

ARLANXEO

Performance Elastomers



Sustainable elastomer solutions for future mobility

Niels van der Aar, Marjan Hemstede - van Urk, Thomas Gross, Kevin Kulbaba, Heiner Stange, Sven Brandau, Martin van Duin

ONLINE MATERIALS 4 SUSTAINABLE MOBILITY CONFERENCE | March 23rd 2021

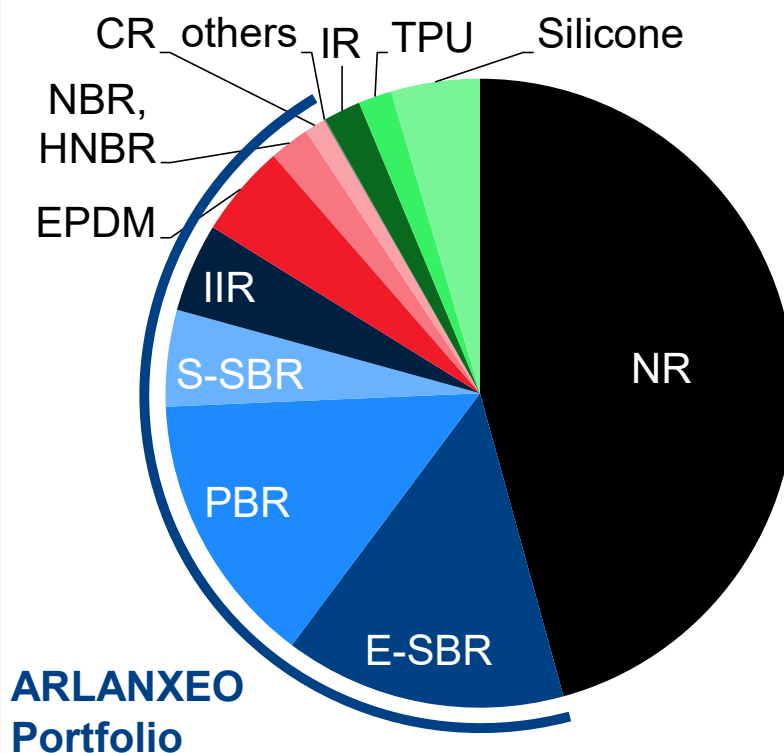


Global Rubber Market

ARLANXEO serves about 45% of the global rubber market

General Figures

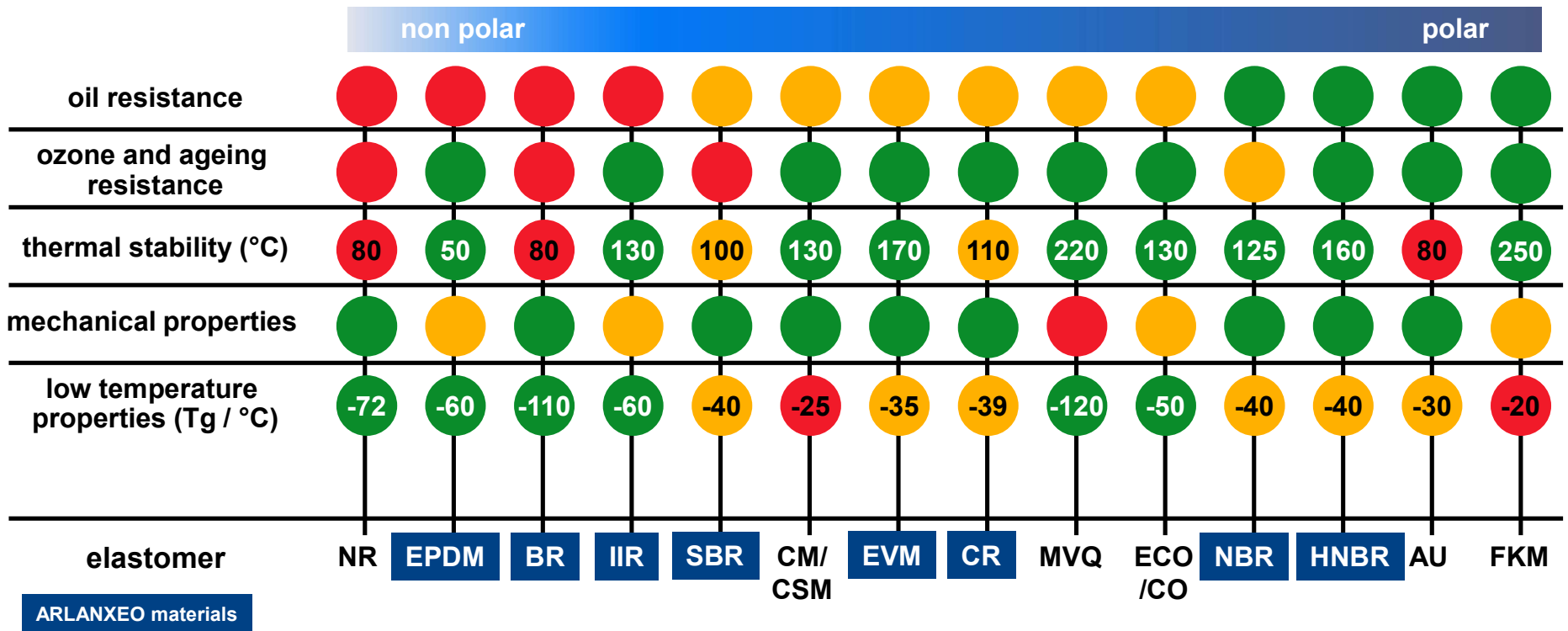
- Total rubber market: ~26.000 kt
 - 60% Tire related
 - 40% Non-tire related
- Typical non-tire industries
 - Automotive/Mobility
 - Oil Additives
 - Plastic Modification
 - Industrial / Machinery
 - Energy / Oil & Gas
 - Consumer Goods
 - Adhesives



