World Materials Forum
From ownership to mobility service for better material efficiency

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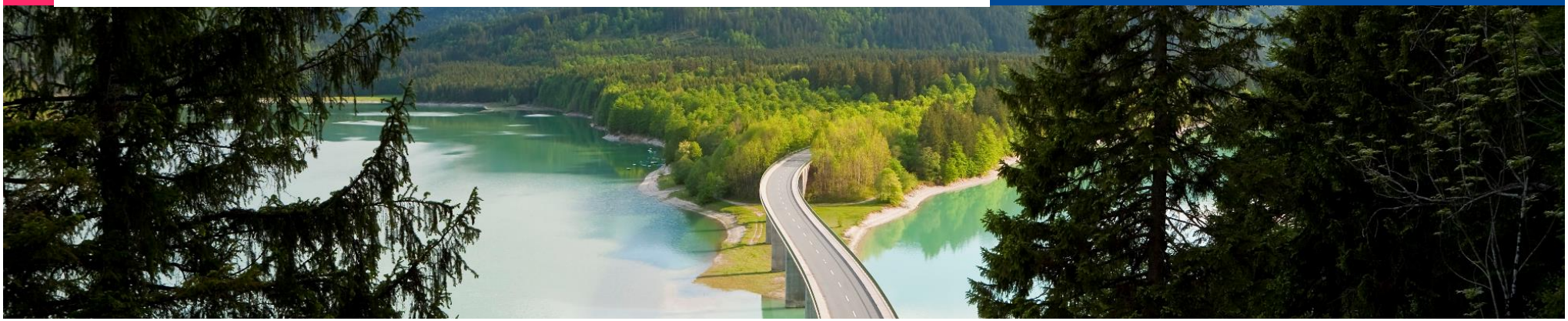

From ownership to mobility service for better material efficiency

1. Automotive Mega Trends by 2030
2. Key figures and trends related to urbanization
3. Automotive mega trends and stringent city demands
4. System integration will allow full benefit of the technology
5. How materials will answer automotive Mega Trends and city demands

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1 **Automotive Mega Trends by 2030**

2 Key figures and trends related to urbanization

3 Automotive mega trends and stringent city demands

4 System integration will allow full benefit of the technology

5 How materials will answer automotive Mega Trends and city demands

Mega trends for the automotive industry by 2030

Electrification / Hybridization of powertrain

Connectivity

Autonomous driving and artificial intelligence

Environmental protection

Mobility services and car sharing

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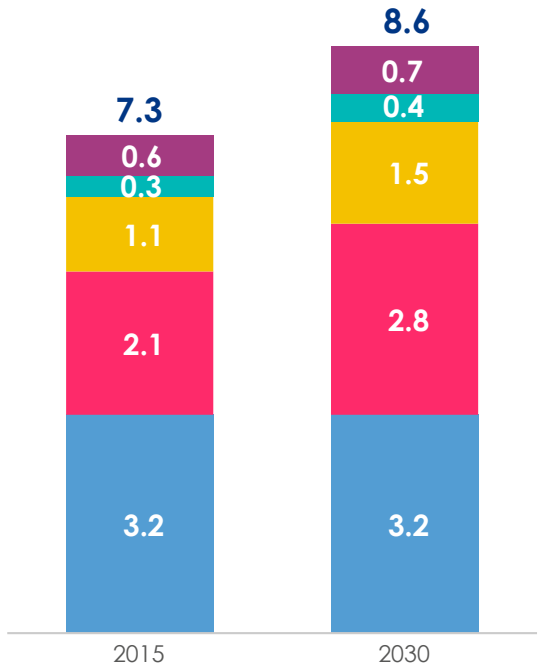
Many different powertrains will co-exist driven by different urbanization patterns

Global population by city archetype
(billion)



Source: McKinsey center for Future Mobility

Relevance of powertrain type

	Optimized ICE	Hybrids	Electric	Typical technologies
High income, suburban sprawl (eg Los Angeles)	◔	◕	◑	Hybrid, BEV, FCEV*
High income, dense cities (eg London)	○	◑	◕	Hybrid, BEV**
Low income, suburban sprawl (eg Chongqing)	◔	◔	◔	Green Gasoline, Hybrid, FCEV
Low income, dense cities (eg Mumbai)	◕	○	◑	Green Gasoline, BEV
Rural areas	◑	◑	◔	Green Gasoline, Hybrid, BEV, FCEV

○ Not relevant ● Highly relevant

** Fuel Cell Electric Vehicle* *** Battery Electric Vehicle*

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Mobility disruption in cities can happen along 3 major trajectories

HIGH-INCOME, DENSE CITIES

Seamless mobility

Rapid social change, system coordination and deployment of mobility solutions results in a **radically different mobility system**

HIGH-INCOME, SUBURBAN SPRAWL

Private autonomy

Technology change accelerates but social change is slow, resulting in **high uptake of EV/AV but** within current ownership models intact

LOW-INCOME, DENSE CITIES

Clean and shared

Despite technology readiness, **AV adoption remains very low while EV and shared mobility accelerate**

Source: McKinsey Center for Future Mobility

WORLD MATERIALS FORUM

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Automotive mega-trends and stringent city demands

AUTOMOTIVE MEGA-TRENDS

	Specifications / Simulation	Electrification	Connectivity	Autonomous driving & artificial intelligence	Mobility services & car sharing
Traffic	+		+++	+	+++
Pollution	+	+++	++	++	++
Accidents	++		++	+++	

