

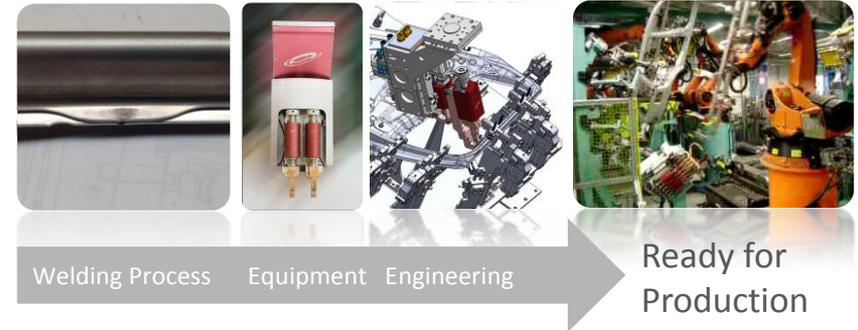
Energy Savings Opportunities with Resistance Projection Welding (**RPW**)

AL-S[®] Technology | Arplas Systems

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ARPLAS – Innovator of **RPW** on thin sheet metal



2018 ARPLAS China opening

2016 Welding of aluminum and hotstamp material added to portfolio

2015 ARPLAS Europe BV was founded as our European manufacturing site

2012 ARPLAS Korea LLC was founded as our Asian manufacturing facility

2010 Service representation in China and Brazil

2006 ARPLAS USA LLC was founded in Detroit MI for manufacturing and service

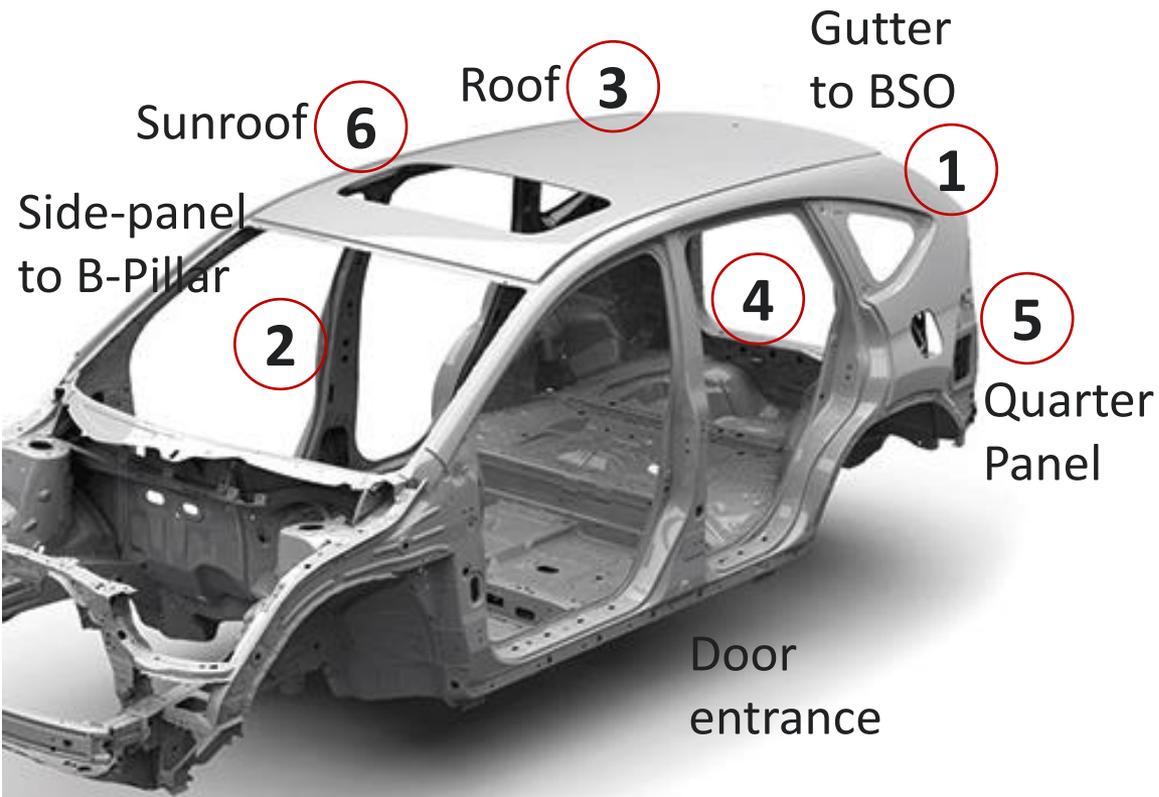
2003 AL-S Technology BV was founded, a company dedicated to the development and worldwide marketing of the AL-S[®] technology

