TRANSPORTATION CONSTRUCTION INDUSTRIAL MATERIALS FINANCIAL

Aluminum in 2012 North American Light Vehicles

Executive Summary

DUCKER WORLDWIDE

September 7, 2011

FINAL

ALUMINUM IN TRANSPORTATION

THE ALUMINUM ASSOCIATION, INC.

AGENDA

DUCKER WORLDWIDE

- SURVEY OBJECTIVES, APPROACH AND RESULTS
- SURVEY SYNOPSIS

SURVEY OBJECTIVES, APPROACH AND RESULTS

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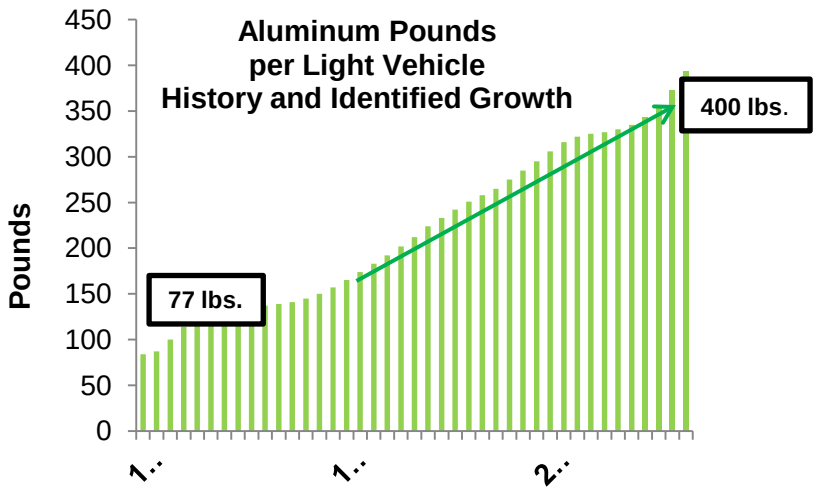
Primary Study Objective – Survey the North American automakers to obtain an accurate estimate of 2012 North American light vehicle aluminum content.

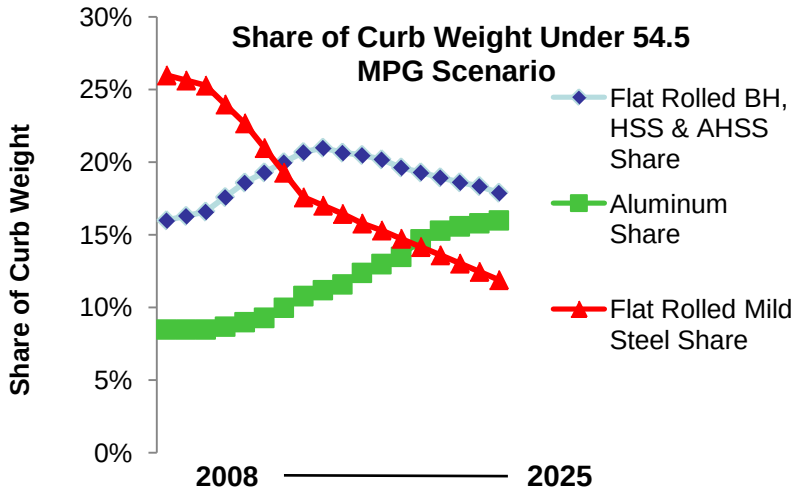
Secondary Study Objective – Survey the North American automakers to obtain an estimate on the "most likely" material mix for North American light vehicles through 2025. All the most relevant factors affecting the future mix were taken into account including technology, cost, material availability and the recently announced fuel economy goal of 54.5 MPG by 2025.

Methodology – Ducker maintains a proprietary vehicle-by-vehicle 32,000 cell database on metallic materials in light vehicles and uses the database to forecast metallic material content and trends by segment, Original Equipment Manufacturers (OEMs) and for as many as 90 different components made from the major product forms for iron, flat rolled steel, aluminum and magnesium. During the spring/summer of 2011, interviews were conducted with automotive engineers at the major auto manufacturers to update the Ducker database and discuss their future material strategies.

Results

- Ducker estimates 343 pounds of finished aluminum per vehicle in 2012, up from 327 pounds in 2009.
- Aluminum is expected to double its share of the average light vehicle material mix to 16% by 2025 compared to the 2008 Environmental Protection Agency (EPA) base year.
- Aluminum currently is the dominant material for powertrain, heat exchangers and road wheels and the study reveals it is rapidly gaining market share for hoods (30%), trunk lids, bumpers, steering knuckles and suspension arms.
- Average vehicle weight (not necessarily size) will be reduced by 408 pounds by 2025 or 10% less than the EPA base year of 2008.
- Aluminum is gaining share at the expense of both traditional and high strength steels (HSLA) which are declining as a percent of the mix.
- Advanced High Strength Steels, with a 590 MPa or more tensile, are also growing at the expense of inferior steels, but AHSS provides limited weight savings potential compared to aluminum. Pound for pound, aluminum replaces more than twice as much weight as AHSS.
- Direct cost of the materials upgrade is estimated at less than $500, before secondary any cost savings from downsized components are taken into account.
- Consumers will see high volume, aluminum-bodied vehicles on the road before the end of this decade.





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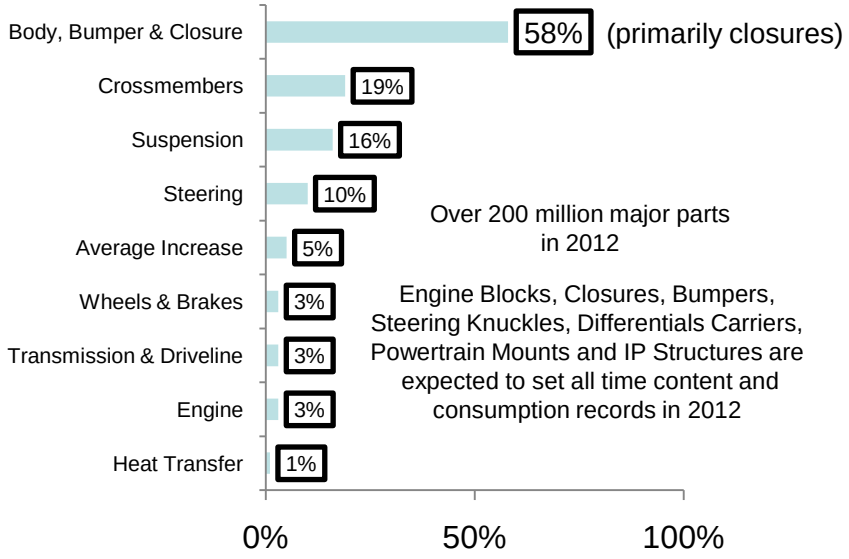
- Current aluminum growth is driven by new applications for body, bumpers and closures.

  Thirty percent of all the hoods on 2012 vehicles will be aluminum; saving 100 million pounds of vehicle weight. Future growth will be driven primarily by the continued conversion of steel to aluminum in these same closure applications, body structures and bumpers. Aluminum saves weight because it has a density of only one third of AHSS. On stiffness dependent components (i.e. hoods, fenders, deck lids) increasing thickness of the aluminum to match steel component stiffness results in aluminum components at half the weight of the steel components they replace. Ducker estimates increasing average vehicle aluminum content by 225 pounds per vehicle by 2025 will result in 180 pounds vehicle weight reduction with no change in component performance.

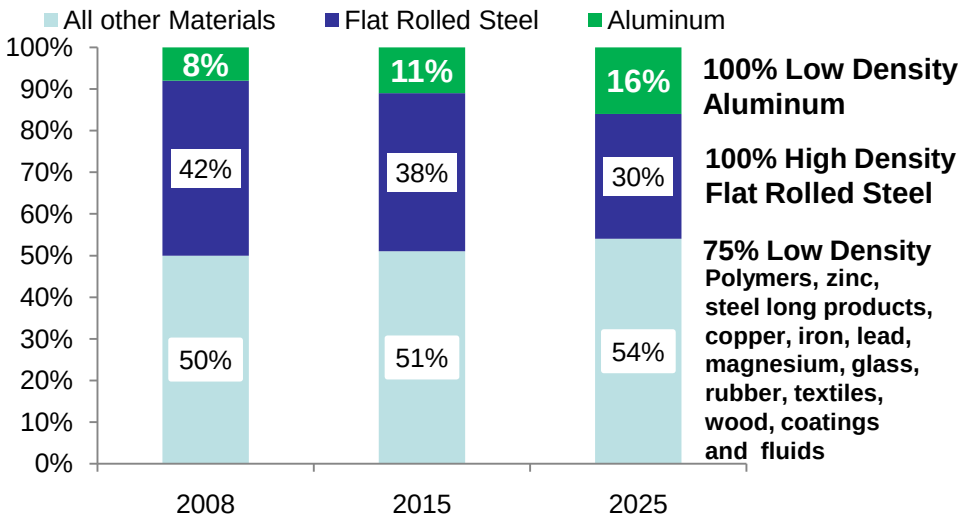
- Advanced High Strength Steels (AHSS) with a tensile strength of 590 MPa or above.

  These steels don't save enough weight. AHSS saves weight through gauge reduction. Due to stiffness limitations, there is a limit on how thin components such as hoods, deck lids, doors and fenders can be and maintain functionality. AHSS has the same density as mild steel. Use of AHSS is expected to increase by 250 pounds per vehicle by 2025 for strength driven body components. This will result in a maximum average vehicle savings of 80 pounds from the new steels. The AHSS under development simply improves the formability of current AHSS. The density of the new AHSS, soon to be introduced, will remain 2.9 times the density of aluminum.

2009- 2012 Aluminum Content Growth

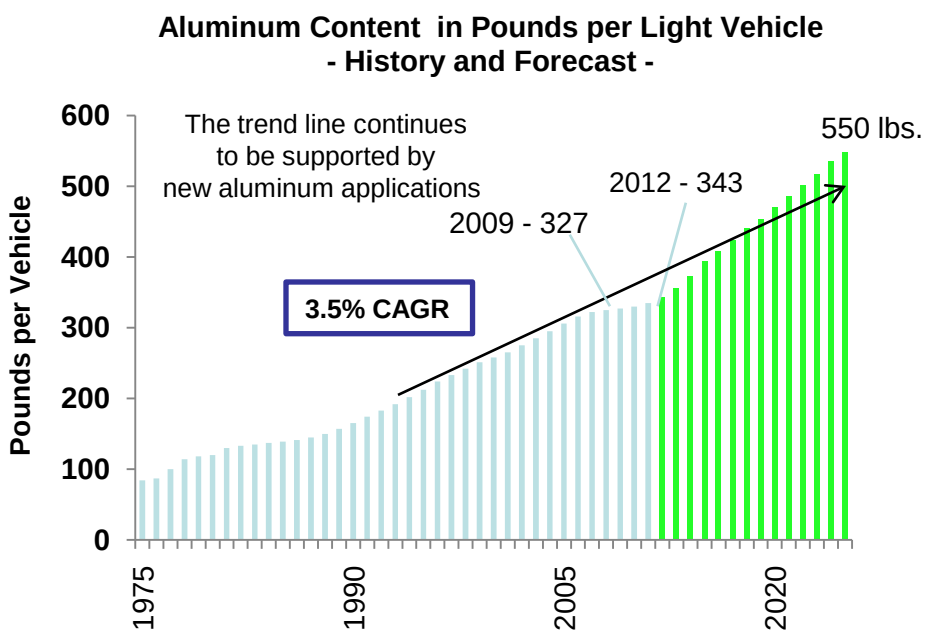


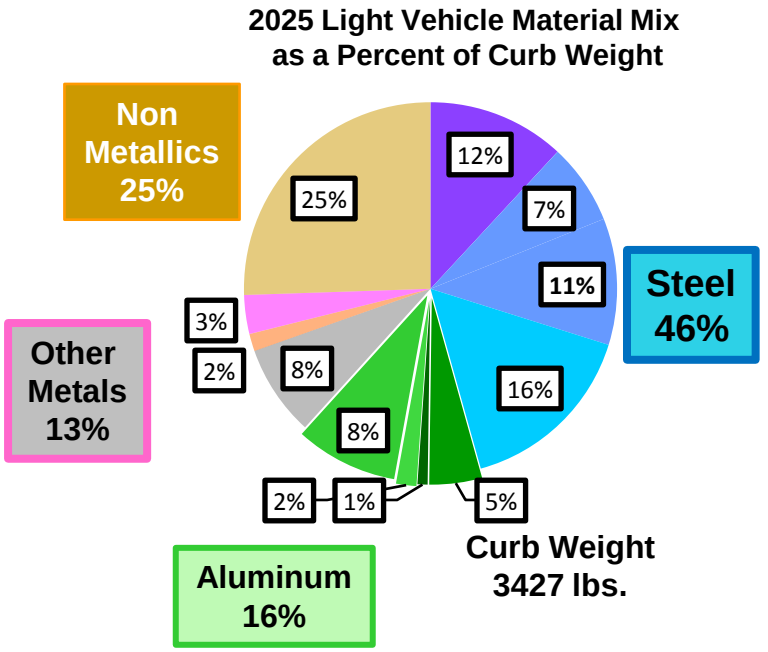
Material Mix in Total is Shifting to Lower Density Materials as a % of Curb Weight



SURVEY SYNOPSIS

- Aluminum will grow from 325 pounds in 2008 EPA base year to 550 pounds by 2025 and save 180 to 200 pounds of direct curb weight and 78 pounds of secondary curb weight.
- The average cost of direct weight savings is estimated to be approximately $2.00 per pound of weight saved not including cost savings from secondary weight reductions. The 78 pounds of secondary weight savings will help offset this penalty.
- Increased use of aluminum is absolutely necessary to achieve a cost effective weight reduction of over 400 pounds by 2025.
- Weight savings opportunities with AHSS are limited beyond conversion of the safety cage and a few other strength dependent parts. A few major OEMs have already reached this point in most of their vehicles. For these OEMs, increasing aluminum intensity is the logical next step.
- Adding 225 pounds of aluminum in less than 20 years is a dramatic increase. Based on history and identified new applications, North American OEMs will add 250 pounds in the period from 1990 to 2015. The 3.5% CAGR aluminum growth rate needed to attain 550 pounds and 16% of curb weight by 2025 is a conservative forecast in our opinion.





AGENDA

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- **EXECUTIVE SUMMARY**

DUCKER WORLDWIDE

Ducker Introduction

- Ducker Worldwide has collected data for the Aluminum Association's Aluminum Transportation Group (ATG) on the growth and development of aluminum content in light vehicle applications on an annual basis since 1991.
- Ducker started its systematic aluminum research efforts in North America in 1991, expanded into Europe and Japan in 2000 and the remainder of the world in 2007.
- Ducker has been conducting studies on HSLA (high-strength, low-alloy) and AHSS use for the American Iron and Steel Institute since 2006.
- Ducker performed recent studies for the EPA and the Department of Energy (DOE) on metallic material options, including magnesium, for reducing vehicle weight up to 25% in order to increase fuel economy. OEM interviews were a major part of these efforts.
- Ducker maintains a proprietary vehicle-by-vehicle 32,000 cell database on metallic materials in light vehicles, and uses the database to forecast metallic material content and trends by segment, OEM and for as many as 90 different components made from all the major product forms for iron, flat rolled steel, aluminum and magnesium. OEM and supplier input obtained on a regular basis is the major source of this data.

Basic assumptions of the study.

- An average of at least 2.5% for GDP in the U.S over the next ten years.

  GDP = Consumption + Investment + Government Purchases + Net Exports

- North American light vehicle production of 13.9 million vehicles in 2012 with at least 75 million vehicles produced in the period 2012 – 2016.
- A combined fuel economy standard of at least 51 mpg for 2025 will be put in place in the next twelve months, and remain in effect through administration changes in Washington.
- Specific aluminum products needed to fill the future demands of OEM's and their parts suppliers will be available in a timely manner.
- The aluminum industry will provide the necessary technical support to satisfy OEM and parts suppliers needs for the latest aluminum technology.
- Oil prices will remain between $80 and $120 per barrel with the same volatility as the last five years for the next five years.

Core findings of the 200 page proprietary study.

Aluminum content in North American (NA) light vehicles has achieved 37 years of uninterrupted growth. Ducker expects average 2012 vehicle content of 343 pounds:

- NA light vehicle industry to require 4.5 million closures, 7 million bumper beams, 13.9 million steering knuckles, 11.9 million suspension arms, 1.7 million cross members and sub frames, 1.5 million drive shafts, 4.5 million differential carriers, 22 million powertrain mounts, 32 million cylinder heads and blocks and 39 million aluminum wheels.
- Engine blocks, closures, bumpers, steering knuckles, differentials carriers, powertrain mounts and IP Structures are expected to set all time content and aluminum consumption records in 2012.
- Sixty percent of the growth from 2009 will be for structural components made from primary aluminum. In the prior decade, the majority of the aluminum content growth was from non-structural components made from secondary aluminum.
- Body, bumper and closure content grew by 58% from 2009 to 2012. 30% of all the hoods and over 20% of the bumper beams will be aluminum in 2012. This is a great indicator for future mill product aluminum growth. Trend line for aluminum hood penetration predicts a minimum 41% share for aluminum hoods in 2017 and at least 53% by 2025 even without any further fuel economy regulations. With the 2025 standards announced in early August 2011, the total predicted 2025 share for all aluminum closures including, hoods, doors, trunk lids and fenders is 42%.
- Imported cast wheels (China) will be used for 50% of the total 2012 light vehicle aluminum wheel requirement. Aluminum will represent 70% of the road wheels required. Engines and transmissions will contain 335 million pounds of non-NAFTA imported aluminum components.
- The only major component that will show an aluminum content decline in 2012 over 2009 is intake manifolds. Manifolds continue to move to magnesium, reinforced nylon and other polymer composites.

GM is the aluminum content leader of the major OEMs at 366 pounds.
Honda is the leader for aluminum content as a percent of curb weight at 10.7%.

- Latest models with above average aluminum content are: Chevy Malibu, Cadillac XTS/ATS/CTS, Dodge/Fiat C Sedan, Ford Explorer, Escape and MKZ, Honda CR-V and Accord, Nissan Altima, Toyota Avalon and Fiat 500.
- D Segment vehicles represent the largest share of each of the five part families considered for conversion to aluminum. The D Segment will contain 363 pounds of aluminum overall (10% of curb weight).
- E Segment vehicles are the most aluminum intensive with an average aluminum content of 421 pounds (9.7% of curb weight).
- Large full frame (LFF) vehicles, mainly pickup trucks, contain below average quantity of structural aluminum components, but a slightly above average amount of aluminum overall at 354 pounds (6.8% of curb weight).
- Ducker believes the future growth of aluminum is highly dependent on the D, E and LFF segments. These segments, particularly LFF, are not good candidates for size reduction due to comfort and functionality requirements. These segments need aluminum bodies and doors more than the other segments.
- Beyond 2012, growth will depend on new applications expected to appear in the next five years. New applications are being driven by the 2016 CAFE standard of 35.5 MPG.

  On September 30, 2011 the EPA ruling for 2017 to 2025 fuel economy will be issued with a 2025 passenger car target of 54.5 MPG and a light truck improvement target of 3.5% per year from 2016 to 2021, and the 2025 truck target "to be determined."

