# CAFE 2025
# Automotive Aluminum:
## (MMV Optimization, AIV)


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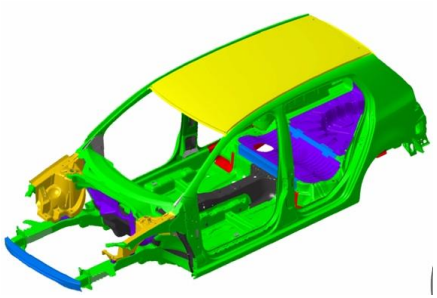



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# Automotive Aluminum – CAFE 2017-2025

- Weight reduction 2008 – 2025
- Body optimization – Aachen
  - Steel, AHSS
  - Aluminum Intensive (AIV)
- BIW Weight Reduction Potential
  - Steel, AHSS
  - Aluminum intensive (AIV)
  - MMV (EU-SLC)



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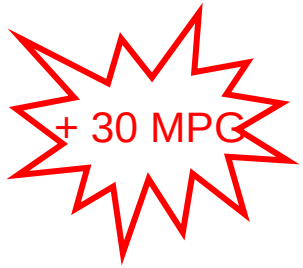
# INPRM 2017-2025

# Mass Reduction Assessment*

| | | Mass Reduction | |
|---|---|---|---|
| Technology Pathway | Technology | 47 MPG Goal | 62 MPG Goal |
| A | HEV | 15% (550 lbs) | 14% (529 lbs) |
| B | Advanced IC Mass reduction | 18% (658 lbs) | 19% (712 Lbs) |
| C | Advanced Gas Mass reduction | 18% (653 lbs) | 26% (970 lbs) |
| D | PHEV, EV HEV | 15% (550 lbs) | 14% (528 lbs) |




* *EPA/NHTSA Analysis and OEM Interviews*

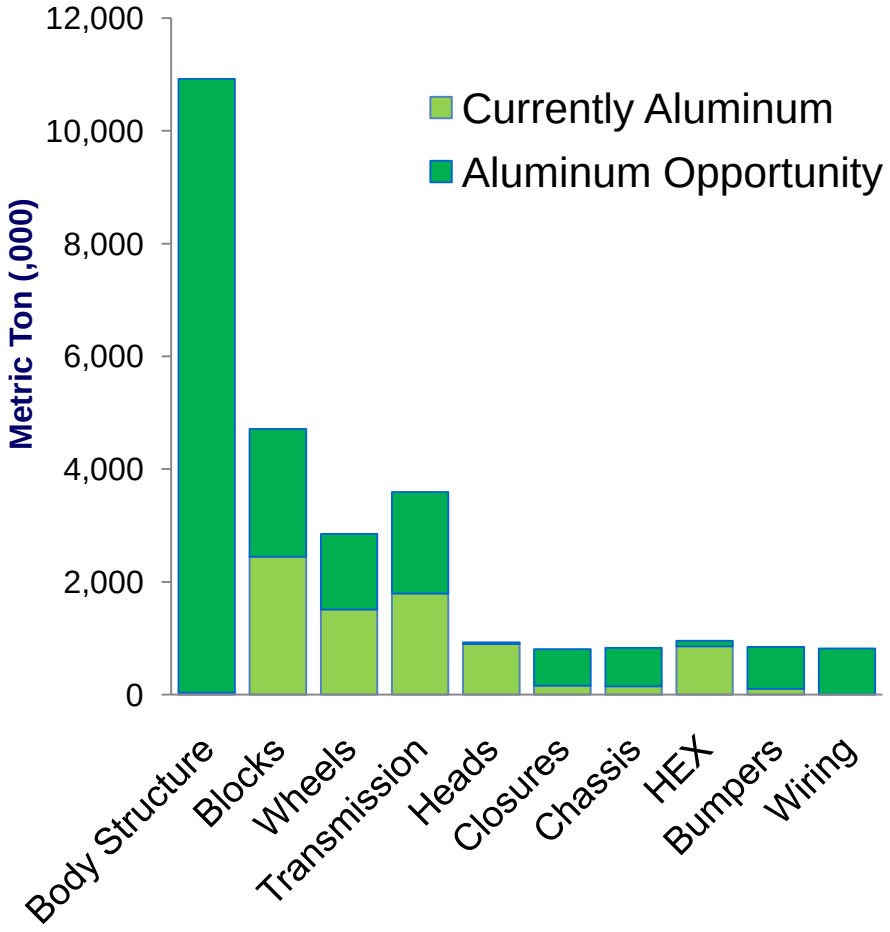
# Automotive Weight Reduction Facts
## (Independent of Material Choice)

