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Cars 2025: Vol. 5

Lighter, faster, cheaper

Equity Research

CO2 rules accelerate shift to a new material paradigm

Fuel standards heighten focus on weight

Automakers have long faced competing demands to make their vehicles both greener and safer. Many of the benefits of fuel efficient engines have been undercut by increases in weight that come with added safety and comfort. But with increasingly stringent fuel economy standards coming around the world, we believe automakers will be forced to increase their focus on making cars lighter, accelerating a shift to new materials that will reshuffle the supply chain.

Emissions scandal increases urgency

We expect a 15% (200 kg) drop in average car body weight by 2025 as automakers race to meet CO2 rules. The VW emissions scandal only increases the urgency by speeding up adoption of "real-driving emission" testing. Reducing weight is the most cost-effective way to cut emissions, at just US$42 for every gram of CO2 reduced per kilometer, vs US$71 for using a hybrid engine or US$124 for electric vehicles. And even EVs face pressure to reduce weight to accommodate heavier batteries to extend their range.

Focus on lean bodies

Most of the focus will be on replacing steel in the "body-in-white" (BiW) that accounts for 33% of a typical car's weight and includes the doors, hood and side panels. We expect the trend to lightweighting will keep BiW steel usage broadly flat at a -0.2% CAGR (supported by growth of 14% in ultra-high tensile steel demand) through 2025, while we forecast rapid growth for aluminum alloys (+17.5%), plastics (+4.8%) and carbon fiber reinforced polymer (+16.1%).

Obvious to less obvious beneficiaries

Potential beneficiaries range from the relatively obvious, such as aluminum suppliers Alcoa (CS), Constellium (CS), UACJ (Neutral) and Kobe Steel (Buy), to ones that are less well understood, such as Aida Engineering (CL-Buy), one of the world's largest makers of the servo presses that are key to processing and shaping difficult materials. We examine a globally diverse mix that include Ford (Buy) on its lead with the all-aluminum F-150; DaikyoNishikawa (CL-Buy) and Minth (Neutral) on the shift to plastics; and UACJ (Neutral).

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Lightweighting in numbers

GLOBAL FOCUS ON CO2

44%

The average emission reduction required per vehicle to meet US, Japanese, European and Chinese 2025 emissions standards. (p. 4)

SHEDDING POUNDS

200kg

The amount of weight the average vehicle has to "lose" to reduce carbon emissions by the required 62 g/km. (p. 12)

MILD STEEL, MILD GROWTH

-0.2%

The 2015-2025E CAGR for BiW steel demand, relatively flat compared with 17.5%/4.8%/16.1% CAGRs for aluminum alloys, plastics and carbon fiber reinforced plastics, respectively. (p. 17)

ALUMINUM: LIGHTWEIGHT BUT SERIOUSLY CONTENDER

1/3

The weight of aluminum relative to traditional steel. Aluminum is also 1.4x as rigid. (p. 22)

THE FUTURE FOR PLASTICS

$1.0bn

The expected increase in the size of the BiW plastics market between 2015 and 2025. (p. 27)

RECYCLING POTENTIAL

92%

The difference in CO2 emissions (per ton) from production of secondary aluminum vs. virgin aluminum. Recycled aluminum also costs 50% less. (p. 34)

TIGHTENING THE BELT TO REACH TARGETS

27%

The portion of emissions cuts that we think will come from weight reduction or "lightweighting," vs. 73% from powertrain improvement. (p. 12)

CIST BENEFITS

$42

The cost of reducing carbon emissions 1 g/km through lightweighting, vs. $71 through hybrid engines and $139 through plug-in hybrid engines. (p. 13)

EXTRA MUSCLE WITHOUT THE FAT

+20%
-5kgs

The strength gain and weight decline Mazda achieved using ultra high-tensile steel in its 2012 CX-5. We expect "super steel" demand to preserve the size of the BiW steel market as traditional steel demand falls. (p. 17)

ALREADY ON THE ROADS

780k

Total 2015 sales for the Ford F150—the most popular car in the US and one with a full aluminum body. (p. 23)

DELAYED UPTAKE

2025

The earliest we'd expect to see carbon fiber enforced plastics used in mass-market vehicles, due to their high costs relative to other lightweighting materials. (p. 27)

ANTIQUATED MACHINES

10+ years

The age of most stamping machines in North America, making them unconducive to lightweighting efforts. We expect replacement with servo presses that can handle harder-to-form materials like aluminum. (p. 38)

Executive summary: Highlighting key beneficiaries from lightweighting

CARS 2025

This is the fifth report in our Cars 2025 series. Access the other reports in the series below and **visit our portal** to see related resources.

Vol. 1: A disruptive new era of the Automotive Age

Vol. 2: Solving CO_2— Engines, batteries & fuel cells

Vol. 3: Monetizing the rise of autonomous vehicles

Vol. 4: Disruption in China's new car market

Our Cars 2025 series explores developments that we believe will transform the industry over the next decade. In this fifth edition, we focus on lightweighting technology. We believe the main challenge over the next decade will be to dramatically reduce vehicle weight amid a wave of new standards aimed at improving fuel economy and strengthening collision safety. We see a shift away from existing steel automotive body design, toward a multi-material approach that employs plastics, aluminum alloys and carbon fiber reinforced plastics (CFRP) best suited to individual auto parts. We look also at changes in market size among the various materials suppliers, as well as potential retooling with the adoption of new materials, placing particular focus on advances in press technology.

Next decade challenge: Lose 15% weight

We see limits to how far powertrain improvements can go to help automakers meet stricter CO2 emission standards. CO2 emission standards in the major markets of Japan, the US, Europe, and China call for a reduction of 62 g/km (44%) between 2015 and 2025. We estimate that powertrain improvements will cut emissions by around 45 g/km over the next 10 years, and believe weight reduction will need to account for the remaining 17 g/km. Assuming the average vehicle needs to be 15 kg lighter to reduce CO2 emissions by 1 g/km, we calculate that a 15% (200 kg) reduction in weight will be needed to cut CO2 emissions by 17 g/km.

Emissions scandal increases urgency

We expect the Volkswagen (VW) emissions scandal that surfaced in October 2015 to have a significant impact on emission/fuel economy regulations. In Europe, discussions are progressing ahead of the adoption of Euro 6c emission standards in 2017, and automakers will need to pay increased attention to the difference between real-world and test-mode fuel economy. We expect the introduction of testing methods that more closely simulate real driving conditions (RDE: Real Driving Emissions testing) to raise the bar even further on compliance with CO2 and exhaust gas (NOx/PM) emissions regulations. We consider lightweighting the most basic means of demonstrably improving fuel economy across driving modes. Among the various options for lowering CO2 emissions, lightweighting represents a cost-effective solution. Reducing CO2 emissions by 1 g/km costs US$42 via lightweighting, US$71 with a hybrid engine, US$139 with a plug-in hybrid engine, and US$284 with fuel cell technology (still in its infancy).

BiW materials to change significantly; forecasting rapid shift to ultra-high tensile steel/aluminum

While lightweighting is a challenge across the range of automotive components, we believe the most appetizing diet for autos is to reduce the weight of the body-in-white (BiW; the body components that account for 33% of a vehicle's weight). In 2015-2025, we project acceleration in the use of ultra-high tensile steel for the high-strength/structural components needed to ensure collision safety, and we see 1,200-1,800MPa tensile strengths entering the mainstream. We also expect automakers to actively adopt 5000/6000-series aluminum alloys for collision absorption/exterior components. We forecast that the BiW global market will expand to US$94 bn by 2025, from US$77 bn in 2015 (CAGR of 2.0%). We see demand for BiW steel remaining broadly flat at a CAGR of -0.2% (supported by growth of 14% in ultra-high tensile steel demand). In contrast, we forecast rapid demand growth for aluminum alloys (17.5%), plastics (4.8%) and CFRP (16.1%, although from a low base).

Recycling could mitigate higher aluminum/CFRP costs

The lightweighting debate tends to focus on virgin aluminum costs, but we see considerable potential for lowering costs via recycled materials. Recycled aluminum generally sells for less than half the price of virgin aluminum, and if the use of recycled materials were to increase, the shift to aluminum and CFRP could exceed our expectations. According to Japan Aluminum Association, electricity costs account for around half the cost of aluminum. CO2 emissions (per ton) from production of secondary aluminum are 92% lower than those of virgin aluminum, indicating that aluminum is a very environmentally friendly material, even compared to copper and steel.

New materials may also necessitate retooling; servo presses key

Since aluminum is harder than steel and poses certain processing challenges (large springback, a high incidence of crinkling, low viscosity), it is more difficult to create a curved surface and form sharp character lines like those evident in exterior panels. Key to overcoming these technical challenges will be introducing stamping machines capable of more detailed pressure adjustments near the bottom dead center. We expect automakers to move ahead actively with the introduction of servo presses as replacements for existing hydraulic and mechanical stampers. We would note also that the introduction of servo presses relates not only to the shift to aluminum products. If multiple uses can be found for ultra-high tensile steel, it will join a number of other steel products that are hard to form. As to how to go about welding together multiple materials, although a number of new technologies have sprung up, we have yet to see a definitive solution.

New BiW materials aid market expansion; steelmakers changing tack toward higher added-value

Through 2025, we expect demand for new lightweighting technology to underpin the shift to aluminum and ultra-high tensile steel. Our global steel team estimates that steelmakers worldwide generated profits of US$ 25bn in 2014 (of which the auto industry contributed around 20-30%). With steelmakers currently facing a decline in per-vehicle steel volume, our best case scenario is for the industry to actively promote a shift to ultra-high tensile steel to boost average prices and sustain profit contributions from the auto sector. In contrast, aluminum suppliers are currently seeing an increase in per-vehicle volume, and we believe this will drive further earnings growth. We forecast expansion in the BiW aluminum market to US$20 bn in 2025 (from US$4 bn in 2015). We estimate that the BiW market for ordinary/high tensile steel will contract to US$17.6 bn in 2025 (from US$ 56.6 bn in 2015), but that the market for ultra-high tensile steel will expand sharply to US$51.4 bn (from US$13.7 bn) over the same period.

We highlight likely beneficiaries from lightweighting over medium term

Alcoa (Coverage Suspended; aluminum supplier): The world's largest aluminum producer, Alcoa is contributing actively to production of Ford's aluminum-bodied F150, and through cooperation is helping drive the shift to aluminum in automotive body design. Alcoa's Micromill aluminum alloys and process technology, launched in 2015, have succeeded in sharply reducing investment costs in aluminum refining, and the company is also leading the way in the development of 6000-series aluminum alloys that are easier to process as automotive parts.

Constellium (Coverage Suspended; aluminum supplier): Constellium is one of the world's largest makers of aluminum products. In 2015, 13% of its shipment volume was for auto applications. It forecasts that aluminum will account for 26% of the North American BiW market in 2025, up from 6% in 2015. Constellium acquired Wise Metals in 2014 and is revamping Wise's production facilities, which center on aluminum cans, to increase supply of aluminum for autos.

Kobe Steel (Buy; steel/aluminum supplier): Kobe Steel engages in both the steel and aluminum businesses. In its steel business, it has contributed to lightweighting and enhancing collision safety for Japanese autos via the development of ultra-high tensile steel for cold-pressing. We see potential for top-line growth in the aluminum business also, driven by demand from the auto industry.

UACJ (Neutral; aluminum supplier): A Japanese aluminum supplier, UACJ has a low sales weighting in auto-use aluminum (5%), but has announced investment plans for North America and is already preparing for a shift to aluminum body designs by Japanese automakers from 2020. Despite harsh earnings of late due to falling capacity utilization at its new Thai production facility, we highlight the company for its positioning as a pure player likely to benefit from the shift to aluminum over the medium term.

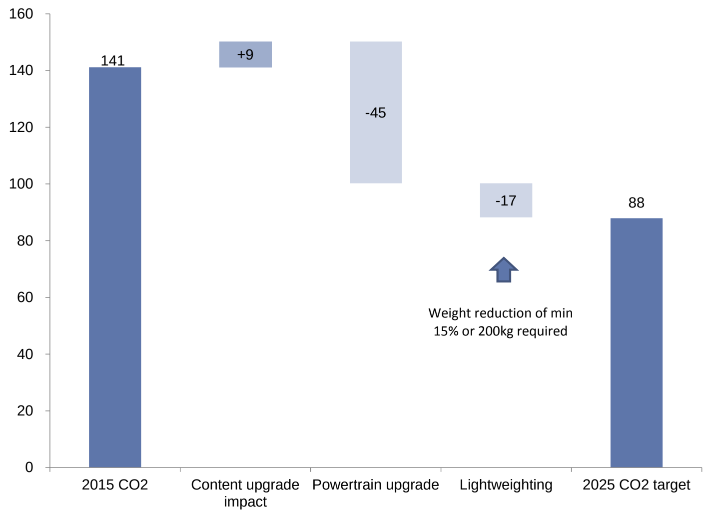
Ford (Buy; full aluminum body F150): Coming off of positive reviews and strong sales of Ford's new aluminum F150 pickup truck, we believe that Ford has shown its aluminum manufacturing capabilities by producing an all-aluminum BiW high-volume, mainstream vehicle as aluminum had been primarily used in high-end sedans and sports cars historically. While some had originally criticized the idea of utilizing significant amounts of aluminum for a pickup truck, given the harsher working environments that some pickups are exposed to, we believe that the F150 has been a success with sales up 3.5% in 2015 despite facing supply constraints in the early months of the year and the company steadily filling commercial orders.

Aida Engineering (CL-Buy; servo press maker): Aida Engineering is one of the world's largest producers of automotive servo presses. We expect advances in the production of automotive body materials, including ultra-high tensile steel, aluminum processing and hot press technologies, to spur a structural shift from machine to servo presses.

DaikyoNishikawa (CL-Buy; plastics supplier): The supply of interior panels to Mazda is a mainstay business, but sales of exterior body panels to both Mazda and Daihatsu also picked up in 2015. In particular, we highlight the structural shift from steel to plastic, especially for rear doors (and also possibly roof panels), at Japanese minicar makers focused on lightweighting. Plastics also have significant cost benefits versus aluminum, and we look for the company to expand its presence in Japan, albeit on a local scale.

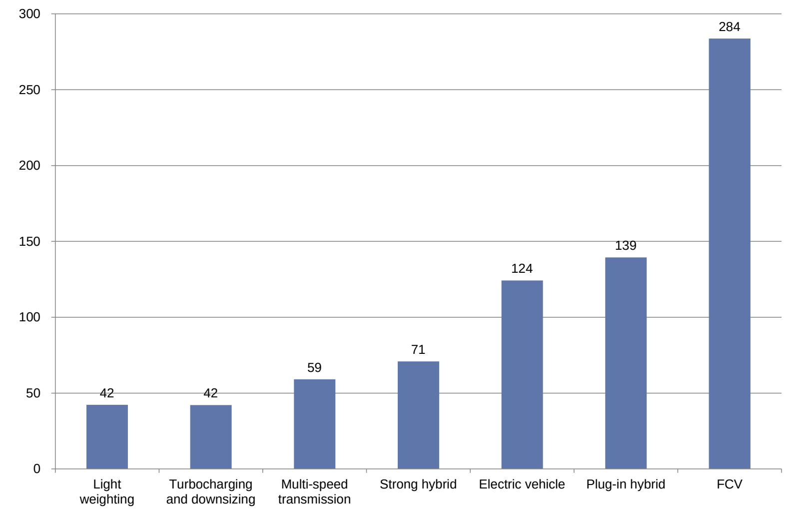
Minth (Neutral; plastics supplier): Minth is a major Chinese plastics manufacturer. Regulations regarding vehicle fuel consumption are tightening across global markets heading toward 2020. In China the fuel consumption standard will decrease by 30% from 2014's 7.22 liter/100km to 2020E's 5.0 liter/100km, followed by another 25% cut to 4.0 liter/100km by 2025E. Over the coming decades we expect more plastic and aluminum components to be used to make automotive structural parts as well as decorative parts. We see Minth as a pioneer in globalization among Chinese component makers (with >40% revenue in 1H15 coming from sales outside China and >90% revenue from global OEMs) will benefit from the global lightweighting trend.

Exhibit 1: Minimum of 15% (200kg) cut in weight needed to meet standards
Solutions for reducing CO2 emissions



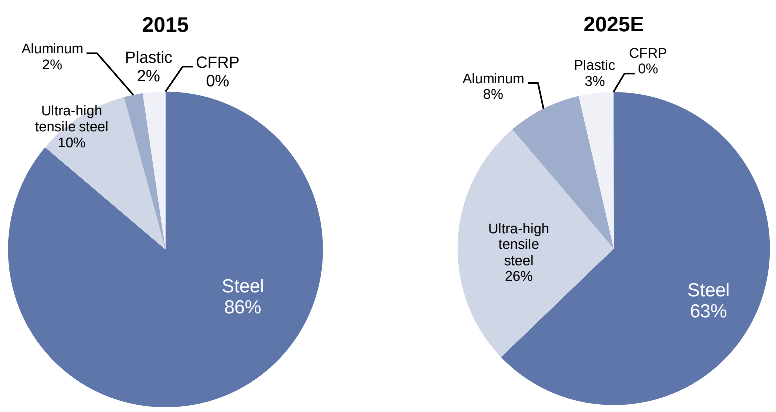
Source: Goldman Sachs Global Investment Research.

Exhibit 2: Lighter cars a reasonable approach to cutting CO2 emissions
Cost comparison for a 1 gram reduction in CO2 emissions (US$)



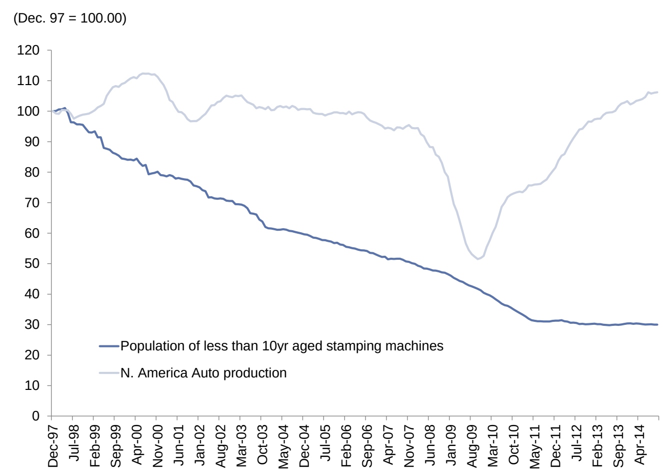
Source: Goldman Sachs Global Investment Research.

Exhibit 3: A multi-material approach to BiW
Material mix shift at BiW



Source: NEDO, Goldman Sachs Global Investment Research.

Exhibit 4: US replacement demand for stamping machines to pick up
No. of stamping machines less than 10 years in service and auto output



Source: Autodata, Japan Forming Machinery Association, Goldman Sachs Global Investment Research.

Exhibit 5: We focus on potential beneficiaries of the shift to ultra-high tensile steel/aluminum

Vehicle lightweighting: Potential beneficiaries

Company	Rating	FX	Apr 04 Price	Target Price	Return Potential (%)	Market Cap. ($mn)	Operating Profits				P/E			P/B			ROE		
							FY14 ($mn)	FY15E ($mn)	FY16E ($mn)	FY17E ($mn)	FY15E (x)	FY16E (x)	FY17E (x)	FY15E (x)	FY16E (x)	FY17E (x)	FY15E (%)	FY16E (%)	FY17E (%)
OEMs																			
Ford	Buy	$	12.8	16	25%	50,064	3,963	6,571	7,456	8,312	6.6	6.3	5.7	1.7	1.5	1.3	26%	24%	22%
Steel maker																			
JFE Holdings	Neutral	¥	1,459	1,500	3%	8,055	2,025	691	970	1,294	33.7	10.0	7.4	0.4	0.4	0.4	1%	4%	6%
Nippon Steel & Sumitomo Meta	Neutral	¥	2,094	1,800	-14%	17,887	3,180	1,458	1,482	2,444	13.2	13.9	9.0	0.6	0.6	0.6	5%	5%	7%
Kobe Steel	Buy	¥	95	150	58%	3,111	1,087	558	790	1,041	-	8.6	5.9	0.5	0.4	0.4	-3%	5%	8%
ARCELORMITTAL	Neutral	€	4.23	3.00	-29%	14,760	3,375	2,039	1,335	1,598	11.0	32.0	17.9	0.4	0.5	0.5	-31%	1%	1%
Voestalpine	Neutral	€	28.71	27.00	-6%	5,717	1,060	1,045	848	841	9.4	10.1	11.0	1.0	0.9	0.9	12%	10%	8%
POSCO	Neutral	KW	219,000	200,000	-9%	16,661	3,052	2,130	1,790	1,875	-182.1	18.6	15.9	0.4	0.4	0.4	0%	2%	3%
Hyundai Steel	Neutral	KW	54,700	47,000	-14%	6,369	1,416	1,294	1,290	1,385	9.7	7.8	7.3	0.5	0.4	0.4	5%	5%	6%
Aluminum maker																			
UACJ	Neutral	¥	222	265	19%	855	215	215	96	216	47.5	11.0	7.7	0.6	0.5	0.5	1%	5%	7%
Alcoa	CS	$	9.40	-	-	12,360	1,456	-	-	-	-	-	-	-	-	-	-	-	-
Constellium	CS	$	4.90	-	-	514	199	-	-	-	-	-	-	-	-	-	-	-	-
Novelis	NC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Resin																			
Daikyo Nishikawa	Buy*	¥	1,585	3,100	96%	1,053	112	154	175	195	9.7	8.9	8.0	2.2	1.8	1.5	28%	25%	23%
Minth Group	Neutral	HKD	18.40	12.36	-33%	2,627	193	226	267	297	16.0	13.6	12.5	2.2	2.0	1.8	14%	15%	15%
CFRP																			
Toray Industries	Neutral	¥	931	1,100	18%	13,650	1,124	1,321	1,596	1,698	15.9	13.3	12.5	1.4	1.3	1.2	9%	11%	10%
Teijin	NC	¥	381	-	-	3,372	-	-	-	-	-	-	-	-	-	-	-	-	-
Mitsubishi Chemical Holdings	NC	¥	558	-	-	7,559	-	-	-		-	-	-	-	-	-	-	-	-
Servo press machine																			
Aida Engineering	Buy*	¥	936	1,200	28%	620	72	69	75	78	9.3	9.2	8.9	0.8	0.8	0.8	9%	9%	9%
H & F	NC	¥	1,206	-	-	107	25	-	-	-	-	-	-	-	-	-	-	-	-
Schuler AG	NC	€	26.8	-	-	912	77	-	-	-	-	-	-	-	-	-	-	-	-

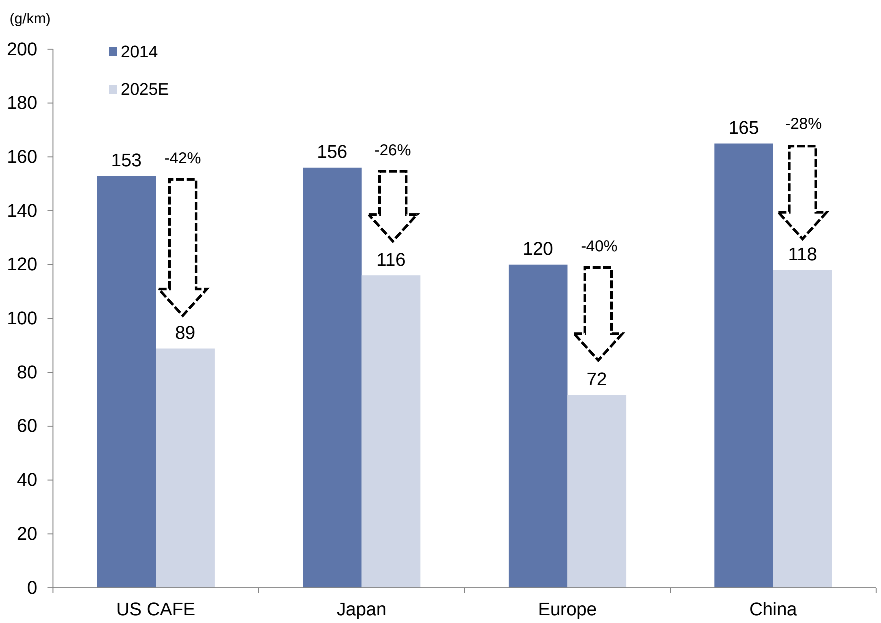
Source: Datastream, Goldman Sachs Global Investment Research.

Next decade challenge: 15% (200 kg) cut in vehicle body weight

Moves to tighten CO2 emissions standards

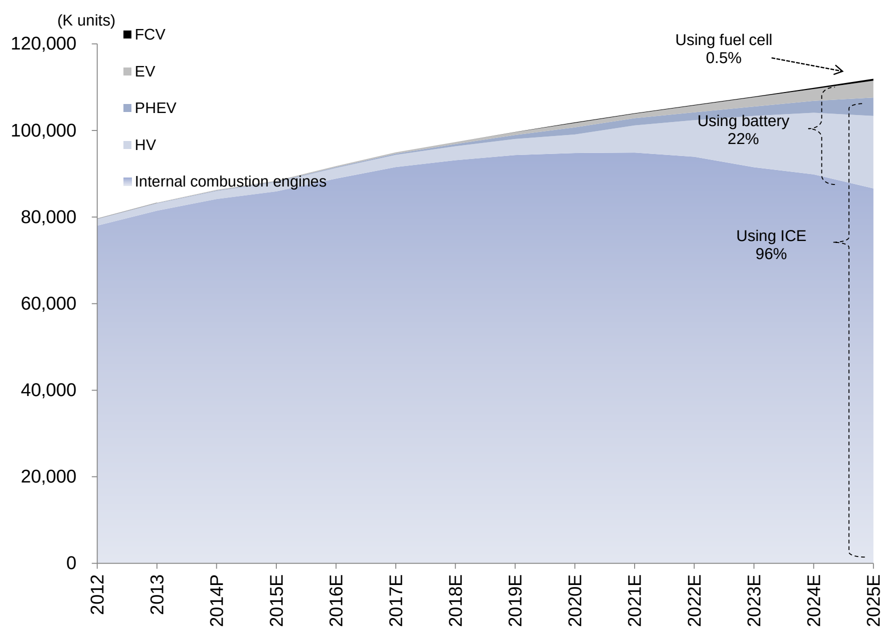
Fuel economy standards could tighten intermittently between 2020 and 2025, mainly in the US and Europe. The US corporate average fuel economy (CAFE) target of 54.5 mpg for the 2025 model year and the possible European CO2 emission target of 72g/km by 2025 (not officially decided yet) represent very challenging hurdles for automakers. China has decided to tighten fuel efficiency standards in response to increasing environmental problems, a heavy reliance on overseas energy (already more than 50%), and urban traffic congestion. We forecast vehicles with an electric powertrain system will account for 25% of global auto sales in 2025, up from 5% in 2015. While we expect hybrids to be the main type of electrified vehicle, we believe PHEV penetration is likely to accelerate in Europe, California, and other markets. Japan and Germany are considering generous subsidies for FCV, and we see potential for FCV demand to expand, albeit on a localized basis.

Exhibit 6: The auto industry faces tough emission standards
CO2 emission standards in major markets



Source: JAMA, US Department of Energy, European Union, Goldman Sachs Global Investment Research.

Exhibit 7: Electrification to advance over the next 10 years
Our forecasts for powertrain composition



Source: IIHS, Goldman Sachs Global Investment Research.

