



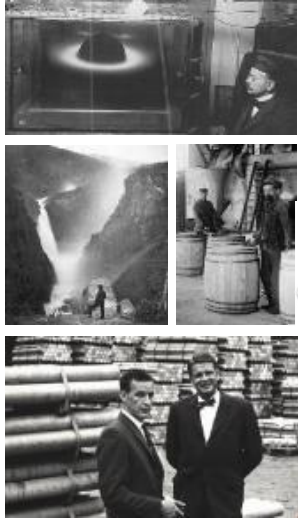


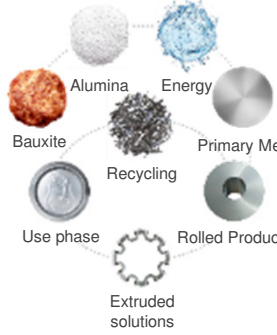


Product implications of EV development in the mid to long term

Egil Hogna
Executive Vice President Hydro
Head of Extruded Solutions

- https://www.youtube.com/watch?time_continue=16&v=qA7uxOt7OJ4

The global and complete aluminium company

“...create a more viable society by innovative and efficient use of natural resources and products”

<p>More than 110 years of industrial development and responsibility</p> 	<p>Aluminium – metal of the future</p> 	<p>Hydropower – infinitely recyclable «green» energy</p> 	<p>Engaged in the entire value chain – R&D, innovation and tailor-made solutions</p> 	<p>35,000 employees at 150 locations in more than 40 countries</p> 	<p>Involved and engaged</p> 
