CRM Value Chain Analysis of Energy Storage

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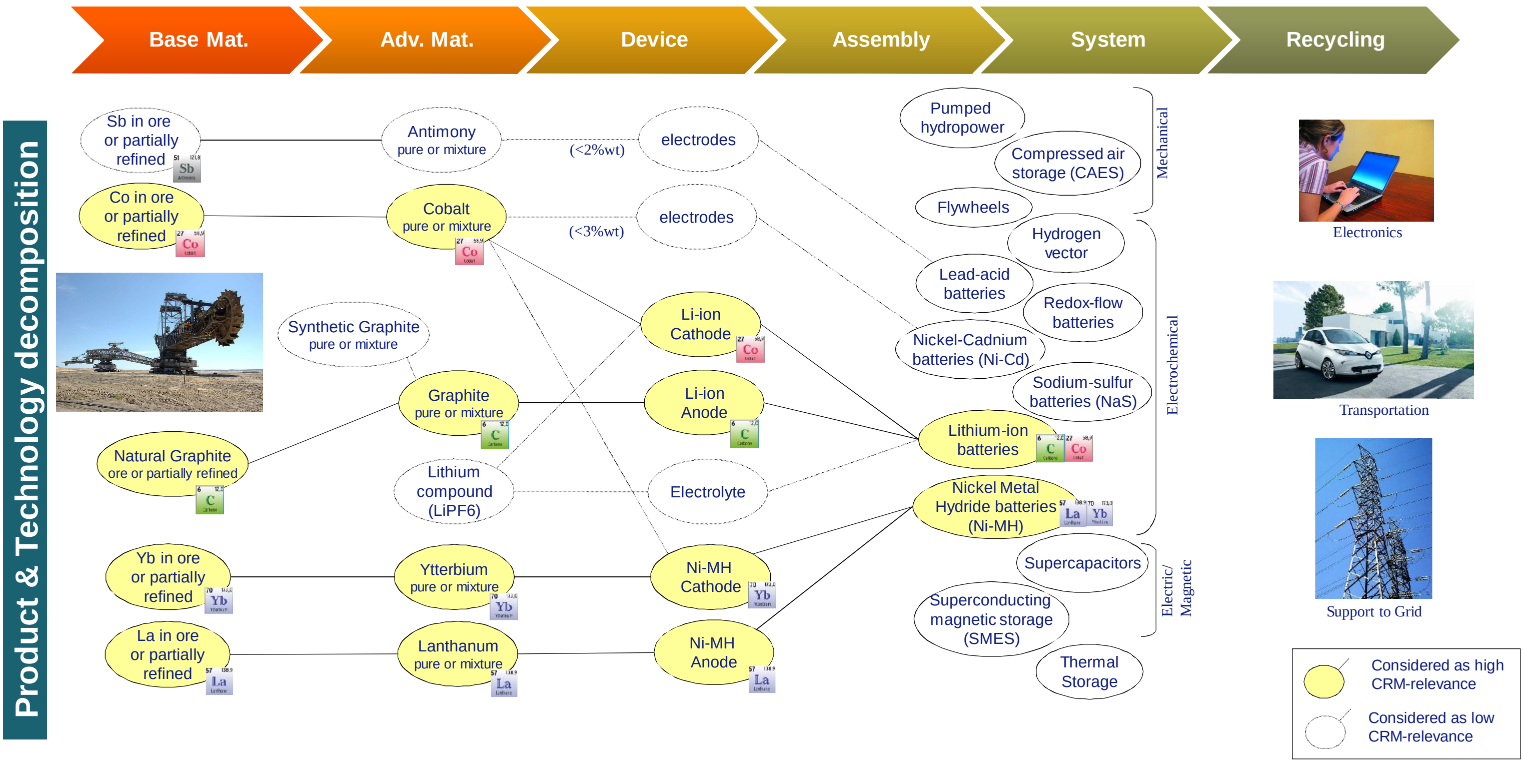