2002 The first patent was granted with many others to follow

1997 The ARPLAS System (AL-S)[®] was introduced and patents were applied

1971 ARPLAS started in 1971 with welding machines. Mr. Arp started a business in Ias (Dutch for weld) machines and developed various cost saving welding systems over the years

Typical AL-S[®] Applications for Automotive Body and Closures



Window frame & waist rail



AL-S[®] Technology in production



DOE –Ultra-Light Door Design



Steel door,
small flanges,
laser welded

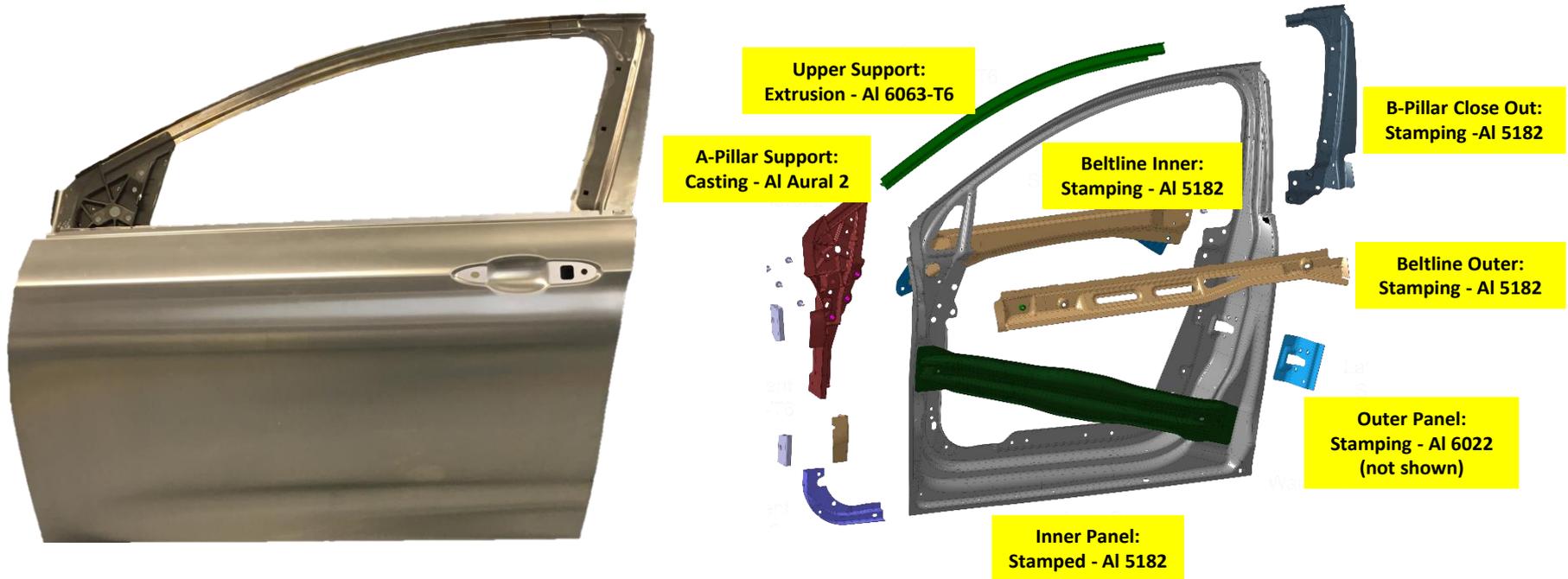


Aluminium
door, small
flanges, RPW
welded

<https://energy.gov/eere/vehicles/downloads/vehicle-technologies-office-merit-review-2017-ultra-light-door-design>
Department of Energy, Office of Energy Efficiency and Renewable Energy (EERE), under award number DE-0007306

