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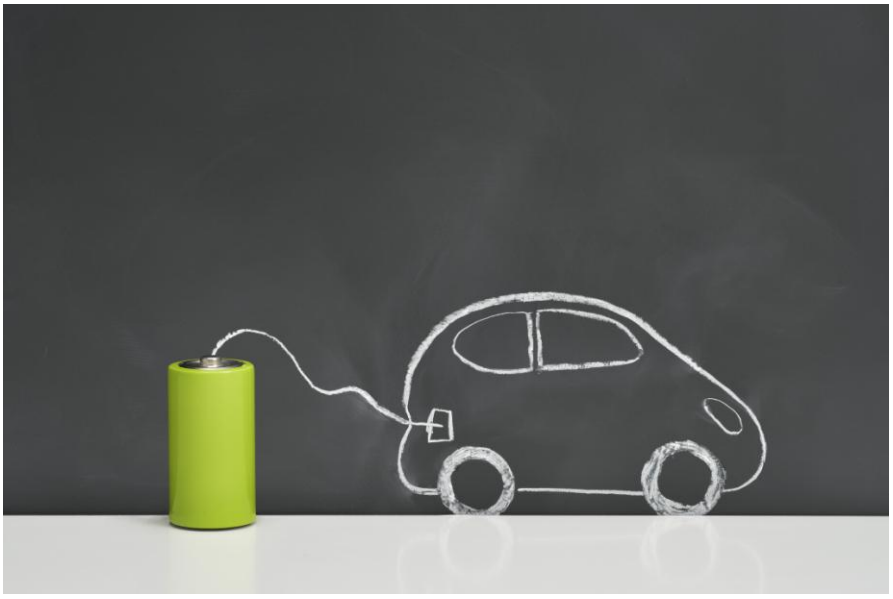
Industry
EV battery makers

Date
2 June 2016

Asia

Energy



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F.I.T.T. for investors

Charging the car of tomorrow

Riding on the global EV market growth – focusing on battery makers

Global battery consumption will increase five-fold over the next decade, as the electric vehicle market expands, driven initially by regulatory changes and government subsidies, before falling costs stimulate affordable demand. While still at an early stage, we address the competitive strengths of four major battery producers – Panasonic, LG Chem, SDI, and Guoxuan High-tech and identify their unique attractions based on technology, scalability, geography, and financial capability. The report also looks in detail at a key component, the cathode, and its relevance for battery technology in the future.

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Analyzing global battery makers – Guoxuan and Panasonic best positioned

We have analyzed four key areas determining the competitive landscape of the major battery makers: 1) technology, 2) scalability, 3) geography and 4) financial capability. Coupled with bottom-up company-specific factors, we believe Guoxuan (Buy) and Panasonic (Buy) are the best ways to play the battery theme. Guoxuan's lead in the Chinese commercial vehicle sector is a strong base from which to leverage China's accelerating growth in the EV market. As for Panasonic, we view its monopoly in Tesla amid an improving earnings outlook for the overall EV battery business as a strong positive. We believe LG Chem (Buy) and SDI (Hold) possess strong competitiveness in technology and financial capability, but view Chinese regulatory changes as an ongoing risk for the Korean NMC-based battery makers.

Guoxuan - most leveraged player to EV lithium battery; initiating with Buy

Guoxuan High-tech is the fourth-largest EV lithium battery player in China, in terms of sales in 2015. It is also the most leveraged major player in the stock market to the EV lithium battery business, which is expected to contribute 90% revenue and 94% gross profit in 2016. We believe Guoxuan's aggressive capacity expansion and competitive advantages will help it to grow market share significantly and enable it to become one of the major beneficiaries of the Chinese government's target of putting 5mn EV units on the road by end-2020. We initiate coverage with a Buy.

Cathode – key battery component for the future

Given the different types of EV batteries in the market, we provide our insights regarding different battery technologies. Among the battery components, we believe cathode is the key to improving battery performance. Battery priorities for EVs are safety and high energy density, and today's widely-used NCA, NMC and LFP batteries offer different strengths and weaknesses. While we expect a combination of energy dense (NMC/NCA) and power dense materials (LFP) to be used in the future, we have analyzed key cathode producers – Umicore, Johnson Matthey, and BASF – and conclude that Umicore is best positioned to benefit among the component plays.

Valuation and sector risks

This report changes price targets and recommendations (see Figure 4 on page 5). Key upside risks are stronger policy support from the government (i.e. greater subsidy and tax credit), and faster-than-expected global EV penetration. Downside risks are battery technology replacement, and passive government support (i.e. elimination of subsidies).

Key Changes

Company	Target Price	Rating
051910.KS	390,000.00 to 350,000.00(KRW)	-
002074.SZ	– to 40.40(CNY)	NR to Buy
006400.KS	114,000.00 to 117,000.00(KRW)	-
UMI.BR	32.00 to 40.00(EUR)	Sell to Hold

Source: Deutsche Bank

Top picks

Guoxuan High-Tech (002074.SZ),CNY33.53	Buy
Panasonic (6752.T),¥1,010	Buy

Source: Deutsche Bank

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Executive summary

EV battery demand to be boosted by EV market growth

EV market growth ahead

With worldwide EV sales expected to more than quadruple over the next decade, the emergence of the EV theme to tackle government emissions and regulatory targets has resulted in the rapid development of rechargeable batteries. The larger catalyst for global mass-market update of EV technology is China, where government subsidies are in place for both passenger and commercial EVs (buses and small trucks). Representing 40% of the global EV market, Chinese EV sales took off from 2H15. Based on the recent FITT report by Vincent Ha, entitled *China Autos – What you should know about China's new energy vehicle (NEV) market*, DB expects a five-year sales CAGR of 33% for China EVs and expects China to account for half of global EV/Plug-in-Hybrid EV demand by 2020.

We expect global electric vehicles sales to grow to +16mn vehicles with pure EV sales rising to 3.0mn vehicles (2.6% of global sales, 6x the 2015 market by 2025). **During this era of rapid growth in the market, we believe EV battery makers are well-positioned to benefit from the rising demand for rechargeable batteries,** while economies-of-scale allow rapid reduction in the battery costs. Of note, we estimate lithium consumption in batteries to show a 23% CAGR in the next decade, reaching 205kt LCE by 2025 from 2015's 25kt LCE.

As global battery producers expand capacity, lithium-ion battery costs are falling rapidly, leading to economies of scale. From US$900/kWh in 2010, battery cell costs have fallen to US$225/kWh today. We believe costs can fall to US$150/kWh by 2020 as global battery majors expand battery manufacturing capacity. The significant cost reduction is opening up new demand applications for lithium-ion, while further making the lithium-ion batteries superior to other battery technologies.

Analyzing global battery makers

Competitive analysis of EV battery makers based on four key criteria

We analyze four major EV battery makers based on technology (energy density, cell price per kWh, etc), scalability (order backlog, market share, profitability), geography (geographic advantages, government subsidies) and financial capability (leverage, capex outlook, EV battery dependency), and provide the competitive landscape of battery majors – Panasonic, SDI, LG Chem, and Guoxuan Hightech.

Figure 1: Comparative analysis of EV battery makers

						2016E EV contributions		2018E EV contributions	
Company	Flagship model	Key markets	Disclosed contracts	NRG density (Wh/kg)	$/kWh (cell)	Sales	OP	Sales	OP
Guoxuan High-tech	e-Bus (2015)	China	2	103	189	89.9%	98.4%	94.9%	99.1%
Panasonic	Model 3 (2017)	US, Japan	86	171	129	2.7%	5.4%	5.5%	7.2%
LG Chem	GM Bolt (2017)	US, EU, China	40	138	147	6.4%	0.6%	8.8%	8.8%
SDI	BMW i3 (2017)	US, EU, China	39	132	210	21.0%	NM	31.7%	7.7%

Source: Deutsche Bank estimates, Company data, InsideEVs, Industry sources

Guoxuan Hightech and Panasonic are preferred EV battery plays

We believe Guoxuan Hightech (002074.SZ, Buy, TP CNY40.40, James Kan) and Panasonic (6752.T, Buy, TP ¥1,500, Hiroshi Taguchi) are the preferred EV battery plays in the region. Guoxuan's presence in China will benefit from and leverage on China's accelerating growth in the EV market, while the company's earnings appear most-leveraged to EV business vs. its peers. We expect 46% earnings CAGR over the next three years, driven by the growing demand for its batteries.

We believe Panasonic is best-positioned in terms of technological capability and economies-of-scale. Panasonic's Tesla Model 3 batteries are the most competitive, in our view, with cell price per kWh expected to be lowest at US$129, while having the highest energy density with 171Wh/kg. In addition, Panasonic has the highest order backlog among the battery makers. We believe the completion of Gigafactory (+35GWh cell capacity) in the US will further enhance its EV battery growth story, while non-Tesla battery orders continue to support the overall profitability.

LG Chem and SDI have been well ranked in our analysis, and we expect earnings growth from EV batteries to accelerate over time as new orders start materializing. Nevertheless, we view the continuing regulatory changes in the Chinese EV market as an ongoing concern, and prefer Guoxuan as a key China play, and Panasonic for its strong presence in Tesla.

While BYD has a meaningful share of the global EV battery capacity, especially for the Chinese market, we do not view BYD as an EV battery play, as the company manufactures batteries only for its own new energy vehicle production. In other words, there are no external EV battery sales by BYD. As a result, we do not view BYD as a direct competitor to other battery peers.

China – subsidies matter; suppliers have to be on the list

It is becoming increasingly difficult for foreign battery makers to gain meaningful exposure in China. At end-2015, China temporarily restricted the use of NMC/NCA based batteries on e-buses for safety reasons. More recently, **the Chinese government announced new standards to strengthen its regulation of providing NEV purchase subsidies only to NEV models equipped with batteries from qualified and registered EV battery makers**. Guoxuan is on the list and all 25 are local makers. Korean makers such as LG Chem and SDI have yet to be included, despite meeting all the necessary requirements, while other companies, such as Panasonic and SK Innovation, are not eligible as they lack battery plant operations in China.

Cathode – key battery component for the future

Cathode – key battery component for the future

Comprising 26% of the total manufacturing cost of a lithium battery, cathodes are the most important component in improving battery performance. Among the different materials for cathodes are NCA (used in EVs), NMC (in PHEVs+EVs), and LFP (in PV + CV EVs). Key considerations for EV batteries are safety and high energy density. While NMC/NCA-type batteries score higher in energy density, LFP provides safer features (but lower energy density). Going forward, we expect a combination of energy dense (NMC/NCA) and power dense (LFP) cathodes to be used, depending on the application.

Among the three cathode producers we have analyzed – Umicore, BASF, Johnson Matthey – we believe Umicore is best placed, given that it has a broader product offering (NMC, NCA, LCO) of cathode materials, while maintaining good profitability.

Figure 2: Comparative analysis of European Chemicals cathode/battery material exposure (2015)

Company	Sales	% of 2016E group Sales	EBIT	% of Group EBIT	Type of cathode/ battery materials
BASF	<E100m	0.2%	Loss-making business, expected to break even by 2020	NA	NiMH, LFP, NCM and electrolytes. R&D focus on develop Li-S and Li-air cathode materials
Johnson Matthey	GBP150m (GBP40m in battery materials)	4.7%	Loss-making business, expected to break even by end of 2016/17	NA	LFP, expanding into nickel rich materials
Umicore	E115m	4.2%	E14m	4.1%	NMC/NCA, LCO, moving away from LFP

Source: Deutsche Bank, Company Data

Figure 3: Peer valuation summary

			Close	Target	Up/Down	PER			PBR			EV/EBITDA			ROE (%)			EPS Growth (%)			Dividend yield (%)		
Company	**Ticker**	**Rating**	**Price (LC)**	**Price**	**side (%)**	**15**	**16E**	**17E**	**15**	**16E**	**17E**	**15**	**16E**	**17E**	**15**	**16E**	**17E**	**15**	**16E**	**17E**	**15**	**16E**	**17E**
EV battery																							
Guoxuan High-tech	002074.SZ	Buy	32.70	40.40	23.5%	43.0	26.9	20.6	10.78	7.62	6.05	31.7	18.2	13.3	24.6	31.4	32.7	-40.1	81.9	30.6	0.5	1.1	1.5
Panasonic	6752.T	Buy	1,011	1,500	48.4%	16.4	13.3	10.7	1.41	1.29	1.19	3.9	3.9	3.4	11.0	10.0	11.6	7.4	-8.7	24.5	1.8	2.5	3.0
LG Chem	051910.KS	Buy	269,500	350,000	29.9%	16.8	12.8	10.4	1.85	1.39	1.25	6.5	5.8	5.0	8.9	11.3	12.7	35.7	37.1	23.3	1.7	1.9	2.2
Samsung SDI	006400.KS	Hold	117,000	117,000	0.0%	147.3	38.9	29.2	0.73	0.73	0.72	2.7	-4.6	0.0	0.5	1.9	2.4	TTB	283.9	33.4	0.0	0.0	0.0
Average						55.9	23.0	17.7	3.69	2.76	2.30	11.2	5.8	5.4	11.3	13.7	14.9	1.0	98.6	27.9	1.0	1.4	1.7
Battery component																							
BASF	BASFn.DE	Buy	69.43	85.00	22.4%	15.9	13.2	12.3	2.10	1.98	1.88	8.8	7.9	7.2	13.6	13.2	13.6	-8.2	5.4	6.9	3.7	4.4	4.6
Umicore	UMI.BR	Hold	45.30	40.00	-11.7%	17.3	21.1	20.2	2.41	2.64	2.46	12.7	10.9	10.0	6.3	15.3	14.8	26.8	-4.9	4.3	3.1	2.6	2.6
Johnson Matthey	JMAT.L	Buy	2,884	3,400	17.9%	17.7	16.7	15.7	3.80	3.30	2.87	12.6	11.3	11.1	25.4	14.3	18.2	5.8	-4.5	6.3	2.1	7.6	2.6
Average						17.0	17.0	16.1	2.77	2.64	2.40	11.4	10.0	9.4	15.1	14.3	15.6	8.2	-1.3	5.8	3.0	4.9	3.3

Note: Panasonic's FY ends in March. For example, CY16 equates to FY3/17 for Panasonic
Source: Deutsche Bank estimates

Figure 4: Summary of earnings/ target price/ rating changes

Company	Ticker	Rating	FY 16/17E NP chg	New TP (LC)	Old TP (LC)	% Chg
EV battery						
Guoxuan High-tech	002074.SZ	Buy from NR	-	40.40	-	-
Panasonic	6752.T	Buy	-	-	1,500	-
LG Chem	051910.KS	Buy	-1/-1%	350,000	390,000	-10.3%
Samsung SDI	006400.KS	Hold	-	117,000	114,000	2.6%
Battery component						
BASF	BASFn.DE	Buy	-	-	85	-
Umicore	UMI.BR	Hold from Sell	-	40	32	25.0%
Johnson Matthey	JMAT.L	Buy	-	-	3,400	-

Source: Deutsche Bank estimates

Strong battery demand growth ahead

The Lithium-ion Age

This is the dawn of the Lithium-ion Age

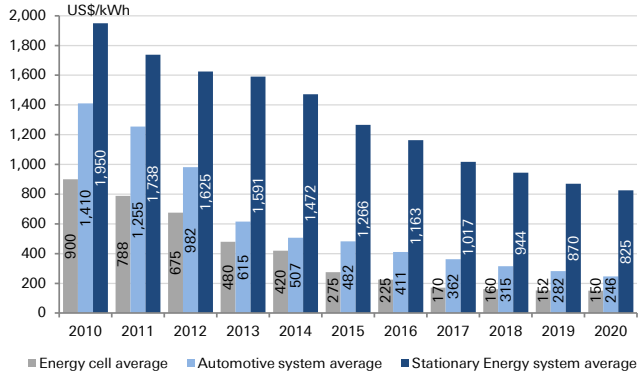
The commercialization of the lithium-ion battery in the 1990s powered a 20-year surge in the telecommunication and computing industries, following the rapid development of light, powerful, rechargeable batteries. As we enter the second half of this decade, the emergence of the Electric Vehicle (EV) is a globally significant theme based on the same battery technology. Governments are setting carbon emission targets for the automotive industry whilst also subsidizing EV technology. Beyond traditional demand markets, the emergence of EV and another potential market is beginning to materialize. Battery energy storage on a grid-, industrial-, commercial- and consumer-scale is reaching commercial viability, and rapidly-falling battery costs suggest that the Energy Storage sector could also grow materially over the next 10 years.

This section contains extracts from DB FITT report 'Welcome to the Lithium-ion Age', published 9 May 2016. Mathew Hocking, James Kan, Paul Young, Chris Terry and David Begleiter are the primary authors

Unprecedented demand growth over next 10 years

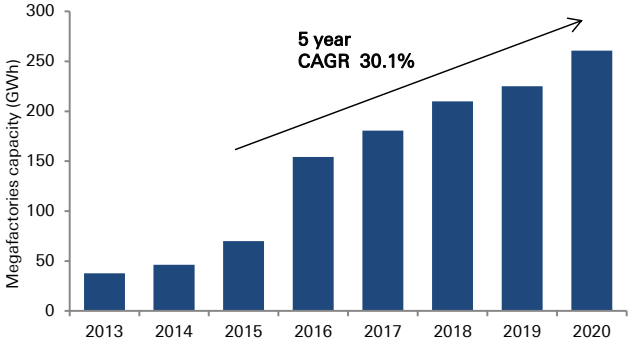
Lithium-ion battery costs are falling rapidly as global battery producers expand manufacturing facilities, unlocking economies of scale. Energy cell costs have fallen from US$900/kWh in 2010 to around US$225/kWh today. This cost reduction is opening up new demand applications for lithium-ion and making lithium-ion batteries superior to other battery technologies, not just on power and performance but also on cost. We believe costs can fall to US$150/kWh by 2020 as multinational companies like Tesla, Panasonic, LG Chem, SDI and BYD further expand global battery manufacturing capacity.

Figure 5: Lithium-ion battery costs are falling



Source: Deutsche Bank; Cairn ERA

Figure 6: The battery supply chain is rapidly increasing too



Source: Deutsche Bank, company data

The Electric Vehicle industry is the major demand market

Global investment in the battery supply chain and the need for cheaper batteries is being driven by the emergence of the Electric Vehicle. This growing market has been pioneered by Tesla in recent years, but the larger catalyst for global mass-market uptake of EV technology is China, where government subsidies are in place for both passenger and commercial EVs (buses and small trucks). Hybrids & plug-in hybrids currently dominate global EV sales, with full-electric EVs accounting for only 0.6% of global auto sales in 2015. We expect total EV sales to grow to over 16 million vehicles by 2025 with full-electric EV sales rising to 3.0 million vehicles (2.6% of global sales, 6x the 2015 market). **This market share gain should lift lithium consumption in EVs from 25kt LCE in 2015 to 205kt LCE in 2025 (23% CAGR over the next 10 years).**

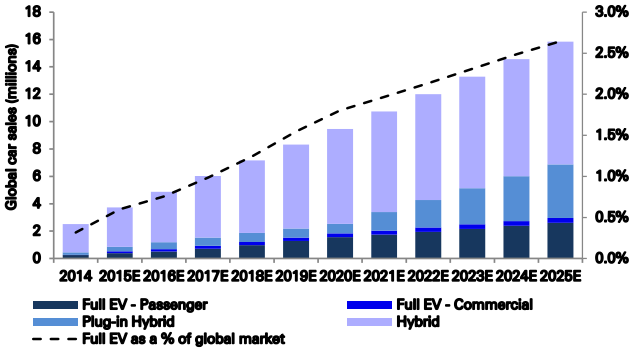
Tesla is now targeting 500,000 units of annual production by 2018, two years earlier than previously planned. On their 1Q16 call, management also suggested that they hope to sustain a 50% growth rate, which would imply over 1 million units by 2020.

Figure 7: DB global EV forecasts (m units)

	2015	2020	2025
Hybrid	2.9	6.9	9.0
Plug-in Hybrid	0.3	0.7	3.9
Full EV - Passenger	0.4	1.6	2.6
Full EV - Commercial	0.1	0.3	0.4
Subtotal	3.7	9.5	16
Diesel	18	19	20
Gasoline	67	73	76
Total	89	102	112
Hybrid as % of global market	3.2%	6.8%	8.0%
Plug-in Hybrid as % of global market	0.4%	0.7%	3.5%
Full EV as % of global market	0.6%	1.8%	2.6%
Full EV as % of Total EV	14.3%	19.4%	18.7%

Source: Deutsche Bank estimates

Figure 8: DB global EV forecasts



Source: Deutsche Bank estimates

Competitive landscape of battery makers

- Guoxuan High-tech and Panasonic are the preferred EV battery plays: Guoxuan has the biggest geographic advantage, while Panasonic is the leader in technology and scalability.
- Guoxuan should benefit from China exposure and its exponential growth in e-buses, while nearly all of its earnings stem from EV batteries.
- Panasonic is the most technologically advanced, while having the biggest scalability. This, coupled with its growing exposure in Tesla with the completion of the Giga-factory, means earnings from the EV battery business should continue to contribute meaningfully to its bottom-line.
- LG Chem and SDI also possess strong competitiveness, but we view the tightening Chinese regulatory environment as an ongoing concern for the Korean NMC-based battery makers.

Analyzing four key criteria

EV battery makers – dominated by Asian producers

Korea, Japan, and China dominate the lithium battery market with 96% market share. Among them, we analyze four companies – LG Chem, SDI, Panasonic, and Guoxuan Hightech – to provide a competitive landscape of major battery producers. Our analysis will be based on four key criteria:

Technology – we compare and contrast companies' energy density and price per kWh based on the information we gathered on their Generation 1 and 2 battery specs.

Scalability – we assess the companies based on order backlog, EV market share, capacity outlook and profitability.

Geography – we highlight and identify geographical advantages the companies have via battery plant locations, and government subsidies.

Financial capability – we analyze financial leverage, capex outlook, and other key metrics to determine which battery makers are best positioned to dominate during the strong growth trends of EVs.

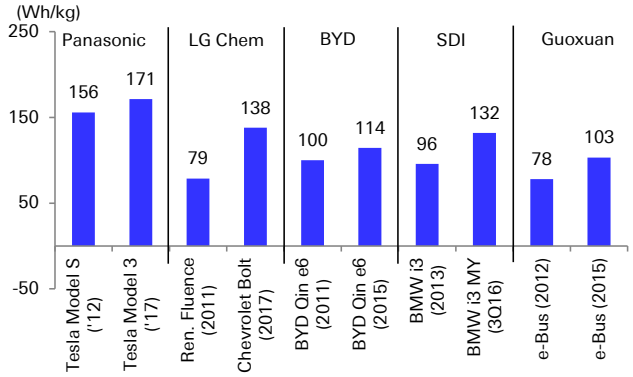
Technology

Energy density – Panasonic first; and LG Chem most improved

Comparing each battery maker's flagship EV model from Gen 1 to Gen 2, it is evident that **Panasonic's NCA-based cylindrical batteries are leading the technological edge with energy density averaging 171Wh/Kg, followed by LG Chem's NMC-based pouch–type averaging 138Wh/Kg**. Given the limited information on battery cells, we derive energy density based on the battery pack weight instead. While Panasonic continues to lead in technological

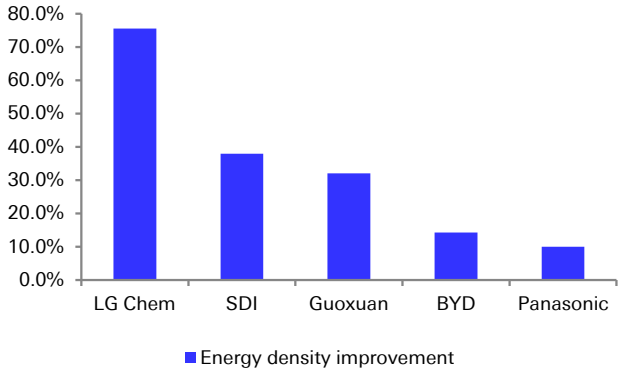
advancement, LG Chem has shown the biggest improvement in energy density from transition of Gen 1 to Gen 2 batteries. The improvement from Gen 1 to Gen 2 has been achieved through a series of R&D, leading to better mix in chemistry for batteries.

Figure 9: Energy density breakdown by battery makers



Source: Deutsche Bank, Company data, Bloomberg Finance LP, InsideEVs

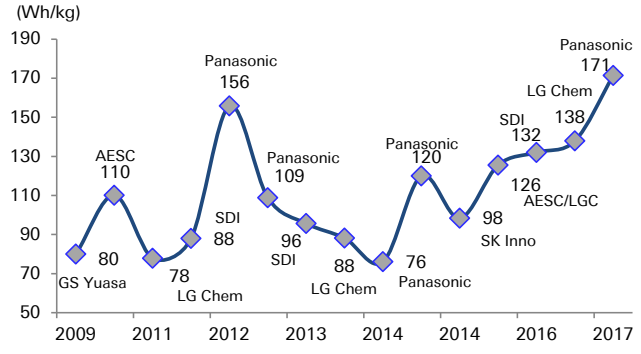
Figure 10: Energy density improvement from Gen 1 to Gen 2



Source: Deutsche Bank, Company data, Bloomberg Finance LP, InsideEVs

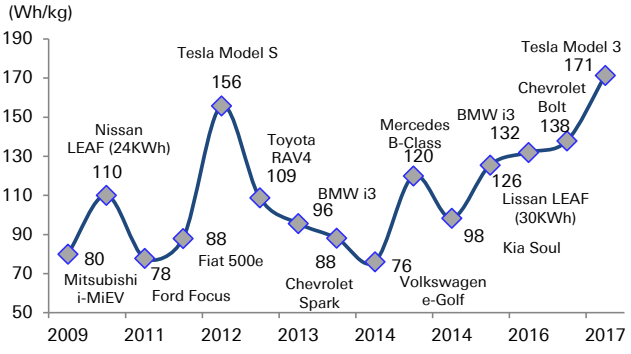
The data we compiled on pure EV batteries since 2009 indicate that energy density has meaningfully increased from 2015 as Gen 2 EVs have been announced. While Panasonic continually shows well above 100 Wh/Kg, Korean battery makers – SDI and LG Chem – have improved their energy density level quite significantly with the start of Gen 2.

Figure 11: EV energy density over time – battery makers



Source: Deutsche Bank, Company data, Bloomberg Finance LP, InsideEVs

Figure 12: EV energy density over time – models

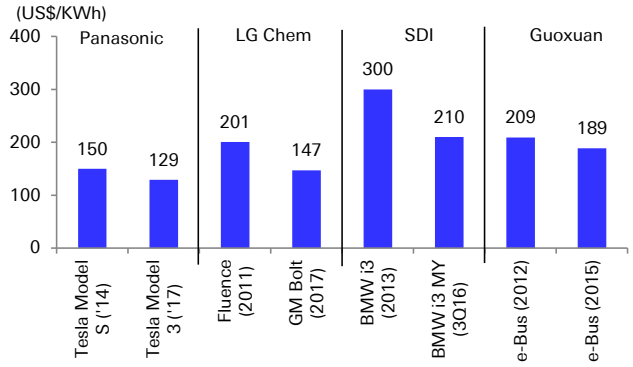


Source: Deutsche Bank, Company data, Bloomberg Finance LP, InsideEVs

Cell price per kWh analysis – Panasonic and LG Chem are leaders

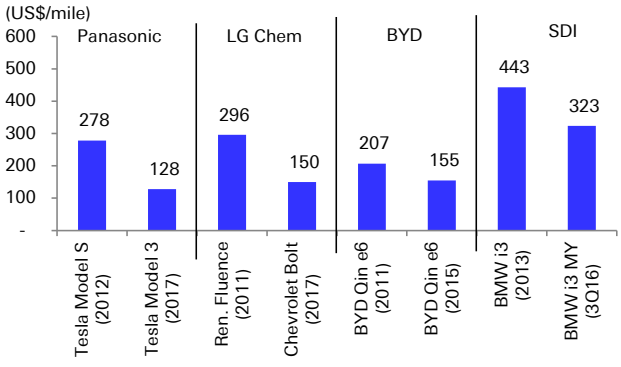
Limited information is disclosed on battery cell price per kWh for many companies. But based on our data findings and channel checks, we believe Panasonic has the lowest cell price per kWh in which we estimate Tesla Model 3 to house cells at US$129/kWh, followed by LG Chem's US$147/kWh. Guoxuan and SDI's cell prices per kWh remain relatively high at US$189 and US$210 respectively. For the case of SDI, it is worth noting that cell price per kWh has been cut by 30% and energy density has increased by 38%.

Figure 13: EV – Battery cell price per kWh breakdown



Source: Deutsche Bank, Company data, Bloomberg Finance LP, InsideEVs

Figure 14: EV price per driving range (EPA)



Source: Deutsche Bank, Company data, Bloomberg Finance LP, InsideEVs, EPA

Looking at Panasonic and LG Chem's cell price per kWh from Gen 1 to Gen 2, LG Chem and Panasonic were able to lower their prices by 27% and 14%, respectively. Despite the market's concern on low cell price per kWh, LG Chem remains confident of delivering low teens OPM in its EV battery business by 2018, during which the company expects the utilization rate to reach at least 80%.