VW scandal may place increased focus on real-world fuel economy

We expect the VW emissions scandal that surfaced in October 2015 to have a significant impact on emission/fuel economy regulations. In Europe, discussions are progressing ahead of the adoption of Euro 6c emission standards in 2017, and automakers will need to pay increased attention to the difference between real-world and test-mode fuel economy. We consider lightweighting the most basic means of demonstrably improving fuel economy across driving modes.

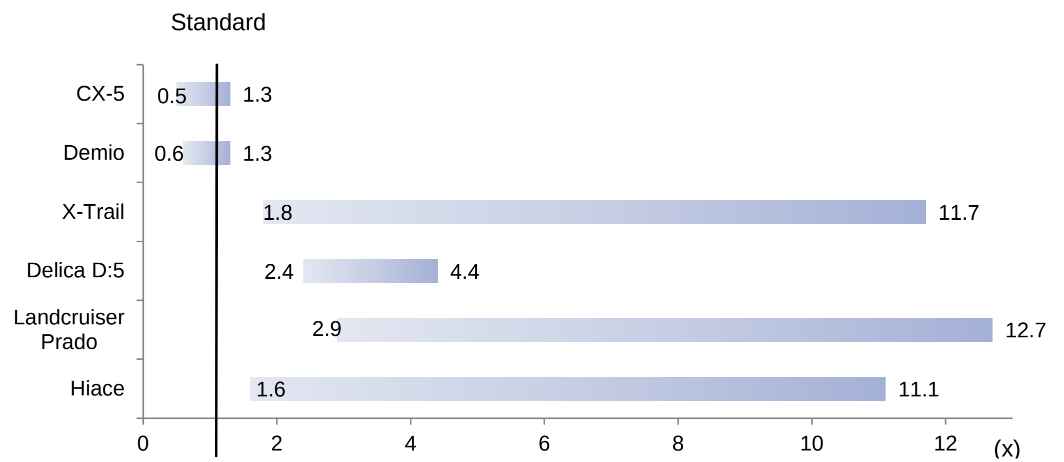
CO2 emissions: The Euro 6c CO2 emission measurements use the Worldwide harmonized Light vehicles Test Procedures (WLTP), the unified testing mode for Japan, the US, and Europe. The difference between test-mode and real-world fuel economy is calculated by comparing real driving emissions (RDE) conditions with WLTP results. New models tested from September 2017 will need to conform to a permitted difference of 2.1x or less between RDE fuel economy and certified (catalog) fuel economy. Discussions are also under way on narrowing this difference to 1.5x.

NOx and PN standards: The New European Driving Cycle (NEDC) is currently used to assess emission levels, but under Euro 6C RDE tests will be adopted as the uniform testing method in Europe. RDE test procedure details are currently under discussion, with technical adjustments being made to testing environments (test course, latitude, altitude, etc.).

Fuel efficiency debate not limited to Europe; Japanese gov't released sample test results in March

The VW exhaust emission scandal has led to an increase in testing of vehicles under real driving conditions in Japan and overseas. On March 3, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) announced results of on-road tests for five passenger cars and one commercial vehicle. NOx emissions relative to testing mode standards for diesel engines were as follows: CX-5 0.5x-1.3x, Mazda Demio 0.6x-1.3x, Nissan X-Trail 1.8x-11.7x, Mitsubishi Delica D5 2.4x-4.4x, and Toyota Land Cruiser Prado 2.9x-12.7x. Excess emissions do not constitute a breach of the law as Japan does not have on-road emission standards. However, given the discrepancies between the testing mode and on-road test results, we think this will prompt Japan to accelerate the introduction of on-road test standards in earnest.

Exhibit 8: On-road NOx emission volumes differ from testing mode results
Results of Diesel sample tests conducted by the MLIT



Source: Ministry of Land, Infrastructure, Transports and Tourism (MLIT).

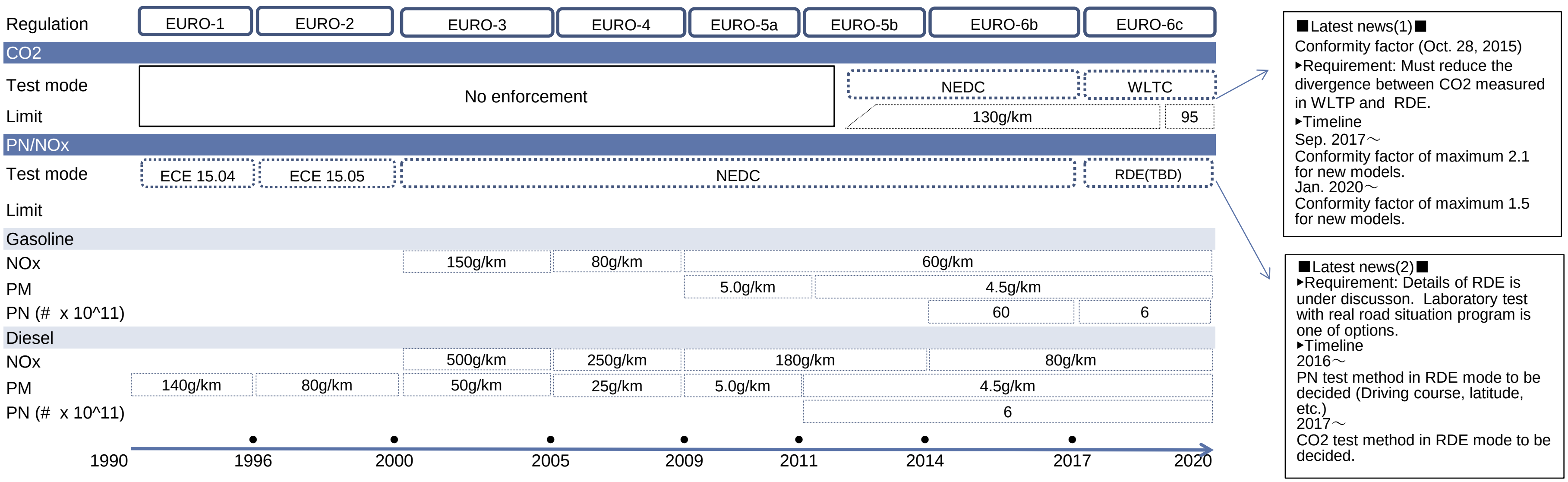
CO2 reduction not compatible with NOx reduction

The main objective of VW's diesel engine emission cover up was to reduce CO_2 emissions. As result, its lean NOx trap (LNT) exhaust gas (NOx) after-treatment system was only effective during testing mode. CO_2 emissions are usually controlled by improving engine thermal efficiency, but this increases emissions of NOx, particulate matter (PM), and other harmful substances. In theory, simultaneously reducing CO_2 and NOx is inherently difficult. Further improvements in engine thermal efficiency and expensive after-treatment systems (urea selective catalytic reduction, SCR) will be needed to meet environmental regulations slated for introduction around 2020 together with RDE.

Dark clouds for compact diesel engines

If RDE testing procedures are introduced, we believe it would result in diesel engine market contraction, at the very least for compact (1l class) engines. This is because after-treatment systems needed to meet emission regulations (LNT and urea SCR) are expensive (¥100,000-200,000) and absorbing them by raising sales prices would be difficult. Denso has a 10%-15% share of the global market for diesel common rail systems, and even if the pressure of fuel injection systems can be increased (to 300MPa from 250MPa) it has indicated that LNT and urea SCR would still be needed to pass RDE tests.

Exhibit 9: Fuel economy/emission standards to grow stricter in 2017-2020
European environmental standards

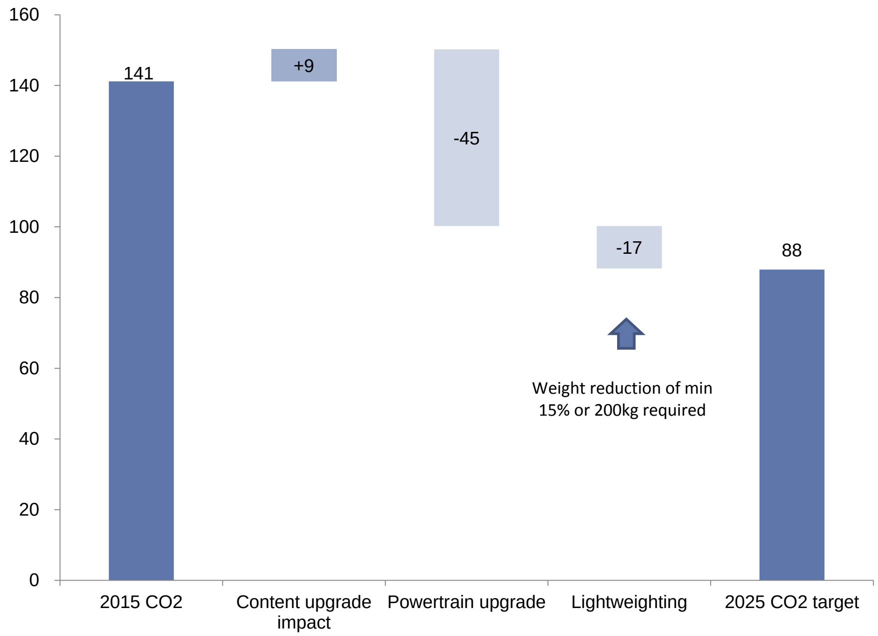


Source: European Union, company data.

Powertrain improvements alone insufficient to meet CO2 emission standards

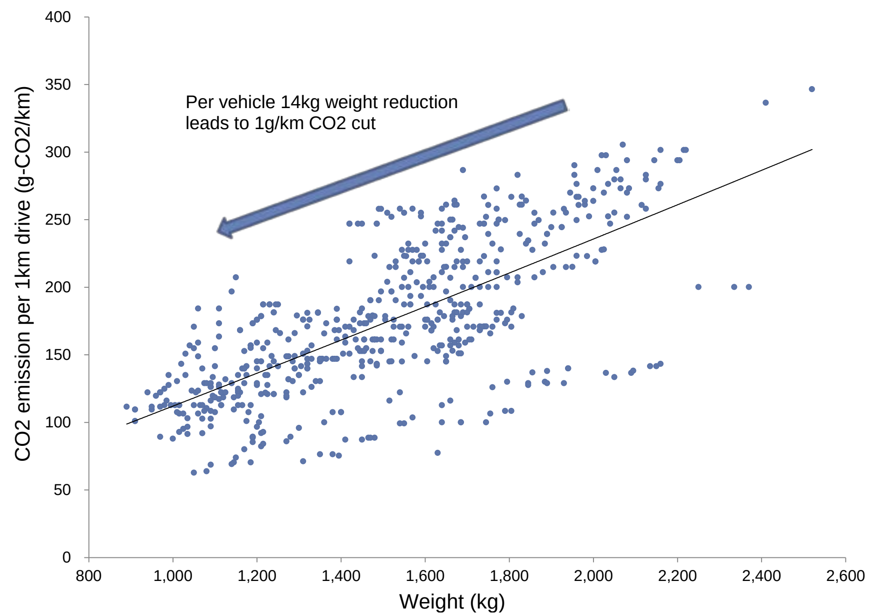
We see limits to how much powertrain improvements can help automakers meet the CO2 emission standards due to be in place by 2025. On a weighted-average basis, CO2 emission standards in the major markets of Japan, the US, Europe, and China call for a reduction of 53 g/km to 88 g by 2025, from 141 g in 2015. Meanwhile, a June 2015 survey by Japan's New Energy and Industrial Technology Development Organization (NEDO) indicates that safety/comfort/environmental enhancements to vehicles will increase their weight by 127 kg to 478 kg by 2030, from 351 kg in 2014. Such a rise in weight would increase CO2 emissions by 9 g/km, effectively bringing the required reduction in CO2 emissions to 62 g (53g + 9g). We estimate that powertrain improvements will cut emissions by around 45 g/km over the next 10 years, and believe weight reduction will need to account for the remaining 17 g/km. Assuming the average vehicle needs to be 15 kg lighter to reduce CO2 emissions by 1 g/km, we calculate that a 15% reduction in weight (around 200 kg) would be needed to cut CO2 emissions by 17 g/km.

Exhibit 10: Achieving CO2 emission standards through powertrain enhancements alone is likely to prove insufficient
Steps toward meeting 2025 CO2 emission standards



Source: Goldman Sachs Global Investment Research.

Exhibit 11: Vehicle weight needs to be reduced by 10-15 kg to cut CO2 emissions by 1 g/km
Relationship between CO2 emissions and vehicle weight

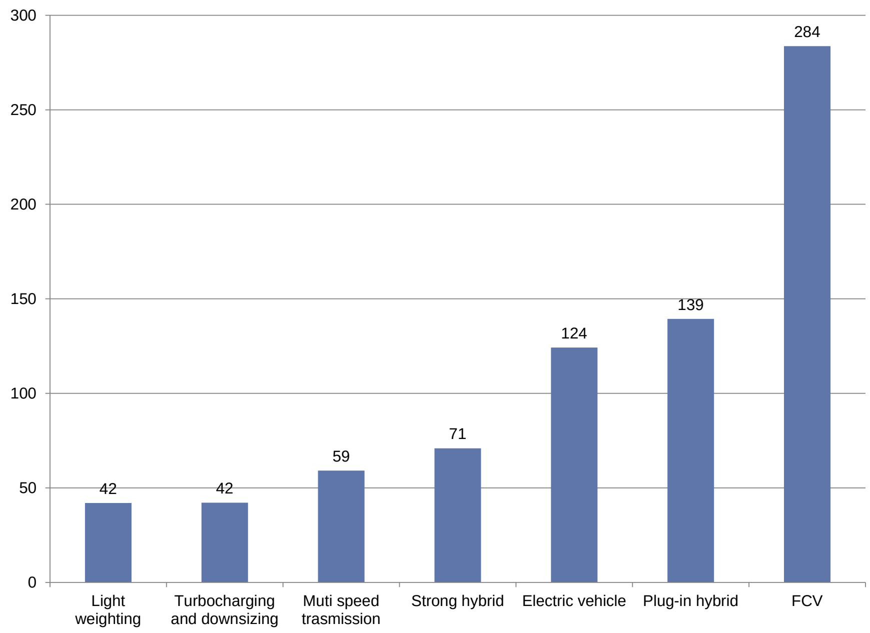


Source: MLIT

Lightweighting a reasonable solution from a cost standpoint, but difficult to achieve

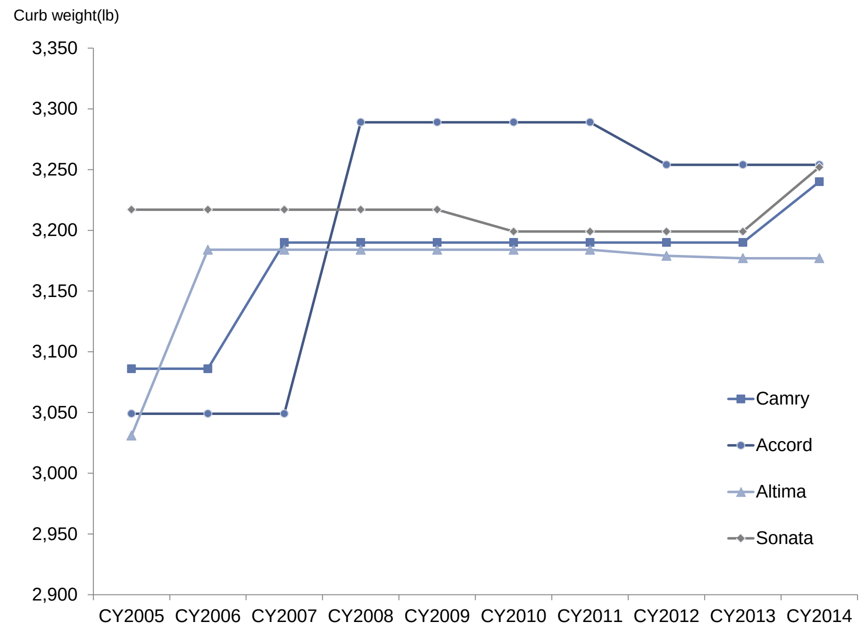
Among the various options for lowering CO2 emissions, lightweighting represents a cost-effective solution. Reducing CO2 emissions by 1 g/km costs US$42 via lightweighting, US$71 with a hybrid engine, US$139 with a plug-in hybrid engine, and US$284 with fuel cell technology (still in its infancy). Although cost effective, lightweighting is difficult to achieve. Over the past 10 years, major sedans sold in North America have been steadily getting heavier despite weight reduction targets. Indeed, the history of automobiles is one of sustained increases in body weight as automakers enhance safety functions and interiors to boost the appeal of their vehicles as products.

Exhibit 12: Lightweighting is a cost-effective approach
Required costs for every 1 g/km reduction in CO2 emissions (USD)



Source: Goldman Sachs Global Investment Research.

Exhibit 13: Many models have dieted unsuccessfully
Weight of major sedans sold in North America



Source: Company data.

Collision safety standards are becoming tighter

Auto safety remains high on the regulatory agenda. New Car Assessment Program (NCAP) and Insurance Institute for Highway Safety (IIHS) collision tests have been tightened in recent years, leading to greater requirements for use of high-strength materials in vehicle bodies, and undermining efforts to produce lighter cars. This dichotomy between lightweighting and collision safety is a source of frustration for auto engineers, and we believe the natural progression is to consider solutions such as employing thinner steel or lighter materials.

Exhibit 14: Wide-ranging collision safety standards around the world
Collision safety standards in major economies

	JNCAP (Japan)	U.S. NCAP (US)	IIHS (US)	Euro NCAP (Europe)	C-NCAP (China)
Full-lap rigid barrier	Speed: 55km/h Dummy: Hybrid III×2 (Male 2)	Speed: 56km/h (35mph) Dummy: Hybrid III×2 (Male and female 1 each)	×	Speed: 64km/h Dummy: Hybrid III×3 (Female 3)	Speed: 50km/h Dummy: Hybrid III×2 (Male and female 1 each)
Offset deformable barrier (passenger seat)	Offset ratio: 40% Speed: 64km/h Dummy: Hybrid III×2 (Male and female 1 each)	×	Offset ratio: 40% Speed: 64km/h Dummy: Hybrid III×1 (Male)	Offset ratio: 40% Speed: 64km/h Dummy: Hybrid III×2 (Male) , Q1.5×1 (1.5yrs old, assistant's back seat), Q3×1 (1.5yrs old, passenger back seat)	Offset ratio: 40% Speed: 64km/h Dummy: Hybrid III×3 (Male 2, Female 1)
Small overlap barrier (passenger seat)	×	×	Offset ratio: 25% Speed: 64km/h Dummy: Hybrid III×1 (Male)	×	×
Moving deformable barrier (passenger seat)	Barrier weight: 950kg Speed: 55km/h/90° Dummy: ES-2×1 (passenger front seat)	Barrier weight: 1,368kg Speed: 62km/h/27° Dummy: ES-2 re×1 (passenger front seat), SID IIs×1 (passenger back seat)	Barrier weight: 1,500kg Speed: 50km/h/90° Dummy: ES-2 re×2 (passenger front seat, passenger back seat)	Barrier weight: 950kg Speed: 50km/h/90° Dummy: ES-2×1 (passenger front seat), Q1.5×1 (1.5yrs old, passenger back seat), Q3×1 (1.5yrs old, assistant's back seat)	Barrier weight: 950kg Speed: 55km/h/90° Dummy: ES-2×1 (passenger front seat)
Pole	×	Speed: 32km/h/75° Dummy: SID IIs×1	×	Speed: 29km/h/90° Dummy: ES-2×1	×
Others	Whiplash mitigation	SUV rollover	Roof crush Whiplash mitigation	Pedestrian test Whiplash mitigation	Whiplash mitigation

Source: NASVA、NHTSA、IIHS、Euro NCAP、C-NCAP。

BiW a core lightweighting technology; adoption likely to accelerate on shift to ultra-high tensile steel/aluminum

BiW an appetizing diet for autos

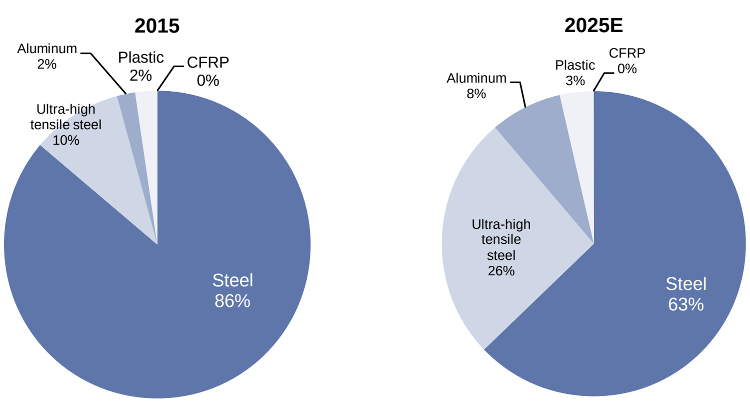
While lightweighting is a challenge across the range of automotive components, we believe the most appetizing diet for autos is to reduce the weight of the body-in-white (BiW; the body components that account for 33% of a vehicle's weight). Between 2015 and 2025, we project an acceleration in use of ultra-high tensile steel for the high-strength/structural components needed to ensure collision safety, and we see 1,200-1,800MPa tensile strengths entering the mainstream. We also expect automakers to actively adopt 5000/6000-series aluminum alloys for collision absorption/exterior components.

Exhibit 15: Reducing the weight of body components is the most appetizing vehicle diet
How we envisage use of materials in vehicle bodies by 2025

Body	% body weight
Frame	20%
Outer plate	6%
Inner plate	7%
Interior	11%
Suspension system	
Suspension	12%
Wheel	7%
Steering	3%
Powertrain	
Exhaust system	7%
Fuel system	
Transmission	18%
Engine	
Electrical parts, etc	
-	9%

(BiW)	2015E		2025E
Reinforcement	980MPa	→	1800MPa
Structual site	590MPa	→	1800MPa
Shock absorption	440MPa	→	AA6061/980MPa
Outer plate	340MPa	→	AA5052

Body material mix



Source: NEDO, Nikkei Automotive, Goldman Sachs Global Investment Research.

A multi-material approach to BiW

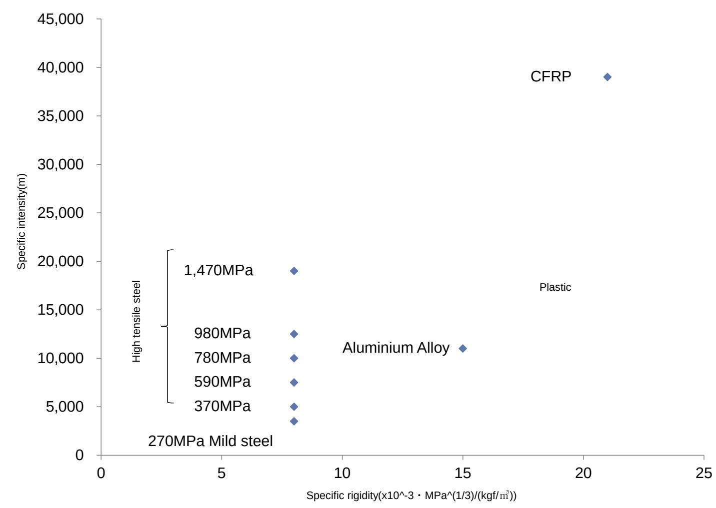
We expect automakers to employ a multi-material approach to BiW lightweighting, adopting materials best suited to different components. Decisions about which materials to adopt will likely be based on the overall merits of density, tensile strength, and cost. Although steel is inexpensive and easy to process, the use of ultra-high tensile steel to improve strength will require further advances in hot press and steelmaking techniques. Plastics reduce weight by around 30% at a moderate price, but we expect them to be used for a limited range of components given collision safety considerations. Aluminum alloys are somewhat expensive but look promising as they are easy to process and reduce weight by up to 50%. Carbon fiber reinforced plastics (CFRPs) are strong and lower weight as much as 80%, but we believe very high costs will prohibit their use in mass-market models in the near term.

Exhibit 16: Aluminum a good balance between lightweighting and cost
Properties of materials used for vehicle body components

	Steel	Plastic	Aluminium	CFRP
Lightweight properties	**0%**	**-30%**	**-50%**	**-80%**
Specific gravity	7.8	~0.9-2.3	~2.5-2.8	1.8
Cost($/kg)	**1.0-2.0**	**1.2-2.4**	**3.0-6.0**	**40.0**
Mechanical properties				
Specific rigidity	△	○-◎	○	◎
Specific intensity	△	x-◎	○	◎
Heat resistance	○	△-○	○	○
Melting point(℃)	1,530	200～300	660	-
Corrosion/Chemical resistance	x	○	△	○
Productivity	○	△-○	○	△

Source: Translation of data published by Japan Industrial Publishing in an Oct 2011 case study (Purasuchikku Jidoushabuhin: Keesu Sutadei Kara Yomitoku Genjou to Kinmirai) (Japanese only).

Exhibit 17: Pursuit of materials lighter than steel
Density and strength of various materials

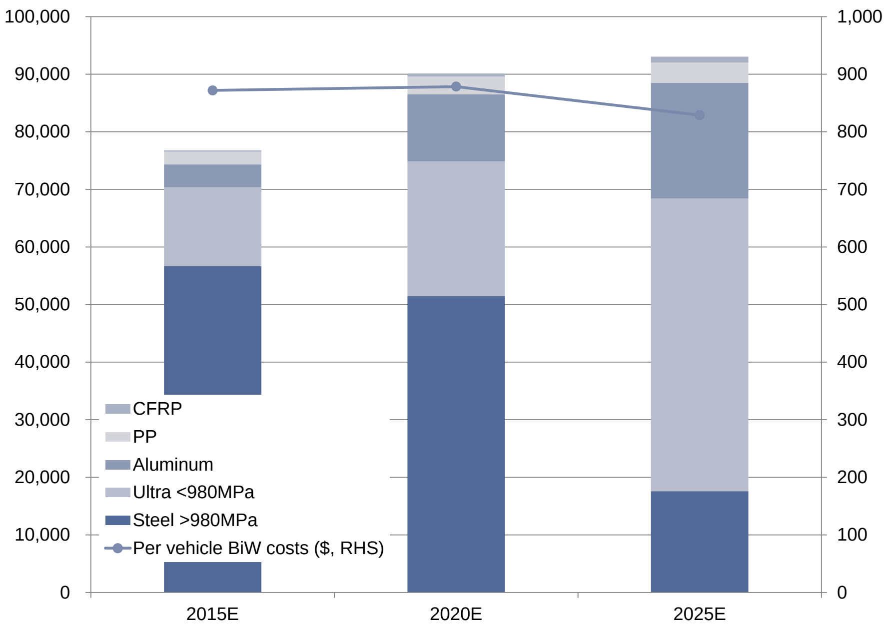


Source: Translation of data published by Japan Industrial Publishing included in an Oct 2011 case study (Purasuchikku Jidoushabuhin: Keesu Sutadei Kara Yomitoku Genjou to Kinmirai) (Japanese only).