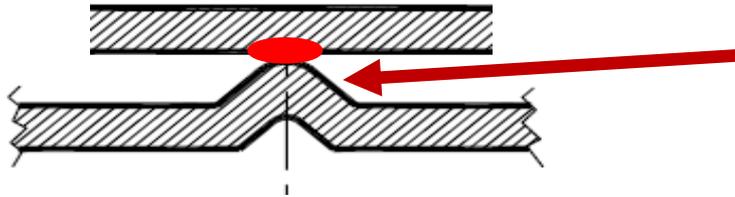
DOE –Ultra-Light Door Design

- 44.4% weight savings over baseline steel Door in White design
- 99x **RPW** – Sheet to sheet, sheet to extrusion, sheet to casting



<https://energy.gov/eere/vehicles/downloads/vehicle-technologies-office-merit-review-2017-ultra-light-door-design>
Department of Energy, Office of Energy Efficiency and Renewable Energy (EERE), under award number DE-0007306

Resistance Projection Welding (RPW) Process

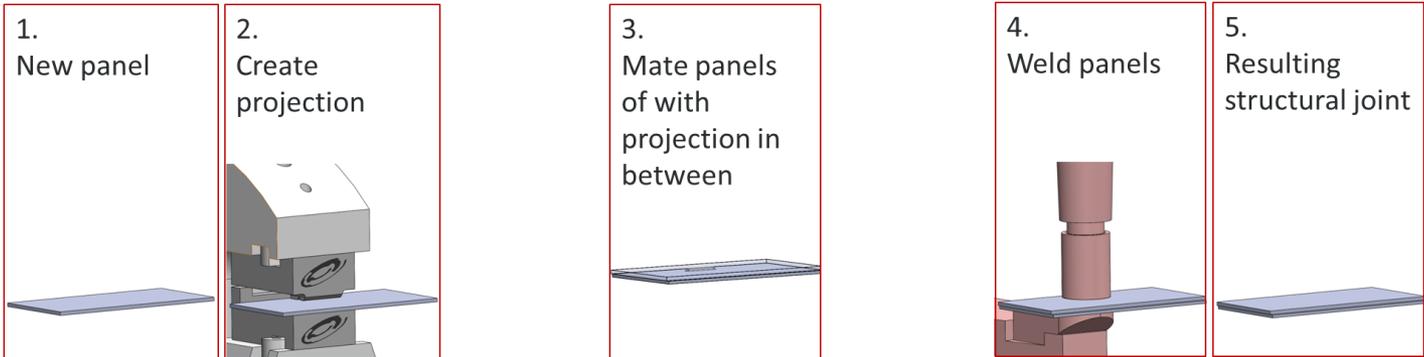


The electrical resistance determining the current depends on the dimple size and shape

No additional material will be used to generate the welding joint

Dimple **breaks** the surface, including oxide layer

AL-S[®] process steps Direct RPWelding



Projection geometry

- Projection size constant across sheet thickness range (0.4mm – 3.2mm)
- Force varies with thickness and material strength



Mild steel

(0.7mm @ 7kN)

W x L 1.5 x 8 mm²



Aluminum

(1.2mm @ 9.6kN)