- **Achieving 2025 objectives will take all available technologies**
  - **Powertrain**
  - **Aero**
  - **Rolling resistance**
  - **Weight**
- **Weight reduction additive to other FE improvements**
  **Including: Diesel, Hybrid, Electric, Aero, Tires, …**
- **10% vehicle weight reduction: 6.5% fuel economy improvement**
  **@ 50 MPG 10% weight reduction = 3.25 MPG**

  **AIV: 10% primary weight reduction (13% total) 8.5% MPG (4.25 MPG)**

# Body is Largest Weight Reduction Opportunity

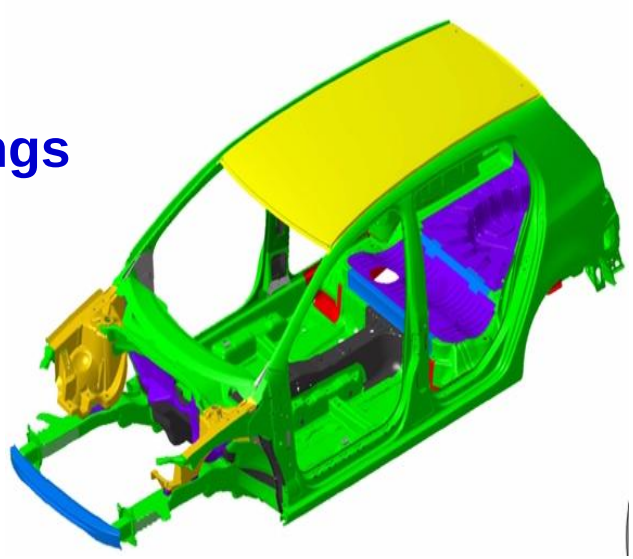
- Aluminum penetration continues to grow in established areas
- Steel historically dominated body, but…
- Potential future weight savings with steel are diminishing
- Aluminum is the next logical step
  - MMV - Closures, Body
  - AIV




*Source: The Aluminum Association*

# Vehicle Lightweight Potential
# High-Strength Steel / Aluminum

- University of Aachen (ika) (Germany)
  - European Aluminum Association (EAA)
- Body in White (BIW) Optimization
- Objective
  - Determine potential BIW weight savings
    - Steel, advanced steels (AHSS)
    - AIV – Aluminum intensive vehicles



# Quantitative Analysis

- **Methodology**

  **Model car body, identify components that are**

  - **Strength limited – crash performance**
  - **Stiffness limited - NVH**

  **Optimize weight of each component**

  - **High-strength steel grades (including advanced high-strength steel)**
  - **High-strength aluminum alloys**

  **Optimized BIW weight assessment**

  - **Steel/HSS/AHSS**
  - **Aluminum (AIV)**



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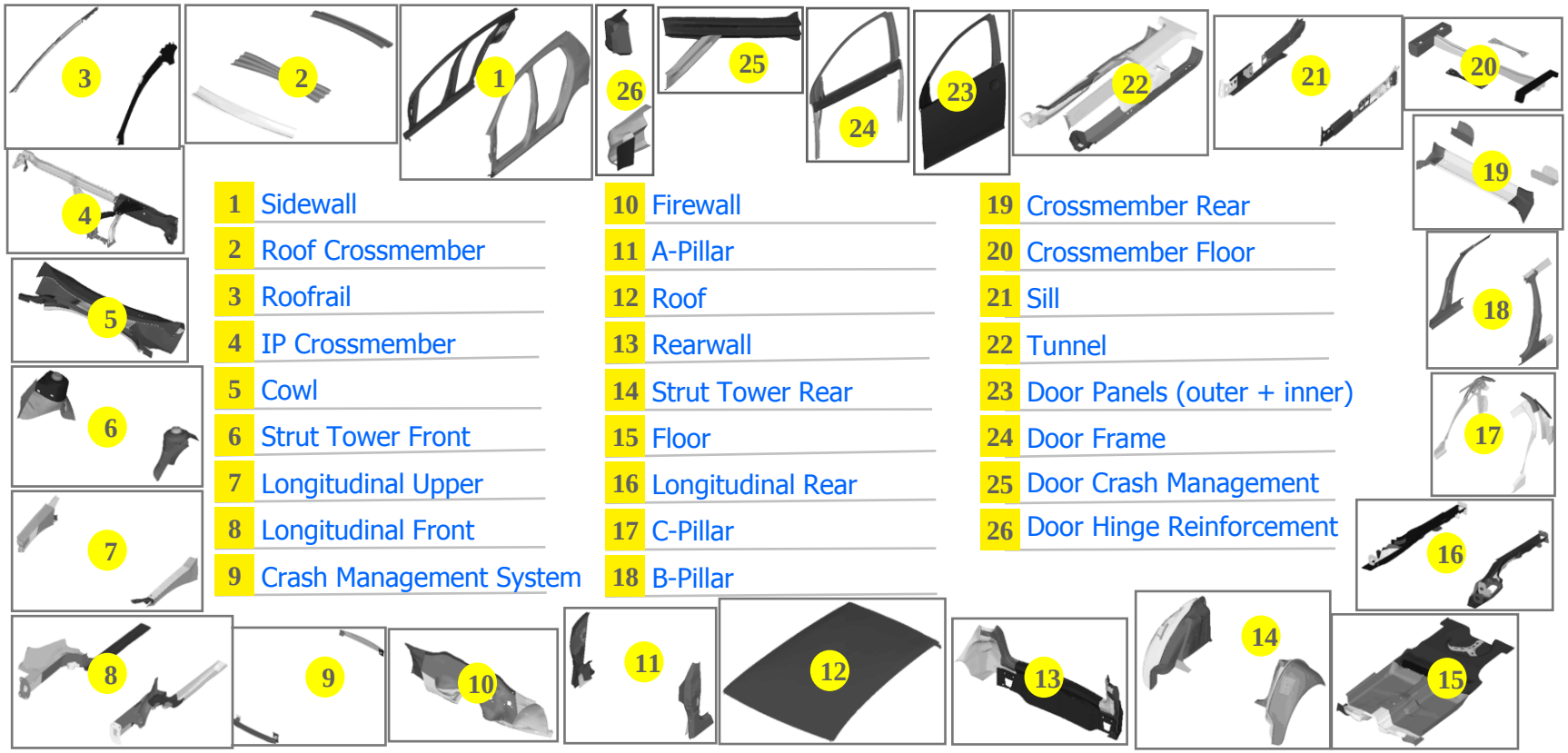
# 26 Components for Evaluation