Looking at batteries in terms of EV price (post tax & incentives) per driving range (EPA standards), Panasonic's Tesla Model 3 is most competitive at US$128/mile (-54% vs. Gen1), which should be well perceived by consumers purchasing EVs. In addition to having a premium EV image, Tesla's Model 3 boasts the most attractive price based on driving range vs. its peers.

Figure 15: EV battery spec breakdown by company and EV model

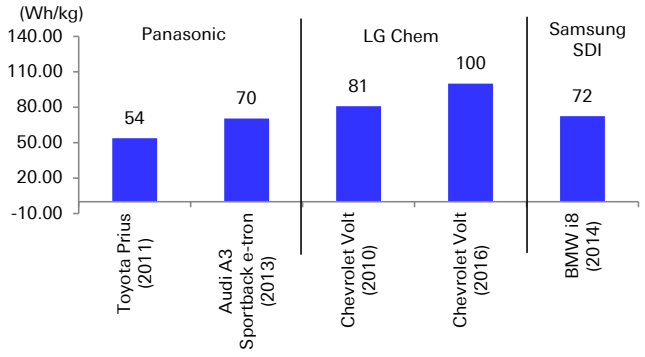
EV model	Renault Fluence	GM Bolt	BMW i3	BMW i3	BYD e6	BYD e6	Tesla Model S	Tesla Model 3	e-Bus	e-Bus
Battery maker	LG Chem		SDI		BYD		Panasonic		Guoxuan	
Release date	2011	2017	2013	2017	2011	2015	2014	2017	2012	2015
kWh per vehicle	22	60	22	33	60	80	85	60	-	-
Battery cell cost (US$)	4,416.00	8,800.00	6,600.00	6,930.00	-	-	12,749.20	7,741.40	-	-
Cell price per kWh (US$/kWh)	**200.7**	**146.7**	**300.0**	**210.0**	**-**	**-**	**150.0**	**129.0**	**208.8**	**188.8**
Pack weight (kg)	280	435	230	250	600	700	545	350	-	-
Energy density (Wh/kg)	**78.6**	**137.9**	**95.7**	**132.0**	**100.0**	**114.3**	**155.8**	**171.4**	**78.0**	**103.0**

Source: Deutsche Bank

PHEV dominated by LG Chem

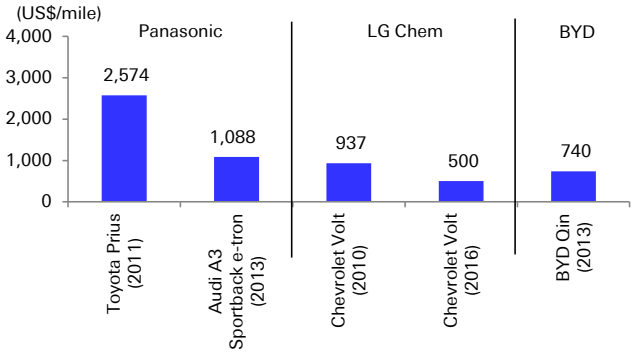
In contrast to the EV segment, we believe LG Chem is the most advanced PHEV battery producer with its energy density reaching 100Wh/kg (+23.6% vs. Gen 1's 80.9Wh/kg) vs. its peers at 70Wh/kg level. While limited information exists on PHEV cell price per kWh, we estimate LG Chem's Gen 2 battery cells to be US$313, down 38% from Gen 1's US$504. The PHEV price to driving range also shows LG Chem to be the most competitive at US$500/mile.

Figure 16: PHEV – energy density comparison



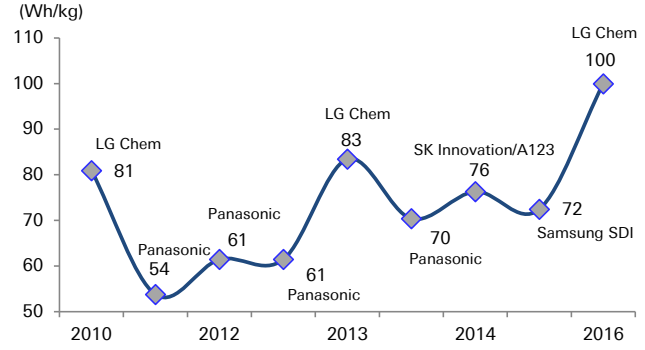
Source: Deutsche Bank, Company data, Bloomberg Finance LP, InsideEVs

Figure 17: PHEV price per driving range (EPA)



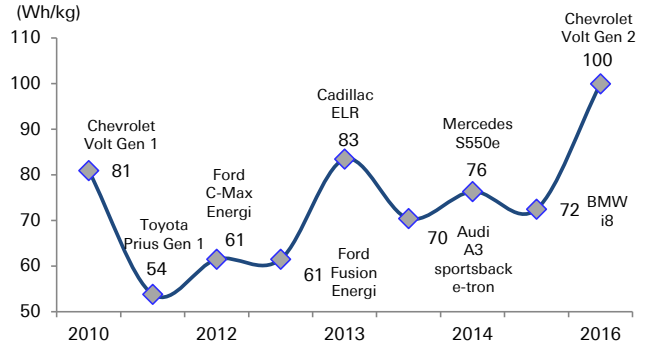
Source: Deutsche Bank, Company data, Bloomberg Finance LP, InsideEVs, EPA

Figure 18: PHEV energy density over time – battery makers



Source: Deutsche Bank, Company data, Bloomberg Finance LP, InsideEVs

Figure 19: PHEV energy density over time – models



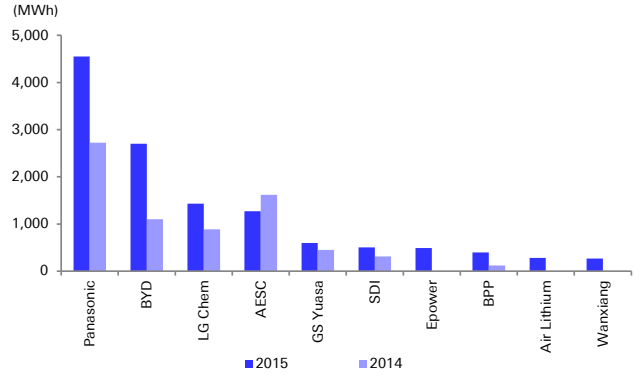
Source: Deutsche Bank, Company data, Bloomberg Finance LP, InsideEVs

Scalability

Panasonic leading the race

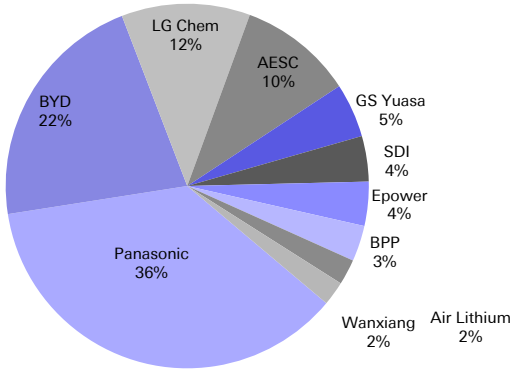
Panasonic is dominating the EV battery market with 36% market share (end 2015), thanks to its monopoly in supplying Tesla. With Tesla Model S being the best-selling EV while requiring greater kWh for battery pack vs. others, Panasonic's battery sales (MWh) jumped 67% YoY. Thanks to aggressive subsidies levied by the Chinese government in promoting EVs during 2H15, BYD's battery sales more than doubled (+146% YoY). LG Chem and SDI continue to maintain their respective No.3 and No.6 market shares, with both showing +60% YoY sales growth.

Figure 20: Top 10 EV battery producers' sales (MWh)



Source: Deutsche Bank, Industry data, Company data

Figure 21: Top 10 EV battery producers' M/S (2015)



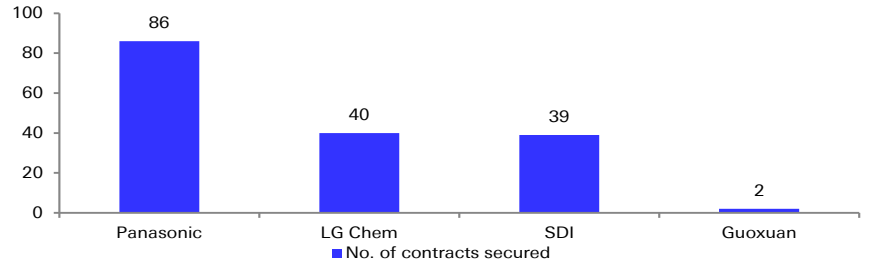
Source: Deutsche Bank, Industry data, Company data

Guoxuan's 2015 battery sales are excluded from figure 20 and 21 above, which we suspect to be the result of its sales exposure to China's CVs (commercial vehicles). Based on Guoxuan's historic financials, we estimate 2015 EV annual sales to be 1.0 GW in 2015 (+142% YoY), which places the company within the top 7.

Order backlog run down – Panasonic ahead

Based on the disclosed order backlog of EV/ESS battery orders by each of the companies, Panasonic is the leader by far, with 86 contracts (45 past record; 41 underway). LG Chem is second with 40 contracts secured so far (we were able to identify 36 of them), followed by SDI (39 contracts). As for Guoxuan, some of its large clients are Zhongtong Bus, Nanjin Golden Dragon, Suzhou Golden Dragon, Ankai Auto, BAIC (Beijing Automotive Group), SAIC (Shanghai Automotive Group) and JAC (Hefei Jianghuai Auto). Note that approximate sales from the contracts with Zhongtong and Nanjing Golden Dragon are valued at RMB2,096m, representing c.98% and c.43% of lithium battery sales in 2015 and 2016E, respectively. To meet diverse customer demand, Guoxuan holds multiple battery plants in Eastern China, and further plans for battery plant expansions in the foreseeable future.

Figure 22: Number of disclosed EV/ESS contracts



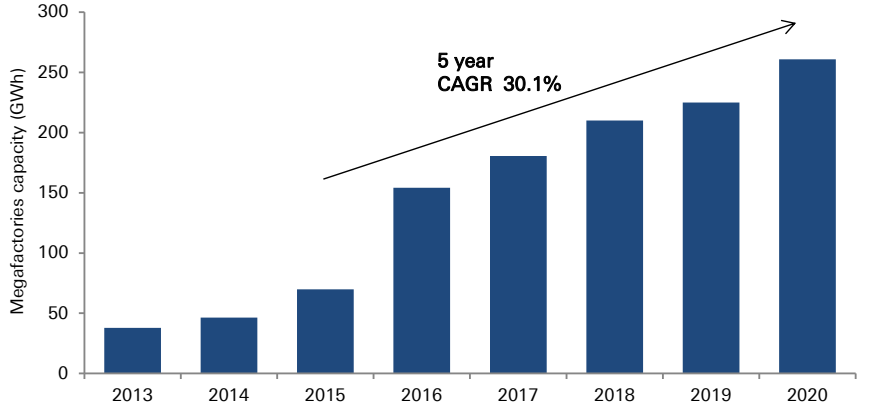
Source: Deutsche Bank, Company data, Bloomberg Finance LP, InsideEVs

Aggressive capacity expansion plans ahead to match order backlog

In an effort to match sizeable order backlog amid falling battery costs, battery makers are expected to aggressively expand capacity.

- Panasonic: In preparation of Tesla Model 3 productions, the Giga Factory (Nevada, USA), which has 35GW cell capacity, will likely be complete by 2017.
- SDI: With a total of 6GW capacity by end-2016, SDI plans to reach 26GW cell capacity by 2018, and eventually target 36GW by 2020.
- LG Chem: The company currently has 9GW capacity and does not disclose its long-term plans for expansion, but notes that it remains open to adding more lines depending on demand.
- Guoxuan: The company will expand its capacity by a 55% CAGR for the next three years, and targets to reach 8.9GW by 2018 from the current 2.4GW.

Figure 23: The battery supply chain is rapidly increasing



Source: Deutsche Bank estimates

Figure 24: LG Chem – announced EV/ESS contract breakdown

Announced	Company	Model	Type	Battery per unit (KWh)	Note
12.2007	HMC/KIA	Avante/Forte LPI	PHEV	-	-
11.2008	HMC/KIA	Sonata/K5	PHEV	-	-
01.2009	GM	Chevy Volt	PHEV	16	2010
10.2009	CT&T	e-Zone	PHEV	-	-
01.2010	Eaton	PV	EV	-	Nov 2010; 4 yr contract
04.2010	Volvo	PV	PHEV	-	-
07.2010	Ford	Focus	EV	23	-
09.2010	Reno	Renault Zoe/ Twizy	EV	Zoe (22), Twizy (6.1)	2H11
12.2010	California SCE	-	ESS	-	32MWh (contract size)
02.2011	First Automobile Works	PV	EV	-	China
07.2013	German SMA	-	ESS	-	Multi-year contract
06.2014	Shanghai Automotive	Roewe e950	PHEV	-	China; 2Q16
06.2014	Qoros	PV	HEV	-	China; 2H16
08.2014	Audi	PV	PHEV	-	next-gen PHEVs
11.2014	German SIEMENS	-	ESS	-	Until 2015; 50MWh (contract size)
01.2015	HMC/KIA	Avante EV	EV	27	2016
02.2015	Japan GPD	-	ESS	-	Until 2017; 31MWh (contract size)
04.2015	Daimler	Smart EV	EV	17.6	2016
05.2015	Gexpro, Ideal, Zelly	-	ESS	-	45KWh (contract size)
05.2015	U.S. Duke	-	ESS	-	2MW (contract size)
05.2015	Great Wall Motor	PV (SUV)	PHEV	-	China; 2017
05.2015	Nanjing Golden Dragon	buses	EV	60-250	China; 2H15
06.2015	Norway Eidesvik	Viking Queen (vessel)	EV	-	Until early July, 2015
08.2015	Audi	Q6 e-tron	EV	92	2018 SUV model; along with SDI
08.2015	Changan	PV	PHEV	-	China; 2H16
09.2015	Chery	Arrizo 5EV, S15EV	EV	-	China; 1Q16
09.2015	Nissan	Leaf	EV	60	From 2017
10.2015	Yamaha	golf carts	EV	5.5	Until 2016
10.2015	GM	Bolt	EV	80	From 2017
11.2015	Tesla	Roadster	EV	70	Battery upgrade
11.2015	German STEAG	-	ESS	-	From 2016; 140MWh (contract size)
12.2015	AES	-	ESS	-	Until 2020; 1GWh (contract size), estimated sales (less than Won500bn)
01.2016	HMC	Ionic	EV	28	From 2016
01.2016	FCA (Chrylser)	Pacifica	PHEV	16	From end-16
01.2016	Solax	-	ESS	-	China
03.2016	Bentley	unknown (still developing)	EV	-	-
Source: LG Chem, local news					

Source: Deutsche Bank, company data, Bloomberg Finance LP

Figure 25: Panasonic – announced EV/ESS contract breakdown

Announced	Company	Model	Type	Battery per unit (KWh)	Note
01.2010	Tesla	Model S	EV	-	-
12.2011	Toyota	Prius PHV	PHEV	4.4	-
03.2012	Ford	Fusion hybrid electric	HV	-	-
03.2012	Ford	C-Max hybrid electric	HV	-	-
03.2012	Ford	Fusion energy	PHEV	-	-
03.2012	Ford	C-Max energy	PHEV	-	-
05.2012	Toyota	RAV4 EV	EV	41.8	
10.2012	Toyota	eQ	PHEV	12	-
03.2013	Honda	RLX Hybrid	HEV	1.3	
02.2014	VW	e-Golf	EV	24.2	-
07.2014	Daimler	B-Class	EW	28	18650 from Tesla
02.2015	VW	e-up!	EV	18.7	-
09.2015	VW	Golf GTE	PHEV	8.8	
11.2015	VW	A3 e-tron	PHEV	8.8	
03.2016	Tesla	Model 3	EV	-	Reached an agreement for Giga factory
Source: Panasonic, local news					

Source: Deutsche Bank, company data, Bloomberg Finance LP

Figure 26: Guoxuan – announced EV/ESS contract breakdown

Announced	Company	Model	Type	Battery per unit (KWh)	Note
02.2016	Jinlong	e-bus	EV	-	6,000 battery units for 2016
02.2016	Zhongtong	e-bus	EV	-	6,000 battery units for 2016
Source: Guoxuan, local news					

Source: Deutsche Bank, company data, Bloomberg Finance LP

Figure 27: SDI – announced EV/ESS contract breakdown

Announced	Company	Model	Type	Battery per unit (KWh)	Note
2009	BMW	-	-	-	SDI as a sole vendor until 2020 (MOU)
2010	AES	-	ESS	-	20MWh contract size
2010	Chrysler	F500	-	-	Began to supply battery packs
2011	Mahindra	-	PHEV	-	Joint venture with Bosch supply EV batteries for Mahindra's first hybrid SUV
2012	KACO	-	ESS	-	ESS supply and R&D cooperation
2012	Fiat	500e	EV	24	-
2013	Ferrari	LaFerrari	PHEV	-	-
2013	ENEL	-	ESS	-	1MWh contract size
2013	WEMAG	-	ESS	-	10MWh contract size
2013	S&C	-	ESS	-	10MWh contract size
2013	BMW	i3	EV	22	-
2013	BMW	i8	PHEV	7.1	-
2013	Porsche	918 Spyder	PHEV	6.8	-
2013	ACME	-	ESS	-	110MWh contract size
2014	Nichicon	-	ESS	-	~W1trn worth contract
2014	Ford	-	-	-	Joint development of ultra-light weight LIB and dual battery system (MOU)
2014	BMW	-	-	-	Increasing battery cells supply in mid/long term (MOU)
2014	Porsche	Cayenne	PHEV	10.8	-
2014	Sungrow	-	ESS	-	China; JV with Sungrow (MOU)
2014	GCN	-	ESS	-	25MWh contract size (commercial ESS)
2014	KEPCO	-	ESS	-	11MWh contract size
2015	BMW	X5	PHEV	9	-
2015	Jaguar Land rover	-	PHEV	-	10K auto target shipment per annum
2015	BMW	740e	PHEV	9	-
2015	Duke Energy	-	ESS	-	To upgrade 36MWh energy storage and power mgmt system
2015	Fiat	500e	EV	24	Joint partnership with Bosch
2015	Audi	E-Tron Quattro	EV	95	-
2015	BMW	225xe	PHEV	7.7	-
2015	BMW	330e	PHEV	7.6	-
2015	Volkswagen	Tiguan GTE	EV	13	-
2015	Bentley	Bentayga	PHEV	-	-
2015	Sharp	-	ESS	-	-
2015	Porsche	Panamera	PHEV	9.4	-
2015	JAC	iEV6S	EV	30	China; Supply of 50M cells in 2016 (MOU), supplied cylindrical 18650
2015	Foton	e-truck	EV	-	China
2015	Yutong	e-bus	EV	-	China
2016	Ulsan city	-	ESS	-	1GW ESS until 2030, partnership with CVNET, KyungDong City Gas
2016	AES	-	ESS	-	10MWh project
2016	KEPCO	-	ESS	-	Joint partnership with KEPCO in ESS export project
Source: Samsung SDI, local news					

Source: Deutsche Bank, company data, Bloomberg Finance LP

Geography

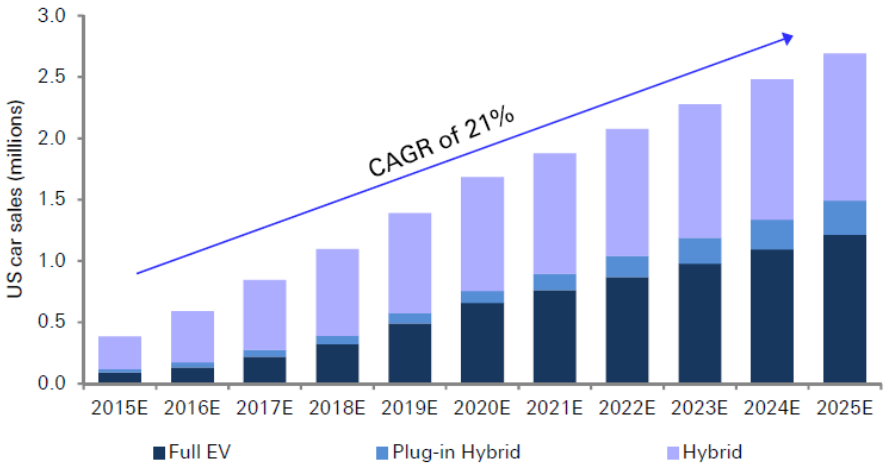
With EV sales expected to be boosted by regulatory changes and subsidy implementation by the government, geographical location related to battery plants and order backlog will be vital in assessing the success of each battery maker.

Figure 28: Comparison of fuel economy regulations

						MPG (CAFE Equivalent)		
Country/ Region	Metric	Test Cycle	2015 Target	2020 Target	2025 Target	2015 Target	2020 Target	2025 Target
US	Fuel Economy/ GHG	FTP + Highway	32.6 mpg / 283 g/mile	N/A	54.5 mpg / 157 g/mile		38.3 mpg	54.5 mpg*
EU	CO2	NEDC	130 g/km	95 g/km	N/A	54.2 mpg	58 mpg	71-81 mpg
China	Fuel Consumption	NEDC	7 L/100km	N/A	N/A	34.1 mpg	47 mpg	N/A
Japan	Fuel Economy	JC08	17 km/L	20.3 km/L	N/A	47 mpg	55 mpg	N/A
India	CO2	MIDC	135 g/km	N/A	N/A	46.5 mpg	N/A	N/A

Source: Deutsche Bank, IHS, 54.5 MPG combined 2025 EPA target is based on 163 grams/mile CO2 emissions, partially achieved through reduced A/C system leakage

Figure 29: US EV outlook from 2015-2025E



Source: Deutsche Bank ,IHS, InsideEVs

Panasonic has the biggest US exposure, followed by LG Chem and SDI

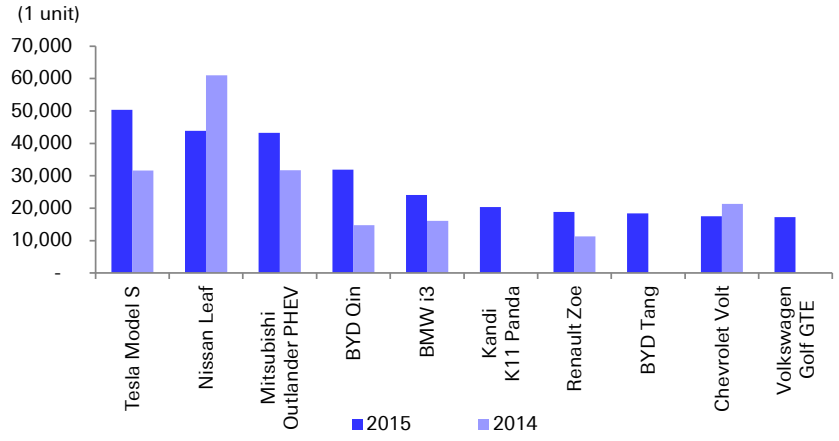
With Tesla as the best-selling EV in 2015, with 25,000 Model S sales, **Panasonic has the biggest exposure in the US EV market, followed by LG Chem and SDI**. Panasonic will likely retain its top market share in the US with the completion of 35GW battery cell plant (50GW pack) in Nevada in 2017, which will be in time for the release of Model 3 EV. The recent pre-order numbers disclosed by Tesla are for more than 400,000 units.

LG Chem operates 2GW battery capacity in Holland, Michigan, which was completed at end-2012 and partially operational from 2013. LG Chem is capable of further expanding its US plant without having to invest heavily in infrastructures, as the plant was originally designed to house further capacities. Separately, LG Chem is planning to construct a 1GW battery facility in Wroclaw, Poland by 2H17 to supply European automakers. LG Chem's flagship EVs in US/EU includes GM Volt/Bolt, Renault Zoe, and Nissan Leaf.

SDI has no battery plants located in the US or EU, but plans for sizeable investments centered around the EU and China for the next five years. Its flagship EV model is BMW i3 (battery supplied from Korea), which was the 5th best-selling EV globally in 2015.

Guoxuan is a local Chinese EV battery producer and lacks exposure in the US/EU. However, its limitations are made up by its strength in the Chinese EV market.

Figure 30: Worldwide EV sales by model

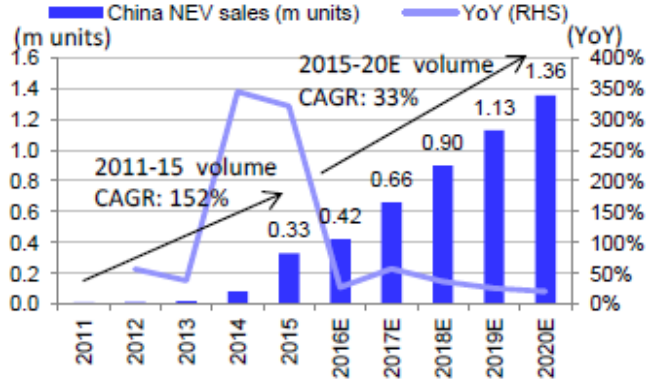


Source: Deutsche Bank, InsideEVs, industry data

China – subsidies matter and have to be on the list

Representing 40% of the global EV market, Chinese EV sales took off from 2H15. Based on the recent FITT report by Vincent Ha, entitled *China Autos – What you should know about China's new energy vehicle (NEV) market*, DB expects a five-year sales CAGR of 33% for China EVs, and expects **China to account for half of global EV/PHEV demand by 2020.** Chinese EV demand is driven mainly by central and local government subsidies. While any financial strain by the government and unexpected subsidy cut/delay could risk the EV demand outlook, it is nevertheless crucial for battery-makers to have a prominent presence in China in order to achieve economies of scale.

Figure 31: China NEV sales forecast



Source: Deutsche Bank estimates, CAAM

Figure 32: China NEV sales forecast breakdown

(m units)	2016E	2017E	2018E	2019E	2020E
Passenger EV	0.20	0.32	0.42	0.51	0.60
YoY%		*60.0%*	*31.3%*	*21.4%*	*17.6%*
Passenger PHEV	0.10	0.16	0.24	0.32	0.40
YoY%		*60.0%*	*50.0%*	*32.5%*	*24.5%*
Total passenger NEV	**0.30**	**0.48**	**0.66**	**0.83**	**1.00**
YoY%		***60.0%***	***37.5%***	***25.5%***	***20.3%***
Commercial EV	0.09	0.14	0.18	0.22	0.25
YoY%		*55.6%*	*28.6%*	*22.2%*	*13.6%*
Commercial PHEV	0.03	0.04	0.06	0.08	0.11
YoY%		*33.3%*	*50.0%*	*33.3%*	*37.5%*
Total commercial NEV	**0.12**	**0.18**	**0.24**	**0.30**	**0.36**
YoY%		***50.0%***	***33.3%***	***25.0%***	***20.0%***
Grand total NEV	**0.42**	**0.66**	**0.90**	**1.13**	**1.36**
YoY%		***57.1%***	***36.4%***	***25.3%***	***20.2%***

Source: Deutsche Bank estimates

Foreign battery makers' difficulty in entering China

It is becoming increasingly difficult for foreign battery makers to gain meaningful exposure in China. At end-2015, China temporarily restricted the use of NMC/NCA based batteries into e-buses for safety reasons, which means LG Chem, SDI and Panasonic will not be able to sell their batteries to e-bus makers unless the rule is overturned. More recently, **the Chinese government announced new standards to strengthen its regulation of providing NEV purchase subsidies only to NEV models equipped with batteries from qualified and registered EV battery makers**. Effective from July, the government already announced 25 registered battery makers which have such qualification but will still be subject to ongoing qualification checks. Guoxuan is on the list and all 25 are local makers. Korean makers such as LG Chem and SDI have yet to be included, despite meeting all the necessary requirements, while other companies, such as Panasonic and SK Innovation, are not eligible as they lack battery plant operations in China.

In our view, the Chinese government's intention is to ensure EV battery quality and to encourage foreign battery makers to localize their production/technology in China. At the moment, we think that the government will probably provide a grace period for 1) more EV battery makers to gain the qualification, and 2) for OEMs to switch to qualified EV batteries for their existing NEV models which are eligible for subsidies now. Yet once the rule is strictly enforced, non-qualified EV battery makers would risk losing out in the Chinese market, as it is unlikely that Chinese OEMs would continue to buy their batteries, even if there is an existing business relationship.

Guoxuan best positioned – leveraging its presence in China

Chinese EV is expected to reach 50% of global market by 2020, and we believe Guoxuan is best positioned to benefit. Headquartered in Fefei city, Anhui province, the company already signed two large orders with bus companies Nanjing and Zhongtong. The approximate sales from these contracts are valued at RMB2,096m, representing c.98% and c.43% of lithium battery sales in 2015 and 2016E, respectively.