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Hydro parts in your car

Semi-finished and fabricated products and components from sheet and extrusions

- Body-in-white: Structural parts such as side sills, roof rails, cross-members, hood, trunk lid, trims
- Crash management systems: Bumpers and crash cans
- Front and rear subframe
- Tank
- Heat transfer applications, heat shield
- Control arms and connectors for suspension, axle links, wheels
- Battery packs and cables
- Powertrain
- Interior, dashboard, decoration



Megatrends impact the way we live and move around

By 2050 the global population will reach 9.8 billion people



Transportation demand

By 2050 70% of the global population will be living in cities



Urbanization

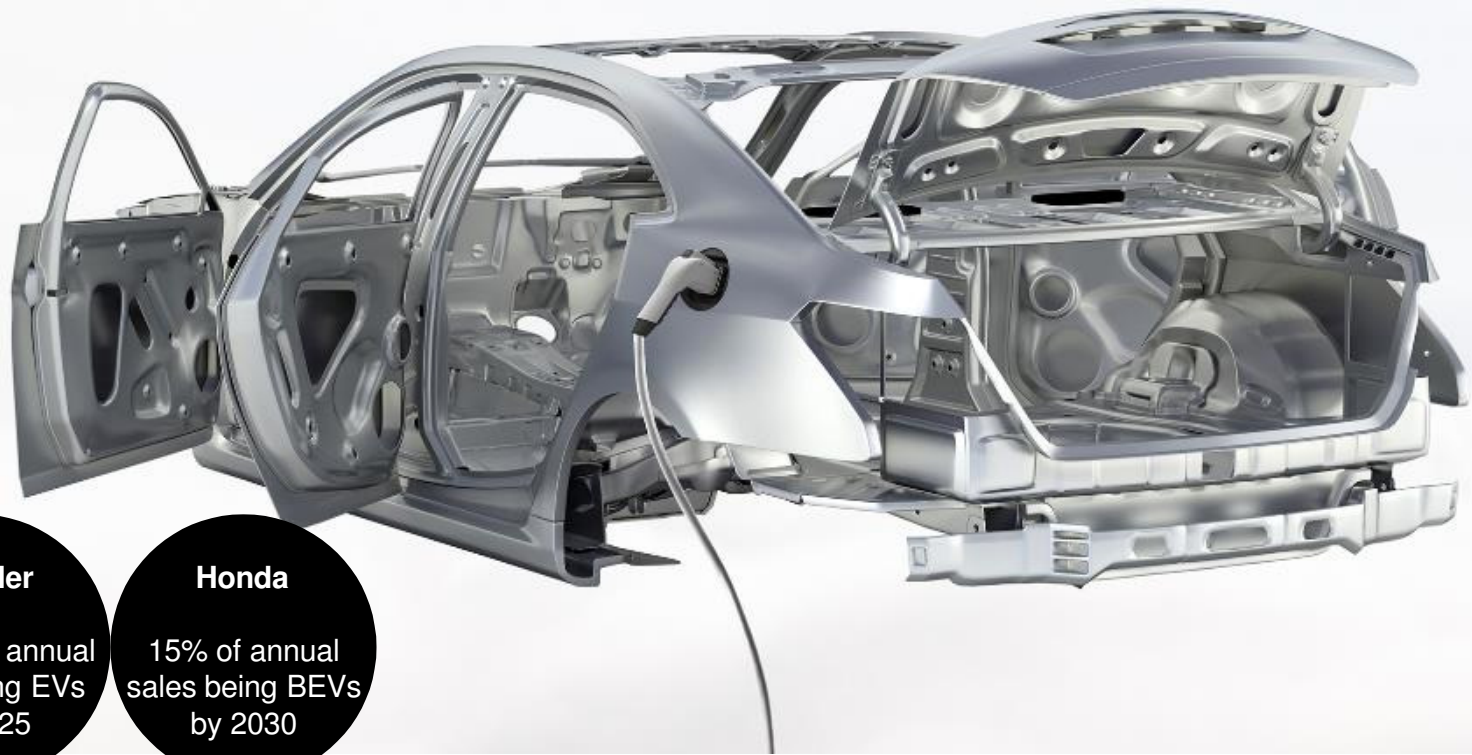
By 2025 global car production is expected to be 120 million cars