W x L 2 x 6 mm²

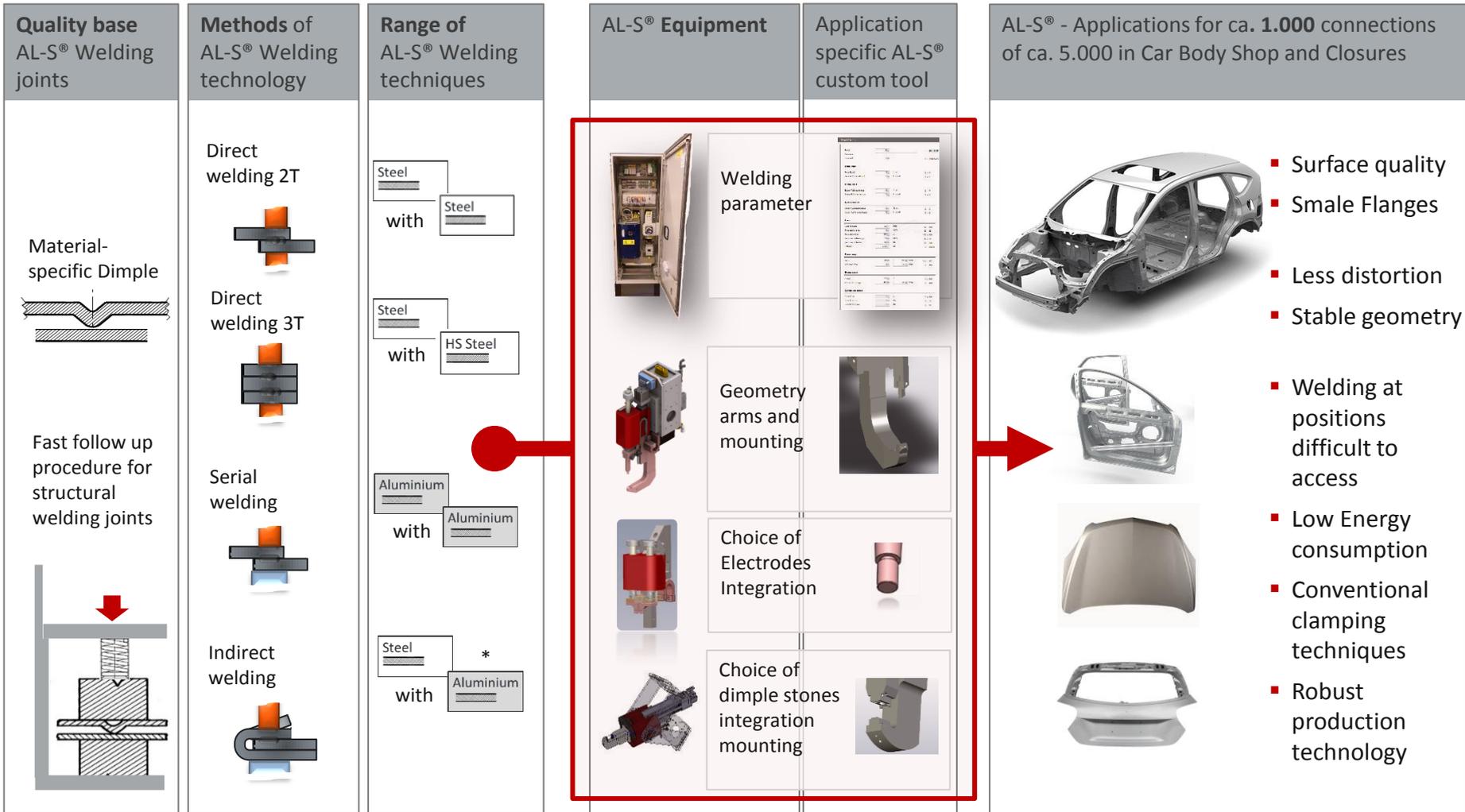


Boron Steel

(1.8mm @ 50kN)

W x L 1.5 x 8 mm²

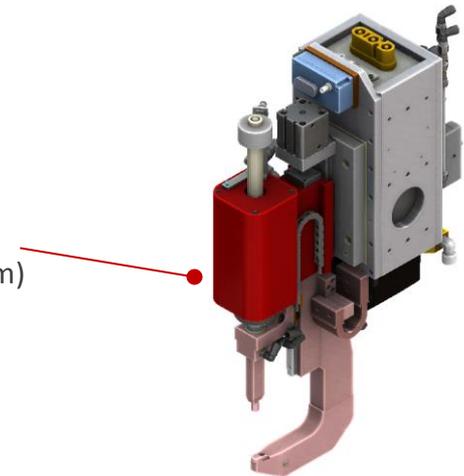
Modular AL-S® Concept – multifunctional RPW equipment for all Applications