OBSERVATIONS AND CONCLUSIONS

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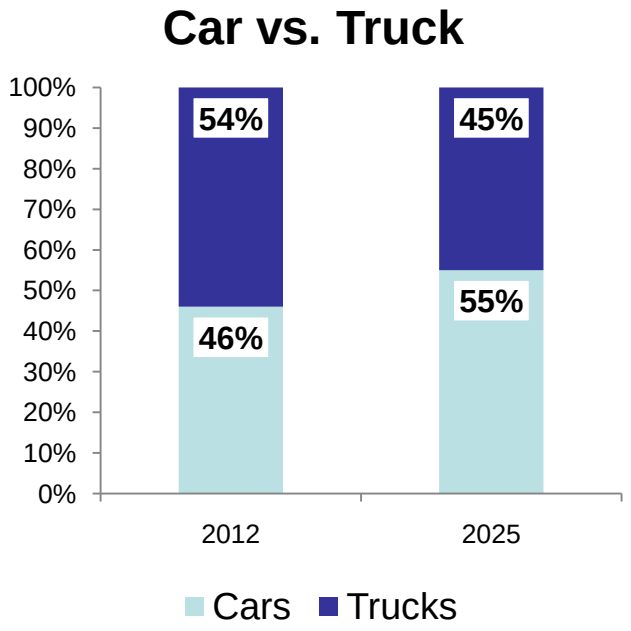
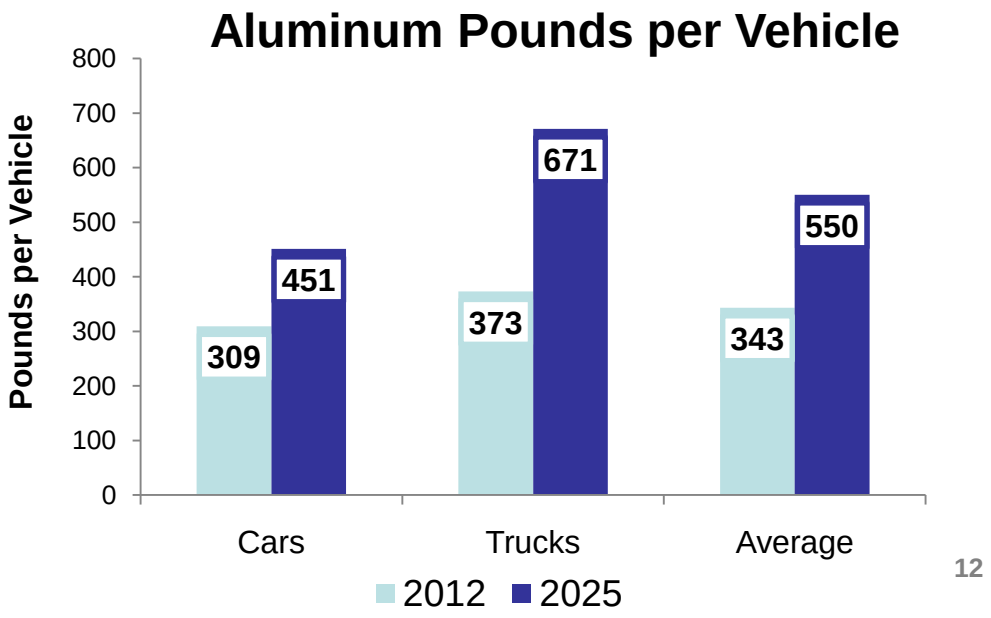
OEMs efforts to meet 35.5 mpg by 2016 coupled with the uncertainty surrounding the fuel economy standards beyond 2016 has caused a flurry of down weighting activity in the last two years.

- Standards for 2016 will push aluminum content from the 2012 level of 343 pounds per vehicle to 375 pounds per vehicle by 2015/2016. The pending 2017 standard is likely to add at least 20 to 25 additional pounds. If there is no 2017 mandate the 20 additional pounds would be in jeopardy. Aluminum growth to near 400 pounds of aluminum per vehicle will be driven by growth in: closures, bumpers and bodies. Traditional aluminum components including engine blocks, wheels and steering knuckles will represent only 15% content growth through 2025.
- During this decade, light vehicle aluminum content growth shifts from castings to mill products.
- U.S. desire to reduce greenhouse gas emissions and reduce NAFTA dependence on oil imports is driving a multitude of proposals and options for improving fuel economy. A final set of recommend standards for 2017 - 2025 will be issued by NHTSA/EPA on September 30, 2011.The NHTSA/EPA recommendations will be based on significant weight savings.
- Ducker believes the NHTSA/EPA recommendations will be based on a maximum overall weight reduction of 10% to 12% on a sliding scale from small to large vehicles with a combined fuel economy target of between 51 MPG and 56 MPG. (54.5 MPG is in latest announcement, for cars with special treatment for trucks).
- Any 2025 target over 50 MPG is very likely to result in unprecedented aluminum content growth.
- An average weight savings of 400 pounds based on the EPA starting weight of 4,085 will require a 2025 aluminum content at or near 550 pounds per vehicle. This equates to a fuel economy of 51 MPG with 44% HEV penetration. An overall flat rolled AHSS content of 375 pounds an a 2% reduction in average vehicle footprint will also be required.
- Aluminum content will increase to 671 pounds or 80% from the 373 pounds 2012 per vehicle for light trucks. Aluminum content will increase to 451 pounds or 50% from the 309 pounds in 2012 for cars. The aluminum product mix will go from 81% castings and 19% mill products to 39% mill products and 61% castings under the 550 pounds of aluminum per vehicle in 2025.

Ducker prefers segment analysis for material content studies, but the classic "car versus "truck" breakdown is also used for some comparisons.

- The 2012-2026 and 2017-2025 fuel economy standards are footprint based; however, the target MPG per square foot are different for "cars" versus "trucks". The final targets of 35.5 MPG for 2016 and 54.5 for cars and at least 46.5 for light trucks for 2025 covers the entire mix. However, every OEM has their own target for fuel economy based on their specific vehicle characteristics. The 2017-2025 rule will give trucks a slower ramp up in MPG than expected for the period 2017-2021. Most likely 2025 segment breakdown is 55% cars and 45% trucks. The 550 pounds of aluminum per vehicle in 2025 to be split 451 pounds for cars and 671 pounds for trucks.
- Trucks including SUVs use more aluminum per vehicle than cars because they can not be easily downsized in terms of footprint, and they have larger engines and transmissions with larger aluminum heads, blocks and transmission cases than most cars.





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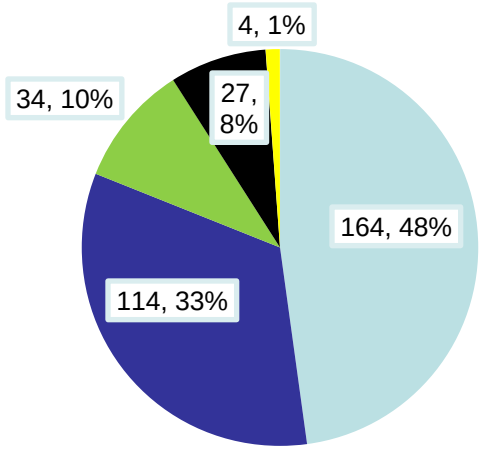
The use of aluminum in NA light vehicles will shift to a significantly larger share of mill products versus castings by 2025.

19% Mill Products
23% / 15.5% Car / Truck

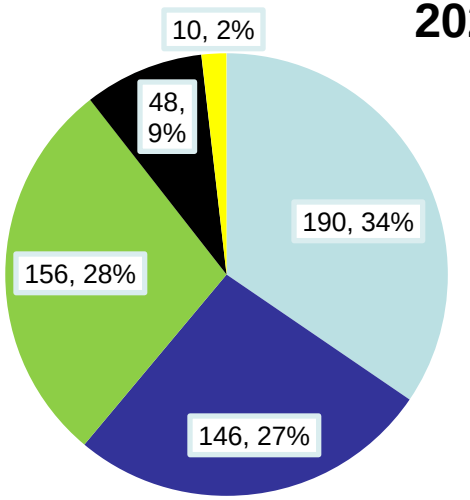
2012



343 Pounds
Car 309 Pounds
Truck 373 Pounds

39% Mill Products
29% / 47% Car / Truck

2025

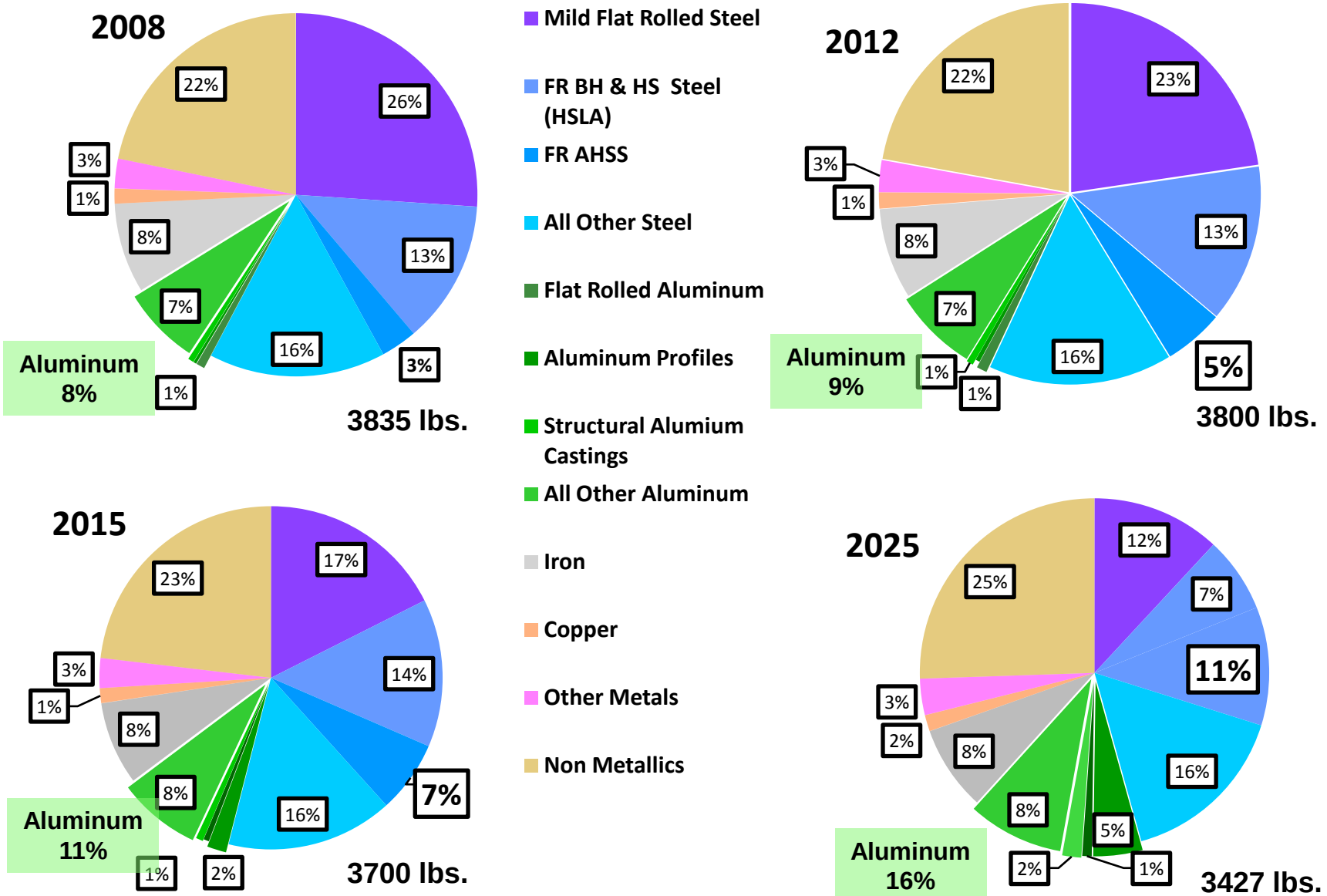


550 Pounds
Car 451 Pounds
Truck 671 Pounds

Type of Vehicle	Increase in Aluminum Content
Car	50%
Truck	80%

- Permanent Mold & Sand Cast
- High Presure Die Cast
- Flat Rolled
- Extruded
- Forged

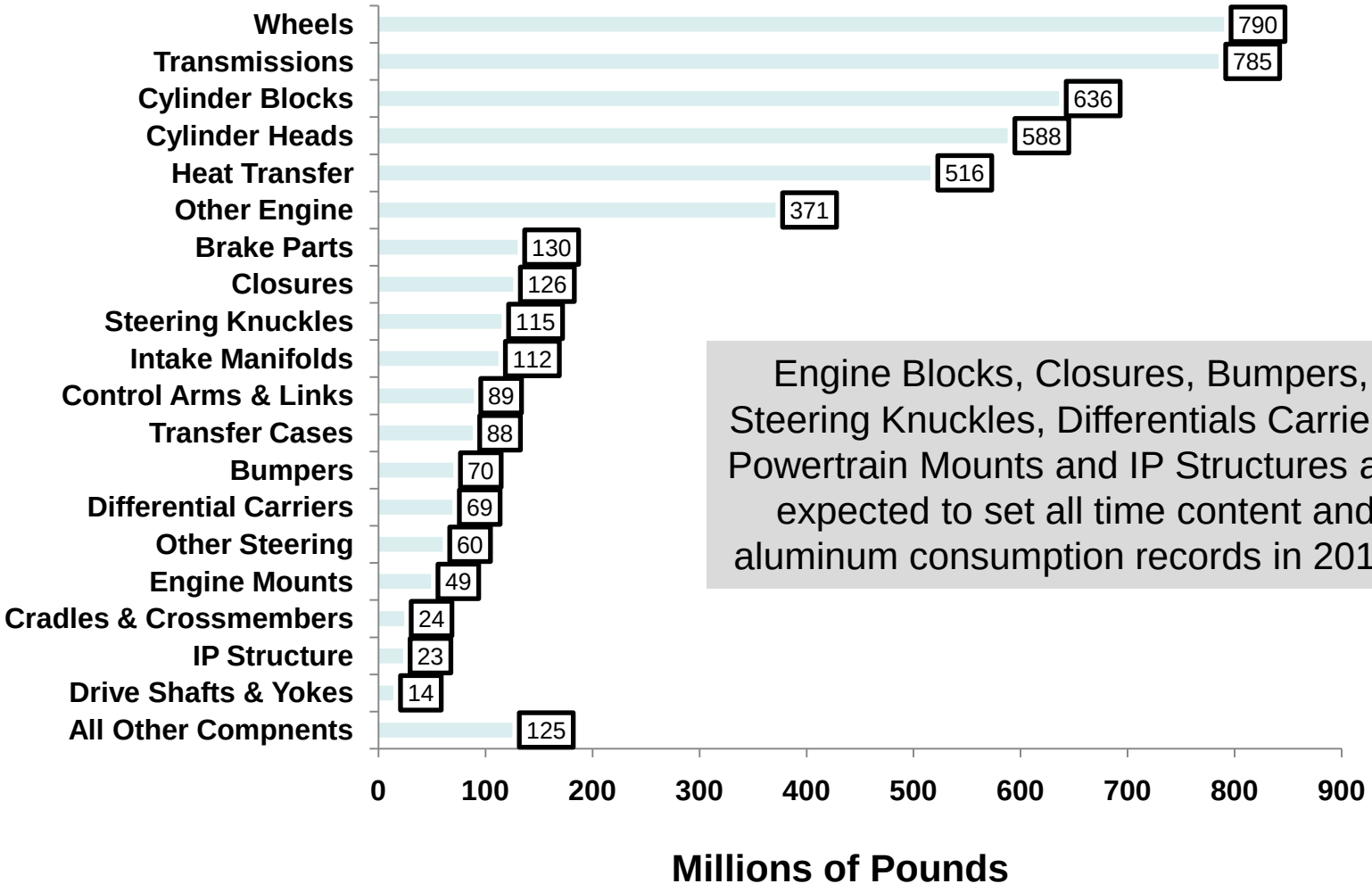
Aluminum is expected to double its share of the light vehicle material mix by 2025 vs. the 2008 EPA baseline vehicle.



COMPONENT ANALYSIS

Aluminum content in 2012 will be concentrated in non-structural components; structural components will be at an all time high of 15-20% of the mix.

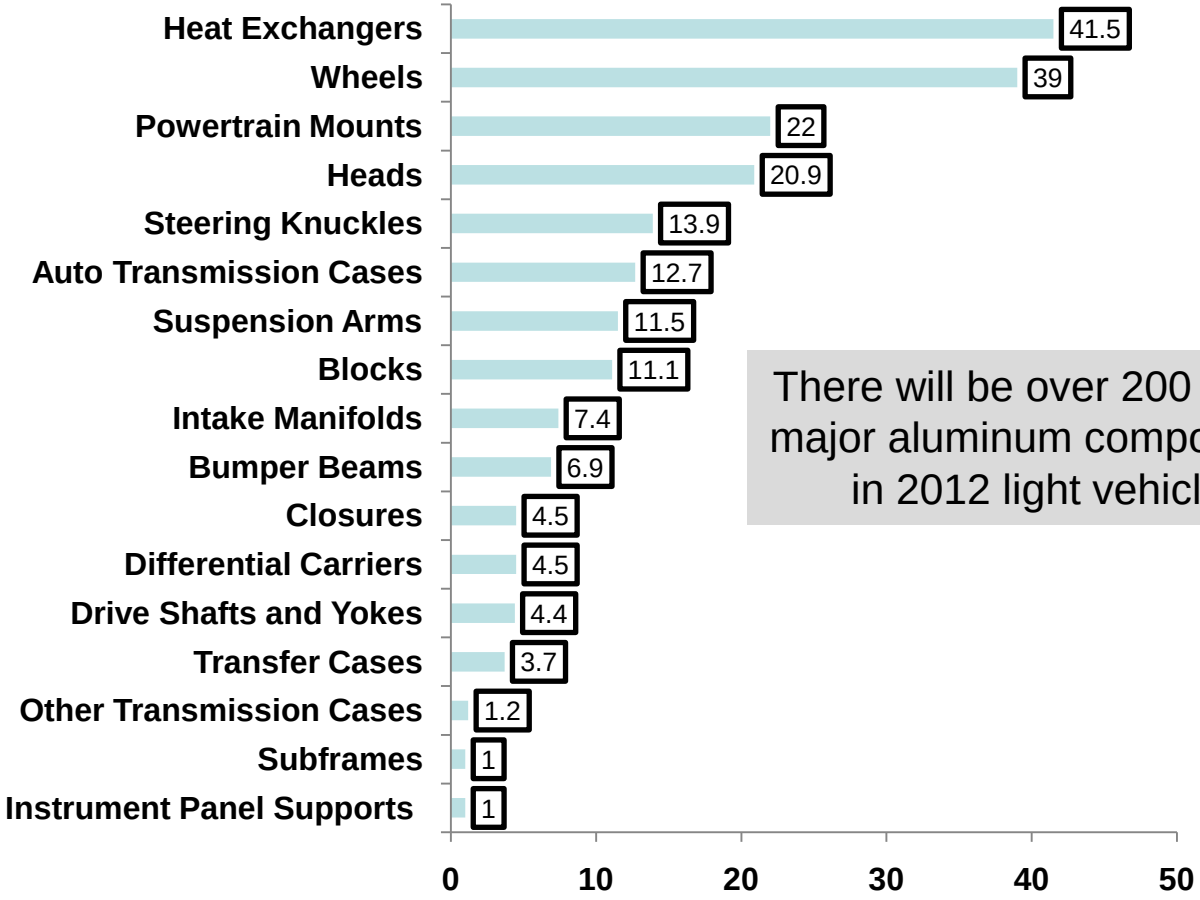
2012 Millions of Pounds of Aluminum Content



Engine Blocks, Closures, Bumpers, Steering Knuckles, Differentials Carriers, Powertrain Mounts and IP Structures are expected to set all time content and aluminum consumption records in 2012

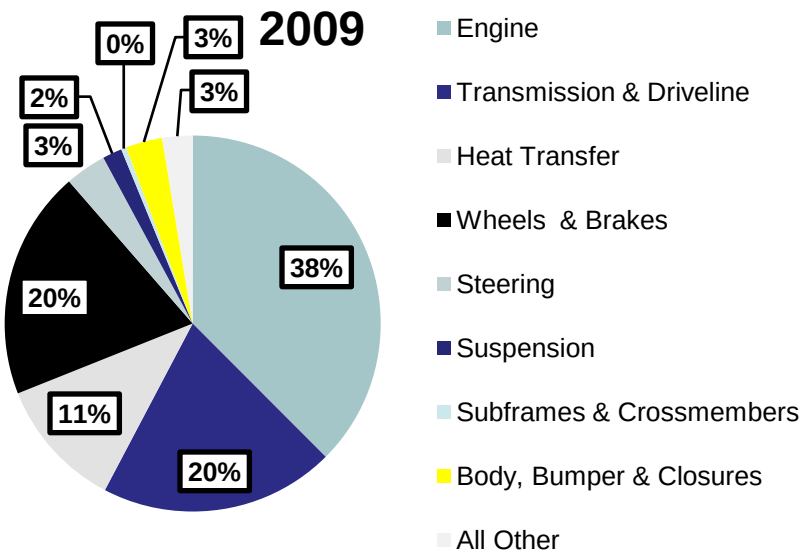
The number of aluminum parts that had to be engineered and will be manufactured for the 2012 vehicles will be an all time record.