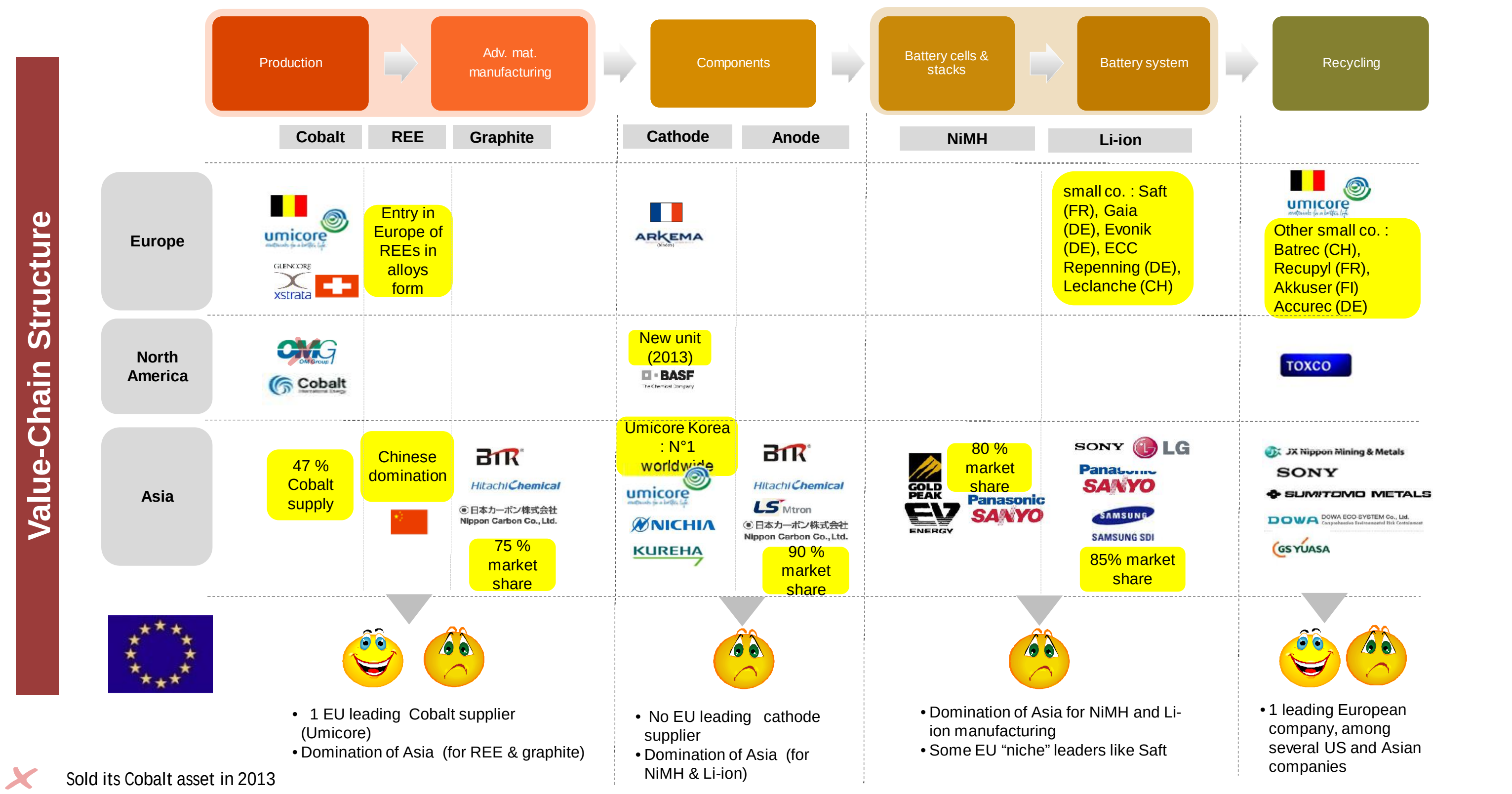

Europe position

- EU companies are not very well placed except Umicore and BASF (cathode manufacturing) but their divisions are located in Korea and the USA.
- EU NiMH and Li-ion batteries manufacturers are very small although some of them may be worldwide leaders on niche markets (ie : Saft for Defense and Space).
- EU companies could be more active in the next years because of the development of automotive and industry markets segments.

Estimation
- 340M€
- 4000 FTP

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CRM Value Chain Analysis of Photovoltaic