Basic configuration for **RPW** welding process

- Low weld force lead to smaller shanks
- Short weld times at high current
- Air cooled – Steel
- Water cooled with dry-connect tips - Aluminum

Force build-up cylinder
(Fast follow-up spring loaded system)

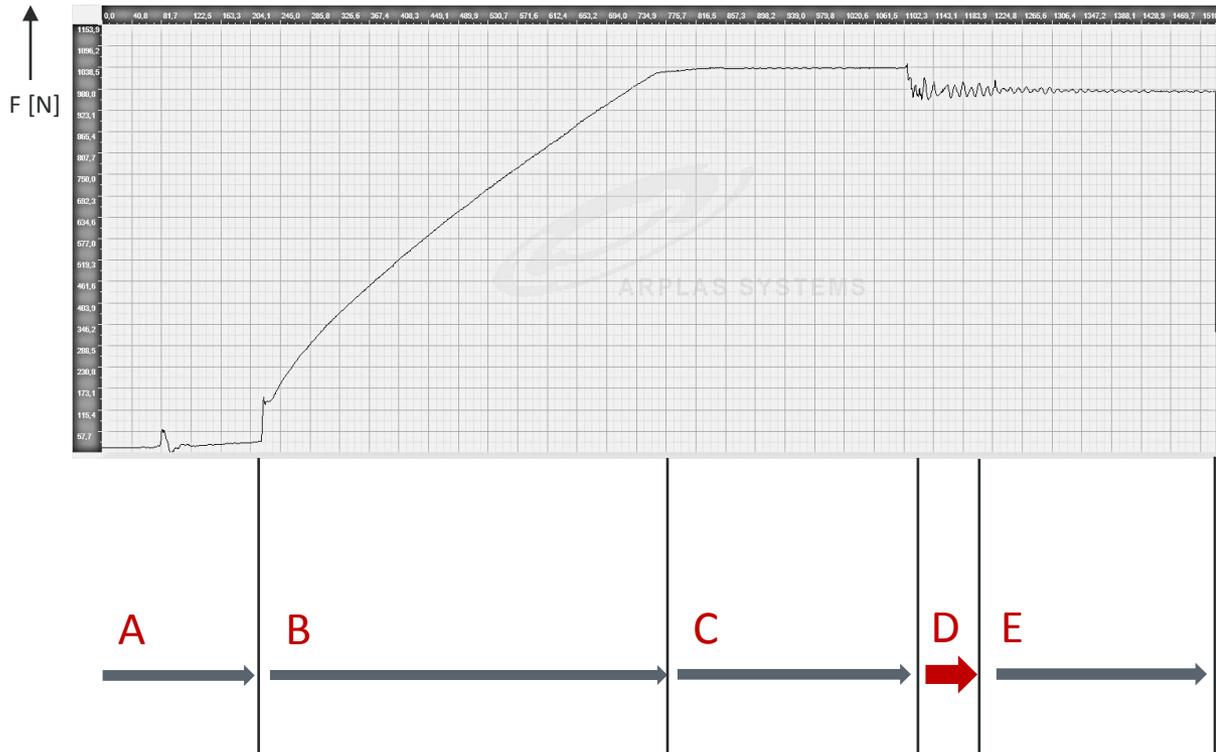


- Following configuration is typical to achieve proper welding joints with AL-S® Equipment

| | Coated Steel | Aluminum |
|------------------------------|--------------------------|----------------------------|
| Dimple Size (W x L) in mm | 1.5 x 8 | 2 x 6 |
| Required Flange Length in mm | ~5 | ~8.5 |
| Weld Force in N | 900 | 1800 |
| Power in kA | 18 | 36 |
| Weld time in ms | 6 | 25 |
| Tip life | 10 000 (no tip dressing) | 7 500 (with tip polishing) |
| Power Supply | AC or DC | DC |