Figure 33: Central government subsidies for NEV buses (10-12m) in 2016

	Battery driving range (R) (unit: km)					
(RMB'000)	6<=R<20	20<=R<50	50<=R<100	100<=R<150	150<=R<250	R>=250
EV Unit load energy consumption (E) (unit: Wh/km.kg)						
E<0.25	220	260	300	350	420	500
0.25<=E<0.35	200	240	280	320	380	460
0.35<=E<0.50	180	220	240	280	340	420
0.50<=E<0.60	160	180	200	250	300	360
0.60<=E<0.70	120	140	160	200	240	300
PHEV	n.a.	n.a.	200	230	250	250

Note: Electric buses of 6m and below in length qualify for 20% of the above standard bus subsidy (10-12m); electric buses of 6-8m length qualify for 50% of the standard bus subsidy; electric buses of 8-10m length qualify for 80% of the standard bus subsidy; electric buses of 12m and above in length qualify for 120% of the standard bus subsidy.

Source: MOF

Figure 34: Beijing government passenger NEV subsidy program (2016)

Beijing	EV	EV	EV	PHEV
(RMB'000)	100<=R<150	150<=R<250	R>=250	R>=50
Central government subsidy	25	45	55	30
Local government subsidy*	25	45	55	n.a.
Free license plate**	Yes	Yes	Yes	No

* Total subsidy not exceeding 60% of NEV MSRP.
** Total free license plates to be issued for NEV not exceeding 60,000.

Source: Beijing Government, Deutsche Bank

Figure 35: Shanghai government passenger NEV subsidy program (2016-17E)

Shanghai	EV	EV	EV	PHEV
(RMB'000)	100<=R<150	150<=R<250	R>=250	R>=50
Central government subsidy	25	45	55	30
Local government subsidy	10	30	30	10
Additional local subsidy*	n.a.	n.a.	n.a.	14
Free license plate	Yes	Yes	Yes	Yes

* Prerequisites: engine size below 1.6L, fuel tank size below 40L, and fuel consumption below 5.9L/100km in hybrid mode.

Source: Shanghai Government, Deutsche Bank

Financial capability

Guoxuan most leveraged to EV batteries

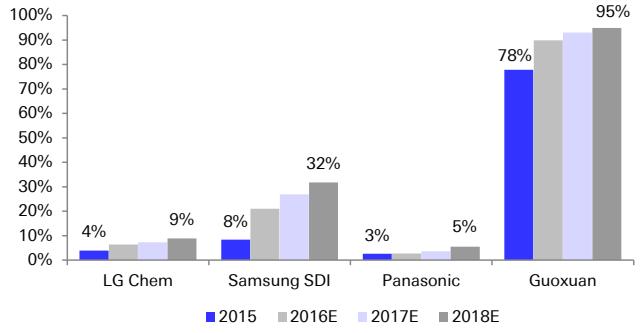
Representing 90% (2016E) of its total revenue, Guoxuan is by far the pure EV battery play amongst its peers, followed by SDI, whose EV battery revenue contribution is expected to reach 31.7% by 2018. We expect LG Chem's EV batteries to contribute 8.8% of total sales, and Panasonic's to contribute 5.5% by 2018. Nevertheless, we expect EV battery growth for all four companies to be exponential, as we expect the battery market to expand 5x over the next decade.

Regarding profitability, Guoxuan, LG Chem, and Panasonic are already profitable, while SDI is eyeing BEP by 2018.

- Guoxuan's profitability is a standout, with its OPM (EV business) at 33.6% as of 2015 and expected to remain in strong double digits. We expect 98% of total OP to stem from EV batteries as of 2016E, while strong profitability is driven mainly by its vertical integration, as well as high run rates in its battery plants.
- LG Chem broke even in the EV battery business in 4Q15, and expects OPM to gradually expand to the low-teen level by 2018, during which the company aims to reach an 80% run rate. We estimate 8.8% OP contribution from EV batteries by 2018E from a mere 0.6% in 2016E.
- Panasonic's battery business related to Tesla is known to be generating 10% OPM, while non-Tesla is doing low single-digit OPM. Nevertheless, we expect Panasonic's EV battery profitability to remain at a mid-to-high single-digit level as the company continuously benefits from being the front-runner in the EV battery market. From 5.4% in FY16E, we expect EV batteries to contribute 7.2% to total operating profit in FY18E.

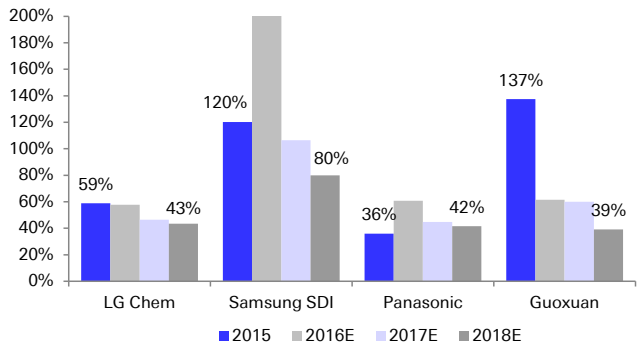
- After an ongoing operating loss, we expect 7.7% of operating profit to stem from EV batteries for SDI in 2018E, on which we estimate 1.0% OPM.

Figure 36: EV sales contribution by company



Note: Panasonic's FY ends in March. For example, CY16 equates to FY3/17 for Panasonic
Source: Deutsche Bank estimates

Figure 37: Capex to EBITDA breakdown



Note: Panasonic's FY ends in March. For example, CY16 equates to FY3/17 for Panasonic
Source: Deutsche Bank estimates

Figure 38: Sales & operating profit contribution from EV batteries

LG Chem								
(Won bn)	**2011**	**2012**	**2013**	**2014**	**2015**	**2016E**	**2017E**	**2018E**
Total sales	22,676	23,263	23,144	22,578	20,207	22,916	27,109	32,238
EV/ESS sales or guidance	-	448	546	632	791	1,456	1,978	2,844
% to total sales	**-**	***1.9%***	***2.4%***	***2.8%***	***3.9%***	***6.4%***	***7.3%***	***8.8%***
Total OP	2,838	1,910	1,743	1,311	1,824	2,244	2,769	3,156
EV/ESS OP	-	-11	-45	-100	-76	14	160	277
% to total OP	**-**	***NM***	***NM***	***NM***	***NM***	***0.6%***	***5.8%***	***8.8%***
EV OPM	**-**	***NM***	***NM***	***NM***	***NM***	***0.9%***	***8.1%***	***9.7%***
Samsung SDI								
(Won bn)	**2011**	**2012**	**2013**	**2014**	**2015**	**2016E**	**2017E**	**2018E**
Total sales	5,444	5,771	5,016	5,474	7,569	5,823	6,451	6,842
EV sales or guidance	-	20	130	325	634	1,223	1,736	2,170
% to total sales	**-**	***0.3%***	***2.6%***	***5.9%***	***8.4%***	***21.0%***	***26.9%***	***31.7%***
Total OP	204	187	-116	71	-60	-678	149	282
EV OP	-	-70	-200	-221	-363	-256	-115	22
% to total OP	**-**	***NM***	***NM***	***NM***	***NM***	***NM***	***NM***	***7.7%***
EV OPM	**-**	***NM***	***NM***	***NM***	***NM***	***NM***	***NM***	***1.0%***
Panasonic								
(Yen bn)	**FY3/12**	**FY3/13**	**FY3/14**	**FY3/15**	**FY3/16**	**FY3/17E**	**FY3/18E**	**FY3/19E**
Total sales	7,846	7,303	7,737	7,715	7,554	7,601	7,746	8,151
EV sales or guidance	-	-	-	224	216	232	314	500
% to total sales	**-**	**-**	**-**	***2.6%***	***2.6%***	***2.7%***	***3.6%***	***5.5%***
Total OP	44	161	305	382	416	317	375	423
EV OP	-	-	-	-	15	19	22	33
% to total OP	**-**	***NM***	***NM***	***NM***	***4.4%***	***5.4%***	***5.2%***	***7.2%***
EV OPM	**-**	***NM***	***NM***	***NM***	***7.0%***	***8.4%***	***6.9%***	***6.7%***
Guoxuan High-tech								
(RMB mn)	**2011**	**2012**	**2013**	**2014**	**2015**	**2016E**	**2017E**	**2018E**
Total sales	798	1,141	1,483	1,868	2,745	5,451	7,931	10,878
EV sales or guidance	188	548	749	994	2,135	4,899	7,379	10,326
% to total sales	***23.6%***	***48.0%***	***50.5%***	***53.2%***	***77.8%***	***89.9%***	***93.0%***	***94.9%***
Total OP	0	0	353	421	738	1,302	1,692	2,217
EV OP	-	-	-	357	717	1,281	1,673	2,196
% to total OP	**-**	**-**	**-**	***84.8%***	***97.2%***	***98.4%***	***98.9%***	***99.1%***
EV OPM	**-**	**-**	**-**	***35.9%***	***33.6%***	***26.1%***	***22.7%***	***21.3%***

Note: Panasonic's FY ends in March. For example, CY16 equates to FY3/17 for Panasonic
Source: Deutsche Bank estimates, company data

Figure 39: Sales & operating profit contribution from EV batteries (in USD)

LG Chem								
(mn US$)	2011	2012	2013	2014	2015	2016E	2017E	2018E
Total sales	19,614	21,869	21,963	20,393	17,197	18,333	21,515	25,586
EV/ESS sales or guidance	-	422	518	571	673	1,164	1,570	2,257
% to total sales	*-*	*1.9%*	*2.4%*	*2.8%*	*3.9%*	*6.4%*	*7.3%*	*8.8%*
Total OP	2,455	1,796	1,654	1,184	1,552	1,795	2,197	2,505
EV/ESS OP	-	-10	-43	-90	-65	11	127	220
% to total OP	*-*	*NM*	*NM*	*NM*	*NM*	*0.6%*	*5.8%*	*8.8%*
EV OPM	*-*	*NM*	*NM*	*NM*	*NM*	*0.9%*	*8.1%*	*9.7%*
Samsung SDI								
(mn US$)	2011	2012	2013	2014	2015	2016E	2017E	2018E
Total sales	4,709	5,425	4,761	4,944	6,442	4,659	5,120	5,431
EV sales or guidance	-	19	123	294	540	978	1,378	1,722
% to total sales	*-*	*0.3%*	*2.6%*	*5.9%*	*8.4%*	*21.0%*	*26.9%*	*31.7%*
Total OP	176	176	-110	64	-51	-542	118	224
EV OP	-	-66	-190	-200	-309	-205	-91	17
% to total OP	*-*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*7.7%*
EV OPM	*-*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*1.0%*
Panasonic								
(mn US$)	FY3/12	FY3/13	FY3/14	FY3/15	FY3/16	FY3/17E	FY3/18E	FY3/19E
Total sales	101,072	84,165	73,471	64,588	62,619	72,394	68,548	74,104
EV sales or guidance	-	-	-	1,872	1,789	2,209	2,777	4,545
% to total sales	*-*	*-*	*-*	*2.6%*	*2.6%*	*2.7%*	*3.6%*	*5.5%*
Total OP	563	1,854	2,897	3,197	3,446	3,021	3,314	3,843
EV OP	-	-	-	-	126	185	191	304
% to total OP	*-*	*NM*	*NM*	*NM*	*4.4%*	*5.4%*	*5.2%*	*7.2%*
EV OPM	*-*	*NM*	*NM*	*NM*	*7.0%*	*8.4%*	*6.9%*	*6.7%*
Guoxuan High-tech								
(mn US$)	2011	2012	2013	2014	2015	2016E	2017E	2018E
Total sales	127	183	245	301	422	779	1,133	1,554
EV sales or guidance	30	88	124	160	328	700	1,054	1,475
% to total sales	*23.6%*	*48.0%*	*50.5%*	*53.2%*	*77.8%*	*89.9%*	*93.0%*	*94.9%*
Total OP	0	0	58	68	114	186	242	317
EV OP	-	-	-	58	110	183	239	314
% to total OP	*-*	*-*	*-*	*84.8%*	*97.2%*	*98.4%*	*98.9%*	*99.1%*
EV OPM	*-*	*-*	*-*	*35.9%*	*33.6%*	*26.1%*	*22.7%*	*21.3%*

Note: Panasonic's FY ends in March. For example, CY16 equates to FY3/17 for Panasonic
Source: Deutsche Bank estimates, company data

Leverage analysis

All four battery makers are deleveraged with net debt to equity ranging between -43~10.5% as of 2016E. While capex to EBITDA appears to be intense for SDI, its recent chemical asset disposal is expected to result in a sizeable Won2.3tr cash inflow, which will mainly be used for R&D and expansions for batteries. From its current 6GW capacity, SDI targets 35GW EV/ESS battery capacity by 2020.

Capital management strategy

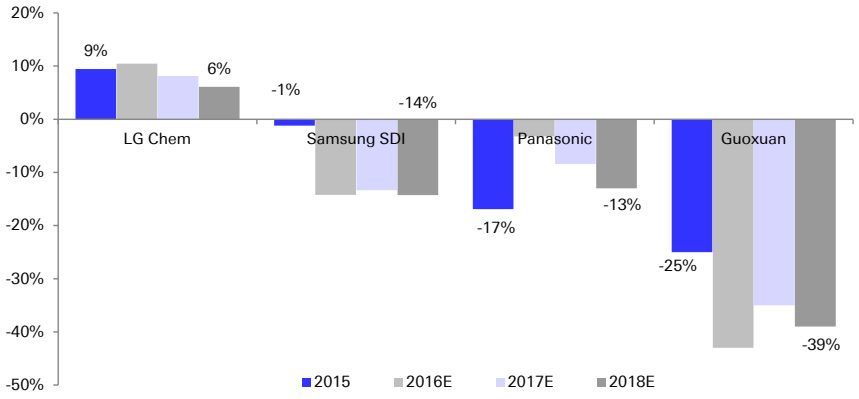
With healthy balance sheets and all the companies (except LG Chem) expected to maintain net cash, companies hold the following capital management strategies for the future.

- Guoxuan's capex may remain high to support its aggressive capacity expansion. However, we do not worry about the funding issue due to 1) sufficient cash on hand after reverse IPO. At the end of year 2015, Guoxuan had c. RMB2,011m; and 2) large cash flow from operation due to strong downstream demand. Similarly, we do not expect Guoxuan's debt level will rise significantly. (The company has net cash actually.) The current capital management plan can support the capex, and debt and pay dividends payments in the next three years, without raising debt significantly.
- LG Chem plans to manage its annual capex within the limits of its EBITDA and targets to maintain its current net debt to equity ratio at

the low-teen to high-single-digit level, as per its historical track record, and does not plan to hurry its investment plans into batteries.

- Panasonic enacted major structural reform measures in the past and worked to improve and strengthen its financial standing. As a result, net cash holdings reached ¥288.3bn at the end of FY3/16. Looking ahead, investment cash flow, including Gigafactory investment, may increase. Basically, however, the company plans to keep investment within the confines of cash flow generated each fiscal year. We assume that major financial leverage will not be needed. Also, we expect the company to more actively step up shareholder returns if it sets certain goals for future investment.
- While capex to EBITDA appears to be intense for SDI, its recent chemical asset disposal is expected to result in a sizeable Won2.3tr cash inflow, which will mainly be used for R&D and expansions for batteries. From its current 6GW capacity, SDI targets 35GW EV/ESS battery capacity by 2020.

Figure 40: Net debt to equity trends



Note: Panasonic's FY ends in March. For example, CY16 equates to FY3/17 for Panasonic
Source: Deutsche Bank estimates

Company section (1)
– EV battery makers

Guoxuan High-Tech (002074.SZ, Buy, TP: CNY40.40)
(James Kan, +85 (2) 2203 6146)

Outlook
Guoxuan is the fourth-largest EV lithium battery player in China in terms of sales in 2015. It is also the most leveraged company in the stock market to EV lithium batteries, with 90% revenue and 94% gross profit from that segment.

Aggressive capacity expansion on the back of secured large orders received and close client relationships should help Guoxuan continue to gain market share in EV lithium batteries and become one of the major beneficiaries of the Chinese government's target of promoting 5m EV units on the road by the end of 2020. The total sales of two big orders received in this year reached c. RMB2,096m, representing c. 43% battery sales in 2016.

Currently, more than 80% of its products were sold for commercial e-buses. Among the top-7 largest EV bus sellers in China, five are clients of Guoxuan. Through the cooperation with more passenger EV makers, Guoxuan will gradually increase sales of lithium battery for passenger cars. Its new manufacturing bases in Laixi and Hefei third phase are well prepared.

We expect the ASP of lithium batteries to drop faster than the company cuts costs, implying shrinking unit profitability. ASP may drop at a CAGR of c.11% in the next three years while COGS may fall at a CAGR of c.4% in the same period. In spite of that, soaring sales volume is likely to fully offset the impact from lower margins. Guoxuan's strong sales volume growth, at a CAGR of 81% from 2015 to 2018 (from 311mn Ah in 2015 to 1,850mn Ah in 2018E), will help its bottom line to climb at a CAGR of 46% in the next three years.

Valuation
As Guoxuan just listed on the A-share market through a reverse IPO, we believe its historical P/E band may not reflect its high growth and ROE, as the previous assets of the shell company witnessed limited growth in the past several years. As such, we calculate P/E at 26x FY17 EPS, the adjusted industry average (excluding outliers), for Guoxuan High-Tech and set its target price at RMB40.4. Our target price implies 29% upside potential, to reflect its strong growth and high ROE above 30% in the next three years.

Risks
Key downside risks include:

1) Significant changes in the Chinese government's new energy subsidy policy;

2) Weaker-than-expected volume growth in the next three years;

3) Quicker-than-expected ASP drop or slower-than-expected cost cutting.

4) Slower-than-expected ramp-up in Hefei third phase and Laixi factories

Leading EV battery maker

Guoxuan High-Tech Co. Ltd. produces lithium battery cell/packs for automakers in China. It is now the fourth-largest EV lithium battery maker in China in terms of total EV lithium battery shipments in 2015, occupying c.7% market share. Its major clients are BAIC (Beijing Automotive Group), SAIC (Shanghai Automotive Group), Zhongtong Bus, JAC (Hefei Jianghuai Auto), Nanjin Golden Dragon, Suzhou Golden Dragon and Ankai Auto, among others.

Guoxuan listed on the A-share market through a reverse IPO in 2015. Currently, it is one of the most leveraged stocks to EV lithium batteries in China with 90% revenue and 94% gross profit contributed by that segment, and we expect these two ratios will rise to as high as 95% and 97% in 2018 respectively. The major international competitors are Panasonic, LG Chem and Samsung SDI, while local competitors are CATL, Lishen and Wanxiang A123.

Aggressive capacity/sales expansions ahead

Since it was first established in Hefei city, Anhui province, in 2006, Guoxuan High-Tech's core business has been producing lithium batteries. Its lithium battery capacity increased from a mere 50mn Ah (0.16GwH) in 2011 to 750mn Ah (c. 2.4Gwh) in 2015 and should further expand to 2,550mn Ah (8.9 Gwh) in 2018E, implying a CAGR of 74% from 2011 to 2018.

The current major lithium-ion type battery produced by Guoxuan is LFP (lithium iron phosphate), providing power for its commercial EVs clients, mainly buses makers. However, its two new factories in Laixi and Hefei are going to produce NMC-LFMP in this year, targeting passenger EVs

Figure 41: Guoxuan's lithium battery capacity

	Cathode type	Status	2014	2015	2016E	2017E	2018E
Hefei original	LFP	Under operation	100	100	100	100	100
Hefei first phase	LFP	Under operation	150	150	150	150	150
Hefei second phase	LFP	Under operation		100	100	100	100
Hefei third phase	LFP/NMC+LMFP	Under construction ETA Sep. 2016			600	600	800
Kunshan	LFP	Under operation		100	100	100	100
Nanjing	LFP	Under operation		300	300	300	300
Laixi	NMC+LMFP	Under construction ETA Sep. 2016			300	300	1000
Tangshan	na.	Scheduled				na.	na.
Effective Capacity (mn Ah)			140	525	975	1,650	2,550
Effective Capacity (Gwh)			**0.4**	**1.7**	**3.3**	**6.7**	**8.9**

Source: Deutsche Bank, Company data

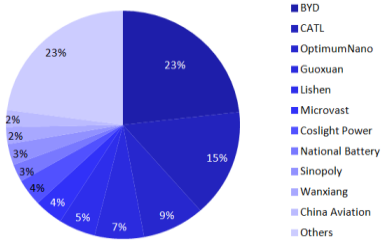
New industry standards to control industry capacity growth and quality

In order to control the development phase and production quality, since the end of last year, the Chinese government (MIIT) has required all the lithium battery manufacturers to achieve the new industry standards for EV lithium batteries and take it as a necessity to receive a subsidy later. So far, MIIT has announced three rounds including 25 companies in total can reach the new industry standards. Guoxuan High-Tech is one of them

Strong clients result in big orders being secured

We have an optimistic view on Guoxuan's sales because of its strong downstream clients, which have very strong presence in the China EV market. The major clients of Guoxuan are large automakers like Zhongtong Bus, Nanjin Golden Dragon, Suzhou Golden Dragon, Ankai Auto, BAIC (Beijing Automotive Group), SAIC (Shanghai Automotive Group) and JAC (Hefei Jianghuai Auto), all

Figure 42: Major Chinese EV battery players in 2015



Source: Deutsche Bank

of which have a strong presence in the China EV market. Among the top-10 largest EV sales in China, seven are to clients of Guoxuan.

Guoxuan has announced two significant contracts with downstream clients, Zhongtong and Nanjing Golden Dragon. The total amount of these contracted sales is as large as RMB2,096mn, representing c.98% lithium battery sales in 2015 and, on our estimates, c.43% lithium battery sales in 2016E

Figure 43: Major EV bus sales in the first four months of 2016 in China

	2016 YTD units	2015 same period	YoY	Market share	Client of Guoxuan ?
Zhongtong	3,199	197	1,524%	21%	Yes
Yutong	2,449	1,023	139%	16%	
Ankai	1,409	180	683%	9%	Yes
BAIC	1,016	224	354%	7%	Yes
Joylong	986	197	401%	7%	
Nanjing Golden Dragon	907	342	165%	6%	Yes
Suzhou Golden Dragon	675	465	45%	4%	Yes
Hunan Zhongche	591	10	5,810%	4%	
Yantai Shuchang	531	0	na.	4%	
Dongfeng	387	479	-19%	3%	
Others	2,861	1,572	82%	19%	
Total	**15,011**	**4,689**	**220%**	**100%**	

Source: Deutsche Bank, MIIT, Cvworld

Strong sales volume offsets shrinking unit profitability

We believe the ASP of lithium batteries may drop faster than the company cuts costs. We expect the ASP of Guoxuan (kWh) to drop at a CAGR of negative 8% and COGS to fall at a CAGR of negative 4%. As a result, margin per Wh should decrease from RMB1.04/Wh in 2015 to RMB0.64Wh in 2018E.

Nonetheless, the strong growth of capacity and sales is likely to fully offset the shrinking unit profitability. We expect the total sales of Guoxuan to increase from 325mn Ah in 2015 to 715/1,205/1,850mn Ah in 2016/2017/2018, respectively, representing a 70%/62%/83% utilization rate in the next three years. The lower utilization rate is being dragged by the new factories, Laixi and Hefei third phase, which will gradually ramp up in the years following 2017 and 2018, while old factories are currently run at full capacity. A shortage of effective capacity is the major reason restricting the further high growth of Guoxuan in FY2016. Therefore, Guoxuan is trying to construct and ramp-up new facilities as quickly as possible.

Overall we are optimistic about Guoxuan's capability to maintain its competitive edge and grow market share and bottom line even when unit profitability erodes slightly. As it is continuing to focus on close customer relationships based on principles of mutual benefit and long-term sustainability, Guoxuan is highly likely to grow with downstream EV makers, in our view.

Panasonic (6752.T, Buy, TP: ¥1,500)

(Hiroshi Taguchi, +81 (3) 5156 6706)

Summary

We believe the primary strengths of Panasonic's competitive advantage in the EV battery market are technologies, investment capacity, and expansion potential in growth markets. We believe Panasonic is a top-class industry player with regard to technologies and investment capacity. These aspects should help sustain a high market share in the global EV battery segment.

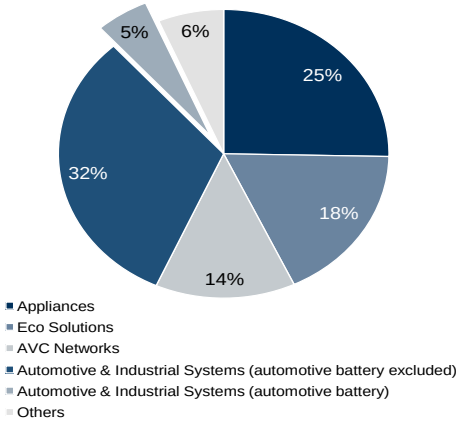
We expect Panasonic's EPS growth rate over the three years from FY3/17-19 to be 10%. We think automotive batteries, avionics, visual and imaging, and air-conditioners will drive profit growth among individual businesses.

Full-fledged ramp-up of business with Tesla has emerged for automotive batteries. Panasonic is also steadily increasing orders for business with other automakers besides Tesla and expanding production sites in Japan and overseas markets. We expect Panasonic to leverage trust relationships already built with automakers to further enhance its standing in the automotive battery business. Key risks are changes in the Tesla business, changes in raw materials prices, and initiatives in the Chinese market, but we do not anticipate a major impact on earnings forecasts at this point. We assign a target price of ¥1,500, and this level offers substantial upside potential from the current share price. We maintain our Buy rating.

Positioning of the automotive battery business at Panasonic

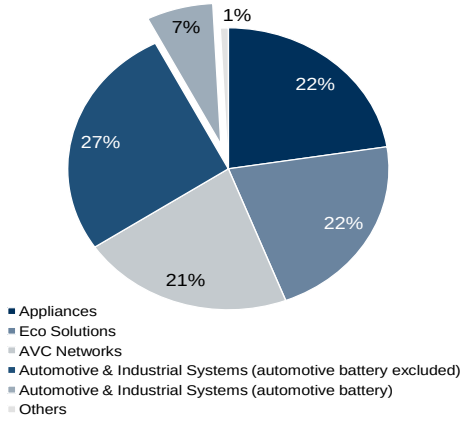
We think automotive batteries hold an important role in Panasonic's ability to continue sustainable growth. We project increases in percentages of overall consolidated results held by the automotive battery business from 3% in FY3/17 to 5% in FY3/19 for sales and 5% to 7% respectively for OP. Automotive business is also a driver in robust growth for Panasonic's consolidated results. Auto-related businesses have a lengthy period from order placement to completing production. We envision even larger contributions in subsequent years as deals covered by current order activity will make major additions in FY3/18 and beyond.

Figure 44: Panasonic's sales breakdown (FY3/19E)



Source: Deutsche Bank e= Deutsche Bank estimates

Figure 45: Panasonic's OP breakdown (FY3/19E)



Source: Deutsche Bank e= Deutsche Bank estimates

Overview of Panasonic's automotive battery business

Panasonic's automotive battery business primarily produces Li-ion batteries, and customers can be largely divided into Tesla and other automakers. The type of Li-ion batteries being manufactured and future initiatives differ between these categories.

Panasonic manufactures Li-ion batteries for Tesla from its Suminoe and Kaizuka plants in Japan and the Gigafactory in the US. It produces cylindrical Li-ion battery cells. Panasonic ships the 18650 Li-ion batteries used by Model S and Model X vehicles from the Suminoe and Kaizuka plants. It has not disclosed production capacities. However, a news release from October 2013 described the conclusion of a contract between Panasonic and Tesla to supply roughly 2bn Li-ion batteries during 2014-17. This level works out to 290,000-330,000 vehicles based on 6,000-7,000 units per vehicle. Additionally, Panasonic already announced and implemented an investment in the Gigafactory and plans to produce Li-ion batteries for the Model 3, slated to begin selling from 2017. Li-ion batteries to be produced at the Gigafactory will have expanded storage capacity. Some media sources are reporting that this battery will be the 21700. Panasonic intends to incrementally raise output capacity while assessing the demand trend. Production capacity is unknown at this point. However, Tesla CEO Elon Musk has presented goals of finished-vehicle output volumes of 500,000 vehicles in 2018 and 1,000,000 vehicles in 2020, and we expect the establishment of production capacity to support these volumes using all of the company's plants worldwide.

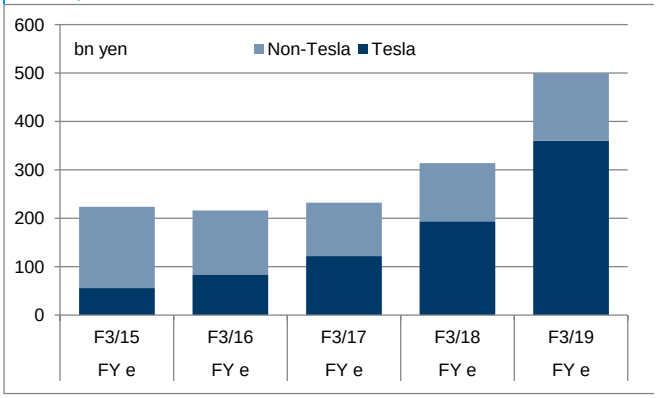
The Kasai plant in Japan is the production site for Li-ion batteries supplied to other automakers. Furthermore, Panasonic plans to add the Sumoto plant (Japan) from 2016 and the Dalian plant (China), which is slated for construction, from 2017. It mainly produces prismatic Li-ion batteries for this business. We think Li-ion batteries made at these sites mainly use NMC (nickel, manganese, and cobalt) and NCA (nickel, cobalt, and aluminum) as the cathode material. Panasonic does not disclose output capacities for the various plants, but it noted in March 2016 that 41 vehicle models use Panasonic products with confirmed orders for 19 models and ongoing order activities for 22 models. We think Panasonic will expand output capacity to accommodate actual orders. Panasonic has officially acknowledged use in the following models: Toyota's Prius PHEV, Ford's Fusion and C-Mac, and Audi's Q5. Some media sources have also reported use in Volkswagen's e-Golf and e-up! models.

