

Equity Research · SMEs

BMS riding the EV wave

Battery management systems (BMS) offering critical protection for Li-ion batteries look set to benefit from the downstream electric vehicle (EV) boom. EVs are all the rage around the world, led by China with an estimated 600,000 all-electric vehicles on roads and an aggressive plan to deploy a further 5mn by 2020. This inexorable trend points to a global Li-ion battery market size equivalent to 200mn kWh by 2020, and thus a spurt in demand for BMS, which rocketed at a CAGR of 104% to 578,000 in 2016 from 8,000 in 2010, bumping up market size to RMB3.76bn from RMB162mn with a CAGR of 69%.

The thriving BMS market. BMS players can be Li-ion battery producers, automakers or BMS specialists. Major Li-ion battery makers in China also produce BMS. Therefore, they sometimes offer a product bundle of both battery pack and BMS, as represented by BYD, Contemporary Amperex Technology, Guoxuan High-Tech and China Aviation Lithium Battery. Traditional car manufacturers are beginning to move into this field, with such domestic auto heavyweights as SAIC Motor, BAIC Motor and Geely all having dedicated BMS R&D teams and BAIC BJEV considering BMS a pivotal technology. BMS specialists differ in technological capabilities: some like Joyson Electronic have obtained a cutting edge through R&D or M&A, while others only offer low-end products. However, all are availed of sufficient market opportunities as demands abound. Some leading BMS pure plays include Joyson Electronic, Huizhou E-power Electronics, Klclear Technology and Chaosiwei Electronics.

SMEs

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SZSE SME Composite/SSE Index



GEI/SZSE Component Index



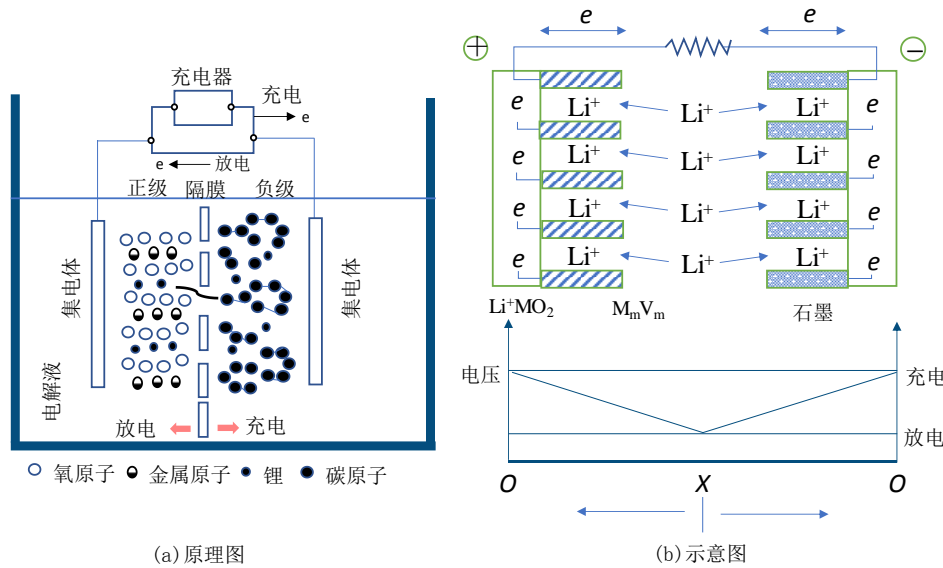
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BMS, the brain of Li-ion battery

A lithium-ion (Li-ion) battery is a type of rechargeable battery in which lithium ions move from the negative electrode to the positive electrode during discharge and back when charging.

Figure 1: How a Li-ion battery works



Source: Lithium-ion Battery, Research Dept, CSCI

Li-ion batteries are prone to burnout or explosion due to short-circuit or overcharging, among other reasons, and thus require BMS to serve such critical functions as protecting cells from being overcharged, over-discharged, overloaded and overheated through real-time monitoring of battery voltage, current and temperature, as well as sending feedback on remaining battery capacity.