AL-S[®] Welding process

- The graph Force/Time shows a typical process sequence for AL-S[®] welding joint



- A:** Pre-stroke phase:
Closing of welding unit until initial contact with parts
- B:** Force build-up
Force built up in the fast follow-up cylinder
- C:** Force stabilisation and Dimple check
Ensure that the force on the electrodes is within the correct parameters and stable
- D:** Firing
- E:** Cooling and Control of the weld Quality
Measure weld quality by comparing the drop in force before the current is release to create the weld

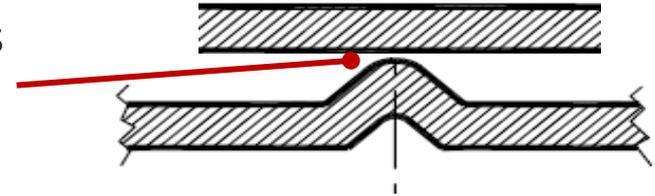
Weld appearance and destruct of **RPW** on thin metal

- Minimal surface distortion due to low force and short welding time
- Nugget size relative to projection size
- Button size for physical destruct evaluation
- Ultrasound compatible for non destructive evaluation

| | Mild Steel | Aluminum |
|-------------|--|---|
| Top |  |  |
| Bottom |  |  |
| Button Pull |  |  |

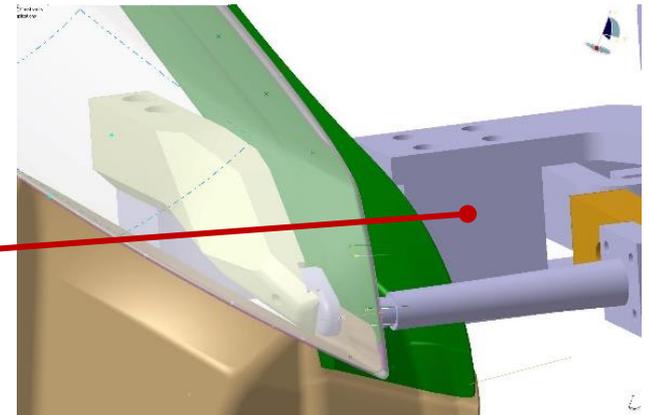
RPW process resulting in low gun force

- The small contact area of the projection creates a location of high resistance between the parts being joined
- Fast follow-up cylinder maintains force during weld avoiding need for pulses or forging with aluminum



| Typical values | RPW | RSW |
|---------------------|--------|---------------------------------|
| Steel (0.8mm) | 1000 N | 3500 N |
| Aluminum (1.5mm) | 2000 N | 3000 N (weld) 6000 N (forge) |

- Slim armature and body of the welding unit allows to reach difficult welding joint positions



Effects of low energy usage for the car

■ Product



- Structural welding joint
- Less weight, less material due to small flanges (compared to spot and laser welding)
- New design possibilities for welded parts with visible surfaces
- Lower CO₂ footprint (compared to spot and laser welding)