Next 10 years: Ultra-high tensile steel mainstream, but aluminum use also likely to pick up

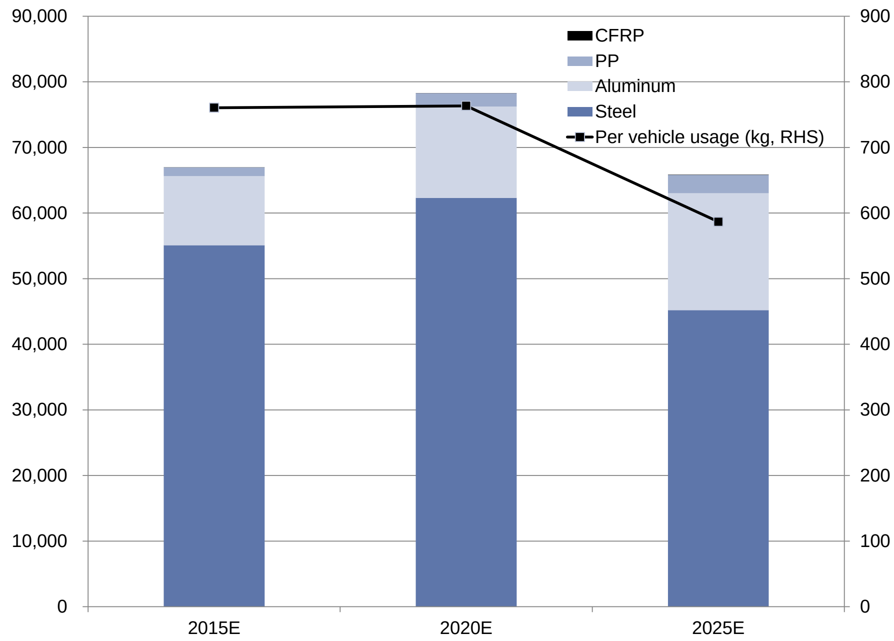
We forecast that the BiW global market will expand to US$94 bn by 2025, from US$77 bn in 2015 (CAGR of 2.0%). However, we expect the composition of BiW materials to change significantly over that period. We see demand for BiW steel remaining broadly flat at a CAGR of -0.2%, in contrast to which we forecast rapid demand growth for aluminum alloys (17.5%), plastics (4.8%) and CFRP (16.1%, although from a low base). We estimate the average BiW weight will decline to 587kg from 761kg, with much of this diet attributable to aluminum. Meanwhile, we project that BiW cost per vehicle will remain more or less flat, at US$846 versus US$872 in 2015. With steel ASP rising on wider use of ultra-high tensile steel, and greater use of high-priced aluminum alloys, we believe BiW lightweighting is unlikely to contribute much in the way of cost savings for auto makers over the next decade.

Exhibit 18: We forecast growth in the aluminum alloy market
Our market forecasts for BiW materials (mn USD)



Source: Goldman Sachs Global Investment Research.

Exhibit 19: We forecast a decline in per-vehicle volume of steel
Our market forecasts for BiW materials ('000 t)



Source: Goldman Sachs Global Investment Research.

High tensile steel/aluminum: We expect a shift to aluminum over the next decade

Greater use of high tensile steel has broadened the applications for steel

High tensile steel refers to steel plate with a tensile strength of 340-790 MPa (vs. 270 MPa or more for ordinary steel). In recent years, ultra-high tensile steel has also been developed with a tensile strength in excess of 980 MPa. The push to reduce vehicle weight and enhance collision safety has also driven repeated improvements in steel quality, and advances in the development of steel with even higher tensile strengths. For A and B pillars in particular, the number of automakers using steel with ultra-high tensile strengths of 1,180 MPa has increased. While definitions of high tensile steel vary in each market, in this report we define steel with a tensile strength of 980 MPa or higher as ultra-high tensile steel.

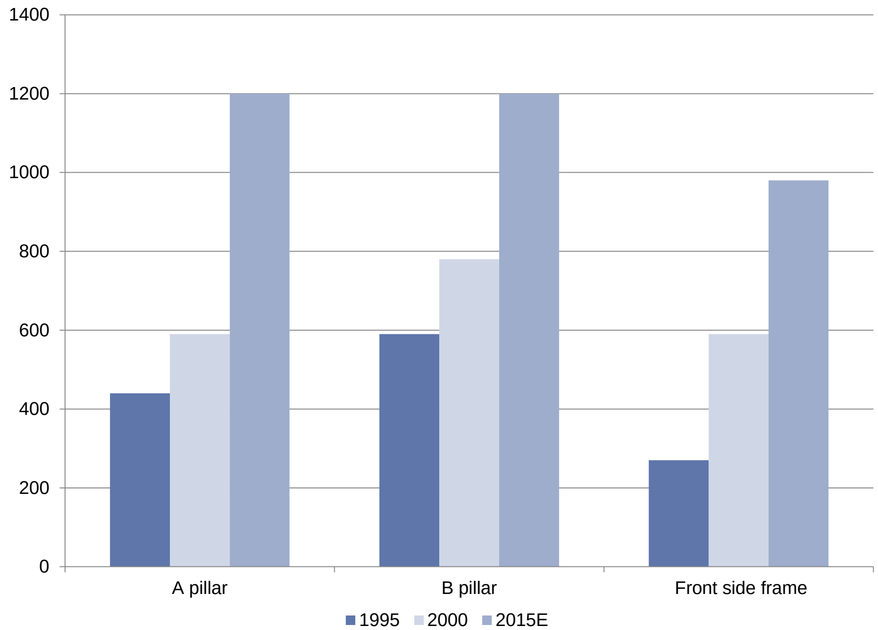
We expect the size of the BiW steel market to remain largely unchanged through 2025

We estimate the market for steel used in BiW at around US$70 bn in 2015, and we expect this figure to remain largely unchanged through 2025. We forecast a decline in the volume of steel per vehicle to around 400 kg, from around 600 kg, as the uptake of non-steel products increases, but see the market remaining around the same size on a value basis due to the shift to ultra-high tensile steel. We think steelmakers looking to successfully navigate the multi-material era will pursue greater value-added in high tensile steel products.

Mass production of cold-pressed ultra-high tensile steel (1,180 MPa) in manufacturers' sights

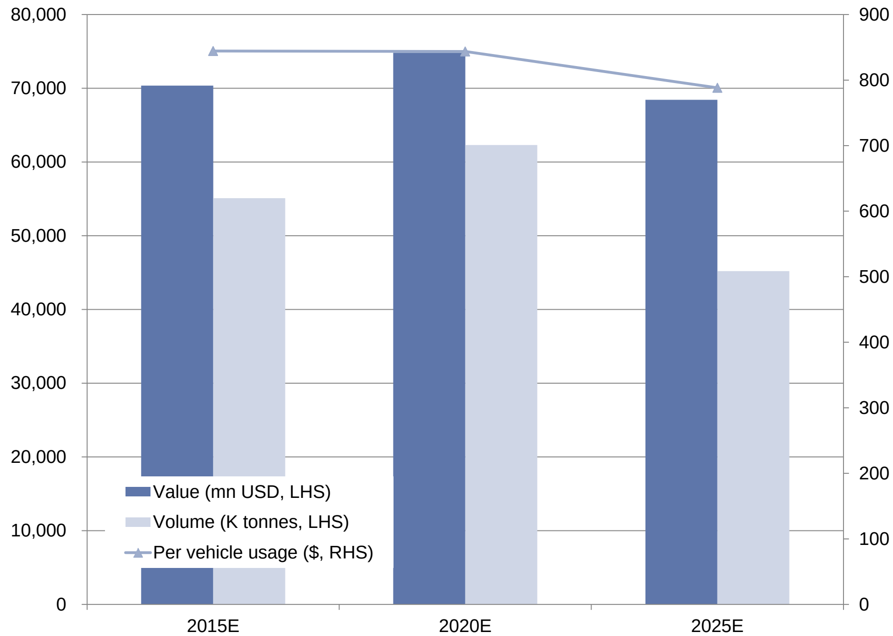
Japanese steelmakers and automakers in the main are committed to boosting the potential of cold-press processing methods, and some producers have already begun to ramp up production of ultra-high tensile steel (1,180 MPa) for use in auto body frame components. However, manufacturers that have transitioned to mass production (Mazda, Futaba Industrial) have commented on the difficulty of processing. They cite: **(1)** the tendency of steel to become brittle and crack as ductility declines when pursuing higher tensile strengths; **(2)** a decline in dimensional precision due to springback (elastic recovery when forming steel materials); and **(3)** degradation of molds used for ultra-high tensile steel, with manufacturers highlighting that the push for even greater high tensile steel strengths brings the risk of mold durability falling to as much as one-tenth the standard mold performance (service life) of 100,000 shots. As manufacturers actively move ahead with the development of ultra-high tensile steel of 1,500 MPa or more, it may be necessary to add a post-production ageing phase of 20 minutes or more into the cold-press process in order to prevent delayed fracture. We think automakers will continue to monitor advances in cold-press processing while also considering other options.

Exhibit 20: Progress with adoption of high tensile steel for auto body components
Transition to high tensile steel, by auto component (MPa)



Source: Goldman Sachs Global Investment Research.

Exhibit 21: We expect the size of the steel market for BiW applications to remain largely unchanged (on a value basis)
Steel market for BiW applications

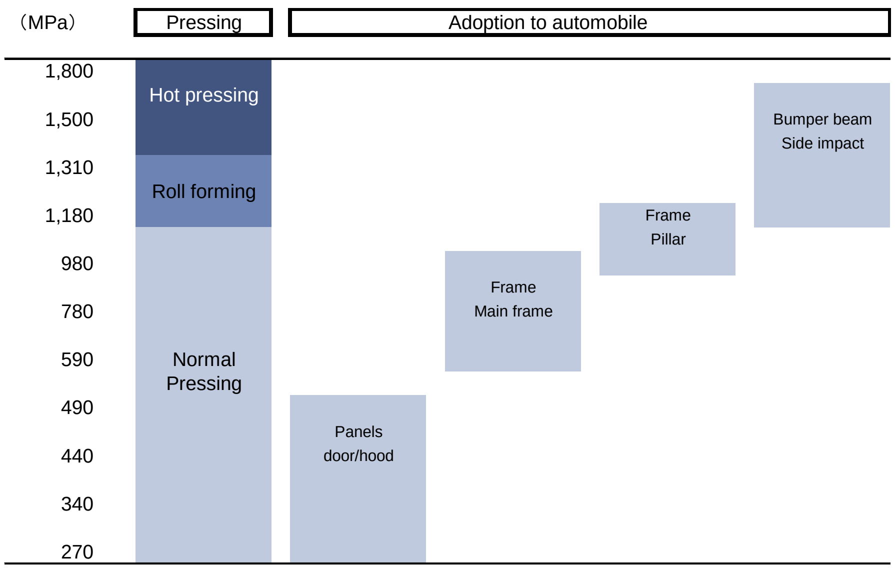


Source: Goldman Sachs Global Investment Research.

Hot-press process increases possibilities for steel; tensile strength to 1,500 MPa, from 500 MPa

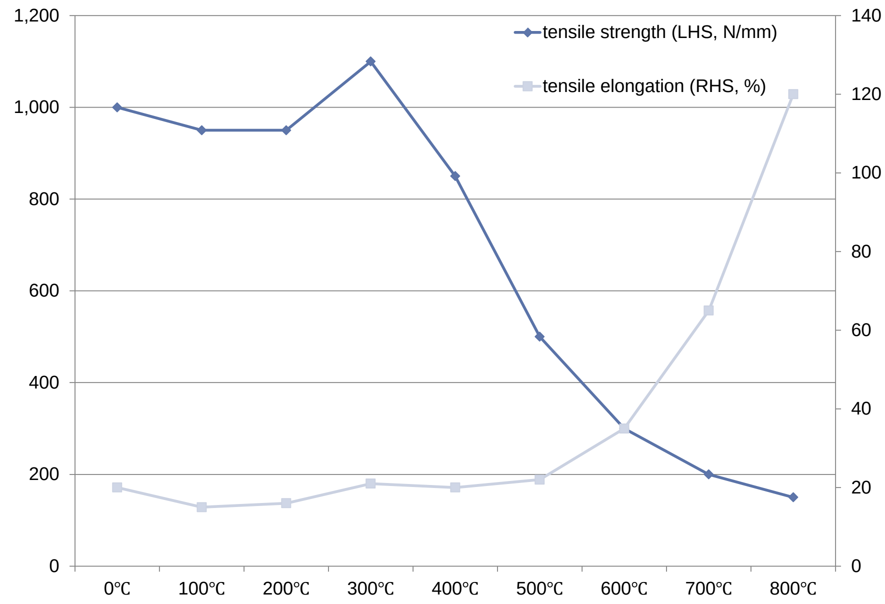
While further advancements in cold-pressed high tensile steel are needed to reinforce key body frame components, it has become possible in recent years to also produce high-strength steel with hot presses. Whereas high tensile steel tends to be extremely strong, poorer shape fixability caused by the springback effect makes processing difficult. From a sourcing perspective, it may not be possible to secure sufficient volumes of ultra-high tensile steel in emerging markets, but hot presses can be used to produce high-strength steel. The hot-press process currently strengthens 500 MPa steel to 1,500MPa by heating the steel to around 900C before pressing and cooling it, and R&D efforts are focused on raising tensile strength to 1,800MPa in future.

Exhibit 22: Hot presses could pave way for 1,800 MPa tensile strength
High tensile steel strength by pressing process



Source: Goldman Sachs Global Investment Research.

Exhibit 23: Applying heat makes high tensile steel easier to process
Balance between high tensile steel temperature and processability

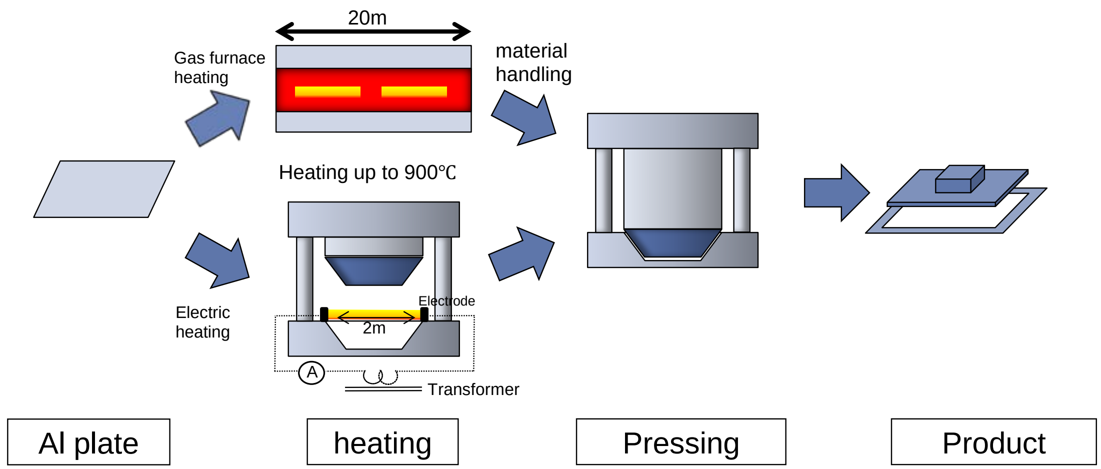


Source: Translation of data published by Japan Industrial Publishing in an Oct 2011 case study (Purasuchikku Jidoushabuhin: Keesu Sutadei Kara Yomitoku Genjou to Kinmirai) (Japanese only).

Hot press productivity improving but still an issue

European automakers have actively employed hot presses for some time. In Japan, the new Prius, launched in December 2015, marked a dramatic increase in the use of hot-pressed parts. In this latest iteration of the Prius, built under the Toyota New Global Architecture (TNGA), 19% of body components are made with hot presses, up from 3% in the previous model. While an increasing number of Japanese models now feature hot-pressed components, the hot pressing process reduces production efficiency by one-sixth because of the time required to heat the steel. High production costs have thus been a bottleneck to wider adoption of hot presses. Costs are also inflated because lasers are needed to trim the steel sheets after they are pressed due to their extreme hardness. However, whereas heating furnaces normally take 4-6 minutes to heat steel over a length of 20 meters, in 2012 Toyota perfected an electric heating process that can heat steel in 10-20 seconds with compact equipment requiring only two meters of space (Toyota uses an electric heating press to increase the tensile strength of 590 MPa steel to 1,470 MPa). We see potential for further production reforms to reduce the cost of hot pressing.

Exhibit 24: Electric process realized for hot pressing
Illustration of a hot press manufacturing process

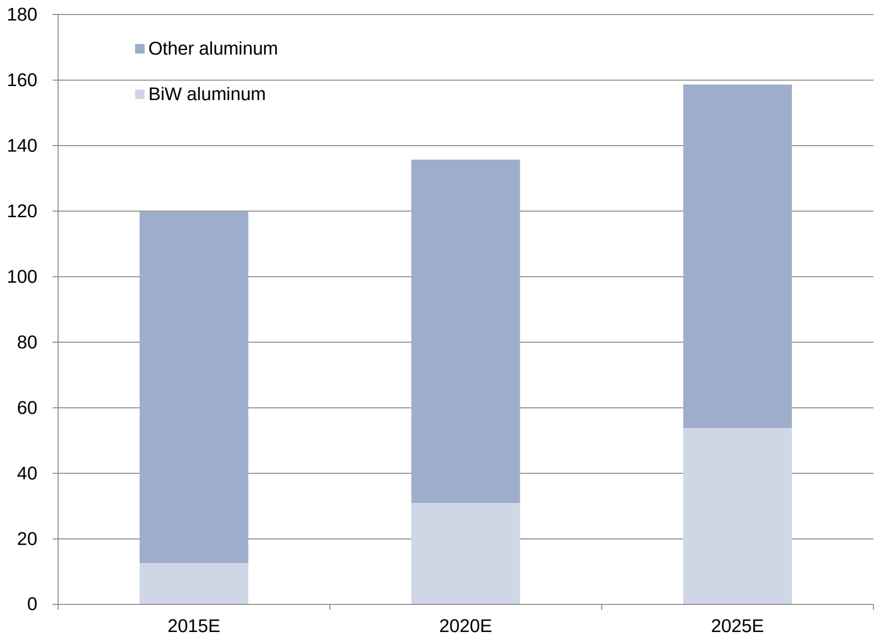


Source: Goldman Sachs Global Investment Research.

Greater use of aluminum crucial to further lightweighting

Cast aluminum components have long been used in auto engines and transmissions. In recent years, automakers have made increasing use of aluminum for hoods, doors, roofs, and other exterior components in an effort to reduce vehicle weight. Aluminum is one-third the weight of steel, and aluminum sheet is about 1.4x as rigid as steel sheet. As a result, replacing steel with aluminum can reduce weight by almost 50%. We estimate that per-vehicle aluminum usage will rise to 159 kg in 2025, from 120 kg globally in 2015, mostly in the BiW. Aluminum is already used for engine hoods in 20%-30% of vehicles, and we expect automakers to use aluminum more in trunk lids, doors, and roofs. For the body frame, however, we believe automakers will continue to use ultra-high tensile steel, and we estimate aluminum body frame penetration will be limited to around 10% by 2025.

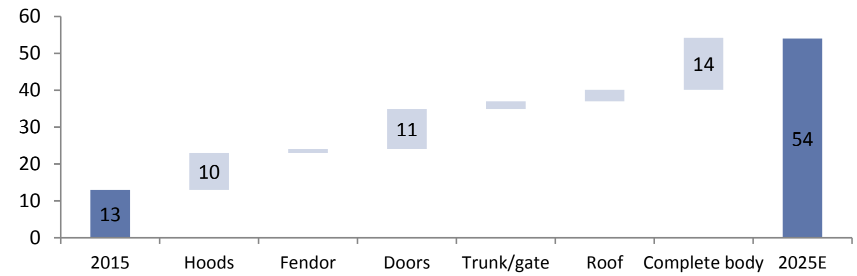
Exhibit 25: We expect greater use of aluminum in BiW
Our forecasts for aluminum usage per vehicle (kg)



Source: Goldman Sachs Global Investment Research.

Exhibit 26: Aluminization accelerate from hood
Aluminization forecast by auto parts

	Weight (kg)		Aluminum usage		Light weight impact
	Steel	Aluminum	2015	2025 GSE	
Hoods	50	25	24%	64%	-10
Fendor	20	10	3%	14%	-1
Doors	150	75	3%	17%	-11
Trunk/gate	30	15	3%	17%	-2
Roof	50	25	2%	14%	-3
Complete body	400	200	2%	9%	-14



Source: Goldman Sachs Global Investment Research.

Shift to aluminum a niche trend before 2014

Aluminum has been used for body components in the past, including in the Honda NSX, the Mazda R8, and other sports cars in the 1990s. More recently, Audi, Land Rover, and other premium European brands have actively incorporated aluminum bodies. Electric vehicle (EV) maker Tesla has uses an all-aluminum monocoque body and BMW's new i3 EV has an aluminum and CFRP body (body lightweighting has made further progress with EVs as automakers look to lengthen driving distances). However, these examples represent either luxury models or models produced in small volume; aluminum bodies have yet to be adopted fully in mass-market cars.

Ford F150 the frontrunner of an aluminum revolution

More than a year has passed since Ford unveiled an all-aluminum BiW for the F150, the best-selling vehicle in the US. The shift to production using aluminum has been smooth, with no issues of note, and the F150 continues to sell well. We believe this demonstrates how the change to an aluminum body has won the support of the US public. We expect other automakers to step up use of aluminum BiWs, mainly for pickups, SUVs, and other heavy-duty vehicles. In Europe, the ambitious investment plans of aluminum suppliers suggest to us that automakers' use of aluminum may also increase in the region.

Exhibit 27: Aluminum body vehicles were formerly reserved for luxury/small-lot models
Examples of aluminum bodies

Model	Company	Characteristic of production facility
Range Rover Sport (Weight:2,144kg)	Land Rover	Adopted aluminum monocoque body from 2013 FMC(the industry's 1st in SUV). Using rivet and adhesive. This is because spot welding process for aluminum requires 5 times the amount of electricity compared with a normal spot welding process.
Model S (Weight:2,108ks)	Tesla	Tesla purchased 6-axis press machine from auto manufacturer in Detroit. Model S adopts aluminum extrusion for main frame which requires strength. Uses both flat seam(expensive) and rivet(reasonable) for joint. Robots of KUKA(German FA manufacturer) are used in production line.
i3 (Weight:1,260kg)	BMW	Adopted aluminum for drive module(chassis) and CFRP for cabin. Uses adhesive to join aluminum and CFRP.

Source: Company data, Nikkei Automotive.

Exhibit 28: Ford switched to an all-aluminum body for the F150, the best-selling vehicle in the US
US unit sales ranking by model (K units)

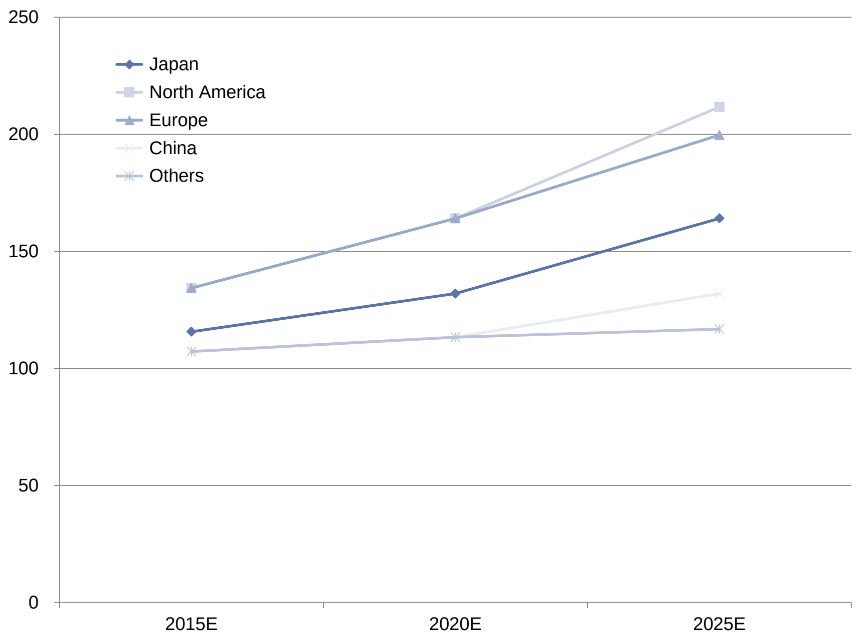
		2014	2015	Yoy	Portion
1	Ford F - Series PU	754	780	3.5%	4.5%
2	Chevrolet Silverado PU	530	601	13.4%	3.4%
3	Ram 1500-3500 PU	440	451	2.6%	2.6%
4	Toyota Camry	429	429	0.2%	2.5%
5	Honda Accord	388	356	-8.4%	2.0%
6	Honda Civic	326	335	2.9%	1.9%
7	Toyota Corolla	339	363	7.0%	2.1%
8	Toyota RAV4	268	315	17.8%	1.8%
9	Honda CR-V	335	346	3.2%	2.0%
10	Nissan Altima	336	333	-0.7%	1.9%
	Total	**16,522**	**17,470**	**5.7%**	**100.0%**

Source: Autodata.

Per-vehicle aluminum volume set to increase, led by Europe/US

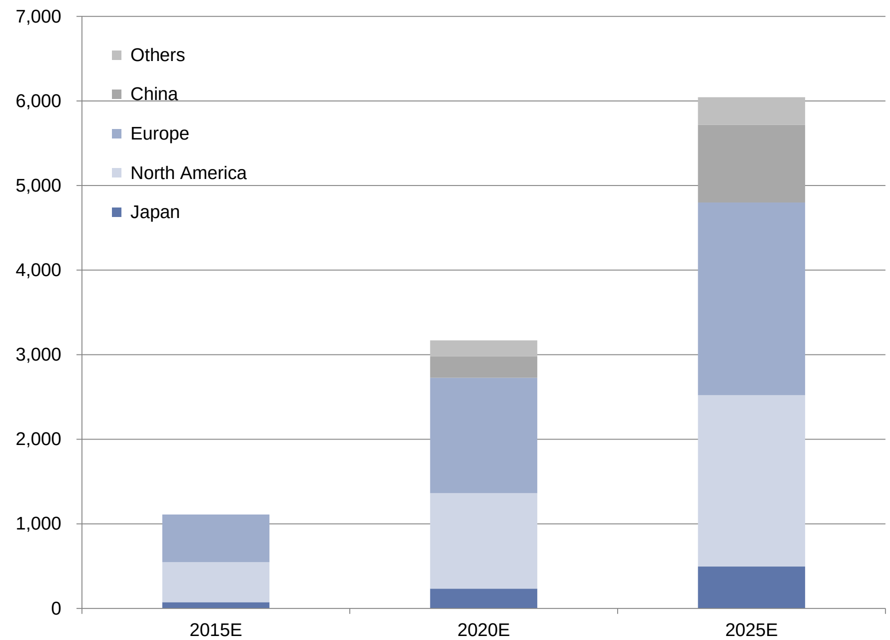
In the US, we forecast that per-vehicle aluminum volume will increase to 212 kg in 2025, from 134 kg in 2015. For Europe, we forecast an increase to 200 kg, from 134 kg. US aluminum major Alcoa has a more bullish outlook (250 kg in 2025), and plans to steadily invest in facilities on this basis. We estimate that the market for BiW aluminum will expand to 6 mn tons in 2025, from 1 mn tons in 2015.

Exhibit 29: Europe and the US leading the shift to aluminum
Per-vehicle aluminum volume, by region (kg)



Source: Goldman Sachs Global Investment Research.