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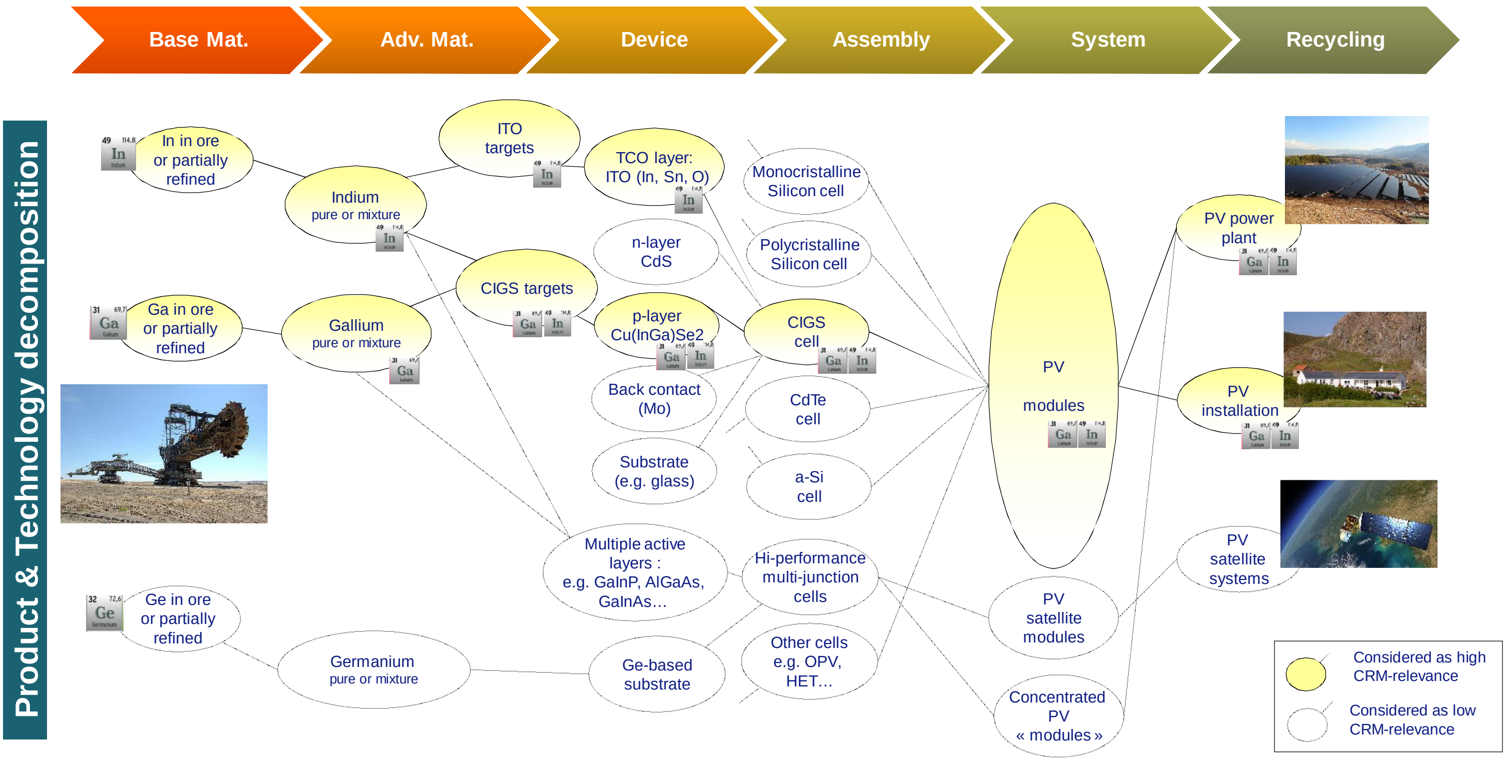