| | | | | | |
|---|---|---|---|---|---|
| 1 | Sidewall | 10 | Firewall | 19 | Crossmember Rear |
| 2 | Roof Crossmember | 11 | A-Pillar | 20 | Crossmember Floor |
| 3 | Roofrail | 12 | Roof | 21 | Sill |
| 4 | IP Crossmember | 13 | Rearwall | 22 | Tunnel |
| 5 | Cowl | 14 | Strut Tower Rear | 23 | Door Panels (outer + inner) |
| 6 | Strut Tower Front | 15 | Floor | 24 | Door Frame |
| 7 | Longitudinal Upper | 16 | Longitudinal Rear | 25 | Door Crash Management |
| 8 | Longitudinal Front | 17 | C-Pillar | 26 | Door Hinge Reinforcement |
| 9 | Crash Management System | 18 | B-Pillar | | |

*Source: ika - University of Aachen / European Aluminium Association*



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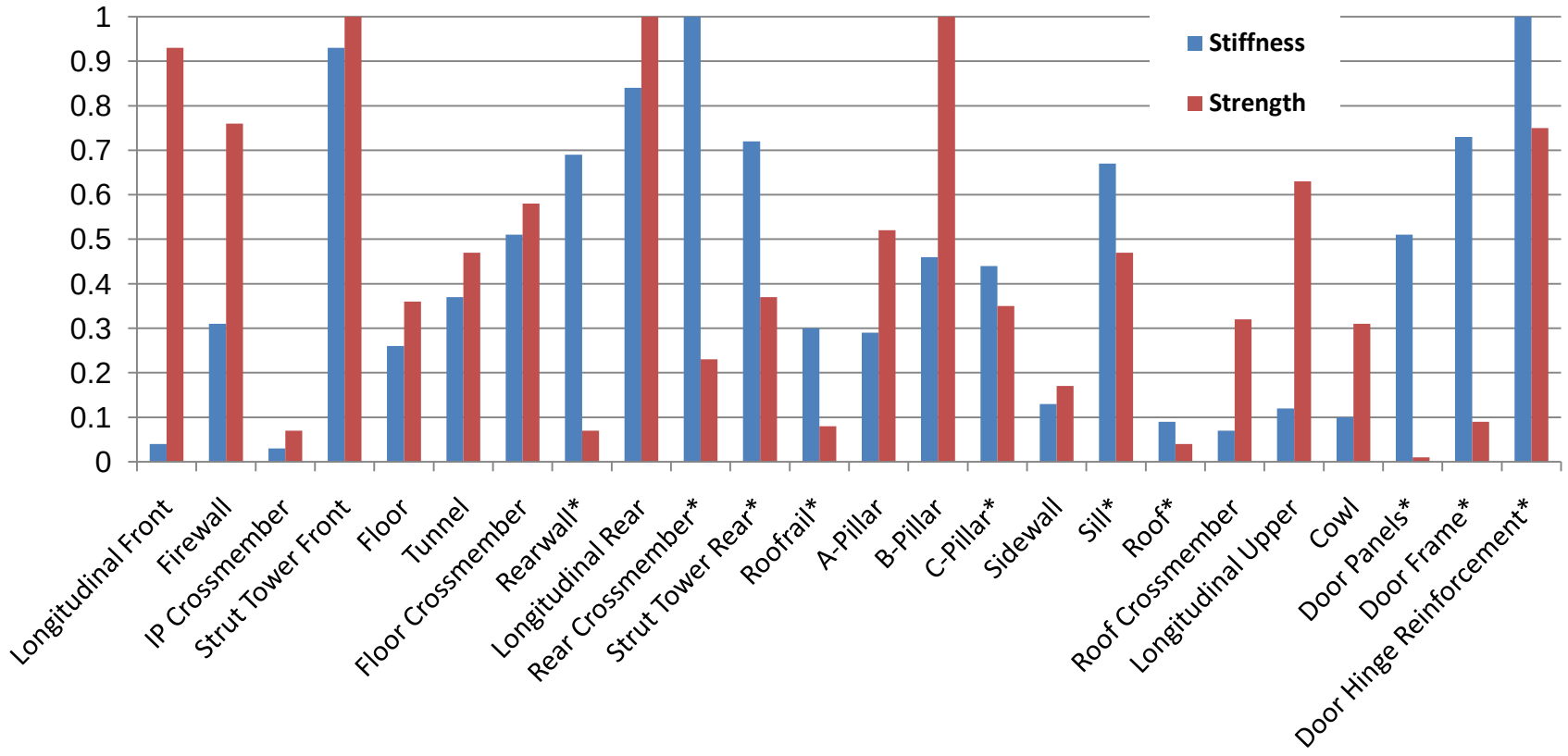
# Results: Strength vs. Stiffness