Table 1: Comparison of different secondary cell types

项目	锂电池	铅酸电池	镍镉电池	镍氢电池
工作电压	3.2-3.7V	2.0V	1.2V	1.2V
能量密度	100-200Wh/Kg	小于 30Wh/Kg	50Wh/Kg	60-80Wh/Kg
循环寿命	大于 1000 次	300 次左右	500 次左右	500 次左右
记忆效应	无	无	有	有
优点	可快速充电、高功率放电； 能量密度高、循环寿命长	可靠性好、技术成熟、价格 低	可快速充电、价格便宜、循 环寿命较长	可快速充电、高功率放电； 能量密度较高、循环寿命长
缺点	价格相对较高，发生强烈碰 撞或温度过高时，稳定性差	不可快速充电，能量密度 低，体积大，寿命短，污染 大	有记忆效应，能量密度低， 对环境有污染	具有一定的记忆效应，价格 较高，充放电效率差
行业生命 周期	快速成长期	成熟期后期	衰退期	成熟期

Source: Nebula Electronics's Prospectus, Research Dept, CSCI

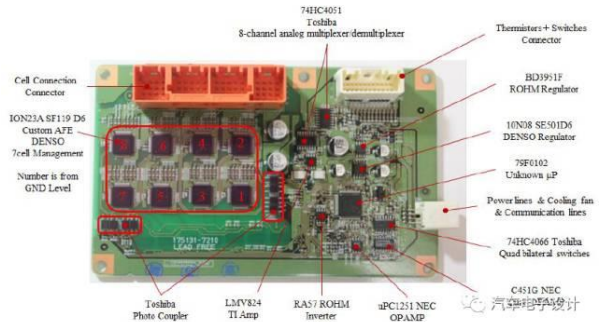
Li-ion BMS can be applied in (1) electronic products such as cell phones, tablets and portable power banks, or (2) energy storage management systems, base stations, and electric vehicles or motorcycles, with the latter more complicated and technologically challenging to design.

Figure 2: A BMS produced by Huizhou E-power Electronics



Source: Huizhou E-power Electronics, Research Dept, CSCJ

Figure 3: The internal structure of a DENSO BMS



Source: DENSO, Research Dept, CSCJ

Take Contemporary Amperex Technology's BMS: The product can perform state of charge (SoC)/state of health (SoH) estimation, parameters monitoring and balance management, so as to optimize a Li-ion battery's overall performance and extend its longevity.

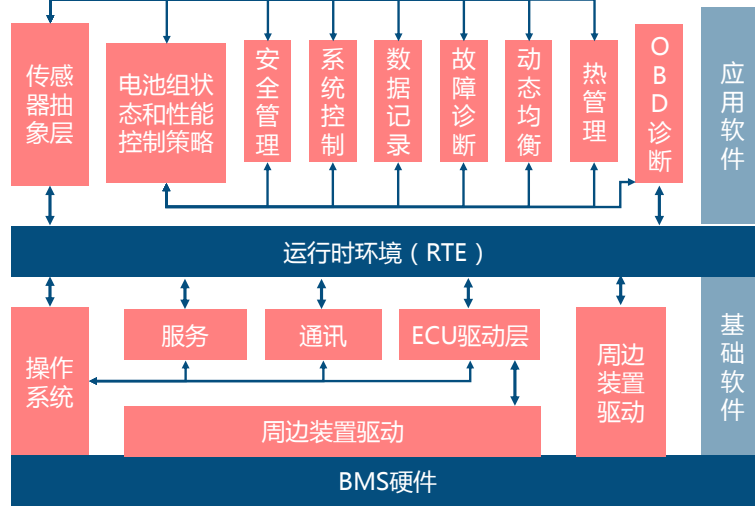
Figure 4: BMS's functions

<p>电池安全管理</p> <ul style="list-style-type: none"> • 过充 / 过放保护 • 过流 / 过温 / 低温保护 • 多级故障诊断保护 • 双重故障监测 	<p>SOC / SOH检测</p> <ul style="list-style-type: none"> • 剩余容量估算 • 电池健康估算 • 高精容量积分 	<p>高压安全管理</p> <ul style="list-style-type: none"> • 高压互锁 (HVIL) • 高压绝缘监测 • 高压开关诊断
<p>电池参数检测</p> <ul style="list-style-type: none"> • 电池电压检测与分析 • 电池电流检测与分析 • 电池温度检测与分析 	<p>均衡管理</p> <ul style="list-style-type: none"> • 基于电压模式的均衡 • 基于时间模式的均衡 • 基于电芯SOC的均衡 • 主动 / 被动均衡可选 	<p>其它功能特点</p> <ul style="list-style-type: none"> • 低成本、低功耗 • 历史数据记录 • 级联灵活扩展 • CRC数据校验

Source: Contemporary Amperex Technology, Research Dept, CSCJ

A BMS usually includes a parameters monitoring unit and a state calculation module.

