Advanced Materials for Sustainable Energy Harvesting & Storage

Meeting of EP Intergroup CCBSD
Sustainable Chemistry: Supporting Research, Innovation and Competitiveness in Europe
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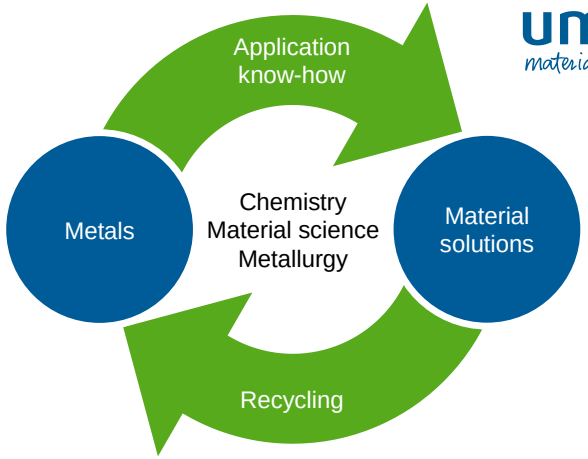
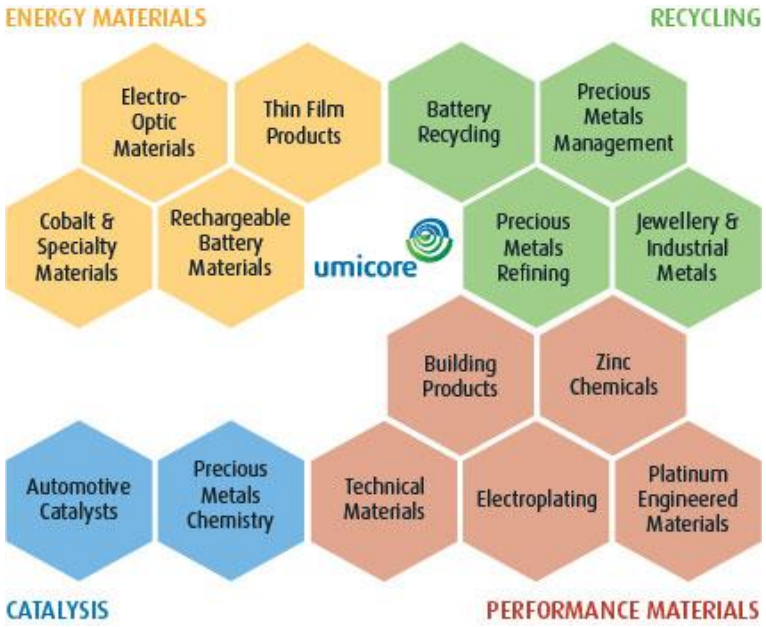
Umicore in a nutshell

- We are a **global materials technology company** (14.600 people, 79 sites, > 50% sales in Europe, Turnover 2012 @ 12.5 B€ or 2.4 B€ excl. metal value)
- Our mission is to make **“materials for a better life” (from metals to high-tech applications)**
- The majority of our **growth comes from clean technologies**
- We use application know-how to create **tailor-made solutions** in close collaboration with our customers
- We **close the loop and secure supply** by recycling production scrap and end-of-life materials





Most Sustainable Corporations in the World GLOBAL100

No. 1 ranking in global index companies (Jan. 2013)

Umicore's development fits with sustainability-driven megatrends

Electrification of the automobile

We are a leading producer of key materials for rechargeable batteries for laptops, mobile phones as well as electrified vehicles

Resource scarcity

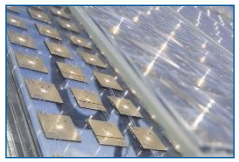
We are the largest recycler of precious metals; we are able to recycle more than 20 different metals

More stringent emission control

We provide catalysts for 1 out of 3 cars in the world as well as for trucks & non-road vehicles

Renewable energy

We supply key innovative materials for high-efficiency solar cells and other photovoltaic applications



