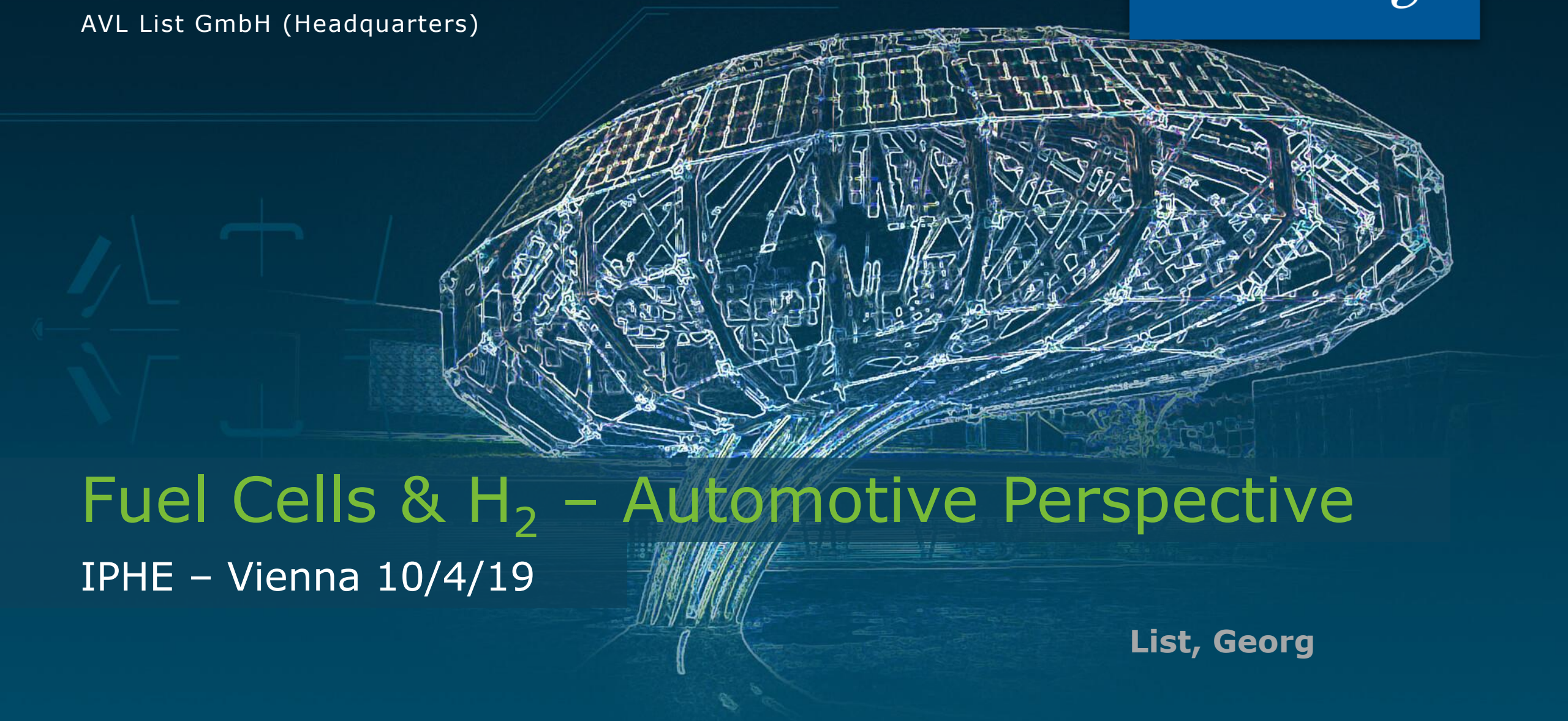
AVL List GmbH (Headquarters)