Source: Company estimates (2017 data)

Elastomer map of properties

Clear polymer – application combinations but for future, new applications ...

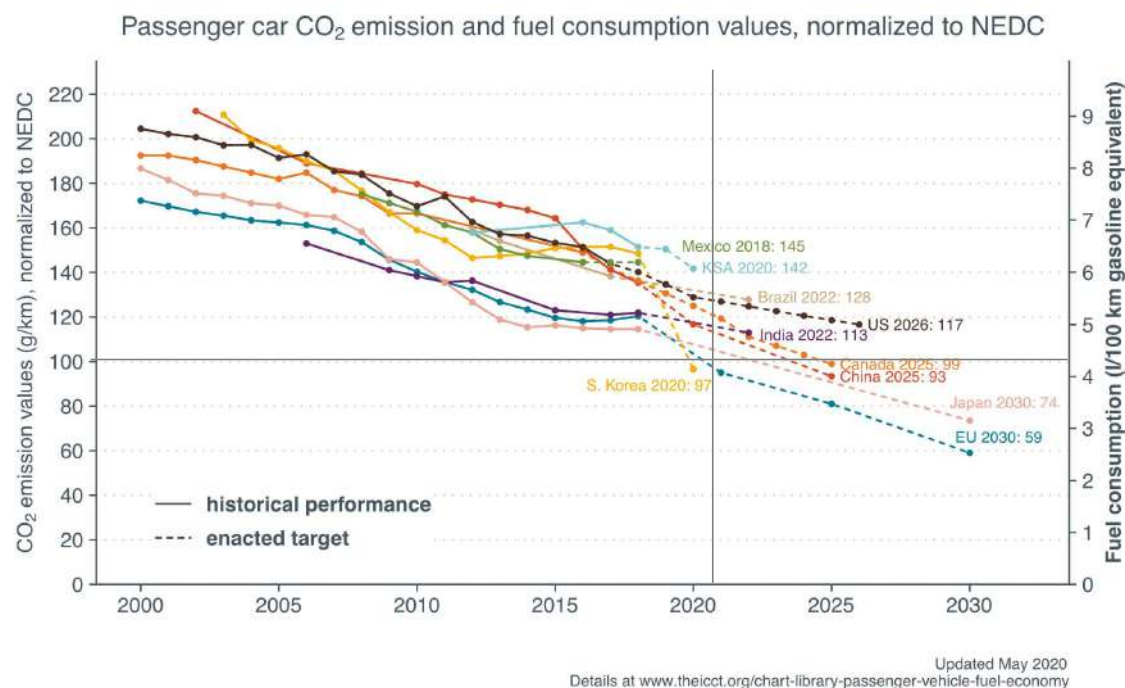


Source: Company estimates

Drive Technology will change...



Derived from the global goals, federal regulation has put strict targets in place for CO₂ emissions in transportation



EU with very ambitious proposed targets until 2030; 2021 target 95 g/km!

“From 2021 on, the average emissions of all newly registered cars of a manufacturer will have to be below the target.”*