Exhibit 30: BiW aluminum market growing, mainly in Europe and North America
Aluminum usage volume forecasts, by region ('000 t)

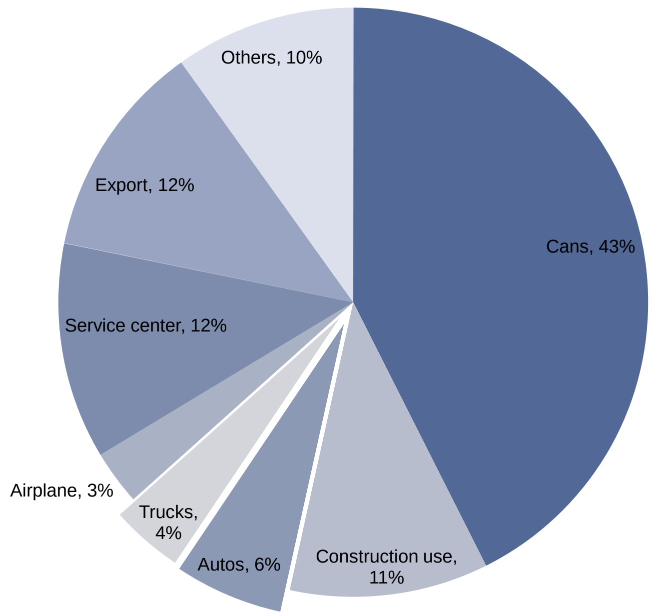


Source: Goldman Sachs Global Investment Research.

Price a potential stumbling block to aluminum use, but we expect no rapid increase

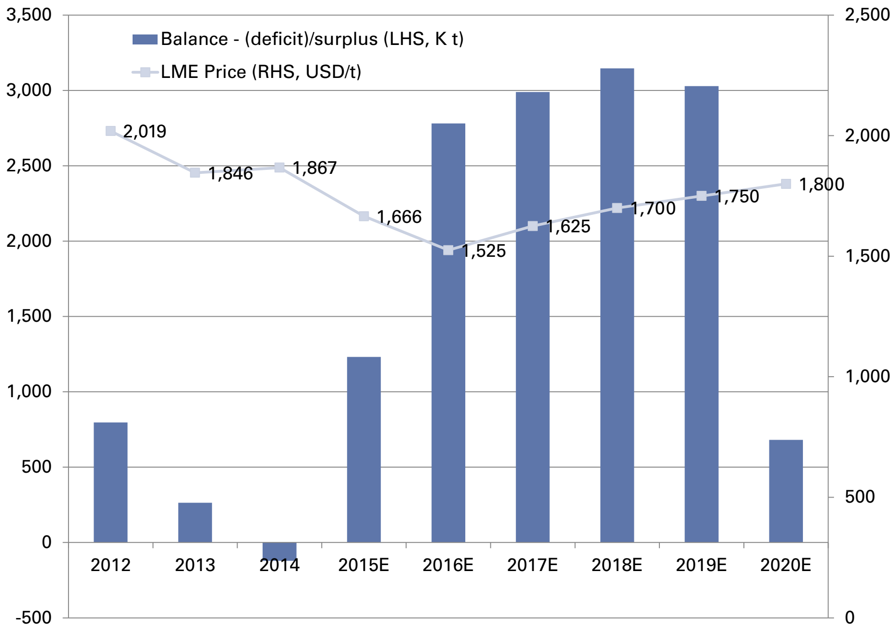
We see price stability and supply structures as the biggest obstacles to the use of aluminum in autos. The auto industry currently accounts for about 6% of total aluminum consumption and thus exerts no major impact on global supply/demand. Our commodities team forecasts excess aluminum supply through 2020 and is not expecting any steep price increase (many contracts between aluminum suppliers and automakers pass through changes in raw material price with a 3-month lag). Electricity accounts around half of aluminum production costs and we highlight electricity price volatility as a potential issue. In Japan, where electricity rates are relatively high, aluminum makers are not actively expanding production.

Exhibit 31: The auto industry accounts for just 6% of the aluminum market
Aluminum consumption by application (2014)



Source: Automotive Technology, Goldman Sachs Global Investment Research.

Exhibit 32: We expect excess aluminum supply to persist for now
Aluminum supply/demand model and price forecasts

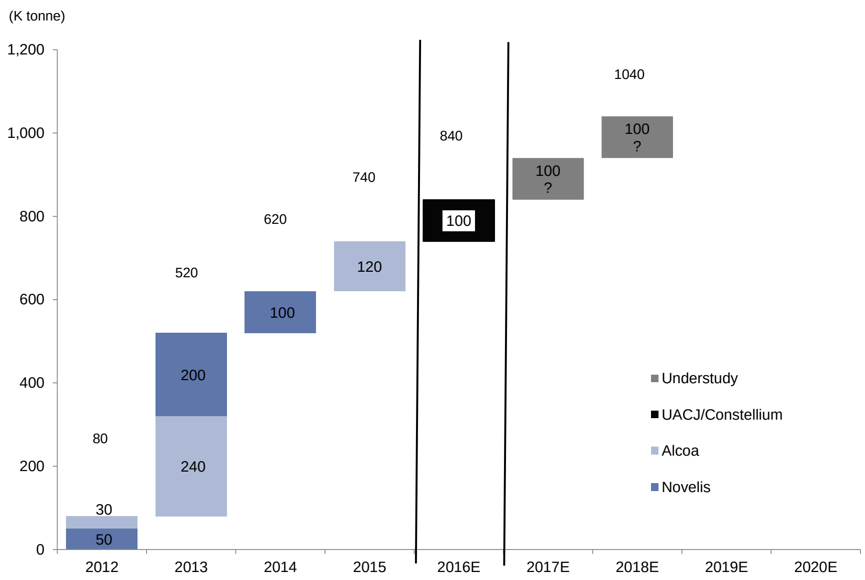


Source: Datastream, Goldman Sachs Global Investment Research.

Supply structures a possible medium-term issue; bake hardening behavior warrants attention

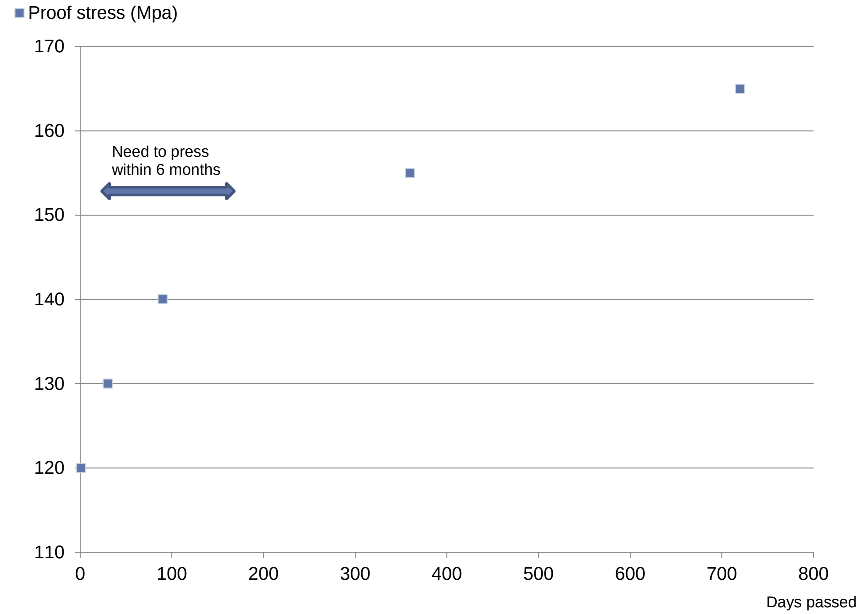
Increasing production of auto-use aluminum is often accommodated by switching lines used for aluminum beverage cans. Aluminum makers have been able to make quick near-term decisions on ramping up auto-use aluminum production because they have been able to divert a large portion of existing plant facilities. Over the medium term, however, greater use of aluminum by automakers could result in a shortage of front-end production capacity. Unlike upgrading back-end processes, front-end investment is expensive for aluminum suppliers. Unless they receive firm commitments from automakers to increase aluminum consumption, we think it would be difficult for aluminum makers to make the large investment required. Based on announced plans to expand production of auto-use aluminum, we forecast demand of around 1 mn tons competing for supply of 1.04 mn tons by around 2018. Due to their bake hardening behavior, aluminum alloys must be dispatched for pressing into auto parts within 2-3 months of production. Geographical relationship is a more important consideration for aluminum suppliers and auto assembly plants than it is for steel suppliers and auto assembly plants.

Exhibit 33: We expect supply of auto-use aluminum in North America to tighten around 2018
Auto-use aluminum alloy capacity expansion plans in North America



Source: Company data.

Exhibit 34: Aluminum needs to be pressed within 3-6 months of production
How aluminum behavior changes over time



Source: Japan Aluminum Association.

Plastics/CFRP: Steady shift to plastics; CFRP adoption also picking up in luxury models

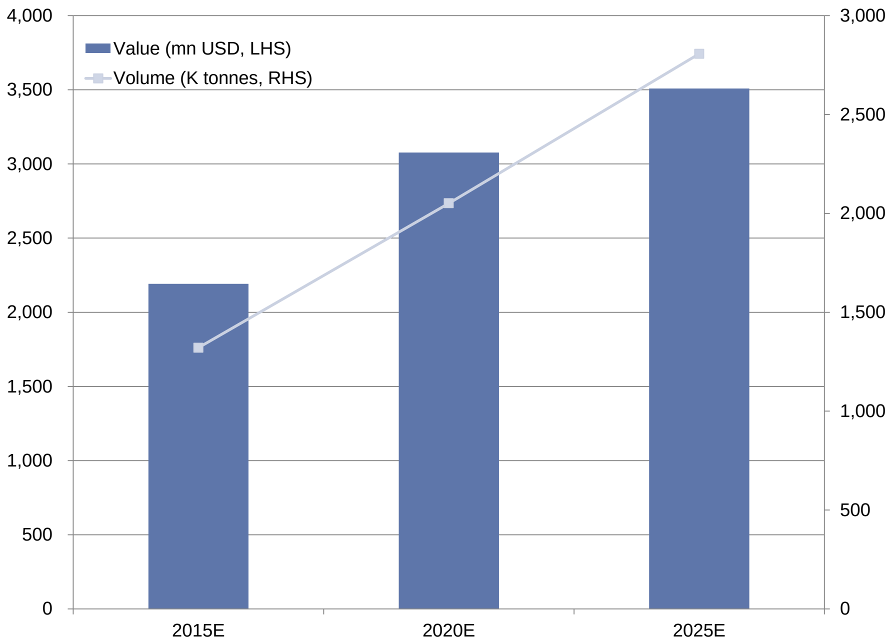
Plastic body components are on the rise; we see strong growth potential for CFRP as of 2025, but still a small market

We estimate the market for BiW plastics was worth around US$2 bn in 2015, and we forecast it will expand to US$3.5 bn by 2025. Plastic is mainly used in bumpers (about 15 kg per bumper), but is steadily being employed in tailgates, particularly by Japanese automakers. We estimate the per-vehicle plastic volume will increase to 25 kg by 2025. For CFRP, on the other hand, cost and ease of processing remain major hurdles and we believe market expansion through 2025 will be limited. We estimate the BiW CFRP market was worth around US$200 mn in 2015 and will only be worth around US$1bn in 2025. Over the next 10 years, we expect the adoption of CFRP to center on luxury cars, like the BMW 7 series. We consider 2025 the earliest potential starting point for use of CFRP in mass-market models.

Plastic offers a wealth of benefits

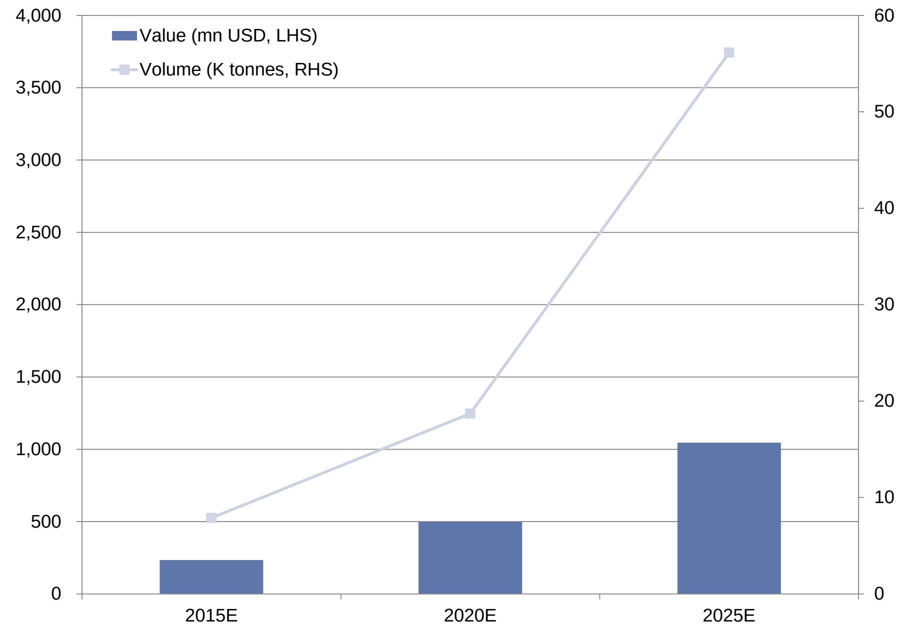
Replacing steel with lighter materials is critical to offset the factors that increase vehicle weight. Besides aluminum, we expect automakers to step up use of plastic for certain auto parts. Plastic has a density of 0.9-2.3, making it lighter than steel (7.8) and aluminum (2.5-2.8), and is a versatile material for auto parts with complex shapes because of its malleability. Plastic is cheaper than aluminum but almost 1.5X the price of steel. Other disadvantages are that is not as heat resistant as aluminum or steel, its surface rigidity is low so it marks easily, and it is vulnerable to solvents. Plastic is processed using injection molding machines rather than presses, so in many cases using plastic requires fresh investment in equipment. The use of plastic for large exterior components in particular would necessitate investment in large injection molding machines.

Exhibit 35: Shift to plastic seems a natural progression
BiW plastic demand outlook



Source: Goldman Sachs Global Investment Research.

Exhibit 36: CFRP likely to still be a small market in 2025
BiW CFRP outlook



Source: Goldman Sachs Global Investment Research.

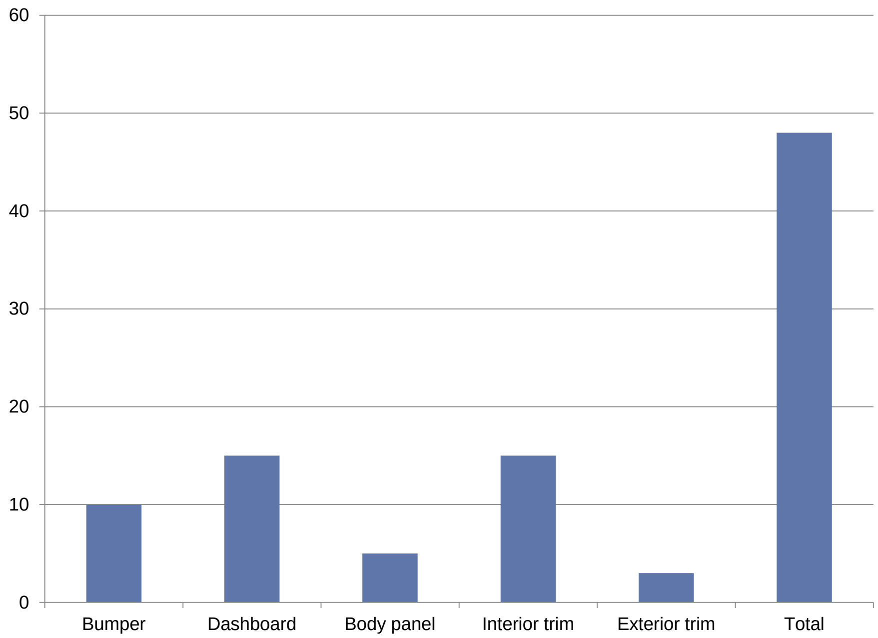
Focus on use of plastic for exteriors

The pace at which plastic is being adopted varies by vehicle part. Most visible interior parts are already made almost exclusively of plastic, such as instrument panels, door trims, and steering. Plastic is now also used almost universally for bumpers. The bumper was originally intended to protect the chassis in a collision, but changes to safety regulations mean that today the bumper plays an important role in minimizing injury to pedestrians if they are hit by a vehicle. Another reason plastic bumpers have become mainstream is that bumpers have become more of a vehicle design feature. We believe plastic could be adopted to reduce the weight of tailgates, fenders, and other parts. Glass fiber reinforced plastic (GFRP) is the mainstream for exterior components in view of collision safety regulations.

Tangible shift to plastics in Japan

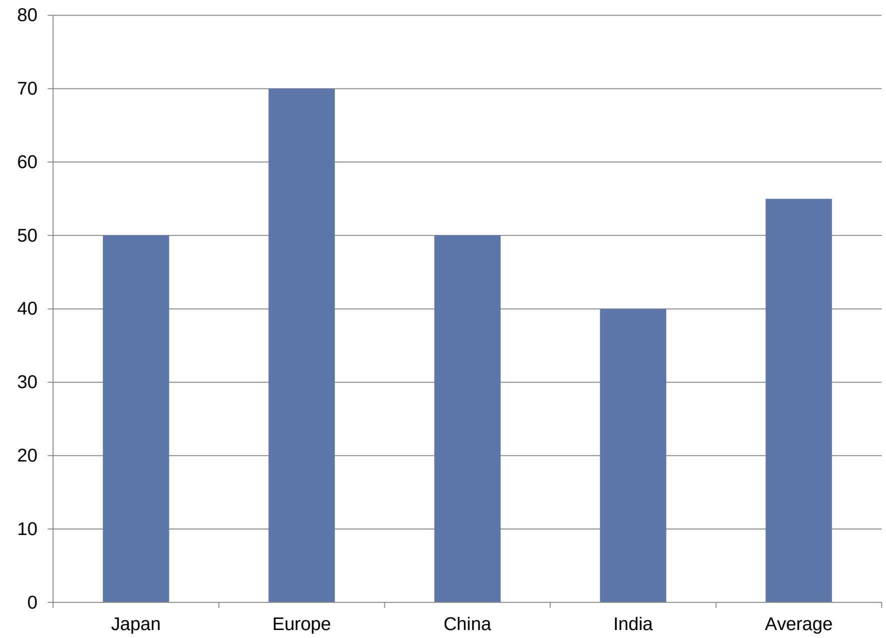
A cheaper alternative to aluminum and CFRP for reducing vehicle weight, plastic is ideally suited for mas-market models from a cost perspective. We believe automakers will target use of plastic in rear doors before fuel economy regulations are tightened in 2020. In Europe, where fuel economy regulations are set to tighten further, many vehicles made by European automakers already feature plastic fenders and other parts, and per-vehicle plastic volume averages 70 kg, versus 50kg for Japanese automakers. In Japan, only minicars have plastic rear doors but we believe some regular passenger cars are likely to feature them too in future.

Exhibit 37: Use of plastic in body panels centers on bumpers
Estimates of per-vehicle plastic usage volume (kg; as of 2012)



Source: Goldman Sachs Global Investment Research.

Exhibit 38: Europe leads the adoption of plastic, but Japan is catching up
Estimates of per-vehicle plastic usage volume by region (kg; as of 2012)

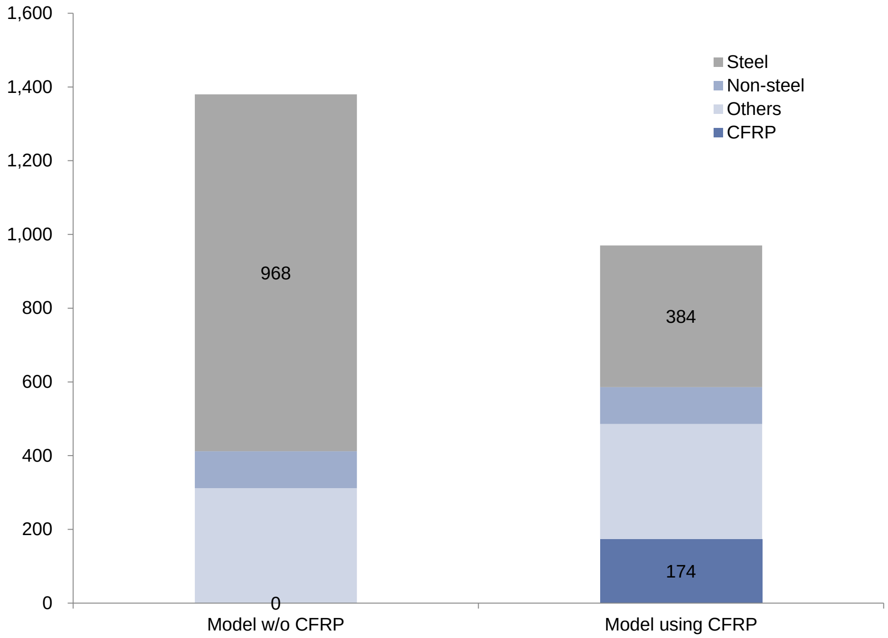


Source: Goldman Sachs Global Investment Research.

CFRP: Costs generally seen to outweigh benefits to date

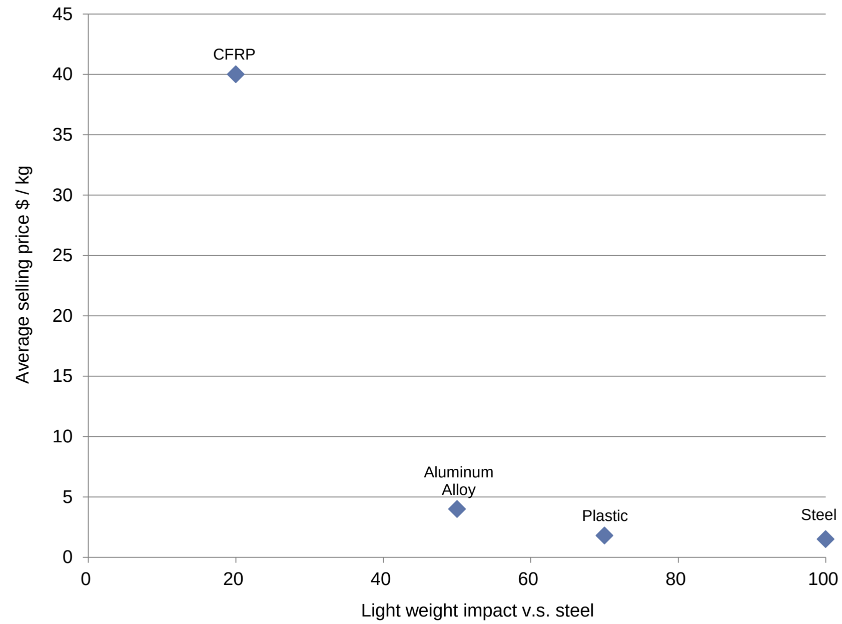
NEDO has calculated that CFRP could reduce the weight of future vehicles by 410 kg (23% of current body weight). From a lightweighting perspective, CFRP is evidently a superior material. However, CFRP use is currently limited to sports cars produced in small volume. CFRP is more expensive than aluminum alloys, with a price of US$40/kg, requires a longer processing time, and is much more difficult to repair (for instance, post-accident plating services are costly). In our view, CFRP is not yet suited to mass-market models.

Exhibit 39: CFRP could reduce vehicle weight by 20-30%
CFRP weight reduction calculation by NEDO (kg)



Source: NEDO.

Exhibit 40: CFRP optimal for lightweighting...
... but also costly



Source: NEDO.

BMW i3 and the new BMW 7 series highlight potential for expanding use of CFRP

The materials used in auto body components are currently shifting from ordinary steel to high tensile steel, ultra-high tensile steel, and aluminum alloys, and we believe CFRP will eventually join the fray too. CFRP is already used in many supercars, but has made few inroads as a material for mass-market models. BMW was able to keep the weight of the i3, released in November 2013, to 1,195 kg by employing a 100 kg CFRP cabin and an aluminum alloy chassis. With a sales price of ¥4.99 mn and an annual sales target of several tens of thousands units, the i3 is one step short of a mass-market model. In the 7 Series for the 2016 model year, BMW has made extensive use of CFRP to cut the BiW weight by 40 kg.

Exhibit 41: CFRP use in supercars
Vehicles that feature CFRP

Company	Toyota	Daimler	BMW
Model	**Lexus LFA**	**Mercedes-Benz SL**	**i3**
Applied parts	Cabin	Inside rear lid	Cabin
Production method	Prepreg, RTM, SMC	RTM	RTM
Weight	19kg(inc. cabin and aluminum)	-	Around 100kg
Mold manufacturers	In-house production	Euro Advanced Carbon Fiber Composites	In-house production
Release	2010	2012	2014
Price	JPY 37.5mn	JPY 9.2mn(EU)	JPY 4.9mn
Production vol.	500 units	-	10,000-20,000 Units per year

Source: Nikkei Automotive.

Exhibit 42: Employing CFRP in the BMW i3 is a complex process
CFRP distribution channel

PAN fiber	Hiroshima plant	Mitsubishi Rayon
↓		
7μ PAN fiber	Washington St. US	SGL Automotive Carbon Fibers JV with BMW (JPY10bn investment)
↓		
Stack process(cloth)	Bayern DE	ACF
↓		
CFRP parts	Landshut plant DE	BMW

Source: Nikkei Automotive.

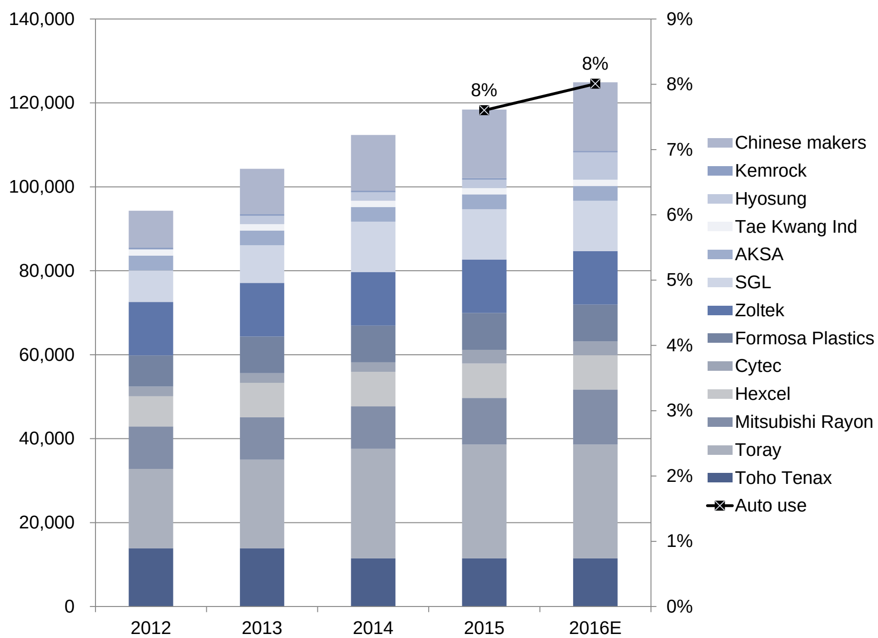
New BMW 7 Series realizes a significant improvement in body rigidity using CFRP

The body of the new BMW 7 Series has an aluminum base (50%-60%) and also uses CFRP (20%-30%). This has enabled BMW to reduce the BiW weight by 40 kg. We believe BMW has cut costs by using CFRP instead of carbon fiber reinforced thermoplastics (CFRTP). The body rigidity achieved in the 7 Series was a highlight of the EuroCarBody 2015 conference. Many of the components used for the BiW are hot pressed, and BMW also fuses various materials (high-tensile steel + CFRP, aluminum + CFRP, etc.) to suit the best combinations for different components. Having created hybrid materials for the BiW, BMW in our view is likely to take a proactive approach to employing CFRP in other series. We see potential for the company to step up use of CFPR in its luxury models as well as its supercars going forward.

