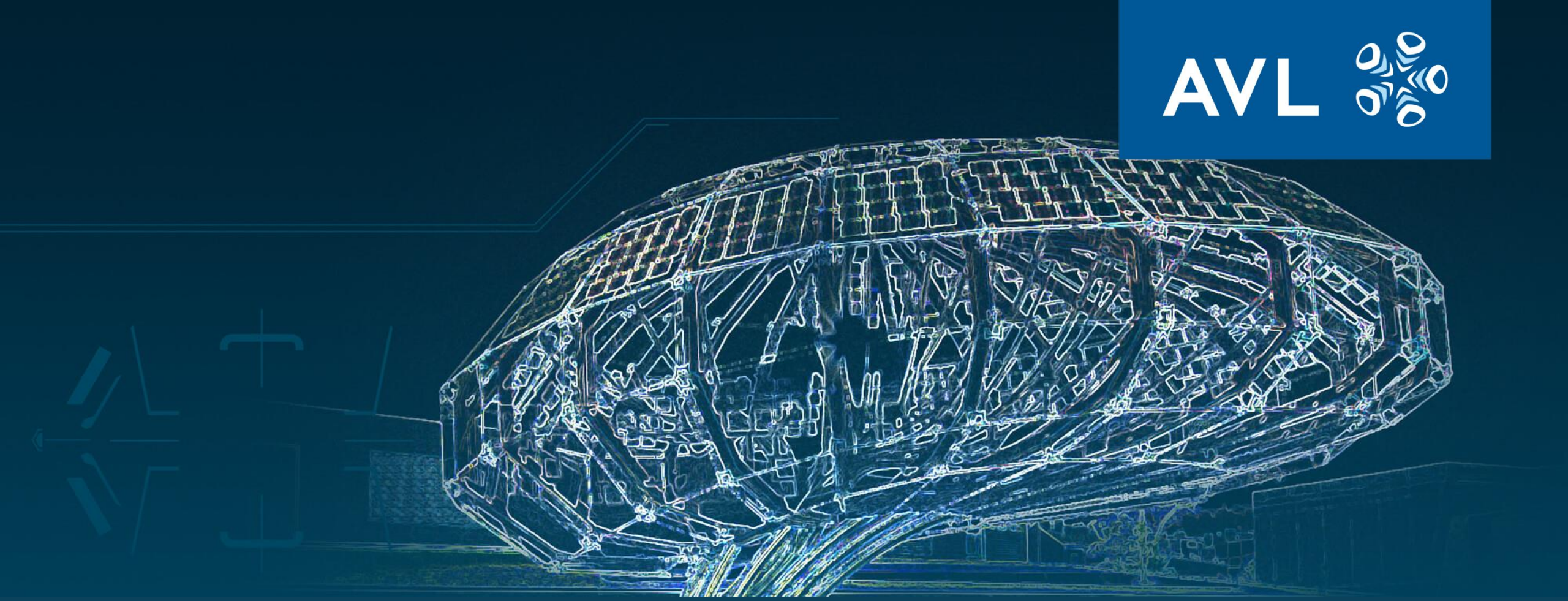


Welcome to the 2018 Product Development in Motion!