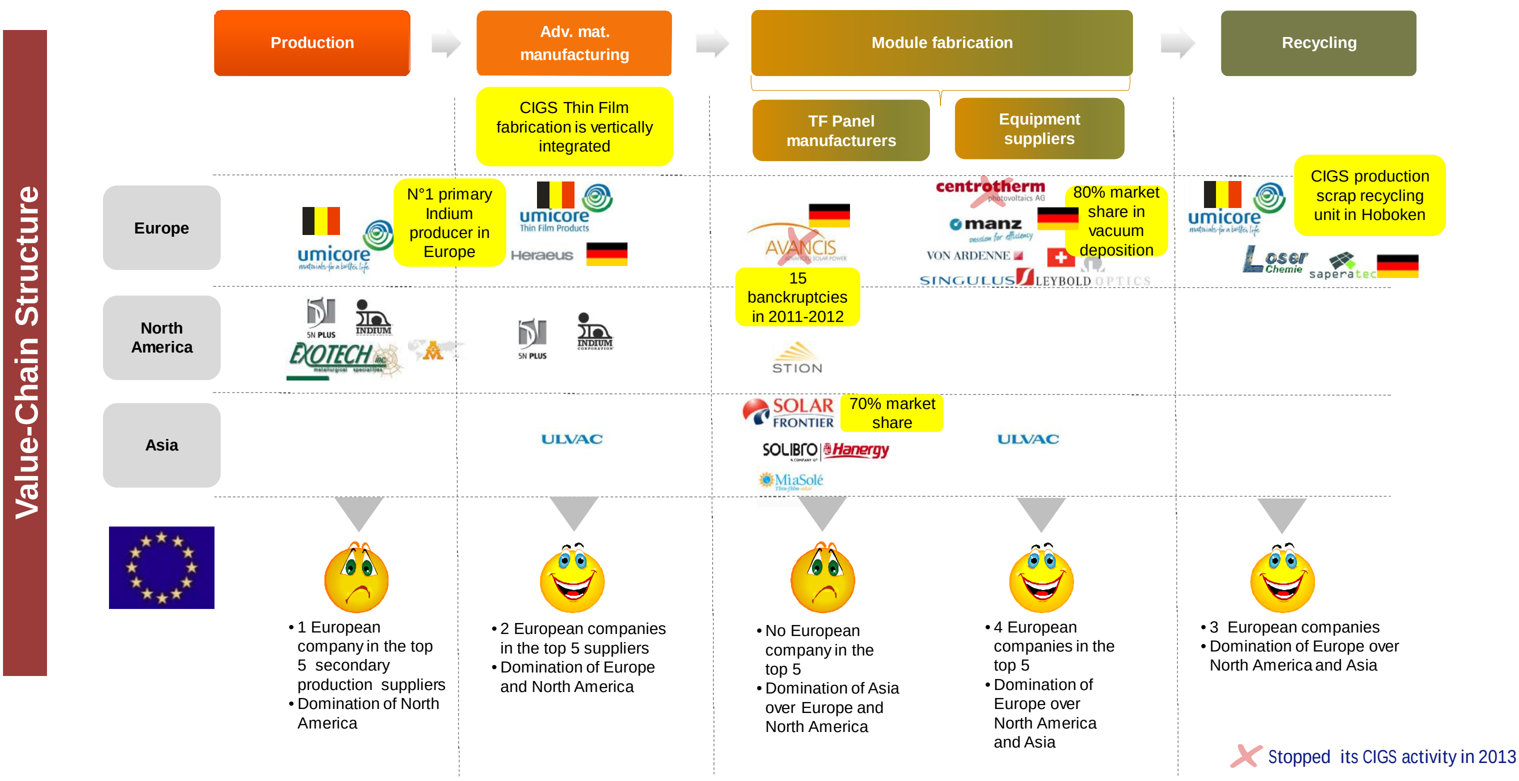

Europe position

- EU companies are well placed in advanced manufacturing, equipment supplying and recycling.
- Global materials technology and recycling group Umicore is a key player in Europe
- EU companies have a large share of equipment supply but the downturn in new fabs investments and the difficult market expectations seem very risky for the next 2 years.
- Importance of CRM-related PV for Europe appears after analysis as a case of potential "false-positive" result (ie. not so important).

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CRM Value Chain Analysis of Wind Energy

