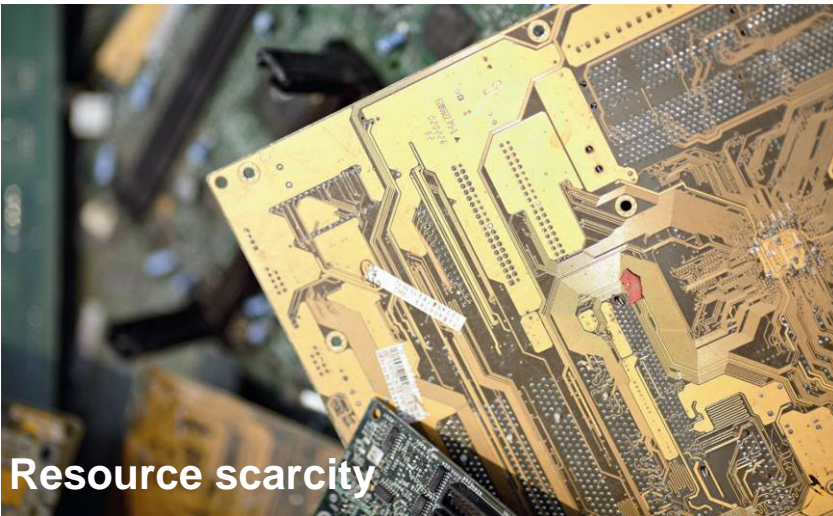


Umicore and clean mobility

Denis Goffaux
Chief Technology Officer
E-mobil BW TECHNOLOGIETAG,
Stuttgart 10 October 2012



Key megatrends for Umicore



Umicore's businesses



- We are a global leader in cathode materials for Li-ion rechargeable batteries
- **Our materials are the enablers for the move to e-mobility solutions**



- We are the world's #1 recycler of precious metals from secondary and end-of-life materials
- **We have developed a unique process for recycling batteries from e-vehicles**