Peter Gillbrand

Vice President
AVL Instrumentation and Test Systems Europe

Solutions for all CUSTOMER SEGMENTS


Passenger Cars


2-Wheelers


Racing


Construction


Agriculture


Commercial Vehicle


Locomotive

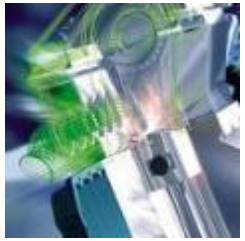

Marine


Power Plants


Aviation

Powertrain Engineering

Development Platform



Simulation & Testing

Enterprise Development Automotive

RESEARCH 10%
of turnover in-house R&D

INNOVATION 1500
granted patents

STAFF

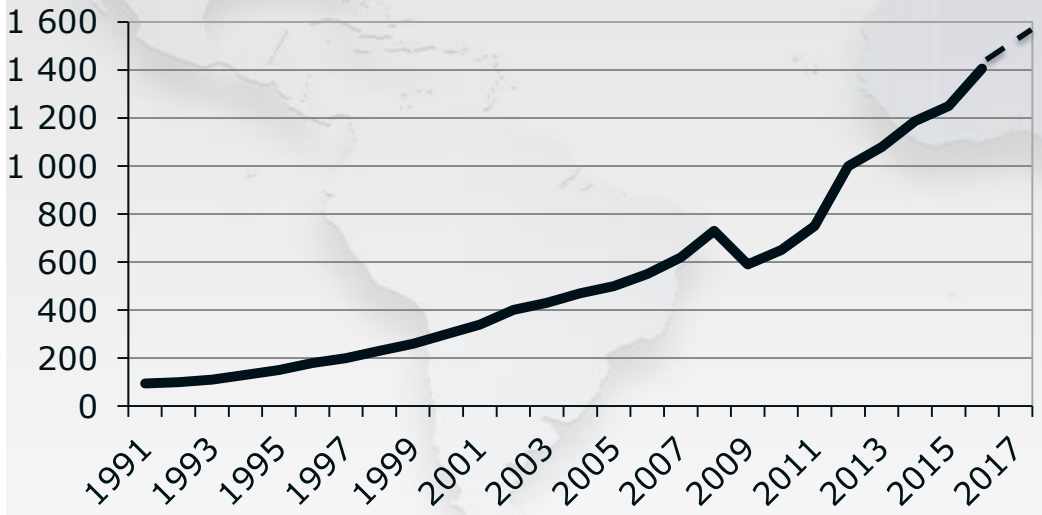
8.600 employees

65% engineers and scientists

GLOBAL FOOTPRINT

30 engineering locations
- **>220** testbeds
- Global customer support network

GROWTH



SALES

1995:
0.15 billion €

2016:
1.40 billion €

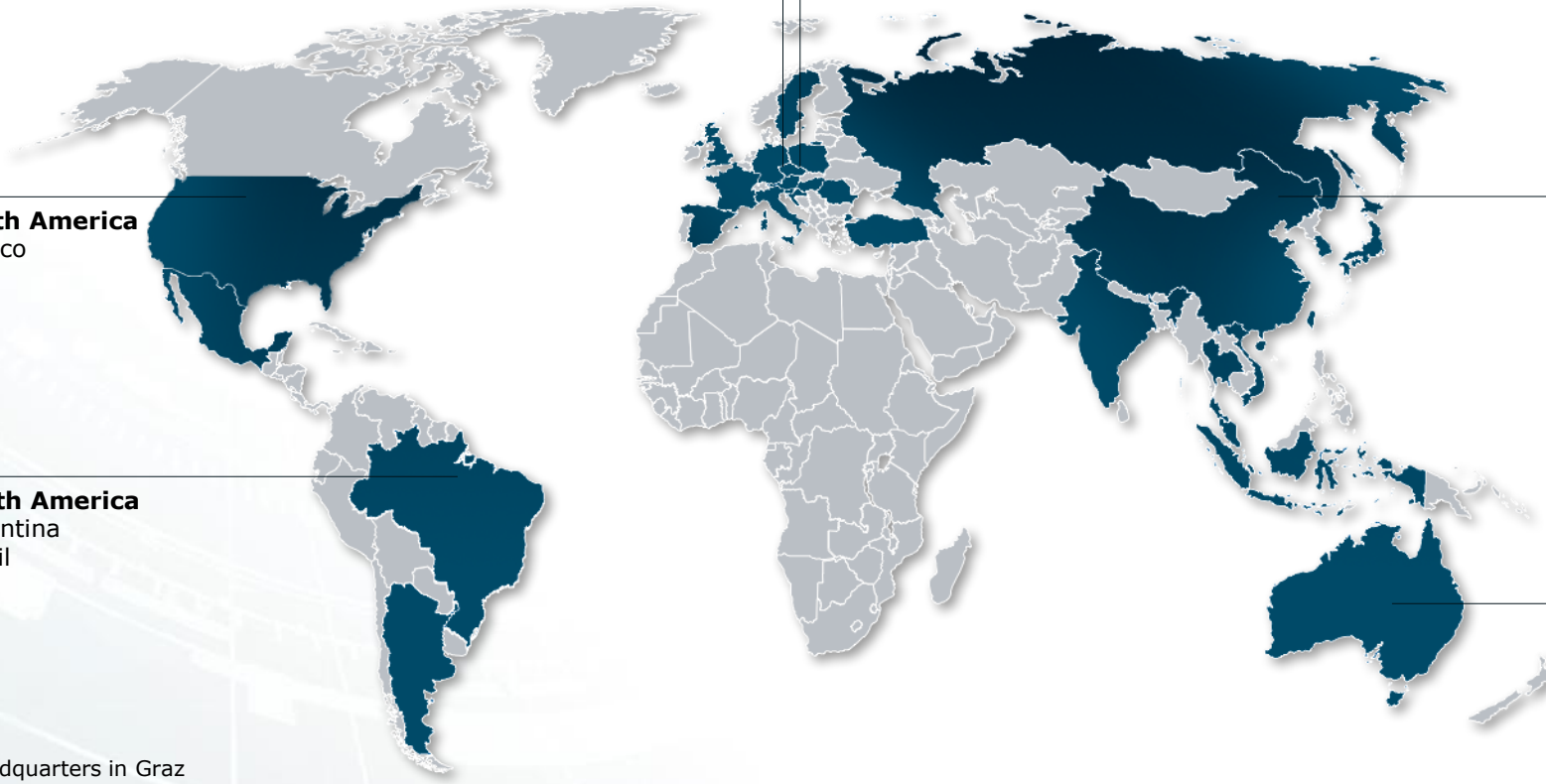
2017:
1.52 billion €

EXPERIENCE
65 years !

Privatley Owned

AVL – A Global Partner

Europe
Austria*
Croatia
Czech Republic
France
Germany
Great Britain
Hungary
Italy
Poland
Romania
Russia
Slovenia
Spain
Sweden
Turkey



North America
Mexico
USA

South America
Argentina
Brazil

Asia
China
India
Indonesia
Japan
Korea
Malaysia
Taiwan
Thailand
Vietnam

Australia

*Headquarters in Graz


FUTURE
PRESENT
PAST

10 years

a long or short period of time?

Idea: Lars Thomsen – Future Matters AG

16 September 2008

Idea: Lars Thomsen – Future Matters AG

Idea: Lars Thomsen – Future Matters AG

A week

a long or a short period of time?

Idea: Lars Thomsen – Future Matters AG

10 years in weeks

10 years * 52 weeks/year = 520 weeks

Idea: Lars Thomsen – Future Matters AG

16 September 2008

532 Weeks ago!

Idea: Lars Thomsen – Future Matters AG

Four (plus one) Mega Trend

C-A-S-E + E

Connected – All vehicles will be connected, all the time

Autonomous – Vehicles will become more and more autonomous

Sharing – Mobility, A to B, will not require vehicle ownership

Electric – vehicles will be increasingly electrified

Emissions / **E**nergy Consumption – well to wheel perspective

Stora Bildagen 2017 - Christian Senger Volkswagen Head of Product Line e-Mobility:

WE ALWAYS BELIEVED IN MOVING PEOPLE FORWARD.

We have always been the driver of progress and moved societies forward.

Mass mobility until 80s.
Democratization of auto-mobility.

MOVING PEOPLE.

Individual mobility until 90s to date.
Quality-based price premium.

MOVING PEOPLE UPWARDS.

Mobility ecosystem 2025.
New value proposition in a connected world.

MOVING PEOPLE FORWARD.