US with less ambitious regulation, reflecting different policies by every state

China with average targets

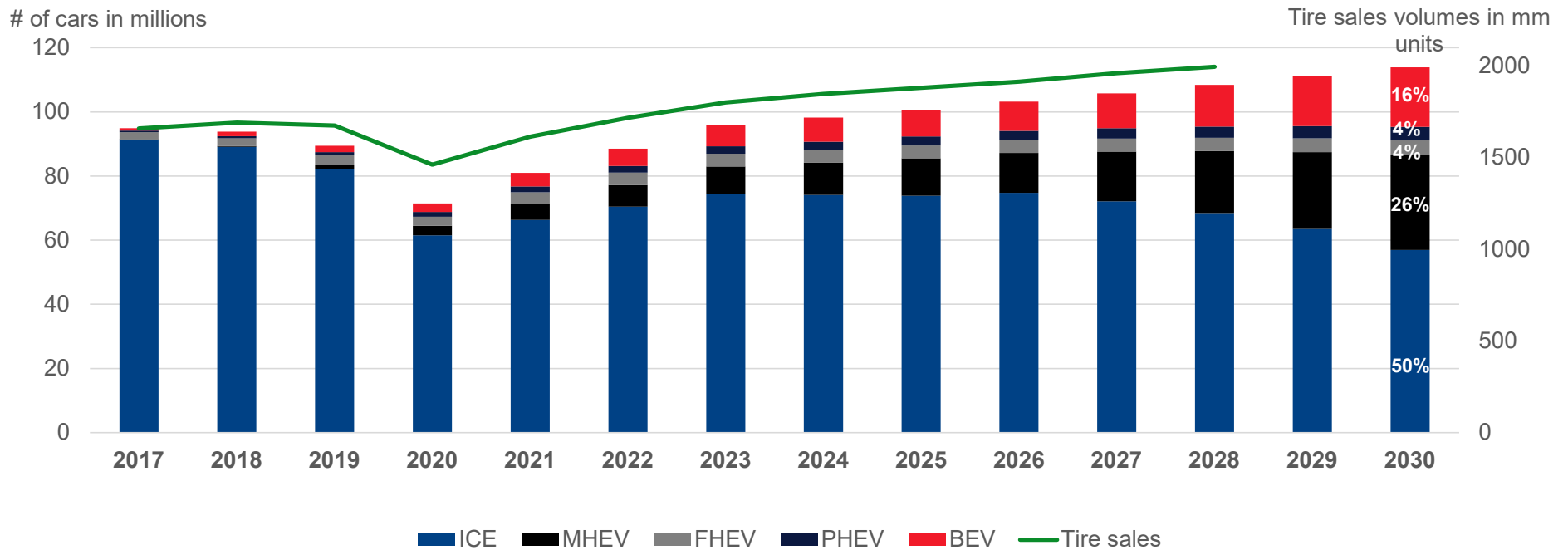
All regulation targets are based on/converted to the NEDC test procedure which is being replaced by WLTP**

* https://ec.europa.eu/clima/policies/transport/vehicles/cars_en

** Test methods for CO₂ emissions: NEDC: New European Driving Cycle, 1997 and WLTP: Worldwide harmonized Light vehicles Test Procedure, 2017

Market trend in passenger cars and tires 2020-2028

Alternative, electrified drive trains will dominate the market growth. Continuously growing requirements for performance tires. But will the tailpipe emission targets be met?

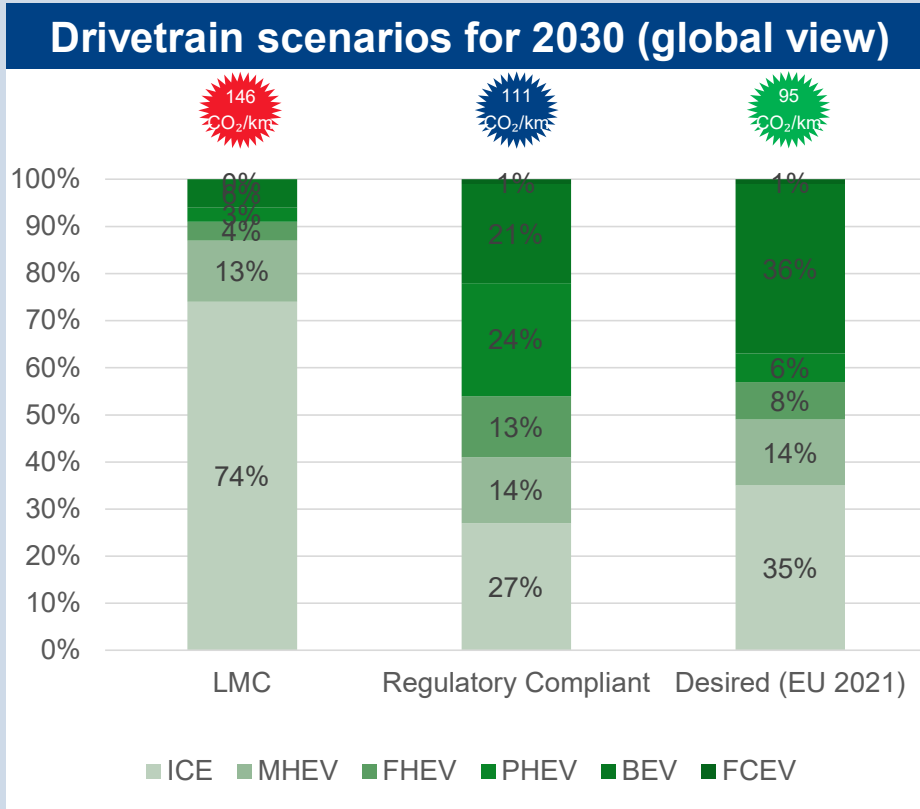


ICE - internal combustion engine, BEV - battery electric vehicle, HEVs - hybrid electric vehicles (M = mild, F = Full, P = Plug-in)

Source: LMC Automotive; LMC scenario Q2 2019 COVID adapted; LMC Tire & Rubber.