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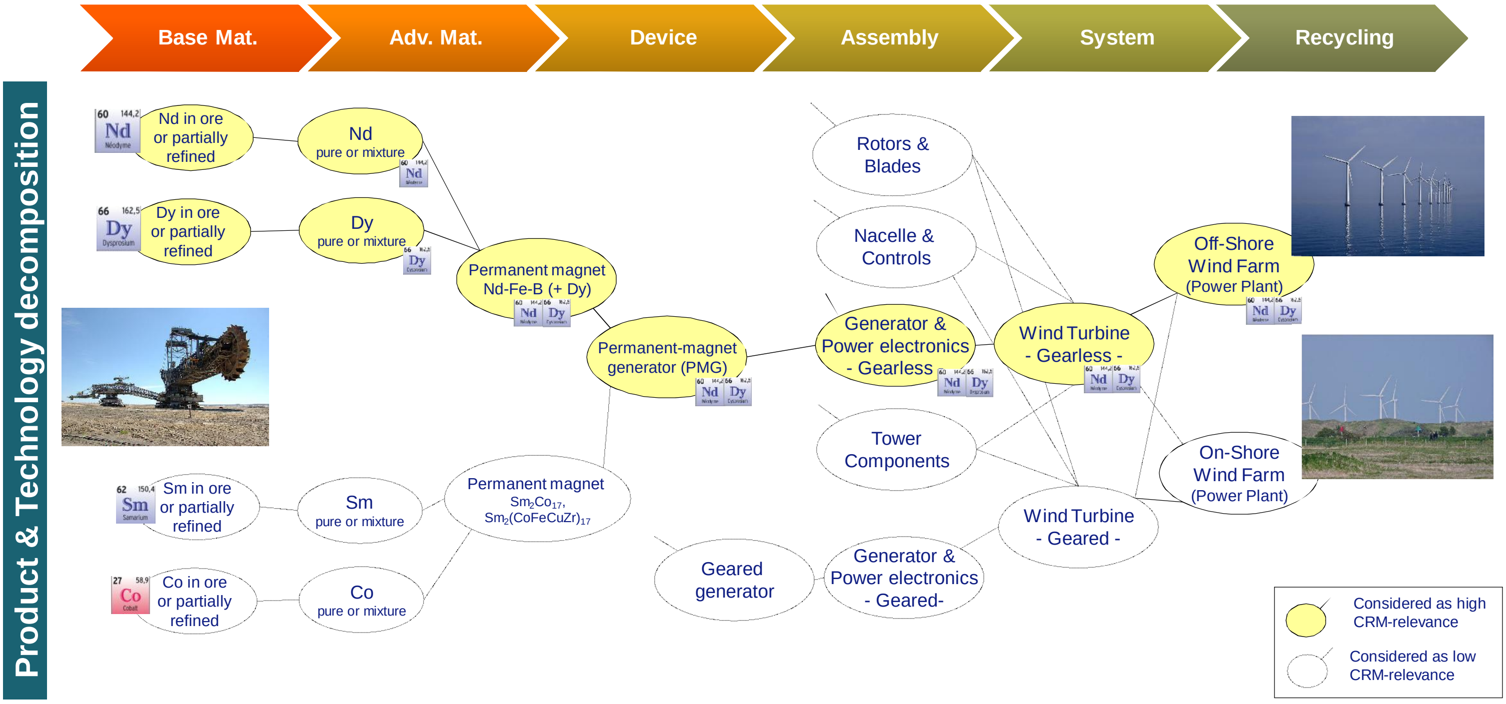

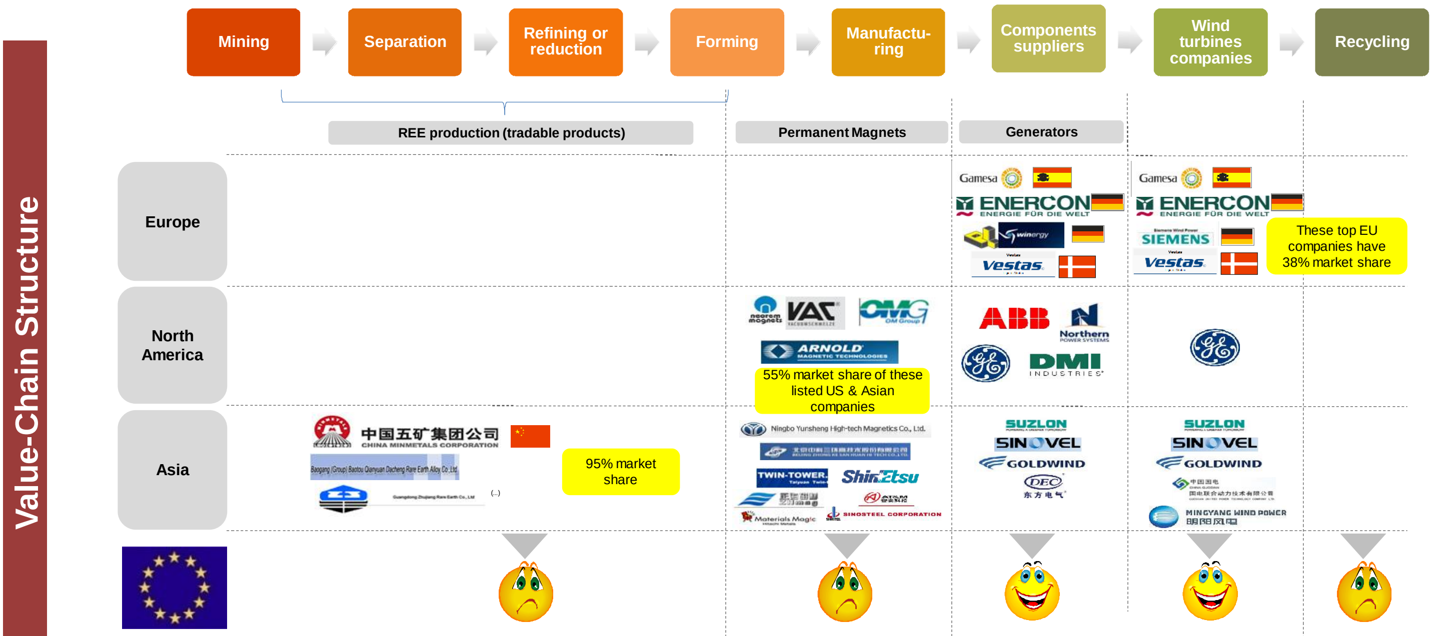

- Europe is poor in CRM reserves and mining
- China possess 95% of the world CRM production and mining capacity