Earnings forecasts for Panasonic's automotive battery business

All of the values presented reflect our estimates because Panasonic does not disclose information on results in the automotive battery business. Panasonic posted ¥216bn in automotive business sales in FY3/16, and we expect expansion to around ¥500bn in FY3/19. Business with Tesla should be the main driver. We project a dramatic rise in sales along with the start of Model 3 shipments. Our US analyst's (Rod Lache) estimates for shipment volumes of Tesla vehicles – the underlying assumption – are 50,643 units in 2015, 81,810 units in 2016 (+62% YoY), 163,000 units in 2017 (+99%), and 355,000 units in 2018 (+118%). We assume that Panasonic supplies all volume for the new-vehicle portion. However, we do not expect much contribution from business with other automakers besides Tesla, because we anticipate such shipments are likely to start rising from 2018.

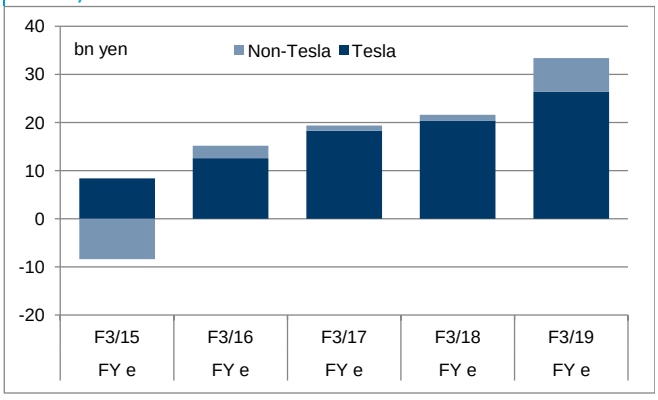
The automotive business generated FY3/16 OP of about ¥15bn, and we forecast an expansion to roughly ¥33bn in FY3/19. We expect profit to grow more slowly than sales mainly due to the impact of depreciation costs and product mix. Depreciation costs for new investments in the Gigafactory represent an additional cost. We also expect a decline in profitability for Model 3 Li-ion batteries, compared to Li-ion batteries mass produced up to now for Model S and Model X vehicles, in light of cost reduction demands and initial yields. However, we think profitability should improve over the medium term. We forecast volume-output benefits from the rise in cumulative production volume for Tesla and other automaker businesses.

Figure 46: Panasonic: Sales trends for the automotive battery business



Source: Deutsche Bank e= Deutsche Bank estimates

Figure 47: Panasonic: OP trends for the automotive battery business



Source: Deutsche Bank e= Deutsche Bank estimates

Strategic position of EV batteries

Panasonic continues to hold a No.1 global market share for EV battery shipment volume (on an MWh basis). The share order in 2015 was Panasonic at 4,552MWh (36% share), BYD at 2,700MWh (22%), and LG Chem at 1,432MWh (12%). We attribute the existing results to steady efforts from previous years, including the battery business acquired from Sanyo Electric.

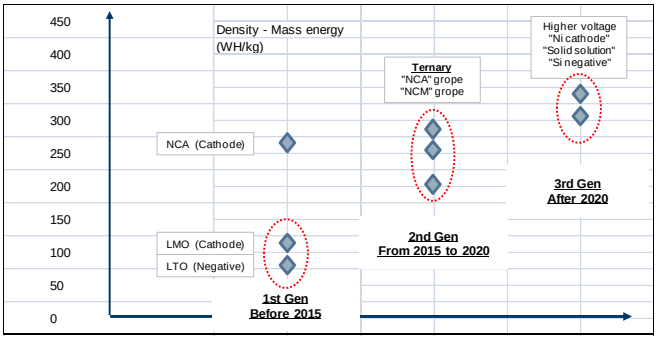
Is Panasonic capable of sustaining a high share?

We think primary sources for Panasonic's competitive advantage in the EV battery market are technologies, investment capacity, and expansion potential in growth markets. We believe Panasonic is a top-class industry player with regard to technologies and investment capacity. These aspects should help it to sustain a high share. The one area of concern is initiatives in the Chinese market which have displayed strong growth in recent years. We think Panasonic might be trailing major rivals in this regard. Panasonic believes it can achieve sufficient growth with existing orders, even without obtaining business from Chinese local auto firms and Chinese EV bus projects.

Technologies: Key points in assessing EV batteries are capacity, durability, and lifespan (recharging count). Battery manufacturers are conducting R&D aimed at raising performance. Automobiles using Panasonic's EV batteries exhibit high performance in actual data. However, relationships with auto firms are probably the most important factor. EV batteries are not general-purpose items. They are customized products that seek to realize maximum safety and performance through joint development with individual auto firms. This means that EV battery firms with a certain level of technologies building long-term relationships with automakers wind up obtaining even more robust technology

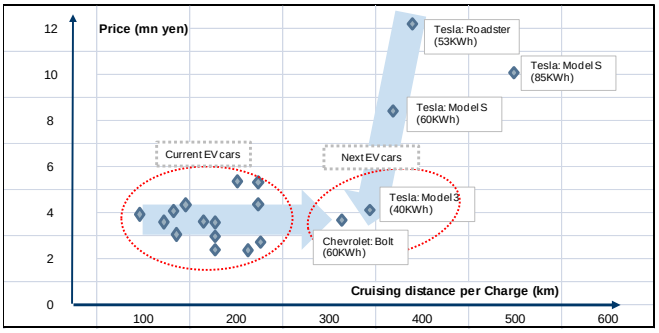
capabilities. We also do not expect auto makers to decide to periodically change suppliers because the EV battery-related field is highly important to auto firms and something that they probably want to develop as a black-box area (not disclosed to rivals). We think Panasonic, LG Chem, and Samsung SDI, which have acquired extensive orders from auto firms, will sustain robust technology capabilities among EV battery makers.

Figure 48: Energy density



Source: Nikkei news paper

Figure 49: Cruising distance and vehicle price



Source: Nikkei news paper

Investment capacity: We believe customers will press EV battery firms to expand their output capacity as EV usage grows. We expect Panasonic to invest ¥150-250bn in the Gigafactory (US). Companies with investment capacity should survive. Investment capacity must be assessed on a total basis, including short-term liquidity, room to increase loans and other liabilities, and whether government subsidies exist.

Chinese market: China's EV battery market is rapidly expanding, and we believe local Chinese battery makers are well positioned to leverage this opportunity. While LG Chem and Samsung SDI have already built plants in China, these plants have yet to receive government approval for subsidies. Panasonic plans to build a plant in Dalian from 2017. It has already confirmed the shipment destination for EV batteries produced at this plant. However, we see a possible impact if the plant does not secure approval from the Chinese government.

Panasonic – EV battery valuation

We estimate that Panasonic's automotive battery business has a value of ¥230bn, or ¥100 per share. We base this calculation on our FY3/18 earnings forecasts, but business value is likely to climb as the automotive business expands.

The Japanese consumer electronics team does not use sum-of-the-parts analysis to calculate target prices. This stance aims to avoid the risk of setting multiples for individual businesses arbitrarily high or low. We apply two assumptions in assessing Panasonic's automotive battery business: 1) use of the same OP and EPS composition ratios for individual segments and 2) adoption of 16x P/E as the fair multiple for all segments.

Figure 50: Panasonic: Value of automotive battery business

F3/18e	OP (bn yen)	% of OP	EPS (yen)	P/E (x)	Value (bn yen)	Per share (yen)
Appliances	93.3	25%	23.6	16.0	880.5	380
Eco Solutions	106.4	28%	26.9	16.0	996.4	430
AVC Networks	96.6	26%	24.4	16.0	903.7	390
AIS (automotive battery excluded)	88.5	24%	22.4	16.0	834.2	360
AIS (automotive battery)	25.9	7%	6.6	16.0	231.7	100
Others	4.0	1%	1.0	16.0	46.3	20
Elimination	-40.0	-11%	-10.1	16.0	-370.7	-160
Consolidated	374.6	100%	94.8	16.0	3,475.8	1,500

Source: Deutsche Bank e= Deutsche Bank estimates

Risks

Business comes with risks. We think the main risks for Panasonic's EV business are price pressure, decline in Tesla's EV market share, dependence on Tesla, the lithium price, and initiatives with Chinese local manufacturers. We do not expect a major impact on Panasonic's earnings from any of these risks at this point, but review our thoughts below.

Price pressure: We see the possibility of increased cost-cutting pressure on Li-ion batteries for Tesla's Model 3. Media sources report a goal of cutting costs for Li-ion batteries produced at the Gigafactory by 30%. No specifics have been given on the timing for achievement of this goal. We expect lower transport costs compared to batteries exported from Japan as well as volume-production effects and other efforts to reduce costs. However, we think it is necessary to pay close attention to forex fluctuations, and other variables amid rising fixed costs (depreciation costs).

Decline in Tesla share: Panasonic is the only battery firm investing in the Gigafactory (US). We therefore expect Panasonic to supply Li-ion batteries for the Model 3. Meanwhile, LG Chem has already started to supply replacement batteries for the Roadster. Rivals might enter in other areas as well. In addition, Tesla might build plants in China and Europe (outside of the US). Suppliers might change considerably, depending on local government stances in these cases.

Dependence on Tesla: Panasonic obtains over 50% of its automotive battery business sales from Tesla. Our consumer electronics team expects Tesla sales to grow. However, some observers question Tesla's preparations for production and maintenance capabilities. We believe Panasonic would also be impacted if Tesla's business were to grow more slowly than expected.

Lithium price: A sharp rise in raw material prices could increase production costs. We do not expect an impact from the recent rise in the lithium price because the Gigafactory has already secured long-term contracts. However, orders volume is growing for other businesses besides Tesla, and we see a possible impact if lithium prices were to rise steeply over the long term.

LG Chem (051910.KS, Buy, TP: Won350,000)

(Shawn Park, +82 (2) 316 8977)

Petrochemical backbone with batteries as new growth engine

LG Chem is one of the largest and most diversified petrochemical companies in Asia with total ethylene capacity of 2.2million tpa. With the petrochemical business acting as the cash cow, LG Chem focused investments into IT materials division during the late 1990s to develop materials for panel displays and batteries (handsets and notebook PCs). Its business into EV batteries magnified, with the company becoming the sole provider of PHEV batteries to GM Volt in 2010, which resulted in battery plant construction in Holland, Michigan in 2012.

LG Chem's batteries are NMC pouch-type polymer batteries, with EV/ESS battery plants located in Korea (5GW), USA (2GW), and China (2GW). Poland's 1GW battery plant construction will also be complete by mid-2017, which will be used to supply European automakers with batteries in the near future. Given limited capex required to add battery capacity (less than Won100bn per 1GW), while also taking less than 12 months for the construction and test runs, LG Chem plans to add battery lines based on demand visibility and new orders.

Figure 51: LG Chem – sales and OP breakdown

(Won bn)	1Q16	2Q16E	3Q16E	4Q16E	FY15	FY16E	FY17E	FY18E
Sales	**4,874**	**5,752**	**6,170**	**6,121**	**20,207**	**22,916**	**27,109**	**32,238**
Petrochem	3,456	4,123	4,368	4,247	14,389	16,194	18,911	22,073
I&E	1,418	1,629	1,802	1,873	5,817	6,722	8,199	10,165
EV battery	-	-	-	-	791	1,456	1,978	2,844
Display glass	-	-	-	-	252	448	658	1,053
Operating Profit	**458**	**531**	**665**	**590**	**1,824**	**2,244**	**2,769**	**3,156**
YoY	26.5%	-5.7%	21.8%	67.5%	39.1%	23.0%	23.4%	14.0%
Petrochem	466	527	634	492	1,676	2,119	2,347	2,500
I&E	-8	5	31	98	147	125	422	657
EV battery	-	-	-	-	-76	14	160	277
Display glass					-76	-90	0	53

Source: Deutsche Bank estimates

EV batteries – strategic positioning

With 40 contracts from 20 global automakers, we believe LG Chem is well positioned to benefit from the growing EV market for the next decade. Our comparative analysis of LG Chem's batteries indicates that the company is well positioned as one of the top tiered battery makers in terms of order book and technology. Financial capability is another strength, with the chemical division continuing to act as a cash cow, while capex related to batteries is expected to be manageable, given its scale.

On the other hand, one major setback for LG Chem is its struggle to qualify as an eligible battery maker in China, as NMC-type batteries are restricted for e-buses, and the company has yet to be included on the list to receive government subsidies. While the restriction on e-buses may take time to be sorted out, we need to wait and see if LG Chem can qualify for registered battery maker status in China. According to the company, all the necessary qualifications have been met, and the request has been resubmitted. LG Chem expects the approval announcement to happen before the new policy comes into effect from July.

EV batteries to be the long-term earnings driver

While we expect LG Chem's earnings to be driven by the chemical divisions, we believe EV batteries will further fuel the growth over the long term. Representing only 4% of total revenue in 2015, we expect EV battery sales to grow at a 53% CAGR for the next three years, and constitute 8.8% of total revenue by 2018E. In terms of earnings contribution, we estimate the EV battery business to represent 9% of total operating profit by 2018E from -4% in 2015, for which we assume the company will reach 9.7% OPM by 2018E.

We value LG Chem's EV battery business at Won1.7tr based on DCF

After factoring in Deutsche Bank's global EV outlook, applying our new findings on LG Chem's battery price per kWh, and taking a more conservative stance on LG Chem's market entry into the China EV market, we value LG Chem's EV battery business at Won1.7tr vs. our previous Won4.1tr. Our EV battery business value is based on DCF and the assumptions are as follows:

- We assume the Generation 2 and 3 EV battery price per kWh to be US$147 (FY17E) and US$100 (FY23E) respectively, and assume a 2% ASP decline p.a.
- Benchmarking from the global auto team's demand outlook, we estimate EV penetration to reach 14% by 2025 from 4% in 2015, implying a 16% CAGR for the next 10 years.
- We assume LG Chem's global market share in EV batteries to peak at 9.2% in 2021E from 2015's 6.1%, and maintain its long-term market share at the 8% level through 2030E.
- For battery capacity and capex, we assume annual expansion of 3~5GW during the Generation 2 era, while we assume 8GW expansion p.a. post 2023E (Gen 3). Net relevant subsidy from governments, we assumed US$80m capex per 1GW capacity, which is in line with today's line addition by LG Chem (less than Won100bn per 1GW).
- We assume OPM to peak in 2021E at 12.3%, but fall with the start of Gen 3 batteries and eventually reach the low single-digit level by 2030. The basis for lower OPM over the long term is to reflect heated competition for batteries as the market saturates over time, while growing competition from Chinese peers will likely erode profitability.
- We apply 8.8 WACC based on 9.7% CoE, 4% CoD and 19.2% D/E, while using a 2% terminal growth rate.

Figure 52: LG Chem's DCF valuation on EV/ESS batteries yields Won1.7tr, or Won23,000 per share

LG CHEM (Won bn)	2016E	2017E	2018E	2019E	2020E	2021E	2022E	2023E	2024E	2025E	2026E	2027E	2028E	2029E	2030E
Sales	1,456	1,978	2,844	3,194	3,727	4,918	5,652	6,067	6,907	7,860	9,034	10,079	11,127	12,190	13,379
D&A	317	247	230	187	210	225	333	434	481	555	629	703	684	684	697
OP	14	160	277	320	383	604	476	505	430	421	458	365	276	202	254
OPM	*0.9%*	*8.1%*	*9.7%*	*10.0%*	*10.3%*	*12.3%*	*8.4%*	*8.3%*	*6.2%*	*5.4%*	*5.1%*	*3.6%*	*2.5%*	*1.7%*	*1.9%*
Ebitda	330	407	507	507	593	829	809	939	912	977	1,087	1,069	960	886	951
Ebitda Margin	*23%*	*21%*	*18%*	*16%*	*16%*	*17%*	*14%*	*15%*	*13%*	*12%*	*12%*	*11%*	*9%*	*7%*	*7%*
Capex	184	103	514	288	288	288	960	821	821	821	821	821	821	821	912
Capex (US$ mil)	150	80	400	240	240	240	800	684	684	684	684	684	684	684	760
Capex % of sales	12.7%	5.2%	18.1%	9.0%	7.7%	5.9%	17.0%	13.5%	11.9%	10.4%	9.1%	8.1%	7.4%	6.7%	6.8%
FX	1,228	1,285	1,285	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Net cash	146	304	-7	219	305	541	-151	118	91	156	266	248	139	65	39
Present Value	146	278	-6	168	214	347	-89	63	45	70	110	93	48	21	11
PV Sum (Won bn)	1,508														
TV (Won bn)	176														
WACC	8.8%														
Terminal Growth	2%														
Total Value (Won bn)	**1,684**														
Per share (Won)	**23,000**														

Source: Deutsche Bank estimates

Fine-tuning earnings and lowering target price based on revised battery DCF

Mainly to reflect our changed assumptions on EV battery DCF and outlook, we fine-tune FY16/17E earnings by -1/-1%. As a result of lower DCF value for batteries, we lower our target price to Won350,000 from the previous Won390,000. Despite the sizeable decline in our battery DCF (Won4.1tr -> Won1.7tr), our target price has only been revised down by 10%, as petrochemicals continue to be the stock's underlying earnings driver.

Figure 53: LG Chem – revising estimates

	New			Previous			Change		
(Won bn)	FY16E	FY17E	FY18E	FY16E	FY17E	FY18E	FY16E	FY17E	FY18E
Sales	22,916	27,109	32,238	22,916	27,109	32,238	0%	0%	0%
EBIT	**2,244**	**2,769**	**3,156**	**2,274**	**2,794**	**3,163**	**-1%**	**-1%**	**0%**
RP	2,071	2,551	2,939	2,101	2,577	2,945	-1%	-1%	0%
NP	1,557	1,919	2,210	1,580	1,939	2,215	-1%	-1%	0%

Source: Deutsche Bank estimates

Figure 54: LG Chem – target price based on sum-of-the-parts

Business (Won bn)	Methodology	Multiple	FY16E EBITDA	Value
Petrochemical	EV/EBITDA	7	2,980	22,053
I&E Materials	EV/EBITDA	8	433	3,594
EV Batteries	DCF			1,508
Net Debt				1,505
Total Value				**25,650**
No Shares (mil)				74
Fair Value per Share (Won)				**350,000**

Source: Deutsche Bank estimates, Company data

Samsung SDI (006400.KS, Hold, TP: Won117,000)

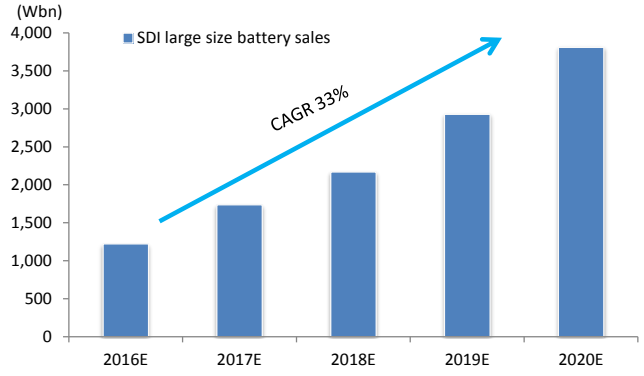
(Seunghoon Han, +82 (2) 316 8907)

Positive in the long term but limited profitability in the near term; maintain Hold

Samsung SDI is focusing on manufacturing prismatic type EV batteries based on NMC chemistry with BMW as its main customer. We estimate SDI was the sole battery supplier for the BMW i-series accounting for roughly 60% of SDI's EV revenues in 2015.

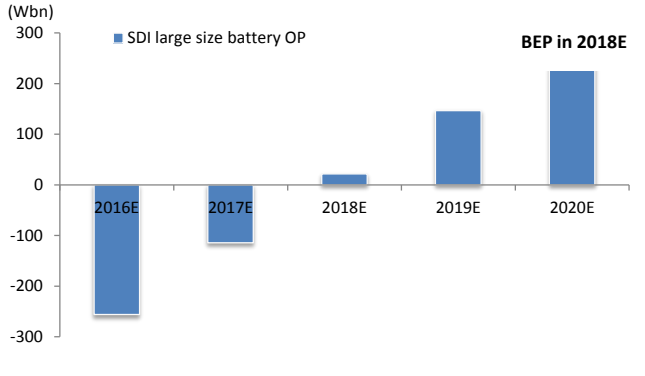
SDI's large size battery revenue was W634bn in 2015 and the company targets to grow reaching US$6.0bn by 2020. We forecast SDI's large size battery revenues as W1.2trn in 2016, to account for 21% of total company sales, up from 8% in 2015. For the long term, we estimate SDI's large size battery revenue to grow at a 33% CAGR over the next four years. SDI plans to invest up to W2.5~3.0tr by 2020 to achieve a total capacity of 36GW.

Figure 55: SDI large size battery sales outlook



Source: Deutsche Bank

Figure 56: SDI large size battery operating profit outlook



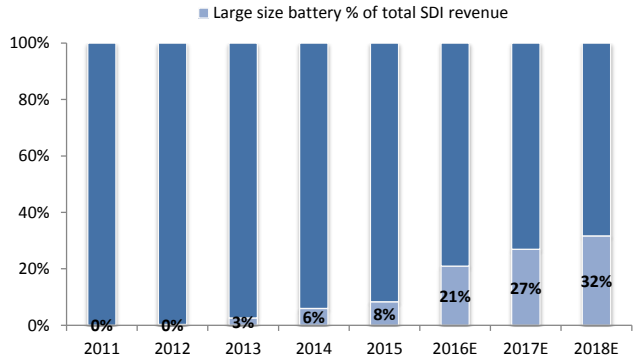
Source: Deutsche Bank

However, SDI's battery business still remains unprofitable, showing the weakest margin structure among our battery coverage with a higher cost base. We believe lack of customer diversification, higher fixed/overhead costs and unfavorable subsidy policy for overseas battery makers in China could slow down SDI's plans to turn around its loss-making battery business.

We expect SDI's large size battery business to report an operating loss of W256bn for an operating margin of -21% (vs. –57% operating margin in 2015). We estimate operating loss to narrow on recent restructuring efforts to reduce labor force and achieve better economies of scale. The company expects cost reductions efforts to contribute from 2018 which could help turnaround the large size battery business.

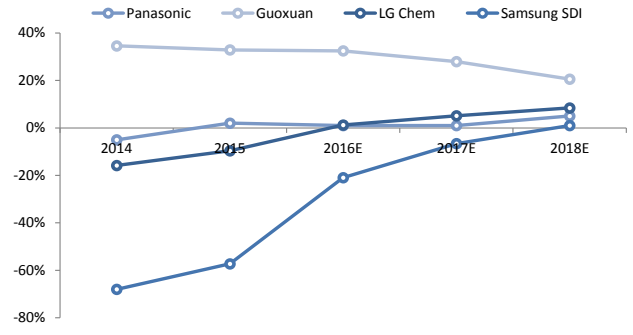
However, the majority of SDI's battery business growth in 2016 seems to target the China market which is currently facing obstacles from continued government policies to protect local battery makers. SDI believes all qualifications have been met and the company is waiting for China government to include SDI as an eligible battery maker to receive subsidy in China. We maintain our Hold rating with limited upside as majority of Samsung SDI's value comes from its investment asset in affiliates.

Figure 57: SDI large size battery sales contribution of total sales



Source: Company data, Deutsche Bank estimates

Figure 58: EV operating margin comparison



Source: Company data, Deutsche Bank estimates
**OPM only for the large sized EV/ESS batteries.*

Near-term challenges #1: Rising uncertainties in China EV battery business

We believe the majority of SDI's EV revenue increase in 2016 is mainly driven by its China business. Battery revenues to BMW i–series, which is its largest customer, could remain at similar levels in 2016 with the majority of sales increase coming from the China market. With the Chinese government strengthening regulations and providing an unfavorable subsidy policy to overseas battery makers, we believe this could result in weaker visibility for the company's 2016 EV growth story.

The China government has imposed stricter policies on battery makers' eligibility to receive subsidies. Recently, two policies have been introduced that has raised concerns for overseas battery makers in China: 1) subsidy restriction for NMC type batteries used in e-buses, and 2) new guidelines for eligibility to receive government subsidies.

SDI indicated that the Chinese government's restriction on e-bus subsidies could be resolved within this year but at different time frames depending on the application. For logistic vehicles, the company expects the issue to be resolved by May, but it could take longer for e-buses, which may not be resolved until the year-end.

In addition, the Chinese government has strengthened its guidelines on companies that could qualify for government subsidy. So far, only 25 battery makers (all locals) have passed the qualification criteria since last November with Korean makers yet to be included, despite applying earlier in the year. Although SDI indicates the company is in talks with China authorities to resolve such issues, we believe the outcome remains uncertain as China is showing a tendency to nurture and/or favor domestic battery players. In addition, the new policy requires battery makers to allocate more R&D engineers based in China which we believe could increase overhead cost.

Near-term challenges #2: Unfavorable cost structure

Our analysis shows that Samsung SDI currently has the lowest profitability among battery companies within our coverage. We believe SDI's current unfavorable cost structure comes from 1) higher initial investment required for SDI's prismatic type production lines, 2) added component cost required for prismatic type and 3) high overhead costs resulting from reallocation of CRT/PDP employees. We believe additional restructuring and greater economies of scales would be needed for SDI to improve its profitability, which the company expects to achieve starting from 2018.

SDI's battery division is suffering from high overhead costs as previous CRT/PDP employees were reallocated to the battery business, which we believe is one of the reasons for the company's cost disadvantage. Although we expect recent self-restructuring measures, such as its plan to cut 1,265 employees by 2017 (source: Chosun Biz), could somewhat improve the cost structure, we believe the company may still have a higher fixed cost base compared to its peers.

Outlook: Positive upsides in the long-term perspective

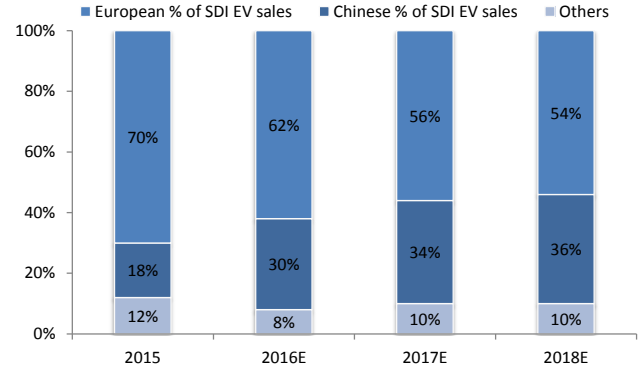
Samsung SDI is targeting to achieve profits from the large size battery business in 2018 as: 1) economies of scale help cost competitiveness; 2) customer diversification leads to better margin profile and 3) favorable product mix with module/pack-level sales increase.

Prismatic cells have higher initial fixed costs versus polymer, but SDI indicated this could reverse if economies of scale are achieved, as prismatic cells are easier to standardize with a higher level of automated production compared to polymer.

SDI's key customers are mostly Europe-centric (such as BMW and Volkswagen) and success with China customers is an important driver to achieve customer diversification. Although uncertainly remains regarding China's new policies, we expect the sales portion of Chinese and battery pack sales to gradually increase, which may help improve profitability as Chinese EV and battery module/pack business are to generate higher margins than the existing cell business.

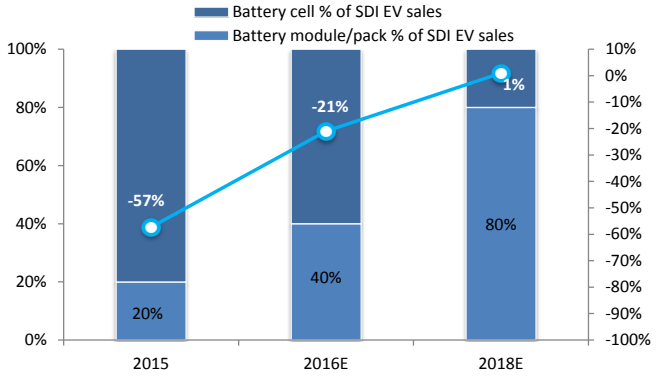
We estimate Chinese customers accounted for about 20% of total EV revenues in 2015 which could increase to mid-30% by 2018. Also we expect higher-margin battery pack sales to only account for 80% of EV battery sales by 2018, up from 20% in 2016.

Figure 59: Customer diversification: Chinese customers gradually increasing.