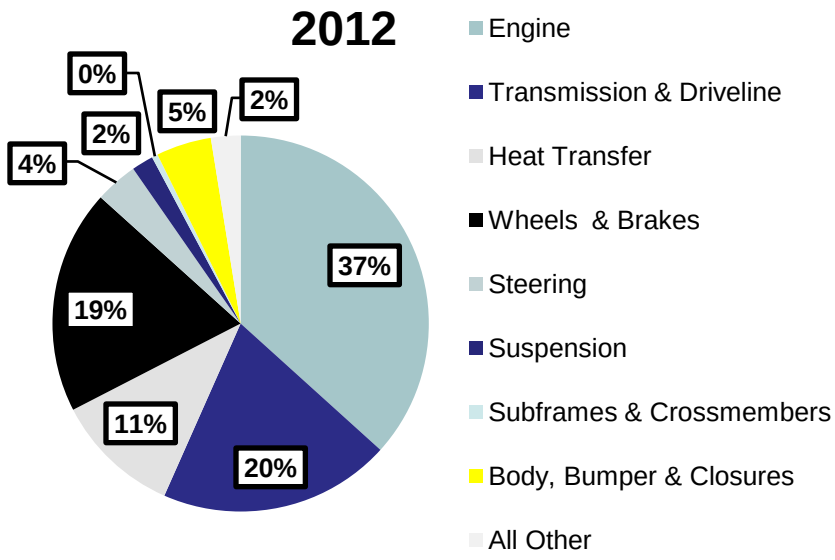
2012 Millions of Aluminum Parts

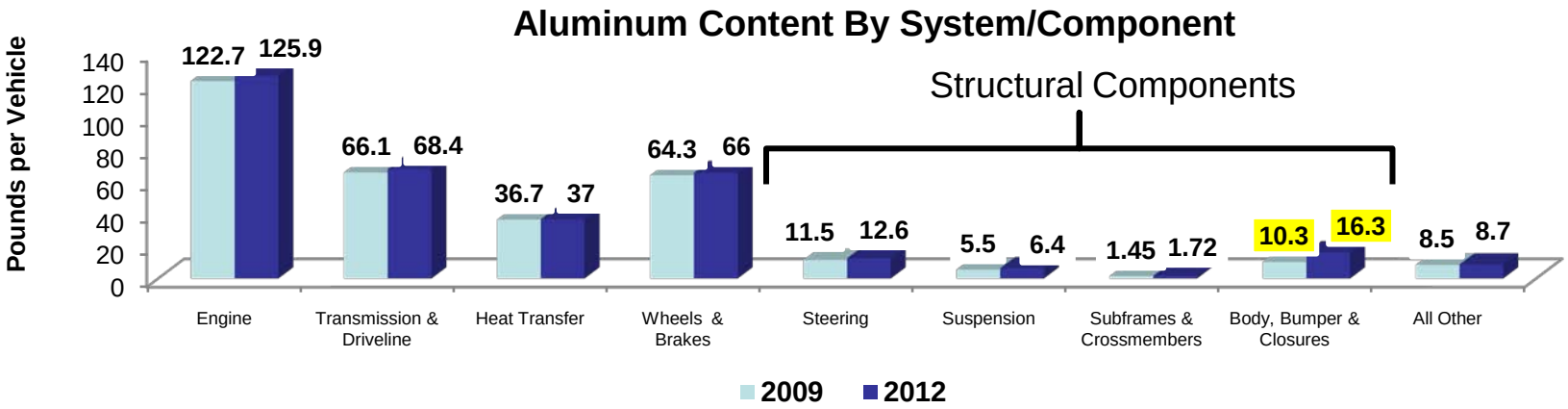


There will be over 200 million major aluminum components in 2012 light vehicles

Aluminum use in structural applications demonstrate 36% growth in 2012 versus 2009.







In 2012, 10 pounds of structural parts were added to every light vehicle since 2009.

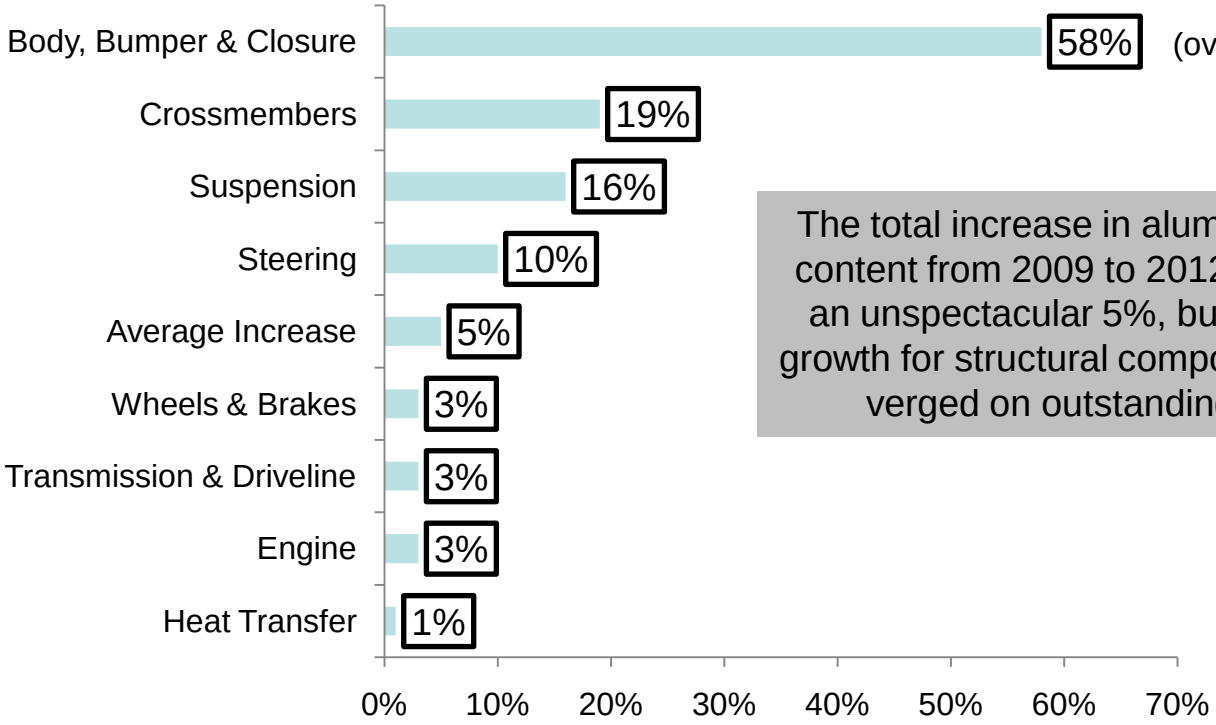
Summary of the aluminum product mix in 2012 versus 2009.

Product	PM Castings	HPDC	R&B, Tube & Shapes	HT Sheet	Fin Stock/ NHT Sheet	Forgings
Pounds per Vehicle	164	114.6	26.8	9	25.2	3.7
Change	+8.6	+3.4	+3.3	+3	+0.2	-2.2

- 32% increase in extruded shapes and a 50% increase in heat treated sheet from 2009 to 2012 is a good sign for aluminum mill products content going forward.
- Forging decline reflects components originally classified as forged in 2009 that had to be reclassified as permanent mold castings for 2012.
- Slow trend to primary vs. secondary aluminum content continued over the last three years.
  In North America, the ratio is close to 50/50. Globally, the ratio is 57% secondary and 43% primary.
- The 2015 and 2025 North American light vehicle aluminum product mixes will look much different.

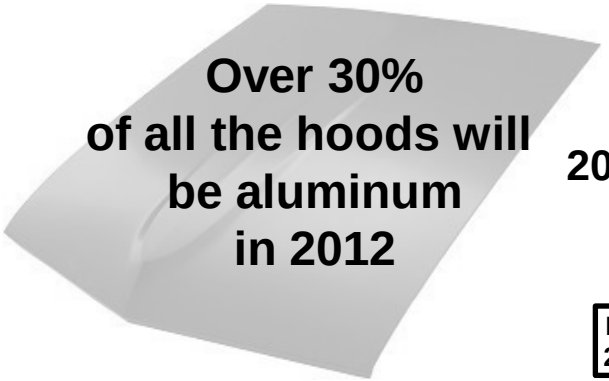
No other chart shows what the aluminum industry has accomplished in the last three years better than the chart below.

2009 to 2012 Aluminum Content Growth

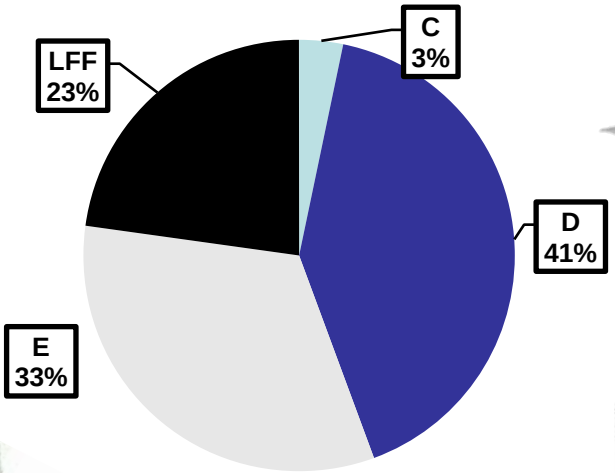


The total increase in aluminum content from 2009 to 2012 was an unspectacular 5%, but the growth for structural components verged on outstanding

Aluminum closure pounds per vehicle will increase by 50% from 2009 to 2012.



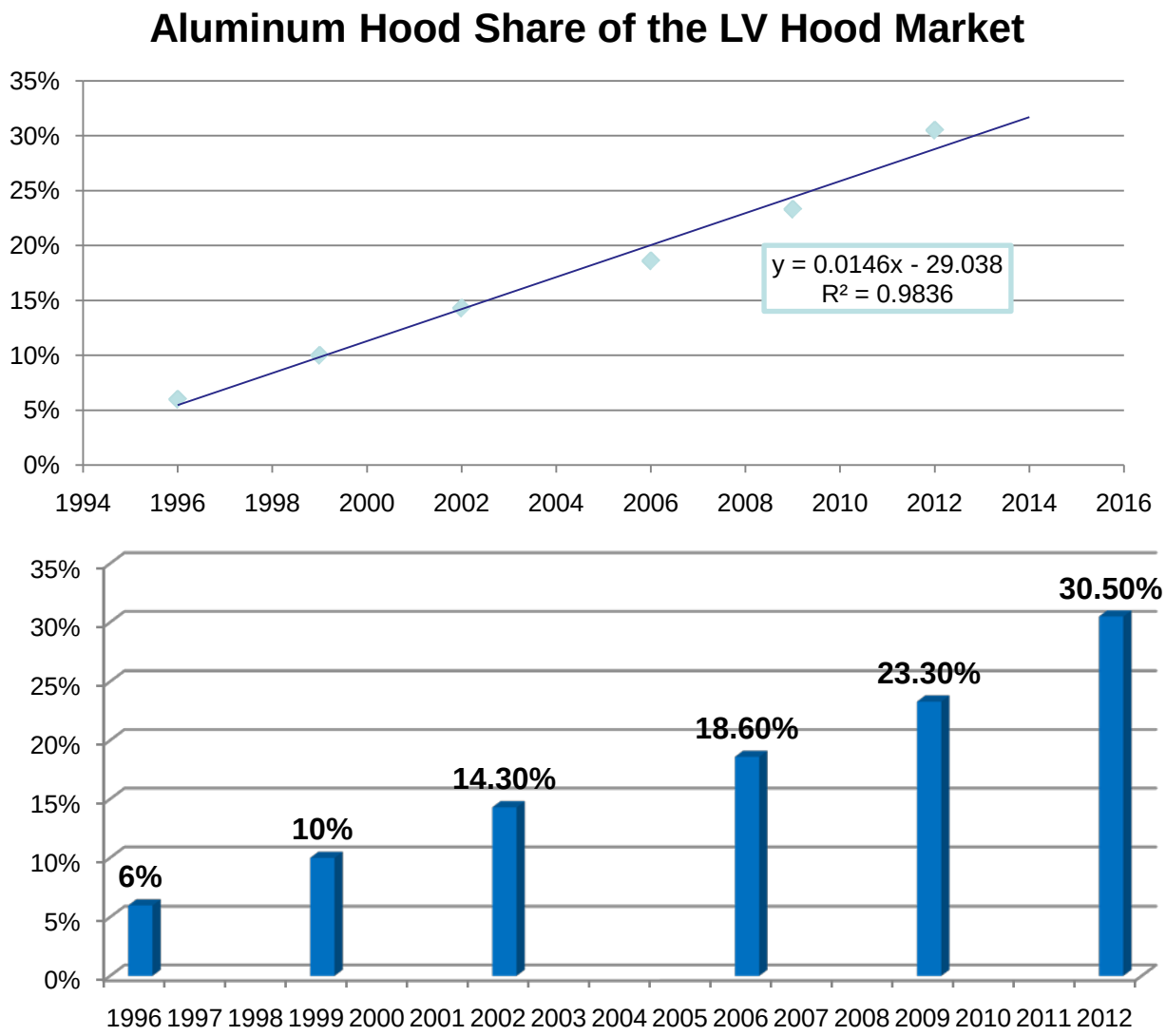
2012 Closures by Segment
129 Million Pounds



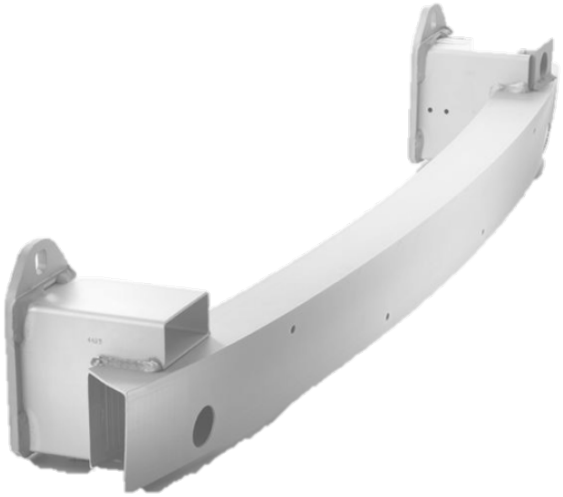
In the Near Future

4.585 Million Parts
9.05 lbs/vehicle
5.9 lbs/vehicle
in 2009

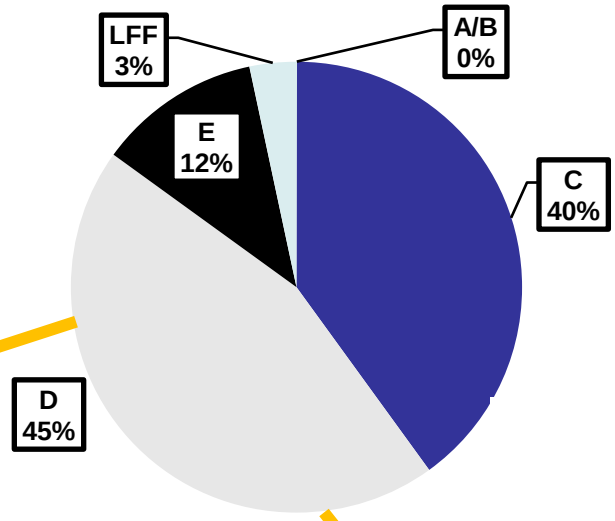
Trend for aluminum hood penetration predicts a minimum 41% share in 2017 and 53% by 2025, even without any further fuel economy mandates.

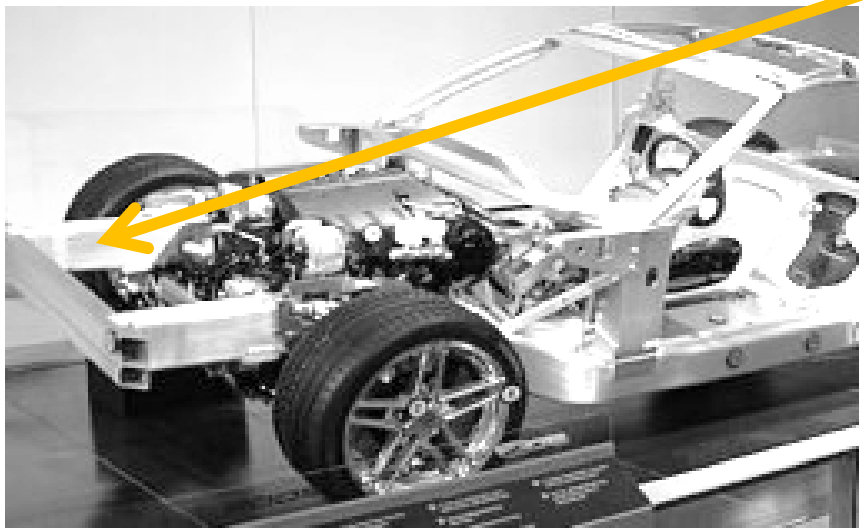


Average aluminum bumper pounds per vehicle increased significantly over the last three years.

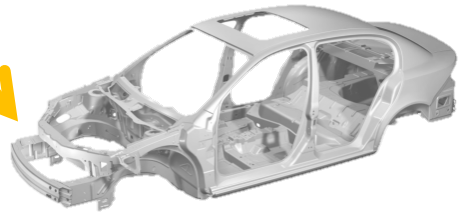


2012 Bumper Beams by Segment
70.8 Million Pounds



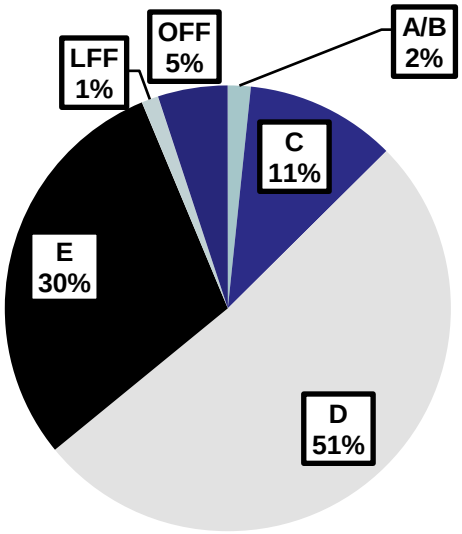


6.93 Million Parts
5.08 lbs/vehicle
2.98 lbs/vehicle
in 2009



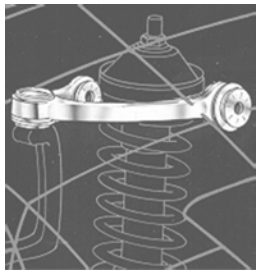
Over 55 million pounds of knuckles are accounted for by D segment vehicles, while C segment vehicles account for approximately 50 million pounds of control arms and links.

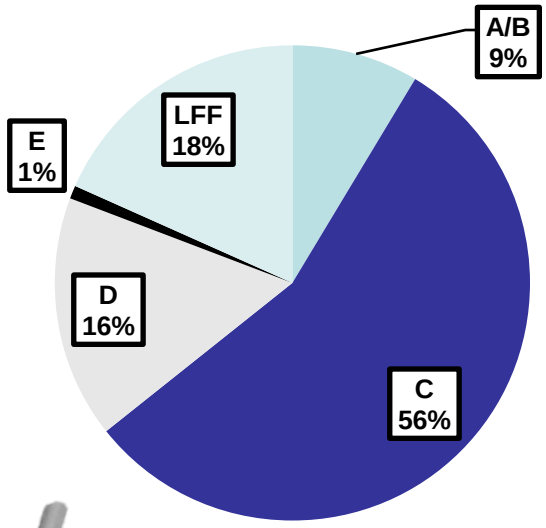
2012 Knuckles by Segment
115.2 Million Pounds



13. 9 Million Units
8.26 lbs/vehicle
7.2 lbs/vehicle
in 2009

2012 Control Arms and Links by Segment
88.5 Million Pounds





11.5 Million Units
6.35 lbs/vehicle
5.48 lbs/vehicle
in 2009

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- VEHICLE SEGMENT ANALYSIS

VEHICLE SEGMENT ANALYSIS

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North American 2012 vehicles in the seven vehicle segments studied are shown below.

Segment	Examples	Segment	Examples	Segment	Examples	Segment	Examples
A 0.3 % 3 Vehicles	Fiat 500		Acura TL		Cadillac CTS		Toyota Tundra
B 2.7% 9 Vehicles	Ford Fiesta		Acura ZDX		Chevy Impala		Nissan Titan
	Chrysler 200		BMW X6		Ford Taurus	**Full Size Full Frame 19% 41 Vehicles**	Ford F-150
	Chevrolet Corvette		Buick Lacrosse		Jeep Grand Cherokee		Chevy Silverado
	Ford Escape		Chevrolet Camaro		Nissan Maxima		Cadillac Escalade
C 23% 40 Vehicles	Honda CRV	**D 36% 64 Vehicles**	Chevrolet Malibu	**E 15% 27 Vehicles**	Chrysler 300		Dodge Ram
	Ford Focus		Ford Mustang		For Explorer		GMC Sierra
	VW Jetta		Honda Pilot / MDX		Ford Flex	**Other Full Frame 3% 11 Vehicles**	Toyota Tacoma
	Chevy Volt		Nissan Altima		Toyota Avalon		Jeep Wrangler

2012 - 13,937,000 Vehicles will be Produced
46% “Car” and 54% for Light Truck

Source: Global Insights / PwC

Ducker believes a "car" versus "truck" analysis is much less valuable for material content analysis than a vehicle segment analysis. The car/truck reference is prevalent in the literature and in the NHTSA/EPA rulings. Therefore, we provide the 2012 production data cut both ways for comparison.