- Estimation of 20% of their activities is dedicated to wind
- China and Japan are the leaders on this value chain segment
- EU PM manufacturer (VAC GmbH) has been bought by OMG (US)

- Europe has 4 companies in top 10 mainly using hybrid or PM (Enercon only) or both technologies and are components and wind turbine manufacturers

- No recycling of REE from wind turbines permanent magnets

Europe position

- Europe has leading components & wind turbine companies (Gamesa, Enercon, Siemens, Vestas) with 38% market share in 2012.
- Europe is not well-positioned for REE and permanent magnets production compared to Asia.

Estimation
• 15b€
• 60 000 FTP

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CRM Value Chain Analysis of LED lighting

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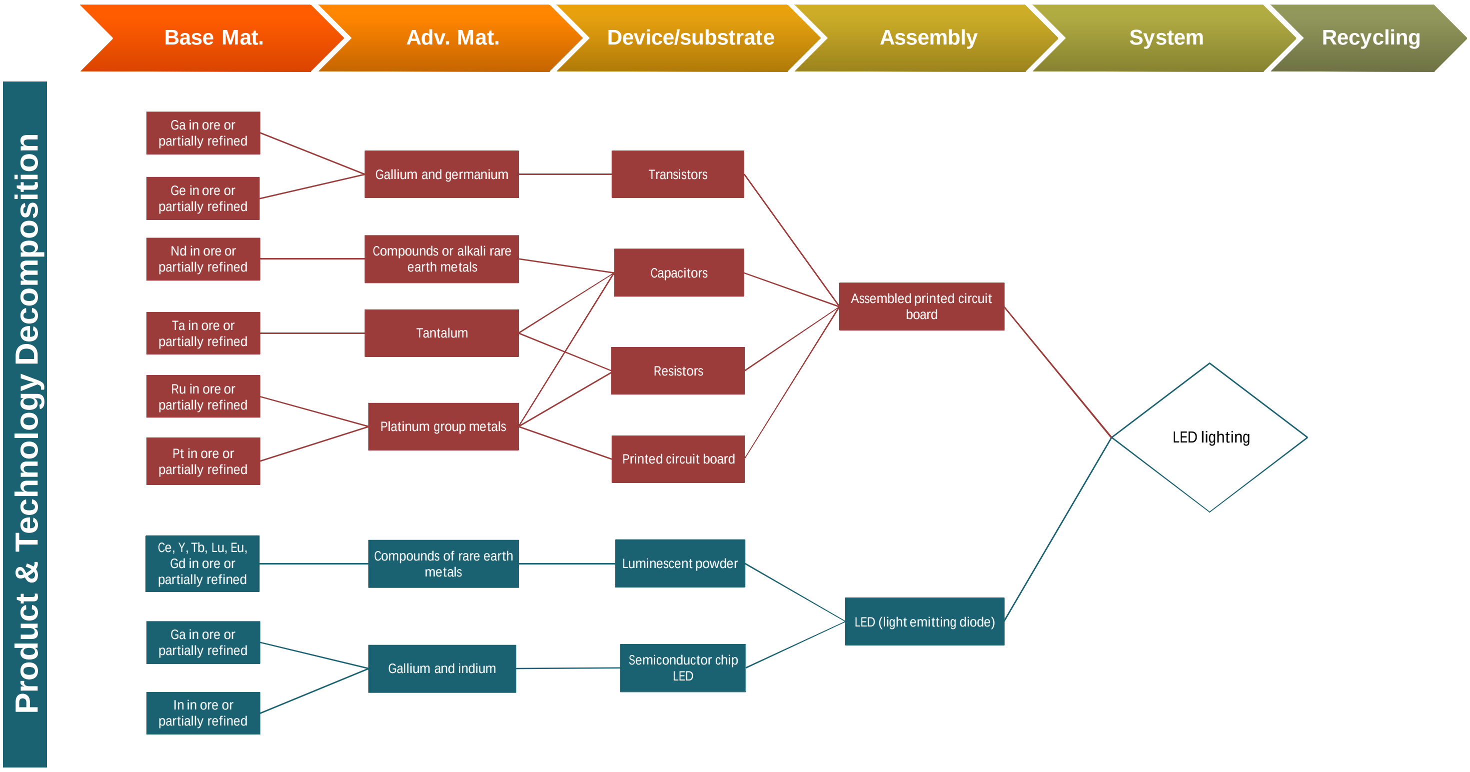
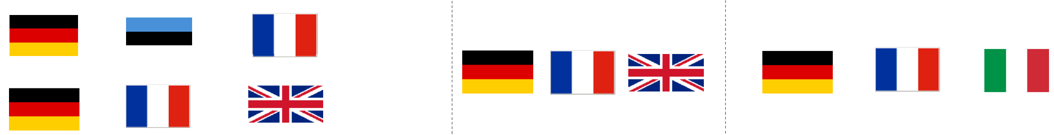
Ulla-Maija MROUEH, Principal Scientist, VTT