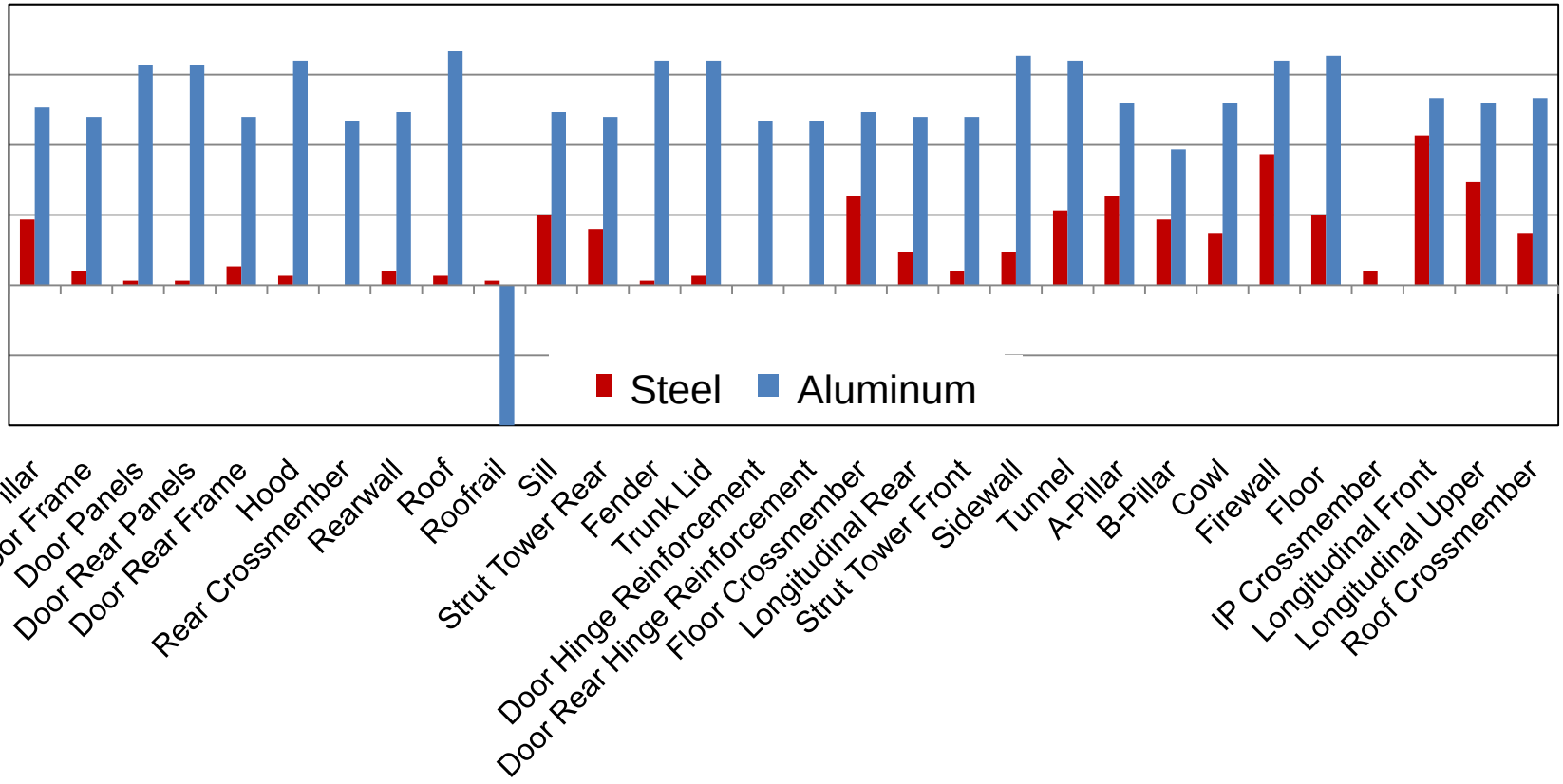
***Strength and Stiffness Relevance Normalized to Values from 0 to 1***