Source: Deutsche Bank

Figure 60: Increase of battery pack sales in the long term

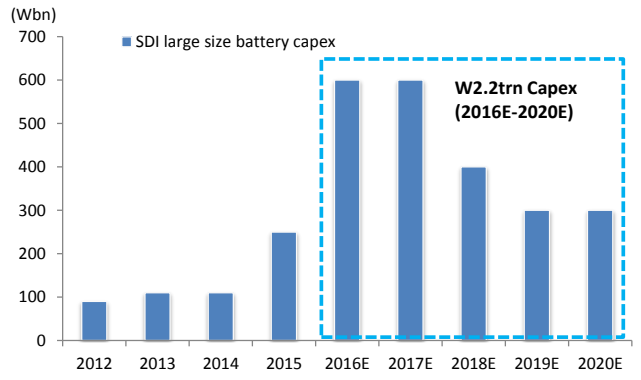


Source: Deutsche Bank

Capex and capacity expansion

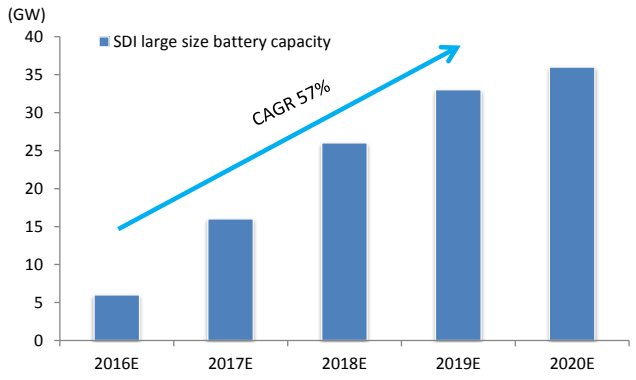
Samsung SDI's current EV/ESS capacity is 4.5GW and it is expected to reach 6.0GW by year-end. The company plans to expand its EV/ESS capacity over the next five years and have announced that it will invest about W2.5~3.0trn by 2020. Based on this, we expect EV/ESS battery capacity to post a 57% CAGR over the next four years to reach 36GW by 2020.

Figure 61: SDI large size battery capex trend and outlook



Source: Deutsche Bank

Figure 62: SDI EV/ESS capacity expansion



Source: Deutsche Bank

We value Samsung SDI's EV battery business at W1.2trn based on DCF

We raise our long-term EV revenue assumptions as we factor in SDI's higher capacity additions. Based on DCF, we value SDI's EV/ESS battery business at W1.2trn, up from previous W945bn. As a result, we raise our target price by 3% to W117,000 (previous W114,000) but investment assets still account for 60% of our total value.

Our DCF assumptions for the EV business are as follows:

- We take a conservative view on SDI's large size battery sales, expecting revenue to post a 24% CAGR over the period of 2016-2025.
- We believe SDI's continued cost reduction efforts, as well as favorable product mix could meaningfully contribute to its profitability from 2018; hence, we forecast SDI's large size battery business to turn to profit in 2018 with 1% OPM. We assume the company's OPM will reach 8% in 2021 with a long-term operating margin of 5%.
- For battery capex, we assume SDI will spend W2.2trn during 2016-2020, which reflects the company's long-term capex plan to spend W2.5~3.0trn until 2020 (DBe: W2.7trn capex spent during 2012-2020). As we expect the company to reach 36GW by 2020, this translates into W77bn per 1GW capacity. In the long term, we expect the company to spend W300bn of capex per annum (2021-2025).
- We apply 8.9% WACC based on 10.1% CoE, 3.0% CoD and 20.0% D/E, while using 2% terminal growth rate.

Figure 63: SDI's DCF valuation on large size battery business

W bn	2016E	2017E	2018E	2019E	2020E	2021E	2022E	2023E	2024E	2025E
Revenues	**1,223**	**1,736**	**2,170**	**2,930**	**3,809**	**4,761**	**5,713**	**6,570**	**7,424**	**8,240**
yoy, %	93%	42%	25%	35%	30%	25%	20%	15%	13%	11%
Operating profit	**-256**	**-115**	**22**	**146**	**267**	**381**	**400**	**394**	**371**	**412**
OP margin, %	-21%	-7%	1%	5%	7%	8%	7%	6%	5%	5%
EBITDA	**-136**	**125**	**342**	**526**	**707**	**761**	**720**	**694**	**671**	**712**
EBITDA margin, %	-11%	7%	16%	18%	19%	16%	13%	11%	9%	9%
D&A	120	240	320	380	440	380	320	300	300	300
% of sales	10%	14%	15%	13%	12%	8%	6%	5%	4%	4%

DCF, W bn, unless noted otherwise										
Sales	1,223	1,736	2,170	2,930	3,809	4,761	5,713	6,570	6,701	6,835
EBITDA	-136	125	342	526	707	761	720	694	671	712
- tax	0	31	85	132	177	190	180	174	168	178
+ change in working capital										
- capex	-600	-600	-400	-300	-300	-300	-300	-300	-300	-300
capex/sales	49%	35%	18%	10%	8%	6%	5%	5%	4%	4%
FCFF	**-736**	**-506**	**-144**	**95**	**230**	**271**	**240**	**221**	**203**	**234**
Discount factor	0.9	0.8	0.8	0.7	0.6	0.6	0.5	0.5	0.5	0.4
Discounted FCFF	**-736**	**-465**	**-121**	**73**	**164**	**177**	**144**	**122**	**103**	**109**
Exit FCF										**1,582**

NPV, W bn	**1,151**
Net debt	0
Net equity value, W bn	**1,151**
Per share value to Samsung SDI	**16,353**
% from terminal value	137%

WACC	8.9%
COE	10.1%
COD	3.0%
D/E	20.0%
Terminal growth	2%

Source: Company data, Deutsche Bank

SDI SOTP valuation

We derive SDI's target price based on SOTP valuation. Key upside risks are a strong recovery in consumer IT demand and faster-than-expected growth in the EV/ESS business. Key downside risks are continued poor earnings delivery, a worsening panel industry and continued weak IT demand.

Figure 64: Samsung SDI SOTP valuation

SOTP					
Operating value					
Small-cell business	**(A)**				**2016E**
Revenue, W bn					2,826
EBITDA, W bn					84
EV/EBITDA, x					5.0
Valuation, W bn					**419**
Mid/large cell business	**(B)**				
DCF-based valuation, W bn					**1,151**
ECM business	**(D)**				**2016E**
Revenue, W bn					1,773
EBITDA, W bn					326
EV/EBITDA, x					4.0
Valuation, W bn					**1,303**

Investment stake					
		2015 BV	**Multiple**	**ROE (%)**	**2016 FV**
Samsung Display		5,190	0.7X	4.1%	3,633
Samsung Engineering		285	1X		285
Samsung C&T		517	1X		517
S1		404	1X		404
Samsung Fine Chem		0	1X		0
Others		145	1X		145
Total investment value	**(E)**	**7,337**			**4,985**
NAV discount	**(F)**				**25.0%**

Net debt, Wbn	**(G)**	**-1,631**
Total equity value	**(A)+(B)+(C)+(D)+(E)*(1-F)-(G)**	**8,243**
Value per share, rounded		**117,000**
Current share price		117,000
Implied up/downside, %		0%
Implied P/E		38.9
Implied P/B		0.72

Source: Company data, Deutsche Bank estimates
**share price as of 1 June*

Battery components

(Martin Dunwoodie, +44 (20) 754 72852)

- Cathode is the key to improving battery performance, with NCA, NMC, and LFP being the most widely used technologies today.
- Key considerations for EVs are safety and energy density (kWh/kg). With NMC/NCA, batteries are higher in energy density but concerns on safety remain. Major NMC/NCA users are LG Chem, SD (NMC) and Panasonic (NCA).
- By contrast, LFP provides safer features but lower energy density, while the technological progress has been slow vs. other cathode materials. Chinese players (Guoxuan, BYD, etc.) are the major producers of LFP type batteries.
- Alternatively, in the future, we expect a combination of energy dense (NMC/NCA) and power dense materials (LFP) to be used, depending on the application.

Cathode materials for Electrified Vehicles

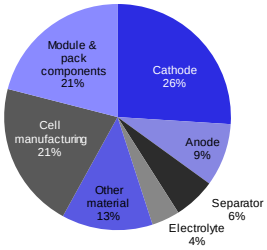
Cathode materials determine the battery quality (e.g. capacity and electrical output) and are therefore the most important materials in battery production. These are one of the key determinants in improving battery performance. The active metal oxide used within the cathode of lithium-ion cells can vary depending on the application and battery properties required. The active material will make up 90-98% of the cathode weight (the rest being adhesive to 'paste' the active material to the cathode metal). The common element in all of these materials is lithium and the actual lithium content can be calculated based on the molecular weight of the lithium, as a proportion to the molecular weight of the active material used.

Key battery components require technology breakthroughs

The four key components of batteries comprise the following: 1) cathodes, 2) anodes, 3) separators, and 4) electrolytes. Cathodes, anodes, electrolytes, and separators account for roughly 26%, 9%, 6%, and 4% of the total manufacture cost of a lithium battery, respectively. To significantly improve the performance of the lithium battery, technology breakthroughs are required in all four components. In particular, the cathode is the key to improving battery performance with the four areas that research is focused on being:

- Increasing energy storage (i.e. increasing driving range)
- Reducing the charging time
- Issues around heat management
- Lowering the cost

Figure 65: Lithium battery manufacture cost breakdown



Source: Argonne National Labs, Supplier Estimates, Industry Experts, Deutsche Bank

Five main lithium metal oxides used in cathodes

Recharging times, discharge rates and stability are all factors that will be considered when selecting a cathode material. Lithium-cobalt oxide has held market dominance, as it was the first technology commercialized, but its market share has declined, from 70% in 2008 to 36% in 2014, as new technologies have been developed. Lithium is the only active material in the battery, so consequently increasing the battery's lithium content increases energy density. The challenge is that lithium is highly reactive, so current

technologies require other materials to be included to ensure stability, increase safety, and maximize life expectancy. Nickel-cobalt-aluminum (NCA) and nickel-manganese-cobalt (NMC) cathode technologies are the two leading technologies being used in the Electric Vehicle industry.

Figure 66: Major lithium metal oxides used in cathodes

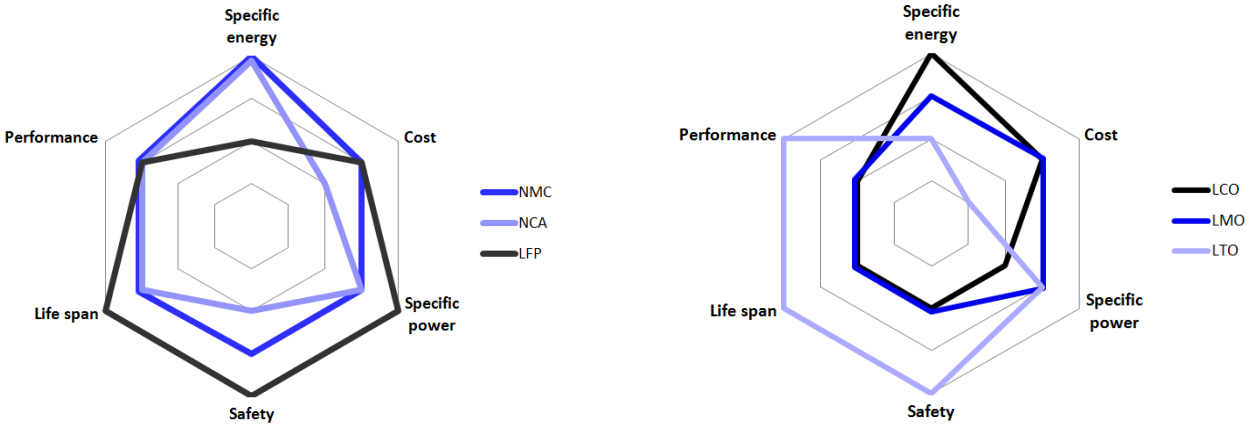
Acronym	Material components	Chemical formula	Uses	Characteristics
LCO	Lithium Cobalt Oxide	$Li_{1-x}CoO_2$	Mobile phones, laptops	Incumbent technology first introduced in 1991, high energy density but incurs longer charge times and shelf life of 1-3 years, can be dangerous if damaged.
LMO	Lithium Manganese Oxide	$Li_{1-x}MnO_4$	Power tools, medical instruments	Low internal cell resistance allows fast recharging and high-current discharging but 1/3 of LCO's energy capacity.
NCA	Nickel Cobalt Aluminum	$Li_{1-x}NiCoAlO_2$	**Electric powertrains for vehicles**, energy storage	High specific energy and long life span; safety and cost were historical concerns but these are now resolved; Tesla uses NCA.
NMC	Nickel Manganese Cobalt	$Li_{1-x}(NiMnCo)O_2$	**Electric powertrains for vehicles**, power tools	Can be tailored to high specific energy or high specific power; most Japanese and Korean producers sell NMC into EV market.
LFP	Lithium Iron Phosphate	$Li_{1-x}FePO_4$	**Electric powertrains for vehicles** , eBikes, garden lights etc.	LFP batteries offer a safe alternative due to thermal and chemical stability of the Fe-P-O bond compared to Co-O bond; the Chinese government is promoting LFP use in China over NCA/NMC.

Source: CSIRO presentation, DB Future Metals conference, 25/06/2013

NMC/NMA is the trend for EV battery, but LFP is not yet abandoned

There are a number of materials being used in cathode production, including NMC (Lithium Nickel Manganese Cobalt Oxide, $LiNiMnCoO_2$), NCA (Lithium Nickel cobalt Aluminum Oxide, $LiNiCoAlO_2$), LFP (Lithium Iron Phosphate $LiFePO_4$), LCO (Lithium cobalt Oxide, $LiCoO_2$), LMO (Lithium Manganese Oxide, $LiMn_2O_4$) and LTO (Lithium Titanate, $Li_4Ti_5O_{12}$), etc. Unfortunately, none of the cathodes available right now can claim to be the optimal product, as certain applications prefer particular chemistries. Figure 67 compares the major characteristics of lithium batteries using different types of cathode.

Figure 67: Characteristic comparisons of different types of lithium battery



Source: Deutsche Bank, Cadex Electronics, Battery university

Mainstream solutions are NMC/NCA and LFP

Different types of lithium battery are suitable for different types of usage, based on the natural chemical characteristics resulting from varying cathodes. For the EV battery, the key considerations are safety and energy density (kWh/kg). Therefore, the current mainstream solutions are: 1) ternary material series, NMC/NCA, which have higher energy density, but concerns on safety remain. The risks of fire hazard are higher; and 2) LFP, which is safer, but energy density is relatively low, and there has been slow progress on performance improvements. In China, most commercial EVs use LFP, as

manufacturers put safety as the first priority, while passenger EV producers prefer to use NMC/NCA, as driving distance matters. A typical user of NCA is Tesla, while a typical user of LFP is BYD.

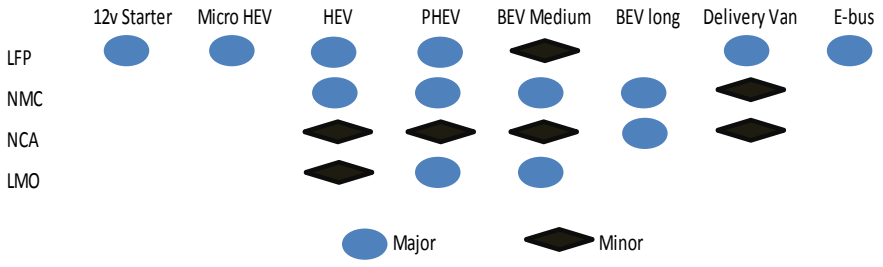
China is promoting the use of LFP on safety grounds

In China, we believe LFP will not yet be given up, especially after several recent accidents involving explosions. The rise of the importance of safety has been swift. The CAAM (China Association of Automobile Manufacturers) recently submitted a suggestion to the MIIT (Ministry of Industry of Information and Technology), asking that it should not allow passenger EVs to install ternary material lithium batteries due to safety considerations. The policy risk may be significant to NMC/NCA cathode producers (which are mainly Japanese and Korean companies). We believe that only c.12% of commercial EVs will use NMC/NCA in 2015-2018. We believe the cathode technology debate will continue without any clear conclusion for a while. The risks of technical breakthrough, intensive competition, government policy interference, and lack of clear industry standards will continue to affect the cathode manufacturing sector.

Long term, we see a blend of materials being most likely

We believe that the most likely end-position with regard to technologies is that a blend will be used to give the required properties, given no one material can satisfy all requirements. We expect that a combination of energy dense (NMC/NCA) and power dense materials (LFP) will be used depending on the application with, for example, larger vehicles such as e-buses requiring more power dense materials and light duty autos requiring more energy dense materials to provide range. We show the material landscape and different applications in Figure 68.

Figure 68: Current cathode material landscape



Source: Deutsche Bank, Johnson Matthey

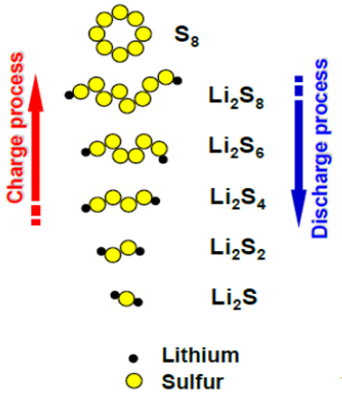
Future technologies being researched include Li-S and Li-air

Future technological advancement is driven by more complex chemistry. There are intense research efforts underway on two major technologies, Li-S and Li-air, but both technologies are a long way from being market-ready.

- **Li-S technology:** uses the multiple-step conversion of sulfur into lithium polysulphides (see Figure 69) instead of the transfer of lithium ions from cathode to anode. This process has a theoretical energy density of 1,675Wh/kg compared to 100-150Wh/kg currently achieved in lithium-ion batteries.
- **Li-air technology:** considered the 'holy grail' of lithium technology, the lithium-air battery has a very high theoretical energy density of

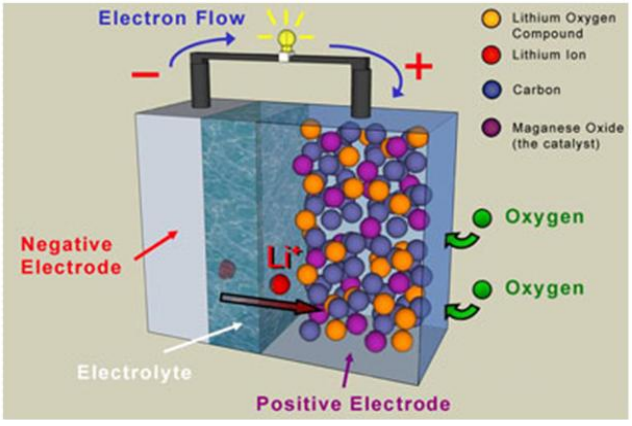
3,842Ah/kg (lithium-ion currently at 137Ah/kg), which is comparable with the energy density of petroleum fuel.

Figure 69: Lithium-sulfur technology



Source: CSIRO presentation, DB Future Metals conference, 25/06/2013

Figure 70: Lithium-air technology



Source: CSIRO presentation, DB Future Metals conference, 25/06/2013

Sulfur is relatively abundant and can directly replace other materials used in existing battery plants. Conversely, the cost of Li-air is largely dependent on the eventual composition of the cathode catalyst layer (will need stabilizing additives, possibly rare earth elements or precious metals), and new infrastructure will be required to produce Li-air batteries in commercial quantities. The key issue for both technologies is keeping the active materials stable through multiple charge-and-discharge cycles (commercial devices are deemed to reach the end of life when 80% of the initial capacity is reached. For portable electronics applications this should occur around 300 cycles, for other applications it is around 1000 – 5000 cycles).

A number of manufacturers of cathode materials

The cathode materials market is fragmented and market shares are uncertain, given this is a new market going through a rapid growth phase. In the main materials market for light duty autos (NMC/NCA), we see five main players currently active in the market: Umicore c.25% market share, Nichia and LG Chem (captive use of materials) both approximately 20% market share, Sumitomo (NCA almost exclusively) and Shanshan (a small presence). Market shares can change quickly, depending on new platform launches and how successful each is.

Route to market different to consumer and provides barriers to entry

Longer term, we expect that three of the major suppliers of cathode materials for automotive OEM will be the three main auto-catalyst manufacturers: BASF, Johnson Matthey and Umicore, given the focus from all three on this market and on the current trend towards higher nickel containing NMC for higher energy density, although it is not confirmed this will be the route going forward for the best trade-off between cost, lifetime and energy density. We note that **supplying into automotive OEMs has different requirements from supplying into consumer applications, with a different value chain and quality requirements**. For example a battery in a mobile phone may only need to last 3-4 years before the consumer replaces the phone. For an automotive OEM there are varying sizes of batteries and requirements and the life of the battery would need to be a minimum of 10 years. The route to market also differs from supplying into consumer, with a direct relationship with the automotive OEM. There are strong parallels with the catalysts business in that the auto OEM

defines the technology to be used and the specification of the battery system. The cathode material manufacturer will then work with the auto OEM in many cases, and battery manufacturer to deliver the specified battery. The catalyst manufacturers have strong competences that lend themselves to being key suppliers of cathode materials, being:

- Technological – with expertise in inorganic materials and surface chemistry, which has parallels in the skill set required for catalysts.
- A well established route to the main end customer, automotive OEM, with a good knowledge of the innovation cycles and also quality control required.

We do not rule out existing cathode material manufacturers supplying into consumer continuing to supply into auto OEM, but the different route to market, core competences and auto OEM requirements makes this more difficult, and we expect the existing three catalyst manufacturers to be major players in cathode materials for automotive applications as well, over the longer term.

Competitive environment similar to catalysts

Market share estimates for auto applications are difficult due to the fragmented nature of the market, and its early stage nature in automotive OEM. Johnson Matthey has indicated it has a 20% market share in LFP, Umicore has a 25% market share in NMC, although BASF has not commented on its market share. We believe the market structure will be similar to catalysts with the auto OEMs focused on having at least two main suppliers, so we do not see competition as any more aggressive than in the catalyst space. In terms of margins, none of BASF, JMAT or Umicore disclose profitability, although we know BASF and JMAT are yet to break even in this business so it is difficult to assess longer-term profitability. Unlike catalysts where the product is at the end of the powertrain and designed to clean-up emissions, the cathode material is a key part of the powertrain and, as such, of potentially greater value to the auto OEM, given the strict quality and performance requirements to be satisfied (e.g. being able to recharge 3,000-4,000 times). Fluctuations in the price of lithium we expect to be borne by the automotive OEM and not the supplier of cathode materials, an existing arrangement in catalysts for PGMs which are a pass-through cost.

Increased value per vehicle for the catalyst manufacturers

This is still a developing business so numbers in terms of the value per vehicle for the cathode materials manufacturers are still very uncertain. However, we believe that for all three catalyst makers, electrification of vehicles is an opportunity, rather than a threat. In terms of the catalyst business the majority of vehicles in the next 10 years will have an internal combustion engine (be it hybrid of some variant or solely ICE – Deutsche Bank forecasts are for c.70% of vehicles in 10 years time to have an ICE). We show the value per vehicle in the table below, as indicated by Johnson Matthey. The multiples are rebased to the value generated by a gasoline engine:

Figure 71: Added value to catalyst names from electrification

	IC Gasoline	IC Diesel	MHEV/FHEV (Gas/Diesel)	PHEV/RHEV	BEV	FCEV	Truck	HEV/PHEV Truck/Bus	Battery Electric Bus
Potential value - emission control	1-2x	5-7x	1-7x	1-7x	-	-	20x	20x	-
Potential value battery materials/MEA	-	-	1x	Up to 12x	Up to 20x	Up to 120x	-	Up to 18x	Up to 80x

Source: Deutsche Bank, JMAT. Abbreviations; HEV: Hybrid electric vehicle, BEV: Battery electric vehicle FCEV: Fuel cell electric vehicle, PHEV: plug in hybrid electric vehicle, MHEV: Mild hybrid electric vehicle, FHEV: Full hybrid electric vehicle

Umicore currently best placed amongst European Chemicals; but a fast-changing market

Umicore currently best placed; but a fast-changing market

In Figure 72, we have provided a comparative analysis of the cathode/battery material exposure for the European chemical players. We note that different players are exposed to different cathode chemistries. BASF is currently exposed to NiMH, LFP, NMC cathode materials, besides developing the electrolytes business with a vision to offer system solutions in the future. BASF's battery materials business is currently loss-making but the company is confident of improving profitability and market share with the third generation batteries (e.g. Li-S and Li-air). Johnson Matthey, on the other hand, has high exposure to LFP with an intention to expand into nickel rich materials. The company expects business to break even in 2016/17. We believe, Umicore is currently best placed in this market, given its broader product offerings (presence in NMC, NCA, LCO, although moving away from LFP) and profitable business, which is not a surprise given Umicore's business is mostly home grown compared to mostly acquisition-built portfolios at Johnson Matthey and BASF. **However, this is a fast-changing market and discovery/commercialization of new cathode materials boasting superior energy densities (e.g. Li-S and Li-air) and government policy interference (e.g. for LFP backing in China) could dramatically alter the market landscape.**

Figure 72: Comparative analysis of European Chemicals cathode/battery material exposure (2015)

Company	Sales	% of 2016E group Sales	EBIT	% of Group EBIT	Type of cathode/ battery materials
BASF	<E100m	0.2%	Loss-making business, expected to break even by 2020	NA	NiMH, LFP, NCM and electrolytes. R&D focus on develop Li-S and Li-air cathode materials
Johnson Matthey	GBP150m (GBP40m in battery materials)	4.7%	Loss-making business, expected to break even by end of 2016/17	NA	LFP, expanding into nickel rich materials
Umicore	E115m	4.2%	E14m	4.1%	NMC/NCA, LCO, moving away from LFP

Source: Deutsche Bank, Company Data

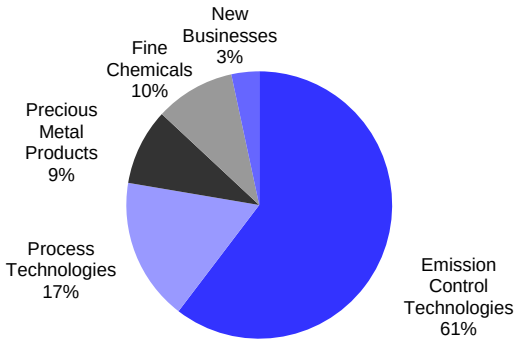
Company section (2)
– Battery components

Johnson Matthey (JMAT.L, Buy, TP: 3400p)

Portfolio focused on clean air, clean energy and sustainable technologies

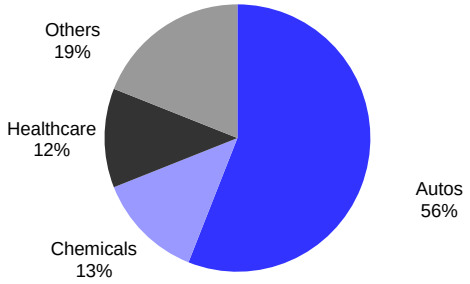
Johnson Matthey is a materials technology company focused on clean air, clean energy and sustainable technologies. The group comprises five main divisions: ECT (catalysts for light and heavy duty), Process Technologies (catalysts for industrial use such as petrochemicals and refineries), Precious Metals Products Division (focused on Precious Metals products and recycling), Fine Chemicals (API supply) and New Businesses which contains the battery materials business. We show the sales and EBIT split of the divisions below; note that New Businesses is currently loss-making with the target of being break-even by the end of fiscal 2017/18.

Figure 73: Divisional breakdown of sales (2015/16E)



Source: Deutsche Bank estimates

Figure 74: Sales by end-market (2015/16E)



Source: Deutsche Bank estimates

An established business in battery materials

JMAT already has an established battery materials business, albeit one it wants to develop significantly in the coming years. **Installed capacity is already 5000 tonnes p.a. with a focus on LFP. This represents 20% market share, with the company already on 15 automotive platforms**. Currently, Battery Technologies is expected to generate sales of GBP150m in 2015/16 of which GBP40m (27%) is in battery materials. The aim is to be break-even (EBIT) by the end of fiscal 2016/17.

Investment to expand technologies and capacity

The group is investing into growing the business further, both in technologies and capacity. Over 5% of Battery Technologies sales are invested into R&D, which is greater than the group average, to be expected given the early stage R&D focus of the business. Capacity expansion is taking place with capex of GBP50m-100m over the next five years (annual capex for the group is GBP212m in 2014/15).

Technology acquisitions likely to cover the full automotive spectrum

Johnson Matthey is present in lithium iron phosphate, but given the development of cathode materials and requirements is looking to expand into nickel rich materials (energy dense and giving more range for auto

applications). We expect in-licensing deals or smaller technology acquisitions to expand their presence in this area and cover the full automotive spectrum. **The business has already been built from various acquisitions with the following made since 2012, moving the company from no presence in battery materials to a 20% market share in LFP within three years:**

- Axeon for GBP41m in October 2012 focused on battery system design, development and supply.
- A123 assets for GBP16m in October 2014 which brought manufacturing capacity in China
- Clariant Battery Material for GBP49m in February 2015 which brought IP, product development, manufacturing and an established customer base.