Fuel Cells & H_2 – Automotive Perspective

IPHE – Vienna 10/4/19

List, Georg

Customer Segments and AVL Business Areas

Passenger Cars

2-Wheelers

Racing

Construction

Agriculture

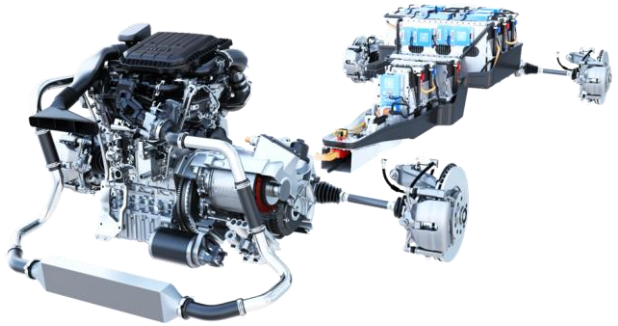
Commercial Vehicle

Locomotive

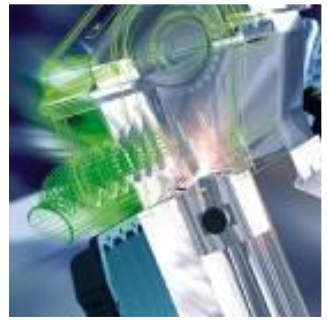
Marine

Power Plants

Powertrain and Vehicle Engineering



Development Platform



Simulation & Testing

AVL - Enterprise Development Automotive

RESEARCH 10%
of turnover in-house R&D

INNOVATION 1,500
granted patents

STAFF

10,500 employees

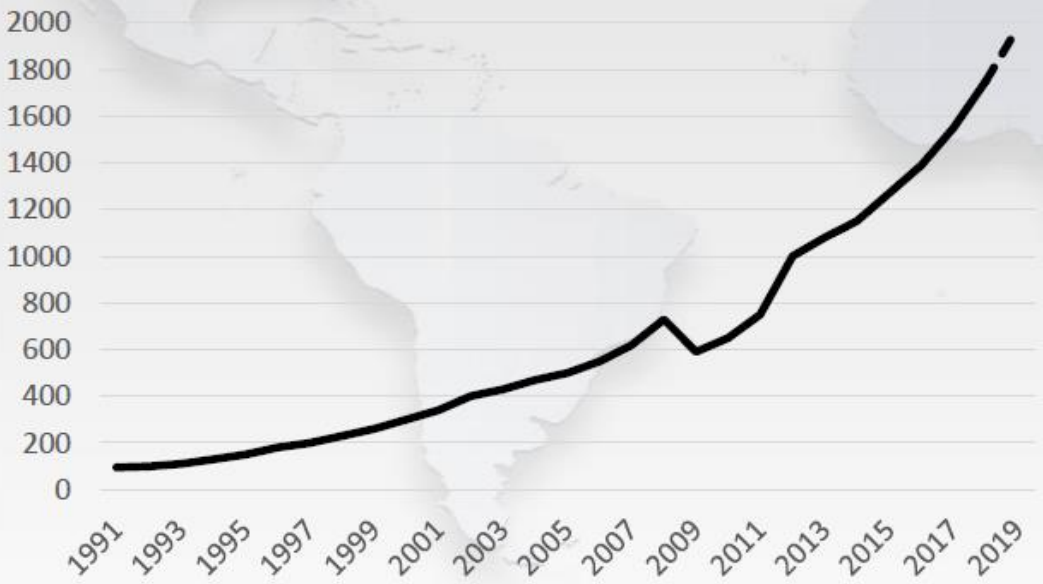
65% engineers & scientists

GLOBAL FOOTPRINT

44 engineering locations

- **>220** testbeds
- Global customer support network

GROWTH



SALES

1995:
0.15 billion €

2018:
1.75 billion €

Plan 2019:
1.98 billion €

EXPERIENCE

70 years !