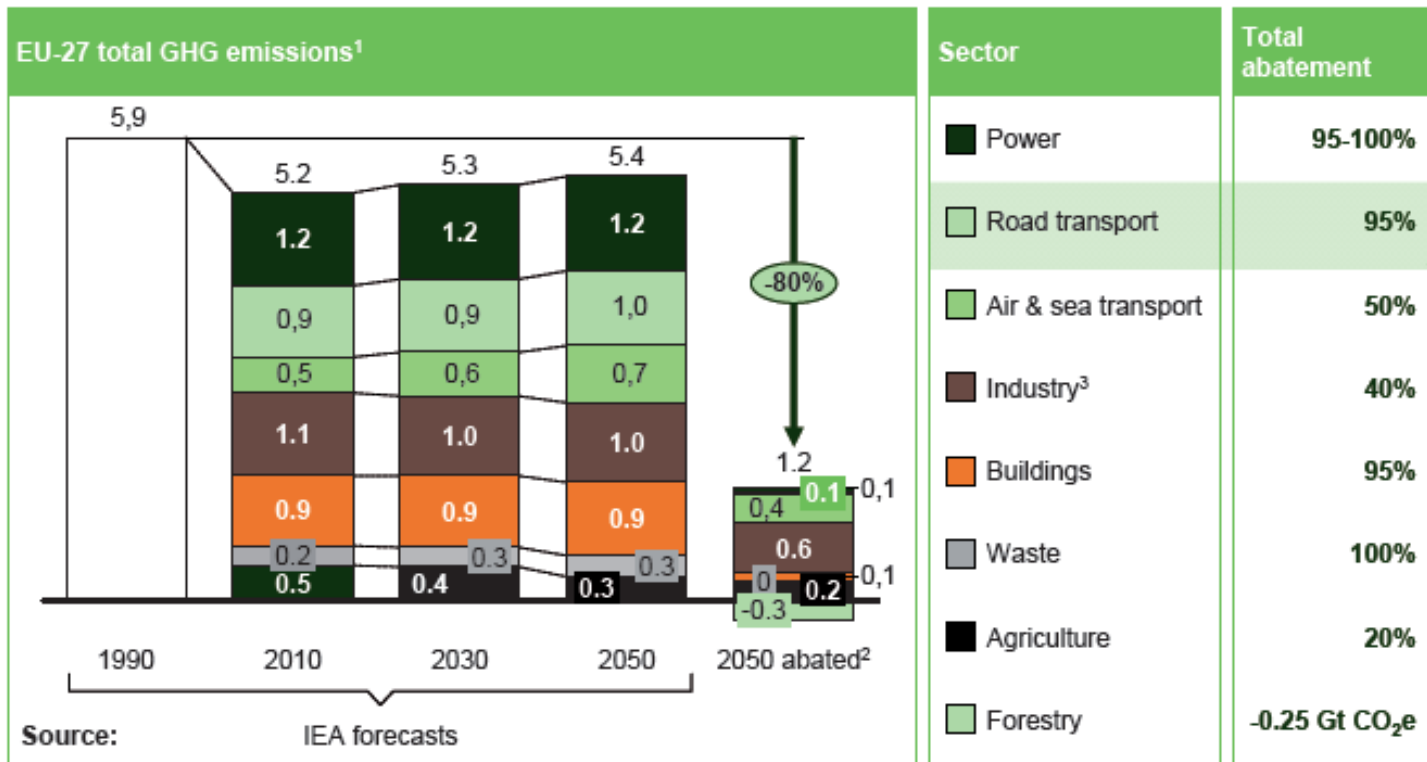


- One in three cars produced today contains a Umicore catalytic converter
- **We are experts in complex catalysts for cleaner ICE and hybrid drivetrains**



- We produce a range of essential materials and chemicals based on precious metals and zinc