Figure 5: State calculation module's structure

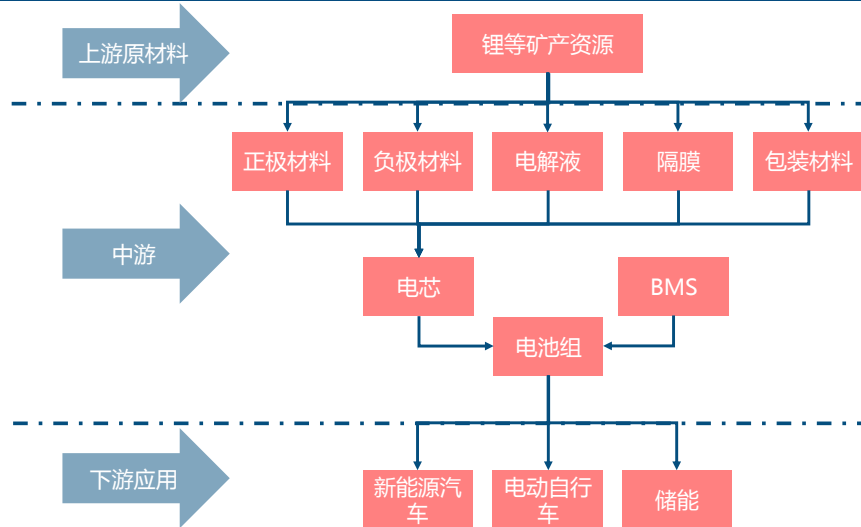


Source: cn.gasgoo.com, Research Dept, CSCI

BMS set to benefit from exponential EV growth

BMS offering critical protection for Li-ion batteries are set to benefit from the downstream EV boom.

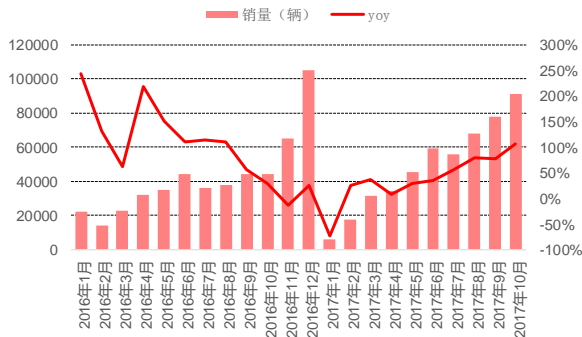
Figure 6: Li-ion battery industry chain



Source: Research Dept, CSCI

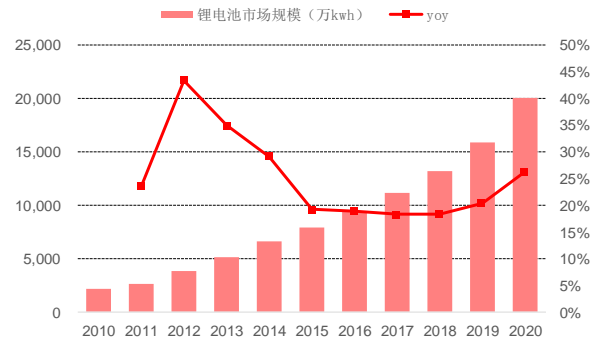
EVs are all the rage across the world, led by China with about 600,000 all-electric vehicles on its roads and an ambitious plan to deploy a further 5mn by 2020. This inexorable trend could in turn create a global Li-ion battery market size of 200mn kWh by 2020.