GLOBALLY, an equal distribution of drivetrains in 2030 can be expected, with a total share of produced ICE's between 91% - 57%*

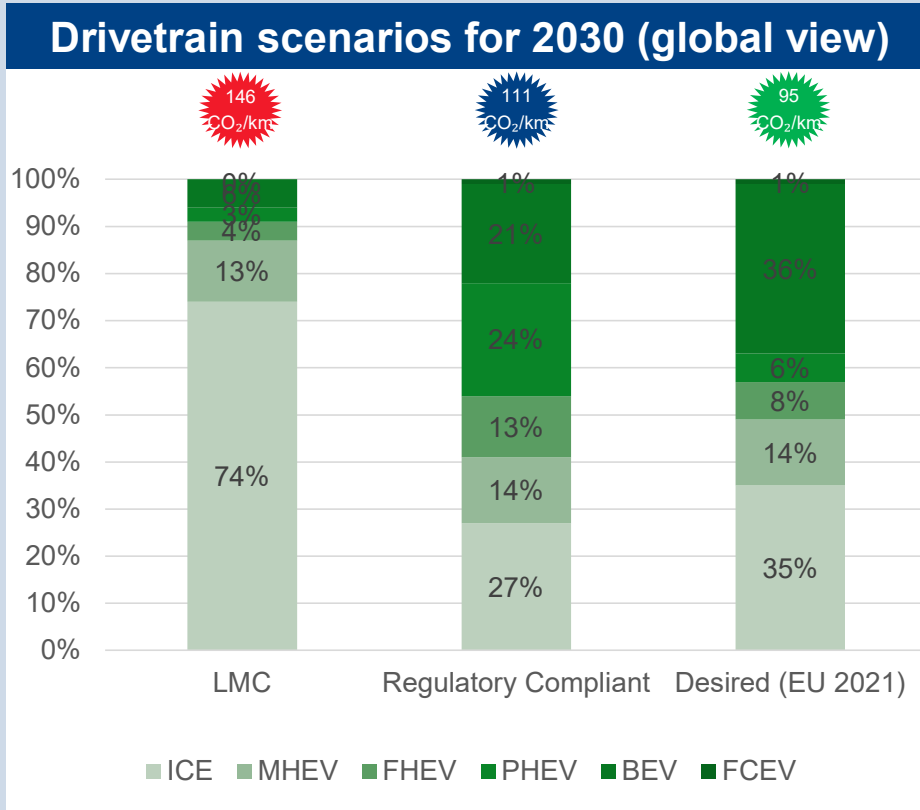


- ### Change over time
- Share of (optimized) ICE will decrease dramatically
 - Increase of MHEV/FHEV to meet the environmental targets, bridge the gap between ICE and BEV, to increase consumer acceptance
 - PHEV/BEV share will increase, as battery costs decrease
 - FCEV share is expected to increase beyond 2030, as restricted targets will be set. However targets currently unknown

*ICE share= ICE + MHEV + FHEV

*Source: ARLANXEO estimates based various market information (LMC, McKinsey), 2018

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OEM announcements

VW Announces New Battery Tech, End Of Combustion Engines For Audi

Volvo Commits To Radically Reducing Carbon Emissions Starting With The XC40 Recharge

Porsche aims for balance sheet CO2 neutrality in 2030

Exhibit 8
Capital expenditures for BEVs will probably double over the next five years, while investments in other vehicles decline.

Cumulative global model-related capital expenditures (capex), \$ billion

Period	Non-battery electric vehicles (BEVs)	BEV	Total
2014-19	~330 (85%)	~60 (15%)	390
2020-25	~280 (70%)	~120 (30%)	400

100% increase in BEV capex from 2014-19 to 2020-25.

600 EV models
will be launched in the next 5 years, and more than 450 will be BEVs

~\$120 billion
of global BEV-related capex through 2025

25-30%
of OEM capex will be BEV related

Questions: How has the coronavirus (COVID-19) situation affected your company's production (operator) capacity? How has the coronavirus (COVID-19) situation affected demand for your company's products/services?
Source: McKinsey COVID-19 EGB Decision-Maker Pulse #2, April 20-27, 2020 (p. 6/7)