EU 2050 CO₂ roadmap



¹ Large efficiency improvements are already included in the baseline based on the International Energy Agency, World Energy Outlook 2009, especially for industry

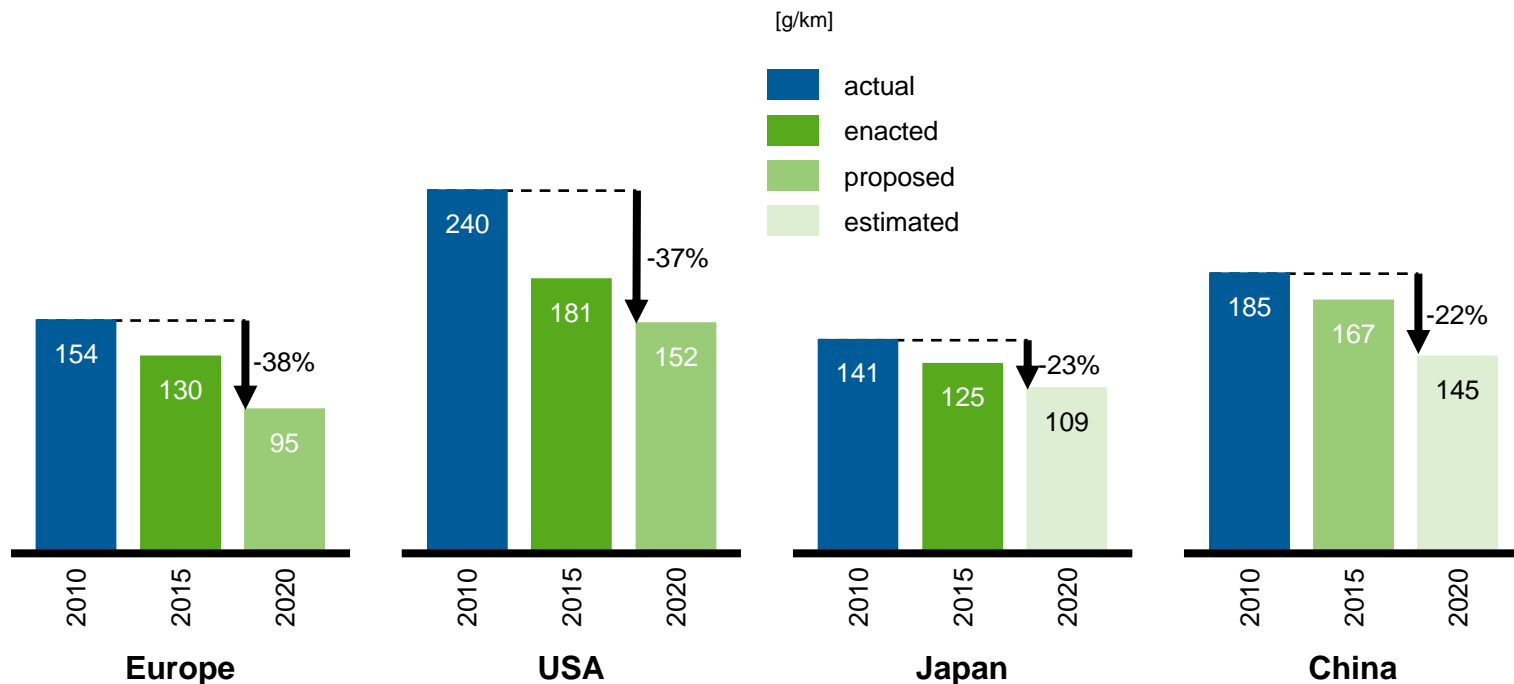
² Abatement estimates within sector based on Global GHG Cost Curve