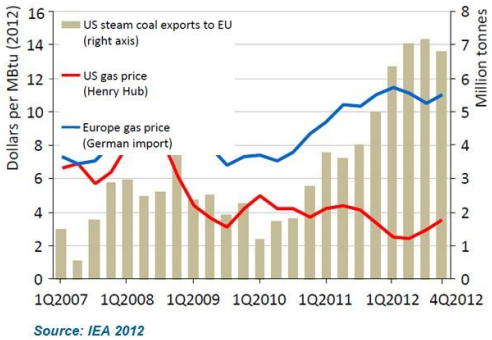
EU faces strong energy challenges and has set ambitious goals and priorities

EU "20-20-20" Targets by 2020:

- **Reduce GHG levels by 20%**
- **Increase share of renewables by 20%**
- **Improve energy efficiency by 20%**

Competitiveness

- Cut Europe's energy bill
- Create growth & jobs
- Boost R&D where EU can become a global leader



Energy Policy

Security of Supply

- Decrease EU's energy dependence
- Help balance trade: single European energy market

Sustainability

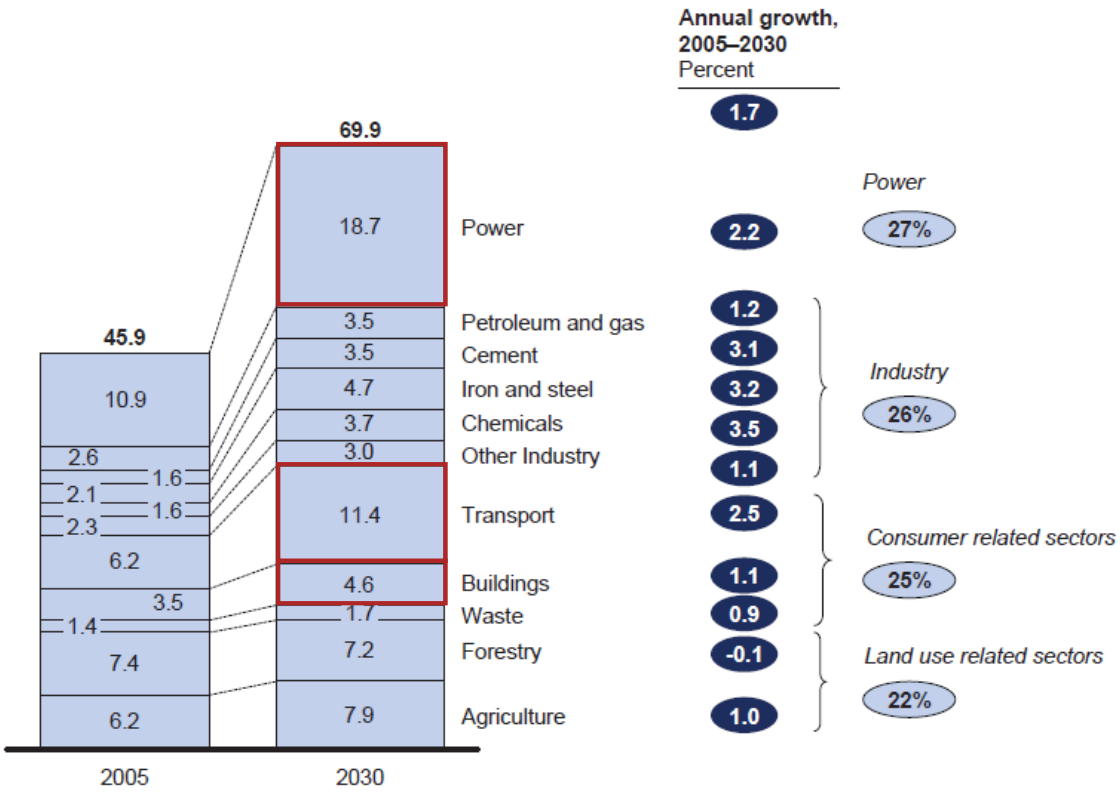
- Fight climate change
- Limit environmental degradation