Lighter and lower emission cars



Climate concerns, regulations and technological opportunity drive e-mobility forward



OEM targets:

VW Group

2.5 million
annual EV
sales by 2025

Daimler

15-25% of annual
sales being EVs
by 2025

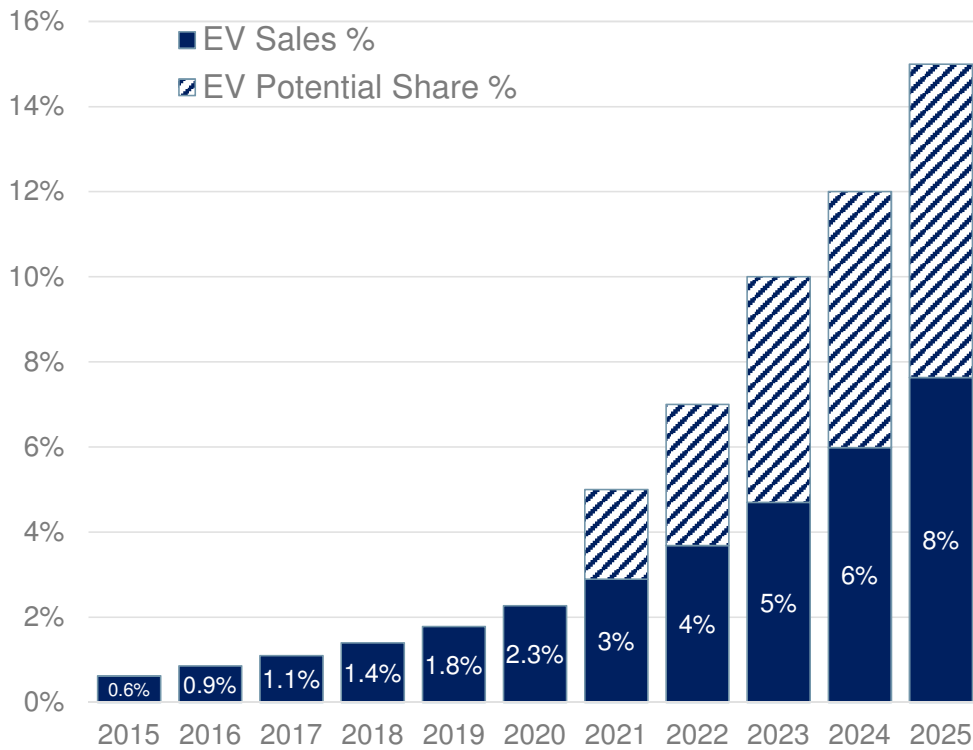
Honda

15% of annual
sales being BEVs
by 2030

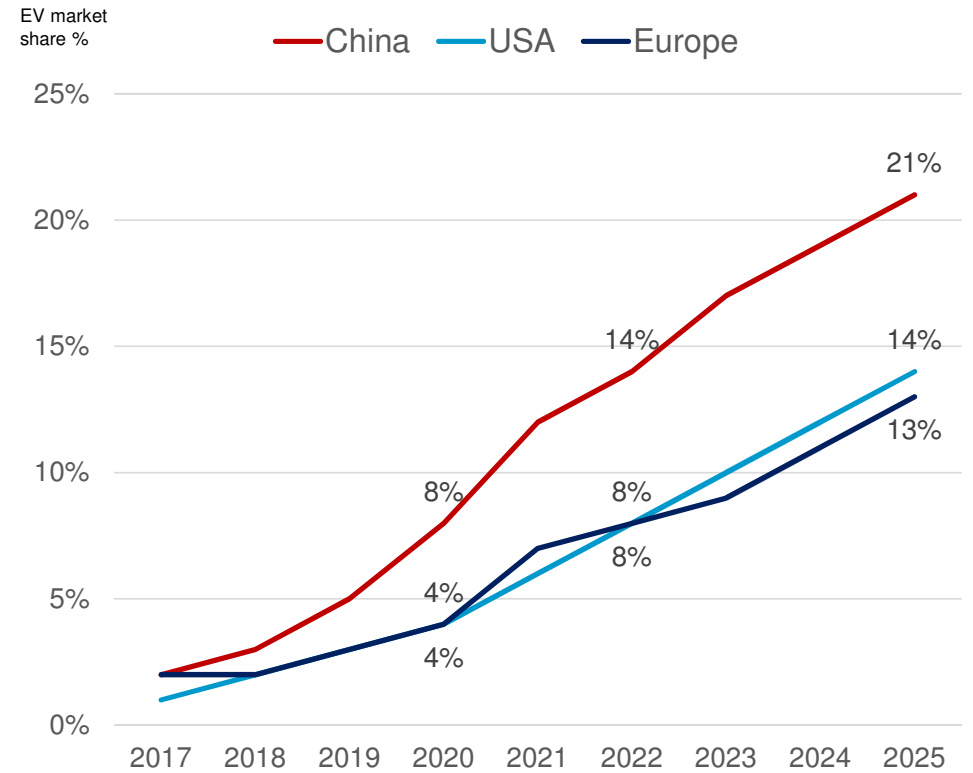
Source: Bloomberg New Energy Finance, September 2017

Electrical Vehicles (EV) sales grow exponentially

Share of EVs as % of global car sales



China will lead the overall demand for EVs



Source: public sources (internal analysis)



