DUCKER WORLDWIDE

Advancing Growth

Aluminum Content in Cars

- Summary Report -

- Public version -

Prepared Exclusively for:

EUROPEAN ALUMINIUM

June 2016

Introduction: Vehicle Scope

Modelling Method

2012 Sample vehicles (still in production) were used to augment the 2016 sample vehicles ONLY to derive the extrapolated and estimated content for the entire 2016 production of 17,360,446 vehicles in 2016

1 2012 Sample

2012 Sample Vehicles
Audi A1(AU210)
Audi A6(AU571)
Audi A7(AU573)
Audi A8(AU641)
BMW 1 (F20)
Citroen C3 Picasso(A58)
Citroen C4(B71)
Fiat 500(312)
Fiat Panda(139)
Ford Focus(C346)
Jaguar XJ(X351)
Lancia Ypsilon(846)
Land Rover Range Rover Evoque(L538)
Mercedes-Benz B-Class(W246)
Opel Insignia(GM G3700)
Peugeot 208(A9)
Peugeot 508(W2)
Porsche Cayenne(PO526)
Renault Clio(X98)
Toyota Yaris(850L)
Volkswagen Up (VW120)
Volkswagen Polo(VW250)
Volkswagen Golf(VW370)
Volkswagen Touareg(VW526)
Volvo S60(Y283)
Volvo XC60(Y413)

19.1% 3,308,867 units

+ 2 2016 Sample

2016 Sample Vehicles	2016 Sample Vehicles
Alfa-Romeo Giulia (952)	Mercedes-Benz GLA (X156)
Audi A3(AU370)	Mercedes-Benz GLC (X253)
Audi A4(AU491)	Mercedes-Benz-S-Class (W222)
Audi Q1 (AU276)	Mini Countryman(F60)
Audi Q3 (AU316)	Nissan Juke (P12C)
Audi Q7(AU536)	Nissan Qashqai (P32S)
BMW 5 (G30)	Opel Astra (D2JO)
BMW 7 (G11)	Opel Corsa (GM 4530)
BMW i3 (I01)	Peugeot 2008 (A94)
BMW X1 (F48)	Peugeot 308 (T9)
Citroen C3 (B61)	Peugeot 5008(P87)
Dacia Duster (H79)	Porsche Macan (PO416)
Fiat 500X (334)	Porsche Panamera(PO623)
Ford C-Max(C344)	Renault Captur (J87)
Ford Fiesta (B299)	Renault Kadjar (HFE)
Ford Kuga (C520)	Renault Megane(BFB)
Ford Mondeo (CD391)	Renault Zoe (X10)
Honda Civic(2SV)	Seat Ibiza (SE250)
Hyundai Tucson (TL)	Seat Leon (SE370)
Jaguar F-PACE (X761)	Skoda Fabia (SK260)
Jaguar XE (X760)	Skoda Octavia (SK371)
Jaguar XF(X260)	Smart Fortwo (C453)
Jeep Renegade (520)	Smart Fortwo (C453) Electric Version
Kia Sportage (QL)	Toyota Auris (130A)
Land Rover Ranger Rover (L405)	Volkswagen Passat(VW481)
Range Rover Sport (L494)	Volkswagen Tiguan (VW326)
Mercedes CLA (C117)	Volkswagen Touran(VW378)
Mercedes-Benz A-Class (W176)	Volvo V40 (Y555)
Mercedes-Benz C-Class(W205)	Volvo V60 (Y352)
Mercedes-Benz E-Class(W213)	Volvo XC90 (V526)

44,4% 7,710,040 units

3 Combined Sample

Combining 2012 and 2016 sample vehicles with 2016 production volumes

63,5% 11,018,907 units

4 Extrapolation

Extrapolation of sample and/or OEM specifications onto entire 2016 European vehicle production

100,0% 17,360,446 units

Representation of 2016 total production

DUCKER WORLDWIDE

Product group and component overview

Overview of product groups and components

Engine
Engine Block
Heads
Pistons
Mounts
Anti-Vibration
Other Engine

Chassis & Suspension
Suspension arms
Knuckles
Subframes

Trim & Interior
Sunroofs
Roof Rail
Glass Surrounds

Heat Transfer
Heat Exchangers
Heat Sinks
Heat Shields

Body Structures
Complete Body Structure
Shock Towers
Rails
Radiator Support
Structural Members
IP-Structures
Floor Group
Body Side Panels
Other

Body Closures
Hoods
Fenders
Boots
Front Doors
Rear Doors
Window Frames
Door Intrusion Beams
Roofs