By 2050: Reduce GHG levels by 80-95% below 1990 levels

In a BAU scenario, the power sector would be accountable for ~ 30% of GHG emissions

Business-as-usual emissions split by sector in 2005 and 2030

$GtCO_2e$ per year



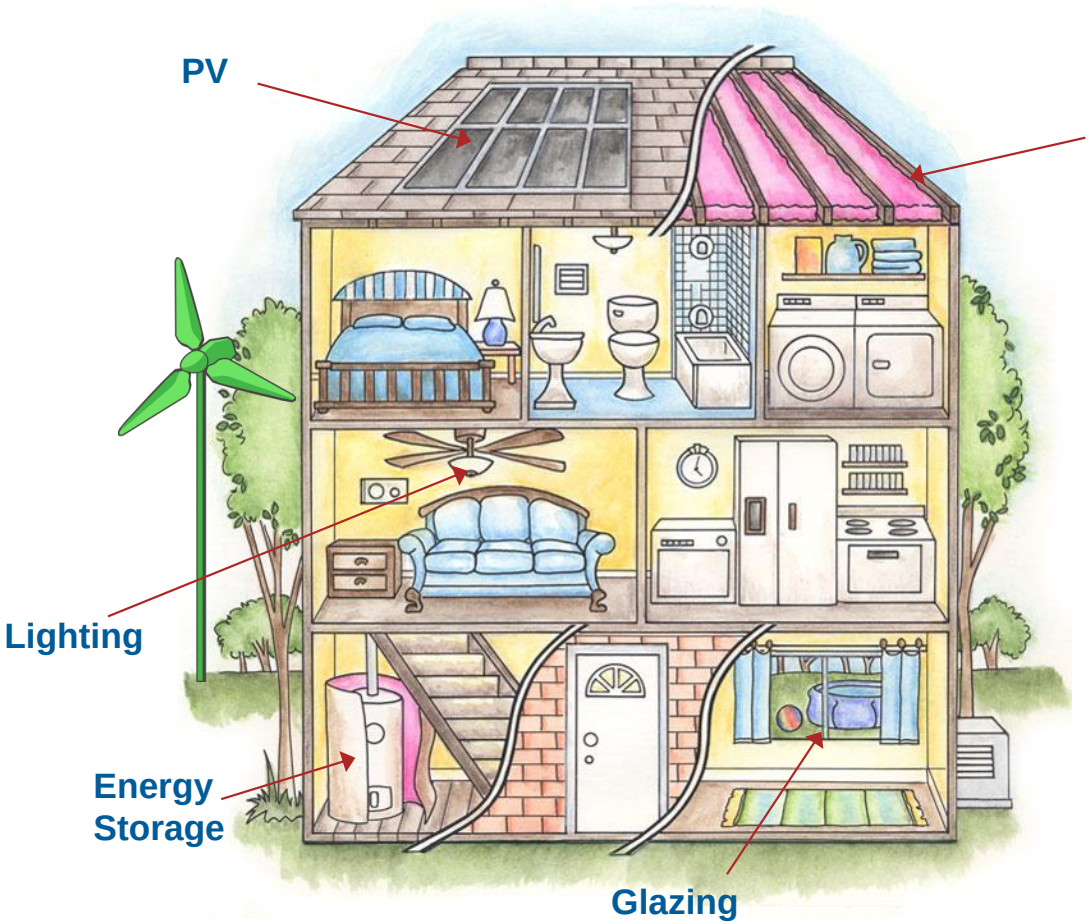
Source: Houghton; IEA; IPCC; UNFCCC; US EPA; Global GHG Abatement Cost Curve v2.0

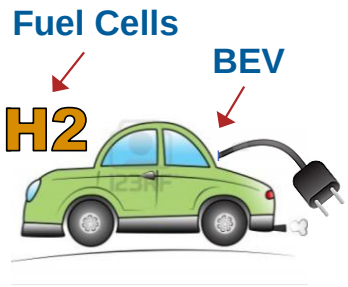
$CO_2 = P \uparrow \times S \uparrow \times E \downarrow \times C \downarrow$