VW e-Mobility

Challenges for Future Powertrains

Short Term

CO_2 Fleet

Affordability

Local Imission

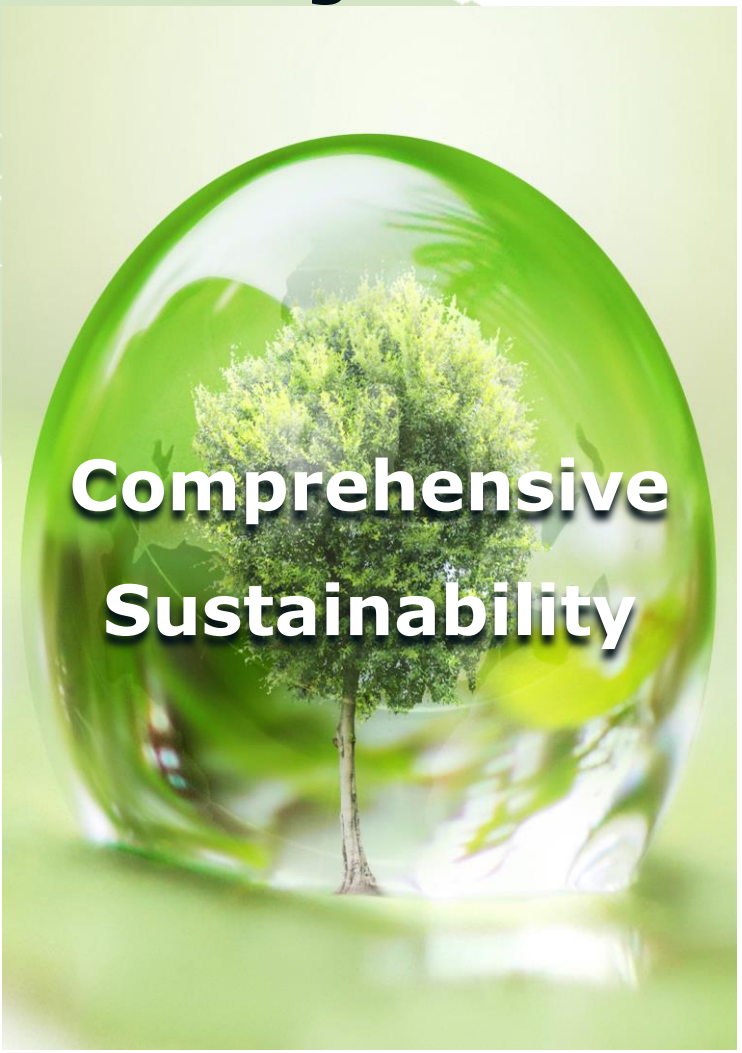
Mid Term

Lifecycle Assessment

New Mobility

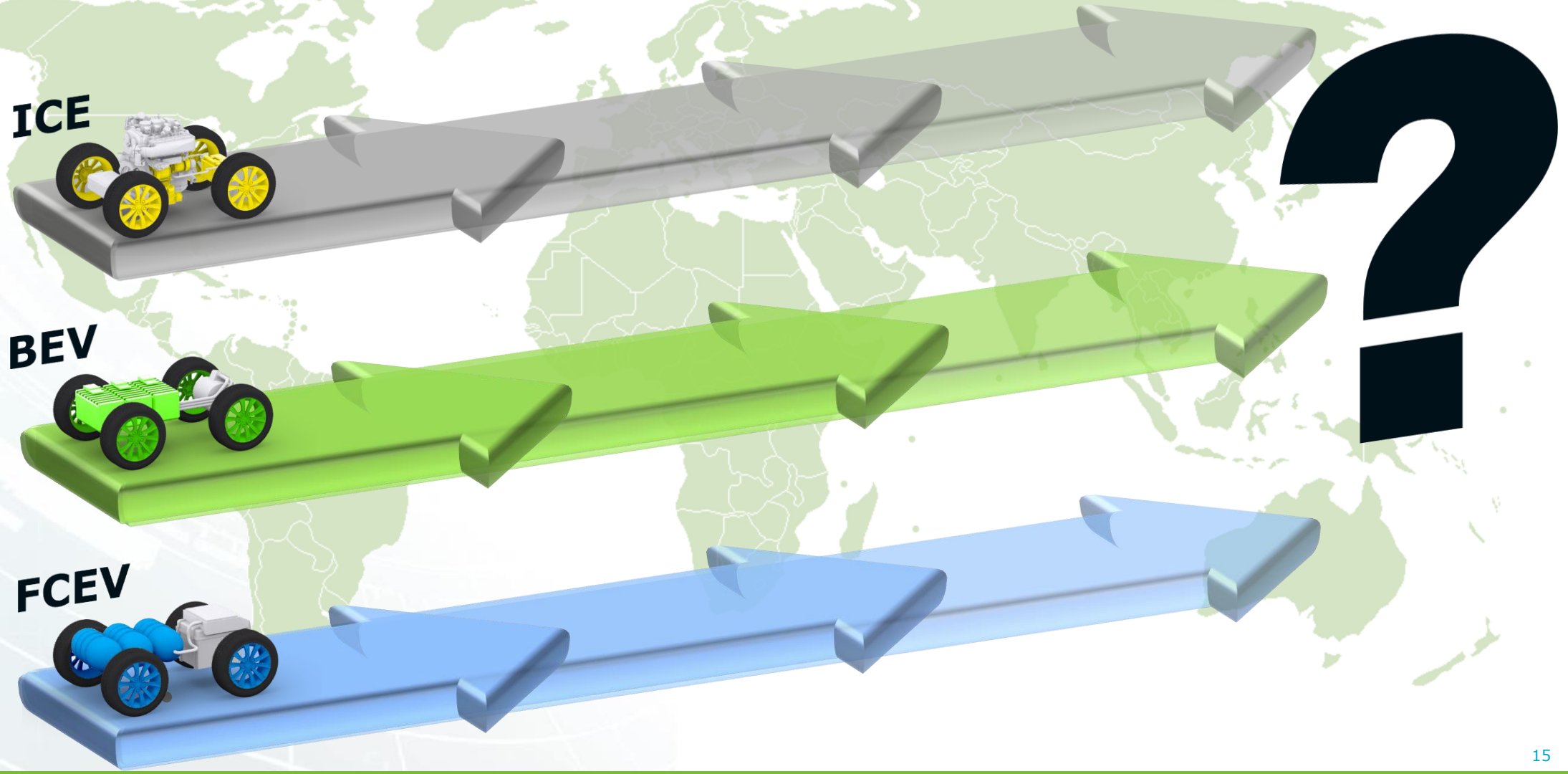
Zero Impact Emission

Long Term



Comprehensive Sustainability

Powertrain Competition



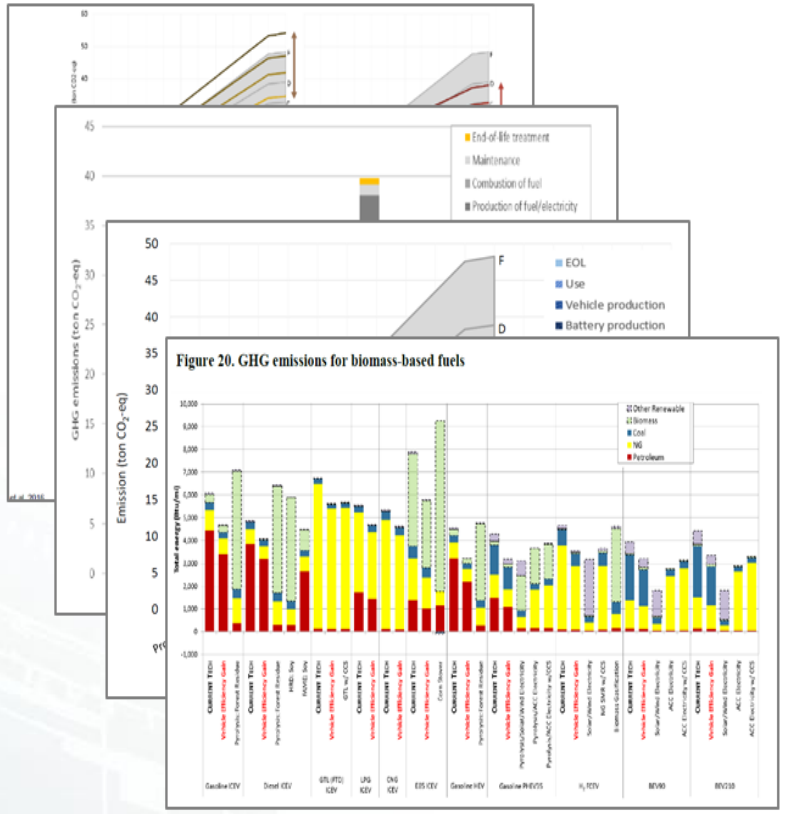

Lifecycle
Affordability
Fleet Renewal
Usage
PARIS 2015
2°
CO_2
Global Warming
Tank To Wheel
Well To Tank
Production Infrastructure Recycling