The car industry is changing

Shorter development time

**Proximity and closeness of suppliers
key**

Focus on weight for lower emissions

New materials requires new design

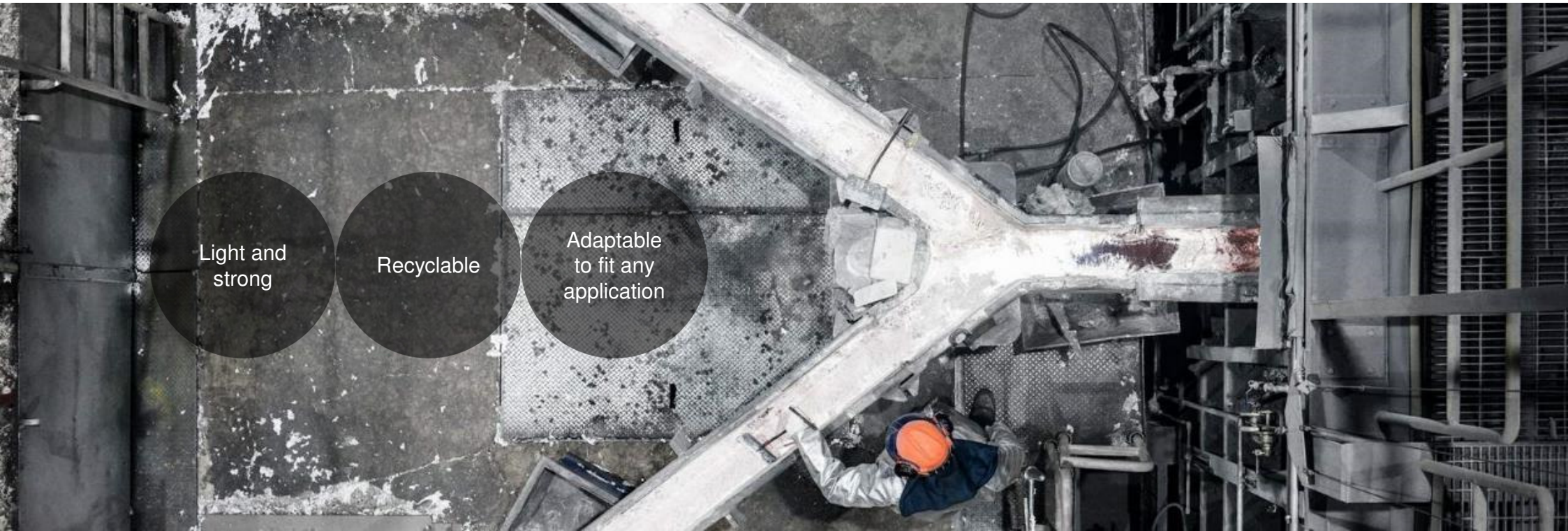
Combustion engine to electrical

New products requires new design

Smarter cars

**Electronic systems in cars requires
new functionalities such as increased
cooling**

Aluminium is part of the solution



Trends impact product development in electric vehicles

4

trends

- **New heavy components => weight reduction in focus**
- **More safety awareness => crash energy absorption key**
- **New partnerships => value chain reconfigures**
- **Sustainability mainstream => emphasis on recyclability**

#1 New, heavy components like batteries require lightweighting



Average Extrusion content
standard vehicle

19 kg



Average Extrusion content
E-Car

65 kg



Peak Extrusion content
E-Car

280 kg



... "By 2022, **Mercedes-Benz Cars** aims to have over ten all-electric vehicles in its portfolio"

... "**Volvo Cars** has announced that every Volvo it launches from 2019 will have an electric motor"

... "Every new **Jaguar Land Rover** model line will be electrified from 2020"

New extruded aluminium products for electric vehicles

Extrusions and Sheets

Precision tubing

1. Structure

Body-In-White

Chassis

2. Battery solutions

Frames *NEW PRODUCT*
(with cooling)

Boxes *NEW PRODUCT*

Tube coolers *NEW PRODUCT*

Radiators

3. E-Motor(s)

Housing *NEW PRODUCT*
(with cooling)