2012 Production Data

2012 SEGMENT	Car	Truck	Total
A&B-Segment Total	485,610	50,950*	536,560
C-Segment Total	2,402,340	719,271	3,121,611
D-Segment Total	2,944,868	2,082,120	5,026,988
E-Segment Total	607,728	1,475,776	2,083,504
Compact Full-Frame Total		418,498	418,498
Full-Size Full-Frame Total		2,645,673	2,645,673
Mini Full-Frame Total		56,558	56,558
Grand Total	**6,440,546**	**7,448,846**	**13,937,000**

2012 Segment	Car	Truck	Total
A&B	90.5%	9.5%	100.0%
C	77.0%	23.0%	100.0%
D	58.6%	41.4%	100.0%
E	29.2%	70.8%	100.0%
Full Size FF		100.0%	100.0%
Other FF		100.0%	100.0%
Grand Total	**46.4%**	**53.6%**	100.0%

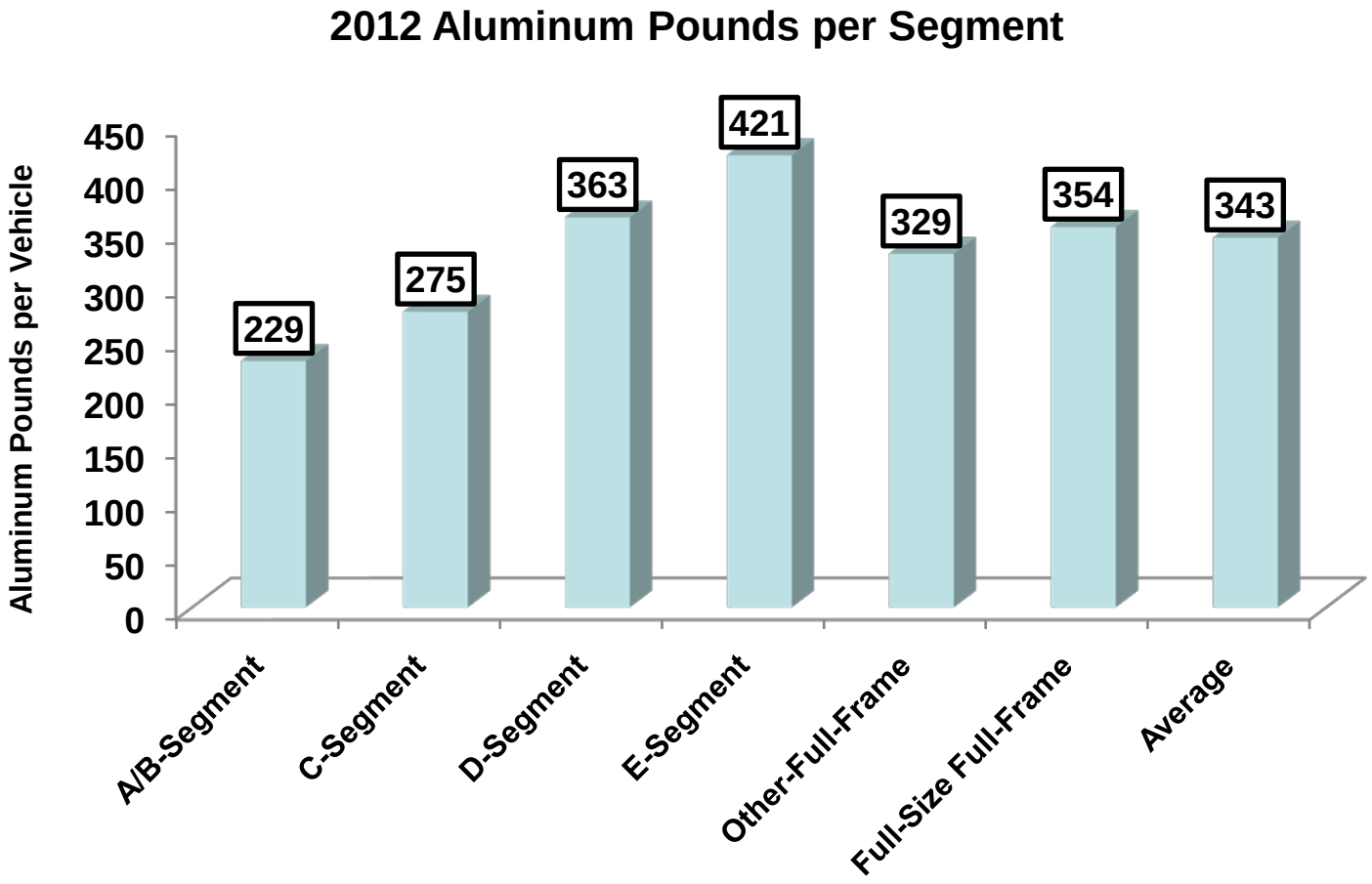
*Ford CUV, Nissan Note, GMC Granite, Chevy BCUV

The 2012-2016 and 2017-2025 fuel economy regulations/rules are footprint based; however the target MPGs per square foot are different for "cars" versus "trucks". The final targets of 35.5 MPG for 2016 and 54.5 for cars and at least 46.5 for light trucks in 2025. The 2017-2025 rule will allow trucks to have a slower improvement rate than cars for the period 2017-2021. Based on a split of 55% cars and 45% trucks in 2025. Ducker expects the 550 pounds of aluminum per vehicle to be split 451 pounds for cars and 671 pounds for trucks.

2012 Aluminum Pounds per Vehicle Segmented by Segment and by Car versus Truck

2012 SEGMENT	Car	Truck	Average
A&B-Segment	230	224	229
C-Segment	265	310	275
D-Segment	332	407	363
E-Segment	417	423	421
Compact Full-Frame		330	330
Full-Size Full-Frame		354	354
Mini Full-Frame		311	311
Grand Total	**309**	**373**	**343**

E Segment vehicles lead the way with total aluminum pounds per segment; as a share of curb weight, the D segment vehicles average over 10% of curb weight in aluminum.



Summary of vehicle segment analysis.

Parts	A/B	C	D	E	LFF	OFF	Millions of Pounds
1. Closures	-	3%	41%	33%	23%	-	126
2. Bumpers	-	40%	45%	12%	3%	-	70
3. Knuckles	2%	11%	51%	30%	5%	1%	115
4. Arms	-	9%	56%	16%	18%	1%	89
5. Other Structures	-	23%	62%	15%	-	-	50
Sum of 1,2,3,4,5	**3.6**	**20.4**	**44.4**	**50.7**	**20.1**	**5.2**	**32.7**
Total of All Aluminum Pounds / Vehicle	**229**	**275**	**363**	**421**	**354**	**329**	**343**

- D Segment vehicles represent the largest share of each of the five part families of most interest to the client. The D Segment will contain 363 pounds of aluminum overall which will be 10% of curb weight.
- E Segment vehicles; however, are the most aluminum intensive segment overall for the key components with an average weight per vehicle of over 50 pounds of these critical parts. With 421 pounds of aluminum overall which will be 9.7% of curb weight.
- Large full frame vehicles, mainly pickup trucks, contain a below average quantity of the critical aluminum components, but a slightly above average amount of aluminum overall at 354 pounds
  This equates to a below average of 6.8% of curb weight.
- Ducker believes the future growth of aluminum is highly dependent on the D, E and LFF segments. These segments, particularly the LFF segment, are not good candidates for vehicle size reduction due to comfort, safety and functionality requirements. These segments need aluminum bodies and doors more than the other segments.

Newest vehicles have an average aluminum content of 10.4% rather than the 2012 average for all vehicles of 9%.

VEHICLE	SOP	EOP	% Aluminum	Total Aluminum Pounds
Fiat 500(312)	**Dec-2010**	**Jun-2015**	**10.50%**	**254**
Chrysler 300(LX)	Dec-2010	Dec-2016	10.60%	420
Ford Explorer(U502)	**Nov-2010**	**Dec-2016**	**9.90%**	**466**
Hyundai Elantra(UD)	Nov-2010	Dec-2015	9.60%	256
Mercedes-Benz ML-Class(W166)	Jul-2011	Jun-2018	11.6%	581
Ford Escape(C520)	**Oct-2011**	**Mar-2017**	**10.9%**	**355**
Ford Focus(C346)	Jan-2011	Dec-2016	9.8%	260
Saab 9-4X(GMT168)	Apr-2011	Dec-2015	11.6%	406
Honda Civic(2HC)	Jan-2011	Jun-2016	10.4%	270
Honda CR-V(2WS)	**Aug-2011**	**Jun-2016**	**10.9%**	**290**
Volkswagen D-Sedan (NMS)(VW411)	Apr-2011	Apr-2017	9.1%	347
Chrysler/Fiat C-Sedan	**Jan-2012**	**Dec-2016**	**11.3%**	**351**
Dodge Viper(ZD)	Nov-2012	Oct-2017	10.7%	369
Mercedes-Benz GL-Class(X166)	Jul-2012	Jun-2019	9.6%	525
Ford Fusion(CD391)	Jun-2012	May-2017	10.2%	336
Lincoln MKZ(CD533)	**Jun-2012**	**May-2017**	**11.3%**	**397**
Cadillac ATS(A1SL)	**July 2012**	**Jun-2017**	**10.3%**	**361**
Chevrolet Malibu(GMX351)	**Feb-2012**	**Jul-2017**	**11.2%**	**385**
Cadillac XTS(P1LL)	**Mar-2012**	**Feb-2018**	**10.7%**	**408**
Honda Accord(2GA)	**Aug-2012**	**Jul-2017**	**10.7%**	**347**
Nissan Altima(L42L)	**Dec-2012**	**Nov-2017**	**11.1%**	**355**
Toyota Avalon(170A)	**Nov-2012**	**Oct-2017**	**10.6%**	**380**

Vehicles of Note for Aluminum

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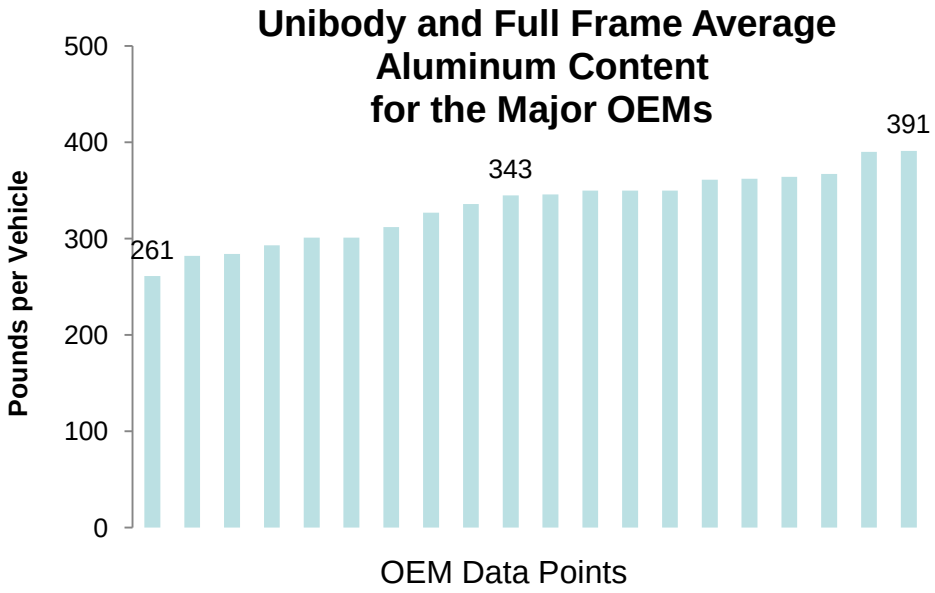
Summary of vehicle and OEM analysis for 2012 excluding low volume OEMs.

OEM	A	B	C	D	E	F	G	H	Average
CW Lbs.	4161	4089	3256	4087	3481	3256	3104	3001	3800
Lbs./Vehicle	366	361	350	345	312	303	292	261	343
% of CW	8.8	8.8	10.7	8.4	10	9.3	9.4	8.7	9.0
6 year	+38	+61	+20	+27	-4	-7	+30	-6	+27



Spread from high to low from the average of 343 pounds is + 48 and – 82 including full frame trucks.

- GM is the North American aluminum content leader of the major OEMs at 366 pounds.
- Honda is the leader for aluminum content as a percent of curb weight at 10.7%.
- The latest models with above average aluminum content are: Chevy Malibu, Cadillac XTS/ATS/CTS, Dodge /Fiat C Sedan, Ford Explorer, Escape and MKZ, Honda CR-V and Accord, Nissan Altima, Toyota Avalon and Fiat 500.

VEHICLE SEGMENT ANALYSIS

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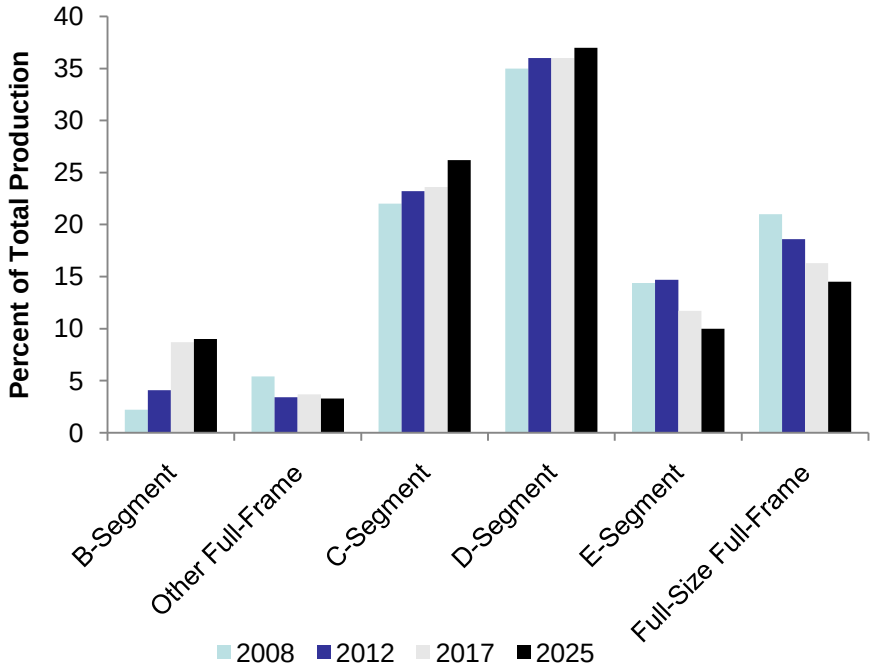
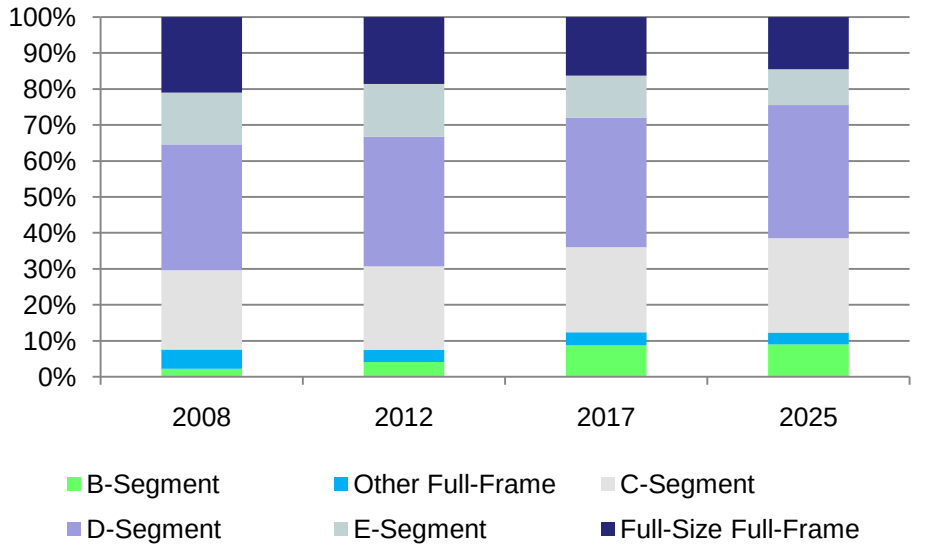
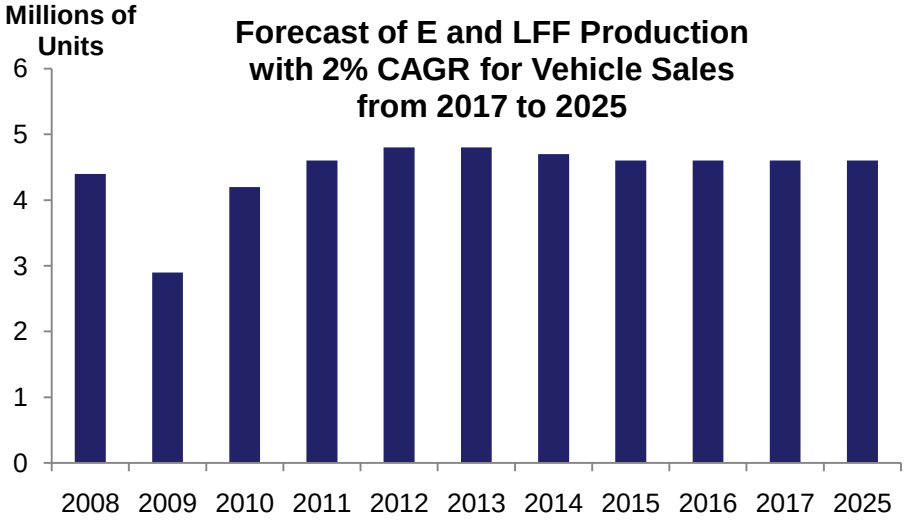
B, C and D segment vehicles will increase their share of total production at the expense of full frame and E segment vehicles; with as little as 2% sales growth for the E Segment and large full frame vehicles a constant volume of 4.6 million units per year over the entire period from 2012 to 2025.