POWERTRAIN

and its Integration in the Vehicle

ADAS & Autonomous Driving

ONE PARTNER

Challenges for Future Powertrains

Short Term

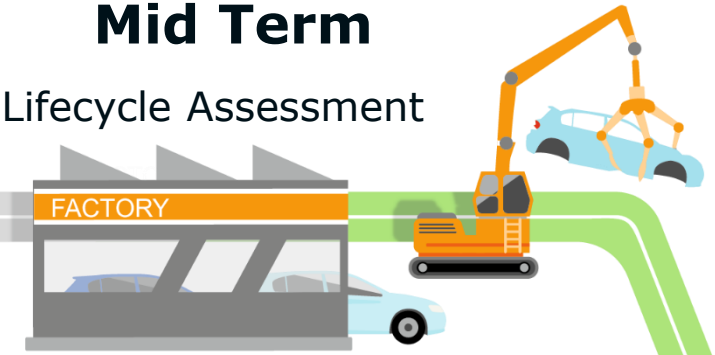
CO_2

Local Emissions

Affordability

Mid Term

Lifecycle Assessment



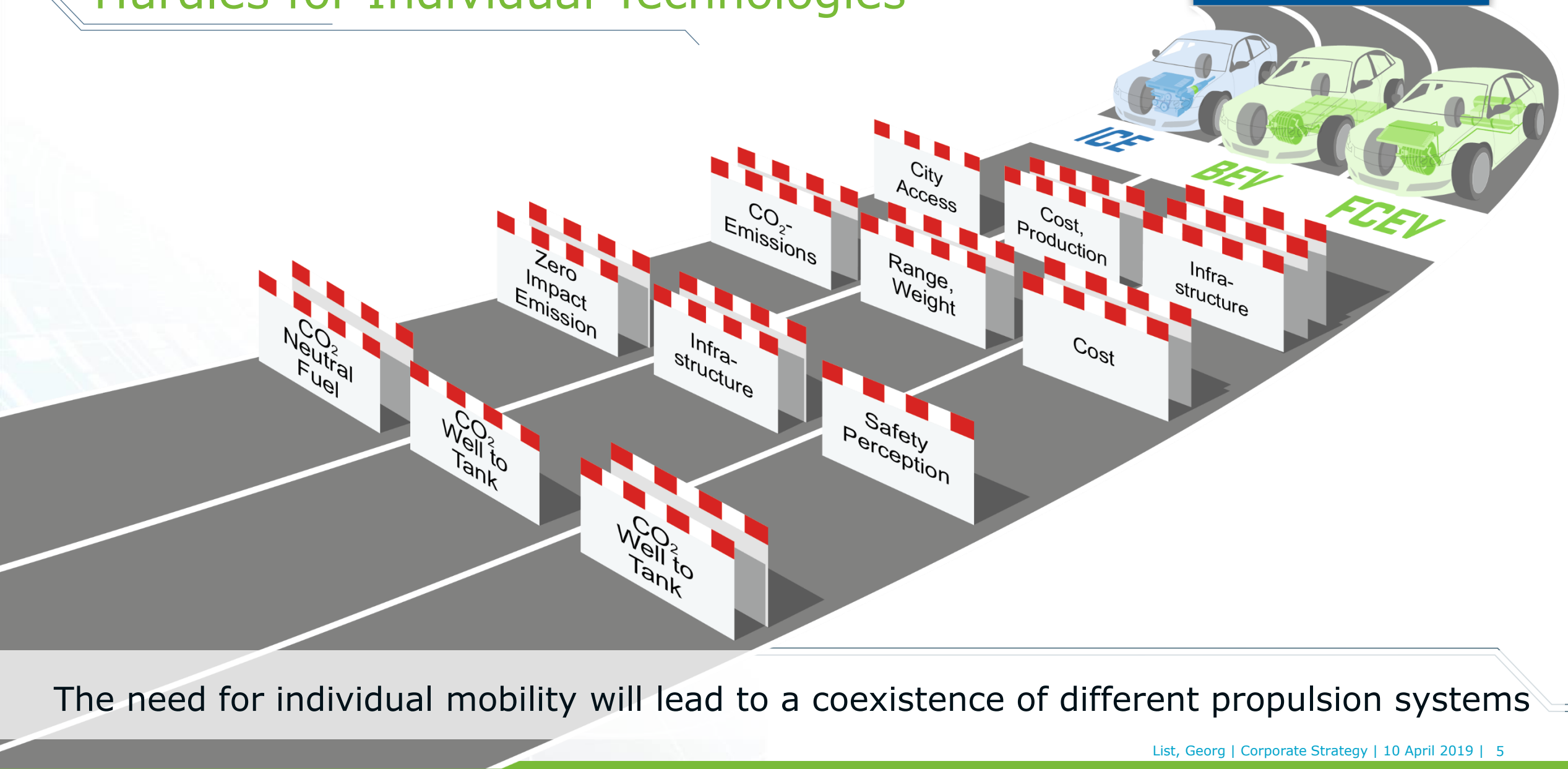
Zero Impact Emissions

New Mobility

Long Term

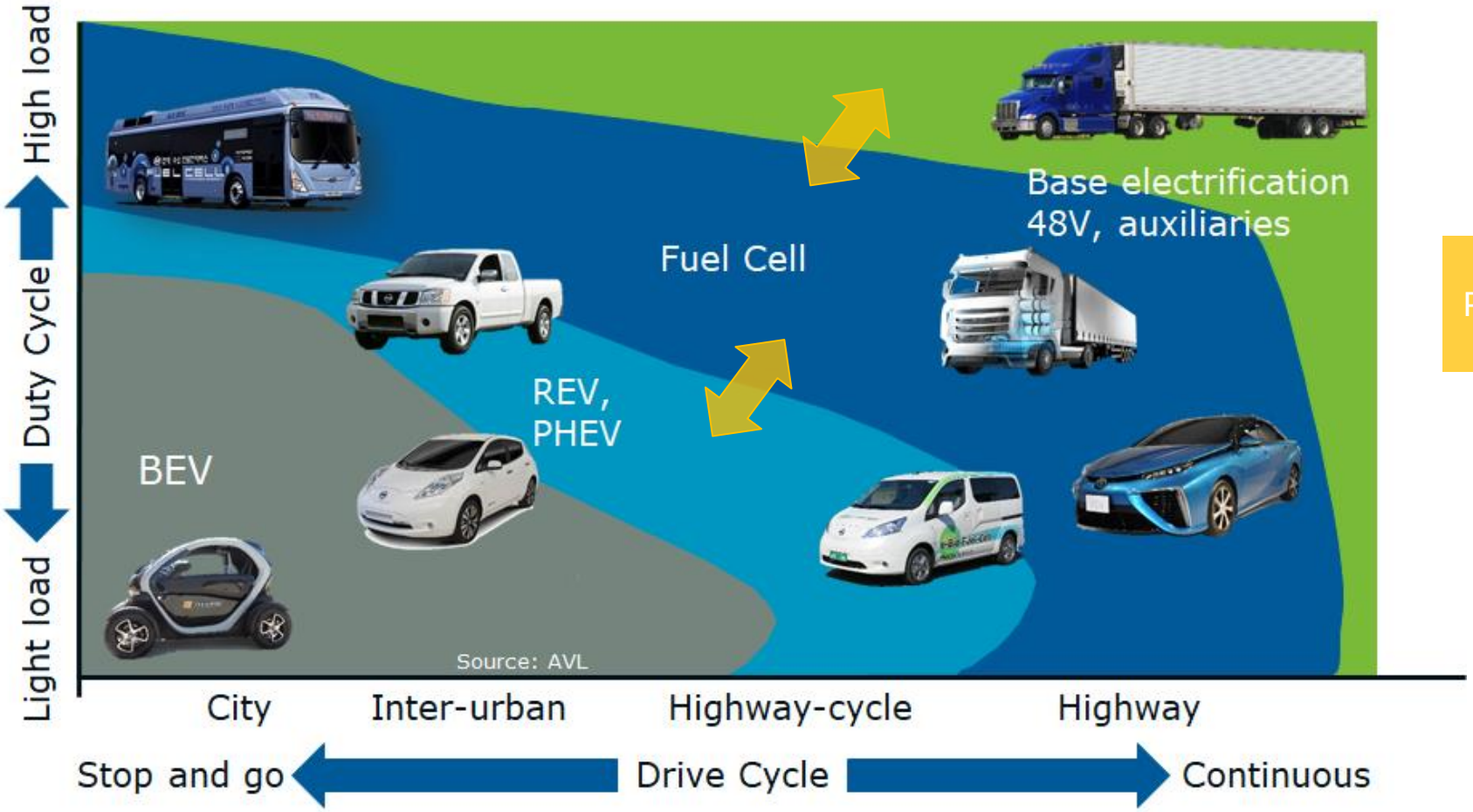
Comprehensive Sustainability

Powertrain Competition
Hurdles for Individual Technologies



The need for individual mobility will lead to a coexistence of different propulsion systems

Affordable E-Mobility includes Fuel Cell Electric Vehicles (FCEVs) - Application Map



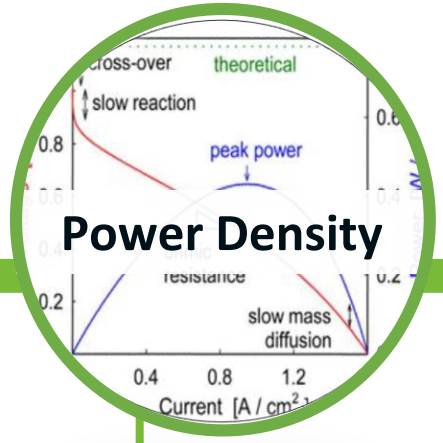
Industrialization, Product Cost & TCO, Infrastructure