Motor cooler *NEW PRODUCT*

4. Power electronics

Heat sinks *NEW PRODUCT*

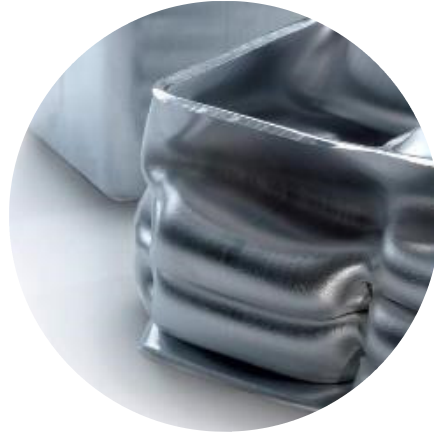
Electric cables *NEW PRODUCT*

MPE cooling

Examples of new products requiring new design thinking



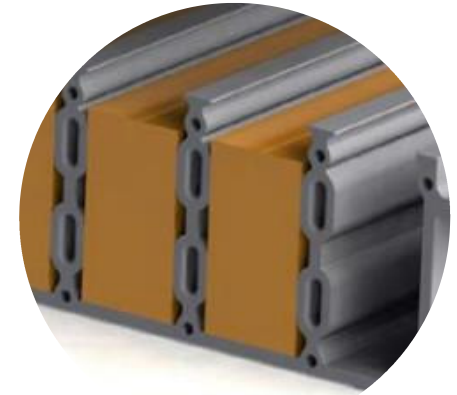
Fixing of battery modules



Protect battery modules and passengers



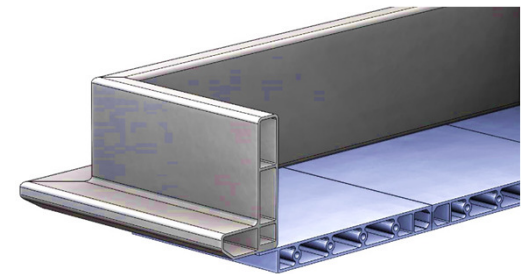
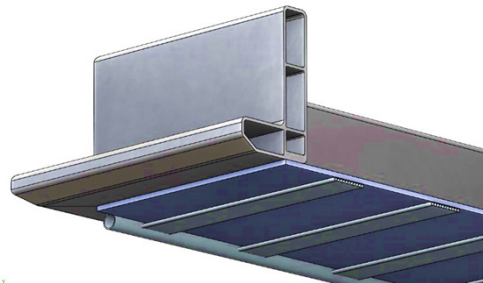
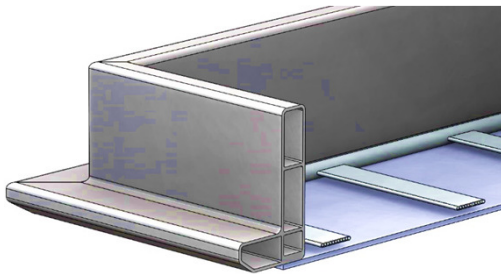
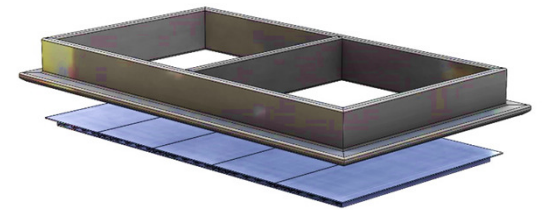
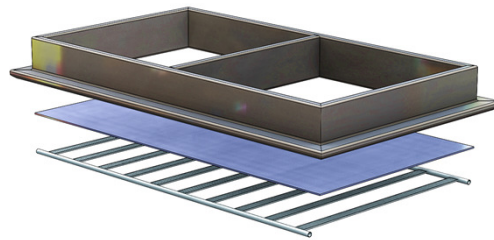
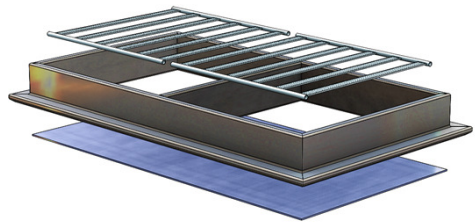
Keep battery modules dry



Cool battery modules

Different concepts for battery tray, box and cooling

Product development around battery packs



#2 Safety and usage of aluminium in new structures

- New alloys with higher strength support aluminium in safety critical applications
- Lighter vehicles break faster (and accelerate quicker)



#3 EV production is a catalyst for value chain consolidation



- New suppliers
- Different partnerships being formed
- Closer interaction in R&D between OEM and supplier
- Tier 1 and Tier 2 are gradually merging
- Fewer players

#4 Design for a circular economy

- Move to multi material vehicles
- Design for disassembly and reuse
- Material detection
- Product design standardization



The world's greenest aluminium?

A low carbon footprint in the total supply chain

- Hydropower-based aluminium with a maximum content of 4.0 kg CO₂ per kg aluminium
- Comprising total emissions from mining, refining, transportation, energy generation, anode production, electrolysis and casting



A new world standard for recycled content

- Aluminium with a guaranteed post-consumer recycled content of minimum 75 percent
- The most advanced sorting technology in the industry allows us to provide the highest recycled content in the market





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