*Source: ika - University of Aachen / European Aluminium Association*

# BIW Lightweighting Potential

***Total maximum weight reduction compared to reference car:***
***Steel (with YS up to 1,200 MPa): 11%  Aluminum (with YS up to 400 MPa): 40%***




*Source: ika - University of Aachen / European Aluminium Association*



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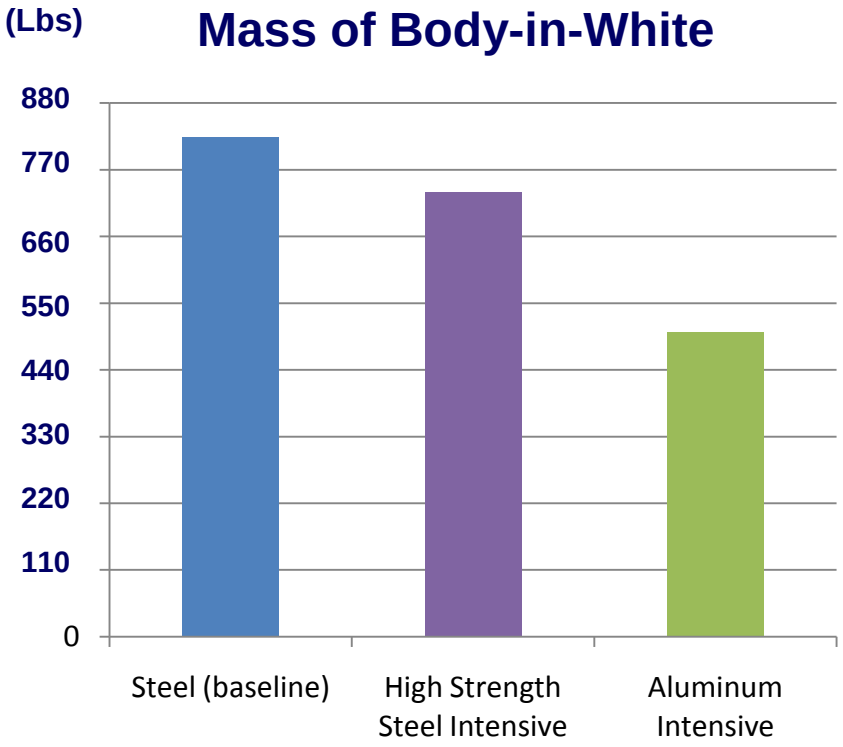
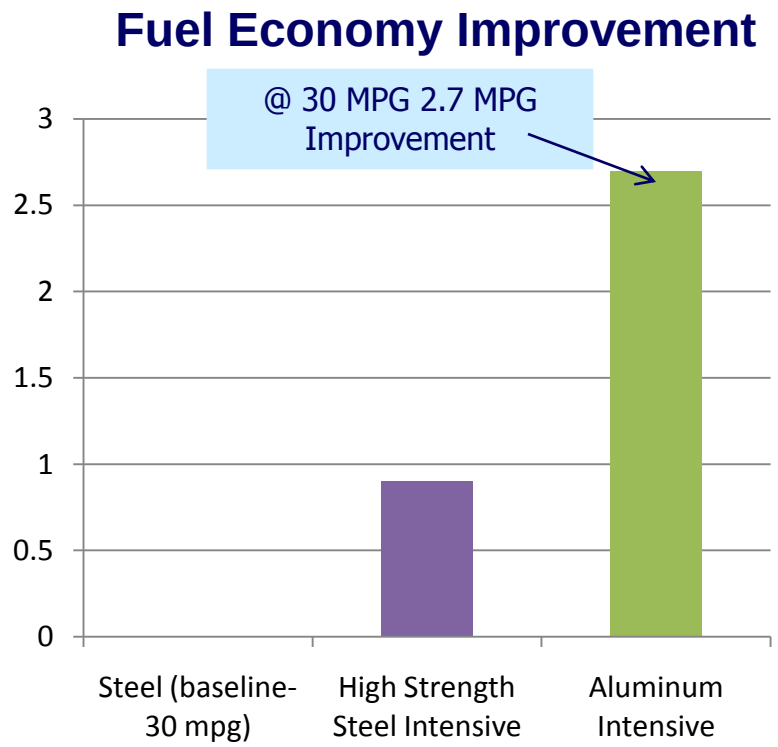
# Aluminum's Weight Advantage Translates Into Fuel Economy Advantage