Reducing CO2 emissions relies upon innovations in energy efficiency, sustainable energy harvesting & storage

Advanced Materials facilitate deployment of sustainable energy technologies

Umicore helps with its innovations





Materials for ENERGY HARVESTING

Materials for ENERGY STORAGE

Materials for ENERGY DISTRIBUTION

Materials for ENERGY EFFICIENCY

Energy Storage using Li-ion batteries could enable a EU value chain while solving sustainability challenges

Example

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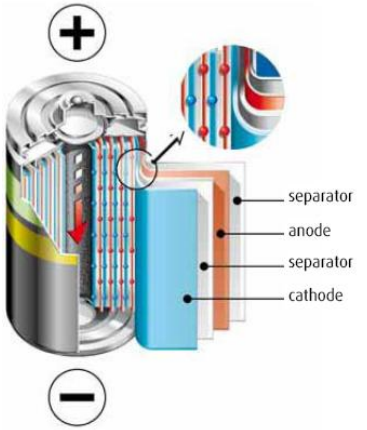
- Large storage potential forecasted (BCG 2013) with EU stronger than Japan, China and ROW
- Batteries 2 times more than Hydrogen & together >80% of the market

	Energy	Power	Safety*	Life	Cost
LCO umicore materials for a better life lithium cobaltite $LiCoO_2$	+++	+++	-	++	+
LMO lithium manganese oxide $LiMnO_2$	-	+++	++	-	++
NMC umicore materials for a better life nickel manganese cobalt $Li(Ni_xMn_yCo_{1-x-y})O_2$	++	++	++	+++	+++
LFP umicore materials for a better life lithium iron phosphate $LiFePO_4$	+	+++	+++	++	++



Developing products with suitable cost & performance requires strong materials R&D

Different NMC material generations are being developed

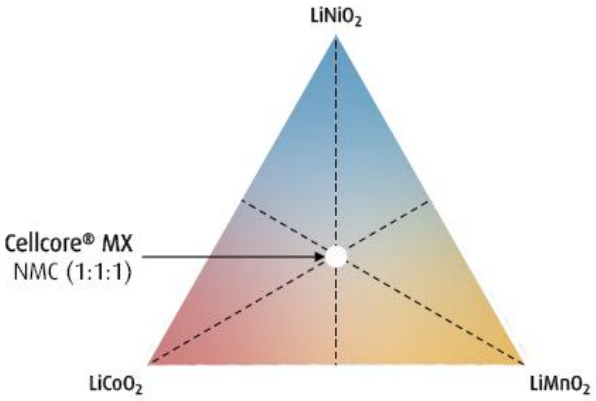
- Reducing cost/kg
- Increasing kWh/kg

⇒ Reducing cost/kWh

2011-2012 → NMC Generation 1

2017 → NMC Generation 2

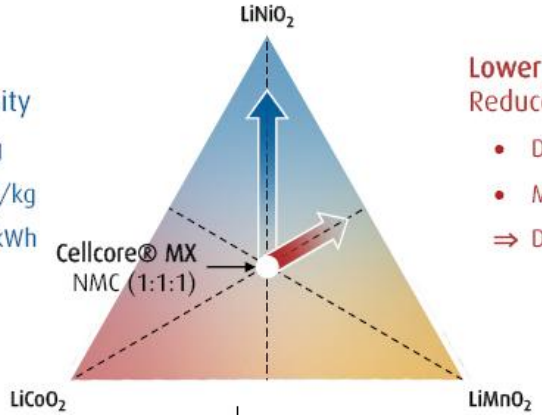
2019-2020 → NMC Generation 3



Higher Ni content
Pushes energy density

- Increase kWh/kg
- Maintaining cost/kg

⇒ Decreases cost/kWh



Lower Co content
Reduces metal cost

- Decrease cost/kg
- Maintaining kWh/kg

⇒ Decreases cost/kWh

Technologies for sustainable energy harvesting & storage require “technology” metals, some being critical for EU