Lifecycle

Affordability

Fleet Renewal

Usage



Key Factors :

- Vehicle Mileage
- Real world fuel / energy consumption
- CO_2 of battery production
- Battery lifetime
- Re-use / Recycling
- Materials

Lifecycle

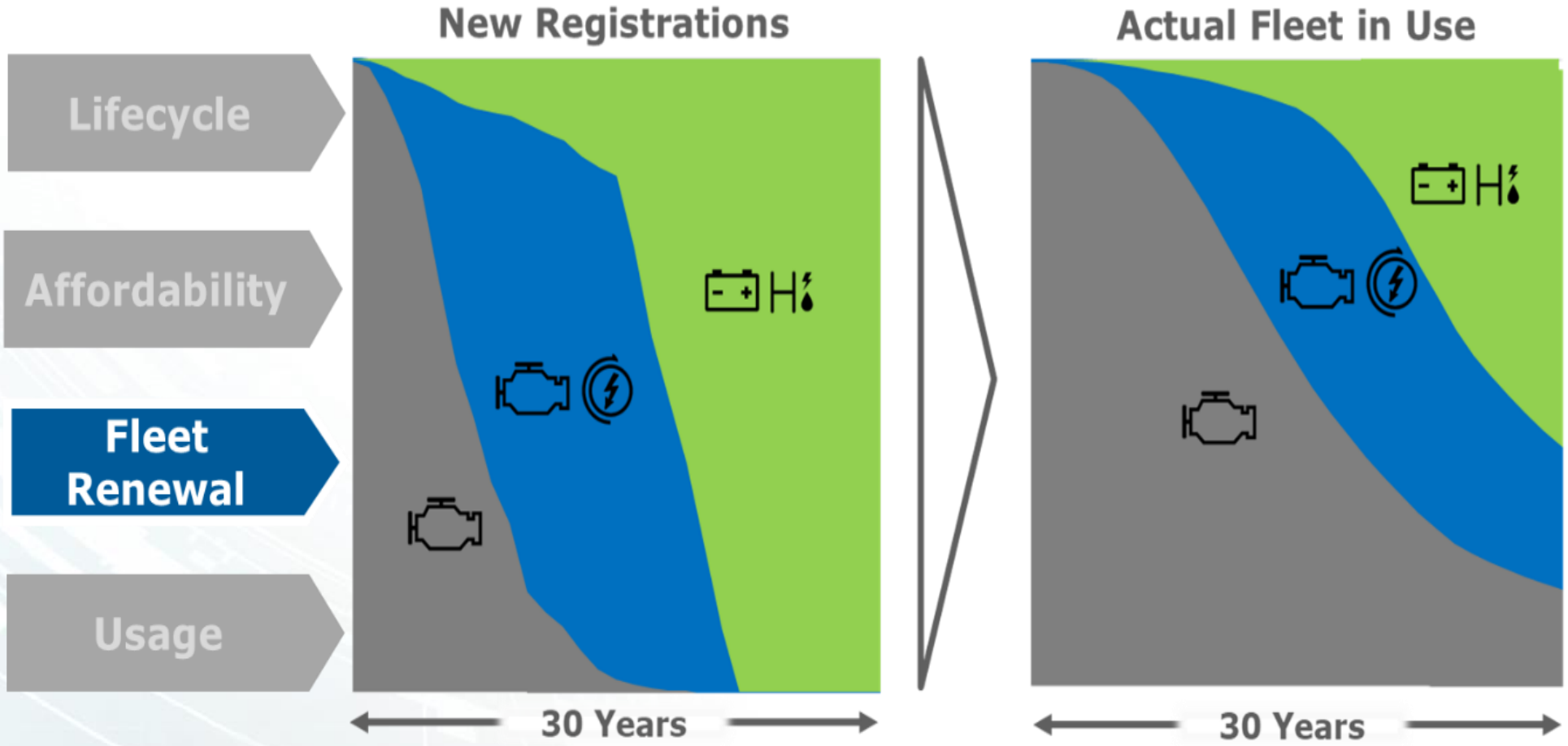
Affordability

Fleet Renewal

Usage

Key Factors :