Figure 7: China electric passenger car sales volume Jan. 2016-Oct. 2017



Source: China Association of Automobile Manufacturers (CAAM), Research Dept, CSCI

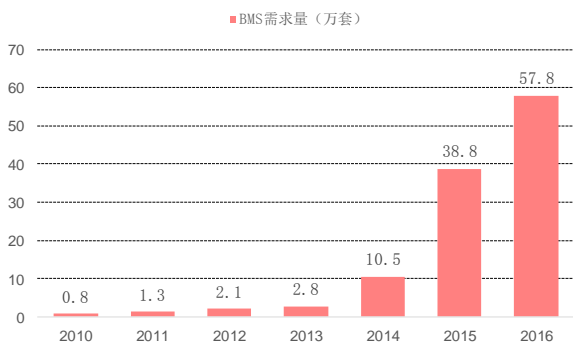
Figure 8: World Li-ion battery market size 2010-2020



Source: realli.net, Research Dept, CSCI

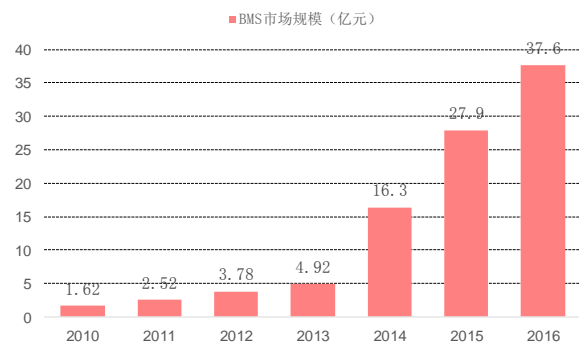
With such exponential growth comes a spurt in demand for BMS, which rocketed at a CAGR of 104% to 578,000 in 2016 from 8,000 in 2010, leading to a market size swelling to RMB3.76bn from RMB162mn at a CAGR of 69%.

Figure 9: BMS demand in China 2010-2016



Source: chyxx.com, Research Dept, CSCI

Figure 10: China BMS market size 2010-2016



Source: chyxx.com, Research Dept, CSCI

The Chinese government is taking the EV market really, really seriously by issuing a series of favorable policies. These include a strategic focus on pure-electric cars, a commitment to set up a nationwide EV charging network by 2020, and a credit-score program tied to EV production, to name just a few.

Table 2: China has issued a raft of policies to encourage EV development

名称	时间	颁布部门
《关于进一步做好节能与新能源汽车示范推广试点工作通知》(财办建[2011]149号)	2011.10	财政部办公厅、科技部办公厅、工信部办公厅、发改委办公厅
《节约能源使用新能源车船免税的车型目录(第一批)》	2012.03	财政部、国家税务总局、工信部
《节能与新能源汽车产业发展规划(2012-2020年)》(国发[2012]22号)	2012.06	国务院
《大气污染防治行动计划实施情况考核办法(试行)》(国办发[2014]21号)	2014.04	国务院办公厅
《关于加快新能源汽车推广应用的指导意见》(国办发[2014]35号)	2014.07	国务院办公厅
《关于2016-2020年新能源汽车推广应用财政支持政策的通知》(财建[2015]134号)	2015.04	财政部、科技部、工信部和发改委
《关于节约能源使用新能源车船车船税优惠政策的通知》(财税[2015]51号)	2015.05	财政部、国家税务总局、工信部
《关于加快电动汽车充电基础设施建设的指导意见》(国办发[2015]73号)	2015.09	国务院办公厅
《电动汽车充电基础设施发展指南(2015-2020年)》(发改能源[2015]1454号)	2015.10	发改委、国家能源局、工信部、住房和城乡建设部

《新能源公交车推广应用考核办法(试行)》(交运发[2015]164号)	2015.11	交通运输部、财政部、
《关于“十三五”新能源汽车充电基础设施奖励政策及加强新能源汽车推广应用的通知》(财建[2016]7号)	2016.01	财政部、科技部、工信部、发改委、国家能源局
《“十三五”控制温室气体排放工作方案》(国发[2016]61号)	2016.10	国务院
《“十三五”国家战略性新兴产业发展规划》(国发[2016]67号)	2016.11	国务院
《关于调整新能源汽车推广应用财政补贴政策的通知》(财建[2016]958号)	2016.12	财政部、科技部、工信部、发改委
《乘用车企业平均燃料消耗量与新能源汽车积分并行管理办法》	2017.12	工信部

Source: Research Dept, CSCI

The thriving BMS market

Generally speaking, there are three types of BMS players: Li-ion battery producers, automakers and BMS specialists.