CFRP capacity expansion plans

Production capacity for polyacrylonitrile (PAN) carbon fiber, a key input for CFRP, was a little over 110,000 tpy as of 2014. We forecast capacity will increase modestly to around 130,000 tpy in 2016. Most PAN carbon fiber is used in aircraft. Auto applications account for just 8% (9,000 t) of final demand and at this time we see no signs of any plans to ramp up capacity quickly to meet auto industry demand for CFRP. We believe the timing of PAN carbon fiber capacity expansion by CFRP suppliers will be a useful leading indicator of CFRP adoption by automakers. CFRP has a lifespan of only three months and its quality deteriorates quickly. Once mixed with plastic, CFRP must be refrigerated and delivered to the production base within around three weeks. As such, a key focal point for us is where CFRP makers locate production sites. We believe BMW currently transports most of the CFRP it uses by air. In future, however, production of CFRP closer to plants may be required.

Exhibit 43: Autos account for only a small portion of demand
PAN carbon fiber production capacity ('000 t)



Source: Company data, Goldman Sachs Global Investment Research.

Exhibit 44: Cost and performance varies depending on production method
CFRP production method

CFRP production method	Method	Advantage	Disadvantage
AC	Typical method. Thermoset prepreg in a high temp/low pressure kettle after cutting laminate processing.	High degree of freedom informing	Low productivity.
SMC	Press and thermoset carbon fiber soaked with resin.	Short cycle time	Low strength
RTM	Put carbon fiber in a mold and thermoset while injecting resin.	-	-

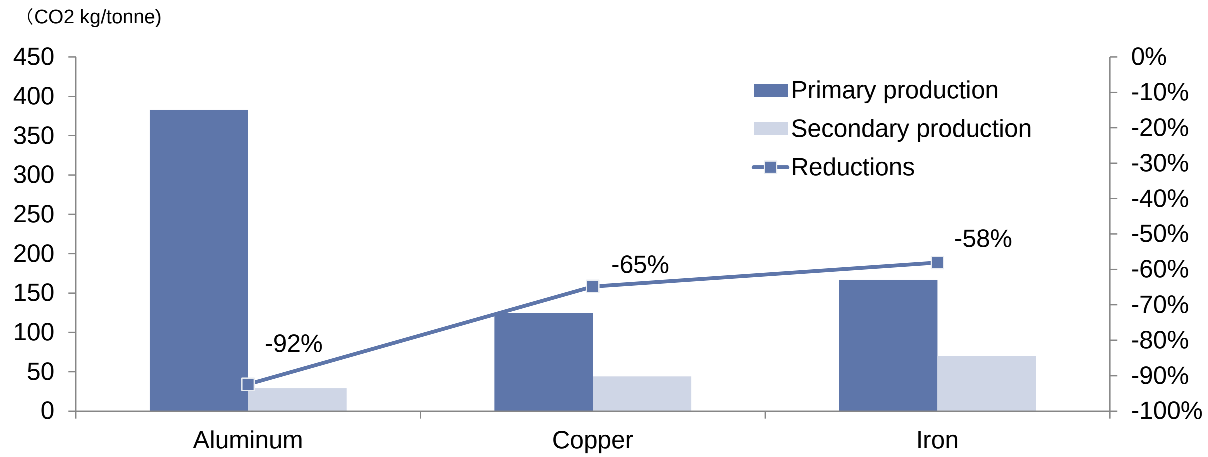
Source: Motor Fan.

Potential for recycled materials: Aluminum well suited to recycling

Recycling could mitigate higher aluminum/CFRP costs

The lightweighting debate tends to focus on virgin aluminum costs, but we see considerable potential for lowering costs via recycled materials. Recycled aluminum generally sells for less than half the price of virgin aluminum, and if the use of recycled materials were to increase, the shift to aluminum and CFRP could exceed our expectations. According to Japan Aluminum Association, electricity costs account for around half the cost of aluminum. CO_2 emissions (per ton) from production of secondary aluminum are 92% lower than those of virgin aluminum, indicating that aluminum is a very environmentally friendly material, even compared to copper and steel.

Exhibit 45: Aluminum is well suited to recycling
CO2 emissions by material



Source: Japan Iron And Steel Recycling Institute.

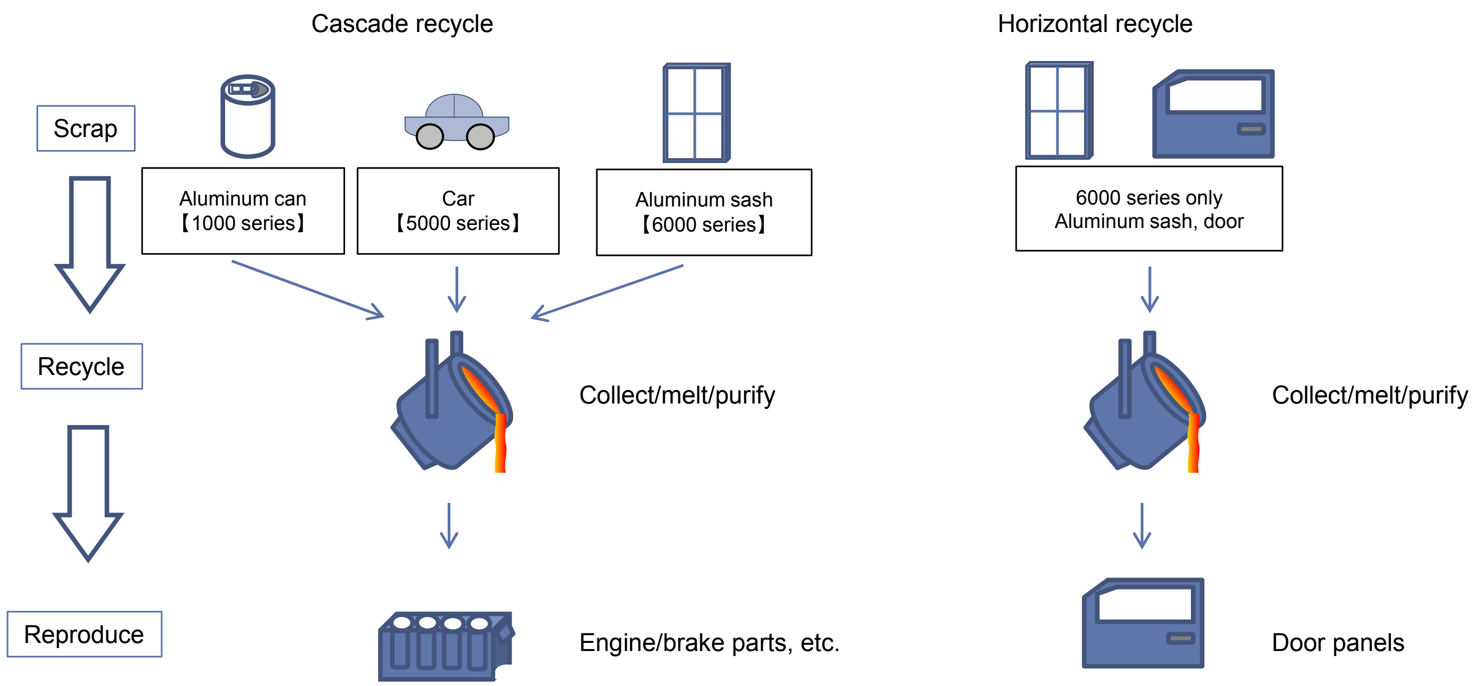
Mixed production of steel and aluminum on the same press line is not desirable

Pressing body panels (especially doors) produces considerable scrap. Constructing systems to effectively recycle this scrap can help reduce material costs, but mixing this scrap with steel or other materials undermines recycling efficiency. In models such as the Ford F150 that use full aluminum bodies, good quality scrap can be obtained because only aluminum is used on the press line. We believe one reason Ford opted for a full aluminum body is this increase in scrap recovery rate.

Laying the foundations for horizontal recycling will take time

Recycling of auto parts and aluminum cans will become even more critical in future. Recycling takes two forms—Cascade (where recycling of a material degrades its properties) and Horizontal-loop (where a material can be recycled without degradation of properties). Auto-use aluminum mainly undergoes cascade-loop recycling at present. Generally, various 5000/6000-series aluminum alloys used in autos are collected together and reused in aluminum die casting as they contain too many impurities to manufacture recycled aluminum. If it becomes possible to recover 6000-series aluminum only, or possible to sort the materials at low cost, it should not be long until recycled aluminum is frequently used in auto exterior panels.

Exhibit 46: Horizontal recycle is essential for aluminum recycle
Aluminum recycle



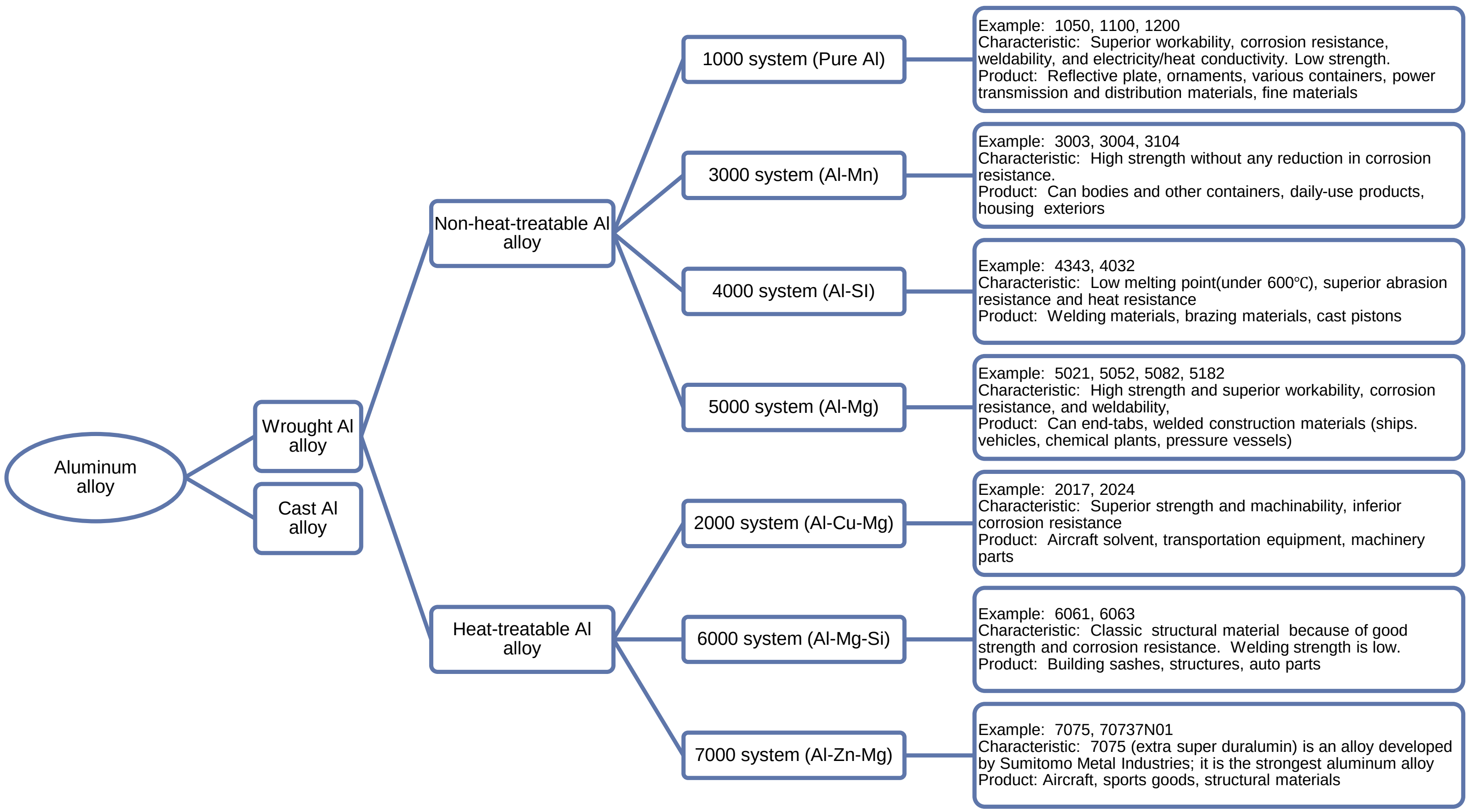
Source: Goldman Sachs Global Investment Research.

Evolution of aluminum sorting equipment

Competition to develop technology for sorting different types of aluminum materials is ongoing in Japan, the US, and Europe, led by the respective governments. Technology has been developed in which collected aluminum materials are broken down into 30-mm squares and then placed on conveyor belts, where lasers and X-rays are used to extract only the aluminum, and the focus now is on reducing costs. Most scrap companies are SMEs, so mechanisms need to be put in place for effectively recovering quality recycled materials by establishing horizontal organizational structures led by the government. We believe the potential uses of recycled aluminum in car manufacturing have yet to be fully realized.

Exhibit 47: Many varieties of aluminum alloys

Types of aluminum



Source: Goldman Sachs Global Investment Research.

Manufacturing equipment: New materials to drive production line change; focus on presses/joining technologies

Processing a major obstacle to wider use of aluminum

Aluminum's main distinction is that it has a density one-third that of steel, so it can significantly contribute to making vehicles lighter. However, aluminum is around three times more expensive than steel and there are challenges in terms of steel-aluminum welding technology and processing technologies (as aluminum contains little clay). In the production process, conventional presses can be used for vehicle body sides, but new molds are needed for aluminum. Moreover, use of aluminum in vehicle frames requires the selection of distinctive engineering methods such as extrusion.

Exhibit 48: Aluminum is light but expensive; stamping is also somewhat challenging
Comparison of steel and aluminum properties

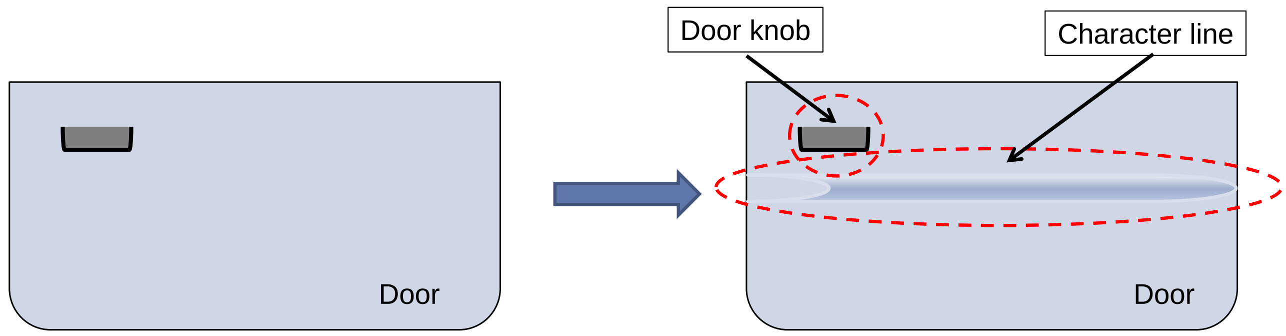
	Press	Welding
Difference from conventional method	・Complicated fabrication of aluminum outer panel with curved surface ・Need tandem/servo press ・Transport equipment should be automated and adapted to handle aluminum	・Aluminum has lower melting point than steel, so aluminum's welding is more difficult than steel's one. ・More welding spot points are needed. ・Substitution for welding assemply is needed
Japanese companies that could stand to benefit	・Aida Engineering ・Komatsu ・H & F etc...	・Fanuc
Companies to which for whether they can respond to the trend	・Press parts makers ・Japanese automakers	・Kawasaki Heavy Industries (Robot div.) ・Yaskawa Electric ・Nachi-Fujikoshi ・Daihen ・OBARA Group

Source: Company data, Goldman Sachs Global Investment Research.

Stamping machine upgrades needed not only for aluminum, but other hard-to-form materials

Since aluminum is harder than steel and poses certain processing challenges (large springback, a high incidence of crinkling, low viscosity), it is more difficult to create a curved surface and form sharp character lines like those evident in exterior panels (starting with the extremely difficult process of forming an indentation in aluminum for the door handle). Key to overcoming these technical challenges will be introducing stamping machines capable of more detailed pressure adjustments near the bottom dead center. We expect automakers to move ahead actively with the introduction of servo presses as replacements for existing hydraulic and mechanical stampers. We would note also that the introduction of servo presses relates not only to the shift to aluminum products. If multiple uses can be found for ultra-high tensile steel, it will join a number of other steel products that are hard to form.

Exhibit 49: Servo presses are preferable for forming sharp character lines
Cleaner character lines on door panels



Source: Goldman Sachs Global Investment Research.

Stamping machine replacement phase approaching, especially in North America

While North American auto output is showing signs of recovering to a record high, the percentage of stamping machines in use aged 10 years or less is at a historical low. The obsolescence of stamping machines in North America was already a major concern prior to the Global Financial Crisis, and we expect appetite for replacement capex to increase sharply. With automakers poised to order stamping machines with an eye on the next 20-30 years, we see servo presses featuring prominently given the need to adapt to future shifts toward ultra-high tensile steel and aluminum auto parts.

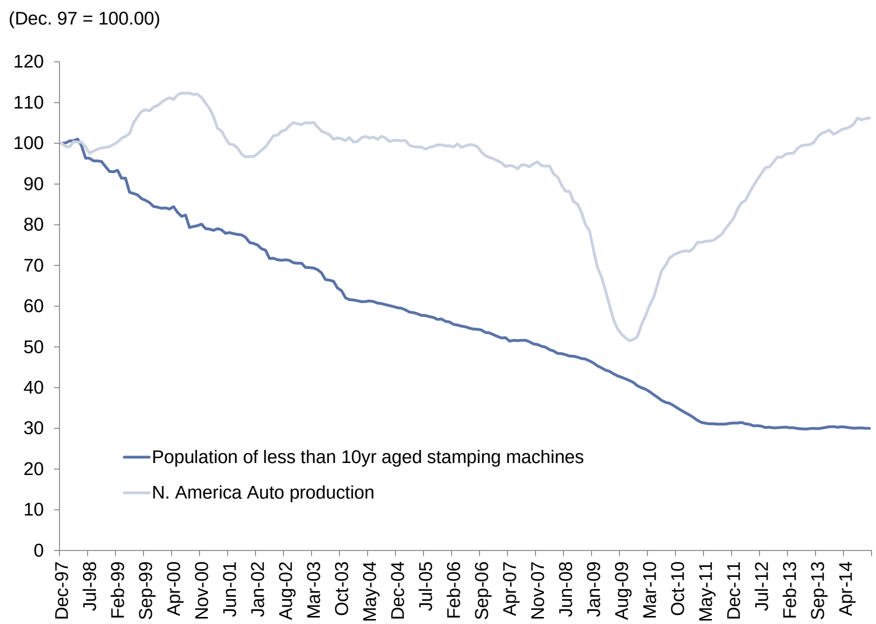
Types of press machines:

Hydraulic stamper: Press driven by a hydraulic system. A long stroke gives hydraulic stampers high forming performance, but low reverse-surface productivity.

Mechanical stamper: Press driven by a motor. A stamping motion is generated by transferring the energy transmitted to the clutch/brake and crankshaft from the rotation of the motor to a reciprocal stroke.

Servo press: Type of mechanical press driven by a motor. However, the use of a servo motor to drive the sliding motion gives the press high forming performance and productivity.

Exhibit 50: We expect US replacement demand for stamping machines to pick up
North America; no. of stamping machines less than 10 years in service and auto output



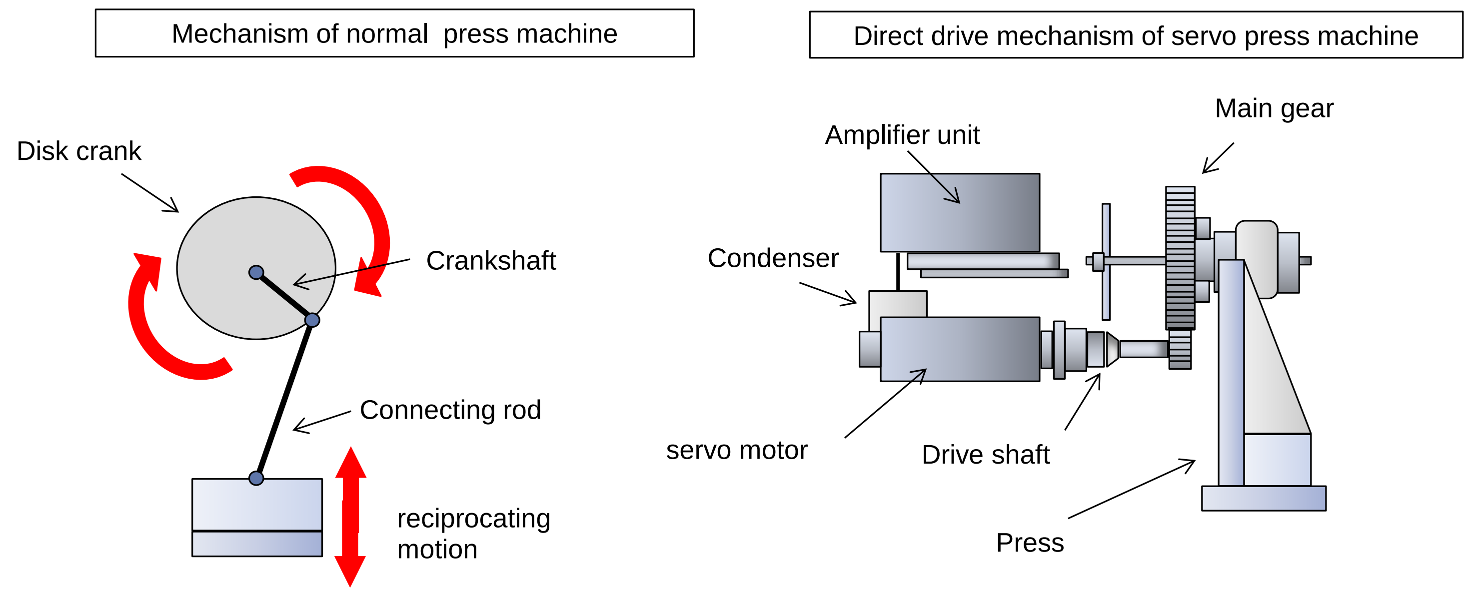
Source: Autodata, Japan Forming Machinery Association.

Exhibit 51: Servo presses have both hydraulic and mechanical press qualities
Comparison of stamping machine types

Operating feature	Hydraulic	Mechanical	Servo
Price (indexed the mechanical = 100)	90	100	200 for small sized, 130 for large sized
Machining performance	Low productivity (slow stamping speed), high molding performance (pressure adjustable/controllable)	High productivity (fast stamping speed), low molding performance (pressure non-adjustable)	High productivity (fast stamping speed), high molding performance (pressure adjustable/controllable)
Drive Source	Hydraulic pumps	Motor	Motor
Drive-connection	Hydraulic pumps > cylinder & motor > axle	Motor > clutch & brakes > axle	Motors directly connected to the axle
Spm(shots per min) on panels	50-60%	100%	150-170%
Energy consumption	100%	100%	50%
Noise	Large	Medium	Small
Maintenance / risks	Complicated: dirty/hazardous/ more frequent maintenance required	Clutch & brakes need to be repaired often	Mostly on motor only

Source: Goldman Sachs Global Investment Research.

Exhibit 52: Difference between normal press machine and servo press machine

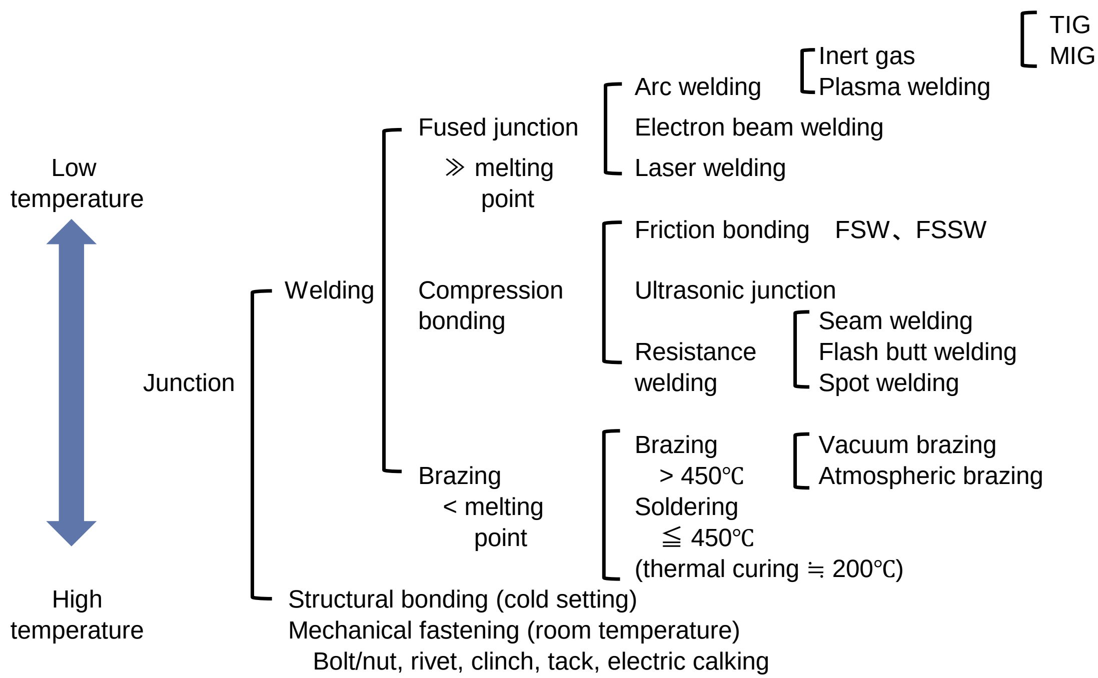


Source: Goldman Sachs Global Investment Research.

Upgrading of welding processes essential

Welding aluminum to aluminum or to steel for exterior panels is significantly different from existing spot welding methods. Large welding machines would be needed if makers decided to use welding robots with power sources attached because the conductivity of aluminum is five times that of steel. Spot welding is difficult for the detailed joining work required in auto assembly, and manufacturers therefore need to use alternate technologies. The most frequently used approach thus far has been improving rigidity using rivet guns and adhesives. However, this method was mainly used for luxury models produced in small volumes, and it has been unclear whether it would be suitable for mass production. From an automaker's standpoint, the key is to install robots with technology capable of maintaining productivity. For robot makers, R&D and added value enhancements aimed at maintaining productivity and rigidity are key factors that will determine their industry positioning, in our view. Toyota has already made possible the laser welding of aluminum to aluminum, and is now actively looking into the development of technologies to enable laser welding of aluminum to steel.

Exhibit 53: Evolution of welding technologies
Types of welding processes



Source: Japan Aluminum Association, Goldman Sachs Global Investment Research.