Value-Chain Structure

Mining/secondary raw material → Separation → Refining or reduction → Manufacturing and component suppliers → LED companies → Recycling

	REE, indium and gallium production (tradable products)	Light emitting diodes (LED)	LED lighting	
Europe production based on Eurostat PRODCOM groups	• Alkali or alkaline-earth metals; rare-earth metals, scandium and yttrium; mercury • Compounds of rare-earth metals, of yttrium or of scandium or mixtures of these metals **360.000.000 EUR** • Beryllium, chromium, germanium, vanadium, gallium, hafnium ("celtium"), indium, niobium ("columbium"), rhenium and thallium, and articles of these metals, n.e.c.; waste and scrap of these metals (excluding of beryllium, chromium and thallium) **520.000.000 EUR**	• Semiconductor light emitting diodes (LEDs) **205.000.000 EUR**	• Electrical lighting or visual signalling equipment for motor vehicles (excluding electric filament or discharge lamps, sealed beam lamp units, ultraviolet, infrared and arc lamps) • Lighting sets for Christmas trees • Searchlights and spotlights (including for stage sets, photographic or film studios) • Electrical signalling, safety or traffic control equipment for railways or tramways • Electrical signalling, safety or traffic control equipment for roads, inland waterways, parking facilities, port installations or airfields **7.000.000.000 EUR which of 14 % LED lighting**	
Top three EU producer countries for the groups above				
	• Europe is poor in CRM reserves and mining • China possess 95% of the world rare earth production and mining capacity • 1 European company in the top 5 secondary production suppliers • Germany and Ukraine are in the top 4 gallium producers	• LED die production in Europe is limited • Asia produced 78 % of LED dies in 2011.	• The number of companies in the total general LED lighting market is around 4,000 – 6,000 globally. The major three participants (GE Lighting, Osram AG and Philips Lighting) had a market share of 52 % in 2011. • There are approximately 750 – 1,000 companies in the general LED lighting market in Europe.	• No recycling of REE from LED at the moment

Europe position

•Europe is not well-positioned for REE and LED die production compared to Asia. Osram Opto Semiconductor is the single leading European producer of LED dies, with about 7 % production share of the global LED supply in 2011.

•The market of manufacturing actual light sources is highly represented in Europe. In the general LED lighting market Philips Lighting, Osram AG and Havells-Sylvania account around 62 % of EU sales.

Estimation
• 1 b€

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CRM Value Chain Analysis of Magnetic Resonance Imaging (MRI)