*Source: ika - University of Aachen and the European Aluminium Association (EAA)*




*Source: Aluminum Association calculated based on ika mass reduction data; assumes 23% secondary weight savings*

# Key Findings – Aachen Study

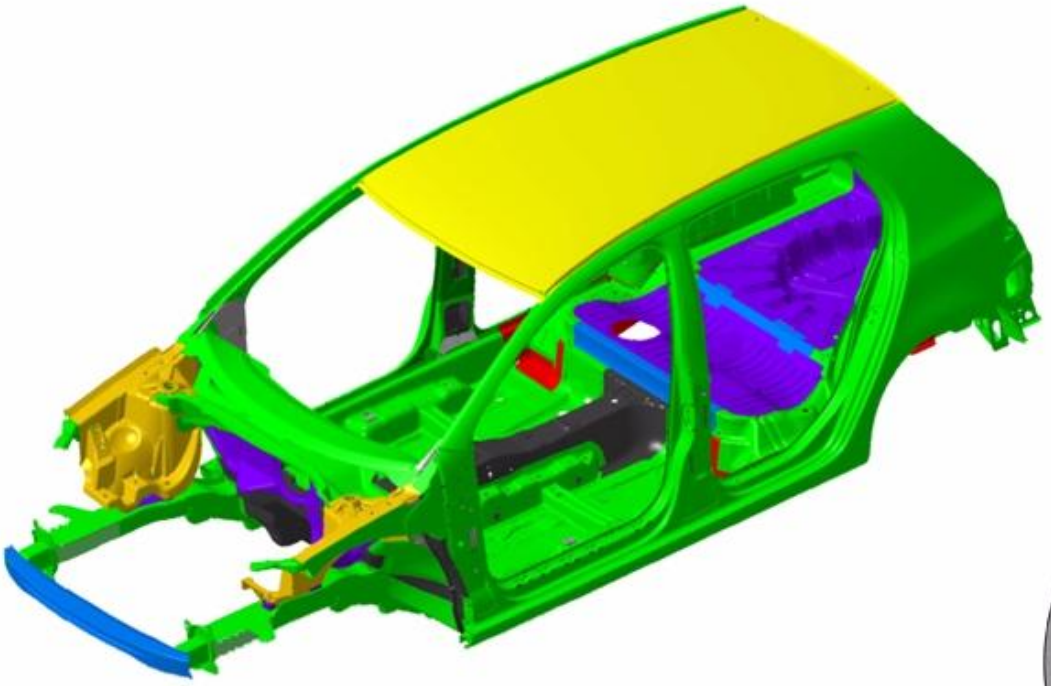
- **Strength not limiting factor for steel to aluminum conversion of most components**

- **Weight reduction potential (BIW and closures):**
  - **Advanced High-strength steel (YS up to 1,200 MPa) = ~11% ( 88 Lbs)**
  - **Aluminum AIV (YS up to 400 MPa) = ~40% (300 Lbs)**

  ***- EU SLC (MMV) ~ 30% (220 Lbs)***

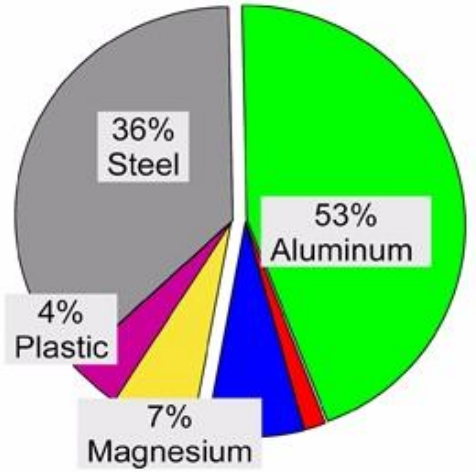
**Full study available at EAA website:**
**http://www.eaa.net/en/applications/automotive/studies/**

# EU Super Light Car (SLC) BIW



SLC BIW: weight 180kg

- Aluminium sheet
- Aluminium cast
- Aluminium extrusion
- Steel
- Magnesium
- Fibre reinforced plastic