In Figure 75, we show Johnson Matthey's presence across the various different types of electric vehicle:

Figure 75: JMAT technology presence

	IC Gasoline	IC Diesel	MHEV/FHEV (Gas/Diesel)	PHEV/RHEV	BEV	FCEV	Truck	HEV/PHEV Truck/Bus	Battery Electric Bus
JM technology presence	√	√	√	√	√	√	√	√	√

Source: Deutsche Bank, Johnson Matthey. Abbreviations; HEV: Hybrid electric vehicle, BEV: Battery electric vehicle FCEV: Fuel cell electric vehicle, PHEV: plug in hybrid electric vehicle, MHEV: Mild hybrid electric vehicle, FHEV: Full hybrid electric vehicle

High growth rates expected through 2025

In terms of Johnson Matthey's longer-term goals, the LFP market today is worth some GBP210m and expected to grow to over GBP1bn by 2025, with Johnson Matthey expecting to maintain its 20% market share over the period. The overall battery materials market is worth approximately GBP700m currently, with Johnson Matthey expecting it to reach GBP5.5bn by 2025 and JMAT targeting at least 10% market share across the broader battery materials for auto applications market. Margins are anticipated to be of the same order as ECT (auto-catalysts), implying an EBIT margin in the region of 13-14% and EBIT by 2025 of GBP70-75m, we estimate c.10% of group EBIT in 2025.

Benefitting from long-term structural growth; Buy

Johnson Matthey should benefit from the growing demand for emissions control catalysts, driven by tightening emissions legislation across the globe and increasing penetration of emerging markets. We expect continued growth in Europe, supported by Euro VI and real world driving, with other regions such as Japan, South Korea, China and India following in the coming years. Process Technologies is challenged currently, due to softness in the oil & gas market, but we expect growth to return in the next 12-18 months, driven by syngas catalysts and new opportunities in coal-to-products and shale gas and cost cutting. We forecast earnings to decline in 2015/16, due to temporary headwinds (lower oil, PGM prices, pensions and disposals) but with the long-term growth drivers intact, we forecast a 10% EPS CAGR for 2017-2019. Buy.

Valuation

Our target price is based on DCF analysis. In our view, this best reflects JM's growth potential. We assume a terminal growth rate of 3.0%, slightly above the sector growth rate (which is based on GDP). This reflects JM's better-than-

sector average growth potential because of tightening emissions legislation globally. We assume a weighted average cost of capital of 8.2%, which is derived from a cost of equity of 9.0% (risk free rate of 4.0%, beta of 1.1 and market risk premium of 4.5%) and post-tax cost of debt of 4.5%.

Risks

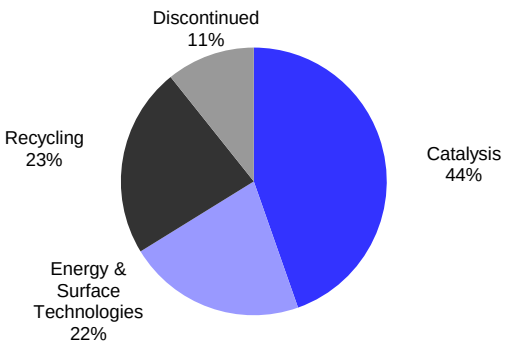
The principal risks to Johnson Matthey include a slowdown in auto production, to which JM has some leverage through its auto-cat business, loss of market share for diesel (higher value catalysts) or a weakening of the US$, which is JM's principal FX exposure. Other risks include a sharp decline in platinum group metal prices, which could reduce earnings in the group's Precious Metals trading business. Other downside risks include faster evolution of competition in heavy-duty and non-road diesel catalysts.

Umicore (UMI.BR, Hold, TP: E40)

Battery materials is part of Energy and Surface Technologies

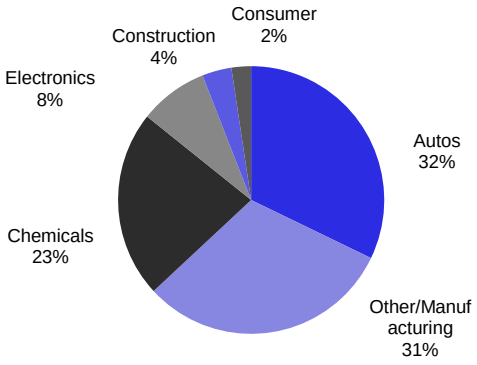
Umicore is a high technology materials company with activities in metals Recycling, Energy and Surface Technologies (including rechargeable battery materials, in particular cathode materials) and Catalysis (including catalysts for autos and trucks).

Figure 76: Divisional breakdown of sales (2016E)



Source: Deutsche Bank estimates

Figure 77: Sales by end-market (2016E)



Source: Deutsche Bank estimates

An extensive history in battery materials

Umicore has a more extensive history in cathode materials than peers, having started to invest over 10 years ago into this area. **The company is involved in a broad range of cathode materials but has a particular focus on NMC**. Umicore has previously disclosed it is specified on 15 automotive platforms, but more recently indicated that, given the number of platforms and models being launched, this number has increased significantly, although they have not given an exact number. **We show Umicore's presence across the different types of battery material in Figure 78 (they have recently moved away from LFP).**

Figure 78: Umicore's cathode material heat map

Segment	Cathode Material Options		
Portables Premium	HE LCO √		NMC/NCA √
Portables Standard	NMC	LCO	LMO
Automotive 'Energy dense' materials	NMC/NCA √		LMO
Automotive 'Power dense' materials	NMC/NCA √	LMO	LFP
Energy Storage System	LFP	NMC/NCA √	LMO

Source: Deutsche Bank, Company Data

Expansion to triple capacity from 2015 to 2018

Umicore recently announced plans to triple its rechargeable battery materials capacity by 2018, marking an acceleration in demand for cathode materials in electrified vehicles. **This is one of Umicore's largest investments, amounting to E160m over a three-year period (this compares with 2015 capex of E240m). The new capacity will be in China and South Korea at existing sites (brownfield and greenfield investments) and will be on stream starting in H2 17, dedicated entirely to NMC for automotive applications.** This investment has a returns target in excess of 15%, consistent with the broader group target. The contribution should be more immediate than a completely new investment as

this is serving existing contracts with extra capacity. It has been predicated on contracted or awarded business, where the company knows which platforms have been awarded.

A strong strategic position in automotive with barriers to entry

Management has commented that qualification requirements and quality requirements are such in the automotive industry that it takes around three years to qualify before production, and once production has started, it is complicated if not impossible to change the design. This creates a barrier to entry for those not already qualified in the industry and is very similar to the experience they have already gained in auto catalysts.

Litigation with BASF over alleged patent infringement

Umicore is currently involved in litigation in the US with BASF, over alleged patent infringement. We note the following:

- The initial determination from the US International Trade Commission (ITC) in March was that Umicore did not directly infringe BASF's patents in rechargeable battery materials, but did contribute to infringement with respect to certain activities including testing and evaluation in the United States.
- This initial decision issued by an administrative law judge at the U.S. ITC is merely a preliminary determination. The full ITC Commission will review the judge's preliminary determination and issue the ITC's final determination by 30 June with the possibility of appeals after that.
- Earlier in May, the ITC decided to review elements of the preliminary ruling which means that it will review key aspects of the initial review in February, including infringement findings. The alternative would have been for the ITC to not review the case and instead declare that the initial decision be final.
- The scope of the case is small. This affects production of the related cathode materials in the US, where Umicore has no production facilities. It also affects the direct importation of the cathode material into the US (but not products containing the cathode material), where Umicore's imports are not material.
- These patents, which expire in 2021, are only in the US and Umicore says there is no precedent for other jurisdictions, so there are no implications for their business outside of the US.

Battery materials estimated to be 5% of group EBIT

Rechargeable battery materials are part of Energy & Surface Technologies division. Umicore does not disclose the exact split of the division but we estimate that cathode materials represents around 20% of divisional sales with a similar REBIT margin to the rest of the division (50% of divisional sales including precursors). This implies cathode materials sales of E115m in 2015 of which around 50% is automotive related, we believe – E60m. Recurring EBIT would be c.E14m (E7m from autos). This equates to 4-5% of group sales in total (2-3% being autos) and 4% of group recurring EBIT (2% autos). As yet this is relatively small business for the group but with the new capacity, this implies a 30-40% CAGR in sales depending on the annual price downs with auto OEM customers and potentially more in EBIT (operational leverage) with our estimated REBIT from battery materials in the region of E70m in 2020 (c.10-15% of 2020 group REBIT).

Earnings improving 2017 on, few catalysts to underperform, upgrading to Hold

Umicore has good assets and strong market positions, with the company providing leverage to increasing precious metals prices. We have been conservative on the stock because of the combination of a high valuation and earnings risk from lower metals prices in 2016 vs. 2015 on the Recycling business. Whilst current multiples remain full at 20x 2017 P/E, with the rise in metals prices (platinum up 13% YTD and gold up 16% YTD) and our forecast for improving earnings in 2017 (higher metals prices and increased volumes in Recycling) along with increasing momentum in rechargeable battery materials, we see few catalysts for underperformance and upgrade to Hold with an increased target price of E40 (increased long-term assumption in our DCF from higher metals prices and growth in battery materials).

Valuation

We believe discounted cash flow analysis best reflects the long-term growth options Umicore has in a range of its businesses. Our key assumptions are an 8.4% WACC and a GDP-based 3.0% terminal growth rate. Our growth rate is above the 2.5% sector average because of higher growth potential with tightening emissions legislation, growth in advanced materials and increased recycling. Our WACC reflects Umicore's sector-typical risk. We use a cost of debt of 5.0% (in line with chemicals peers) and cost of equity of 8.8% (risk free rate of 4.0%, beta of 1.1 and market risk premium of 4.5%).

Risks

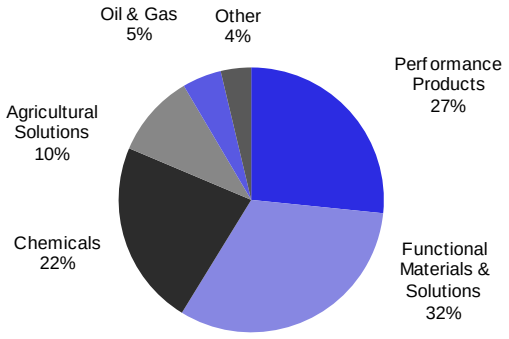
Upside risks include higher auto production (for the auto catalysts business) and metals prices (mainly PGM's for the recycling business), which could lead to higher forecasts and valuation. If Umicore's market share in heavy duty diesel increases materially, that would also have a positive impact on forecasts and valuation. Conversely lower metals prices (Recycling), auto production or market share in HDD would have a negative impact on our forecasts and valuation.

BASF (BASFn.DE, Buy, TP: E85)

BASF is chemicals conglomerate and a major supplier to the auto industry

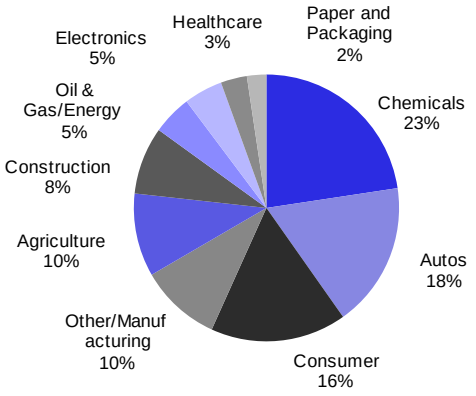
BASF is a major supplier to the automotive industry with over 15% of its Chemicals sales into this sector and it is an area where they see good future growth opportunities. The group has five divisions: Chemicals, Performance Products, Functional Materials & Solutions (which is where catalysts and battery materials sits), Oil & Gas and Agrochemicals. We show the divisional breakdown of sales and the end-market breakdown in Figure 79 and Figure 80:

Figure 79: Divisional breakdown of sales (2016E)



Source: Deutsche Bank

Figure 80: Sales by end-market (2016E)



Source: Deutsche Bank estimates

Battery materials is largely technology-related activity (R&D mainly at present)

The group intensified its efforts into electric vehicles around five years ago with it becoming clearer that the issues constraining performance, especially of electric vehicles, were chemistry related and in particular how to get more energy into the battery. **For BASF, the business is still largely technology-related activity (not generating positive EBIT yet**) and unlike the rest of the group, is being built from acquisition (technology companies and in-licensing) with significant R&D, although the company does not disclose any numbers around this. The key acquisitions of businesses and technologies are given in Figure 81:

Figure 81: BASF key acquisitions/R&D investments/License agreements in battery materials

List of Acquisition/Investments/License Agreement	Cathode Material/Electrolytes	Year
Investment in Sion Power	Post Li-on	2012
Ovonic Battery Company	NiMH	2012
Electrolyte activities of Merck	Electrolytes (Li-on)	2012
Lithium Iron Phosphate (LFP) license from LiFePO4+C Licensing AG	Cathodes (Li-on)	2012
Novolyte Technologies	Electrolytes (Li-on)	2012
Vinylene Carbonate license from Mitsubishi Chemical Corp	Electrolytes (Li-on)	2012
Nickel Cobalt Manganese (NCM) production plant starts up in Elyria, Ohio	Cathodes (Li-on)	2012
New R&D laboratory and application technology center, Amagasaki, Japan	Electrolytes and Cathodes (Li-on)	2014
New BASF TODA Battery Materials LLC joint venture formed in Tokyo, Japan	Cathodes (Li-on)	2015
CAM-7 cathode materials license from CAMX Power LLC	Cathodes (Li-on)	2016

Source: Deutsche Bank, Company Data

BASF is currently more me-too but expects to be a market leader in 2018/19

The area at the moment is still in the early stages of development so market shares and market positions are moving quickly and technologies that are dominant now will be obsolete in the next two to three years. BASF believes that on the current generation of batteries it offers no specific advantage, but on the new third generation batteries due to come out in 2018/19 it believes it will be a market leader.

Growth in battery materials a function of the end-market (electric vehicles)

In terms of technology, BASF is taking a long-term view and ensuring it has access to different types of technology. They are researching into lithium iron phosphate (LFP), a power dense material, nickel manganese cobalt (NMC) which is energy dense and are licensing nickel metal hydride technology which they acquired. For generation IV and V batteries they are researching into lithium sulfur compounds. The alliances and technologies in-licensed are designed to give BASF options and a good view into the market as technologies today will be obsolete in 3-5 years' time and nobody has a concrete view of how the market will look in the next 10 years.

BASF targets both cathode materials and the electrolyte

As well as cathode materials, the electrolyte is a key component in battery performance. The two together comprise a system, with changes to one necessitating changes to the other to optimize performance. BASF believes that understanding the interdependence allows systems to be designed faster and more effectively. **This is one of the differences versus peers in focusing on more than just the cathode materials. The group is also looking further out and sees potential in lithium sulfur batteries for 2022 onwards**.

E500m in battery materials sales targeted by 2020

The key driver of growth for battery materials will be the growth of the end-market and in particular the uptake of electric vehicles. At present the top-line for battery materials is relatively low (no disclosure, though we would estimate sales to be below E100m) and the business is loss making, although they have a target of E500m sales by 2020 (sales CAGR of c40%) and to move to be EBIT positive by that time. The company applies its usual metrics to the performance of the business and expects it to deliver a positive return after the cost of capital. BASF does not disclose customers but has indicated it is included on some well known platforms.

BASF: Portfolio options, self-help and cycle upside - BUY

BASF delivers strong cash flow and sector-leading over-the-cycle growth rates. While the company is leveraged to both the economic cycle and some chemical cycles, that leverage is much lower than in the past, thanks to greater business diversification, stronger focus on value vs. just volumes, proactive portfolio management and increased geographical diversification. Management plans to continue cutting costs with the new DrivE program (targeting E1bn savings by 2018) and separate cost cutting programs for Performance Products and Asia. It remains focused on strategies designed to reduce overall cyclicality and create more sustainable cash generation. A strong commitment to shareholder cash return also remains supportive. The ongoing soft macro and consolidation in the chemicals industry has created significant pressure on management to act. We therefore see BASF at a tipping point in relation to portfolio shift. With attractive dividend yield and portfolio optionality, the current valuation (with many businesses on "low-

cycle" earnings) does not reflect true over-the-cycle potential of BASF's earnings. Hence we rate the stock as Buy.

Valuation

We set our target using a sum-of-the-parts model (using peer group comparison [with reference to forward EV/Sales, EV/EBITDA and EV/EBIT] and a 2P DCF for Oil & Gas – using a long-term oil price of $60). We back-test against a DCF model. Our assumptions include a WACC of 8.1% (cost of equity 9.4% – erp 4.5%, rfr 4%, beta 1.2 – cost of debt 5.0%) and a long-term growth rate of 2.5%, in line with that of the chemicals industry.

Risks

Risks include weaker-than-expected economic recovery (particularly in Europe), material strengthening of the euro/$ rate, substantially lower oil prices and larger-than-expected dilutive acquisitions (particularly in the more downstream specialty chemicals areas).

Appendix

Figure 82: List of 25 companies approved by the Chinese government (MIIT)

First round: 2015/11/11	1	宁德时代新能源科技有限公司	CATL
	2	深圳沃特玛电池有限公司	OptimumNano
	3	珠海银隆新能源有限公司	Zhuhai Yinlong
	4	淄博国利新电源科技有限公司	Zibo Guoli new Power Source
	5	天津中聚新能源科技有限公司	Sinopolybattery
	6	哈尔滨光宇电源股份有限公司	Cncoslight
	7	天津力神电池股份有限公司	Tianjin Lishen
	8	力神动力电池系统有限公司	Lishen Power
	9	湖南科霸汽车动力电池有限公司	Cpeve
	10	上海卡耐新能源有限公司	Cenat
Second round: 2015/12/14	11	万向 A 一二三系统有限公司	Wanxiang A123
	12	惠州比亚迪电池有限公司	BYD
	13	合肥国轩高科动力能源有限公司	Guoxuan High-Tech
	14	中信国安盟固利动力科技有限公司	Citic Guoan MGL
	15	多氟多（焦作）新能源科技有限公司	Do-Fluoride Jiaozuo New Energy
	16	河南环宇赛尔新能源科技有限公司	Huanyu power
	17	江苏海四达电源股份有限公司	Jiangsu Highstar
Third round: 2016/4/5	18	天津市捷威动力工业有限公司	Jiewei Power
	19	深圳市比克动力电池有限公司	Shenzhen BAK Battery Co., Ltd.
	20	山西皇城相府中道能源有限公司	Zdenergy
	21	河南新太行电源有限公司	Xintaihang power
	22	浙江天能能源科技有限公司	Zhejiang Tianneng power
	23	东莞市迈科新能源有限公司	McNair
	24	星恒电源股份有限公司	Xingheng
	25	山东威能环保电源科技股份有限公司	Shandong Winabattery

Source: Deutsche Bank, MIIT

Figure 83: EV comparison summary

Brand	Model	Release	Battery supplier	Price after credit ($)	Battery size (KWh)	Pack weight (kg)	Miles/KWh	US$/mile	Energy density
Tesla	Model 3	2H17	Panasonic	27,500	60.0	350.0	3.58	128	171.4
Tesla	Model S (85)	2012	Panasonic	73,600	85.0	545.5	3.12	278	155.8
Chevrolet	Bolt	2017	LG Chem	30,000	60.0	435.0	3.33	150	137.9
BMW	BMW i3 MY	3Q16	SDI	36,845	33.0	250.0	3.45	323	132.0
Nissan	LEAF (30 kWh)	2H15	AESC/ LGC	27,550	30.0	239.0	3.57	257	125.5
Mercedes	B-Class ED	2014	Panasonic	34,875	36.0	300.0	2.42	401	120.0
BYD	e6	2H15	BYD	38,430	80.0	700.0	3.10	155	114.3
Nissan	LEAF (24 kWh)	2010	AESC/ LGC	22,360	24.0	218.0	3.04	306	110.1
Toyota	RAV4	2012	Panasonic	43,110	41.8	384.1	2.46	419	108.8
BYD	e6	2011	BYD	38,430	60.0	600.0	3.10	207	100.0
Kia	Soul	2014	SKI	25,275	27.0	274.5	3.44	272	98.4
BMW	BMW i3	2013	SDI	35,850	22.0	230.0	3.68	443	95.7
Chevrolet	Spark	2013	LG Chem	18,495	19.0	215.5	4.32	226	88.2
Fiat	500e	2012	SDI	25,700	24.0	272.7	3.63	295	88.0
Mitsubishi	i-MiEV	2009	Yuasa Mitsubishi JV	16,345	16.0	200.0	3.88	264	80.0
Ford	Focus Electric	2011	LG Chem	22,495	23.0	295.5	3.30	296	77.8
Volkswagen	e-Golf	2014	Panasonic	22,315	24.2	318.0	3.43	269	76.1
smart	fortwo ED	2007	Panasonic/LGC	18,250	14.0	NA	4.50	290	NA
Honda	Fit	2012	Yuasa Mitsubishi JV	29,915	20.0	NA	4.10	365	NA
Tesla	Model X (75D)	2015	Panasonic	73,700	75.0	NA	3.16	311	NA
Tesla	Model X (90D)	2015	Panasonic	86,700	90.0	NA	2.86	337	NA
BYD	e5	2016	BYD	20,000	48.0	NA	3.94	106	NA

Source: Deutsche Bank, insideEVs, EPA (Environmental Protection Agency), Company data

Figure 84: PHEV comparison summary

Brand	Model	Release	Battery supplier	Price after credit ($)	Battery size (KWh)	Pack weight (kg)	Miles/KWh	US$/mile	Energy density
Chevrolet	Volt - Gen 2	2016	LG Chem	26,495	18.4	184.1	2.88	500	100.0
Cadillac	ELR (2016)	2013	LG Chem	59,490	16.5	197.7	2.24	1,608	83.4
Chevrolet	Volt - Gen 1	2010	LG Chem	32,780	16.0	197.7	2.19	937	80.9
Mercedes	S550e	2014	SK Innovation/A123	90,625	8.7	114.0	1.61	6,473	76.3
BMW	BMW i8	2014	SDI	133,657	7.1	98.0	2.11	8,910	72.4
Audi	A3 Sportback e-tron	2013	Panasonic	33,732	8.8	125.0	3.52	1,088	70.4
Ford	C-Max Energi	2012	Panasonic	26,953	7.6	123.6	2.63	1,348	61.5
Ford	Fusion Energi	2013	Panasonic	31,518	7.6	123.6	2.63	1,576	61.5
Toyota	Prius - Gen1	2011	Panasonic	28,315	4.4	81.8	2.50	2,574	53.8
Volvo	XC90 T8 Twin	2015	LG Chem	64,495	9.2	NA	1.85	3,794	NA
BMW	BMW 330e	2016	SDI	44,695	7.6	NA	2.89	2,032	NA
Porsche	Cayenne S E-Hybrid	2014	NA	72,859	10.8	NA	1.30	5,204	NA
Toyota	Prius - Gen2	2016	Panasonic	NA	8.8	NA	2.50	NA	NA
Porsche	Panamera S E-Hybrid	2013	NA	92,343	9.4	NA	1.70	5,771	NA
Honda	Accord	2013	Yuasa Mitsubishi JV	36,974	6.7	NA	1.94	2,844	NA
HMC	Sonata	2015	LG Chem	30,516	9.8	NA	2.76	1,130	NA
BMW	X5 xDrive40e	2015	SDI	58,427	9.0	NA	1.56	4,173	NA

Source: Deutsche Bank, insideEVs, EPA (Environmental Protection Agency), Company data

Figure 85: Major Companies across the supply chain of lithium industry

RAW MATERIALS	BATTERY COMPONENTS	CELLS	APPLICATIONS
LITHIUM (Li2O, LiOH, Li2O3)	ANODE	CELL CONSTRUCTION	EVs/PHEVs/HEVs
Soquimich	Altair Nanotechnologies	Panasonic	Tesla
FMC Corp	ConocoPhilip	LG Chem	Ford
Orocobre	Hitachi Chemical	Foxconn	GM
Albemarle	Kureha	Boston Power	BYD
Bacanora Minerals	Nippon Carbon	Sansumg SDI	Daimler
Pure Energy Minerals	Pyrotek	Tesla	Honda
Jiangxi Ganfeng	Superior Graphite	BYD	Nissan
Tianqi Group	LG Chem	Continental	Toyoto
Galaxy		Johnson Controls	Volkswagen
Neometals	CATHODE	GM	Geely Automobile
Pilbara Minerals	Umicore	Lishen	Chevrolet
	Nichia Chemical	LithChem	Aston Martin
GRAPHITE/SYNTHETIC GRAPHITE	Sumitomo	Maxwell	Mercedes Benz
Syrah Resources	L&F	NEC	Audi
China - various	Shanshan	Sanyo	Zoyte Auto
Brazil	3M	Toshiba	BAIC Motor Corp
Triton Minerals	BASF		SAIC Motor Corp
Mason Graphite	Bamo-Tech		Chongqing Changan Auto
Graphite One	Easpring	BATTERY PACKS	
Energiser/Malagasy	Nippon denko	A123	STATIONARY STORAGE
Talga Resources	Toda Kogyo	AC Propulsion	Tesla
	Formosa	All Cell Technologies	LG Chem
COBALT COMPOUNDS	King-ray	Boston Power	Samsung
Tanaka Corporation		BYD	AES
Kansai Catalyst	SEPARATORS (FOILS)	Coda	BYD
Santoku	Applied Materials	LG Chem	Saft Groupe
Glencore	Asahi Kasei	Continental	Coda Energy
	Celgard	XALT energy	Stem
NICKEL COMPOUNDS	DuPont	Electrovaya	Green Charge Networks
Tanaka Corporation	Entek	EnerDel	Sonnen-Batterie
Kansai Catalyst	Evonik Industries	OptimumNano	Vestas
Sumitomo	SK Energy	Guoxuan	EDF Energy
WSA	Toray Tonen	China Aviation	Enel
	Cangzhou Mingzhu	Sinopoly	Duke Energy
MANGANESE COMPOUNDS		CATL	National Grid
Mitsui	ELECTRODES	GM	First Solar
Sumitomo	Cheil Industries	GSYuasa	GE
S32	LithChem	Hitachi	Siemans
	Mitsubishi Chemical	Johnson Controls-saft	
ALUMINUM	Mitsui Chemical	Lishen	ELECTRONICS/CONSUMER PRODUCTS
Alcoa	Novolyte Technologies	NEC	Sony
	Panex	Panasonic	Google
	Shenzhen Capchem	Sanyo	Huawei
	Do-Fluoride Chemicals	Samsung SDI	Samsung SDI
	Tianci Materials	Tesla	Xiaomi
	ShanShan		Apple
	Shinestar		Panasonic
	Tomiyama Yakuhin		

Source: Deutsche Bank

History

This contains extracts from DB's Global Metals & Mining team's FITT report 'Welcome to the Lithium-ion Age', published on 9th May 2016.

A battery consists of one or more electrochemical cells in which chemical energy is converted into electricity and used as power source. A battery has two terminals, a positive terminal (cathode) and a negative terminal (anode) which allows charged particles to pass from one terminal to the other, generating an electric current.

Batteries have been under development for over 2000 years; however, modern batteries as we use them today date back to 1859, when the first rechargeable battery was invented. The lead-acid battery was made of low-cost materials and could be used in a number of applications where a small amount of energy storage was required to support power generation from another source. Lead-acid batteries continue to be the most common batteries found in internal combustion vehicles today.

The next 100 years saw significant research into other battery technologies, not only to compete with lead-acid batteries, but to also open up applications that were not being pursued at the time due to the low energy-to-weight ratio of lead-acid batteries. New battery technologies like zinc-carbon cells, nickel-iron cells and nickel-cadmium batteries were commercialized by the early 1900s.

The second half of the 20th century focused on further refinements to existing battery chemistries, with the common alkaline battery being commercialized in 1959 and the nickel-hydrogen and nickel-metal hydride (NiMH) batteries entering the market in 1989. These batteries were much more powerful than lead-acid and other existing technologies and could be used in more compact, lightweight applications.

The breakthrough of lithium-ion

Using lithium metal in batteries was first considered in 1912 though it took until the 1970s before significant research was invested in developing a lithium-based battery. Lithium is the metal with the greatest electrochemical potential (the amount of free energy per charged particle), which suggested it would have excellent energy-to-weight performance.

Early attempts to develop rechargeable lithium batteries used lithium metal as the anode, which allowed for very high energy densities. However, it was discovered in the 1980s that small dendrites, needle-like lithium metal particles, formed on the anode during discharge which upon growing would eventually penetrate the separator and cause an electrical short. The research community sought a non-metallic alternative for the anode which would allow for lithium to be used in the cathode and in the electrolyte solution. Since that time, carbon-based anodes have been the dominant anodes used in commercial applications, with graphite the most efficient form of carbon used.

The development of the lithium-cobalt-oxide cathode in the early 1980s, along with the discovery of graphite as an anode material, led Asahi Chemical to build the first lithium-ion cell in 1985. The technology was commercialized by Sony Corporation in 1991. Today, there are over 80 different lithium-ion battery chemistries in production with unique performance metrics (energy density, power density, battery life) and costs.