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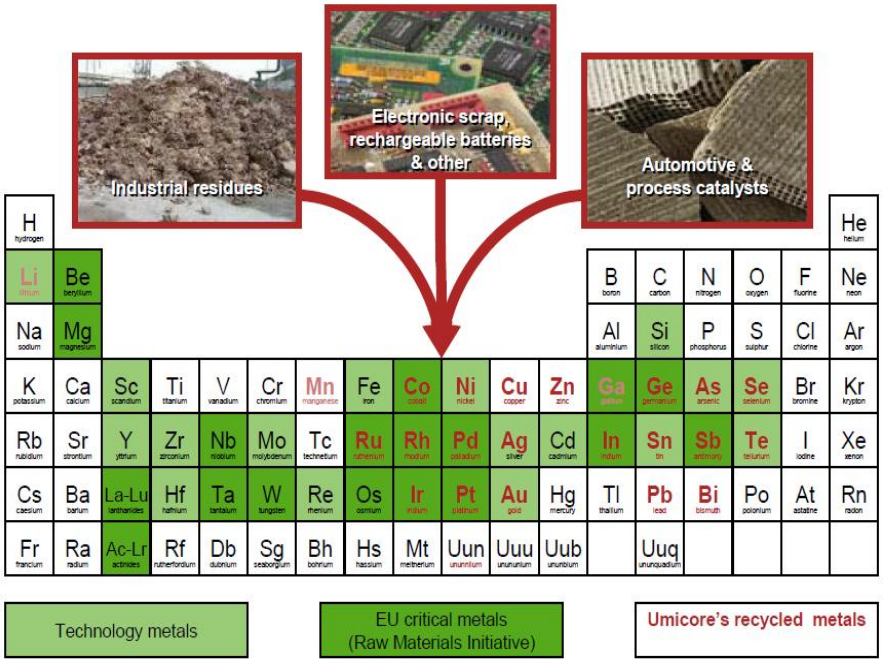
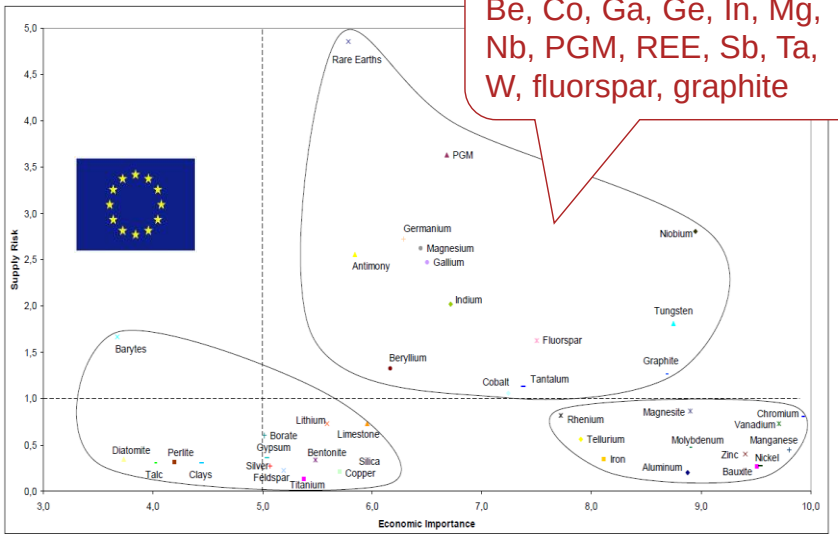


Criticality for Europe: EU-Raw Materials Initiative



Geopolitical concerns

- **REE in China**
- **Pt in Southern Africa**
- **Co in Congo**
- **Li in the Andes**
- **Pd in Russia**

Impact for Advanced Materials Scientists?