Segment	2008 %	2012 %	2017 %	2025 %
B-Segment	2.2	4.1	8.7	9
Other Full-Frame	5.4	3.4	3.7	3.3
C-Segment	22	23.2	23.6	26.2
D-Segment	35	36	36	37
E-Segment	14.4	14.7	11.7	10
Full-Size Full-Frame	21	18.6	16.3	14.5



Source: Ducker, IHS / CSM

AGENDA

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- **2012 AND BEYOND**

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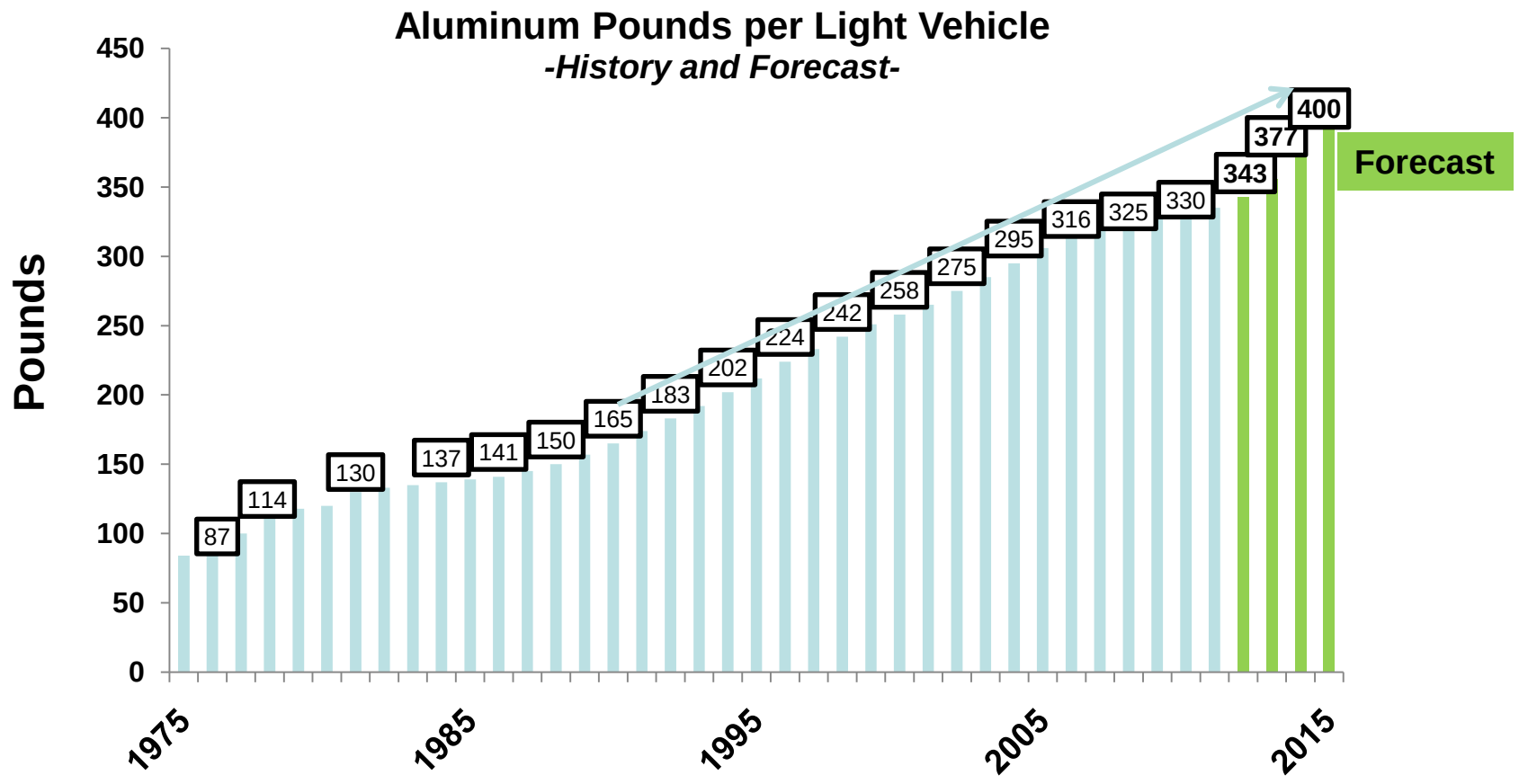
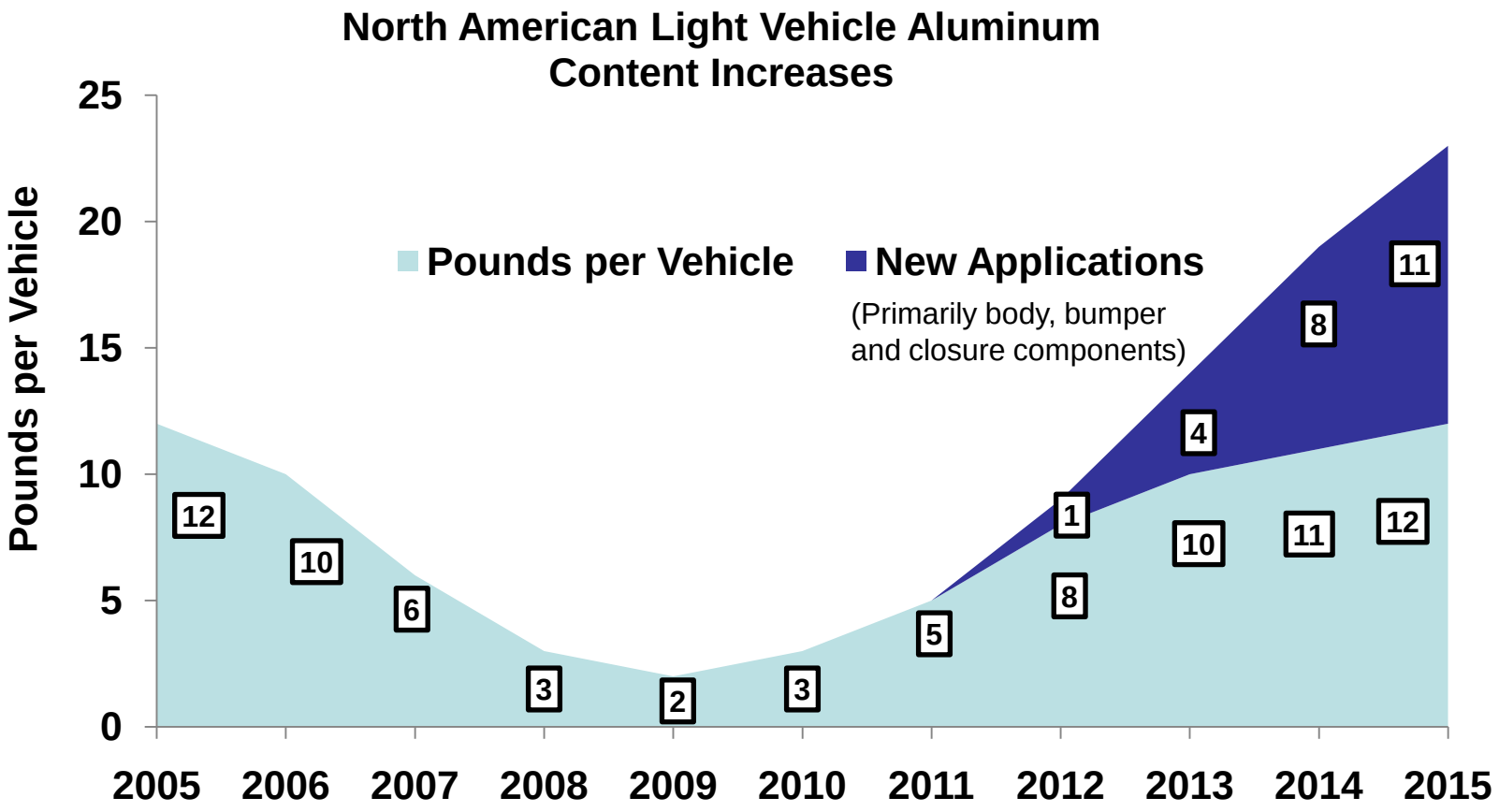
After a short period of slow growth, NA light vehicle aluminum content will take a large step toward the long term trend line in 2012, reaching 400 pounds per vehicle by 2015/2016.

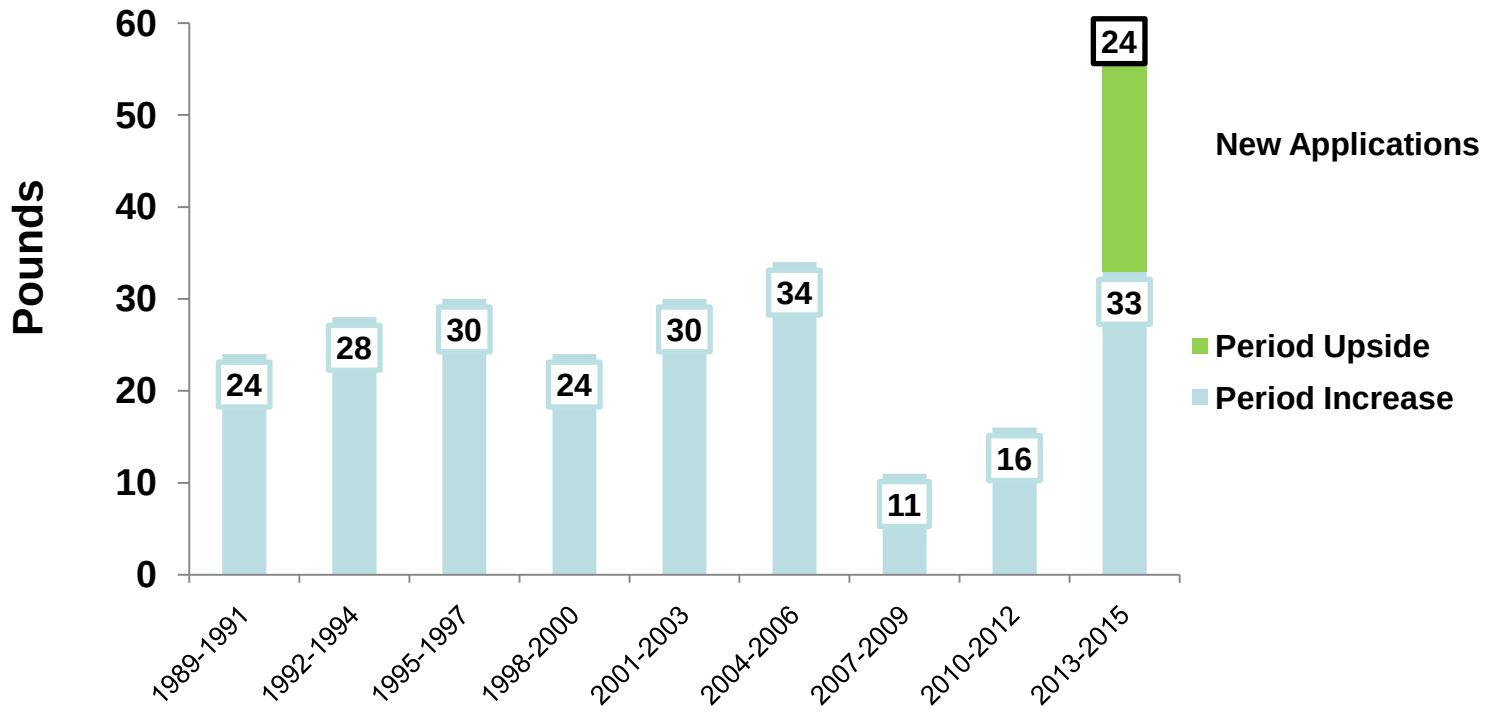


To achieve 400 pounds by 2015/2016 a growth scenario with significant new applications is required. Ducker believes there are positive signs that these applications will be in place by 2015/2016.



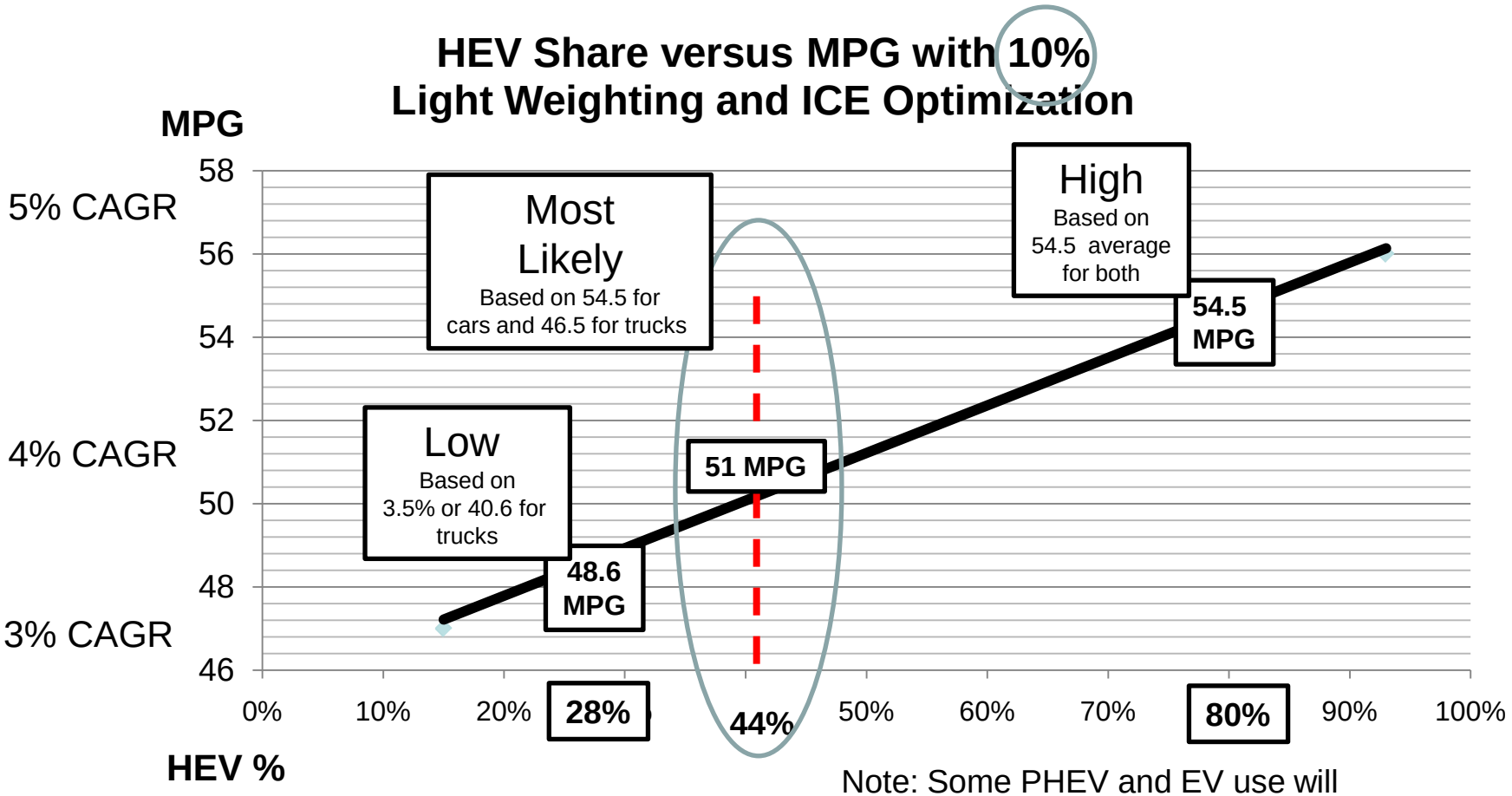
Aluminum growth analyzed at a three year interval is more meaningful than annual analysis.

Looking at Aluminum Growth per Year in Three Year Blocks is More Accurate than single year analysis



Source: Ducker

The Ducker long term forecast is based on: 10% average weight savings, 44% HEV, very little footprint reduction by segment and a most likely 51 MPG fuel economy target for 2025.



Note: Some PHEV and EV use will allow the overall alternative powertrain share to be somewhat lower

Line slope is based on limited data, and is somewhat conceptual

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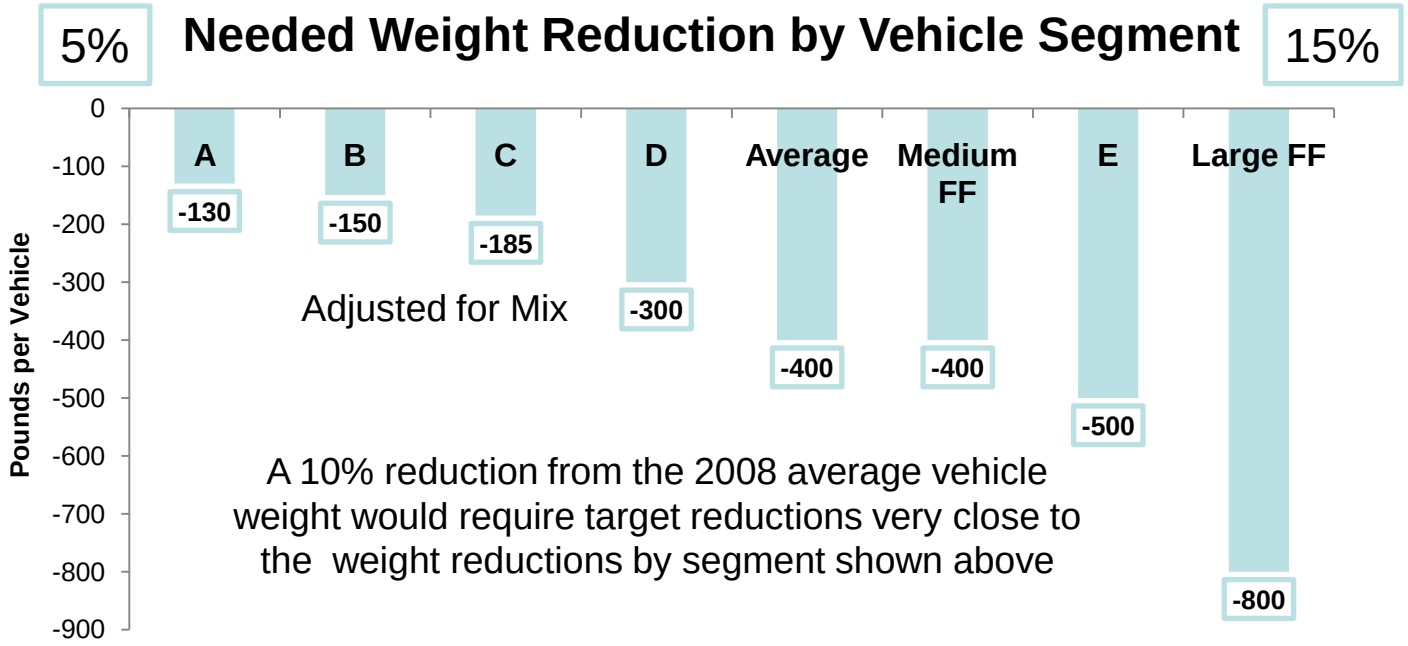
Ducker believes the original weight reduction option assumptions outlined by NHTSA/EPA will be changed dramatically in the final ruling. A 25% reduction is no longer considered achievable. OEMs, however, could choose to act differently as long as they do not sacrifice safety.

We believe the revisions to the September 2010 Proposal of Intent will vary weight reduction by vehicle segment. Ducker believes the average will be 10% due to safety concerns about reducing weight in the A, B & C segments.