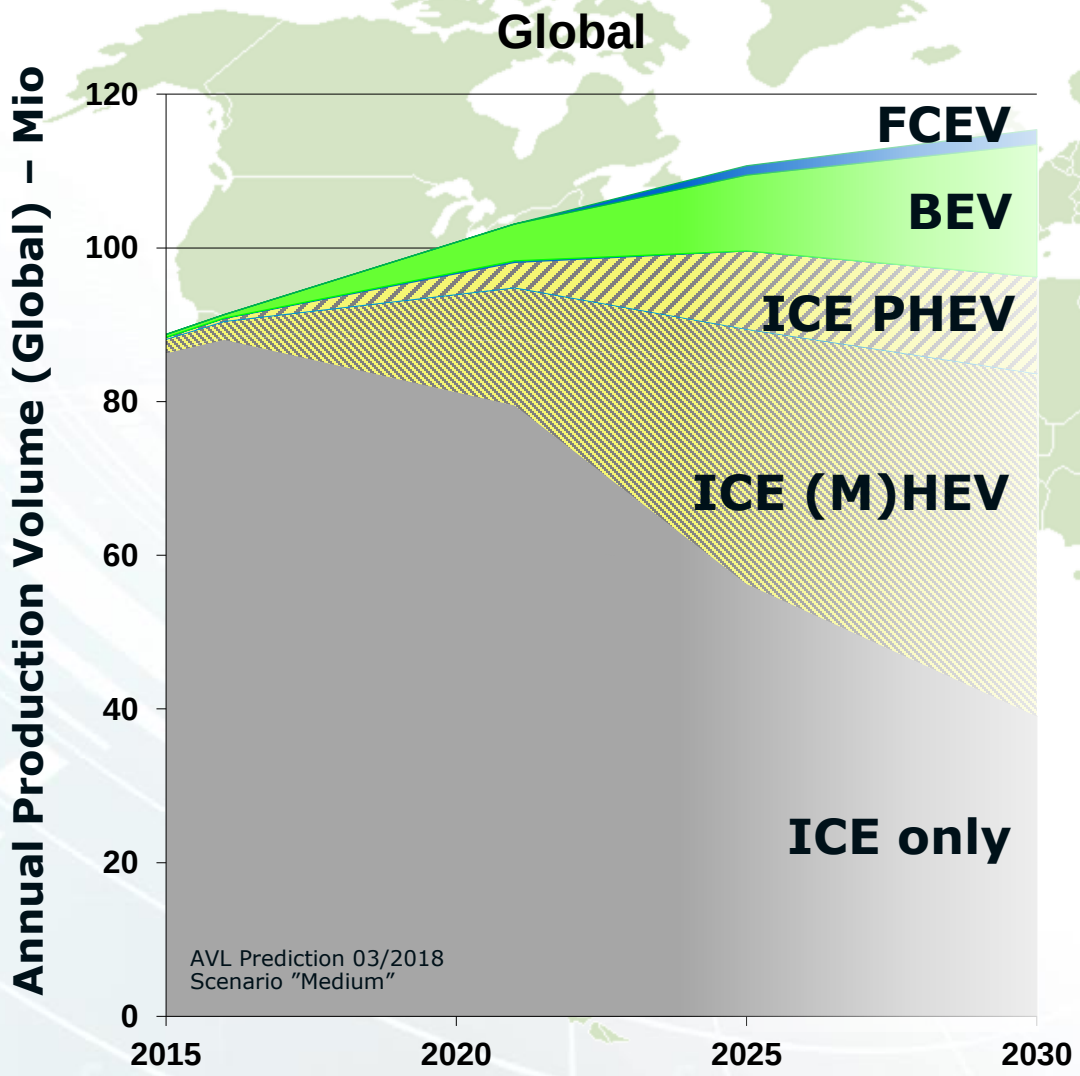
- Utilization of existing value chain
- Additional / replacement invest
- Industrialization / Processes
- Material cost / availability
- Infrastructure Invest
- Energy cost incl. tax


New Registrations
Actual Fleet in Use
Lifecycle
Affordability
Fleet Renewal
Usage
30 Years
30 Years

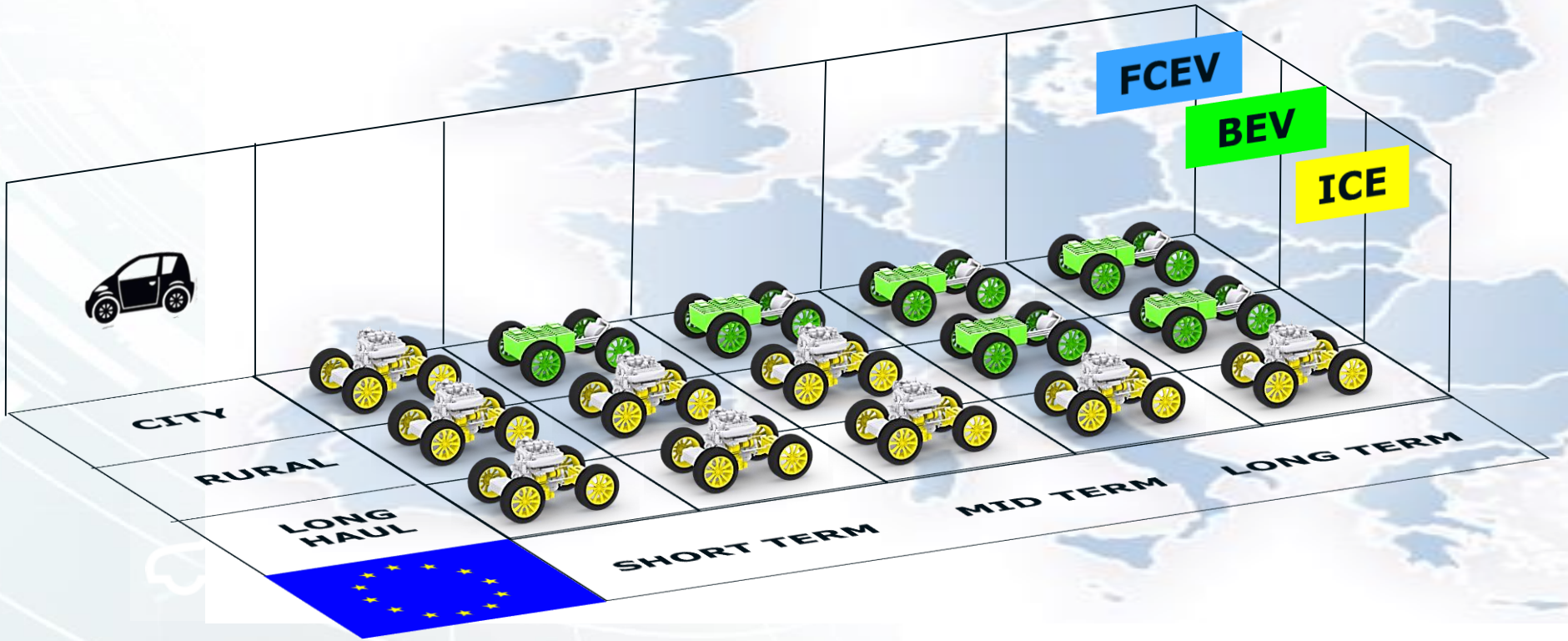
Key Factors :

- City vs. Long haul
- Private vs. commercial use
- Vehicle type
- Regional vs. Global
- Emerging vs. Mature Markets
- Energy Carrier