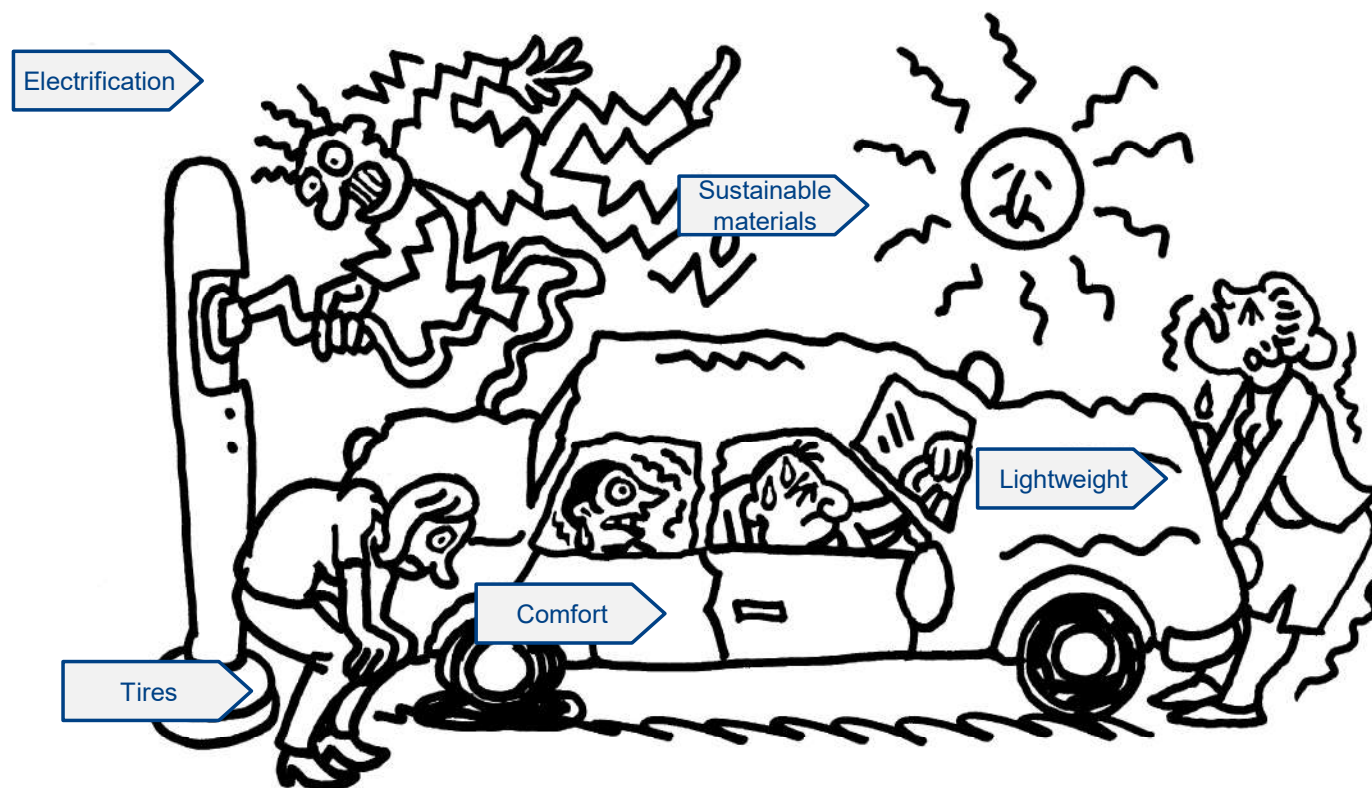
Sources:

- [VW Announces New Battery Tech, End Of Combustion Engines For Audi \(forbes.com\)](#)
- [Volvo Commits To Radically Reducing Carbon Emissions Starting With The XC40 Recharge \(forbes.com\)](#)
- [Porsche aims for balance sheet CO2 neutrality in 2030 - Porsche AG](#)
- [From no mobility to future mobility: Where COVID-19 has accelerated change \(mckinsey.com\)](#)

*ICE share= ICE + MHEV + FHEV

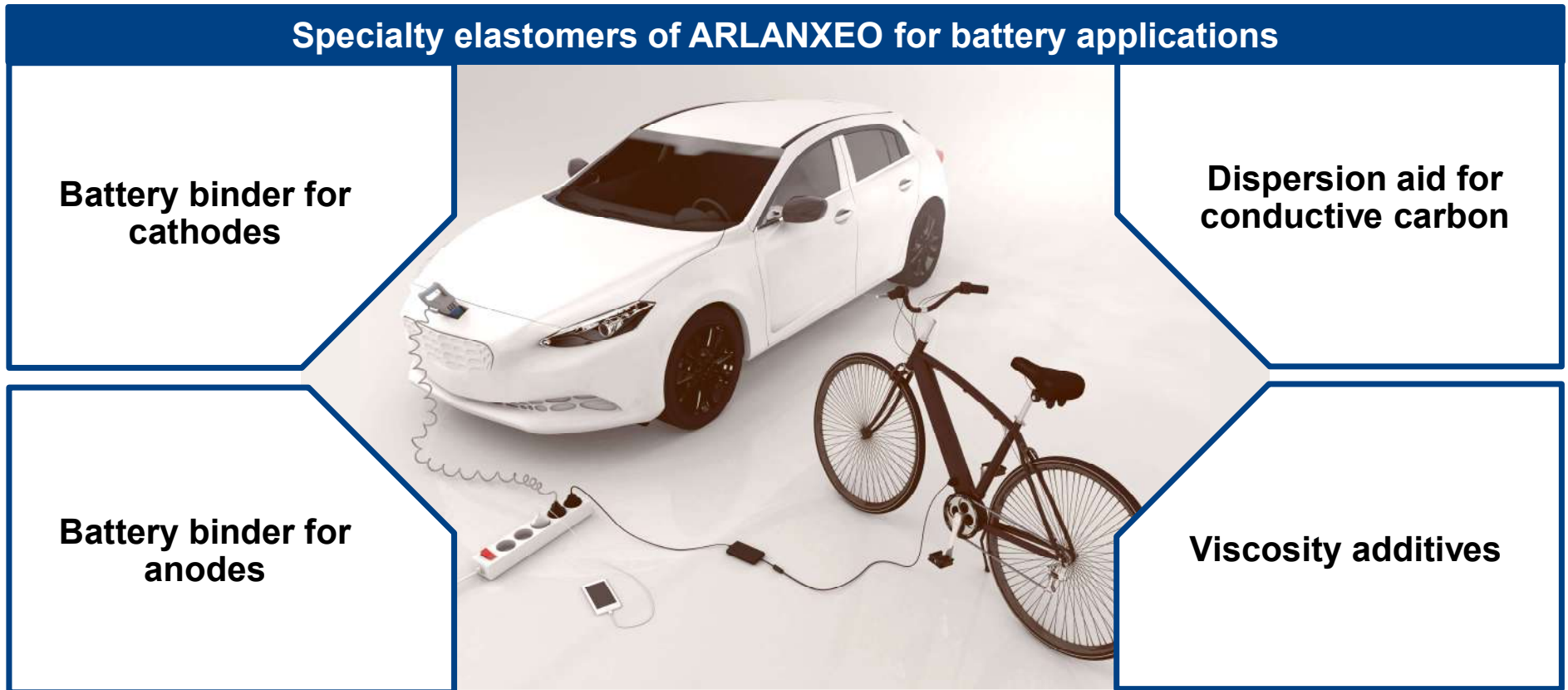
*Source: ARLANXEO estimates based various market information (LMC, McKinsey), 2018