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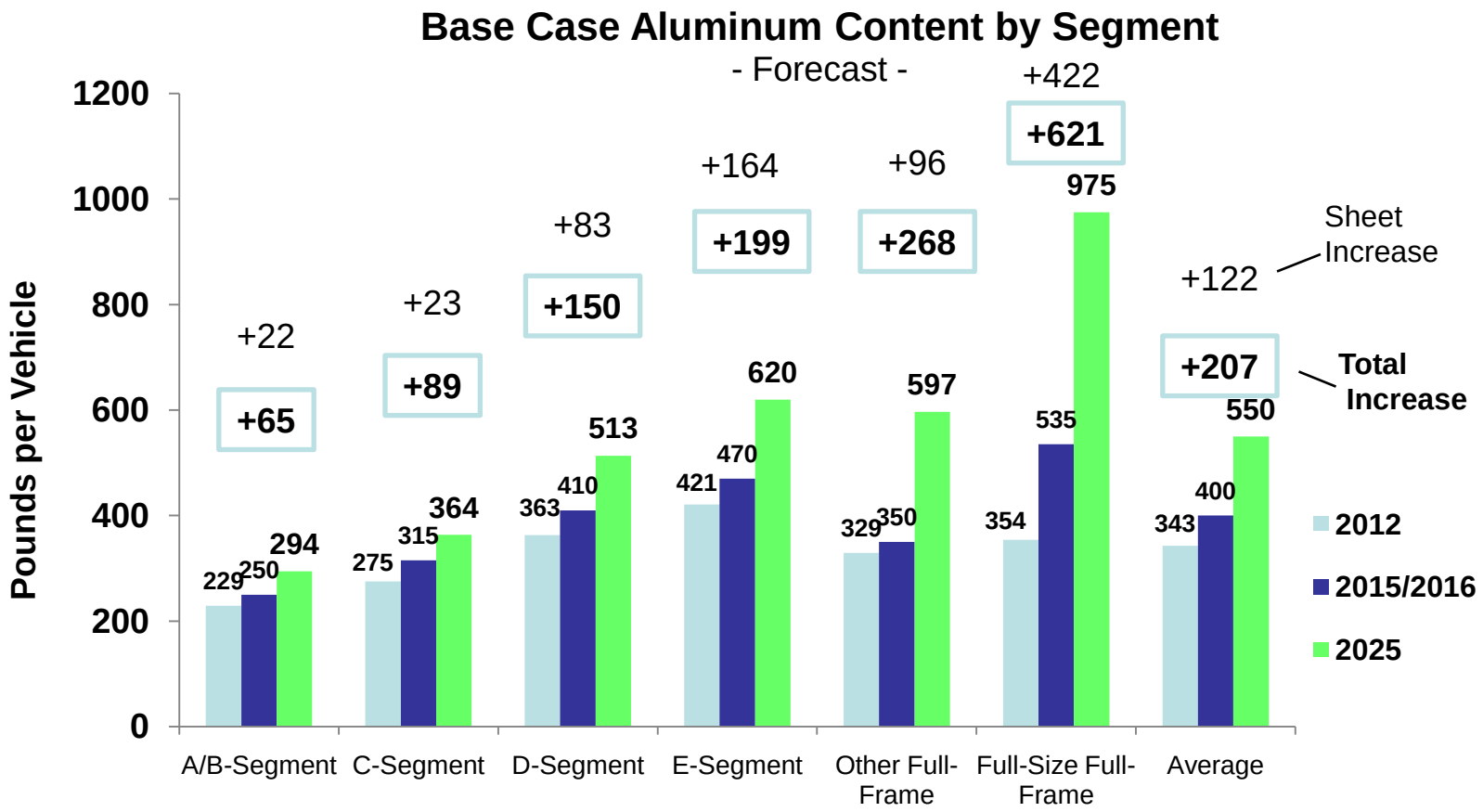
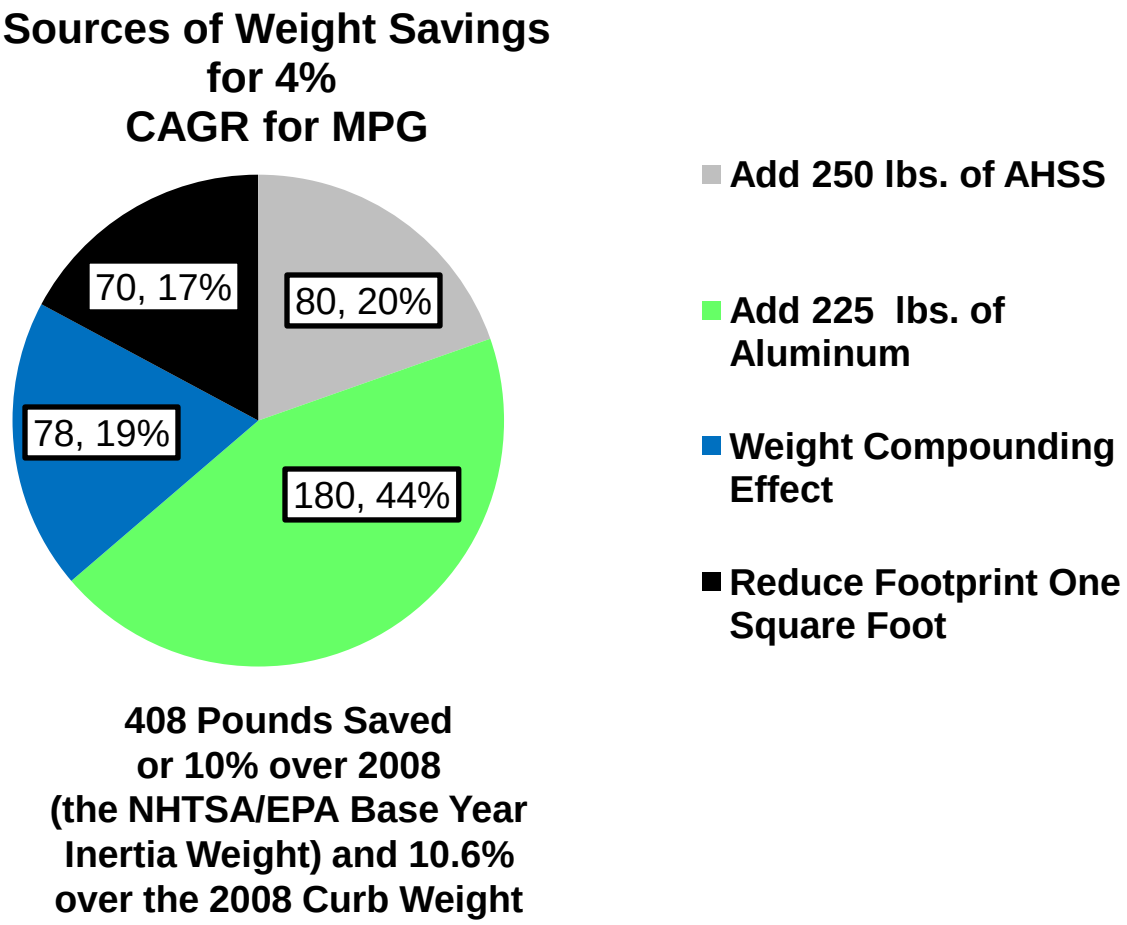
Within the anticipated NHTSA weight reduction targets by vehicle segment, aluminum content shown below would be needed to satisfy the overall reduction estimate of 10%. The additional amount of aluminum will range from 65 pounds per vehicle for A/B segment vehicles to 621 pounds per vehicle for Large Full Frame (LFF) pickups and large SUVs.



A mixed material and footprint reduction strategy can save over 400 pounds or 10% over the 2008 EPA vehicle weight. This combined with 44% HEV or the equivalent in PHEV/EV share will result in 51 MPG by 2025.

Savings of over 400 pounds of curb weight by 2025 could come from the following sources:



408 Pounds Saved or 10% over 2008 (the NHTSA/EPA Base Year Inertia Weight) and 10.6% over the 2008 Curb Weight

Material changes along with a 2% footprint reduction will reduce average vehicle weight by 10% of 2008 average vehicle inertia weight and 10.6% from the 2008 average curb weight. When combined with HEV penetration of 44% and appropriate engine resizing, a 2025 fuel economy of 51 MPG is achievable with no decline in safety, performance, functionality or comfort. Cost of these changes with investment should be less than $1,000 per vehicle before considering cost savings resulting form secondary weight savings from other downsized components.

Average Light Vehicle Material Content in Net Pounds per Vehicle

Material Category	2008	2010	2012	2015	2025
Mild Flat Rolled Steel	999	976	861	650	408
FR BH & HS Steel (HSLA)	489	496	513	516	240
Flat Rolled AHSS	124	156	194	251	375
All Other Steel (Long Products)	602	606	596	580	542
Flat Rolled Aluminum	29	31	34	67	156
Aluminum Extrusions	10	12	14	19	30
Structural Aluminum Castings	20	20	22	25	60
All Other Aluminum	266	267	273	289	304
Iron	307	305	295	290	270
Copper	52	52	52	52	52
Other Metals	101	103	104	105	115
Polymers	340	345	350	366	400
Other Non Metallics	496	493	492	490	475

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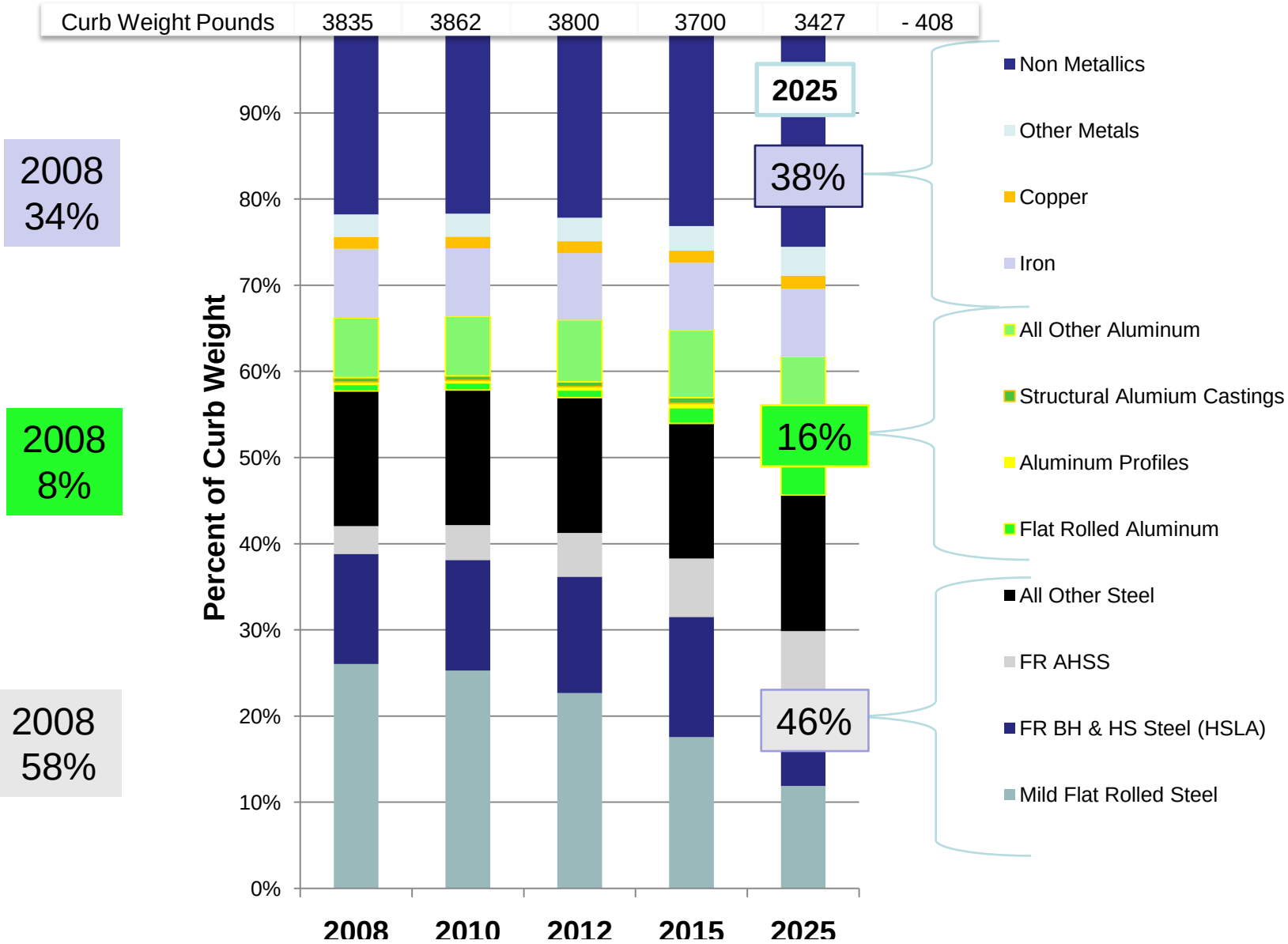
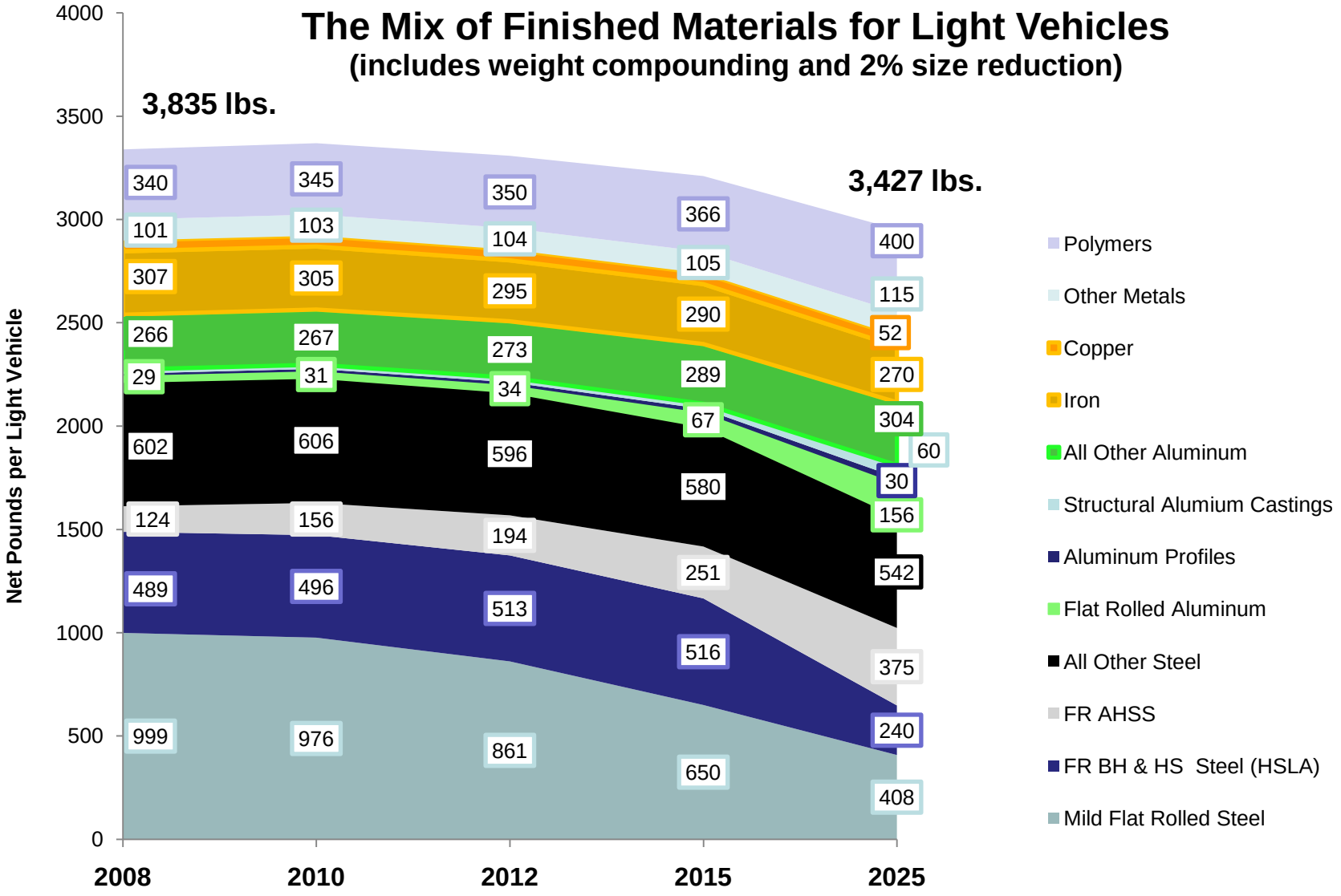
To achieve a 10% weight savings, the light vehicle material mix will need to shift to lower density materials.



Material mix shift is necessary to achieve a 10% weight reduction for light vehicles and 51 MPG.



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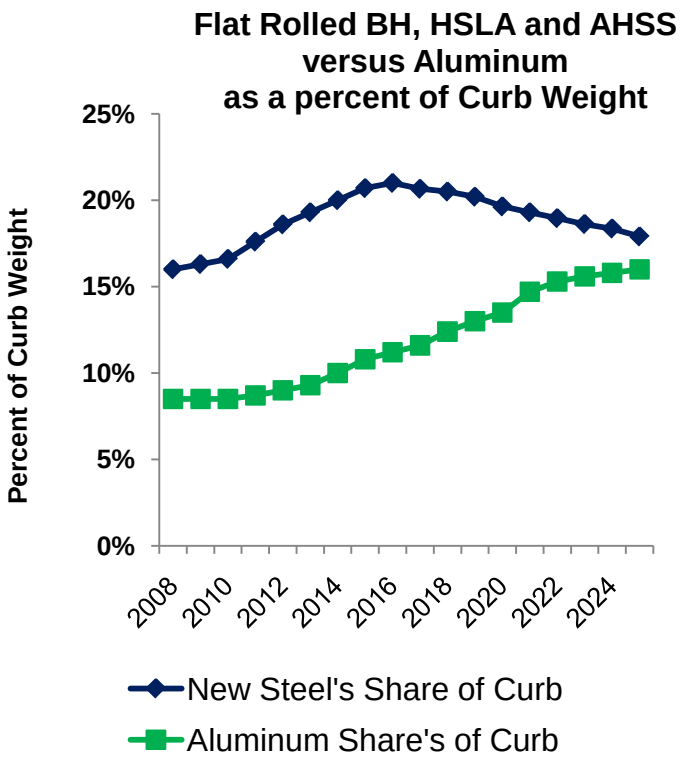
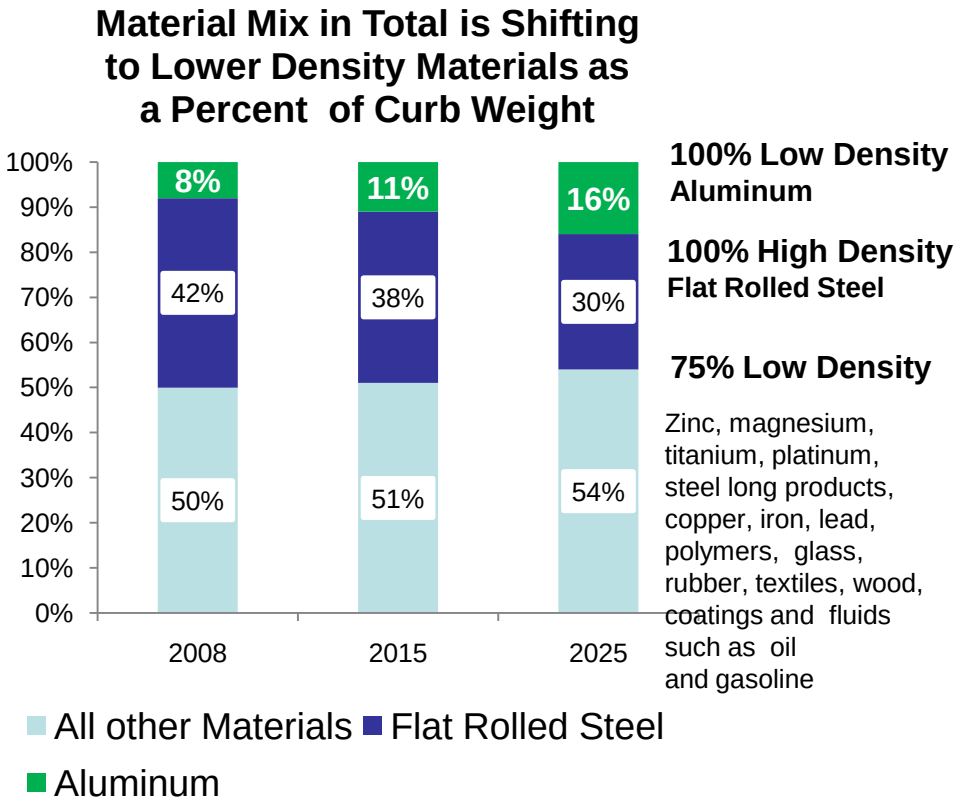
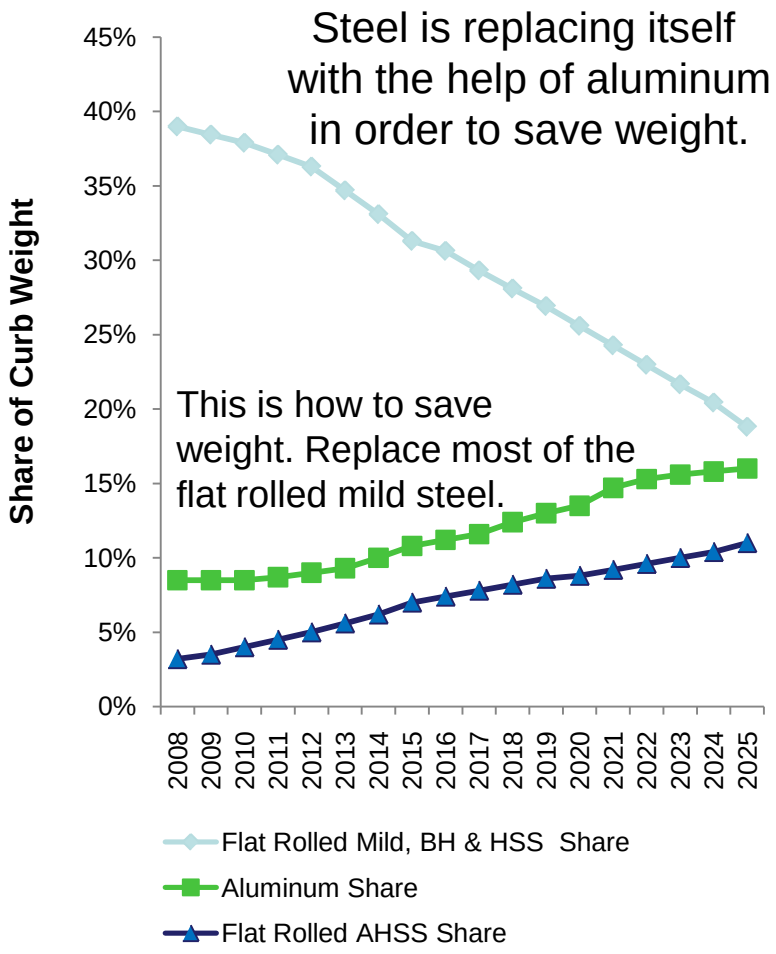
AHSS will replace HSLA steel to save weight, but the combined share of all the varieties of high strength steel has a finite penetration level as a percent of curb weight. Ducker believes that the combined limit is between 20% and 25%*. Substitution of aluminum for some portion of the Bake Hard and HSLA segments has already begun, with 30% of the hoods being aluminum in 2012. By 2016, the new steels will peak at 21%. By 2025, both aluminum and the flat rolled bake hard, HSLA and AHSS combination will be about 16% of curb weight.