Fuel Cells can be used in every mobility sector but they provide more value for vehicles that are energy intense (heavy load and/or long ranges)

FCEV Challenges

Cost

- Product Cost (scale-up, tank)
- Performance Increase
- Lower TCO (H2, Industrialization)



Power Density

- Volume Reduction
- Weight Reduction
- Power Density Increase

Temperature

- Increase Op. Temperature
- Stability Low Temperature
- Freeze Start up Robustness

Infrastructure

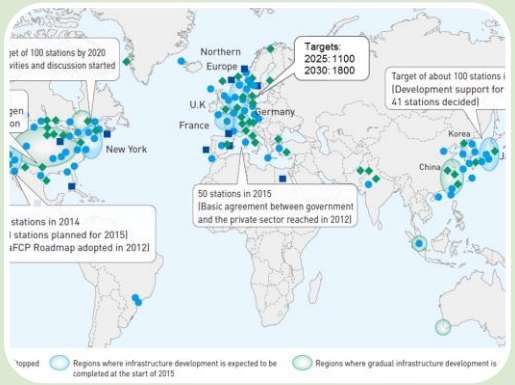
- Increase Coverage
- Standards for Trucks
- Renewable Hydrogen

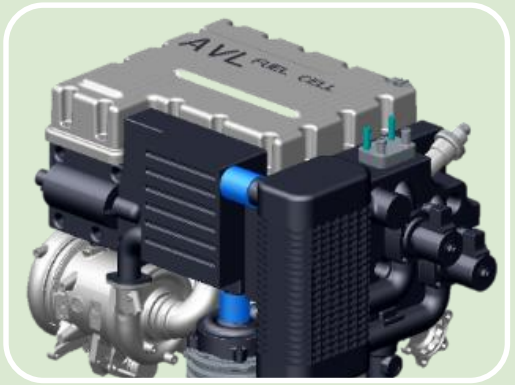
Durability

- Better Materials
- Operating Strategies
- Truck Requirements

Challenges can be overcome – 10 passenger car and 10 commercial vehicle OEMs are working on it and will have launched FCEVs by 2023

Fuel Cell Technology is here to stay but continued Support is required





Infrastructure

Support: Committed roadmap, orchestration

Under way:

- Government plans for stations & production
- OEMs take this topic in their own hands

Commercialization

Support: Demonstrators & "public fleets"

Under way:

- Development moved from R&D to series
- Products launched create cost scaling effects

Innovation

Support: Continue R&D funding for breakthroughs

Under way:

- Affordable, robust products, stack & storage
- Long range with short re-fueling & fun to drive


Thank You
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