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# Summary: Automotive Aluminum 2025

- **Weight reduction critical to achieving 2025 objectives**
- **Significant gains achievable (1.5 – 4.0 MPG @ 50 MPG)**
  - **AHSS**
  - **MMV Optimization – steel, AHSS, Aluminum**
  - **Aluminum (AIV) – Aluminum, AHSS**
- **There will be a BIW Mix**
  - **Steel – price critical market segment: MAXIMUM downsizing**
  - **MMV (body) – size-cost optimization: MODERATE downsizing**
  - **AIV (body) – size critical market segment: LIMITED downsizing**

**For more information or to download a copy of this presentation, visit us online at:**

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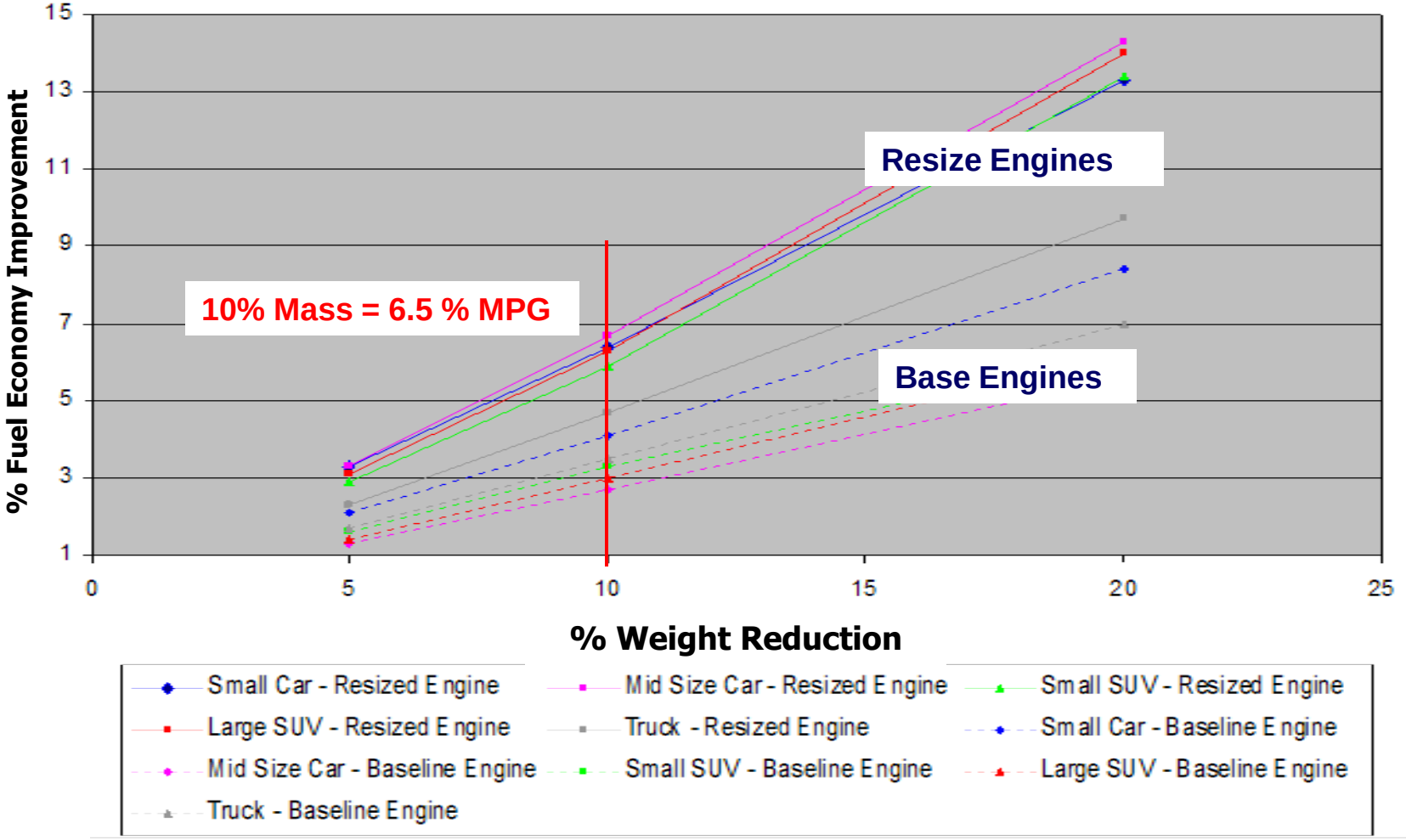
# Achieve 47-62 MPG by 2025