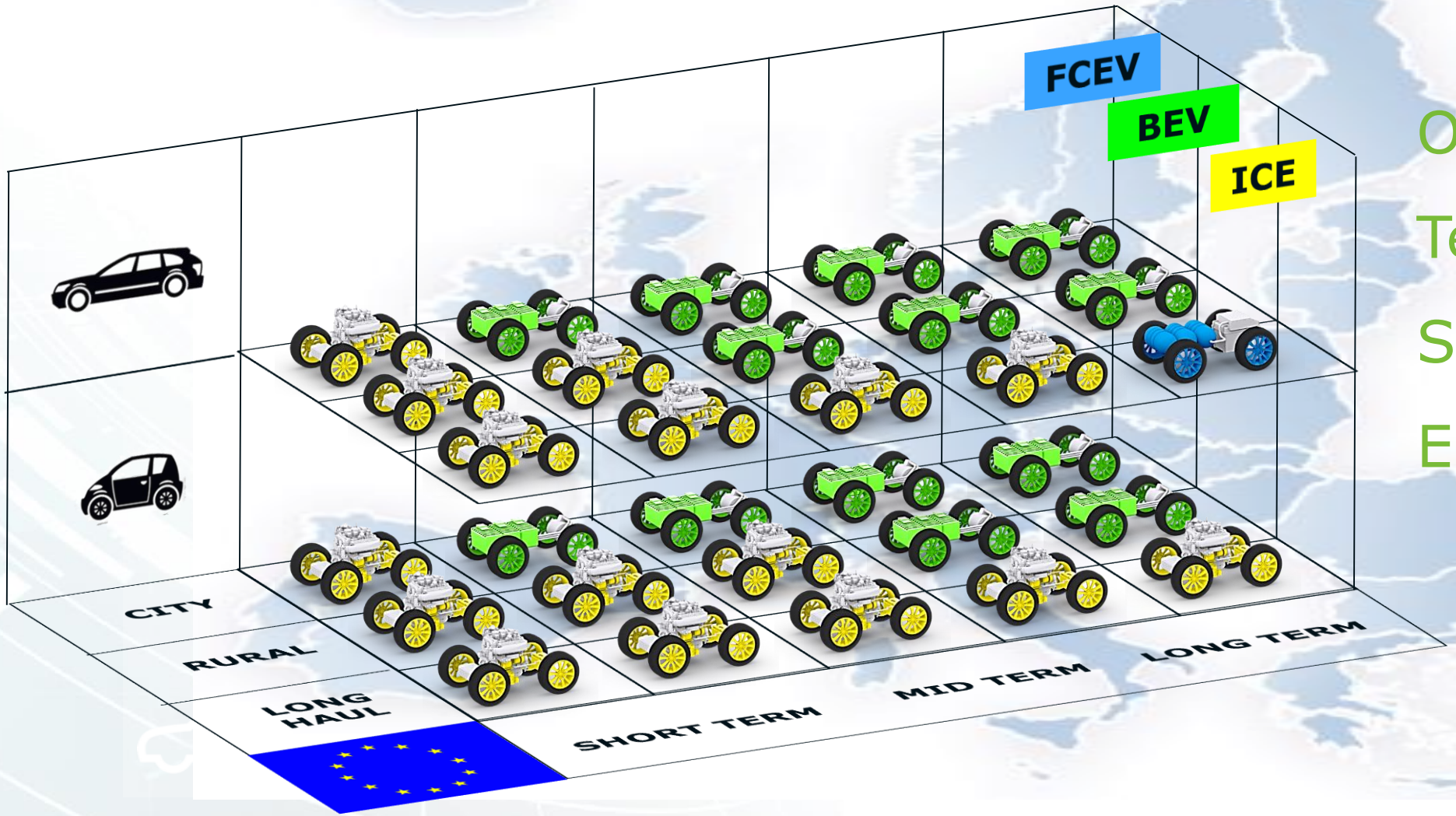
Global Technology Shares – One Potential Scenario