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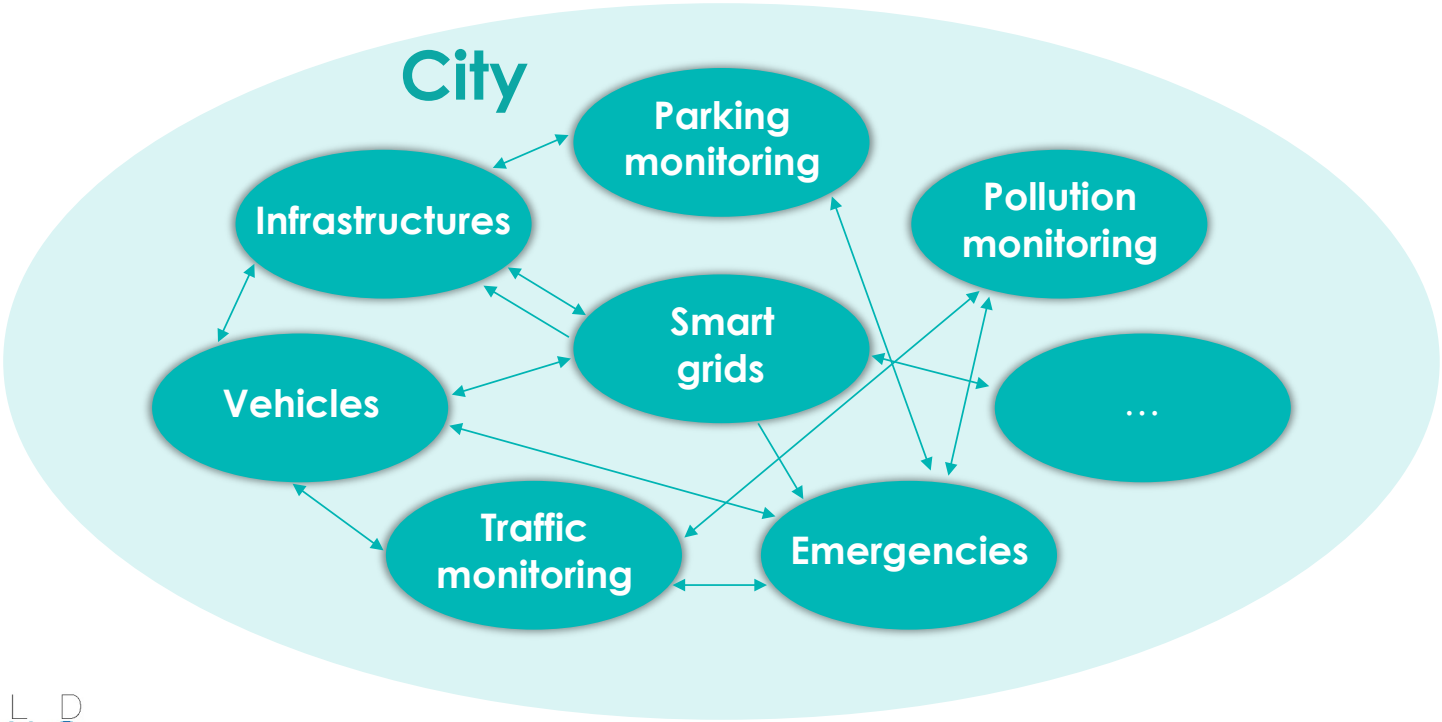
Specialized eco-systems will allow system integration within cities

- Sub-systems monitoring will bring value to cities
- System integration will become key to take benefit of all the sub-systems and their interactions



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5 **How materials will answer automotive Mega Trends and city demands**

How materials will answer automotive Mega Trends and city demands

Smart	Less	Longer
Electrification		
■ Hybridization, BEV, Fuel Cell ■ On board energy generation ■ Wireless charging, electrified roads, smart grids — **20 to 100%**	■ Less precious materials for catalyst ■ Energy recovery — **20%**	■ Re-use of batteries in stationnary conditions — **20%**
Connectivity		
■ Smart sensors/algorithms that allow condition monitoring/ predictive maintenance — **10%** ■ Connectivity to manage traffic, infrastructures and road conditions		■ Over the air updateability
Autonomous driving		
■ New technos: radars, lidars, sonars, cameras ■ Artificial intelligence ■ Better efficiency through driving monitoring and adaptation, valet parking,… — **20%**	■ Less energy consumption — **15%** ■ More active and less passive safety — **10%**	■ Longer life of the vehicle by optimized usage of the powertrain — **10%** ■ Less accidents
Environmental protection		
■ Specifications adapted to use cases including learning systems. ■ Smarter designs and representative tests ■ IoT to optimize the equipment usage rate ■ Smart Material to increase residual / after sale value and allow post SOP enhancements — **20%**	■ Less specifications by more accurate simulation models and high performance computing — **10%** ■ Additive manufacturing ■ Optimal material usage through scraps, recycling, additive manufacturing and equipment usage ■ Additive Manufacturing for spare parts ■ Circular economy — **20%** ■ Recycling	■ Specifications for repearability ■ Real time product monitoring — **20%** ■ Use renewable energy for electricity if BEV or hydrogen generation if fuel cell ■ IoT with predictive maintenance ■ Upgradability/retrofit — **5%** ■ Repearability
Mobility services and car sharing		
■ New materials adapted to shared mobility ■ Adaptive interiors ■ New mobility services — **20%**	■ Adapted vehicles to the different use cases, car sharing — **20%** ■ Less vehicles on the road	■ Materials adapted to shared mobility concepts

CO2 saving estimation *Material saving estimation*

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