Key beneficiaries

Alcoa

Alcoa has invested substantially in aluminum BiW capacity growth through three main projects: (1) Davenport, Iowa, to which it contributed US$300 mn to expand auto finishing capacity in 2013; (2) Alcoa, Tennessee, where the company invested US$275 mn in a project completed in mid-2015; and (3) Saudi Arabia, where Alcoa contributed US$95 million of a total US$380 million investment to build a cold mill, heat treatment and finishing line, which was completed in 2014.

Alcoa was a key driver of the aluminum BiW shift in North America, through its contract to supply the aluminum (97% of the body) for the 2015 Ford F-150, and it continues to invest heavily in its stronger and more fuel-efficient Micromill technology.

We note that Alcoa is currently undergoing the split of its business into an upstream primary aluminum production business (which will retain the Alcoa name) and a downstream business, to be named Arconic, that will house its packaging, BiW, and aerospace processing capacity. Therefore, if the split goes through, Arconic would benefit directly from BiW growth. Creating a standalone upstream aluminum company in the current aluminum price environment could be difficult given Alcoa's pension/OPEB liabilities. However, even if the split does not occur, we do not expect the potential of the BiW space to change, making it likely Alcoa will remain committed to BiW and aerospace growth irrespective of whether the split occurs.

Constellium

Constellium is a downstream aluminum company with primarily packaging, aerospace and automotive end market exposure in North America and Europe. Constellium made its first foray into BiW in North America with its initial JV with UACJ -- announced in May 2014 – to build a 100kt BiW line in Bowling Green, Kentucky. Constellium then took the more significant step of acquiring Wise Metals in 2014 for US$1.4 bn. At the time, Constellium's goal was to construct BiW capacity (beyond its 100kt joint venture capacity) at Wise's facility in Muscle Shoals, Alabama, taking advantage of excess rolling capacity there and potentially converting Wise's can sheet capacity into BiW capacity over time. Wise's operating results have been weaker than expected, and Constellium's capex budget became a concern for investors. As a result, Constellium recently took two steps: (1) It announced an expansion of its JV with UACJ, whereby UACJ will fund 49% of the capex requirements for three 100kt BiW lines. (2) It issued US$425 mn of senior secured bonds to boost liquidity and help fund its remaining portion of the BiW joint venture capex. While Constellium expects Wise's substrate to remain a key part of its North American BiW strategy, it is unclear whether additional BiW finishing capacity will be constructed at the Muscle Shoals facility or at its existing JV with UACJ in Bowling Green, Kentucky. We believe that Constellium has now over-funded its BiW capex needs, and we believe that as long as the demand is there for its lines, the three BiW lines should be completed.

US aluminum companies looking to get into BiW have not begun building capacity without commitments for at least part of the offtake with auto companies. In fact, Alcoa and Novelis built their capacity explicitly for the F-150.

Constellium's first 100kt finishing line is 100% booked between 15 customers, but Constellium has not identified who they are. The second line is less than 50% booked, and the last line is not yet booked.

Kobe Steel (5406.T, Buy): Well-positioned for lightweight solution

What's changed

Kobe Steel's business portfolio includes ultra-high tensile steel and aluminum, two materials that will play a crucial role in auto body lightweighting. The company established the Multi-Material Structural Design and Joining Research Section within its Technical Development Group in April 2014, and its multifaceted approach to supplying automakers is one of the company's strengths. Kobe Steel has auto-use steel sheet production capacity (combined continuous annealing line (CAL) and continuous galvanizing line (CGL) capacity) of 1.4 mn tonnes/year in Japan and 1.5 mn tonnes/year in the US through a joint venture with Pro-Tec and US Steel. A Chinese joint venture with Angang Steel (Kobe Steel's stake: 49%) is scheduled to start commercial production in early 2016. The JV is expected to have annual production capacity of 600,000 tonnes (Angang Steel is scheduled to supply the hot-rolled coil input). Pro-Tec's CAL has capacity of 500,000 tonnes, but at the moment makes soft steel, which has low margins, rather than high tensile steel. We expect it to switch to high tensile steel as the automaker verification process advances. With respect to aluminum panel business expansion, in June 2013 Kobe Steel entered into a technical alliance with Hydro, a major European maker of aluminum rolled products. In September 2013, Kobe Steel independently established an aluminum panel manufacturing and sales company in China. A plant with annual capacity of 100,000 tonnes/year is scheduled to start production in 2016. In May 2014, Kobe Steel established a US JV with Toyota Tsusho as a launch pad for moves into North America. The joint venture initially planned to source master coils from Wise Alloys, a US maker of aluminum beverage cans. However, Wise Alloys was acquired by competitor Constellium, and a new supplier of master coils has not yet been decided. Kobe Steel said it will limit business development in the US to downstream processing as it does not want to assume the risk of large investment in hot rolling facilities.

Investment opinion

We maintain our Buy rating. Slowing Chinese demand is a strong headwind for steel and construction machinery businesses and in 2H3/17 Kobe will conduct major scheduled maintenance at its mainstay Kakogawa Works. While the earnings environment is challenging in FY3/16 and will likely remain so in FY3/17, Kobe Steel's IPP contract with Kansai Electric is scheduled to expire in March 2017. We expect hikes to electricity prices to significantly boost electricity business profitability and drive overall profits higher.

Valuation

Our 12-month target price of ¥150 is based on the FY3/17E steel sector average EV/GCI vs. CROCI correlation and future earnings at the power business (implies FY3/17E P/B of 0.7X, P/E of 14X; sector cash return multiple still 0.35X).

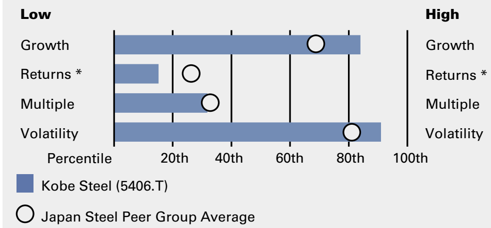
Risks

Further slowing of infrastructure-related demand, including for steel and construction machinery, in China; earlier-than-expected nuclear plant restarts.

INVESTMENT LIST MEMBERSHIP
Japan Buy list

Coverage View: Neutral

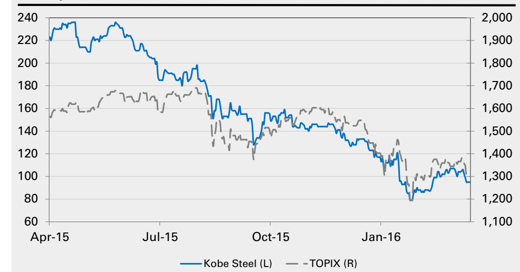
Investment Profile



* Returns = Return on Capital For a complete description of the investment profile measures please refer to the disclosure section of this document.

Key data				Current
Price (¥)				95
12 month price target (¥)				150
Market cap (¥bn)				345.2
Local GAAP (¥bn)	**3/15**	**3/16E**	**3/17E**	**3/18E**
Revenue New	**1,886.9**	**1,836.5**	**1,825.0**	**1,860.0**
Op. profit New	**119.5**	**67.0**	**88.0**	**115.0**
Op. profit Old	119.5	67.0	88.0	115.0
Op. profit CoE New	**--**	**65.0**	**--**	**--**
Op. profit CoE Old	--	65.0	--	--
EPS(¥) New	**23.8**	**(5.5)**	**11.1**	**16.2**
yoy % chg.	5.3	(123.1)	301.0	46.8
EPS (¥) Old	23.8	(5.5)	11.1	16.2
P/E (X)	**7.4**	**NM**	**8.6**	**5.9**
P/B (X)	**0.8**	**0.5**	**0.4**	**0.4**
EV/EBITDA (X)	**4.8**	**5.6**	**5.0**	**4.3**
CROCI (%)	**4.7**	**2.4**	**4.0**	**4.4**
EV/GCI (X)	**0.3**	**0.3**	**0.2**	**0.2**

Price performance chart



Share price performance (%)	3 month	6 month	12 month
Absolute	(27.5)	(29.1)	(57.4)
Rel. to TOPIX	(16.0)	(21.4)	(48.8)

Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 4/04/2016 close.

Kobe Steel: Summary financials

Profit model (¥bn)	3/15	3/16E	3/17E	3/18E
Revenue	1,886.9	1,836.5	1,825.0	1,860.0
Cost of goods sold	(1,581.5)	(1,577.8)	(1,539.2)	(1,541.0)
Gross profit	**305.4**	**258.7**	**285.8**	**319.0**
SG&A and other	(185.9)	(191.7)	(197.8)	(204.0)
Operating profit	**119.5**	**67.0**	**88.0**	**115.0**
Net interest income/(expense)	(8.9)	(8.5)	(8.5)	(8.5)
Equity in earnings of affiliates	0.1	2.0	2.0	2.0
Net other nonoperating inc/(exp)	(8.9)	(33.5)	(21.5)	(20.5)
Recurring profit	**101.7**	**27.0**	**60.0**	**88.0**
Extraordinary income	15.7	0.0	0.0	0.0
Extraordinary expense	(13.0)	(40.0)	0.0	0.0
Pretax profit	**104.3**	**(13.0)**	**60.0**	**88.0**
Income tax	(12.3)	(7.0)	(17.4)	(25.8)
Minority interest	(5.4)	0.0	(2.4)	(3.2)
Net income	**86.6**	**(20.0)**	**40.2**	**59.0**
Capital expenditures (excl. leases)	(73.7)	(115.0)	(120.0)	(120.0)
Capital expenditures (incl. leases)	(95.3)	(115.0)	(120.0)	(120.0)
Depreciation & amortization	(89.9)	(110.0)	(115.0)	(120.0)
EPS (basic) (¥)	**23.8**	**(5.5)**	**11.1**	**16.2**
EPS (fully diluted) (¥)	**23.8**	**(5.5)**	**11.1**	**16.2**
BVPS (¥)	213.7	204.2	213.3	227.0
DPS (¥)	4.0	2.0	2.5	4.0
Dividend payout ratio (%)	16.8	(36.3)	22.6	24.6

Year-on-year change (%)	3/15	3/16E	3/17E	3/18E
Revenue	3.4	(2.7)	(0.6)	1.9
Operating profit	4.3	(43.9)	31.3	30.7
Recurring profit	19.6	(73.4)	122.2	46.7
Net income	23.3	(123.1)	301.0	46.8
EPS (basic)	5.3	(123.1)	301.0	46.8
EPS (fully diluted)	5.3	(123.1)	301.0	46.8

Margins (%)	3/15	3/16E	3/17E	3/18E
Operating profit	6.3	3.6	4.8	6.2
EBITDA	11.1	9.6	11.1	12.6
Recurring profit	5.4	1.5	3.3	4.7
Net income	4.6	(1.1)	2.2	3.2

Cash flow statement (¥bn)	3/15	3/16E	3/17E	3/18E
Net income	86.6	(20.0)	40.2	59.0
D&A add-back	89.9	110.0	115.0	120.0
Minority interest add-back	5.4	0.0	2.4	3.2
Net (inc)/dec in working capital	(20.6)	38.6	(34.1)	(49.0)
Other operating cash flow	(8.2)	(2.0)	(2.0)	(2.0)
Cash flow from operations	**153.1**	**126.6**	**121.5**	**131.2**
Capital expenditures (incl. leases)	(95.3)	(115.0)	(120.0)	(120.0)
Purchases of long-term securities	0.0	0.0	0.0	0.0
Sales of long-term securities	0.0	0.0	0.0	0.0
Other investing cash flow	21.6	0.0	0.0	0.0
Cash flow from investments	**(73.7)**	**(115.0)**	**(120.0)**	**(120.0)**
Dividends paid (common & preferred)	0.0	(14.5)	(7.3)	(9.1)
Incr./(decr.) in debt	(109.9)	0.0	0.0	0.0
Common stock issuance	0.0	0.0	0.0	0.0
Other financing cash flow	(39.0)	0.0	0.0	0.0
Cash flow from financing	**(148.9)**	**(14.5)**	**(7.3)**	**(9.1)**
Total cash flow	**(69.5)**	**(3.0)**	**(5.7)**	**2.1**

Balance sheet (¥bn)	3/15	3/16E	3/17E	3/18E
Cash & equivalents	103.2	100.2	94.5	96.6
Accounts receivable	355.6	328.8	326.7	333.0
Inventory	442.7	409.3	406.7	414.5
Other current assets	151.6	151.6	151.6	151.6
Total current assets	**1,053.0**	**989.9**	**979.5**	**995.7**
Net PP&E	927.0	932.0	937.0	937.0
Net intangibles	20.0	20.0	20.0	20.0
Total investments	207.9	209.9	211.9	213.9
Other long-term assets	92.3	92.3	92.3	92.3
Total assets	**2,300.2**	**2,244.1**	**2,240.8**	**2,258.9**
Accounts payable	424.3	402.7	364.0	329.0
Short-term debt	241.4	241.4	241.4	241.4
Other current liabilities	197.8	197.8	197.8	197.8
Total current liabilities	**863.5**	**841.9**	**803.2**	**768.2**
Long-term debt	436.0	436.0	436.0	436.0
Other long-term liabilities	149.0	149.0	149.0	149.0
Total long-term liabilities	**585.0**	**585.0**	**585.0**	**585.0**
Total liabilities	**1,448.5**	**1,426.9**	**1,388.2**	**1,353.2**
Minority interest	75.3	75.3	77.7	80.9
Total common equity	**776.5**	**742.0**	**774.9**	**824.8**
Total liabilities & equity	**2,300.2**	**2,244.1**	**2,240.8**	**2,258.9**
Net debt	574.2	577.1	582.9	580.8

Ratios	3/15	3/16E	3/17E	3/18E
CROCI (%)	4.7	2.4	4.0	4.4
ROE (%)	10.9	(2.4)	4.8	6.7
ROA (%)	3.8	(0.9)	1.8	2.6
Net debt/equity (%)	67.4	70.6	68.4	64.1
Interest coverage ratio (X)	7.5	4.5	5.9	7.7

Valuation	3/15	3/16E	3/17E	3/18E
P/E (X)	7.4	NM	8.6	5.9
EV/EBITDA (X)	4.8	5.6	5.0	4.3
EV/GCI (X)	0.3	0.3	0.2	0.2
P/B (X)	0.8	0.5	0.4	0.4
Dividend yield (%)	2.3	2.1	2.6	4.2
FCF yield (%)	8.1	2.8	0.4	2.6

Note: Last actual year may include reported and estimated data.

Source: Company data, Goldman Sachs Research estimates.

UACJ (5741.T, Neutral): Benefiting from aluminum body shift

What's changed

UACJ is the third-largest maker of aluminum products in the world after Alcoa (US) and Novelis (US). UACJ has invested US$150 mn in a joint venture with Constellium (UACJ stake: 49%) in Bowling Green, Kentucky. The plant is scheduled to commence production of auto-use aluminum panel material in Apr-Jun 2016 (annual production capacity is 100,000 tonnes). Continuous heat treatment and surface treatment lines will process master coils supplied by the Logan rolling mill of UACJ's US subsidiary Tri-Arrows Aluminum (TAA). Any supply shortfall will be covered by Contsellium's plant in France.

UACJ forecasts the aluminum BiW market in North America will expand to around 1mn tons in 2020 and expects the Bowling Green joint venture to be operating at full capacity of 100,000 tonnes/year from 2018-2019. At its 1H3/16 results briefing, UACJ said it was considering a second line at Bowling Green, but did not comment on what form the investment would take or other details. However, TAA has already announced a US$290 mn investment to increase hot rolling capacity at Logan in anticipation of expanding demand for auto-use aluminum panels, and has also earmarked some investment for cost reduction. It appears that UACJ has longer term aluminum BiW market expansion firmly in its sights.

Investment opinion

We maintain our Neutral rating. We believe UACJ looks attractive as a beneficiary of expanding demand for auto-use aluminum panels over the longer term, particularly in the US. In the short term, however, we see negatives in the form of rising inventory valuation losses and increasing depreciation for overseas bases, as well as impairment risk on the delayed ramp-up at the Thai manufacturing base. A fragile balance sheet at a time when UACJ is accelerating investment in Thailand and the US is another issue. UACJ's current medium-term plan has an end-FY3/17 D/E ratio target of 1.33X, but we forecast it will be 1.71X.

Valuation

We maintain our EV/GCI vs. CROCI/WACC-based 12-month target price of ¥265. Our target price is based on our sector-relative cash return multiple of 0.45X and the average of our FY3/17 and FY3/18 estimates. Our target price implies FY3/17E P/B of 0.6X and P/E of 13X.

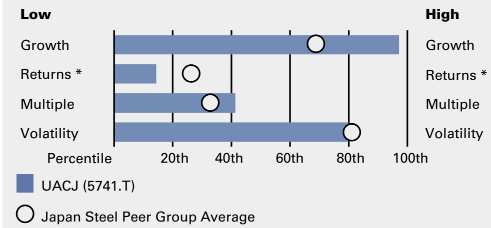
Risks

LME aluminum price swings, changes in Japan/US ingot premium levels, production trends at the Thai plant.

INVESTMENT LIST MEMBERSHIP
Neutral

Coverage View: Neutral

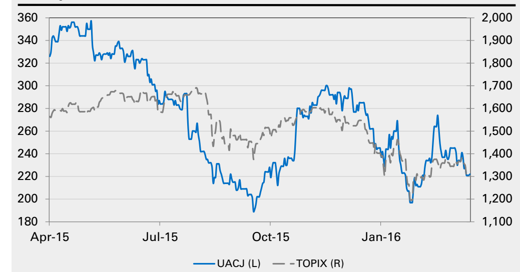
Investment Profile



* Returns = Return on Capital   For a complete description of the investment profile measures please refer to the disclosure section of this document.

Key data				Current
Price (¥)				222
12 month price target (¥)				265
Market cap (¥bn)				95.0
Local GAAP (¥bn)	**3/15**	**3/16E**	**3/17E**	**3/18E**
Revenue New	**572.5**	**518.3**	**515.9**	**564.4**
Op. profit New	**23.7**	**11.5**	**24.1**	**32.1**
Op. profit Old	23.7	11.5	24.1	32.1
Op. profit CoE New	**--**	**11.5**	**--**	**--**
Op. profit CoE Old	--	11.5	--	--
EPS(¥) New	**20.2**	**4.7**	**20.1**	**29.0**
yoy % chg.	(13.0)	(76.9)	330.0	44.2
EPS (¥) Old	20.2	4.7	20.1	29.0
P/E (X)	**18.4**	**47.5**	**11.0**	**7.7**
P/B (X)	**0.9**	**0.6**	**0.5**	**0.5**
EV/EBITDA (X)	**8.6**	**11.2**	**7.6**	**6.7**
CROCI (%)	**5.1**	**3.6**	**5.0**	**5.6**
EV/GCI (X)	**0.6**	**0.5**	**0.5**	**0.5**

Price performance chart



Share price performance (%)	3 month	6 month	12 month
Absolute	(20.1)	9.9	(31.9)
Rel. to TOPIX	(7.5)	21.9	(18.2)

Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 4/04/2016 close.

UACJ: Summary financials

Profit model (¥bn)	3/15	3/16E	3/17E	3/18E
Revenue	572.5	518.3	515.9	564.4
Cost of goods sold	(500.4)	(462.9)	(448.1)	(484.5)
Gross profit	**72.1**	**55.4**	**67.8**	**79.9**
SG&A and other	(48.5)	(43.9)	(43.7)	(47.8)
Operating profit	**23.7**	**11.5**	**24.1**	**32.1**
Net interest income/(expense)	(3.2)	(4.5)	(4.6)	(4.7)
Equity in earnings of affiliates	0.7	0.5	0.7	1.7
Net other nonoperating inc/(exp)	--	--	--	--
Recurring profit	**21.3**	**7.9**	**20.6**	**29.6**
Extraordinary income	0.0	0.0	0.0	0.0
Extraordinary expense	0.0	0.0	0.0	0.0
Pretax profit	**18.9**	**9.9**	**20.6**	**29.6**
Income tax	(9.2)	(6.4)	(8.9)	(11.1)
Minority interest	(1.0)	(1.5)	(3.1)	(6.1)
Net income	**8.6**	**2.0**	**8.6**	**12.4**
Capital expenditures (excl. leases)	--	--	--	--
Capital expenditures (incl. leases)	(46.5)	(40.0)	(40.0)	(40.0)
Depreciation & amortization	(22.6)	(23.7)	(27.9)	(28.9)
EPS (basic) (¥)	**20.2**	**4.7**	**20.1**	**29.0**
EPS (fully diluted) (¥)	**20.2**	**4.7**	**20.1**	**29.0**
BVPS (¥)	402.8	401.4	415.6	435.5
DPS (¥)	6.0	6.0	6.0	9.0
Dividend payout ratio (%)	29.7	128.3	29.8	31.0

Year-on-year change (%)	3/15	3/16E	3/17E	3/18E
Revenue	57.2	(9.5)	(0.5)	9.4
Operating profit	33.2	(51.4)	109.6	33.2
Recurring profit	27.0	(63.0)	160.8	43.7
Net income	(13.1)	(76.9)	330.0	44.2
EPS (basic)	(13.0)	(76.9)	330.0	44.2
EPS (fully diluted)	(13.0)	(76.9)	330.0	44.2

Margins (%)	3/15	3/16E	3/17E	3/18E
Operating profit	4.1	2.2	4.7	5.7
EBITDA	8.1	6.8	10.1	10.8
Recurring profit	3.7	1.5	4.0	5.2
Net income	1.5	0.4	1.7	2.2

Cash flow statement (¥bn)	3/15	3/16E	3/17E	3/18E
Net income	8.6	2.0	8.6	12.4
D&A add-back	22.6	23.7	27.9	28.9
Minority interest add-back	1.0	1.5	3.1	6.1
Net (inc)/dec in working capital	(10.1)	20.0	5.0	(10.3)
Other operating cash flow	4.6	(0.5)	(0.7)	(1.7)
Cash flow from operations	**26.8**	**46.7**	**43.9**	**35.4**
Capital expenditures (incl. leases)	(46.5)	(40.0)	(40.0)	(40.0)
Purchases of long-term securities	0.0	0.0	0.0	0.0
Sales of long-term securities	0.0	0.0	0.0	0.0
Other investing cash flow	(3.1)	0.0	0.0	0.0
Cash flow from investments	**(49.7)**	**(40.0)**	**(40.0)**	**(40.0)**
Dividends paid (common & preferred)	(2.6)	(2.6)	(2.6)	(3.9)
Incr./(decr.) in debt	33.3	(4.6)	0.5	7.2
Common stock issuance	(0.1)	0.0	0.0	0.0
Other financing cash flow	(4.1)	0.0	0.0	0.0
Cash flow from financing	**26.5**	**(7.1)**	**(2.1)**	**3.3**
Total cash flow	**3.6**	**(0.5)**	**1.8**	**(1.2)**

Balance sheet (¥bn)	3/15	3/16E	3/17E	3/18E
Cash & equivalents	21.1	20.6	22.4	21.1
Accounts receivable	108.6	98.3	97.8	107.0
Inventory	117.7	99.8	92.0	101.1
Other current assets	22.5	22.5	22.5	22.5
Total current assets	**269.9**	**241.2**	**234.7**	**251.8**
Net PP&E	292.4	308.7	320.8	331.9
Net intangibles	65.9	65.9	65.9	65.9
Total investments	20.3	20.8	21.5	23.2
Other long-term assets	29.5	29.5	29.5	29.5
Total assets	**678.0**	**666.1**	**672.4**	**702.2**
Accounts payable	110.1	101.9	98.6	106.6
Short-term debt	140.7	135.6	128.9	128.3
Other current liabilities	37.1	37.1	37.1	37.1
Total current liabilities	**287.9**	**274.6**	**264.6**	**272.1**
Long-term debt	167.0	167.4	174.6	182.3
Other long-term liabilities	36.0	36.0	36.0	36.0
Total long-term liabilities	**202.9**	**203.4**	**210.6**	**218.3**
Total liabilities	**490.8**	**478.0**	**475.2**	**490.4**
Minority interest	14.8	16.3	19.4	25.5
Total common equity	**172.3**	**171.7**	**177.8**	**186.3**
Total liabilities & equity	**678.0**	**666.1**	**672.4**	**702.2**
Net debt	286.5	282.5	281.1	289.5

Ratios	3/15	3/16E	3/17E	3/18E
CROCI (%)	5.1	3.6	5.0	5.6
ROE (%)	4.9	1.1	4.5	6.1
ROA (%)	1.3	0.3	1.3	1.8
Net debt/equity (%)	153.1	150.2	142.6	136.7
Interest coverage ratio (X)	7.4	2.6	5.2	6.8

Valuation	3/15	3/16E	3/17E	3/18E
P/E (X)	18.4	47.5	11.0	7.7
EV/EBITDA (X)	8.6	11.2	7.6	6.7
EV/GCI (X)	0.6	0.5	0.5	0.5
P/B (X)	0.9	0.6	0.5	0.5
Dividend yield (%)	1.6	2.7	2.7	4.1
FCF yield (%)	(11.4)	6.0	3.4	(3.8)

Note: Last actual year may include reported and estimated data.

Source: Company data, Goldman Sachs Research estimates.

Ford (F, Buy): F150 success shows Ford’s aluminum know-how, Super Duty next up

What’s changed

Coming off of positive reviews and strong sales of Ford’s new aluminum F150 pickup truck, we believe that Ford has shown its aluminum manufacturing capabilities by producing an all-aluminum BiW high-volume, mainstream vehicle as aluminum had been primarily used in high-end sedans and sports cars historically. While some had originally criticized the idea of utilizing significant amounts of aluminum for a pickup truck, given the harsher working environments that some pickups are exposed to, we believe that the F150 has been a success with sales up 3.5% in 2015 despite facing supply constraints in the early months of the year and the company steadily filling commercial orders.

Looking ahead, Ford’s upcoming 2017 Super Duty is expected to go on sale in 2H16 featuring an aluminum body and as well as a frame that utilizes 95% high strength steel, leading to a 350lb weight reduction. The Super Duty is expected to be built at the company’s Kentucky Truck plant in Louisville, and the company is expected to make a smoother transition with the new model as Ford applies the learnings from the F150 launch. While there have not been additional formal announcements regarding the use of aluminum in other Ford products, we believe that the company has significant opportunities to apply its aluminum leadership and manufacturing knowledge to other products, particularly light trucks such as the Expedition SUV and Transit vans in order to improve fuel economy in an environment with increasing mpg/CO2 requirements.

Investment opinion

We reiterate our Buy rating on Ford as we continue to expect the Super Duty launch and full F150 inventory to drive earnings acceleration given strong truck demand led by housing. As such, we expect Ford to gain market share following a capacity expansion with the launch of the Super Duty. In addition, we expect Ford’s China positioning to continue to improve as the company launches new products and rolls out the Lincoln brand. We also believe the company has the product and brand equity to see further share gains from its existing 4.5% market share. We believe Ford’s guidance is conservative and see potential upside to the company’s 9.5% NA margin target outlined at the Detroit Auto Show as management seeks additional cost opportunities.

Valuation

Our US$16 12-month price target is derived from an average of two methodologies: 1) valuing the automotive assets using 2016 and 2017 EBITDA estimates plus pension and OPEB, then adding back the value of unconsolidated affiliates, FMCC, and cash, then subtracting out debt, retiree liabilities, and minority interests; and (2) applying an 11.0x multiple to our consolidated 2016 and 2017 EPS forecasts. We discount 2017 back at a 15% cost of equity.