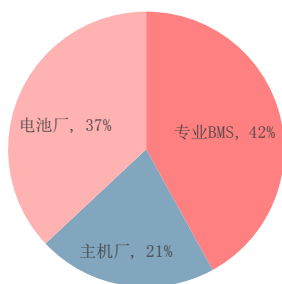
Most leading Li-ion battery producers in China are also able to produce BMS. Therefore, they sometimes offer a product bundle of both battery pack and BMS, as represented by BYD, Contemporary Amperex Technology, Guoxuan High-Tech and China Aviation Lithium Battery.

Traditional automakers used to outsource BMS, such as BMW making such purchases from the likes of Bosch and Preh. However, things have started to change, with large car manufacturers beginning to move into the BMS field through M&A and strategic partnership. Domestic heavyweights such as SAIC Motor, BAIC Motor and Geely have all set up their BMS R&D teams, with BAIC BJEV considering BMS a pivotal technology.

BMS specialists differ in technological capabilities: some like Joyson Electronic have obtained a cutting edge through R&D or M&A, while others can only supply low-end products. However, all these players are availed of sufficient demands across different price ranges. Leading BMS pure plays include Joyson Electronic, Huizhou E-power Electronics, Klclear Technology and Chaosiwei Electronics.

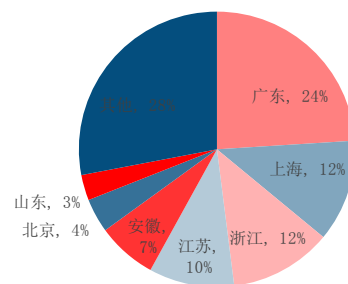
As it stands, most of the domestic BMS producers are located in Guangdong, Shanghai, Zhejiang and Jiangsu, with Guangdong hosting an overwhelming 24% of these companies.

Figure 11: Share of different types of BMS players



Source: chyxx.com, Research Dept, CSCI

Figure 12: Geographic distribution of domestic BMS producers



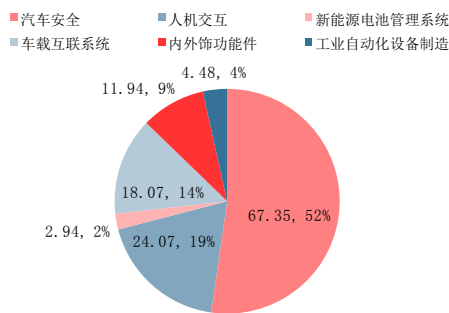
Source: chyxx.com, Research Dept, CSCI

Strong players

Joyson Electronic

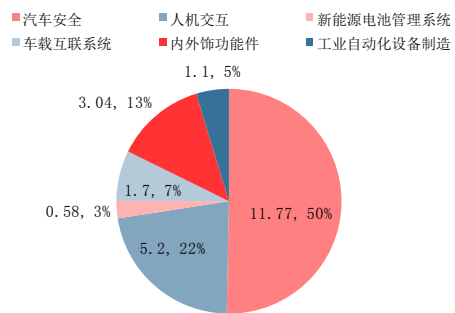
Joyson Electronic (600699:CH) floated on the stock market in 2011 through a backdoor listing, and has since embarked on a string of M&A, acquiring German automotive interior company Quin, US system integration and safety-critical components expert KSS, and German car navigation system provider TechniSat Digital GmbH. In 1H17, Joyson Electronic's vehicle safety/human machine interface (HMI)/BMS/in-vehicle connectivity/automotive interior/industrial automation lines respectively posted RMB6.735bn/RMB2.407bn/RMB294mn/RMB1.807bn/RMB1.194bn/RMB448mn in revenue. Growing at a fast 20.15% YoY in 1H17, Joyson Electronic's BMS products are widely adopted by big name automakers such as Mercedes-Benz, Porsche and Geely.