ARLANXEO Identifies 5 Challenges



1. Electrification

Development of high-performance rubbers for batteries



1. Electrification

Development of high-performance rubbers for batteries

Thermal Management

- Heating and cooling of battery system needed to enable long battery life and optimal power
- Special coolants developed for battery thermal management
- Thermal conductivity for seals in battery heat disposal

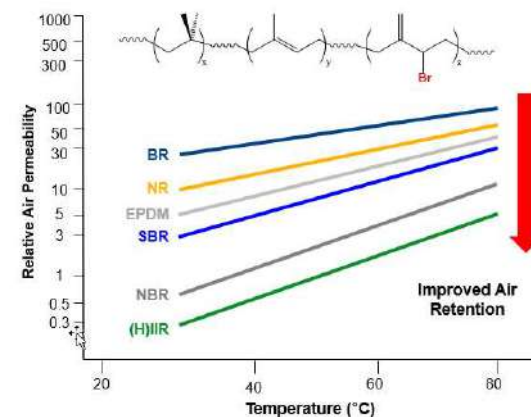


Cables and Sensors

- New cables technology needed not only for the powertrain, but: periphery devices (e.g., charger stations)
- Aggregates like AC or Coolant pumps are no longer driven by a belt but each with a separate electric motor
- Flame retardant cables, grommets, plugs and sockets are needed to prevent spread of fire in case of short circuit or overheating (Halogen free)
- Effective Electro Magnetic Shielding (EMS) is crucial
- Electrically conductive housings, gaskets and mounts are needed

Hydrogen fuel cell

- Sealing materials require excellent H₂ gas permeation resistance and moderate thermal resistance
- Thickness, polymer chain mobility, filler type*



Reference: Elastomer Sealing Performance in Hydrogen Fuel Cells. Kevin Kulbaba c.s., presented at the fall 196th Technical Meeting of the Rubber Division, American Chemical Society Cleveland, OH, October 8 - 10, 2019