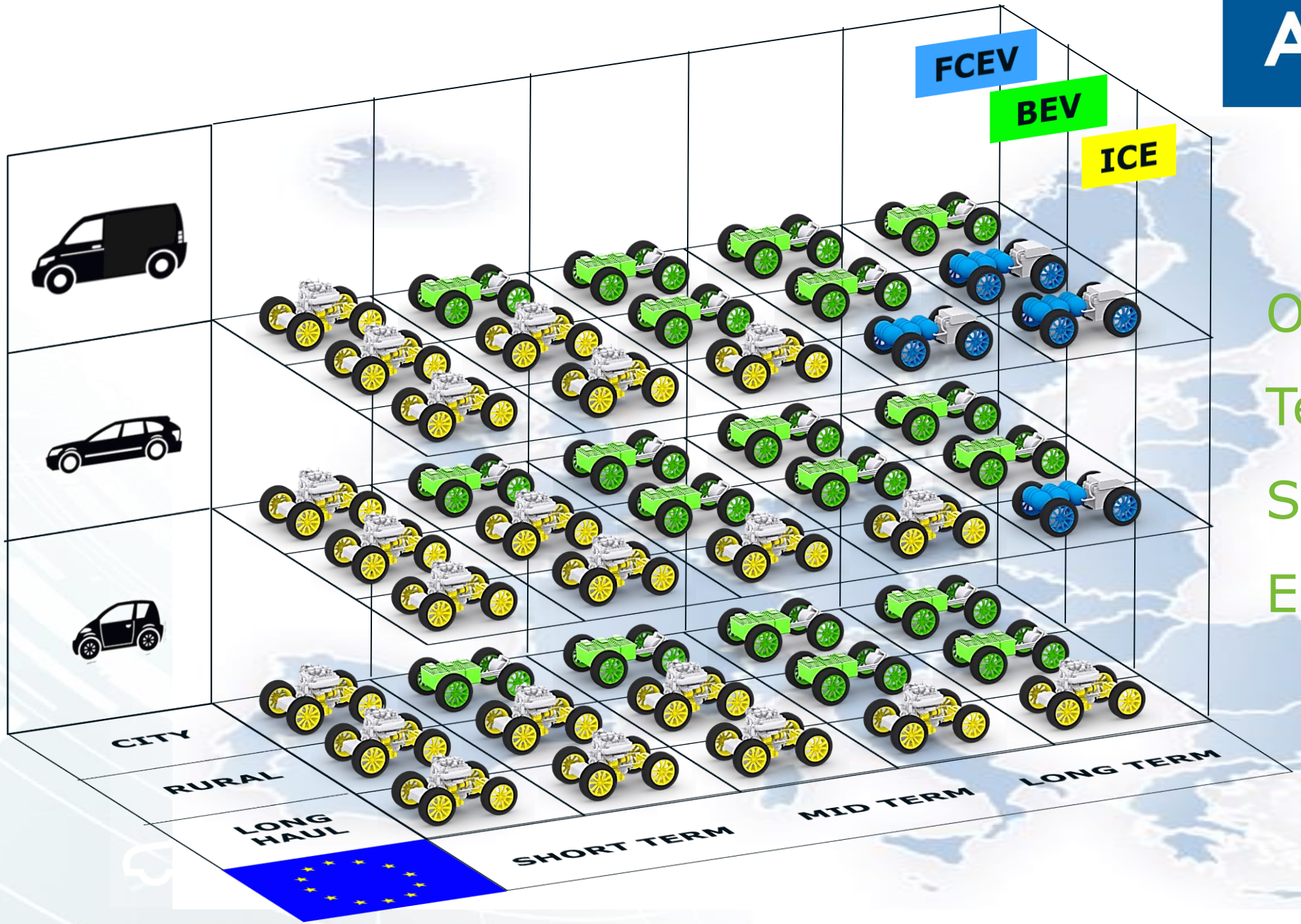
One possible Technology Scenario EUROPE



One possible Technology Scenario EUROPE

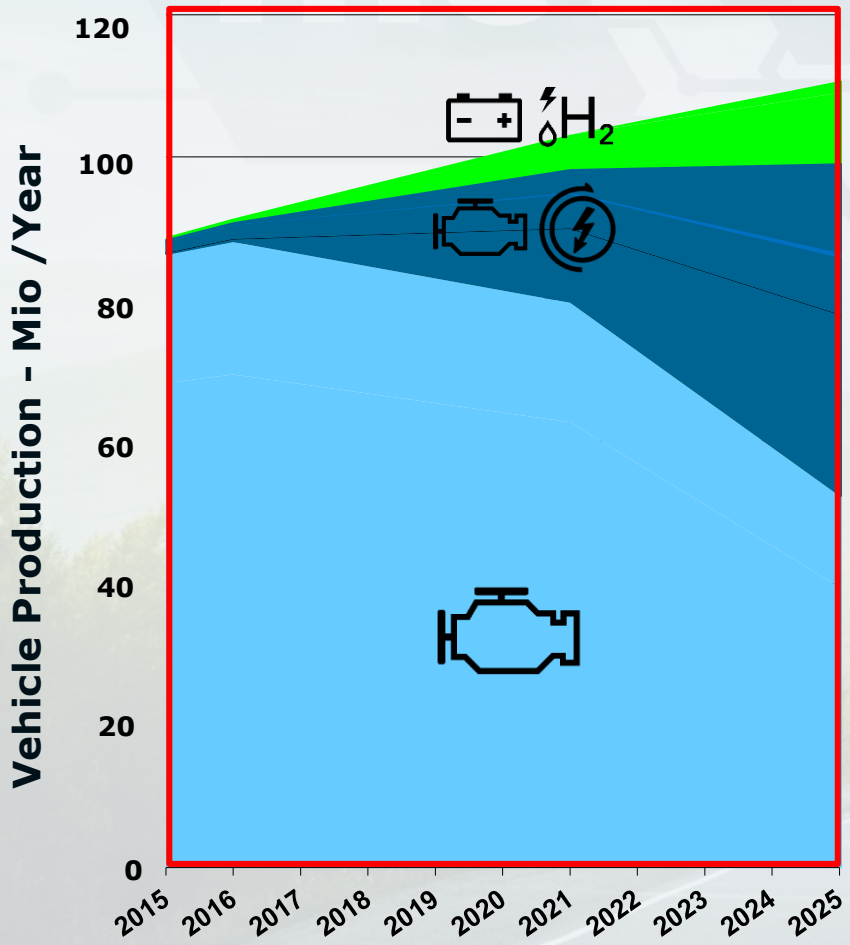


One possible Technology Scenario EUROPE



One possible Technology Scenario EUROPE

Mid Term Global Technology Forecast
Different Scenarios - LDV



AVL Prediction:

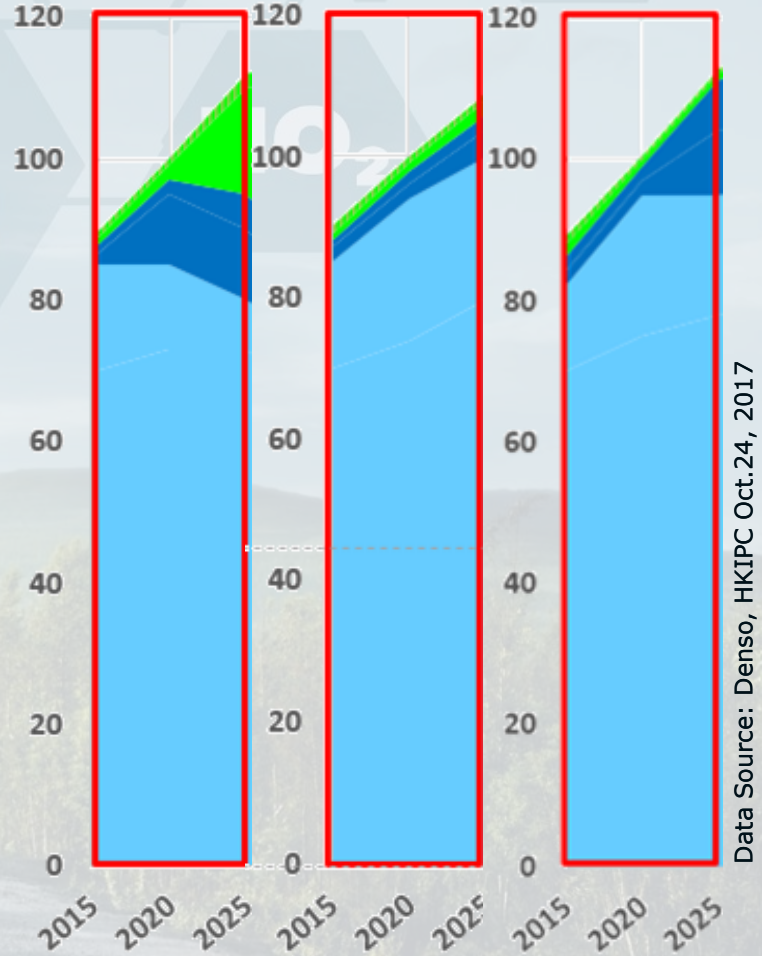
2025

50%

Electrified Vehicles

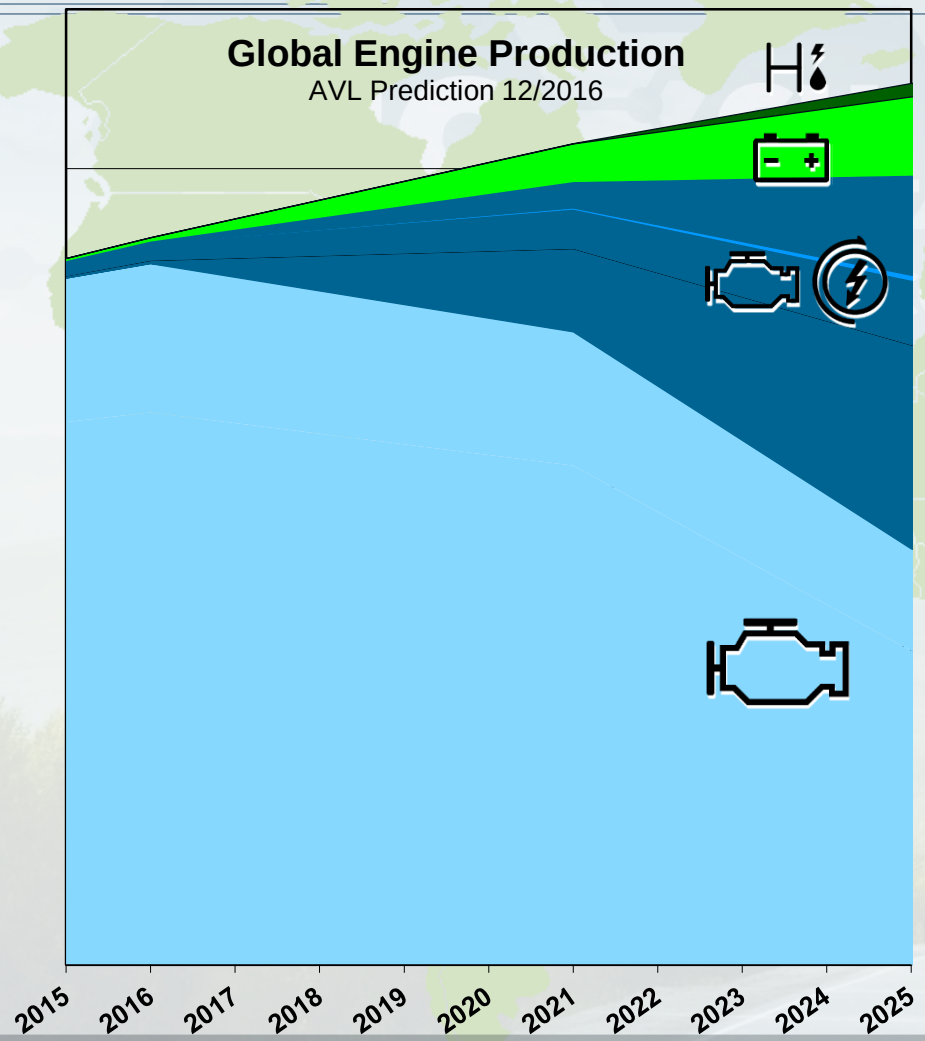
100 Mio

Internal Combustion Engines



Data Source: Denso, HKIPC Oct.24, 2017

TECHNOLOGIES IN THE NEXT 10 YEARS



2025

Fuel Cell: Challenges are e.g infrastructure & cost

BEV: Dependent on infrastructure, incentives and access restr.

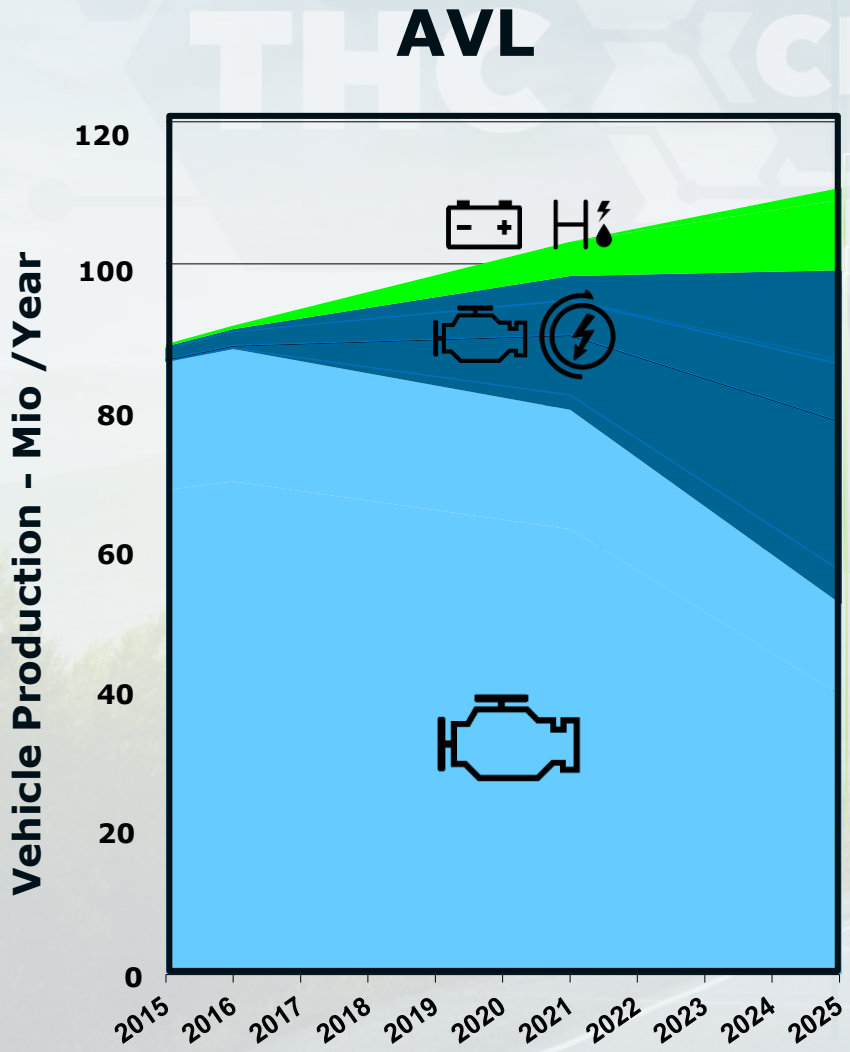
Hybrids & Plug In Hybrids:
Fuel consumption and access restr. as major driver

Mild Hybrid:
- 48 V in various configurations
- Power Increase
- ICE utilizes synergies

ICE:
- Significantly higher effort for emission compliance (RDE, China6, SULEV xx, …),
- "Zero Impact Emission Concepts" starting
- Increasing share turbocharging + Rightsizing, Advanced boosting, exhaust energy recuperation, full map stoichiometric, EGR
- E-fuels and E-gas increasing

2025: 50% electrified, still 100 mio ICE´s , however, high scatter of predictions

Future Technology Diversity
Impact on Engineering Demand



Connected & Autonomous

New EV / Fuel Cell

Huge variety of new complex XHEV systems

Significantly higher effort for emission compliance (RDE, China 6b, SULEV xx, …)

→ Dramatically enhanced development demand


Thank You
AVL
www.avl.com