Steering
Steering Rack

Wheels & Brakes
Wheels
Brakes
Other

Driveline
Transmission Case
Transfer Case
Other Transmission

Crash Management Systems
Crash Boxes
Bumpers

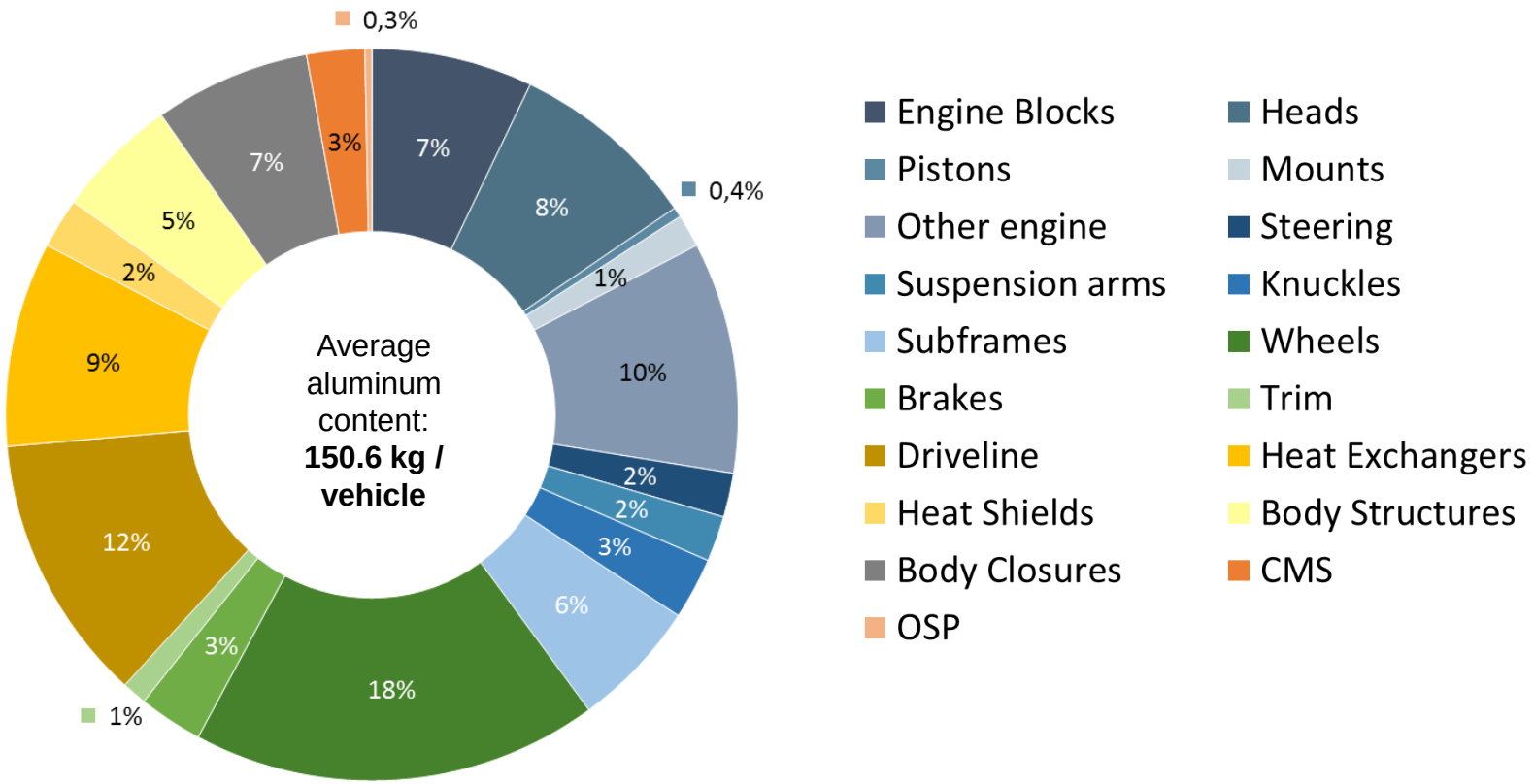
2016 Aluminum Content

Total European Car Production – Component Weight Distribution

Although much focus is on aluminum sheet products for body and closure, the share of castings, between powertrain and wheels is nearly 50% of the total average aluminum content