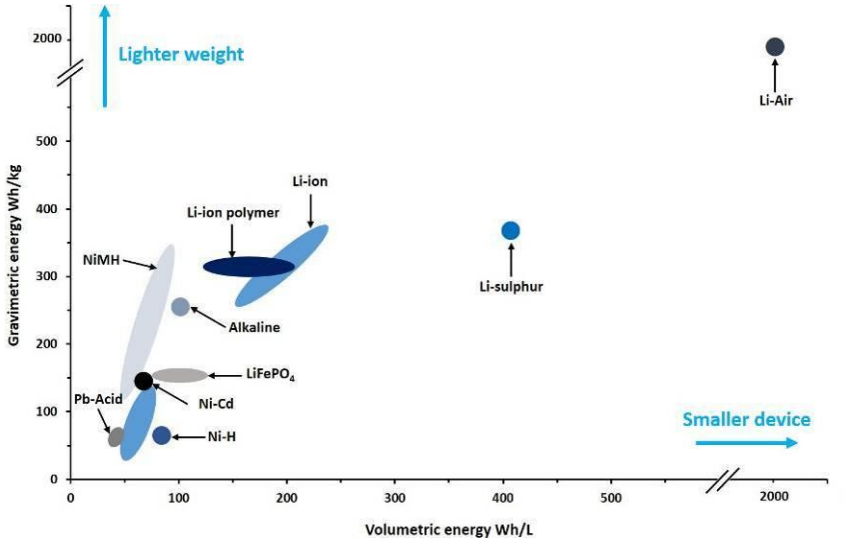
Lithium-ion is the leading technology

Why lithium?

Lithium is the lightest known metal, the least dense solid element with the greatest electrochemical potential, which leads to excellent energy-to-weight performance. It also has a very low melting point, which enables it to be used in metallurgical applications.

Lithium is highly reactive in pure form, with a single valence electron that is easily given up to bond with other molecules. Its very high electrochemical potential (its willingness to transfer electrons) makes it a powerful component of battery cells. A typical lithium-ion battery generates around three volts compared to 2.1 volts for lead-acid or 1.5 volts for zinc-carbon cells.

Figure 86: Lithium-based battery technologies have superior energy density



Source: CSIRO

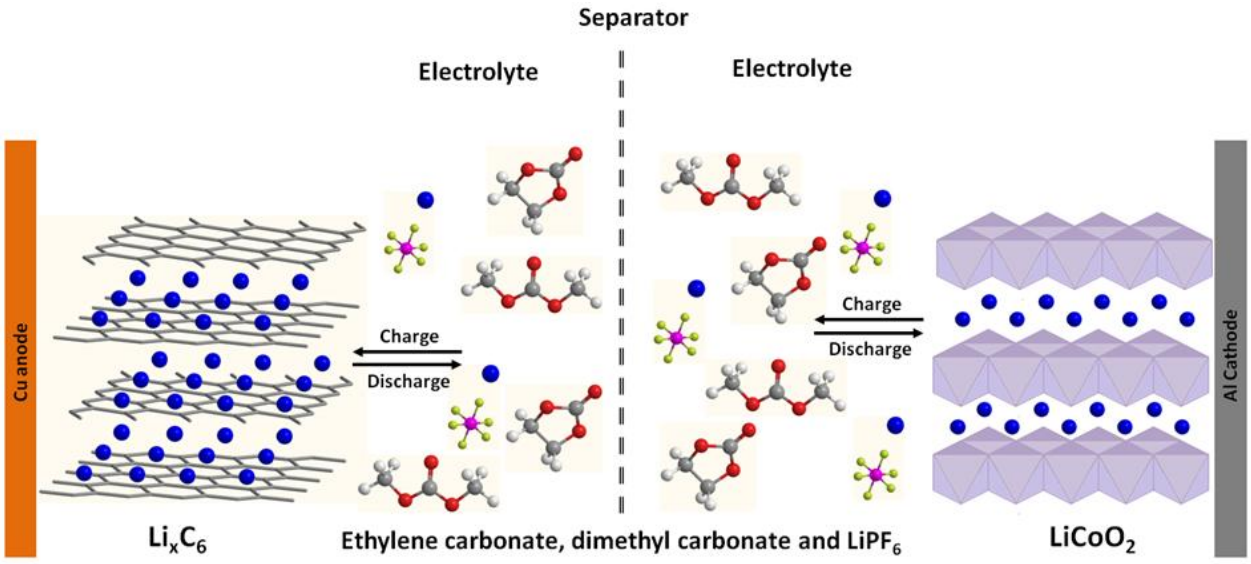
How the lithium ion cell works

Rechargeable battery cells use a negative electrode material (anode) and a positive electrode material (cathode) to convert chemical energy into electrical energy and vice-versa.

- The lithium-ion cell uses a lithium-based metal oxide as the cathode and normally a carbon-based material as the anode.
- Graphite is generally the anode material of choice because of accessibility, price and a molecular structure that allows for storage of a large amount of ions within the crystal lattice (charge capacity).
- Electrons pass between the anode and the cathode via a liquid solvent, the electrolyte, which also contains some lithium ions (the industry standard electrolyte is 1M $LiPF_6$ in solution).

As the battery is charged, lithium ions move through the electrolyte from the positive electrode (cathode) and attach to the negative electrode (anode). For example, if a graphite anode is being used, the lithium ions attach to the carbon lattice. When discharging, the lithium ions move back from the anode to the cathode, and this movement of electrons generates an electric current.

Figure 87: An example of lithium-ion cell using a lithium-cobalt oxide cathode and a graphite anode



Source: Bhatt and O'Mullane, Chemistry in Australia, June 2013

Small tweaks in chemistry unlocking cell efficiencies

In Electric Vehicles, battery cells are placed within modules which are then placed into larger packs that include electronic battery management systems, electrical connectors, switches, and thermal controls (heating and cooling). Typically, the pack level systems account for around 20% of the cost of the battery pack (i.e. battery cells/modules account for 80%). Slow but steady progress continues to be made in improving the energy density of batteries through reformulation of the materials used (typically taking non-active materials out), reducing the cost of materials, cell design, production speed, and production yield. This has resulted in increased energy density and reduced costs on both a cell level and battery pack level.

The first lithium ion cells produced by Sony Corporation in the 1990s had energy density levels of roughly 90Wh/kg and cost US$2,000/kWh. Today's Panasonic 18650 batteries used in Tesla Electric Vehicles have an energy density of approximately 150Wh/kg and they cost less than US$250/kWh. We expect this trend to continue.

Competing battery technologies

Global R&D efforts are being focused on lithium-ion batteries as well as a number of other technologies. While lithium-ion is the leading technology being commercialized, individual demand applications that require specific battery requirements (power-to-weight ratio, charge capacity, cycle life, battery cost etc) could see other technologies increasing penetration. While the power-to-weight ratio of lithium-ion makes it a clear leader in EV, other battery technologies could be viable alternatives for applications like energy storage.

Vanadium flow batteries

Vanadium flow or vanadium redox batteries use vanadium ions, which can exist in solution in four separate states of oxidation, to store chemical potential energy. Vanadium flow batteries have very quick response time (how quickly a charge can be generated), but relatively low energy density. As a result, their best current application is in back-up power within commercial applications or electrical grids. Vanadium flow batteries also have excellent lifespan (over 20 years) with minor maintenance required along the way. However, the key challenge for vanadium flow is price; current pricing is around US$800/kWh compared to lithium-ion which is US$250-300/kWh on a cell level or around US$500/kWh for an integrated lithium-ion battery energy storage system. Two years ago, the two technologies were at cost-parity, however the reduction in lithium-ion pricing has shifted that argument quickly towards lithium-ion.

Zinc-bromine batteries

A zinc-bromine flow battery stores zinc-bromide solution in two tanks with the solution pumped through a reactor stack and back to the tanks. During the charging cycle, metallic zinc is plated on to the negative electrode surfaces in the cell stacks, while bromide is converted into bromine on the positive electrode surface. On discharge, these reactions reverse and an electric current is created. Zinc-bromine flow battery failure rates are higher than lithium-ion due to the more complex reactions occurring on a molecular level. Adding to this issue, zinc-bromine batteries have a lower energy density than lithium-ion, leading to larger and more expensive battery installations.

Figure 88: Battery energy densities

Lithium-ion batteries	
Lithium-cobalt-oxide (LCO)	203Wh/kg
Nickel-manganese-cobalt (NMC)	95-130Wh/kg
Lithium-manganese-oxide (LMO)	110-120Wh/kg
Lithium-iron-phosphate (LFP)	95-140/Wh/kg
Lead-acid battery	**33-42Wh/kg**
Vanadium-flow	**10-20Wh/kg**
Zinc bromine flow	**34-54Wh/kg**
Aluminum-air	**1300Wh/kg**
Hydrogen fuel cell	**40MWh/kg**

Source: Deutsche Bank, industry data

Model updated:31 May 2016

Running the numbers

Asia

China

Metals & Mining

Guoxuan High-Tech

Reuters: 002074.SZ Bloomberg: 002074 CS

Buy

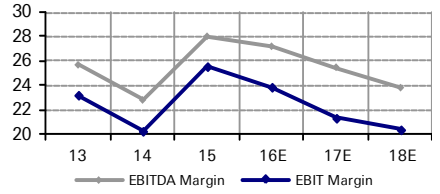
Price (1 Jun 16)	CNY 33.53
Target Price	CNY 40.40
52 Week range	CNY 16.29 - 41.50
Market Cap (m)	CNYm 29,384
	USDm 4,463

Company Profile

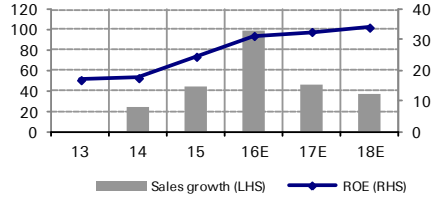
Guoxuan High-Tech Co., Ltd develop, manufacture and sell the lithium battery material and lithium battery. The major products are Lithium battery cell and lithium battery pack for electrical automotive.

Price Performance

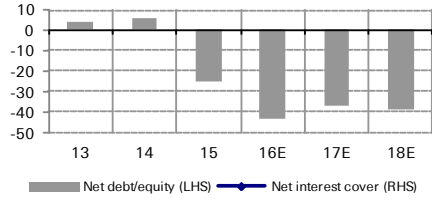
Margin Trends



Growth & Profitability



Solvency



Fiscal year end 31-Dec	2013	2014	2015	2016E	2017E	2018E
Financial Summary						
DB EPS (CNY)	0.98	1.11	0.67	1.21	1.59	2.09
Reported EPS (CNY)	0.98	1.11	0.67	1.21	1.59	2.09
DPS (CNY)	0.00	0.00	0.15	0.36	0.48	0.63
BVPS (CNY)	5.8	6.9	3.4	4.3	5.4	6.9
Weighted average shares (m)	253	253	876	876	876	876
Average market cap (CNYm)	1,436	2,766	25,156	29,384	29,384	29,384
Enterprise value (CNYm)	1,585	2,927	24,419	27,776	27,668	27,079
Valuation Metrics						
P/E (DB) (x)	5.8	9.8	43.0	27.6	21.2	16.0
P/E (Reported) (x)	5.8	9.8	43.0	27.6	21.2	16.0
P/BV (x)	0.97	2.05	10.78	7.81	6.20	4.88
FCF Yield (%)	nm	2.0	nm	3.9	1.4	3.9
Dividend Yield (%)	0.0	0.0	0.5	1.1	1.4	1.9
EV/Sales (x)	1.0	1.5	8.9	5.1	3.5	2.5
EV/EBITDA (x)	4.1	6.8	31.7	18.7	13.7	10.5
EV/EBIT (x)	4.5	7.6	34.8	21.3	16.4	12.2
Income Statement (CNYm)						
Sales revenue	1,520	1,900	2,745	5,451	7,931	10,878
Gross profit	631	743	1,220	2,337	3,199	4,284
EBITDA	390	433	769	1,483	2,021	2,590
Depreciation	37	48	67	181	330	373
Amortisation	0	0	0	0	0	0
EBIT	353	385	702	1,301	1,692	2,217
Net interest income(expense)	0	0	0	0	0	0
Associates/affiliates	0	0	0	0	0	0
Exceptionals/extraordinaries	0	0	0	0	0	0
Other pre-tax income/(expense)	-43	-41	-22	-30	-30	-21
Profit before tax	310	344	680	1,271	1,661	2,196
Income tax expense	48	51	93	203	266	351
Minorities	14	11	3	5	6	10
Other post-tax income/(expense)	0	0	0	0	0	0
Net profit	248	282	585	1,064	1,389	1,834
DB adjustments (including dilution)	0	0	0	0	0	0
DB Net profit	248	282	585	1,064	1,389	1,834
Cash Flow (CNYm)						
Cash flow from operations	0	270	520	2,056	1,636	2,163
Net Capex	0	-214	-558	-913	-1,213	-1,013
Free cash flow	0	56	-38	1,143	423	1,150
Equity raised/(bought back)	0	0	1,493	0	0	0
Dividends paid	0	0	-37	-320	-418	-550
Net inc/(dec) in borrowings	0	0	-396	300	400	100
Other investing/financing cash flows	0	-17	109	0	0	0
Net cash flow	0	39	1,132	1,124	405	700
Change in working capital	*0*	*-171*	*-193*	*908*	*-44*	*6*
Balance Sheet (CNYm)						
Cash and other liquid assets	726	864	2,011	3,134	3,540	4,049
Tangible fixed assets	681	891	1,550	2,281	3,165	3,805
Goodwill/intangible assets	269	322	307	307	307	307
Associates/investments	0	0	0	0	0	0
Other assets	1,564	1,993	2,846	3,615	5,353	7,359
Total assets	3,240	4,069	6,713	9,338	12,364	15,519
Interest bearing debt	788	976	1,248	1,498	1,792	1,702
Other liabilities	901	1,303	2,424	4,049	5,803	7,755
Total liabilities	1,689	2,280	3,671	5,547	7,595	9,456
Shareholders' equity	1,464	1,741	3,016	3,762	4,736	6,020
Minorities	88	48	26	29	32	42
Total shareholders' equity	1,551	1,789	3,042	3,791	4,768	6,062
Net debt	*62*	*113*	*-763*	*-1,637*	*-1,748*	*-2,347*
Key Company Metrics						
Sales growth (%)	nm	25.0	44.5	98.5	45.5	37.2
DB EPS growth (%)	na	13.7	-40.1	81.9	30.6	32.0
EBITDA Margin (%)	25.7	22.8	28.0	27.2	25.5	23.8
EBIT Margin (%)	23.2	20.3	25.6	23.9	21.3	20.4
Payout ratio (%)	0.0	0.0	22.5	30.0	30.1	30.0
ROE (%)	16.9	17.6	24.6	31.4	32.7	34.1
Capex/sales (%)	0.0	11.2	20.3	16.7	15.3	9.3
Capex/depreciation (x)	0.0	4.4	8.3	5.0	3.7	2.7
Net debt/equity (%)	4.0	6.3	-25.1	-43.2	-36.7	-38.7
Net interest cover (x)	nm	nm	nm	nm	nm	nm

Source: Company data, Deutsche Bank estimates

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Model updated:30 May 2016

Running the numbers

Japan

Japan

Electronics / Consumer

Panasonic

Reuters: 6752.T Bloomberg: 6752 JT

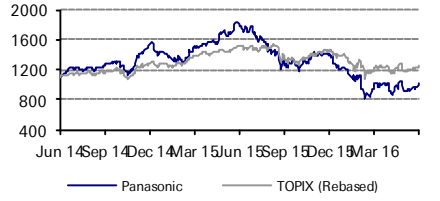
Buy

Price (1 Jun 16)	JPY 1,011
Target Price	JPY 1,500
52 Week range	JPY 802 - 1,807
Market Cap (bn)	JPYbn 2,467
	USDm 22,235

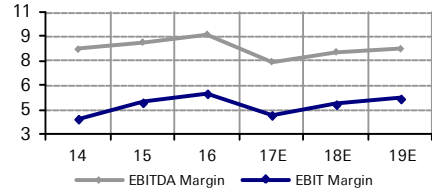
Company Profile

Japanese conglomerate founded in 1935. Employs internal company system consisting of four companies: Appliances, Eco solutions, AVC networks, and Automotive & Industrial systems. Decisive restructuring efforts have improved profitability and finances.

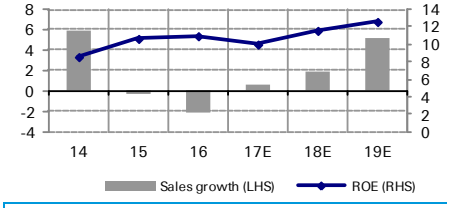
Price Performance



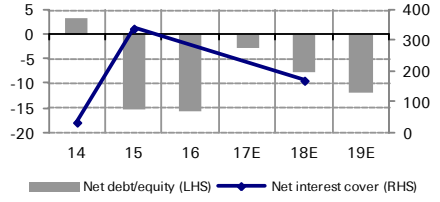
Margin Trends



Growth & Profitability



Solvency



Hiroshi Taguchi
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Fiscal year end 31-Mar	2014	2015	2016	2017E	2018E	2019E
Financial Summary						
DB EPS (JPY)	52.10	77.65	83.40	76.11	94.75	112.02
Reported EPS (JPY)	52.10	77.65	83.40	76.11	94.75	112.02
DPS (JPY)	18.00	18.00	25.00	25.00	30.00	35.00
BVPS (JPY)	669.7	746.9	734.6	785.6	850.2	927.0
Weighted average shares (m)	2,312	2,311	2,317	2,317	2,317	2,317
Average market cap (JPYbn)	2,210	2,979	3,172	2,467	2,467	2,467
Enterprise value (JPYbn)	2,026	2,527	2,688	2,214	2,107	1,994
Valuation Metrics						
P/E (DB) (x)	18.3	16.6	16.4	13.3	10.7	9.0
P/E (Reported) (x)	18.3	16.6	16.4	13.3	10.7	9.0
P/BV (x)	1.73	2.11	1.41	1.29	1.19	1.09
FCF Yield (%)	17.2	9.0	4.9	3.3	7.6	8.3
Dividend Yield (%)	1.9	1.4	1.8	2.5	3.0	3.5
EV/Sales (x)	0.3	0.3	0.4	0.3	0.3	0.2
EV/EBITDA (x)	3.2	3.8	3.9	3.9	3.4	3.0
EV/EBIT (x)	6.6	6.6	6.5	7.0	5.6	4.7
Income Statement (JPYbn)						
Sales revenue	7,736.5	7,715.0	7,553.7	7,601.4	7,745.9	8,151.4
Gross profit	2,097.7	2,187.8	2,213.7	2,126.5	2,218.3	2,362.9
EBITDA	636.2	668.4	690.5	567.2	624.5	672.7
Depreciation	331.1	286.5	274.8	250.0	250.0	250.0
Amortisation	0.0	0.0	0.0	0.0	0.0	0.0
EBIT	305.1	381.9	415.7	317.2	374.5	422.7
Net interest income(expense)	-9.3	-1.1	3.5	1.7	-2.2	-0.3
Associates/affiliates	5.1	11.9	12.6	5.0	5.0	5.0
Exceptionals/extraordinaries	0.0	0.0	0.0	0.0	0.0	0.0
Other pre-tax income/(expense)	-89.6	-198.3	-202.2	0.0	0.0	0.0
Profit before tax	206.2	182.5	217.0	318.9	372.3	422.4
Income tax expense	89.7	-2.0	14.5	127.6	137.8	147.8
Minorities	0.0	0.0	0.0	0.0	0.0	0.0
Other post-tax income/(expense)	-1.2	-16.9	-21.8	-20.0	-20.0	-20.0
Net profit	120.4	179.5	193.3	176.4	219.5	259.6
DB adjustments (including dilution)	0.0	0.0	0.0	0.0	0.0	0.0
DB Net profit	120.4	179.5	193.3	176.4	219.5	259.6
Cash Flow (JPYbn)						
Cash flow from operations	582.0	491.5	398.7	422.2	456.9	474.1
Net Capex	-201.7	-224.2	-241.8	-345.0	-280.0	-280.0
Free cash flow	380.2	267.3	156.8	77.2	176.9	194.1
Equity raised/(bought back)	-0.1	-0.4	17.0	0.0	0.0	0.0
Dividends paid	-11.6	-37.0	-46.3	-58.0	-69.6	-81.2
Net inc/(dec) in borrowings	-502.2	326.0	-248.2	-9.3	-58.1	-7.6
Other investing/financing cash flows	229.8	132.1	-145.5	-180.0	0.0	0.0
Net cash flow	96.2	687.9	-266.1	-170.1	49.2	105.3
Change in working capital	*154.2*	*81.4*	*74.5*	*-4.2*	*-12.6*	*-35.4*
Balance Sheet (JPYbn)						
Cash and other liquid assets	592.5	1,280.4	1,014.3	844.1	893.3	998.6
Tangible fixed assets	1,425.4	1,374.8	1,301.2	1,646.2	1,676.2	1,706.2
Goodwill/intangible assets	0.0	0.0	0.0	0.0	0.0	0.0
Associates/investments	271.8	313.7	344.5	344.5	344.5	344.5
Other assets	2,923.3	2,988.0	2,937.0	2,947.1	2,977.8	3,063.8
Total assets	5,213.0	5,956.9	5,597.0	5,781.9	5,891.8	6,113.1
Interest bearing debt	642.1	972.9	725.9	786.6	728.5	720.9
Other liabilities	2,984.4	2,991.5	3,016.7	3,022.7	3,040.7	3,091.3
Total liabilities	3,626.6	3,964.4	3,742.7	3,809.3	3,769.2	3,812.2
Shareholders' equity	1,548.2	1,823.3	1,705.1	1,823.4	1,973.3	2,151.6
Minorities	38.3	169.3	149.3	149.3	149.3	149.3
Total shareholders' equity	1,586.4	1,992.6	1,854.3	1,972.6	2,122.6	2,300.9
Net debt	*49.6*	*-307.5*	*-288.3*	*-57.5*	*-164.8*	*-277.7*
Key Company Metrics						
Sales growth (%)	5.9	-0.3	-2.1	0.6	1.9	5.2
DB EPS growth (%)	na	49.0	7.4	-8.7	24.5	18.2
EBITDA Margin (%)	8.2	8.7	9.1	7.5	8.1	8.3
EBIT Margin (%)	3.9	5.0	5.5	4.2	4.8	5.2
Payout ratio (%)	34.5	23.2	30.0	32.8	31.7	31.2
ROE (%)	8.6	10.6	11.0	10.0	11.6	12.6
Capex/sales (%)	2.6	2.9	3.2	4.5	3.6	3.4
Capex/depreciation (x)	0.6	0.8	0.9	1.4	1.1	1.1
Net debt/equity (%)	3.1	-15.4	-15.5	-2.9	-7.8	-12.1
Net interest cover (x)	32.9	339.5	nm	nm	169.5	nm

Source: Company data, Deutsche Bank estimates

Model updated:29 May 2016

Running the numbers

Asia

South Korea

Chemicals

LG Chem

Reuters: 051910.KS Bloomberg: 051910 KS

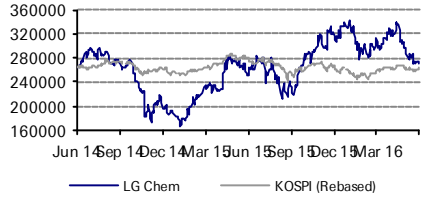
Buy

Price (1 Jun 16)	KRW 269,500
Target Price	KRW 350,000
52 Week range	KRW 213,000 - 341,500
Market Cap (bn)	KRWm 19,916
	USDm 16,712

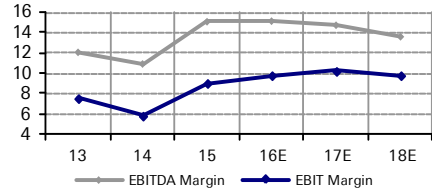
Company Profile

LG Chem is a major petrochemical player in Asia, in which products include olefin, polyolefin, ABS, synthetic rubber, and PVC. The company also has electronic materials division, in which polarizer films for LCDs and lithium-ion batteries for electronic appliances are major products. LG Corp is the major shareholder with a 30% stake.

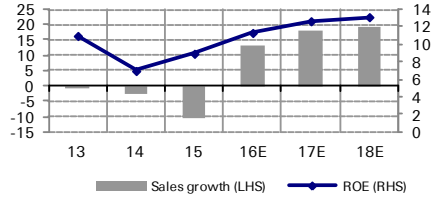
Price Performance



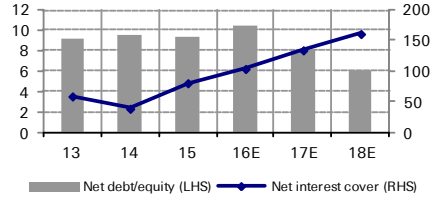
Margin Trends



Growth & Profitability



Solvency



Shawn Park
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Fiscal year end 31-Dec	2013	2014	2015	2016E	2017E	2018E
Financial Summary						
DB EPS (KRW)	16,712.75	11,326.56	15,370.13	21,071.55	25,970.97	29,908.40
Reported EPS (KRW)	16,712.75	11,326.56	15,370.13	21,071.55	25,970.97	29,908.40
DPS (KRW)	4,000.00	4,000.00	4,500.00	5,000.00	6,000.00	7,000.00
BVPS (KRW)	158,669.2	165,979.1	177,599.4	194,381.8	215,591.3	239,785.7
Weighted average shares (m)	74	74	74	74	74	74
Average market cap (KRWbn)	20,990	18,574	19,073	19,916	19,916	19,916
Enterprise value (KRWbn)	21,618	19,215	19,785	20,176	19,966	19,757
Valuation Metrics						
P/E (DB) (x)	17.0	22.2	16.8	12.8	10.4	9.0
P/E (Reported) (x)	17.0	22.2	16.8	12.8	10.4	9.0
P/BV (x)	1.89	1.09	1.85	1.39	1.25	1.12
FCF Yield (%)	4.1	3.8	1.1	3.9	2.8	3.2
Dividend Yield (%)	1.4	1.6	1.7	1.9	2.2	2.6
EV/Sales (x)	0.9	0.9	1.0	0.9	0.7	0.6
EV/EBITDA (x)	7.8	7.8	6.5	5.8	5.0	4.5
EV/EBIT (x)	12.4	14.7	10.8	9.0	7.2	6.3
Income Statement (KRWbn)						
Sales revenue	23,144	22,578	20,207	22,916	27,109	32,238
Gross profit	4,270	4,054	4,697	5,204	5,820	6,304
EBITDA	2,788	2,461	3,044	3,465	3,990	4,379
Depreciation	1,021	1,118	1,196	1,196	1,196	1,196
Amortisation	24	33	24	25	25	26
EBIT	1,743	1,311	1,824	2,244	2,769	3,156
Net interest income(expense)	-30	-34	-23	-22	-21	-20
Associates/affiliates	5	20	0	0	0	0
Exceptionals/extraordinaries	0	0	0	0	0	0
Other pre-tax income/(expense)	-118	-137	-251	-151	-197	-198
Profit before tax	1,601	1,160	1,550	2,071	2,551	2,939
Income tax expense	331	306	398	501	617	711
Minorities	5	-14	-19	-26	-31	-36
Other post-tax income/(expense)	-31	-31	-35	-39	-46	-54
Net profit	1,235	837	1,136	1,557	1,919	2,210
DB adjustments (including dilution)	0	0	0	0	0	0
DB Net profit	1,235	837	1,136	1,557	1,919	2,210
Cash Flow (KRWbn)						
Cash flow from operations	2,180	2,104	1,999	2,768	2,412	2,534
Net Capex	-1,310	-1,401	-1,790	-2,000	-1,850	-1,900
Free cash flow	870	703	209	768	562	634
Equity raised/(bought back)	0	0	0	0	0	0
Dividends paid	-308	-300	-293	-330	-367	-440
Net inc/(dec) in borrowings	110	-153	-184	8	-79	196
Other investing/financing cash flows	0	-575	94	-800	-130	-162
Net cash flow	671	-324	-175	-354	-14	228
Change in working capital	*-287*	*-167*	*-404*	*-60*	*-775*	*-948*
Balance Sheet (KRWbn)						
Cash and other liquid assets	1,928	1,769	1,512	1,253	1,384	1,789
Tangible fixed assets	8,560	8,700	9,353	10,220	10,940	11,712
Goodwill/intangible assets	263	525	501	476	451	425
Associates/investments	454	523	525	1,245	1,245	1,245
Other assets	6,242	6,611	6,729	7,088	8,334	9,860
Total assets	17,446	18,128	18,621	20,283	22,354	25,032
Interest bearing debt	3,010	2,934	2,750	2,758	2,679	2,875
Other liabilities	2,634	2,874	2,746	3,160	3,742	4,437
Total liabilities	5,644	5,807	5,496	5,918	6,422	7,312
Shareholders' equity	11,726	12,266	13,125	14,365	15,932	17,720
Minorities	0	0	0	0	0	0
Total shareholders' equity	11,726	12,266	13,125	14,365	15,932	17,720
Net debt	*1,083*	*1,164*	*1,237*	*1,505*	*1,295*	*1,086*
Key Company Metrics						
Sales growth (%)	-0.5	-2.4	-10.5	13.4	18.3	18.9
DB EPS growth (%)	-15.6	-32.2	35.7	37.1	23.3	15.2
EBITDA Margin (%)	12.0	10.9	15.1	15.1	14.7	13.6
EBIT Margin (%)	7.5	5.8	9.0	9.8	10.2	9.8
Payout ratio (%)	23.9	35.3	29.3	23.7	23.1	23.4
ROE (%)	11.0	7.0	8.9	11.3	12.7	13.1
Capex/sales (%)	5.9	6.3	8.9	8.7	6.8	5.9
Capex/depreciation (x)	1.3	1.2	1.5	1.6	1.5	1.6
Net debt/equity (%)	9.2	9.5	9.4	10.5	8.1	6.1
Net interest cover (x)	59.1	38.9	80.7	103.9	134.4	161.0

Source: Company data, Deutsche Bank estimates

Model updated:01 June 2016

Running the numbers

Asia

South Korea

Hardware & Equipment

Samsung SDI

Reuters: 006400.KS Bloomberg: 006400 KS

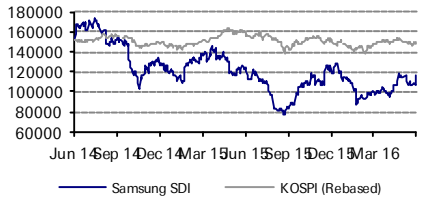
Hold

Price (1 Jun 16)	KRW 117,000
Target Price	KRW 117,000
52 Week range	KRW 76,800 - 129,000
Market Cap (bn)	KRWm 8,045
	USDm 6,751

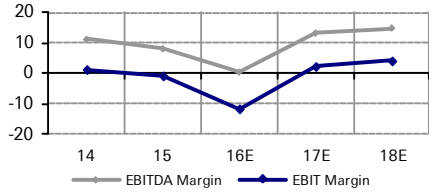
Company Profile

Samsung SDI was founded in 1970 as a display component company, initially manufacturing components for CRT TVs. In 2000, SDI ventured into lithium ion batteries and has since grown to no.1 industry position. SDI continues to R&D into ESS (energy storage systems) and batteries for electric vehicle as long-term growth driver for the company. SDI also acquired from Samsung Electronics its solar panel business in 2011 with focus on renewable energy as its long-term growth driver.