³ CCS applied to 50% of large industry (cement, chemistry, iron and steel, petroleum and gas, not applied to other industries)

SOURCE: www.roadmap2050.eu

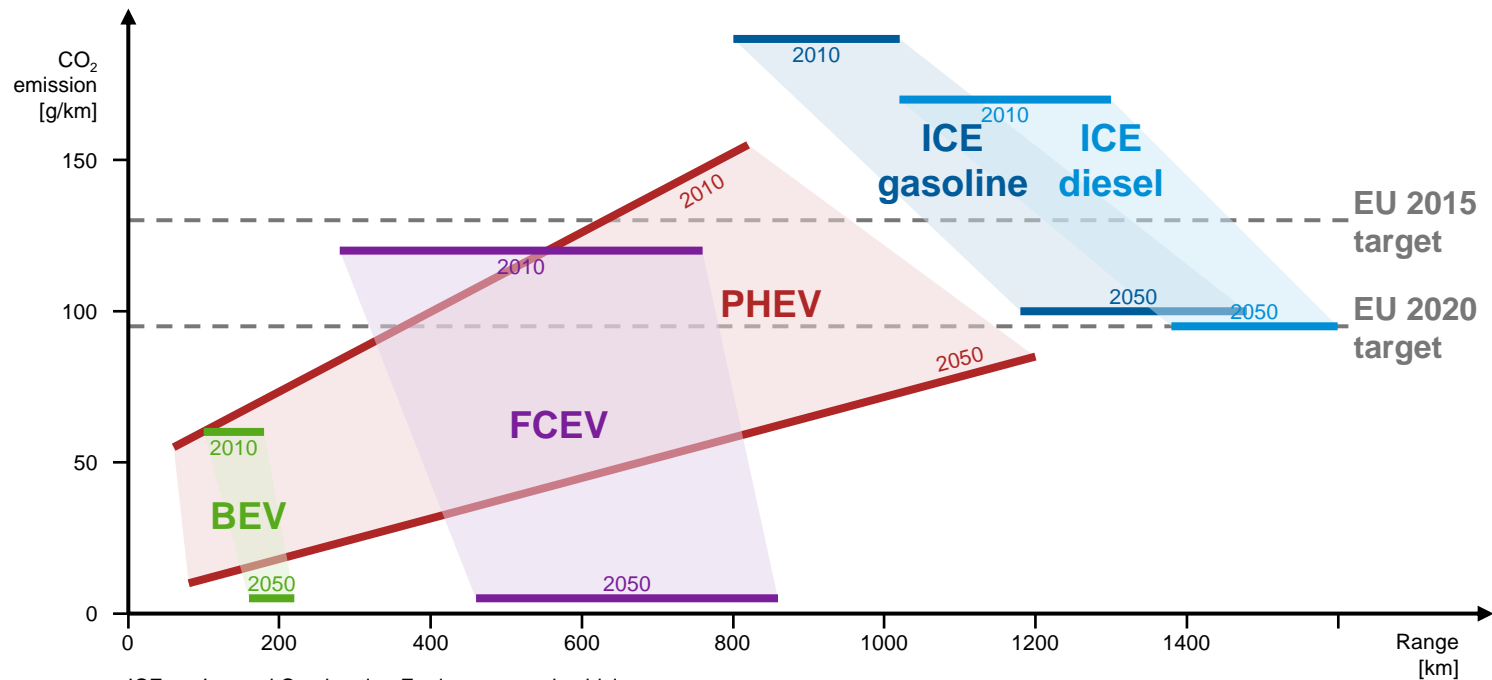
Reduction targets exist in most regions

CO₂ emission targets for passenger vehicles



Source: Continental (2011)

Different engine configurations will be needed to reach the 2050 goals

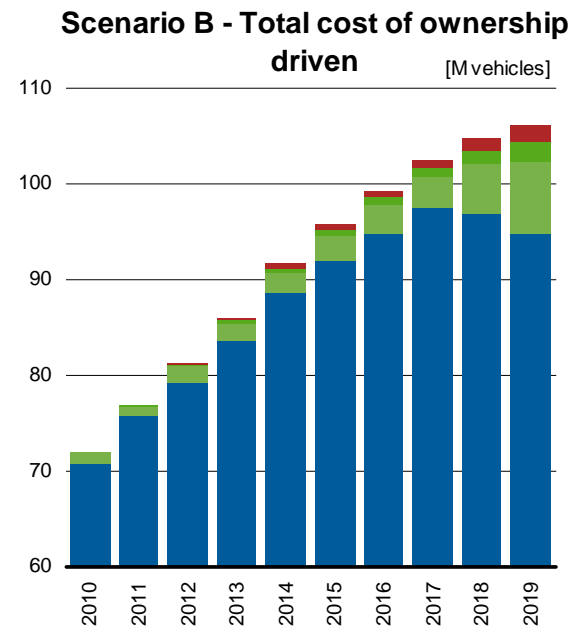
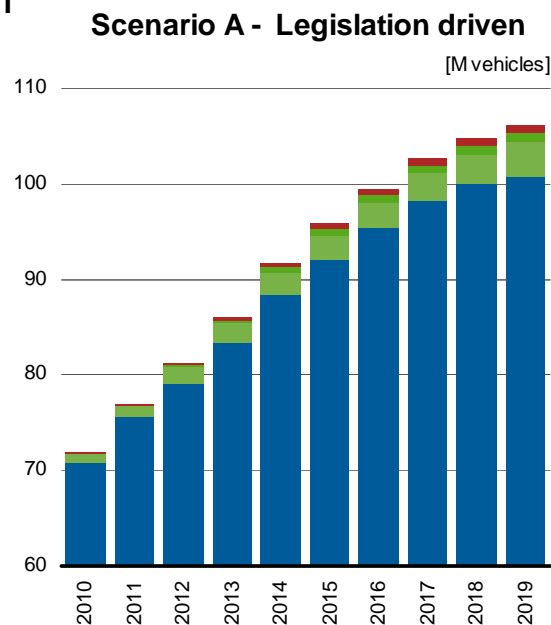