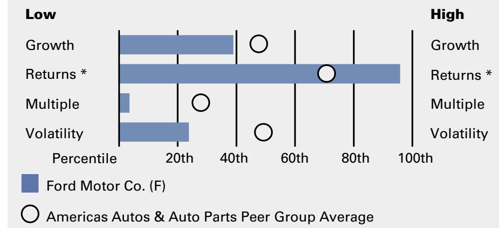
Risks

Primarily a decline in SAAR on the back of a weaker macro environment.

INVESTMENT LIST MEMBERSHIP
Americas Buy list

Coverage View: Neutral

Investment Profile



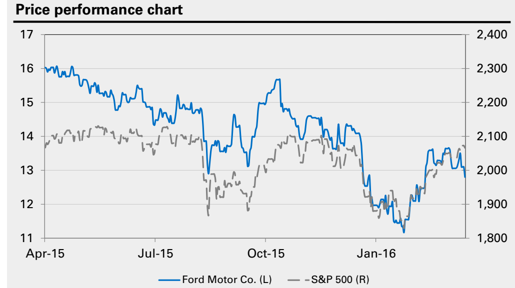
* Returns = Return on Capital For a complete description of the investment profile measures please refer to the disclosure section of this document.

Key data	Current
Price ($)	12.80
12 month price target ($)	16.00
Market cap ($ mn)	50,803.2
Dividend yield (%)	4.7
Net margin (%)	5.4
Debt/total capital (%)	26.3

	12/15	12/16E	12/17E	12/18E
Revenue ($ mn)	140,566.0	149,700.5	153,559.1	148,362.0
EPS ($)	1.93	2.02	2.23	2.04
P/E (X)	7.8	6.3	5.7	6.3
EV/EBITDA (X)	2.1	2.8	2.1	2.1
ROE (%)	62.2	48.0	24.2	19.1

	12/15	3/16E	6/16E	9/16E
EPS ($)	0.58	0.48	0.58	0.55

Price performance chart



Share price performance (%)	3 month	6 month	12 month
Absolute	(8.4)	(8.5)	(20.1)
Rel. to S&P 500	(10.7)	(13.6)	(20.1)

Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 4/04/2016 close.

Ford Motor Co.: Summary financials

Profit model ($ mn)	12/15	12/16E	12/17E	12/18E
Total revenue	140,566.0	149,700.5	153,559.1	148,362.0
Operating Expenses	(133,995.0)	(142,244.1)	(145,247.4)	(141,502.9)
EBITDA	**10,871.0**	**12,048.3**	**13,430.3**	**12,354.0**
Depreciation & amortization	(4,300.0)	(4,591.9)	(5,118.6)	(5,494.9)
EBIT	**6,571.0**	**7,456.4**	**8,311.6**	**6,859.1**
Net interest income/(expense)	(540.0)	(506.2)	(479.3)	(439.1)
Income/(loss) from associates	2,028.0	2,000.0	2,160.0	2,332.8
Others	2,741.0	2,800.0	2,940.0	3,087.0
Pretax profits	**10,800.0**	**11,750.2**	**12,932.3**	**11,839.8**
Provision for taxes	(3,086.0)	(3,642.6)	(4,009.0)	(3,670.3)
Minority interest	2.0	(8.0)	(8.4)	(8.8)
Net income	**7,716.0**	**8,099.7**	**8,914.9**	**8,160.7**
EPADR Diluted ($)	**1.93**	**2.02**	**2.23**	**2.04**
DPS ($)	0.60	0.60	0.60	0.60

Growth & margins (%)	12/15	12/16E	12/17E	12/18E
Sales growth	3.5	6.5	2.6	(3.4)
EBITDA growth	32.3	10.8	11.5	(8.0)
Net income growth	66.5	5.0	10.1	(8.5)
EBITDA margin	7.7	8.0	8.7	8.3
EBIT margin	4.7	5.0	5.4	4.6
Net margin	5.5	5.4	5.8	5.5

Cash flow statement ($ mn)	12/15	12/16E	12/17E	12/18E
Net income	7,716.0	8,099.7	8,914.9	8,160.7
D&A add-back (incl. ESO)	4,300.0	4,591.9	5,118.6	5,494.9
Minority interest add-back	(2.0)	8.0	8.4	8.8
Net (inc)/dec working capital	70.4	745.4	(217.8)	(428.6)
Other operating cash flow	215.6	(2,863.1)	(3,156.5)	(4,422.6)
Cash flow from operations	**12,300.0**	**10,581.8**	**10,667.6**	**8,813.1**
Capital expenditures	(7,100.0)	(7,863.8)	(7,678.0)	(7,418.1)
Acquisitions	0.0	0.0	0.0	0.0
Divestitures	0.0	0.0	0.0	0.0
Others	0.0	200.0	400.0	400.0
Cash flow from investing	**(7,100.0)**	**(7,663.8)**	**(7,278.0)**	**(7,018.1)**
Dividends paid	(2,371.0)	(3,381.4)	(2,381.4)	(2,381.4)
Inc/(dec) in debt	(800.0)	(600.0)	(500.0)	(500.0)
Other financing cash flows	(129.0)	2,800.0	2,400.0	2,800.0
Cash flow from financing	**(3,300.0)**	**(1,181.4)**	**(481.4)**	**(81.4)**
Total cash flow	**1,900.0**	**336.6**	**1,708.3**	**313.6**

Balance sheet ($ mn)	12/15	12/16E	12/17E	12/18E
Cash & equivalents	23,600.0	23,936.6	25,644.9	25,958.5
Accounts receivable	5,993.0	6,196.6	6,310.6	6,097.1
Inventory	8,143.1	8,273.8	8,454.4	8,242.7
Other current assets	5,264.2	5,264.2	5,264.2	5,264.2
Total current assets	**43,000.3**	**43,671.2**	**45,674.1**	**45,562.4**
Net PP&E	30,844.8	34,116.6	36,676.0	38,599.2
Net intangibles	137.7	137.7	137.7	137.7
Total investments	14,391.8	14,191.8	13,791.8	13,391.8
Other long-term assets	16,604.4	16,604.4	16,604.4	16,604.4
Total assets	**104,978.9**	**108,721.7**	**112,884.0**	**114,295.5**
Accounts payable	18,956.2	20,027.9	20,096.3	19,233.6
Short-term debt	2,315.7	2,315.7	2,315.7	2,315.7
Other current liabilities	19,381.4	19,381.4	19,381.4	19,381.4
Total current liabilities	**40,653.4**	**41,725.1**	**41,793.5**	**40,930.8**
Long-term debt	10,484.3	9,884.3	9,384.3	8,884.3
Other long-term liabilities	24,160.0	22,980.9	21,308.8	18,571.0
Total long-term liabilities	**34,644.3**	**32,865.1**	**30,693.0**	**27,455.2**
Total liabilities	**75,297.7**	**74,590.2**	**72,486.5**	**68,386.0**
Total common equity	**0.0**	**33,754.5**	**40,012.0**	**45,515.3**
Minority interest	**369.0**	**377.0**	**385.4**	**394.2**
Total liabilities & equity	**104,978.9**	**108,721.7**	**112,884.0**	**114,295.5**

Additional financials	12/15	12/16E	12/17E	12/18E
Net debt / EBITDA (X)	(1.0)	(1.0)	(1.0)	(1.2)
Interest cover (X)	8.5	9.9	11.6	10.0
ROA (%)	7.5	7.6	8.0	7.2
ROIC (%)	23.6	26.6	24.1	15.9
Dupont ROE (%)	**2,091.1**	**23.7**	**22.1**	**17.8**
Margin (%)	5.5	5.4	5.8	5.5
Turnover (X)	1.3	1.4	1.4	1.3
Leverage (X)	284.5	3.2	2.8	2.5

Note: Last actual year may include reported and estimated data.

Source: Company data, Goldman Sachs Research estimates.

Aida Engineering (6118.T, CL-Buy): Servo press industry leader; taking on the challenge of difficult materials

What's changed

We see a major impact on the press machinery industry from the introduction of materials such as high-tensile steel and aluminum to the auto industry, in a bid to make vehicles lighter. We think the introduction of servo presses plays a key role in the change in automotive body materials, particularly low-formability aluminum materials, where servo presses can make finer pressure adjustments around the lower dead center. The use of presses driven by servo motors has created structural change in the press industry, and we believe the company is well-positioned to capitalize on these changes given its strengths in servo presses. The company's sales mix comprises 29% servo presses, 53% machine presses, and 18% services and other business (based on FY3/15 earnings). We expect the servo press sales mix to increase as the need for lighter materials grows.

Investment opinion

We reiterate our CL-Buy rating. Orders for servo tandem lines are firm across the board, from both Japanese and foreign OEMs. We view positively that, amid a weak capex appetite overall in the auto industry, the company is steadily building up orders from individual projects. We could see share price swings in reaction to short-term order momentum, but our structural growth story for the company based on servo press demand is unchanged.

Valuation

Our 12-month target price of ¥1,200 is based on FY3/19ECROCI/WACC vs. EV/GCI (we still use a sector cash return multiple of 0.50X, historical average discount of 40%).

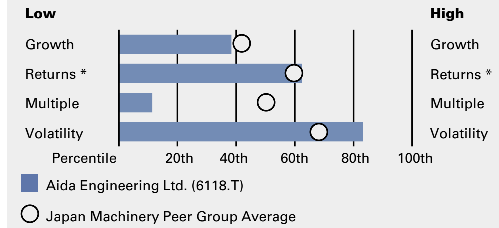
Risks

Further yen appreciation (our estimates are based on ¥115/US$), diminishing appetite in the auto industry for investment into press machinery, and greater competition between servo press makers. Global market share in the press industry is Schuler 30%, Aida 23%, Komatsu 15%, Fagor 13%, and Hitachi Zosen Fukui 9% (as of 2014).

INVESTMENT LIST MEMBERSHIP
Japan Buy list
Japan Conviction Buy list

Coverage View: Neutral

Investment Profile

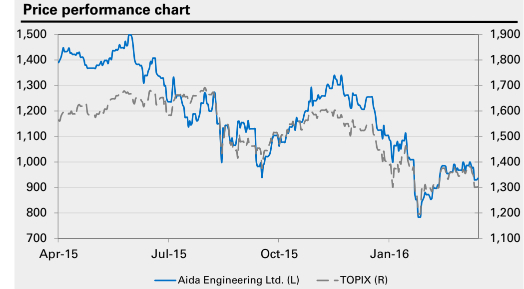


* Returns = Return on Capital. For a complete description of the investment profile measures please refer to the disclosure section of this document.

Key data				Current
Price (¥)				936
12 month price target (¥)				1,200
Market cap (¥bn)				57.5

Local GAAP (¥bn)	3/15	3/16E	3/17E	3/18E
Revenue New	**76.9**	**77.0**	**78.0**	**80.0**
Op. profit New	**7.9**	**8.3**	**8.3**	**8.6**
Op. profit Old	7.9	8.3	8.3	8.6
Op. profit CoE New	**7.7**	**7.9**	**--**	**--**
Op. profit CoE Old	7.7	7.9	--	--
EPS(¥) New	**100.0**	**100.6**	**101.8**	**105.1**
yoy % chg.	19.4	0.6	1.2	3.2
EPS (¥) Old	100.0	100.6	101.8	105.1
P/E (X)	**10.7**	**9.3**	**9.2**	**8.9**
P/B (X)	**1.0**	**0.8**	**0.8**	**0.8**
EV/EBITDA (X)	**3.0**	**2.9**	**2.7**	**2.3**
CROCI (%)	**13.9**	**11.9**	**11.6**	**11.6**
EV/GCI (X)	**0.6**	**0.4**	**0.4**	**0.3**

Price performance chart



Share price performance (%)	3 month	6 month	12 month
Absolute	(23.2)	(8.3)	(32.7)
Rel. to TOPIX	(10.9)	1.7	(19.1)

Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 4/04/2016 close.

Aida Engineering Ltd.: Summary financials

Profit model (¥bn)	3/15	3/16E	3/17E	3/18E
Revenue	76.9	77.0	78.0	80.0
Cost of goods sold	(59.7)	(58.8)	(58.9)	(60.0)
Gross profit	**17.2**	**18.2**	**19.1**	**20.0**
SG&A and other	(9.4)	(9.9)	(10.8)	(11.4)
Operating profit	**7.9**	**8.3**	**8.3**	**8.6**
Net interest income/(expense)	0.2	0.2	0.2	0.2
Equity in earnings of affiliates	0.0	0.0	0.0	0.0
Net other nonoperating inc/(exp)	(17.1)	(18.2)	(19.1)	(20.0)
Recurring profit	**8.2**	**8.5**	**8.5**	**8.8**
Extraordinary income	0.4	0.0	0.0	0.0
Extraordinary expense	(0.1)	0.0	0.0	0.0
Pretax profit	**8.5**	**8.5**	**8.5**	**8.8**
Income tax	(2.3)	(2.3)	(2.3)	(2.4)
Minority interest	0.0	0.0	0.0	0.0
Net income	**6.2**	**6.2**	**6.2**	**6.4**
Capital expenditures (excl. leases)	(2.0)	(4.1)	(4.0)	(3.0)
Capital expenditures (incl. leases)	(1.9)	(4.1)	(4.0)	(3.0)
Depreciation & amortization	(1.7)	(2.0)	(2.3)	(2.5)
EPS (basic) (¥)	**100.7**	**100.6**	**101.8**	**105.1**
EPS (fully diluted) (¥)	**100.7**	**100.6**	**101.8**	**105.1**
BVPS (¥)	1,089.0	1,101.9	1,169.1	1,242.2
DPS (¥)	30.0	30.0	31.0	32.0
Dividend payout ratio (%)	30.0	29.8	30.4	30.4

Year-on-year change (%)	3/15	3/16E	3/17E	3/18E
Revenue	10.5	0.1	1.3	2.6
Operating profit	24.5	5.6	0.0	3.6
Recurring profit	22.4	3.7	0.0	3.5
Net income	19.8	0.6	0.0	3.2
EPS (basic)	20.7	(0.1)	1.2	3.2
EPS (fully diluted)	20.7	(0.1)	1.2	3.2

Margins (%)	3/15	3/16E	3/17E	3/18E
Operating profit	10.2	10.8	10.6	10.8
EBITDA	12.5	13.4	13.5	13.9
Recurring profit	10.7	11.0	10.9	11.0
Net income	8.0	8.1	7.9	8.0

Cash flow statement (¥bn)	3/15	3/16E	3/17E	3/18E
Net income	6.2	6.2	6.2	6.4
D&A add-back	1.7	2.0	2.3	2.5
Minority interest add-back	0.0	0.0	0.0	0.0
Net (inc)/dec in working capital	(3.6)	0.4	(0.3)	(0.6)
Other operating cash flow	0.8	(0.2)	(0.2)	(0.2)
Cash flow from operations	**5.1**	**8.4**	**8.0**	**8.1**
Capital expenditures (incl. leases)	(1.9)	(4.1)	(4.0)	(3.0)
Purchases of long-term securities	0.0	0.0	0.0	0.0
Sales of long-term securities	0.0	0.0	0.0	0.0
Other investing cash flow	0.6	0.0	0.0	0.0
Cash flow from investments	**(1.2)**	**(4.1)**	**(4.0)**	**(3.0)**
Dividends paid (common & preferred)	(1.6)	(1.8)	(1.9)	(1.9)
Incr./(decr.) in debt	(0.6)	0.0	0.0	0.0
Common stock issuance	0.0	0.0	(0.8)	0.0
Other financing cash flow	0.1	(3.5)	0.0	0.2
Cash flow from financing	**(2.1)**	**(5.4)**	**(2.7)**	**(1.7)**
Total cash flow	**1.8**	**(1.1)**	**1.2**	**3.3**

Balance sheet (¥bn)	3/15	3/16E	3/17E	3/18E
Cash & equivalents	30.3	29.3	30.5	33.8
Accounts receivable	22.6	22.6	22.9	23.5
Inventory	14.5	11.1	11.1	11.3
Other current assets	7.2	7.2	7.2	7.2
Total current assets	**74.6**	**70.2**	**71.7**	**75.9**
Net PP&E	19.2	21.3	23.1	23.6
Net intangibles	1.1	1.1	1.1	1.1
Total investments	9.3	9.3	9.3	9.3
Other long-term assets	0.9	0.9	0.9	0.9
Total assets	**105.1**	**102.8**	**106.1**	**110.7**
Accounts payable	12.7	9.7	9.7	9.9
Short-term debt	0.9	0.9	0.9	0.9
Other current liabilities	19.7	19.7	19.7	19.7
Total current liabilities	**33.3**	**30.3**	**30.4**	**30.5**
Long-term debt	1.0	1.0	1.0	1.0
Other long-term liabilities	3.5	3.5	3.5	3.5
Total long-term liabilities	**4.5**	**4.5**	**4.5**	**4.5**
Total liabilities	**37.9**	**34.9**	**34.9**	**35.1**
Minority interest	0.0	0.0	0.0	0.0
Total common equity	**67.3**	**67.9**	**71.2**	**75.6**
Total liabilities & equity	**105.1**	**102.8**	**106.1**	**110.7**
Net debt	(28.4)	(27.4)	(28.6)	(31.9)

Ratios	3/15	3/16E	3/17E	3/18E
CROCI (%)	13.9	11.9	11.6	11.6
ROE (%)	9.7	9.2	8.9	8.7
ROA (%)	6.3	6.0	5.9	5.9
Net debt/equity (%)	(42.3)	(40.3)	(40.2)	(42.2)
Interest coverage ratio (X)	196.6	207.5	207.5	215.0

Valuation	3/15	3/16E	3/17E	3/18E
P/E (X)	10.7	9.3	9.2	8.9
EV/EBITDA (X)	3.0	2.9	2.7	2.3
EV/GCI (X)	0.6	0.4	0.4	0.3
P/B (X)	1.0	0.8	0.8	0.8
Dividend yield (%)	2.8	3.2	3.3	3.4
FCF yield (%)	4.9	7.5	6.9	8.9

Note: Last actual year may include reported and estimated data.

Source: Company data, Goldman Sachs Research estimates.

DaikyoNishikawa (4246.T, CL-Buy): Leading the shift to plastic among Japanese vehicles

What's changed

Regulations regarding vehicle fuel consumption are tightening across global markets heading toward 2020. Alongside the current shift to high-tensile steel and aluminum to manufacture the vehicle chassis, over the next five years we expect plastic to be more widely used to make automotive body parts such as rear doors and hoods. We estimate that the use of plastic to make these parts reduces vehicle weight by 2% and only pushes costs up by 2%. We believe plastic is a highly cost-effective material, and we see potential for greater cost benefits to emerge if the shift to plastic accelerates. Over the longer term we also expect carbon fiber reinforced plastic to come on the scene, but at the moment its relatively high cost has limited its usage to a handful of luxury models. A relative lack of strength is often cited as one of the weaknesses of plastic, but this can be overcome by mixing the material with glass fiber. We expect plastic, with its relatively low cost, to be increasingly used in mass-produced vehicles over the medium term. DaikyoNishikawa is in an unusual position to benefit from the auto industry's shift to plastic. Automakers generally tend to manufacture car bumpers and other plastic components in house, but Mazda outsources around 40% of its production to DaikyoNishikawa. We believe the company's strength is that its operation covers all stages from the procurement of plastic materials to product design and manufacture, and that this allows it to build up expertise in house.

Investment opinion

Our rating on the shares is Buy and we retain them on our Conviction List. The company's earnings environment looks favorable, as volume and sales mix looks healthy at its core customer Mazda, which contributes around 70% of sales. Plastic is increasingly used to manufacture the rear door of minicars and we expect this trend to take hold in registered vehicles. Mazda plans to start introducing plastic rear doors in earnest from 2017, and we expect the penetration rate to rise quickly, from an estimated 14% in FY3/18 to 40% in FY3/19 and 50% in FY3/20. We think the company stands to benefit from this change.

Valuation

Our 12-month target price is ¥3,100, which we base on DCF as we expect the company to benefit from what we see as an accelerating shift to plastic in the auto industry heading toward 2020 (our DCF model uses zero terminal growth from FY3/20 and 8% WACC).

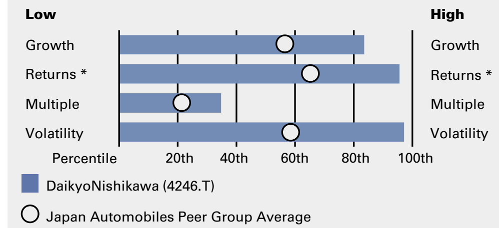
Risks

A downturn in production volume at its core customer Mazda, or its second-largest customer Daihatsu.

INVESTMENT LIST MEMBERSHIP
Japan Buy list
Japan Conviction Buy list

Coverage View: Neutral

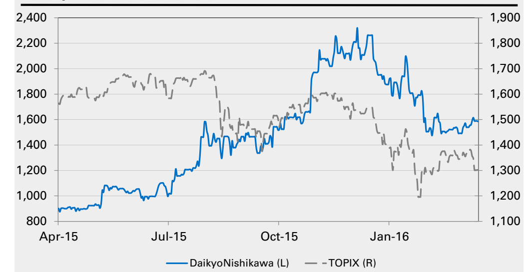
Investment Profile



* Returns = Return on Capital For a complete description of the investment profile measures please refer to the disclosure section of this document.

Key data				Current
Price (¥)				1,585
12 month price target (¥)				3,100
Market cap (¥bn)				114.7
Local GAAP (¥bn)	**3/15**	**3/16E**	**3/17E**	**3/18E**
Revenue New	**134.3**	**161.0**	**172.0**	**187.0**
Op. profit New	**12.4**	**18.5**	**19.5**	**21.5**
Op. profit Old	12.4	18.5	19.5	21.5
Op. profit CoE New	**--**	**15.5**	**--**	**--**
Op. profit CoE Old	--	15.5	--	--
EPS(¥) New	**95.8**	**163.1**	**179.0**	**199.3**
yoy % chg.	32.2	70.2	9.8	11.3
EPS (¥) Old	95.8	163.1	179.0	199.3
P/E (X)	**7.2**	**9.7**	**8.9**	**8.0**
P/B (X)	**1.2**	**2.2**	**1.8**	**1.5**
EV/EBITDA (X)	**5.7**	**3.9**	**3.5**	**3.0**
CROCI (%)	**18.1**	**16.0**	**15.6**	**15.5**
EV/GCI (X)	**0.4**	**0.9**	**0.7**	**0.6**

Price performance chart



Share price performance (%)	3 month	6 month	12 month
Absolute	(23.9)	12.4	75.9
Rel. to TOPIX	(11.8)	24.7	111.2

Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 4/04/2016 close.

DaikyoNishikawa: Summary financials

Profit model (¥bn)	3/15	3/16E	3/17E	3/18E
Revenue	134.3	161.0	172.0	187.0
Cost of goods sold	(114.0)	(132.2)	(141.9)	(153.7)
Gross profit	**20.3**	**28.8**	**30.1**	**33.3**
SG&A and other	(8.0)	(10.3)	(10.6)	(11.8)
Operating profit	**12.4**	**18.5**	**19.5**	**21.5**
Net interest income/(expense)	(0.4)	(0.5)	(0.4)	(0.4)
Equity in earnings of affiliates	(1.3)	0.2	0.2	0.2
Net other nonoperating inc/(exp)	1.4	(1.2)	(0.2)	(0.2)
Recurring profit	**10.8**	**17.4**	**19.3**	**21.3**
Extraordinary income	0.3	0.0	0.0	0.0
Extraordinary expense	(0.3)	(0.2)	0.0	0.0
Pretax profit	**10.8**	**17.2**	**19.3**	**21.3**
Income tax	(3.8)	(5.7)	(6.4)	(7.0)
Minority interest	0.0	0.4	0.4	0.4
Net income	**6.9**	**11.8**	**13.2**	**14.7**
Capital expenditures (excl. leases)	--	--	--	--
Capital expenditures (incl. leases)	(15.4)	(10.0)	(12.0)	(15.0)
Depreciation & amortization	(7.9)	(9.0)	(9.2)	(10.0)
EPS (basic) (¥)	**95.8**	**163.1**	**179.0**	**199.3**
EPS (fully diluted) (¥)	**95.8**	**163.1**	**179.0**	**199.3**
BVPS (¥)	580.7	724.0	863.9	1,036.5
DPS (¥)	16.3	21.0	25.5	27.5
Dividend payout ratio (%)	17.0	12.9	14.2	13.8

Year-on-year change (%)	3/15	3/16E	3/17E	3/18E
Revenue	23.8	19.8	6.8	8.7
Operating profit	55.7	49.7	5.4	10.3
Recurring profit	37.2	60.4	10.8	10.7
Net income	59.7	70.2	12.1	11.3
EPS (basic)	32.2	70.2	9.8	11.3
EPS (fully diluted)	32.2	70.2	9.8	11.3

Margins (%)	3/15	3/16E	3/17E	3/18E
Operating profit	9.2	11.5	11.3	11.5
EBITDA	15.1	17.1	16.7	16.8
Recurring profit	8.1	10.8	11.2	11.4
Net income	5.2	7.3	7.7	7.9

Cash flow statement (¥bn)	3/15	3/16E	3/17E	3/18E
Net income	6.9	11.8	13.2	14.7
D&A add-back	7.9	9.0	9.2	10.0
Minority interest add-back	0.0	(0.4)	(0.4)	(0.4)
Net (inc)/dec in working capital	(8.5)	(0.9)	(0.4)	(0.5)
Other operating cash flow	3.8	(1.7)	(1.7)	(1.7)
Cash flow from operations	**10.1**	**17.9**	**20.0**	**22.1**
Capital expenditures (incl. leases)	(15.4)	(10.0)	(12.0)	(15.0)
Purchases of long-term securities	0.0	0.0	0.0	0.0
Sales of long-term securities	0.0	0.0	0.0	0.0
Other investing cash flow	(0.7)	0.0	0.0	0.0
Cash flow from investments	**(16.1)**	**(10.0)**	**(12.0)**	**(15.0)**
Dividends paid (common & preferred)	(0.3)	(1.4)	(1.8)	(2.0)
Incr./(decr.) in debt	(1.0)	0.0	0.0	0.0
Common stock issuance	0.0	0.0	0.0	0.0
Other financing cash flow	6.6	0.5	0.6	0.6
Cash flow from financing	**5.4**	**(0.9)**	**(1.2)**	**(1.4)**
Total cash flow	**(0.7)**	**7.0**	**6.8**	**5.7**

Balance sheet (¥bn)	3/15	3/16E	3/17E	3/18E
Cash & equivalents	20.8	27.8	34.6	40.3
Accounts receivable	26.3	31.5	33.7	36.6
Inventory	6.3	7.6	8.1	8.8
Other current assets	6.5	8.0	9.5	11.0
Total current assets	**60.0**	**74.9**	**85.9**	**96.7**
Net PP&E	49.5	50.5	53.3	58.3
Net intangibles	1.4	1.4	1.4	1.4
Total investments	4.7	4.7	4.7	4.7
Other long-term assets	0.0	0.0	0.0	0.0
Total assets	**115.6**	**131.5**	**145.2**	**161.1**
Accounts payable	28.1	33.7	36.0	39.1
Short-term debt	7.5	7.5	7.5	7.5
Other current liabilities	15.8	15.8	15.8	15.8
Total current liabilities	**51.4**	**57.0**	**59.3**	**62.4**
Long-term debt	12.0	12.0	12.0	12.0
Other long-term liabilities	8.6	8.6	8.6	8.6
Total long-term liabilities	**20.6**	**20.6**	**20.6**	**20.6**
Total liabilities	**72.0**	**77.6**	**79.9**	**83.0**
Minority interest	1.5	1.5	1.5	1.5
Total common equity	**42.0**	**52.4**	**63.8**	**76.6**
Total liabilities & equity	**115.6**	**131.5**	**145.2**	**161.1**
Net debt	(1.4)	(8.3)	(15.1)	(20.8)

Ratios	3/15	3/16E	3/17E	3/18E
CROCI (%)	18.1	16.0	15.6	15.5
ROE (%)	17.2	24.2	22.2	20.5
ROA (%)	6.5	9.6	9.6	9.6
Net debt/equity (%)	(3.1)	(15.4)	(23.1)	(26.7)
Interest coverage ratio (X)	26.0	30.8	32.5	35.8

Valuation	3/15	3/16E	3/17E	3/18E
P/E (X)	7.2	9.7	8.9	8.0
EV/EBITDA (X)	5.7	3.9	3.5	3.0
EV/GCI (X)	0.4	0.9	0.7	0.6
P/B (X)	1.2	2.2	1.8	1.5
Dividend yield (%)	2.4	1.3	1.6	1.7
FCF yield (%)	(10.4)	6.8	6.7	6.0

Note: Last actual year may include reported and estimated data.