Average component content per vehicle 2016

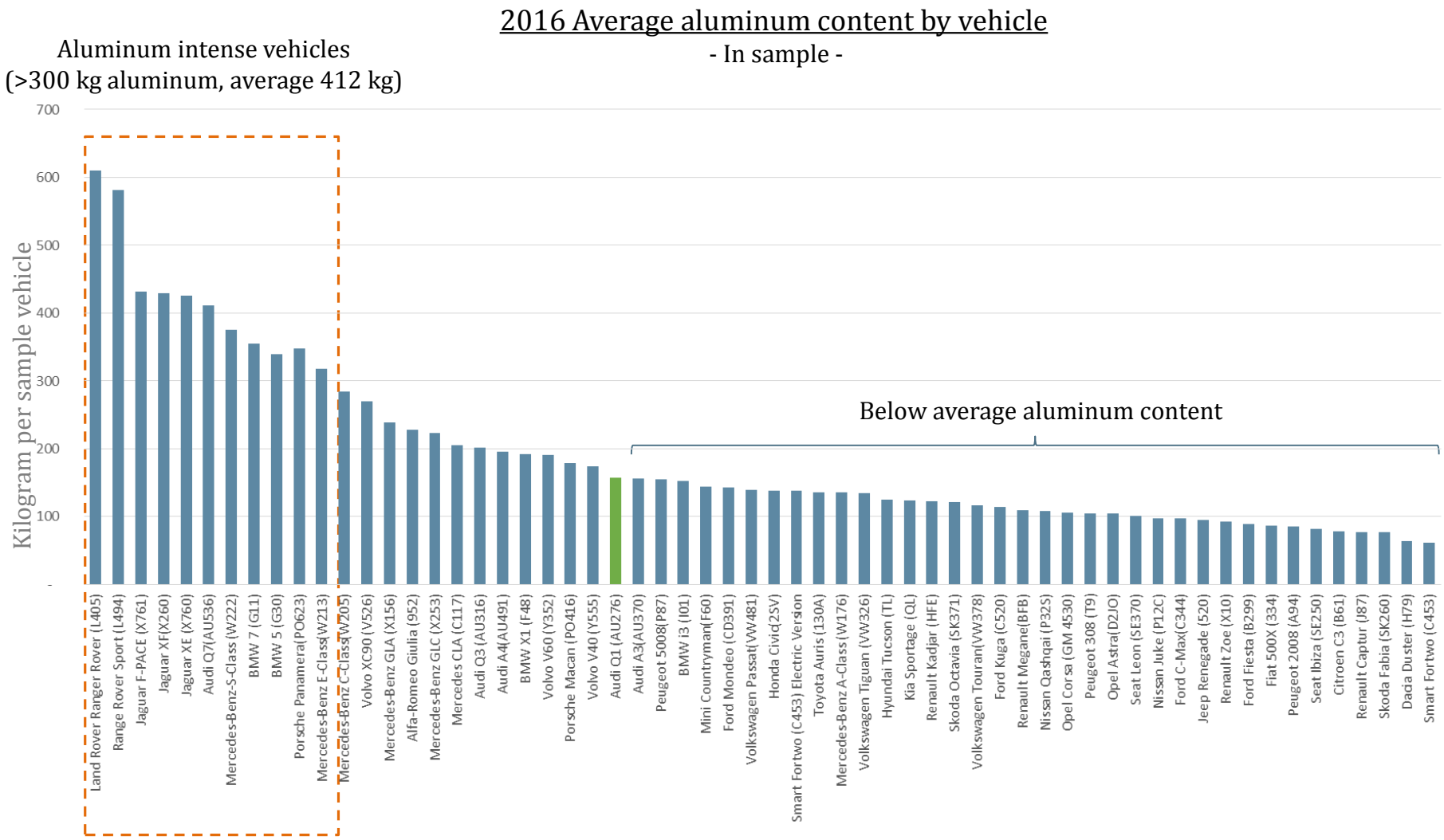
- Total European car production -



CMS = Crash Management Systems
OSP = Other Small Parts

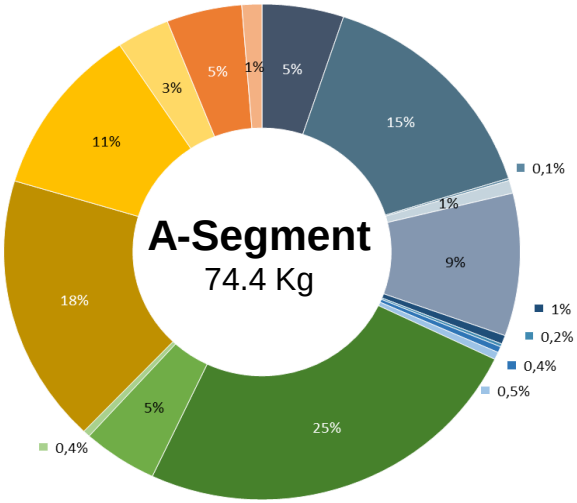
Average Aluminum Content

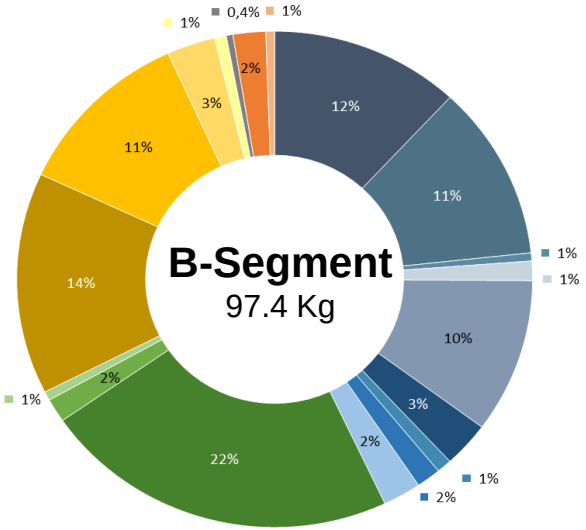
Average aluminum content per vehicle ranges from 62 kg for the Smart Fortwo, up to 610 kg for the Range Rover Sport.