Figure 13: Joyson Electronic's revenue composition 1H17, hundred million yuan



Source: company announcement, Research Dept, CSCI

Figure 14: Joyson Electronic's gross margin composition 1H17, hundred million yuan



Source: company announcement, Research Dept, CSCI

Figure 15: Joyson Electronic's major offerings

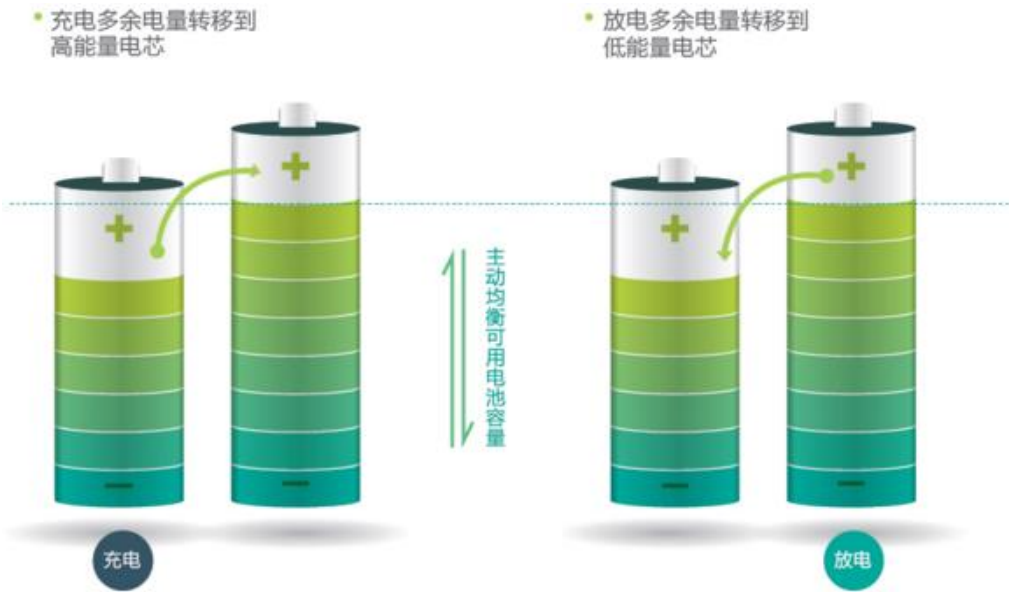


Source: company announcement, Research Dept, CSCI

Klclear Technology

Klclear Technology, a Shenzhen-based company founded in 2010, possesses key BMS technologies regarding active balancing, wireless communication, function safety and capacity management.

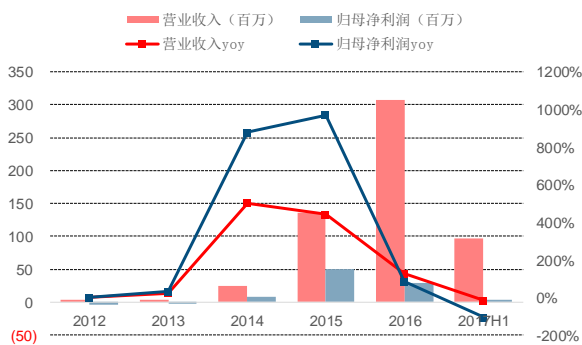
Figure 16: How active balancing works



Source: gg-lb.com, Research Dept, CSCI

Klclear Technology grew operating revenue by a massive 90-fold from RMB3.4mn in 2012 to RMB307mn in 2016, with BMS for electric coaches/passenger cars its moneyspinner. However, operating revenue dipped in 1H17, owing to a 38% Y/Y drop in commercial EV sales impacted by subsidy policy headwinds. This led to a decrease in net profit attributable to the parent, which could also be attributed to higher R&D expenses, a stock incentive and the recognition of an asset impairment loss.

Figure 17: Klclear Technology's revenue and profit 2012-1H17



Source: Wind, Research Dept, CSCI

Figure 18: Klclear Technology's BMS solutions



Source: company website, Research Dept, CSCI

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Company Rating Definition

The Benchmark: Hong Kong Hang Seng Index; Time Horizon: 12 months

Buy	12-month absolute total return: $\geq 10\%$
Hold	12-month absolute total return: $> -10\%$ but $< 10\%$
Sell	12-month absolute total return: $\leq -10\%$

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