ICE Internal Combustion Engine-powered vehicle
 BEV Battery-powered Electric Vehicle
 PHEV Plug-in Hybrid Electric Vehicle
 FCEV Fuel Cell-powered Electric Vehicle

Source: A portfolio of power-trains for Europe: A fact-based analysis (EU coalition study 2010)

Significant growth opportunities across all technologies

- E-mobility platforms set to grow exponentially
- Requirement for more efficient ICE in terms of CO₂
- Clean air requirements eg for NO_x, particulates, hydrocarbons will also tighten



- Electric Vehicle (EV)
- PHEV (Plug-in Hybrid Electric Vehicle)
- HEV (Hybrid Electric Vehicles)
- ICE (Internal Combustion Engine-powered vehicle)

Source: Umicore estimate based on external data sources

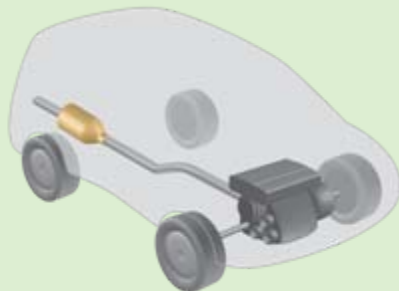
Different characteristics of catalysts, batteries and fuel cells

		ICE		HEV		PHEV		EV	
		Normal	Start-stop	Mild	Full	Parallel system	Range extender	BEV	FCEV
Emission control catalyst	Relative size	+++	+++	+++	++	++	+	No emission control catalyst	
	Relative complexity	+	+	+	++	+++	+		
Battery	Relative size			+	+	++	++	+++	++
	Relative complexity			+	++	+++	++	++	++
Fuel cell		No fuel cell							+++

Umicore's unique presence in clean mobility

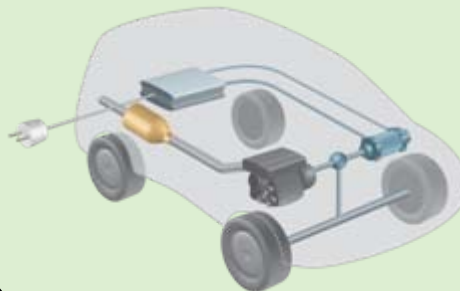
Catalyst for ICE

- Top three producer of catalysts
- Leader in catalysts for complex engine types (HEV, alternative fuels)
- Heavy duty diesel capability



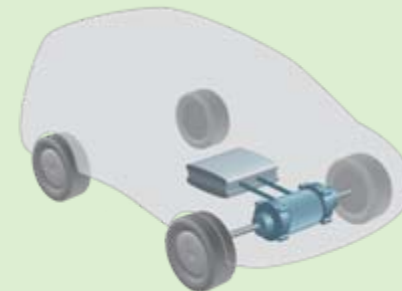
Materials for xEV batteries

- Extensive product and IP portfolio
- Broad production footprint
- >15yrs experience
- Auto industry TS16949
- Already on >12 platforms



Catalysts for fuel cell

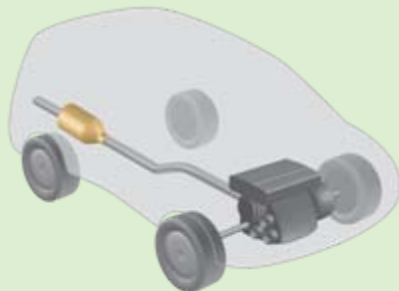
- Electrocatalysts & Membrane Electrode Assemblies (SolviCore)
- Umicore focus is on automotive applications
- Fuel Cell cars require electrocatalysts and battery



Key materials challenges

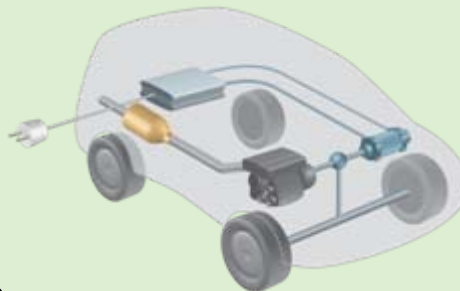
ICE

- Continuous reduction in precious metals loadings
- More complex emissions catalysts for fuel efficient ICE & HEV
- Even stricter regulations on particulates, NOx...