2. In future, the most critical tire properties likely to relate to safety and environmental aspects

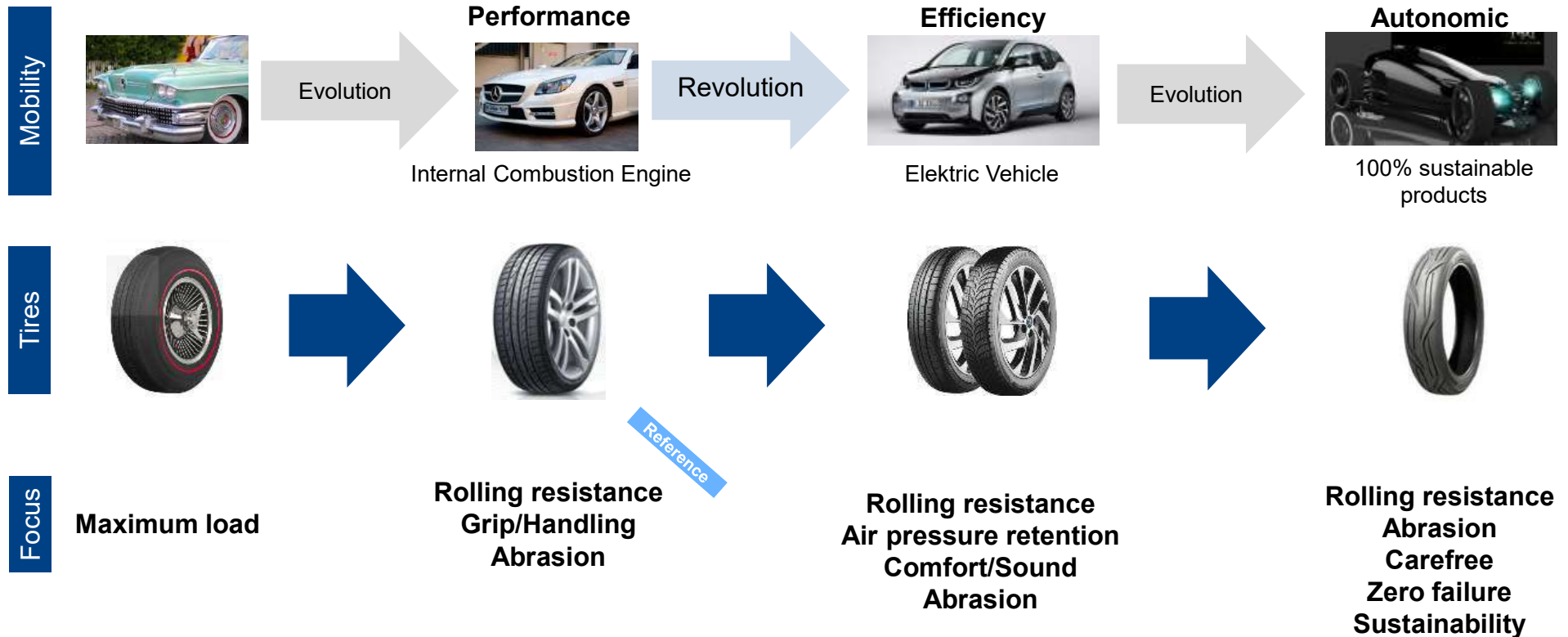


Image sources: <https://pxhere.com/en/photo/1382713>, <https://pxhere.com/en/photo/593617>, https://de.wikipedia.org/wiki/Datei:BMW_i3_Electric_Test_Vehicle_0074.jpg,

BRIDGESTONE, ARLANXEO AND SOLVAY LAUNCH TECHSYN TO GIVE TYRES UNRIVALLED STRENGTH AND ENVIRONMENTAL PERFORMANCE



Reference: press release [Bridgestone, ARLANXEO and Solvay launch TECHSYN | ARLANXEO Website / Customer Portal](#)

3+4. Lightweight and Comfort (NVH – Noise and Vibration)

Low Density/Compactness

- Trend dense to micro dense dynamic weather strip seals
- Increased usage TPE-V, TPE-S in static weather strip seals and thermal management systems
- More compact, smaller diameter seals and reinforced hoses



Thermoplastic Modification

- Replacement metal parts by plastic or composites materials
- Need for impact resistance
- Modification with rubber for high toughness
- 2K Molding: Need for direct bonding of rubber to plastic
- More complex injection molded shapes (3-D printing)



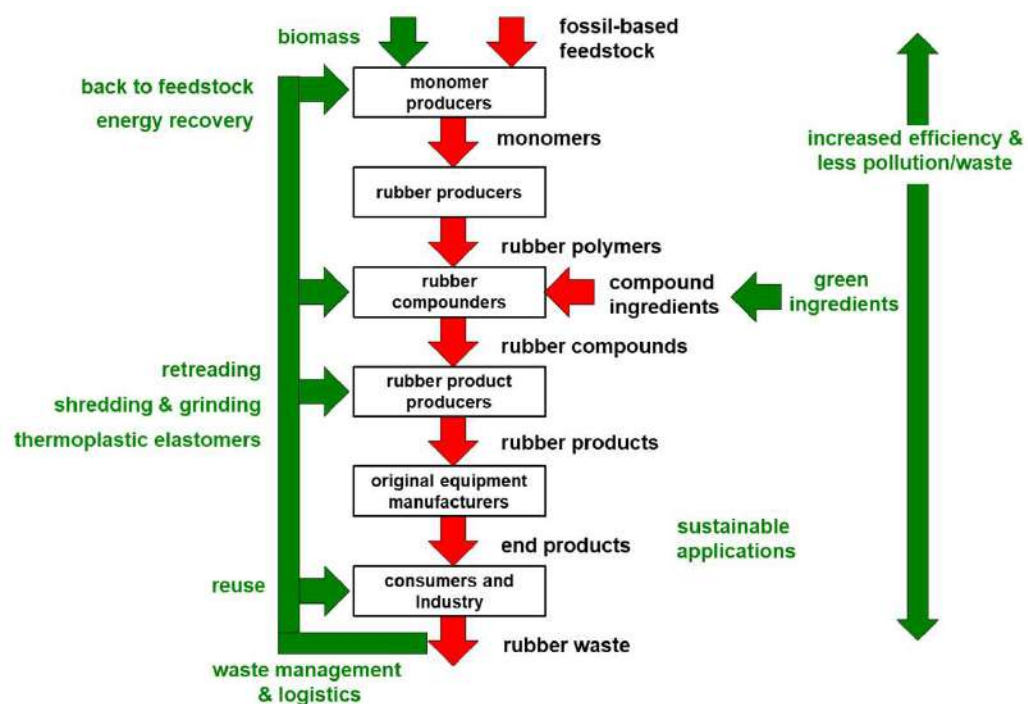
Noise and Vibration

- More and thicker plus lower density sealing systems for lightweight and reduction of surrounding noise, since electric engines are more quiet
- ICEV/HEV: OEMs are increasing their AVS requirements, longer life and higher under the hood temperatures
- BEV/FCEV:
 - Performance mounts: Much different frequency range
 - Height adjustable suspension using air springs to lower the car esp. at higher speeds, to reduce aerodynamic drag

