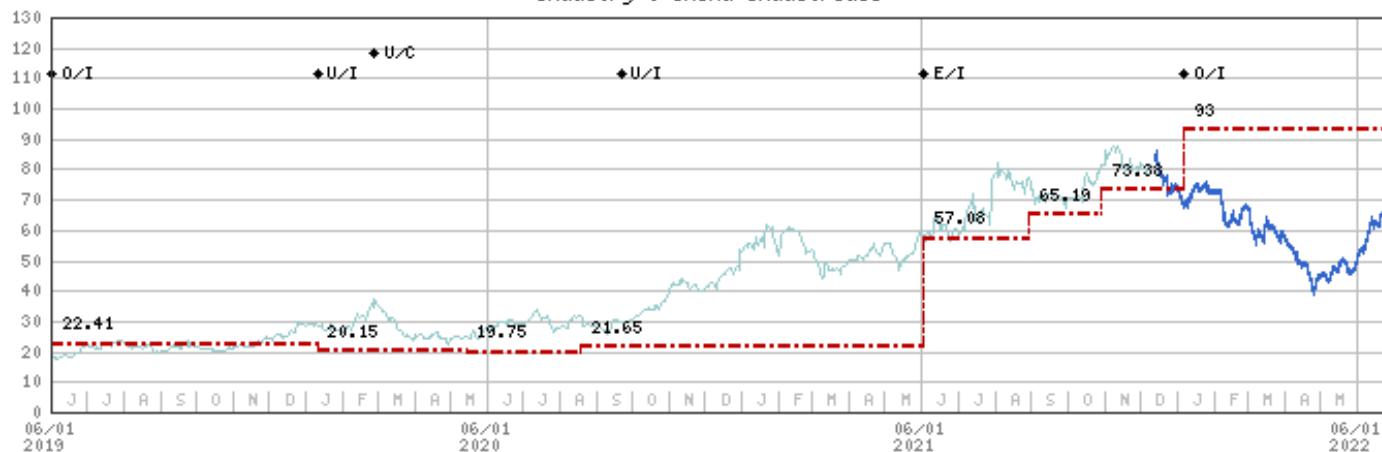
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Industry : China Industrials



Stock Rating History: 6/1/17 : /A; 3/1/18 : /I; 3/5/18 : 0/I; 1/10/20 : U/I; 2/27/20 : U/C; 9/21/20 : U/I; 6/2/21 : E/I; 1/7/22 : O/I

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Source: Morgan Stanley Research Date Format : MM/DD/YY Price Target -- No Price Target Assigned (NA)

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INDUSTRY COVERAGE: China Industrials

COMPANY (TICKER)	RATING (AS OF)	PRICE* (06/23/2022)
Chelsea Wang		
CCCC (601800.SS)	U (05/19/2021)	Rmb9.10
CCCC (1800.HK)	O (07/21/2017)	HK\$3.99
China Railway Construction (601186.SS)	E (05/12/2022)	Rmb7.82
China Railway Construction (1186.HK)	O (01/28/2016)	HK\$4.93
China Railway Group (601390.SS)	E (05/12/2022)	Rmb6.16
China Railway Group (0390.HK)	O (09/01/2017)	HK\$4.82
China State Construction Engineering (601668.SS)	E (05/12/2022)	Rmb5.52

Joy Zhang

DR Laser (300776.SZ)	E (12/17/2021)	Rmb172.10
Han's Laser (002008.SZ)	O (09/21/2020)	Rmb31.54
Hefei Meyer Optoelectronic Technology (002690.SZ)	O (05/14/2020)	Rmb21.00
Huagong Tech Co. Ltd. (000988.SZ)	O (09/21/2020)	Rmb22.67
Raycus Fiber Laser (300747.SZ)	O (09/21/2020)	Rmb33.51
Shenzhen SC New Energy Technology Corp (300724.SZ)	U (03/08/2022)	Rmb102.86
Shenzhen Yinghe Technology (300457.SZ)	U (01/10/2020)	Rmb27.18
Sinotruk (Hong Kong) Limited (3808.HK)	E (01/28/2021)	HK\$10.78
Suzhou Maxwell Technologies Co Ltd (300751.SZ)	O (02/05/2021)	Rmb448.70
WeiChai Power (2338.HK)	E (09/08/2021)	HK\$12.52
WeiChai Power (000338.SZ)	E (09/08/2021)	Rmb12.61
Wuxi Lead Intelligent (300450.SZ)	O (01/07/2022)	Rmb68.18
Zhejiang Hangke Technology (688006.SS)	O (06/23/2022)	Rmb71.18

Sheng Zhong

Centre Testing International Group (300012.SZ)	O (10/19/2021)	Rmb22.32
CIMC Enric Holdings (3899.HK)	E (08/25/2021)	HK\$8.75
CRRC Corp Ltd (1766.HK)	O (09/21/2016)	HK\$2.89
CRRC Corp Ltd (601766.SS)	O (08/02/2018)	Rmb5.17
Estun Automation Co Ltd (002747.SZ)	O (12/07/2020)	Rmb20.17
Haitian International Holdings Limited (1882.HK)	O (03/06/2015)	HK\$20.20
Hongfa Technology Co Ltd (600885.SS)	E (05/12/2020)	Rmb58.10
Jiangsu Guomao Reducer Co Ltd (603915.SS)	O (02/01/2021)	Rmb20.89
Jiangsu Hengli Hydraulic Co.Ltd (601100.SS)	E (02/27/2020)	Rmb58.00
Leader Harmonious Drive Systems (688017.SS)	O (02/01/2021)	Rmb138.00
LK Technology Holdings Ltd (0558.HK)	E (08/17/2021)	HK\$17.24
Raytron Technology Co., Ltd. (688002.SS)	E (08/25/2021)	Rmb40.69
Sany Heavy Industry Co., Ltd. (600031.SS)	E (02/27/2020)	Rmb18.26
Shenzhen Inovance Technology (300124.SZ)	O (01/04/2022)	Rmb68.05
Times Electric (3898.HK)	O (01/28/2016)	HK\$33.90
Zhejiang Dingli Machinery Co Ltd. (603338.SS)	U (02/27/2020)	Rmb48.71
Zoomlion Heavy Industry (1157.HK)	O (03/01/2019)	HK\$4.05
Zoomlion Heavy Industry (000157.SZ)	E (12/17/2021)	Rmb6.00

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* Historical prices are not split adjusted.

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