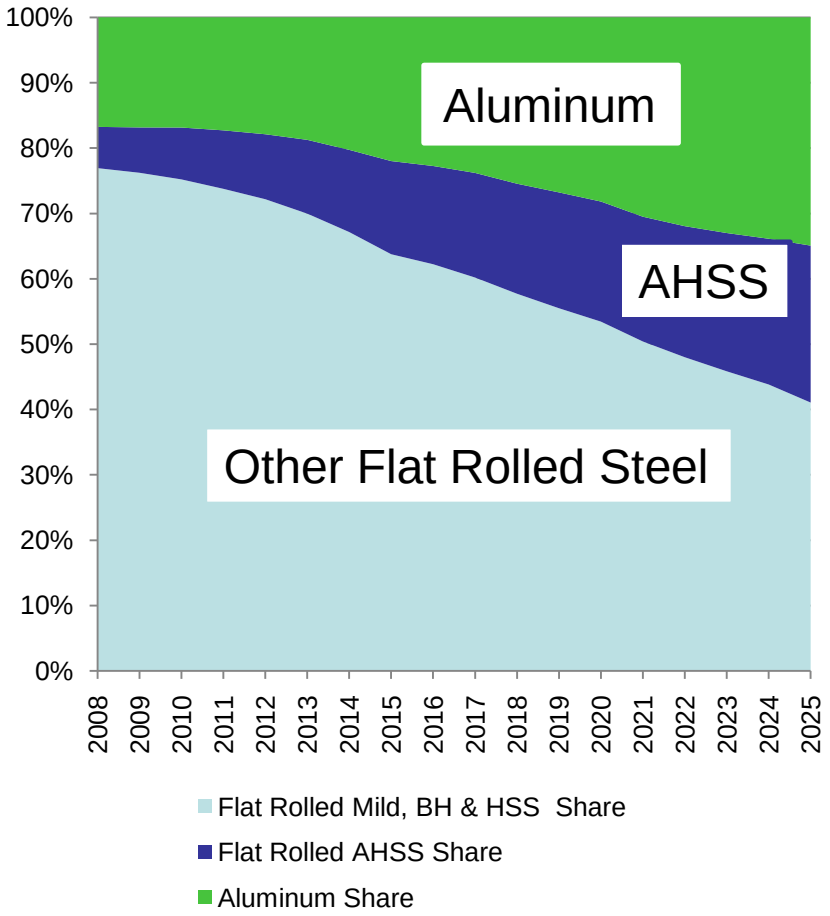


*The material and alloy mix for wheels was held constant at 2012 levels for the analysis

As aluminum and AHSS replace other steels to save weight, the mix of materials in light vehicles will show dramatic change.

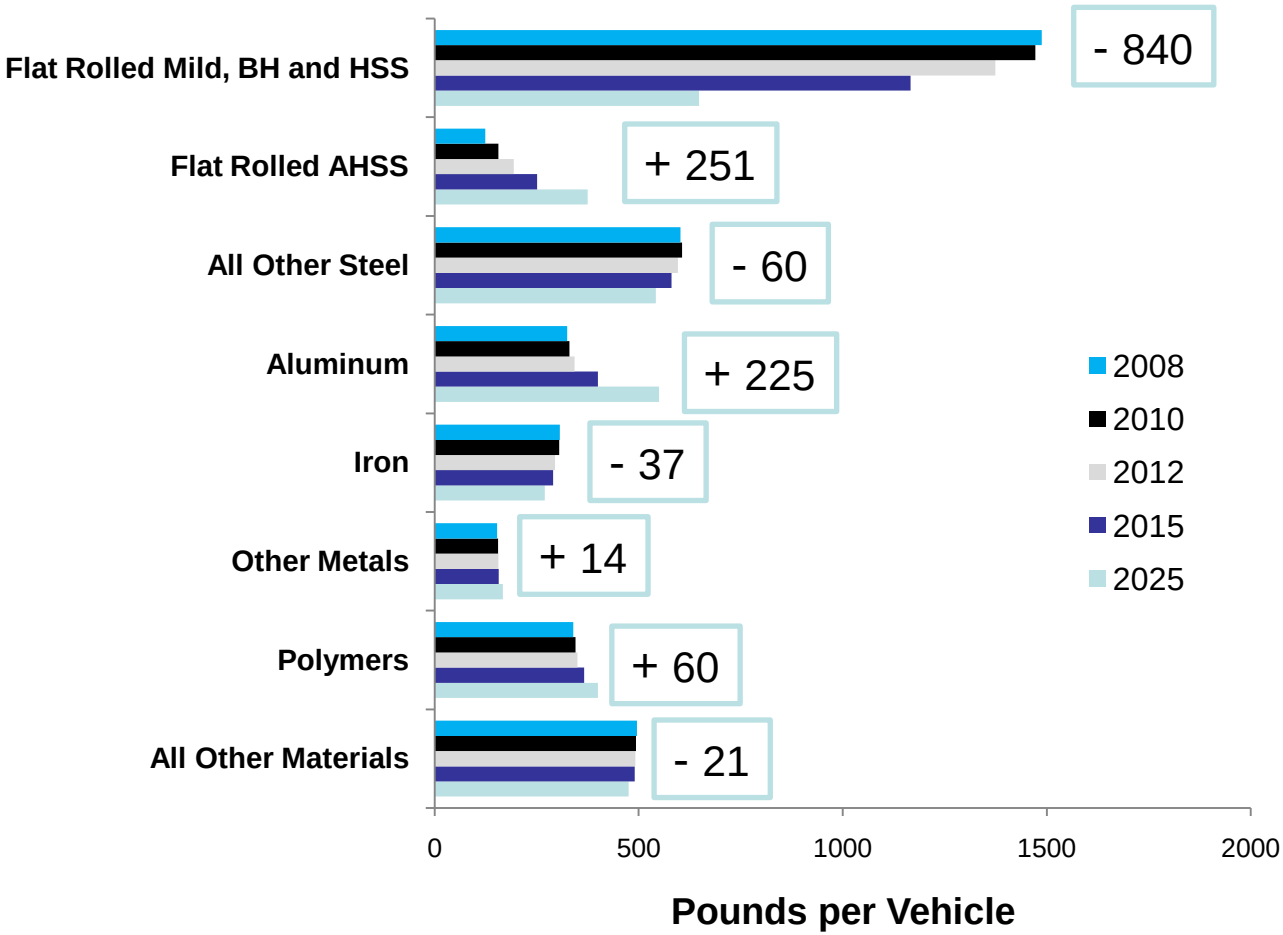


This mix with weight compounding and a 2% size reduction will cut curb weight 10%.



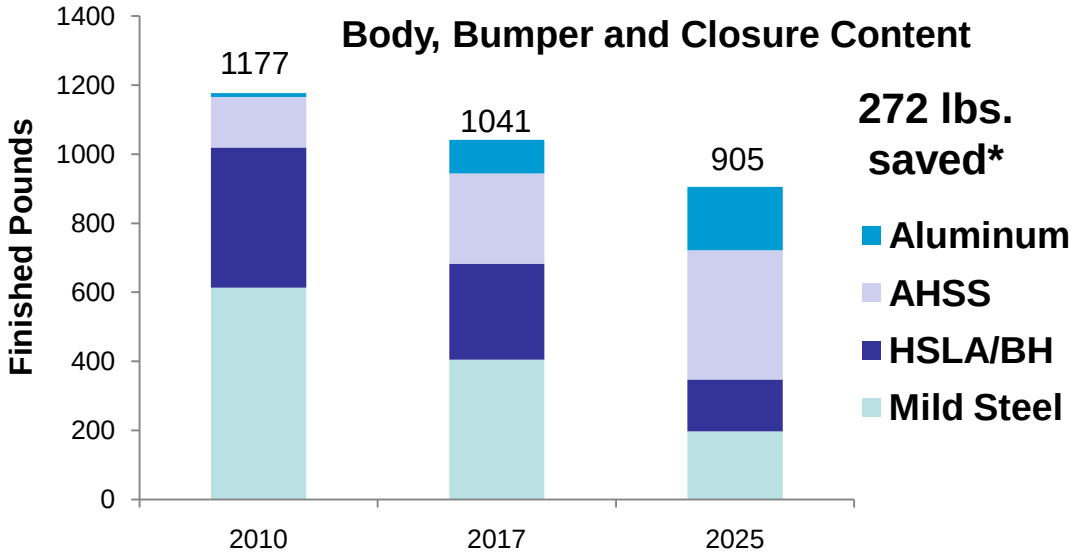
Over an 18 year period, light vehicle curb weight will be reduced by over 400 pounds while improving safety, performance and comfort; a testimony to the engineering ability of the American auto makers. A 51-55 MPG average by 2025 is within grasp at a reasonable cost to the consumers.

Finished Pounds per North American Light Vehicle

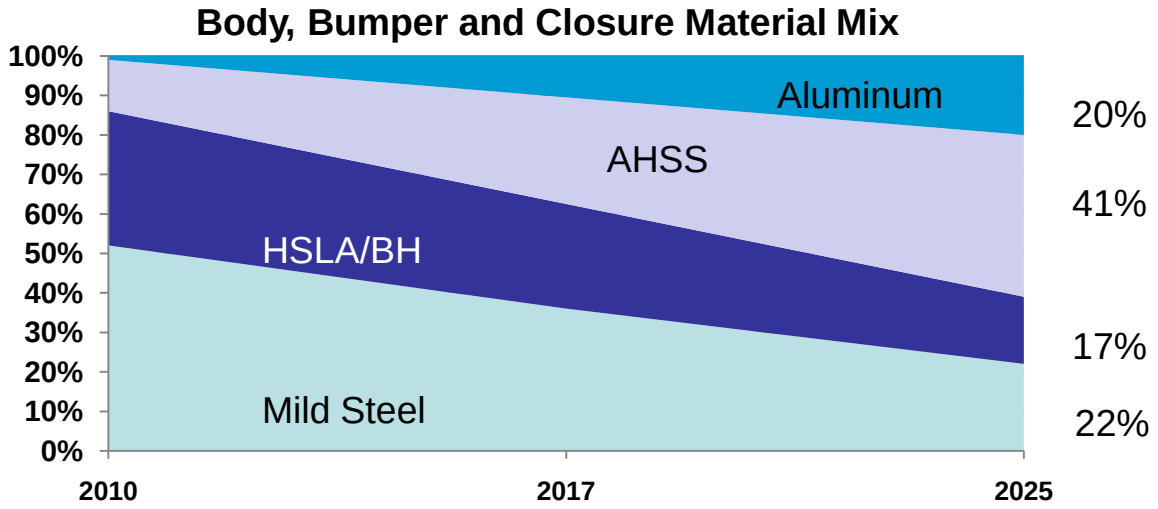


The NA light vehicle material mix for body, bumper and closure components will change dramatically over the 2010 thru 2025 timeframe.

400 pounds of AHSS and Aluminum will replace 670 pounds of HSLA/BH And mild steel in the body, bumpers and closures average light vehicle by 2025.

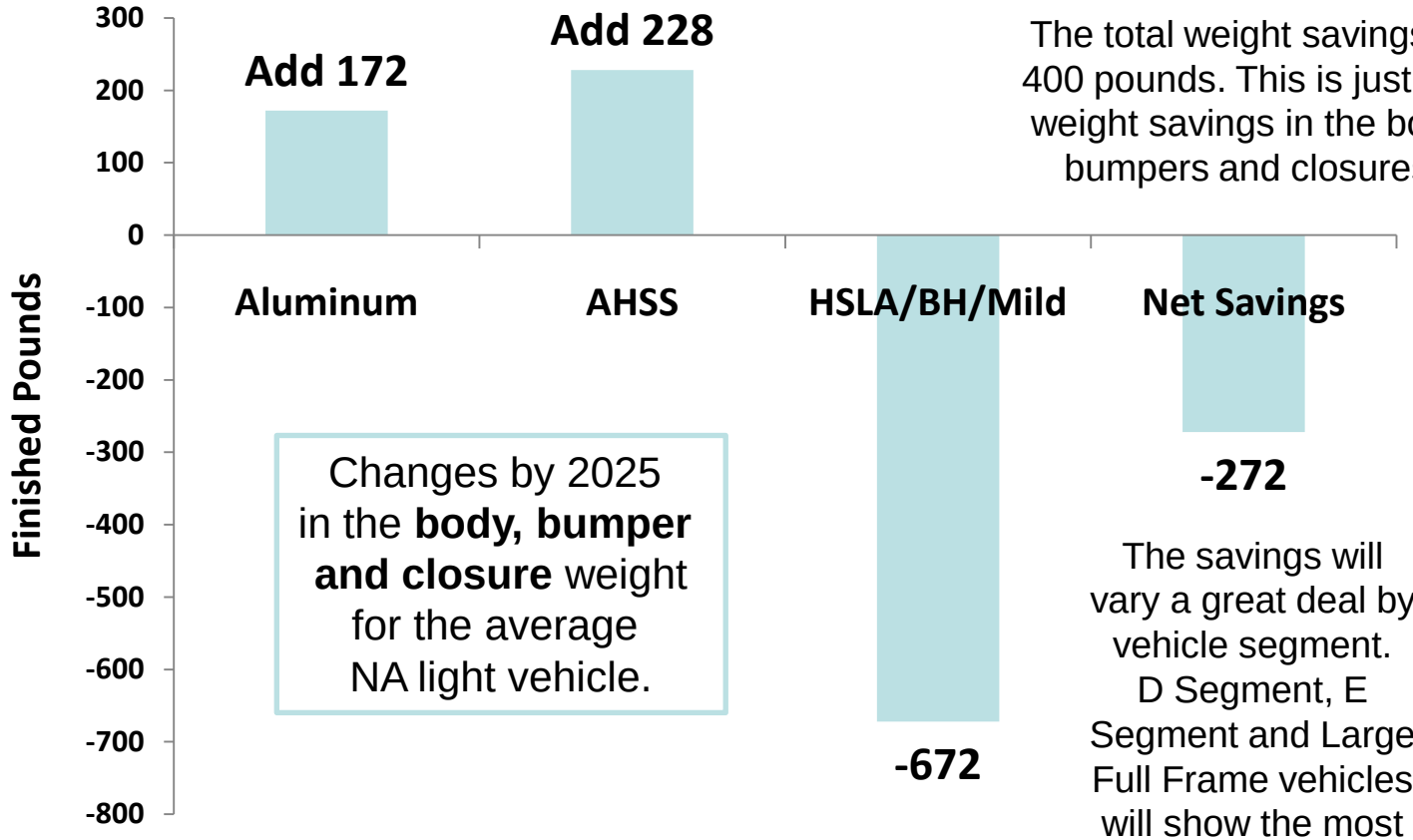


Aluminum and AHSS content for these components will go from 14% of the mix to 61% of the mix. This shift will save nearly 25% of the weight for these components in the average light vehicle.



*Includes 2% size reduction and appropriate weight compounding

Adding 400 pounds of aluminum and AHSS to the body, bumpers and closures of the average light vehicle along with a 2% footprint reduction and minor weight compounding in the body can save 272 pounds by 2025. This will reduce other steel content in the body, bumpers and closures by 650 to 700 pounds, and make a major contribution to the goal of an economical 400 pound (10%) average weight reduction of 5-15% depending on current vehicle size and segment.



The total weight savings is 400 pounds. This is just the weight savings in the body, bumpers and closures.

Changes by 2025 in the **body, bumper and closure** weight for the average NA light vehicle.

The savings will vary a great deal by vehicle segment. D Segment, E Segment and Large Full Frame vehicles will show the most dramatic change in material mix.

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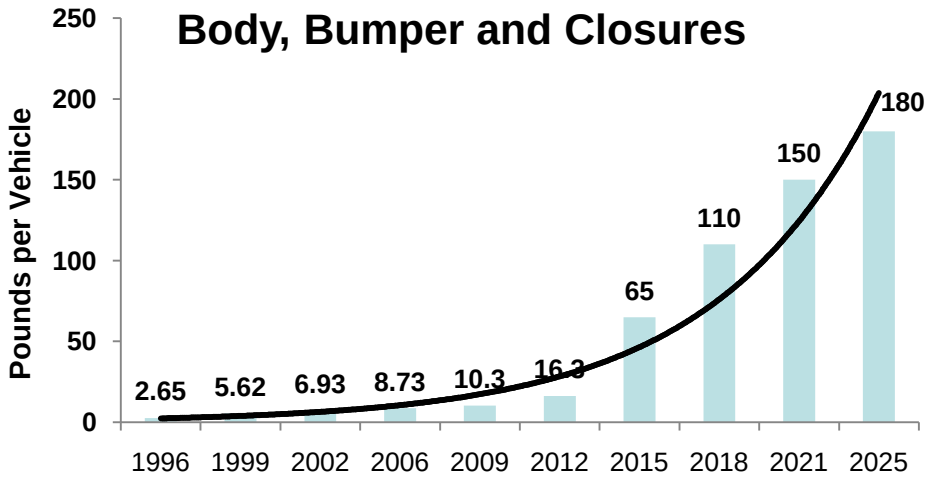
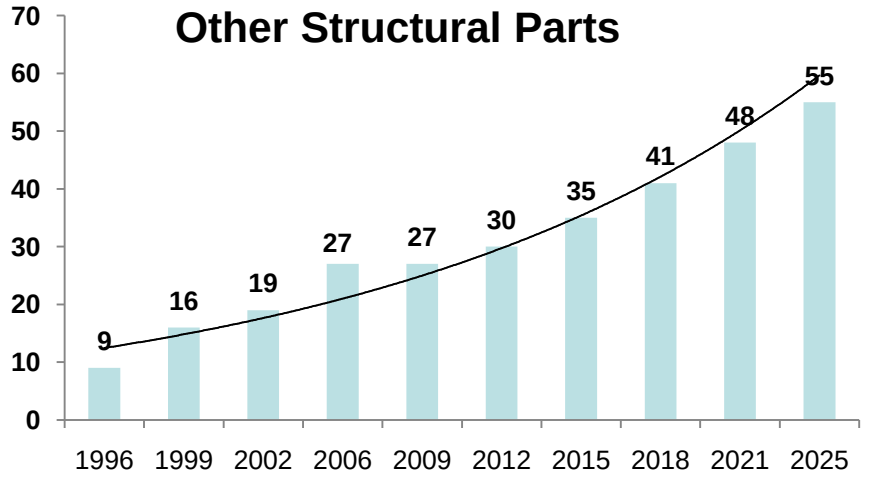
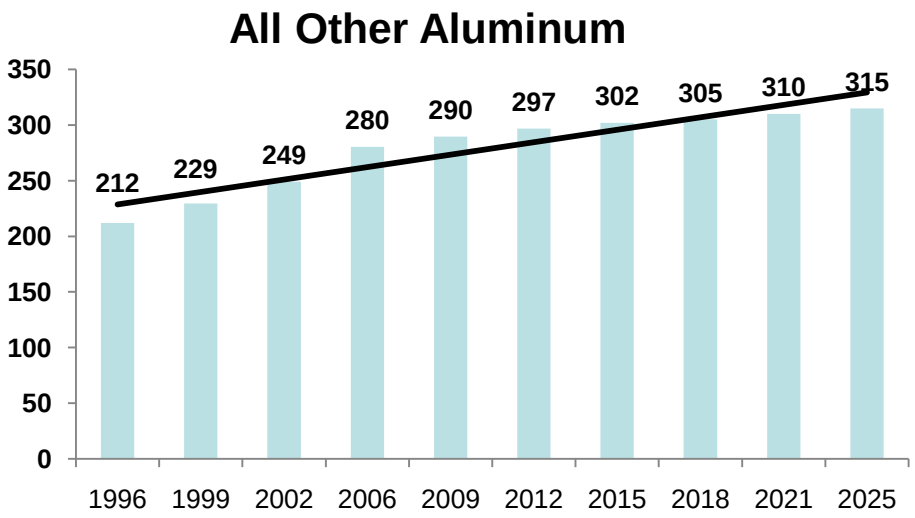
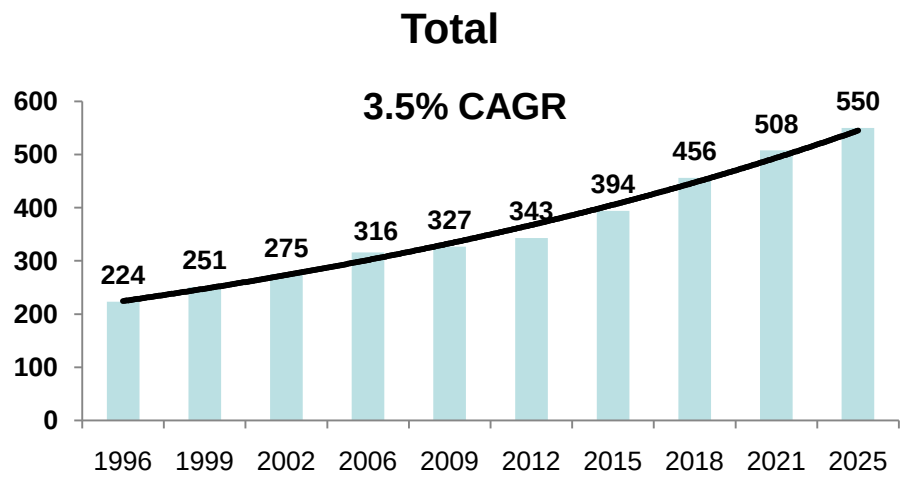
Aluminum body and structural components will lead growth in content.