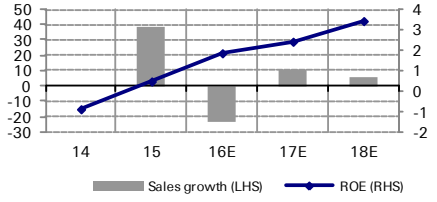
Price Performance



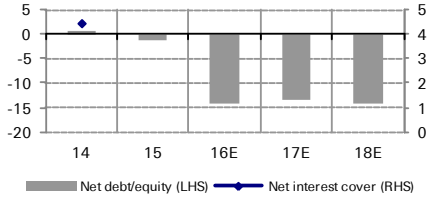
Margin Trends



Growth & Profitability



Solvency



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Fiscal year end 31-Dec	2014	2015	2016E	2017E	2018E
Financial Summary					
DB EPS (KRW)	-1,219.38	783.11	3,006.56	4,009.65	5,857.65
Reported EPS (KRW)	-1,219.38	783.11	3,006.56	4,009.65	5,857.65
DPS (KRW)	0.00	0.00	0.00	0.00	0.00
BVPS (KRW)	164,621.1	156,459.4	159,632.9	163,630.3	169,470.1
Weighted average shares (m)	70	70	70	70	70
Average market cap (KRWbn)	10,300	8,118	8,045	8,045	8,045
Enterprise value (KRWbn)	3,014	1,624	-80	-19	-185
Valuation Metrics					
P/E (DB) (x)	nm	147.3	38.9	29.2	20.0
P/E (Reported) (x)	nm	147.3	38.9	29.2	20.0
P/BV (x)	0.70	0.73	0.73	0.72	0.69
FCF Yield (%)	nm	1.9	1.2	1.9	6.0
Dividend Yield (%)	0.0	0.0	0.0	0.0	0.0
EV/Sales (x)	0.6	0.2	0.0	0.0	0.0
EV/EBITDA (x)	5.0	2.7	-4.6	0.0	-0.2
EV/EBIT (x)	42.6	nm	nm	-0.1	-0.7
Income Statement (KRWbn)					
Sales revenue	5,474	7,569	5,823	6,451	6,842
Gross profit	929	1,383	1,036	1,381	1,589
EBITDA	604	604	17	845	1,013
Depreciation	444	533	565	567	601
Amortisation	89	130	130	130	130
EBIT	71	-60	-678	149	282
Net interest income(expense)	-16	-14	7	24	25
Associates/affiliates	190	280	129	198	234
Exceptionals/extraordinaries	0	0	0	0	0
Other pre-tax income/(expense)	-46	-167	910	0	0
Profit before tax	199	39	369	370	541
Income tax expense	280	13	145	89	130
Minorities	4	-28	17	6	8
Other post-tax income/(expense)	0	0	0	0	0
Net profit	-84	54	207	276	403
DB adjustments (including dilution)	0	0	0	0	0
DB Net profit	-84	54	207	276	403
Cash Flow (KRWbn)					
Cash flow from operations	311	881	1,098	1,060	1,304
Net Capex	-476	-726	-1,000	-900	-810
Free cash flow	-166	155	98	160	494
Equity raised/(bought back)	0	0	0	0	0
Dividends paid	0	0	0	0	0
Net inc/(dec) in borrowings	594	-28	-100	0	0
Other investing/financing cash flows	-531	533	1,597	-221	-328
Net cash flow	-103	660	1,596	-61	166
Change in working capital	*-391*	*-69*	*-75*	*-173*	*-94*
Balance Sheet (KRWbn)					
Cash and other liquid assets	1,709	1,885	3,281	3,220	3,386
Tangible fixed assets	3,325	3,229	3,064	3,398	3,607
Goodwill/intangible assets	1,279	1,278	965	965	965
Associates/investments	7,596	6,600	6,736	6,736	6,736
Other assets	2,060	3,233	2,291	2,450	2,579
Total assets	15,969	16,225	16,337	16,768	17,273
Interest bearing debt	1,778	1,750	1,650	1,650	1,650
Other liabilities	2,364	3,222	3,211	3,361	3,454
Total liabilities	4,142	4,972	4,860	5,010	5,104
Shareholders' equity	11,586	11,012	11,235	11,517	11,928
Minorities	240	241	241	241	241
Total shareholders' equity	11,827	11,253	11,477	11,758	12,169
Net debt	*69*	*-135*	*-1,631*	*-1,570*	*-1,736*
Key Company Metrics					
Sales growth (%)	nm	38.3	-23.1	10.8	6.1
DB EPS growth (%)	na	na	283.9	33.4	46.1
EBITDA Margin (%)	11.0	8.0	0.3	13.1	14.8
EBIT Margin (%)	1.3	-0.8	-11.6	2.3	4.1
Payout ratio (%)	nm	0.0	0.0	0.0	0.0
ROE (%)	-0.9	0.5	1.9	2.4	3.4
Capex/sales (%)	8.7	9.6	17.2	14.0	11.8
Capex/depreciation (x)	0.9	1.1	1.4	1.3	1.1
Net debt/equity (%)	0.6	-1.2	-14.2	-13.4	-14.3
Net interest cover (x)	4.5	nm	nm	nm	nm

Source: Company data, Deutsche Bank estimates

Model updated:29 April 2016

Running the numbers

Europe

Germany

Bulk

BASF

Reuters: BASFn.DE Bloomberg: BAS GY

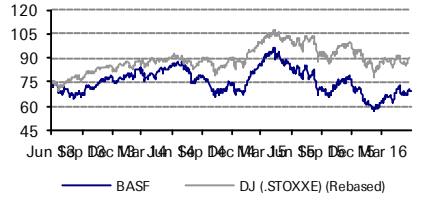
Buy

Price (1 Jun 16)	EUR 69.55
Target Price	EUR 85.00
52 Week range	EUR 56.70 - 85.25
Market Cap (m)	EURm 63,880
	USDm 71,121

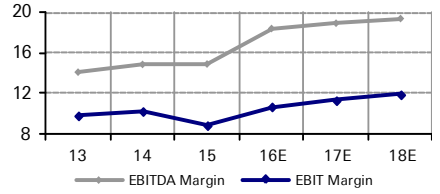
Company Profile

BASF is the largest global chemicals company and has a very broad portfolio of businesses. It is active in most areas of chemicals (spanning from commodity chemicals to specialty chemicals) alongside a leading franchise in agrochemicals and an Oil & Gas business (E&P and gas trading). The company has strong market share positions in most of its activities and is geographically very well diversified.

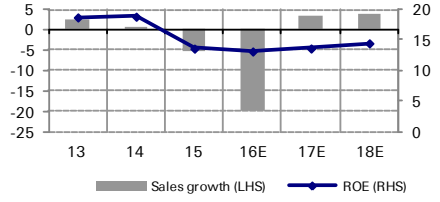
Price Performance



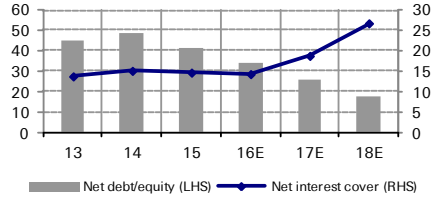
Margin Trends



Growth & Profitability



Solvency



Fiscal year end 31-Dec	2013	2014	2015	2016E	2017E	2018E
Financial Summary						
DB EPS (EUR)	5.37	5.44	5.00	5.27	5.63	6.21
Reported EPS (EUR)	5.27	5.61	4.34	4.53	4.91	5.49
DPS (EUR)	2.70	2.80	2.90	3.05	3.20	3.36
BVPS (EUR)	29.5	30.1	33.7	35.1	36.9	39.0
Weighted average shares (m)	918	918	918	918	918	918
Average market cap (EURm)	66,100	71,578	72,751	63,880	63,880	63,880
Enterprise value (EURm)	83,079	93,138	92,649	81,918	79,713	77,268
Valuation Metrics						
P/E (DB) (x)	13.4	14.3	15.9	13.2	12.4	11.2
P/E (Reported) (x)	13.7	13.9	18.2	15.4	14.2	12.7
P/BV (x)	2.63	2.32	2.10	1.98	1.89	1.78
FCF Yield (%)	4.9	2.3	5.0	6.5	8.0	8.1
Dividend Yield (%)	3.8	3.6	3.7	4.4	4.6	4.8
EV/Sales (x)	1.1	1.3	1.3	1.5	1.4	1.3
EV/EBITDA (x)	8.0	8.4	8.8	7.9	7.2	6.6
EV/EBIT (x)	11.4	12.2	14.8	13.5	12.1	10.7
Income Statement (EURm)						
Sales revenue	73,973	74,326	70,449	56,457	58,332	60,557
Gross profit	21,644	21,904	23,324	20,611	21,603	22,708
EBITDA	10,427	11,043	10,495	10,386	11,036	11,735
Depreciation	2,519	2,770	3,600	3,690	3,782	3,877
Amortisation	635	647	647	647	647	647
EBIT	7,273	7,626	6,248	6,049	6,607	7,212
Net interest income(expense)	-528	-504	-425	-422	-351	-269
Associates/affiliates	-36	-197	-284	-284	-290	-295
Exceptionals/extraordinaries	0	0	0	0	0	0
Other pre-tax income/(expense)	4	278	9	19	29	39
Profit before tax	6,713	7,203	5,548	5,362	5,995	6,686
Income tax expense	1,540	1,711	1,247	1,046	1,319	1,471
Minorities	331	337	314	160	165	170
Other post-tax income/(expense)	0	0	0	0	0	0
Net profit	4,842	5,155	3,987	4,156	4,511	5,045
DB adjustments (including dilution)	87	-156	602	682	661	661
DB Net profit	4,929	4,999	4,589	4,838	5,172	5,706
Cash Flow (EURm)						
Cash flow from operations	7,870	6,958	9,446	8,073	8,891	9,124
Net Capex	-4,660	-5,296	-5,812	-3,952	-3,792	-3,936
Free cash flow	3,210	1,662	3,634	4,121	5,099	5,188
Equity raised/(bought back)	0	0	0	0	0	0
Dividends paid	-2,702	-2,766	-2,806	-2,664	-2,797	-2,937
Net inc/(dec) in borrowings	0	0	0	0	0	0
Other investing/financing cash flows	-1,522	30	-118	348	-78	216
Net cash flow	-1,014	-1,074	710	1,805	2,224	2,467
Change in working capital	*805*	*-699*	*1,347*	*-491*	*-250*	*-352*
Balance Sheet (EURm)						
Cash and other liquid assets	1,815	1,718	2,241	1,796	1,856	1,926
Tangible fixed assets	18,254	23,496	25,260	23,909	22,755	21,652
Goodwill/intangible assets	12,235	12,967	12,537	12,537	12,537	12,537
Associates/investments	6,635	7,476	8,473	8,473	8,473	8,473
Other assets	25,443	25,702	22,325	22,325	23,066	23,945
Total assets	64,382	71,359	70,836	69,040	68,687	68,533
Interest bearing debt	14,407	15,384	15,197	12,947	10,782	8,386
Other liabilities	22,186	27,780	24,094	23,244	23,461	23,720
Total liabilities	36,593	43,164	39,291	36,191	34,244	32,105
Shareholders' equity	27,111	27,614	30,916	32,275	33,850	35,812
Minorities	678	581	629	574	593	616
Total shareholders' equity	27,789	28,195	31,545	32,849	34,443	36,427
Net debt	*12,592*	*13,666*	*12,956*	*11,151*	*8,927*	*6,459*
Key Company Metrics						
Sales growth (%)	2.6	0.5	-5.2	-19.9	3.3	3.8
DB EPS growth (%)	-4.8	1.4	-8.2	5.4	6.9	10.3
EBITDA Margin (%)	14.1	14.9	14.9	18.4	18.9	19.4
EBIT Margin (%)	9.8	10.3	8.9	10.7	11.3	11.9
Payout ratio (%)	51.2	49.9	66.8	67.3	65.1	61.1
ROE (%)	18.7	18.8	13.6	13.2	13.6	14.5
Capex/sales (%)	6.3	7.1	8.2	7.0	6.5	6.5
Capex/depreciation (x)	1.5	1.5	1.4	0.9	0.9	0.9
Net debt/equity (%)	45.3	48.5	41.1	33.9	25.9	17.7
Net interest cover (x)	13.8	15.1	14.7	14.3	18.8	26.8

Source: Company data, Deutsche Bank estimates

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Model updated:26 May 2016

Running the numbers

Europe

Belgium

Specialty Chemicals

Umicore

Reuters: UMI.BR Bloomberg: UMI BB

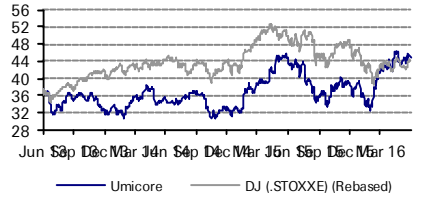
Hold

Price (1 Jun 16)	EUR 45.01
Target Price	EUR 40.00
52 Week range	EUR 32.38 - 46.15
Market Cap (m)	EURm 4,881
	USDm 5,434

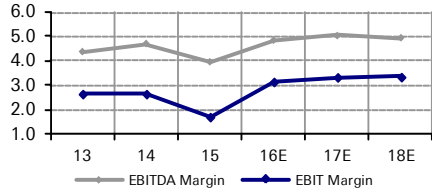
Company Profile

Umicore is a materials technology group. Its activities are centered on four business areas: Catalysis (emissions control in the main, focusing on light duty vehicles), Energy Materials (including rechargeable battery materials), Performance Materials (including zinc products for construction and batteries) and Recycling (recycler of last resort and capable of handling very complex waste streams). Each business area is divided into market focused business units offering materials and solutions.

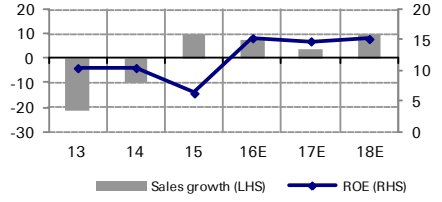
Price Performance



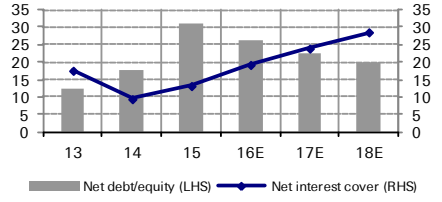
Margin Trends



Growth & Profitability



Solvency



Fiscal year end 31-Dec	2013	2014	2015	2016E	2017E	2018E
Financial Summary						
DB EPS (EUR)	1.96	1.78	2.26	2.15	2.24	2.51
Reported EPS (EUR)	1.60	1.63	1.00	2.52	2.62	2.89
DPS (EUR)	1.00	1.00	1.20	1.20	1.20	1.25
BVPS (EUR)	15.3	15.8	16.0	17.2	18.4	19.9
Weighted average shares (m)	111	108	108	108	108	108
Average market cap (EURm)	3,974	3,709	4,242	4,881	4,881	4,881
Enterprise value (EURm)	4,474	4,352	4,893	5,480	5,449	5,426
Valuation Metrics						
P/E (DB) (x)	18.2	19.3	17.3	21.0	20.1	17.9
P/E (Reported) (x)	22.3	21.1	39.3	17.8	17.2	15.6
P/BV (x)	2.22	2.11	2.41	2.62	2.44	2.26
FCF Yield (%)	5.2	5.1	0.9	3.1	2.8	2.7
Dividend Yield (%)	2.8	2.9	3.1	2.7	2.7	2.8
EV/Sales (x)	0.5	0.5	0.5	0.5	0.5	0.5
EV/EBITDA (x)	10.4	10.5	12.7	10.8	10.0	9.2
EV/EBIT (x)	17.2	18.6	29.6	16.6	15.0	13.6
Income Statement (EURm)						
Sales revenue	9,819	8,835	9,698	10,456	10,851	11,948
Gross profit	1,475	1,447	1,382	1,501	1,576	1,726
EBITDA	430	416	384	507	547	592
Depreciation	163	175	212	170	177	191
Amortisation	7	7	7	7	7	0
EBIT	260	234	165	329	362	400
Net interest income(expense)	-15	-25	-13	-17	-15	-14
Associates/affiliates	-1	21	10	16	16	16
Exceptionals/extraordinaries	0	0	0	0	0	0
Other pre-tax income/(expense)	-8	0	-12	0	0	0
Profit before tax	237	231	151	328	363	403
Income tax expense	52	47	51	66	91	101
Minorities	6	8	8	8	8	8
Other post-tax income/(expense)	0	0	16	21	21	21
Net profit	179	177	109	275	285	315
DB adjustments (including dilution)	40	16	137	-41	-41	-41
DB Net profit	219	193	246	234	244	273
Cash Flow (EURm)						
Cash flow from operations	501	403	265	414	390	402
Net Capex	-294	-215	-225	-261	-252	-270
Free cash flow	207	187	40	153	138	133
Equity raised/(bought back)	0	0	0	0	0	0
Dividends paid	-115	-115	-114	-130	-130	-130
Net inc/(dec) in borrowings	0	0	0	0	0	0
Other investing/financing cash flows	-6	-92	62	31	24	20
Net cash flow	86	-19	-13	55	32	23
Change in working capital	*97*	*56*	*-113*	*3*	*-38*	*-63*
Balance Sheet (EURm)						
Cash and other liquid assets	99	90	75	77	81	87
Tangible fixed assets	999	1,062	1,023	1,102	1,167	1,243
Goodwill/intangible assets	218	266	252	254	257	259
Associates/investments	245	284	237	237	237	237
Other assets	1,951	2,150	2,444	2,477	2,570	2,723
Total assets	3,512	3,851	4,030	4,147	4,312	4,549
Interest bearing debt	314	396	628	576	548	531
Other liabilities	1,475	1,705	1,617	1,652	1,707	1,797
Total liabilities	1,789	2,101	2,245	2,228	2,254	2,328
Shareholders' equity	1,677	1,705	1,732	1,857	1,992	2,151
Minorities	46	46	53	62	65	70
Total shareholders' equity	1,723	1,750	1,785	1,920	2,057	2,221
Net debt	*215*	*306*	*554*	*499*	*467*	*444*
Key Company Metrics						
Sales growth (%)	-21.7	-10.0	9.8	7.8	3.8	10.1
DB EPS growth (%)	-20.4	-9.3	26.8	-4.9	4.3	12.2
EBITDA Margin (%)	4.4	4.7	4.0	4.8	5.0	5.0
EBIT Margin (%)	2.7	2.7	1.7	3.2	3.3	3.3
Payout ratio (%)	62.2	61.2	119.9	47.3	45.7	43.1
ROE (%)	10.4	10.5	6.3	15.3	14.8	15.2
Capex/sales (%)	3.0	2.4	2.3	2.5	2.3	2.3
Capex/depreciation (x)	1.7	1.2	1.0	1.5	1.4	1.4
Net debt/equity (%)	12.5	17.5	31.0	26.0	22.7	20.0
Net interest cover (x)	17.6	9.5	13.2	19.3	23.9	28.6

Source: Company data, Deutsche Bank estimates

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Model updated:05 April 2016

Running the numbers

Europe

United Kingdom

Specialty Chemicals

Johnson Matthey Plc

Reuters: JMAT.L Bloomberg: JMAT LN

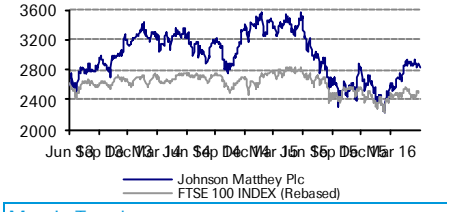
Buy

Price (1 Jun 16)	GBP 2,827.00
Target Price	GBP 3,400.00
52 Week range	GBP 2,230.00 - 3,516.00
Market Cap (m)	GBPm 5,681
	USDm 8,270

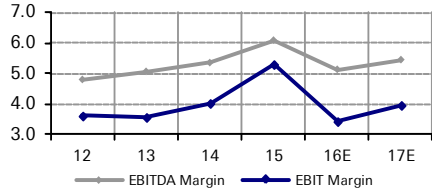
Company Profile

Johnson Matthey is a specialty chemicals company that manufactures catalysts (both automotive and process catalysts), pharmaceutical materials and pollution control systems. The company's Precious Metals Products activities comprise refining of platinum, gold and silver, a marketing operation for PGM's and also fabrication of products from these metals. The focus of the company is on its Environmental Technologies division where the catalysts businesses are reported. Johnson Matthey has operations around the world.

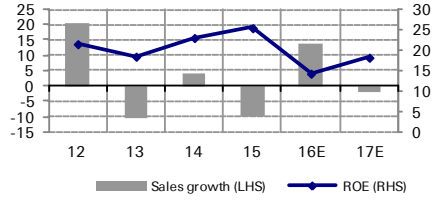
Price Performance



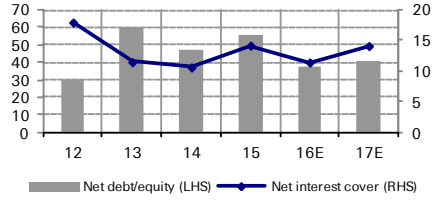
Margin Trends



Growth & Profitability



Solvency



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Fiscal year end 31-Mar	2012	2013	2014	2015	2016E	2017E
Financial Summary						
DB EPS (GBP)	153.70	147.68	170.63	180.60	172.54	183.43
Reported EPS (GBP)	148.71	131.33	167.73	211.19	126.76	174.13
DPS (GBP)	155.00	57.00	62.50	68.00	219.00	74.00
BVPS (GBP)	720.9	678.3	768.9	892.0	873.2	1,006.1
Weighted average shares (m)	212	206	203	203	201	194
Average market cap (GBPm)	4,129	4,721	5,917	6,493	5,681	5,681
Enterprise value (GBPm)	4,755	5,804	6,824	7,691	6,540	6,674
Valuation Metrics						
P/E (DB) (x)	12.6	15.6	17.1	17.7	16.4	15.4
P/E (Reported) (x)	13.1	17.5	17.4	15.1	22.3	16.2
P/BV (x)	3.27	3.39	4.25	3.80	3.24	2.81
FCF Yield (%)	7.6	3.4	4.4	nm	4.8	5.6
Dividend Yield (%)	8.0	2.5	2.1	2.1	7.7	2.6
EV/Sales (x)	0.4	0.5	0.6	0.8	0.6	0.6
EV/EBITDA (x)	8.3	10.7	11.4	12.6	11.1	10.9
EV/EBIT (x)	11.0	15.2	15.2	14.4	16.7	15.0
Income Statement (GBPm)						
Sales revenue	12,023	10,729	11,155	10,060	11,461	11,246
Gross profit	753	704	799	818	974	956
EBITDA	576	543	596	612	587	612
Depreciation	126	127	127	135	137	150
Amortisation	17	34	21	-56	58	18
EBIT	433	382	448	533	392	445
Net interest income(expense)	-24	-33	-42	-38	-34	-31
Associates/affiliates	0	0	1	1	0	0
Exceptionals/extraordinaries	0	0	0	0	0	0
Other pre-tax income/(expense)	0	0	0	0	0	0
Profit before tax	409	349	407	496	358	413
Income tax expense	94	79	68	69	105	78
Minorities	-1	-1	-2	-1	-1	-1
Other post-tax income/(expense)	0	0	0	0	0	0
Net profit	316	270	340	429	255	337
DB adjustments (including dilution)	11	34	6	-62	92	18
DB Net profit	327	304	346	367	347	355
Cash Flow (GBPm)						
Cash flow from operations	464	396	477	126	521	524
Net Capex	-151	-234	-214	-212	-248	-218
Free cash flow	314	162	263	-86	272	306
Equity raised/(bought back)	0	0	0	0	0	0
Dividends paid	-103	-328	-119	-130	-138	-440
Net inc/(dec) in borrowings	0	0	0	0	0	0
Other investing/financing cash flows	-1	-191	-39	-49	205	0
Net cash flow	210	-357	106	-265	339	-134
Change in working capital	*-28*	*-52*	*-45*	*-387*	*78*	*20*
Balance Sheet (GBPm)						
Cash and other liquid assets	168	97	234	78	87	85
Tangible fixed assets	910	994	1,023	1,081	1,192	1,260
Goodwill/intangible assets	647	798	754	736	718	700
Associates/investments	12	6	8	14	14	14
Other assets	1,528	1,639	1,766	2,270	2,112	2,075
Total assets	3,265	3,533	3,785	4,180	4,123	4,135
Interest bearing debt	623	932	967	1,073	742	875
Other liabilities	1,110	1,209	1,269	1,307	1,626	1,312
Total liabilities	1,733	2,141	2,236	2,380	2,368	2,188
Shareholders' equity	1,531	1,394	1,560	1,811	1,755	1,947
Minorities	0	-1	-6	-11	0	0
Total shareholders' equity	1,532	1,393	1,553	1,800	1,755	1,947
Net debt	*454*	*835*	*733*	*994*	*655*	*790*
Key Company Metrics						
Sales growth (%)	20.4	-10.8	4.0	-9.8	13.9	-1.9
DB EPS growth (%)	29.1	-3.9	15.5	5.8	-4.5	6.3
EBITDA Margin (%)	4.8	5.1	5.3	6.1	5.1	5.4
EBIT Margin (%)	3.6	3.6	4.0	5.3	3.4	4.0
Payout ratio (%)	104.2	43.4	37.3	32.2	172.8	42.5
ROE (%)	21.5	18.5	23.0	25.4	14.3	18.2
Capex/sales (%)	1.3	2.2	1.9	2.1	2.2	1.9
Capex/depreciation (x)	1.2	1.8	1.7	1.6	1.8	1.5
Net debt/equity (%)	29.7	60.0	47.2	55.2	37.4	40.6
Net interest cover (x)	18.0	11.5	10.6	14.2	11.5	14.1

Source: Company data, Deutsche Bank estimates

Acknowledgements

The authors of this report would like to acknowledge Jason Zhu and Ryan Kwon for their contribution

Appendix 1

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Sell: Based on a current 12-month view of total share-holder return, we recommend that investors sell the stock

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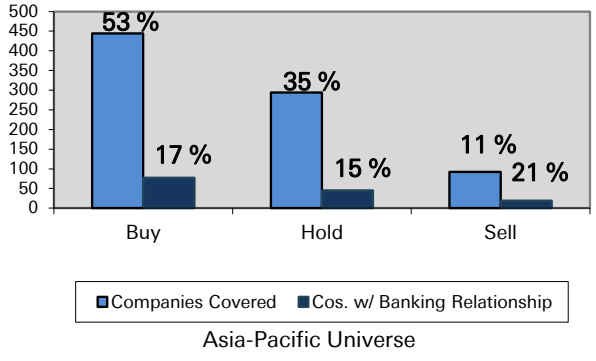

Asia-Pacific Universe

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