Source: Company data, Goldman Sachs Research estimates.

Minth (0425.HK, Neutral): To benefit from the global lightweighting trend

What's changed

Minth is primarily engaged in the design, manufacture, and sale of trims, decorative parts, body structure parts and other related auto parts. It has a global manufacturing footprint as well as global customer bases. In 1H2015, as per company announcement, among the new business awards there were 51% for overseas market outside China and 42% for aluminum parts (currently mainly the decorative parts like aluminum trims/roof rack/wheel cover, aluminum structural parts under development for future product pipeline). Other lightweighting components include plastic front-end module, grille, etc.

Regulations regarding vehicle fuel consumption are tightening across global markets heading toward 2020. In China the fuel consumption standard will decrease by 30% from 2014's 7.22 liter/100km to 2020E's 5.0 liter/100km, followed by another 25% cut to 4.0 liter/100km by 2025E. Over the coming decades, we expect more plastic and aluminum components to be used to make automotive structural parts as well as decorative parts. We see Minth as a pioneer in globalization among Chinese component makers (with >40% revenue in 1H15 coming from sales outside China and >90% revenue from global OEMs) that will benefit from the global lightweighting trend.

Investment opinion

We see the company has clear visibility in terms of business growth: 1) in 1H2015, the annualized new business awards amounted to Rmb2.9bn, 35.5% higher than 1H14; 2) accumulative booked business reached Rmb26bn by June 2015 vs. 1H15's revenue at Rmb3.4bn. Also, we believe further globalization will enhance the company's competitiveness in both China and the overseas market (e.g., wining global sourcing orders for global models). The global auto industry's lightweighting trend will clearly boost the growth of its aluminum/plastic parts further.

Valuation

Minth is trading at a 2016E P/B of 1.7X and a 2016E P/E of 11.3X, higher than H-share OEMs (2.0X and 12.8X). Our 12-month target price, based on 2016E P/B average and 2016E-18E ROE, is HK$12.36 (we apply a parts valuation premium of 15% to factor in Minth's competitive positioning and the higher industrial consolidation of component makers). We maintain Neutral.

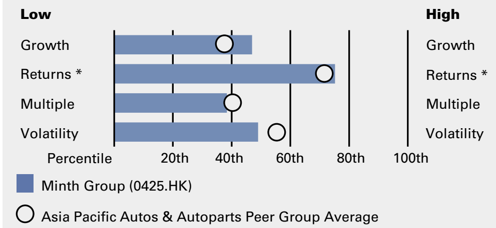
Risks

Higher/lower global/China car market; Quicker/slower adaptation of lightweighting component in global auto industry; higher/lower market share of Minth.

INVESTMENT LIST MEMBERSHIP
Neutral

Coverage View: Neutral

Investment Profile

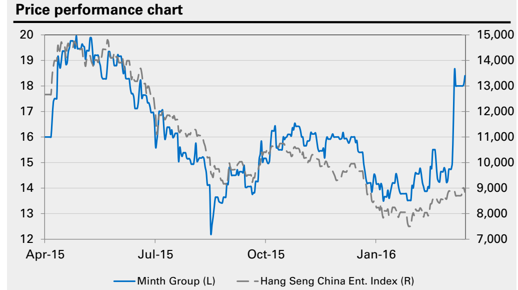


* Returns = Return on Capital For a complete description of the investment profile measures please refer to the disclosure section of this document.

Key data				Current
Price (HK$)				18.40
12 month price target (HK$)				12.36
Market cap (HK$mn)				17,563.4

IFRS (Rmbmn)	12/15	12/16E	12/17E	12/18E
Revenue New	7,654.1	9,214.4	10,084.5	11,731.3
Op. profit New	1,422.1	1,747.8	1,924.0	2,265.0
Op. profit Old	1,422.1	1,747.8	1,924.0	2,265.0
Op. profit CoE New	--	--	--	--
Op. profit CoE Old	--	--	--	--
EPS(Rmb) New	1.15	1.36	1.48	1.72
yoy % chg.	12.7	17.7	8.9	16.7
EPS (Rmb) Old	1.15	1.36	1.48	1.72
P/E (X)	11.4	11.3	10.4	8.9
P/B (X)	1.6	1.7	1.5	1.4
EV/EBITDA (X)	8.0	6.7	6.0	5.1
CROCI (%)	16.1	18.0	17.5	18.1
EV/GCI (X)	1.5	1.5	1.3	1.2

Price performance chart



Share price performance (%)	3 month	6 month	12 month
Absolute	19.5	33.1	19.3
Rel. to Hang Seng China Ent. Index	30.5	41.6	69.2

Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 4/01/2016 close.

Minth Group: Summary financials

Profit model (Rmb mn)	12/15	12/16E	12/17E	12/18E
Total revenue	**7,654.1**	**9,214.4**	**10,084.5**	**11,731.3**
Cost of goods sold	(4,895.0)	(5,874.3)	(6,408.9)	(7,443.7)
SG&A	(1,147.1)	(1,371.7)	(1,491.1)	(1,734.6)
R&D	--	--	--	--
Other operating profit/(expense)	141.5	151.9	156.2	170.0
EBITDA	**1,753.6**	**2,120.3**	**2,340.7**	**2,722.9**
Depreciation & amortization	(331.5)	(372.5)	(416.7)	(457.9)
EBIT	**1,422.1**	**1,747.8**	**1,924.0**	**2,265.0**
Interest income	135.4	116.4	112.2	120.9
Interest expense	(70.5)	(59.1)	(59.1)	(59.1)
Income/(loss) from uncons. subs.	38.3	38.3	38.3	38.3
Others	43.4	21.6	21.6	21.6
Pretax profits	**1,568.8**	**1,865.0**	**2,037.0**	**2,386.7**
Income tax	(249.1)	(299.1)	(331.3)	(396.3)
Minorities	(48.0)	(57.7)	(63.1)	(73.5)
Net income pre-preferred dividends	**1,271.7**	**1,508.2**	**1,642.6**	**1,916.9**
Preferred dividends	0.0	0.0	0.0	0.0
Net income (pre-exceptionals)	**1,271.7**	**1,508.2**	**1,642.6**	**1,916.9**
Post-tax exceptionals	0.0	0.0	0.0	0.0
Net income	**1,271.7**	**1,508.2**	**1,642.6**	**1,916.9**
EPS (basic, pre-except) (Rmb)	1.15	1.36	1.48	1.72
EPS (basic, post-except) (Rmb)	1.15	1.36	1.48	1.72
EPS (diluted, post-except) (Rmb)	1.14	1.36	1.48	1.72
DPS (Rmb)	0.46	0.54	0.59	0.69
Dividend payout ratio (%)	39.7	40.0	40.0	40.0
Free cash flow yield (%)	(0.9)	2.3	4.6	5.1

Growth & margins (%)	12/15	12/16E	12/17E	12/18E
Sales growth	14.5	20.4	9.4	16.3
EBITDA growth	20.9	20.9	10.4	16.3
EBIT growth	19.6	22.9	10.1	17.7
Net income growth	13.8	18.6	8.9	16.7
EPS growth	12.7	17.7	8.9	16.7
Gross margin	36.0	36.2	36.4	36.5
EBITDA margin	22.9	23.0	23.2	23.2
EBIT margin	18.6	19.0	19.1	19.3

Cash flow statement (Rmb mn)	12/15	12/16E	12/17E	12/18E
Net income pre-preferred dividends	1,271.7	1,508.2	1,642.6	1,916.9
D&A add-back	331.5	372.5	416.7	457.9
Minorities interests add-back	48.0	57.7	63.1	73.5
Net (inc)/dec working capital	(434.8)	(490.2)	(272.6)	(517.5)
Other operating cash flow	(165.5)	(49.9)	(49.9)	(49.9)
Cash flow from operations	**1,050.9**	**1,398.2**	**1,799.8**	**1,880.9**
Capital expenditures	(1,180.3)	(1,000.0)	(1,000.0)	(1,000.0)
Acquisitions	0.0	0.0	0.0	0.0
Divestitures	0.0	0.0	0.0	0.0
Others	0.0	0.0	0.0	0.0
Cash flow from investments	**(1,180.3)**	**(1,000.0)**	**(1,000.0)**	**(1,000.0)**
Dividends paid (common & pref)	(450.6)	(508.7)	(603.3)	(657.0)
Inc/(dec) in debt	(283.8)	0.0	0.0	0.0
Common stock issuance (repurchase)	0.0	0.0	0.0	0.0
Other financing cash flows	(18.6)	(22.4)	(24.5)	(28.5)
Cash flow from financing	**(753.0)**	**(531.0)**	**(627.7)**	**(685.5)**
Total cash flow	**(882.4)**	**(132.8)**	**172.1**	**195.3**

Balance sheet (Rmb mn)	12/15	12/16E	12/17E	12/18E
Cash & equivalents	2,766.7	2,633.9	2,806.0	3,001.3
Accounts receivable	2,067.1	2,488.5	2,723.5	3,168.2
Inventory	1,196.0	1,435.3	1,565.9	1,818.8
Other current assets	1,852.3	1,852.3	1,852.3	1,852.3
Total current assets	**7,882.2**	**8,410.0**	**8,947.8**	**9,840.7**
Net PP&E	4,175.4	4,820.0	5,420.3	5,979.5
Net intangibles	85.8	68.7	51.7	34.7
Total investments	276.4	336.3	396.2	456.1
Other long-term assets	736.2	736.2	736.2	736.2
Total assets	**13,155.9**	**14,371.2**	**15,552.1**	**17,047.1**
Accounts payable	851.9	1,022.3	1,115.3	1,295.4
Short-term debt	1,958.0	1,958.0	1,958.0	1,958.0
Other current liabilities	858.6	953.2	1,007.0	1,116.7
Total current liabilities	**3,668.5**	**3,933.5**	**4,080.3**	**4,370.1**
Long-term debt	0.0	0.0	0.0	0.0
Other long-term liabilities	81.0	91.0	101.0	111.0
Total long-term liabilities	81.0	91.0	101.0	111.0
Total liabilities	**3,749.5**	**4,024.5**	**4,181.3**	**4,481.1**
Preferred shares	**0.0**	**0.0**	**0.0**	**0.0**
Total common equity	**9,192.2**	**10,097.1**	**11,082.7**	**12,232.8**
Minority interest	214.2	249.5	288.1	333.1
Total liabilities & equity	**13,155.9**	**14,371.2**	**15,552.1**	**17,047.1**
BVPS (Rmb)	**8.26**	**9.07**	**9.96**	**10.99**

Ratios	12/15	12/16E	12/17E	12/18E
CROCI (%)	16.1	18.0	17.5	18.1
ROE (%)	14.5	15.6	15.5	16.4
ROA (%)	9.8	11.0	11.0	11.8
ROACE (%)	15.6	16.6	16.5	17.6
Inventory days	86.7	81.7	85.5	83.0
Receivables days	88.3	90.2	94.3	91.7
Payable days	61.2	58.2	60.9	59.1
Net debt/equity (%)	(8.6)	(6.5)	(7.5)	(8.3)
Interest cover - EBIT (X)	NM	NM	NM	NM

Valuation	12/15	12/16E	12/17E	12/18E
P/E (analyst) (X)	11.4	11.3	10.4	8.9
P/B (X)	1.6	1.7	1.5	1.4
EV/EBITDA (X)	8.0	7.9	7.1	6.0
EV/GCI (X)	1.5	1.5	1.3	1.2
Dividend yield (%)	3.5	3.5	3.8	4.5

Note: Last actual year may include reported and estimated data.

Source: Company data, Goldman Sachs Research estimates.

Glossary

Real Driving Emissions (RDE) testing: Method of regulating exhaust gas emissions based on data obtained during on-road testing. This involves installing a portable emission measurement system (PEMS) on the vehicle, and measuring nitrous oxide (Nox) and particle number (PN) emissions when driving along a predetermined route. Europe is now mulling the introduction of RDE.

World-Harmonized Light-Duty Vehicles Test Procedure (WLTP): WLTP is a global harmonized standard to test CO2 emissions

and fuel consumption, and is currently being developed under the Article 29 Working Party (WP29). The procedure will likely provide results with a more accurate reflection of actual fuel economy relative to unique test procedures currently adopted by each country.

Zero emission vehicle (ZEV) regulations: The emission regulatory framework at the state level in the United States. Regulations announced by California will exclude hybrids from the ZEV category from 2018 and only include PHEVs, EVs, and FCVs.

Body-in-white (BiW): Refers to the body shell (body frame and structural parts) prior to painting. Body shells are mostly divided into monocoque and ladder frame types.

High-tensile steel: Steel plate with high tensile strength used primarily in certain structural components. Definitions vary depending on the company and market, but most commonly refer to steel plate with a tensile strength of 340 MPa or higher (ordinary steel plate has a tensile strength of around 270 MPa).

Carbon Fiber Reinforced Plastic (CFRP): Composite material consisting of carbon fibers and plastic. Lighter than aluminum and also highly durable, CFRP has become increasingly popular in the aerospace industry in recent years. CFRP is divided primarily into thermoset and thermoplastic composites.

Lean NOx Trap (LNT): Type of exhaust gas emission filtration system. LNT systems temporarily absorb and store NOx from exhaust gas emissions, and then reduce the stored NOx gas during fuel rich operation via late-stage fuel injection.

Urea selective catalytic reduction (SCR): Type of exhaust gas emission filtration system. SCR systems inject an aqueous urea solution into the fuel immediately prior to the catalytic process to selectively reduce NOx levels using the ammonia generated by chemical reactions set off by the heat of the exhaust stream.

Electric vehicle (EV): EV is an automobile that runs on a motor with electric power charged from an external source. It is free of CO2 emissions as it does not use gasoline or other petroleum derivatives. Lithium ion batteries are the mainstream power source for EVs.

Fuel cell vehicle (FCV): Whereas a gasoline car obtains kinetic energy using an engine to heat the gasoline, an FCV stores hydrogen as fuel and generates power using a fuel cell installed in the vehicle. Since electricity is used to power the motor, FCVs have similar properties to electric vehicles (EVs) and are also called FCEVs.

Hybrid vehicle (HV): An HV is an automobile that runs on two power sources: Engine and electric motor(s). HVs largely break down into three categories based on their drivetrain, namely series, parallel, and power-split. The motor's support leads to fuel efficiency improvement during the drive.

Plug-in hybrid vehicle (PHV): PHV is a type of HV that allows one to charge electricity directly to a storage battery from a residential power plug. Similar to HVs, PHVs have series and parallel drivetrains. A PHV's battery volume is larger compared to that of a HV, but smaller compared to that of an EV. Driving distance for PHVs depends on the battery size.

Appendix

Exhibit 54: Examples of aluminum auto parts in the US and Japan

Japan		North America			
Toyota		Ford		Chrysler	
TOYOTA		FORD		Chrysler	
PRIUS	hood, back door	F150(2014)	All aluminum	300	hood, trunk lid
SAI	hood	FUSION	hood	RAM	
86	hood	MUSTANG	hood	1500	hood
LEXUS		EXPLORER	hood	C/V	hood
LS	hood	EXPEDITION	hood, back door	JEEP	
GS	hood	LINCOLN		CHEROKEE	hood
IS	hood	LS	hood, fender, trunk lid	WRANGLER	hood
HS	hood	MKZ	hood	DODGE	
CT	hood, back door	MKS	hood, trunk lid	DART	hood
NX	hood	TOWN CAR	hood	DURANGO	hood
Honda		NAVIGATOR	hood, back door	JOURNEY	hood, back door
LEGEND	hood, trunk lid	GM		CHARGER	hood
ACCORD(HV/PHEV)	hood	CHEVROLET		CHALLENGER	hood
FIT (some grade)	hood	TAHOE	hood, back door	MAGNUM	hood
Nissan		SURBURBAN	hood, back door	TESLA	
FUGA	hood, door	COLORADO	hood	MODEL S	All aluminum
CIMA	hood, door	SILVERADO LT	hood	Honda	
SKYLINE	hood	IMPALA	hood	HONDA	
SKYLINE Coupe	hood	MALIBU	hood	PILOT	hood
GT-R	hood, door, trunk	TRAVERS	hood	ODYSSEY	hood, fender
Fairlady Z	hood, back door	CAMARO	hood	ACURA	
LEAF	hood, door	GMC		RLX	hood, door (OTR)
Mazda		YUKON XL	hood, back door	Nissan	
ROADSTER	hood, trunk, fender	ACADIA	hood	NISSAN	
FHI		SIERA DENARI	hood	ALTIMA	hood
BRZ	hood	BUICK		MAXIMA	hood, trunk lid
FORESTER	hood	LACROSSE	hood	INFINITY	
LEVORG	hood	REGAL	hood	FX	hood, door
MMC		ENCLAVE	hood	EX	hood
LANCER EVOLUTION X	hood, fender, roof	CADDILAC		G37	hood
OUTLANDER	roof	ATS	hood	Mazda	
		CTS	hood, door	B2000	hood
		SRX	hood	FHI	
		ESCALADE	hood, back door	OUTBACK	hood, back door
		CT6	hood, fender, door	B9 TRIBECCA	hood

Source: Japan Aluminum Association.

Exhibit 55: Examples of aluminum auto parts in Europe

Europe					
Volkswagen		BMW		PSA	
VOLKSWAGEN		3-Series	hood	PEGEOT	
PHAETON Exclusive	fender, door, trunk	4-Series	hood, fender, door	3008	hood, fender
AUDI		5-Series	hood, fender, door	307	hood
A3	hood, fender	6-Series	hood, fender, door	508	hood
A5	fender	7-Series	hood, fender, door, trunk, roof	CITROEN	
A6	hood, door, fender, trunk	M3	hood, fender	DS4	hood
A8	All aluminum (space frame)	M5	hood, fender, door	DS5	hood
S5	hood, fender	X5	hood	FCA	
S7	hood, door, fender, trunk	Z4	hood, fender	FERRARI	
Q3	hood, back door	ROLLS-ROYCE		FF	All aluminum (space frame)
Q5	hood, back door	PHANTOM	All aluminum	F12	All aluminum (space frame)
Q7	hood, fender, roof, door	GHOST	All aluminum	458 ITALIA	All aluminum (space frame)
TT	All aluminum	Volvo		CALIFORNIA	All aluminum (space frame)
R8	All aluminum (space frame)	S60	hood	MASERATI	
PORSCHE		S70	hood, back door	QUATTROPORTE	hood, fender, door, trunk
911	hood, fender, door, engine hood	S80	hood	TATA	
911 TURBO	hood, fender, door, engine hood	V50	hood	JAGUAR	
CAYMAN	hood, fender, door, engine hood	V70	hood, back door	XE	All aluminum (monocoque)door, w/o truck
BOXTER	hood, fender, door, engine hood	C30	hood	XF	All aluminum (monocoque)door, w/o truck
PANAMERA	hood, fender, door, back door	C70 (cabriolet)	hood, trunk, roof	XJ	All aluminum (monocoque)
CAYENNE	hood, fender, door, engine hood	RENAULT		XK	All aluminum (monocoque)
MACAN	hood, fender, back door	CLEO(LUTECIA)	hood	F	All aluminum (monocoque)
LAMBORGHINI		GM		LAND ROVER	
AVENTADOR	hood, fender, door	OPEL		RANGE ROVER	All aluminum (monocoque)
GALLARDO	All aluminum (space frame)	INSIGNIA	hood	EVOQUE	hood, fender
Daimler		SIGNUM	hood	DISCOVERY	hood, fender
MERCEDES-BENZ		FORD		FREELANDER	hood
B-CLASS	hood	ASTON MARTIN		MCLAREN	
C-CLASS	hood, fender, door, trunk, roof	VANQUISH (2012-)	All aluminum (space frame)	MP4-12C	hood, fender, roof
E-CLASS	hood, fender, trunk	DBS	All aluminum (w/o fender)	NEVS	
S-CLASS	hood, fender, door, trunk	DB9	All aluminum (w/o fender)	SAAB	
CLS	hood, fender, door, trunk	RAPIDE	All aluminum (w/o fender)	9-3 Station Wagon	hood, back door
SL	All aluminum (monocoque)			9-5	hood
SLK	hood, fender				
SLS(AMG)	All aluminum (space frame)				

Source: Japan Aluminum Association.

Disclosure Appendix

Reg AC

We, Kota Yuzawa, Patrick Archambault, CFA, Stefan Burgstaller, Shuhei Nakamura, Yuichiro Isayama, Yipeng Yang, Stephen Benson, Toshihide Kinoshita and Yuqian Ding, hereby certify that all of the views expressed in this report accurately reflect our personal views about the subject company or companies and its or their securities. We also certify that no part of our compensation was, is or will be, directly or indirectly, related to the specific recommendations or views expressed in this report.

Unless otherwise stated, the individuals listed on the cover page of this report are analysts in Goldman Sachs' Global Investment Research division.

Investment Profile

The Goldman Sachs Investment Profile provides investment context for a security by comparing key attributes of that security to its peer group and market. The four key attributes depicted are: growth, returns, multiple and volatility. Growth, returns and multiple are indexed based on composites of several methodologies to determine the stocks percentile ranking within the region's coverage universe.

The precise calculation of each metric may vary depending on the fiscal year, industry and region but the standard approach is as follows:

Growth is a composite of next year's estimate over current year's estimate, e.g. EPS, EBITDA, Revenue. **Return** is a year one prospective aggregate of various return on capital measures, e.g. CROCI, ROACE, and ROE. **Multiple** is a composite of one-year forward valuation ratios, e.g. P/E, dividend yield, EV/FCF, EV/EBITDA, EV/DACF, Price/Book. **Volatility** is measured as trailing twelve-month volatility adjusted for dividends.

Quantum

Quantum is Goldman Sachs' proprietary database providing access to detailed financial statement histories, forecasts and ratios. It can be used for in-depth analysis of a single company, or to make comparisons between companies in different sectors and markets.

GS SUSTAIN

GS SUSTAIN is a global investment strategy aimed at long-term, long-only performance with a low turnover of ideas. The GS SUSTAIN focus list includes leaders our analysis shows to be well positioned to deliver long term outperformance through sustained competitive advantage and superior returns on capital relative to their global industry peers. Leaders are identified based on quantifiable analysis of three aspects of corporate performance: cash return on cash invested, industry positioning and management quality (the effectiveness of companies' management of the environmental, social and governance issues facing their industry).

Disclosures

Coverage group(s) of stocks by primary analyst(s)

Kota Yuzawa: Japan-Automobiles. Patrick Archambault, CFA: America-Autos & Auto Parts, America-Autos Dealers. Stefan Burgstaller: Europe-Autos & Auto Parts. Shuhei Nakamura: Japan-Advanced Materials sector. Yuichiro Isayama: Japan-Machinery. Yipeng Yang: China Autos. Stephen Benson: Europe-Paper & Forest, Europe-Steel. Toshihide Kinoshita: Japan-Automobiles. Yuqian Ding: China Autos.

America-Autos & Auto Parts: BorgWarner Inc., Dana Holding, Delphi Automotive Plc, Ford Motor Co., General Motors Co., Harley-Davidson Inc., Harman International Industries Inc., Johnson Controls Inc., Lear Corp., Magna International Inc., Magna International Inc., Meritor Inc., Metaldyne Performance Group, Nemak, Tenneco Inc., Tesla Motors Inc..

America-Autos Dealers: AutoNation Inc., Group 1 Automotive Inc., Penske Automotive Group, Sonic Automotive Inc..

China Autos: Anhui Jianghuai Automobile Co., Baoxin Auto Group, Brilliance China Automotive, BYD Co., China Harmony New Energy Auto, Chongqing Changan Auto (A), Chongqing Changan Auto (B), Dongfeng Motor, FAW Car, Fuyao Glass Industry Group (A), Fuyao Glass Industry Group (H), Geely Automobile Holdings, Great Wall Motor Co. (H), Great Wall Motor Co.(A), Guangzhou Automobile Group, Huayu Automotive Systems, Minth Group, SAIC Motor, Sinotruk (Hong Kong), Weichai Power (A), Weichai Power (H), Weifu High-Technology Group (A), Weifu High-Technology Group (B), Zhengtong Auto Services Holdings, Zhongsheng Group.

Europe-Autos & Auto Parts: Autoliv Inc., BMW, CNH Industrial, CNH Industrial, Continental, Daimler AG, Faurecia, Fiat Chrysler Automobiles NV, Fiat Chrysler Automobiles NV, GKN, Hella KGaA Hueck, Michelin, Nokian Renkaat, Peugeot, Porsche, Renault, Valeo, Volkswagen, Volvo.

Europe-Paper & Forest: D S Smith, Mondi Group, Smurfit Kappa Group, Stora Enso, UPM-Kymmene.

Europe-Steel: Acerinox, Aperam SA, ArcelorMittal, Kloeckner & Co., Outokumpu, Salzgitter, SSAB, ThyssenKrupp, Voestalpine.

Japan-Advanced Materials sector: Daicel, Daido Steel, Hitachi Metals, JFE Holdings, Kansai Paint, Kobe Steel, Kuraray, Nippon Carbon, Nippon Paint Holdings, Nippon Shokubai, Nippon Steel & Sumitomo Metal, Tokyo Steel Manufacturing, Toray Industries, UACJ.

Japan-Automobiles: Aisin Seiki, Bridgestone, Calsonic Kansei, Daihatsu Motor, DaikyoNishikawa, Denso, FCC, Fuji Heavy Industries, Hino Motors, Honda Motor, Isuzu Motors, Keihin, Mazda Motor, Mitsubishi Motors, Nissan Motor, Nissin Kogyo, Stanley Electric, Sumitomo Rubber Industries, Suzuki Motor, Toyoda Gosei, Toyota Boshoku, Toyota Industries, Toyota Motor, TS Tech, Unipres, Yamaha Motor.

Japan-Machinery: Aida Engineering Ltd., Daikin Industries, Fanuc, Harmonic Drive Systems Inc., Hitachi Construction Machinery, JTEKT, Keyence, Komatsu, Kubota, Makita, NSK, NTN, Okuma Corp., SMC, THK, Tsubaki Nakashima Co., Yaskawa Electric.

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Goldman Sachs Investment Research global coverage universe

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