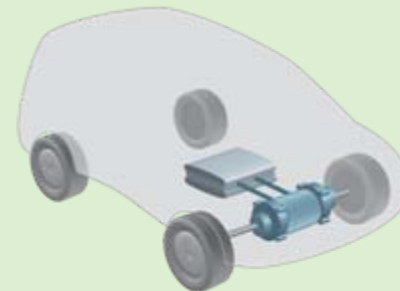
xEV

- Battery performance (range and charging) requires improvements in chemistry
- Lower battery cost requirements = innovation in materials
- Temperature



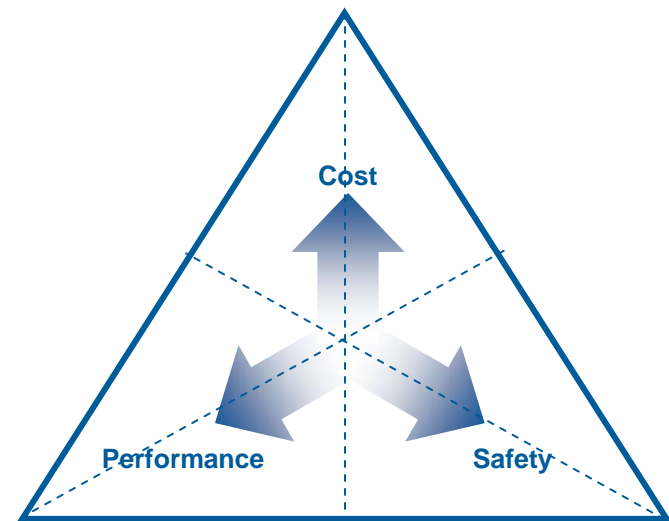
Fuel cell

- Continued reduction in precious metal loadings and cost
- Security of supply – need for more recycling of precious metals
- Requires combination of battery and fuel cell materials



Umicore's materials development takes a system approach

- Some 60% of Umicore's total R&D budget is dedicated to materials and services for clean mobility
- Materials are developed in close collaboration with the customer
- Full system approach is required to obtain the best results for customers
- Materials are THE key enabler for efficient and effective clean mobility



Closing the loop

- Life cycle analysis (LCA) approach is essential to ensure viability of e-mobility solutions
- Recycling will become more important for:
 - LCA benefits
 - Security of supply
 - Consumer confidence
- Legislation already in place in Europe
- Umicore is a global leader in recycling automotive catalysts, rechargeable batteries and fuel cell components



Supporting e-mobility initiatives



- Umicore supports various e-mobility initiatives
- Umicore co-ordinates the i-Move project of Flanders Drive
 - 175 electric vehicles
 - 300 charging points
 - tested by employees and private persons in day-to-day conditions
- E-vehicle fleet at Umicore
- Kompetenznetzwerk Lithium-Ionen Batterien e.V. (KLiB)
- Student initiatives Umicore Solar Car, Regeneracing (FC), Lessius Team



Umicore CEO, Marc Grynberg, test drives an e-car with Flemish Minister of Innovation, Ingrid Lieten

Summary

- Materials define performance
- System approach is key
- Technology neutrality

The presenter

Denis Goffaux

Chief Technology Officer



Denis Goffaux holds a degree in Engineering from the University of Liège, Belgium. He joined Umicore Research in 1995 and has lived and worked in Belgium, Chile, Korea, China and Japan. He was previously head of the Rechargeable Battery Materials business line and Country Manager Japan. He was appointed to the Executive Committee of Umicore in July 2010. Besides his position as Chief Technology Officer, he also is responsible for Environment, Health & Safety.

materials for a better life