## Forecast: Deploy *all* available technologies

| | | Fleet Gain |
|---|---|---|
| • Engine | Hybrid, diesel, electric, friction, VVT, … | 50% |
| • Vehicle | Transmission, tires, aero, brakes, … | 25% |
| • Weight | | 25% |
| • Downsize fleet<br>Average 6 inches shorter | | 10% |
| • Advanced Steel (BIW) | | 10% (w/major downsizing) |
| • Aluminum in MMV – AHSS<br>Components, closures, BIW(MMV) | | 3% (w/minor downsizing) |
| • AIV (5% of fleet)<br>Preserve size, content, capacity<br>EV range, battery cost | | 2% (no downsizing) |

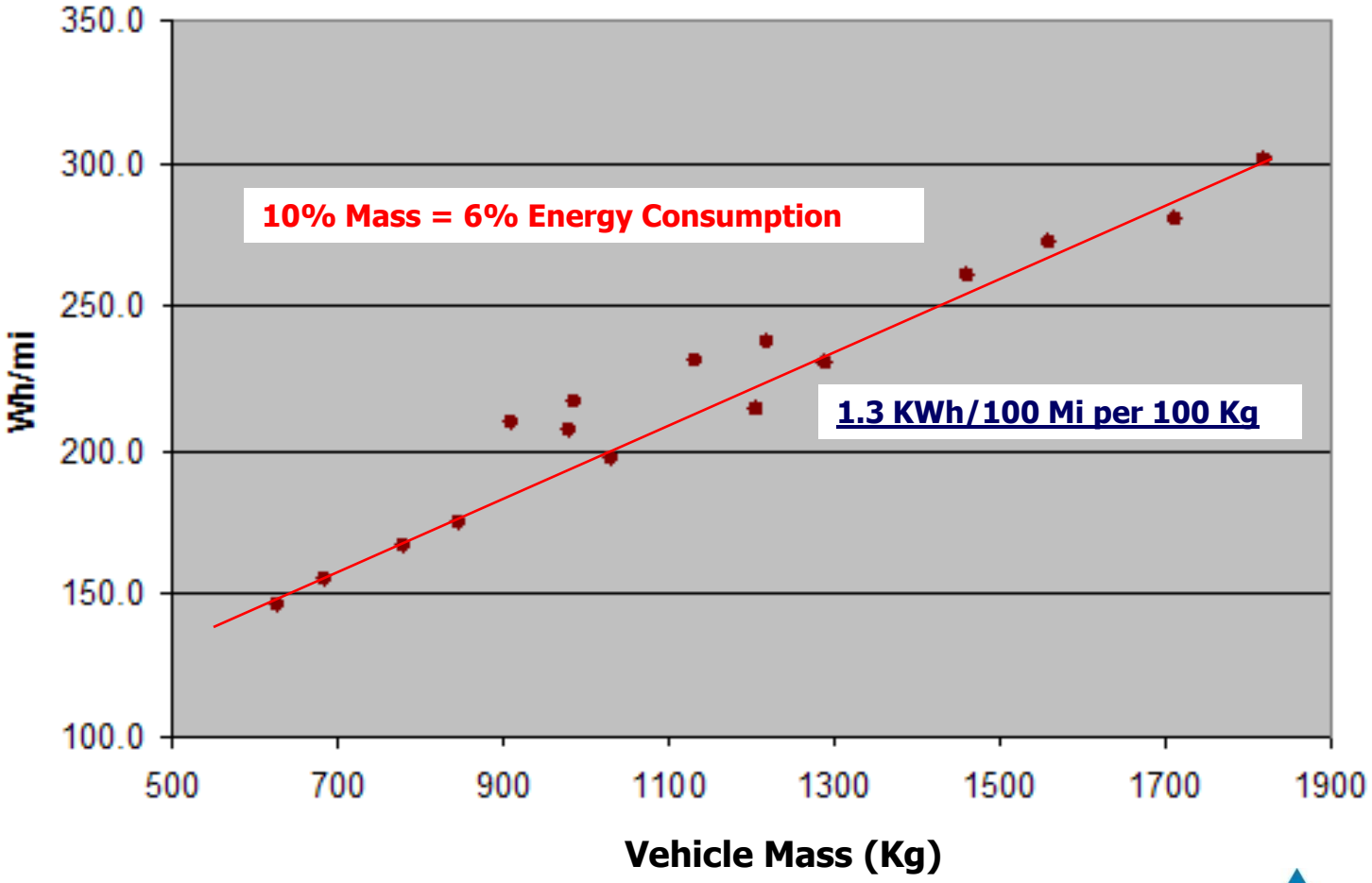
# Weight Reduction vs. Fuel Economy

## Conventional Vehicles: Gas, Diesel



# Weight Reduction vs. Energy Consumption

## Electric Vehicles: EV, HEV, PHEV



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