Pictures from A2Mac1

5. Targets for the use of Sustainable materials by OEMs

Well-known adage: Re-use, Reduce, Recycle



Rubber Value Chain (reference: Handbook of Synthetic Rubber, ARLANXEO, 2021)

Circular Developments

- ~~Rubber waste~~
- ~~Back to energy~~
- Re-use in new rubber application (e.g., scrapped tires in dock vendors)
- Re-process for new rubber application (e.g., retreading tires)
- Recycle of rubber compound (after grinding, devulcanizing, pyrolysis black)
- Back to monomers (feedstock)
- Use of bio-monomers and bio-ingredients like oil and fillers

Innovation is essential for Sustainable Development

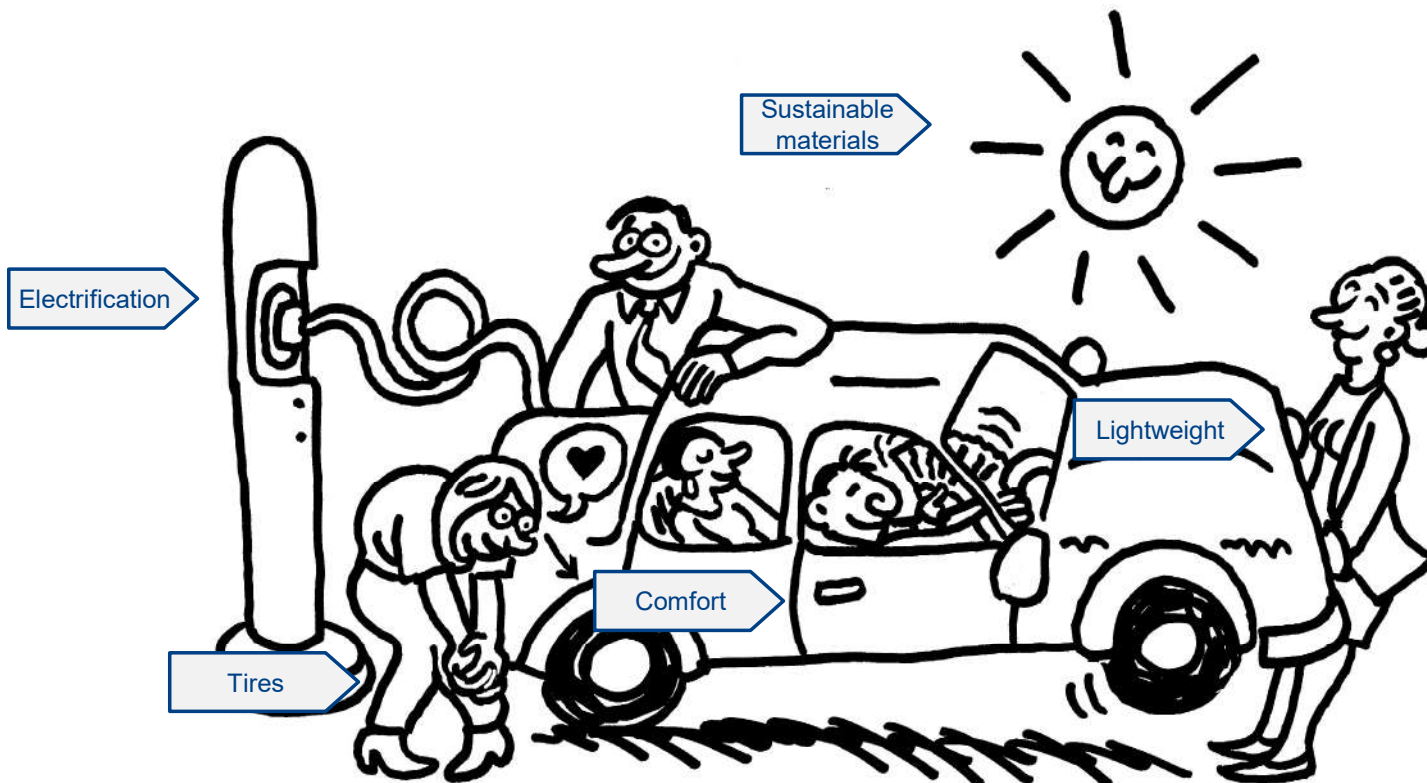
ARLANXEO's Elastomer Roadmap for New Mobility

Focus Areas

1. Electrification
2. Tires
3. Lightweight
4. Comfort
5. Sustainable materials



Creating Lots of Opportunities for New Mobility



Questions & Answers



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