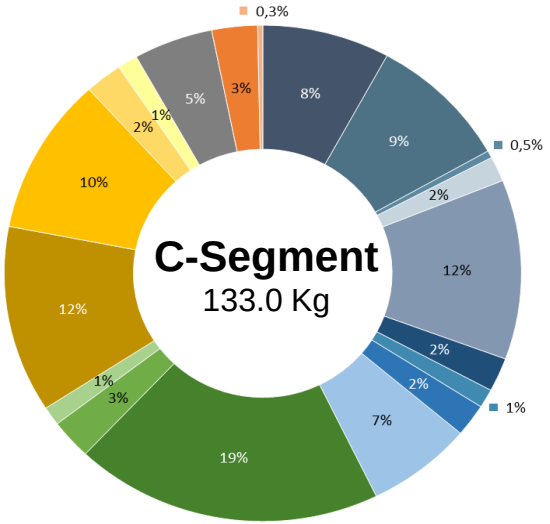


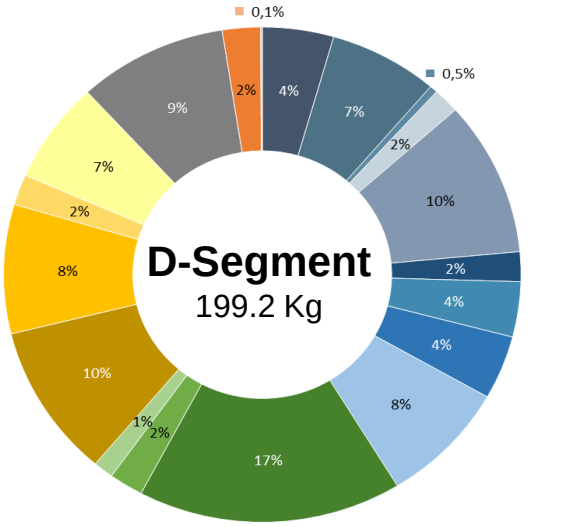
Total Production Component Comparison by Segment

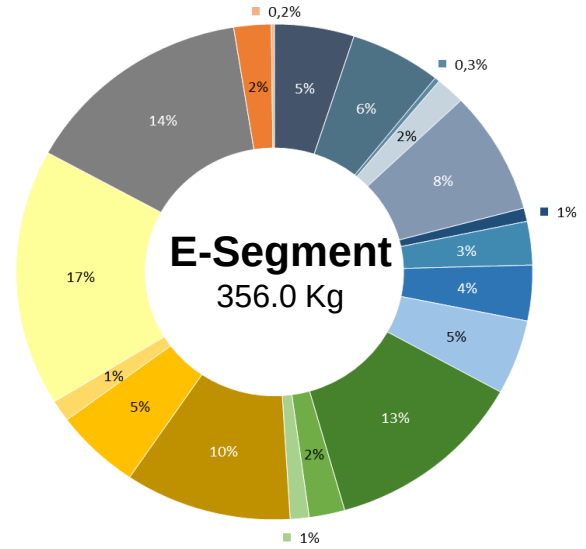
Aluminum content share by application varies most significantly within the E-Segment, where the share of aluminum for body & closures is greater than any other category