Functional properties & performance are at the heart of materials
but additional aspects need to be considered

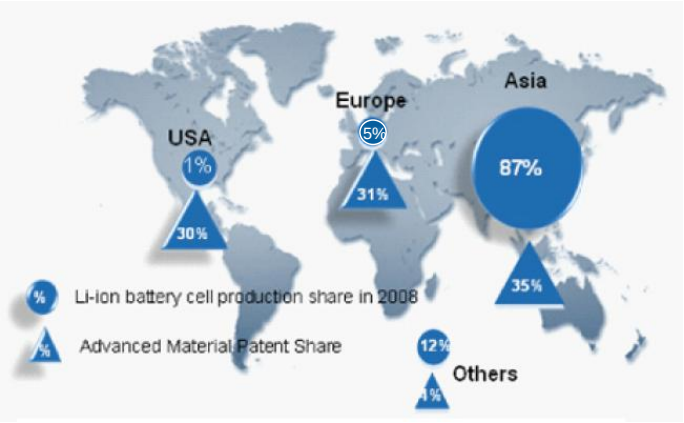
- **Availability of needed elements**
  Is there enough, can we get access, will the price remain affordable?
  → Critical metals
- **Can the specific (critical) materials be recycled at their end-of-life (as alloy and/or element)?**
- **How can we design a product in a way that the "critical" components remain accessible for separation and recycling?**
- **What impact does the substitution of critical materials have on the recyclability of the product/component?**
- **What is the most promising approach for sustainable use of critical elements – savings & substitution or improved recycling?**

Advanced Materials for clean energy & EU?
EU is facing growing global competition

- **Difficult to match** investment project **incentives** available in competing regions
- **Other regions strongly focus** on strategic manufacturing to fight off competition
- EU does the basic research, others **commercialize advanced products & processes**
- **Asia is moving** up traditionally EU value chains due to fast catch up in innovation

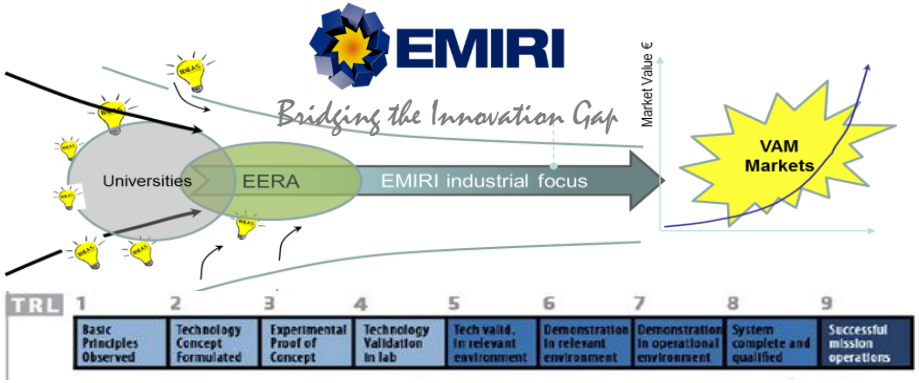
EU needs to reinforce & develop its assets to compete

- EU has **considerable assets** in global advanced materials competition (**leading research** organisations and **companies** in several applications)
- EU is **still strong** in global race for patents (2nd)
- The **disconnect between R&D and Innovation** (manufacturing and commercialization) **is HOWEVER present**
- **Involvement of Industry must be stimulated & facilitated such as would be the case in Horizon 2020**



Global patent and manufacturing shares for Li-ion batteries

Organizations active in adv. materials for low carbon energy technologies teaming up in EMIRI



EMIRI is a European industry-driven grouping (40+ organizations incl. leading materials companies) with goal to:

- Establish Industrial Leadership in EU
- In advanced materials for competitive low carbon energy in line with the SET Plan goals and its materials roadmap
- Through involvement of all stakeholders for strategic RESEARCH & INNOVATION programmes (use more effectively resources available at EU scale)

EMIRI is the organisation to:

- Propose a cross-cutting focus to develop advanced materials for low carbon energy
- Be based on SET Plan Materials Roadmap
- Span the entire innovation value chain to achieve commercially successful development of advanced materials for energy applications in Europe