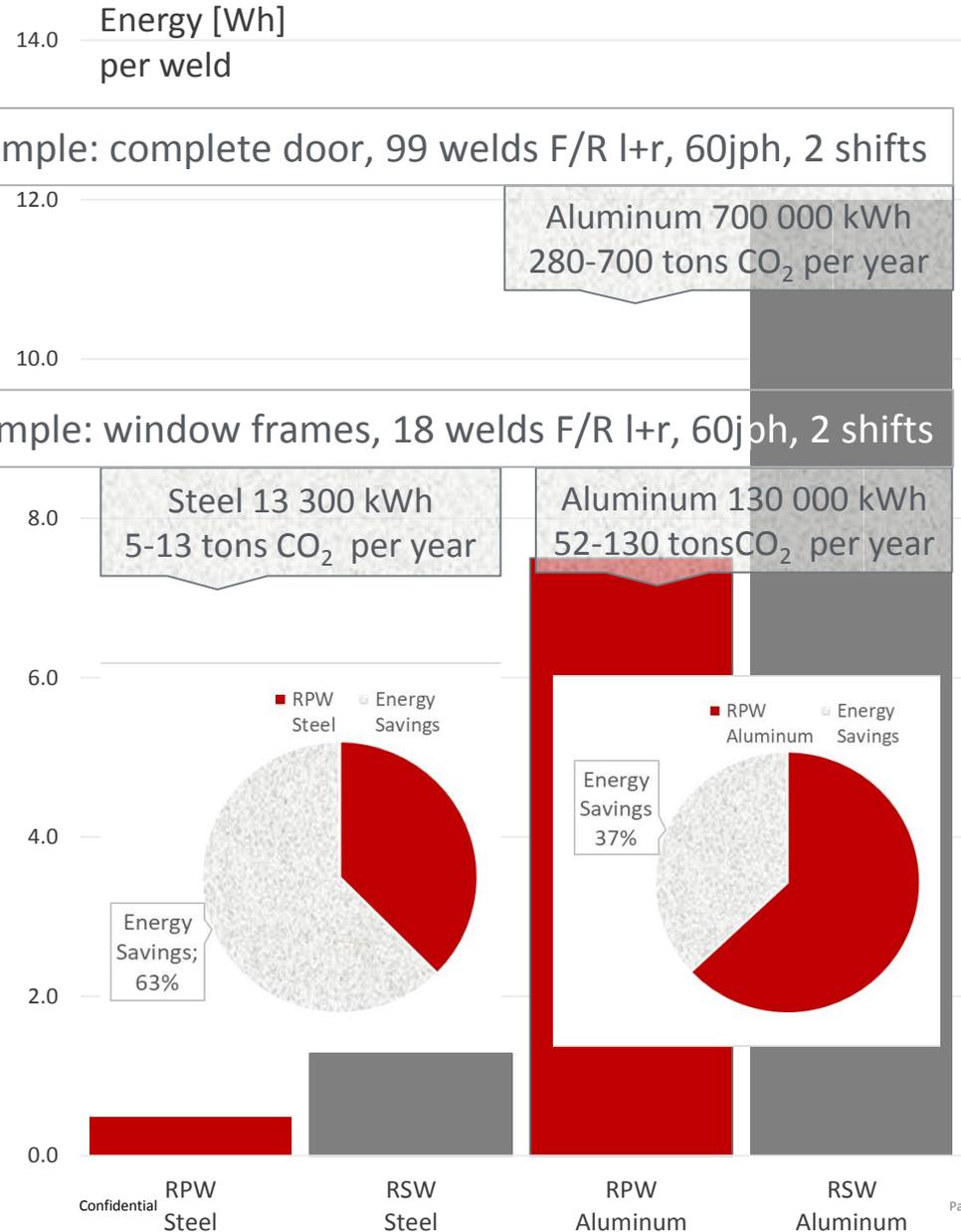
Energy Savings per weld



Example: complete door, 99 welds F/R l+r, 60jph, 2 shifts



Example: window frames, 18 welds F/R l+r, 60jph, 2 shifts



■ Comparing:

Resistance Projection Welding (RPW)
to
Resistance Spot Welding (RSW)

| | Coated Steel (0.7mm) | | Aluminum (1.5mm) | |
|----------------------|----------------------|-----------|------------------|--------------|
| | RPW Steel | RSW Steel | RPW Aluminum | RSW Aluminum |
| Current [kA] | 18 | 7,5 | 36 | 40 |
| Duration [ms] | 6 | 96 | 25 | 83 |
| Voltage [V] | 16 | 6,4 | 30 | 13 |
| Energy [Wh] per weld | 0,5 | 1,3 | 7,5 | 12,0 |