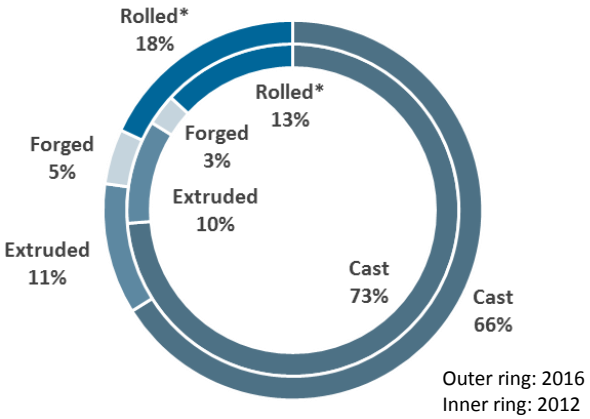


- Engine Blocks
- Heads
- Pistons
- Mounts
- Other engine
- Steering
- Suspension arms
- Knuckles
- Subframes
- Wheels
- Brakes
- Trim
- Driveline
- Heat Exchangers
- Heat Shields
- Body Structures
- Body Closures
- CMS
- OSP

CMS = Crash Management Systems
OSP = Other Small Parts

Product Form Analysis – Total Market

2016 vs. 2012 semi product for aluminum content
- Total Aluminum Content-



2016 aluminum production by semi product
- Total Aluminum Content-

	Cast	Extruded	Forged	Rolled*
2016 Average Kg per vehicle	99.5	16.8	7.1	27.2
2016 Total content	1,731 tT	292 tT	123 tT	473 tT

* Rolled includes sheet aluminum used in body closures, body structure, heat exchangers and heat shields / sinks and other sheet components

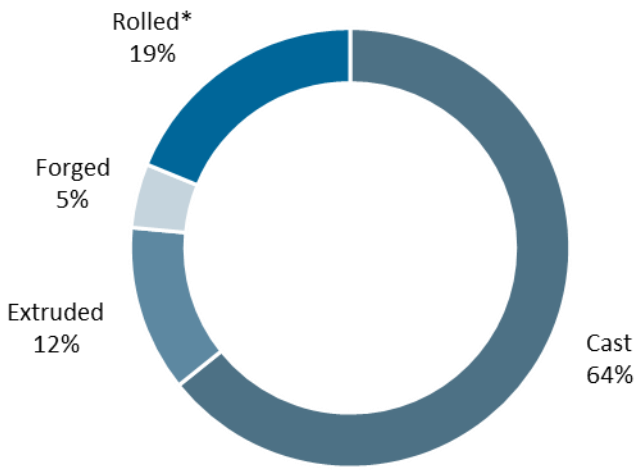
- Although still dominant, the share of aluminum castings in the total aluminum consumption has decreased by 8 percentage points in the last 4 years
- Especially the share of rolled products has grown significantly due to the increased penetration rate for body closures and body structures, predominantly for C, D, and E-Segment vehicles
- The share of forgings and extrusions remains relatively stable in the total aluminum consumption

Future Aluminum Use

Product Form Analysis – Total Market 2020 Forecasts

Low forecast

2020 semi products
for aluminum content
- Total Content -

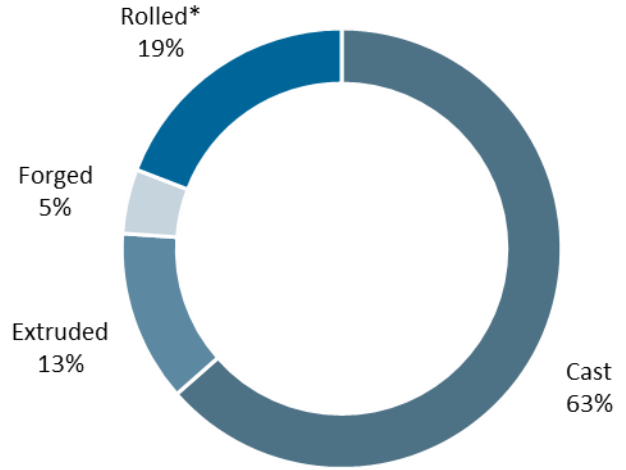


2020 aluminum production by semi products
- Total Production -

	Cast	Extruded	Forged	Rolled*
2020 Average Kg per vehicle	102.4	19.5	7.5	30.0
2020 Total content	1,962 tT	374 tT	144 tT	574 tT