North American Light Vehicle Aluminum Content









Source: Ducker

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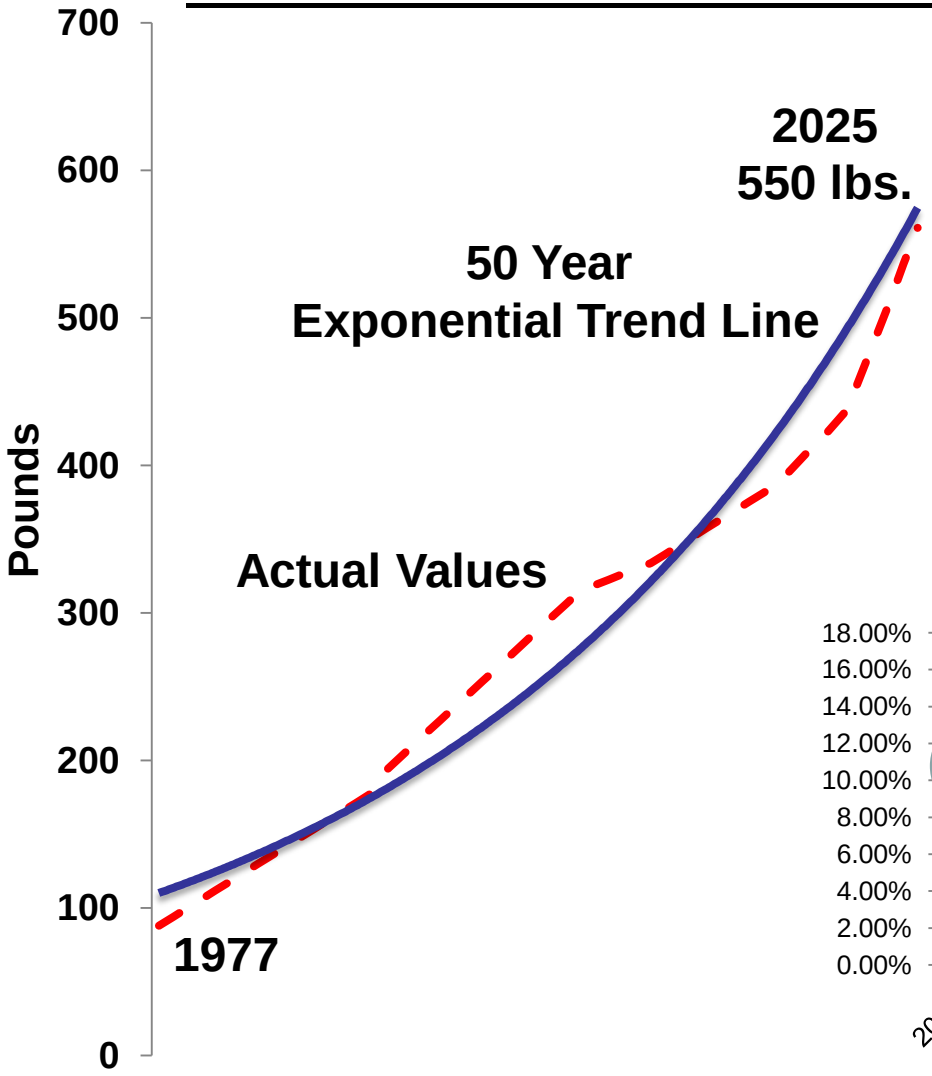
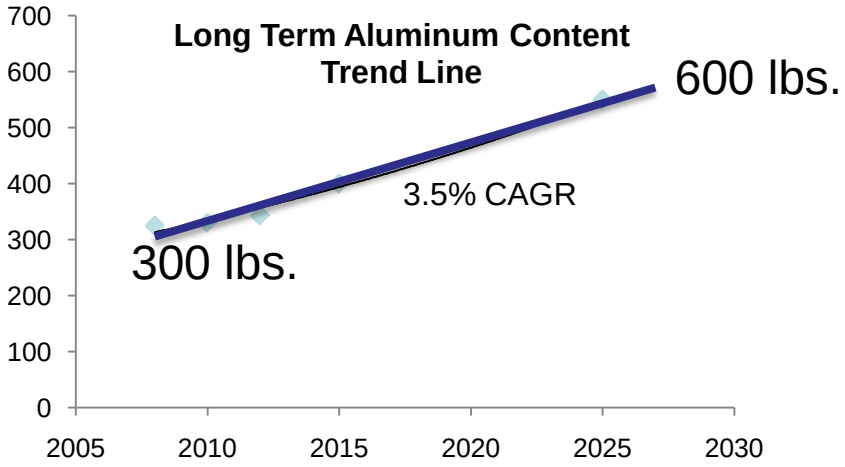
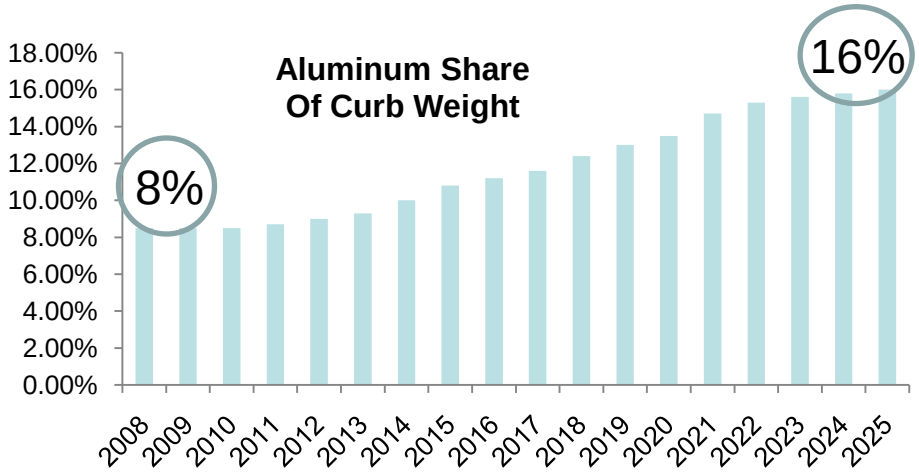
Aluminum content increase from 8% to 16% of curb weight is consistent with long term trend.

North American 51 MPG Case Results for Light Vehicle Aluminum Content







Source: Ducker

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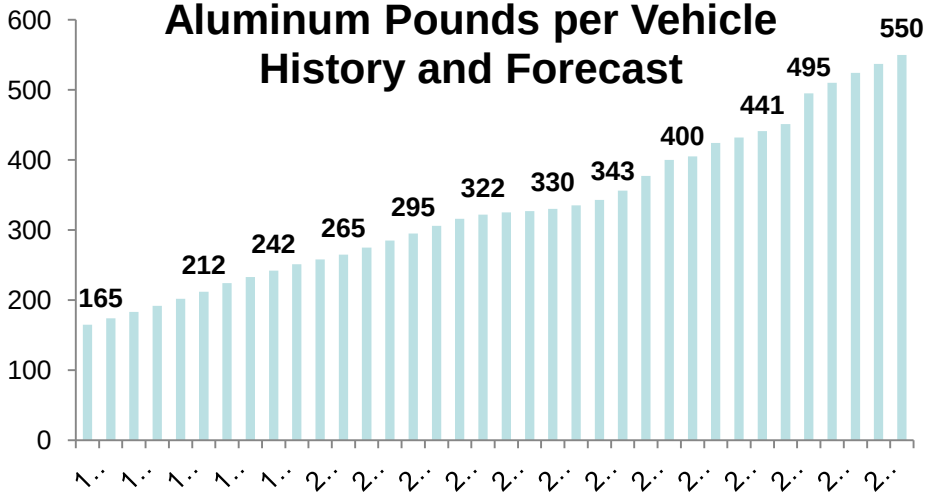
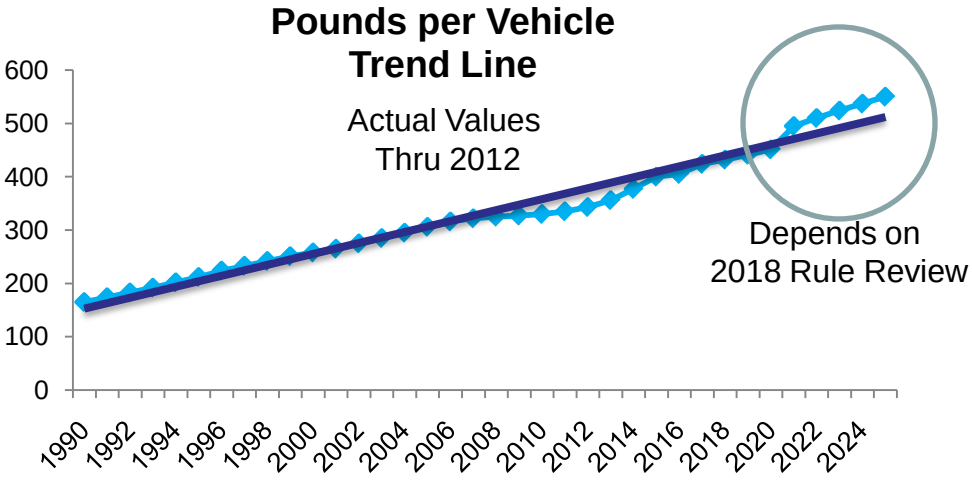
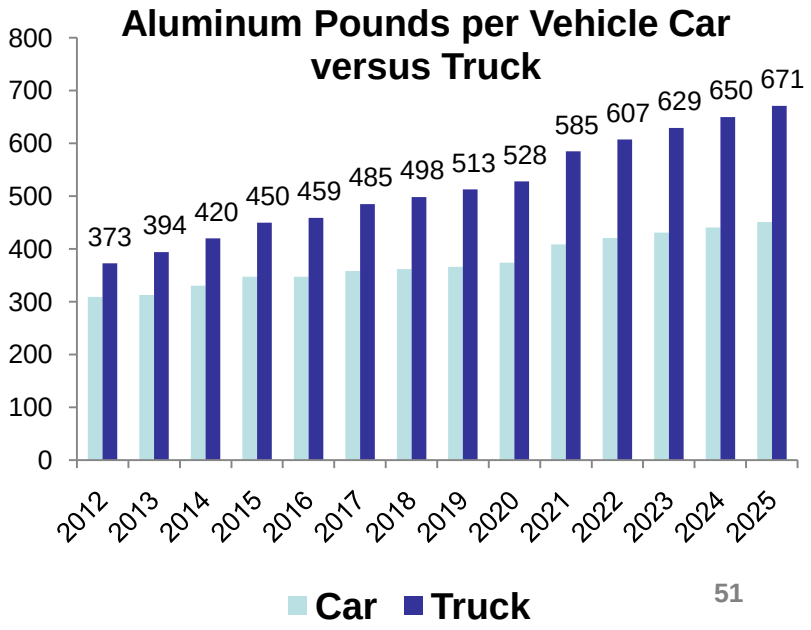
More than the new CAFE rules are driving aluminum growth. History favors aluminum.



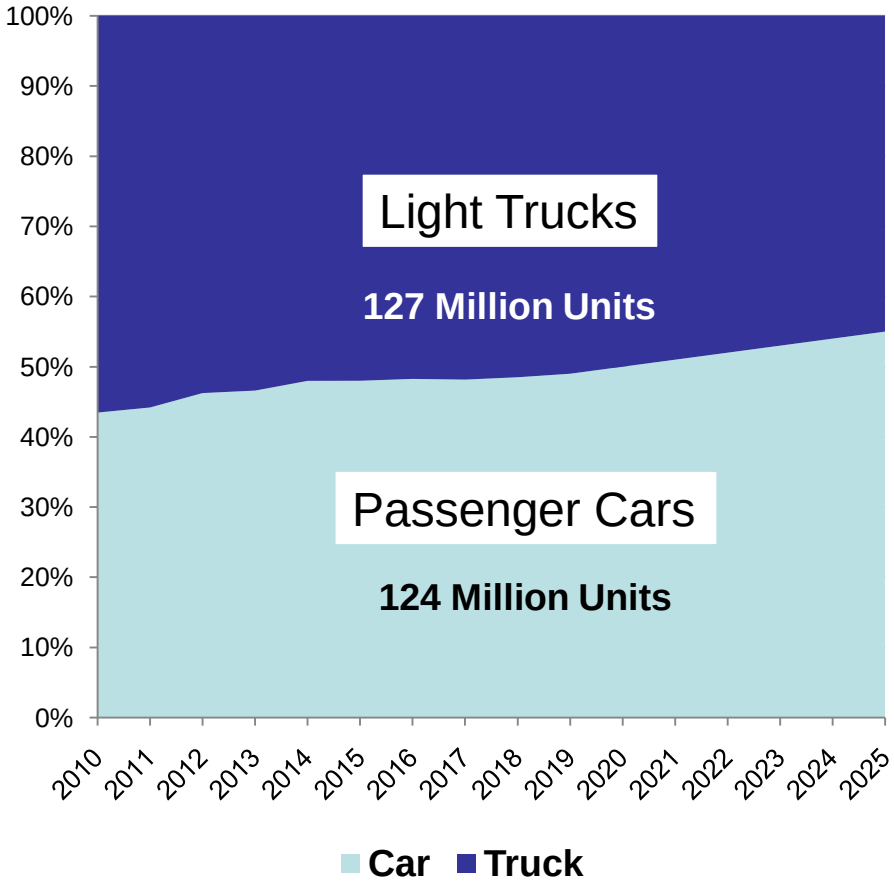
- Historical trend predicts continued growth for aluminum content. This is not a "hockey stick" forecast. It is very realistic.
- OEMS are convinced improving fuel economy creates a competitive advantage. They don't want expensive alternative powertrains to be forced on consumers, but they see the commercial and political value of saving weight. Aluminum is the most cost effective and safe way to achieve significant weight reduction.



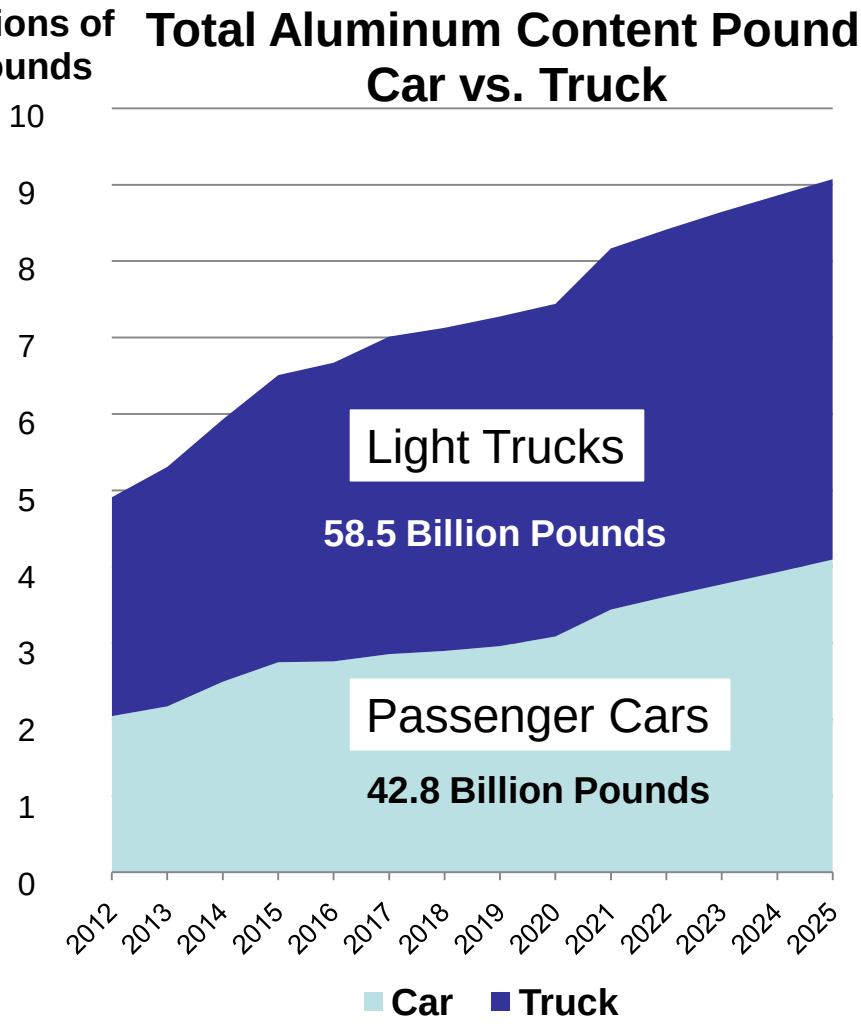


The mix is slowly shifting to more cars, but aluminum use today and in the future will be 36% greater in light trucks. The average aluminum content for all the vehicles expected to be assembled in NA over the 2012-2025 time period is forecast to be 448 pounds per vehicle.

Car versus Truck Share of Total Production



Total Aluminum Content Pounds Car vs. Truck



Aluminum will be a significant contributor to the achievement of at least a 10% reduction in light vehicle weight by 2025.

- The primary objective of this study was to determine a very accurate estimate of the aluminum content in the light vehicles to be assembled in North America in 2012. Ducker's estimate is 343 pounds per vehicle in 2012 versus 327 pounds in 2009. The study also attempted to determine the most likely material mix for future North American light vehicles through 2025. All the factors affecting the future mix were taken into account, including technology, cost, material availability and most importantly the current and recently announced fuel economy regulations. A scenario for 2025 of 10% weight savings, 44% HEV penetration and a 2% average footprint reduction resulted in the achievement of a fuel economy of 54.5 MPG for cars and at least 46.5 MPG for light trucks. The primary sources of the weight savings came from the additions of aluminum and advanced high strength steels for mild, bake hard and HSLA steels primarily in the body and closures of the average vehicle.
- Aluminum content is expected to grow at 3.5% CAGR over the next fifteen years in the continued quest for cost effective vehicle weight savings. Current aluminum growth is being driven by new applications for body, bumpers and closures. Thirty percent of all the hoods on the 2012 vehicles will be aluminum; saving 100 million pounds of vehicle weight. Future growth will be driven primarily by the continued conversion of steel to aluminum in these same applications. Advanced high strength steels (AHSS) are also replacing HSLA and mild steels in these applications. AHSS is initially a cost effective way to save weight. The problem is these steels don't save enough weight. We added 250 pounds of AHSS to the base year 125 pounds in order to save a maximum of 80 pounds for the most strength driven components in the vehicle body. AHSS simply saves weight through gauge reduction. There is a design limit on how thin you can go on a component such as a hood and still maintain functionality. AHSS has the same density as mild steel. Aluminum on the other hand saves weight because it has a density of only one third that of AHSS. Even when you increase the thickness of the aluminum to meet the stiffness of steel, the aluminum parts only weigh half as much as the steel parts they replace. We added 225 pounds of aluminum to the average vehicle and saved 180 pounds with no change in part performance.

The forecast of a 2025 light vehicle aluminum content of 550 pounds per vehicle is only slightly above the long term trend line, and quite achievable at a very reasonable direct cost of less than $500 per vehicle to the OEMs and their tier one suppliers.

- Aluminum will need to grow in content from 325 pounds in the NHTSA/EPA base year of 2008 to 550 pounds in 2025 in order to save 180 to 200 pounds of direct curb weight and 78 pounds of secondary curb weight. The average cost of direct weight savings was determined to be approximately $2.00 per pound of weight saved. The 78 pounds of secondary weight savings would help offset this penalty, but we did not place a value on the secondary weight savings in this exercise. This increased use of aluminum is absolutely necessary for a cost effective weight reduction in curb weight of over 400 pounds by 2025.The weight savings from AHSS diminishes rapidly after you convert the safety cage and a few other parts. A few major OEMs have already reached this point in most of their vehicles. Increasing aluminum intensity is the next step for these OEMs.
- Although adding 225 pounds of aluminum in less than 20 years is a very dramatic increase, North American OEMs have already added or are programed to add 250 pounds in the period 1990 to 2015. The 3.5% CAGR needed to attain 550 pounds by 2025 is a conservative forecast in our opinion.

This concludes our report. Thank you.

For over 50 years, Ducker Worldwide has enabled clients to navigate and thrive in a dynamic, global marketplace. Our unique and proven combination of custom market intelligence, critical thinking and strategic consulting create valuable opportunities that deliver critical results.

For more information regarding our strategic services, expertise and to learn how Ducker Worldwide can help you, please contact one of our team members at 248-644-0086 or visit our website at www.ducker.com