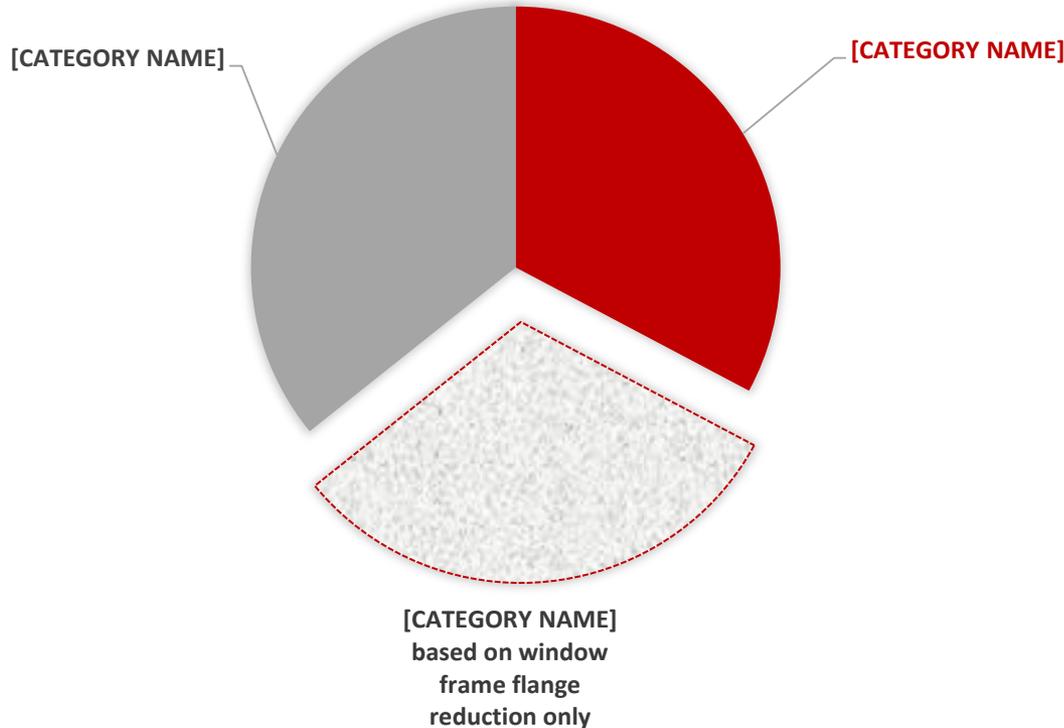
Energy E=Pt Power P=VI Values based on AWS guideline

Total **energy** savings based on case study for 4 doors in Al



Example: complete door, 99 welds F/R l+r, 60jph, 2 shifts

ENERGY SAVINGS
PER CAR IN KWH



- 80kWh/car can be about the average electricity consumption in vehicle assembly plants for the welding
- 3kWh/car savings could be achieved with RPW welding of the complete aluminum doors compared to spot welding.
- ca. 4% contribution to lower the electricity consumption and CO₂ carbon footprint for the car welding process

Total **cost** savings based on case study for 4 doors in Al



Example: complete door, 99 welds F/R l+r, 60jph, 2 shifts



- Financial savings in production due to lower energy consumption
- Financial savings due to small flange (8 instead of 16mm) if 80% recycled
- Financial savings due to lower car weight based on 200 000km

- Financial savings due to lower power consumption compared to spot welding can be 55 000,-€ to 120 000,-€ per year, depending on local electricity prices.
- Financial savings due to 8mm smaller Al flanges can be 90 000,-€ to 120 000,-€ per year, depending on scrap prices and material mix.

Effects of low energy usage for the manufacturer

■ User Production



- Stable serial production with high availability and process quality monitoring, automation compatible to model changes
- Conventional fixtures and less metal distortion
- Less energy and material consumption
- Savings in electricity costs
- Lower CO₂ footprint (compared to spot and laser welding)



Energy savings **Tip life** **Gutters** **No water**
Green **Low maintenance** **Aluminium** **Afterhem welding**
9mm **Magnesium** **Short Flange** **Certifications**
Simplicity **4.5mm** **Window frames** **Quality**

GLOBAL LEADER HIGH-TECH WELDING TECHNOLOGY



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