High forecast

2020 semi product
for aluminum content
- Total Content -



2020 aluminum production by semi products
- Total Production -

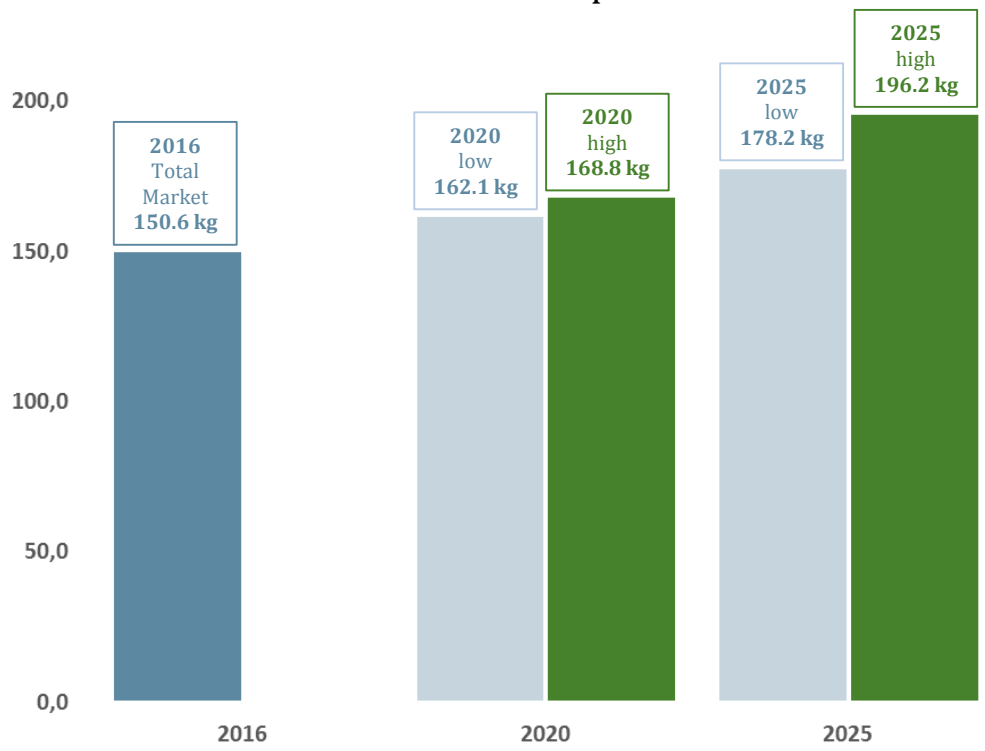
	Cast	Extruded	Forged	Rolled*
2020 Average Kg per vehicle	107.6	21.4	8.0	32.5
2020 Total content	2,062 tT	409 tT	154 tT	622 tT

* Rolled includes sheet aluminum used in body closures, body structure, heat exchangers and heat shields / sinks and other sheet components.

* The growth for rolled products are mainly coming from body closure and body structures.
* The share of heat exchangers will go down.

Future Scenarios – Total Market

Overall aluminum content per vehicle is poised to grow from 2016 thru 2025. The vast majority of growth is expected to be sheet driven, particularly for closure applications



	2020		2025	
	low	high	low	high
CAGR (2016- Year)	1,9%	2,9%	1,9%	3,0%
Growth (Year compared to 2016)	7,7%	12,1%	18,3%	30,3%

- Based on scenario forecasts, aluminum content per vehicle will continue to grow to nearly 170 kg in 2020, and around 190 kg by 2025
- The use of aluminium Auto Body Sheet is expected to increase by 110% over the next 10 years
- Differences between low and high case scenarios are largely attributed to penetration rates and use of aluminum for body closures, structures, as well as chassis & suspension components
  - A great deal of growth is due to an anticipated increase of aluminum vacuum die casting replacing steel stamped components (sub-frames, shock towers) within the body and structure
- Additionally, growth of aluminum content will also fluctuate largely based on the OEMs ability to meet CO2 requirements with powertrain improvements and a potential switch from a mass based European CO2 regulation in the future
- Forecast aluminium content for a specific year is based on vehicle production data of future models. A decision to postpone a major update of one or several models can have large effects on the average aluminium content for a given year.
- If for example an OEM are planning convert some models to aluminium shortly after 2020 it will not be included in the 2020 forecast but only in the 2025 forecast

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