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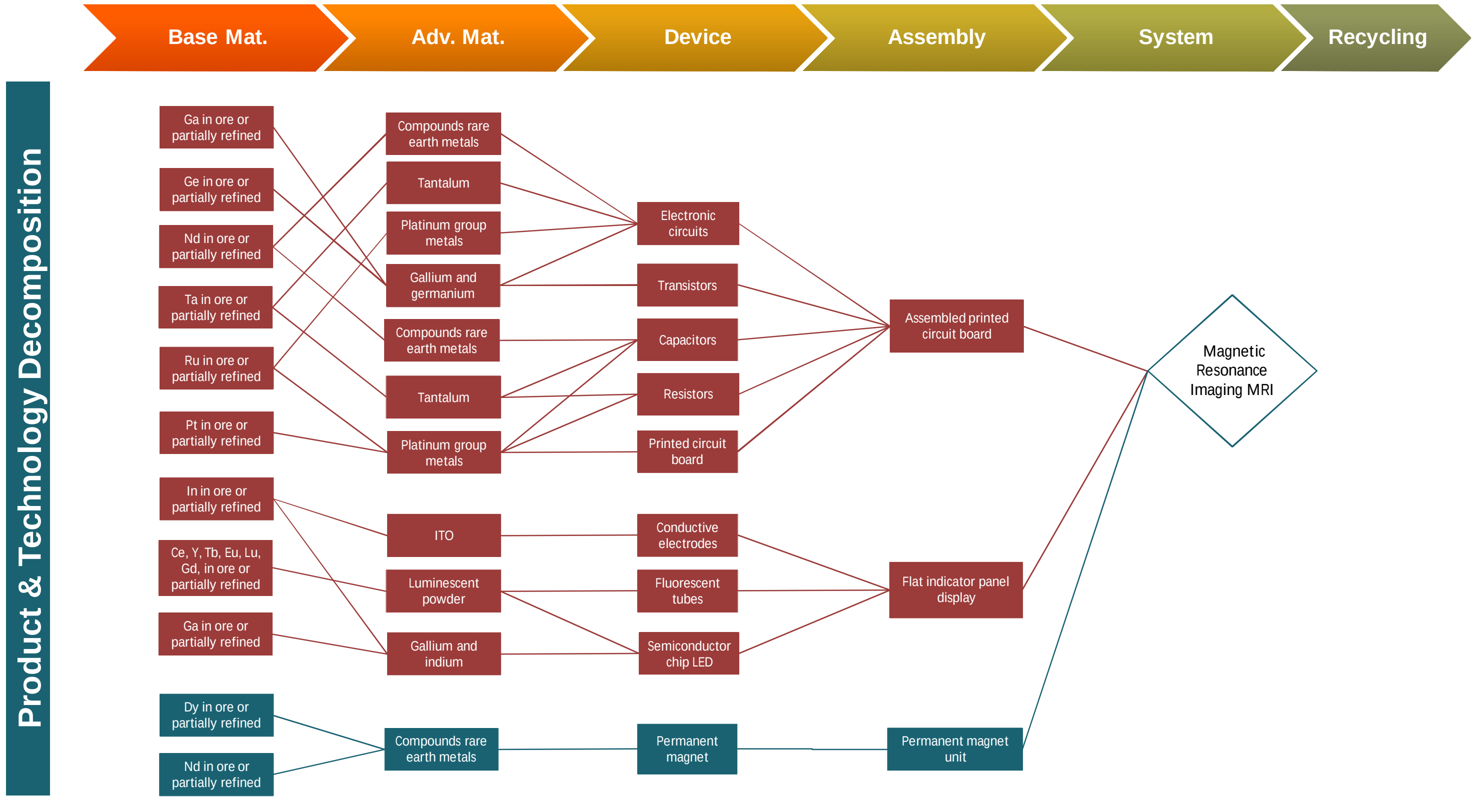

Value-Chain Structure

Mining → Separation → Refining or reduction → Forming → Manufacturing and component suppliers → MRI companies → Recycling

	REE production (tradable products)	Permanent magnets	Magnet unit and MRI systems	
Europe production based on Eurostat PRODCOM groups	• Alkali or alkaline-earth metals; rare-earth metals, scandium and yttrium; mercury • Compounds of rare-earth metals, of yttrium or of scandium or mixtures of these metals **360.000.000 EUR**	• Permanent magnets and articles intended to become permanent magnets, of metal **380.000.000 EUR**	• Apparatus based on the use of X-rays, for medical, surgical, dental or veterinary uses (including radiography and radiotherapy apparatus) **3.300.000.000 EUR which of 20 % MRIs**	
Top three EU producer countries for the groups above	Germany, Estonia, France	Germany, United Kingdom, Finland	Germany, Finland, Italy	
	• Europe is poor in CRM reserves and mining • China possess 95% of the world CRM production and mining capacity	• China and Japan are the leaders on this value chain segment • There are only a few final permanent magnet producers located in Europe. • China produces around 80 % of all permanent magnets, Japan around 17 %, and Europe around 3 %.	• Europe has 2 companies (Siemens Medical Solutions & Phillips Healthcare) in top 5 MRI production companies	• No recycling of REE from MRI permanent magnets

Europe position

• Europe has leading magnetic resonance imaging companies (Siemens Medical Solutions and Phillips Healthcare) with 48% market share in 2011 within EU.

• Europe is not well-positioned for REE and permanent magnets production compared to Asia.

Estimation
• 680 M €

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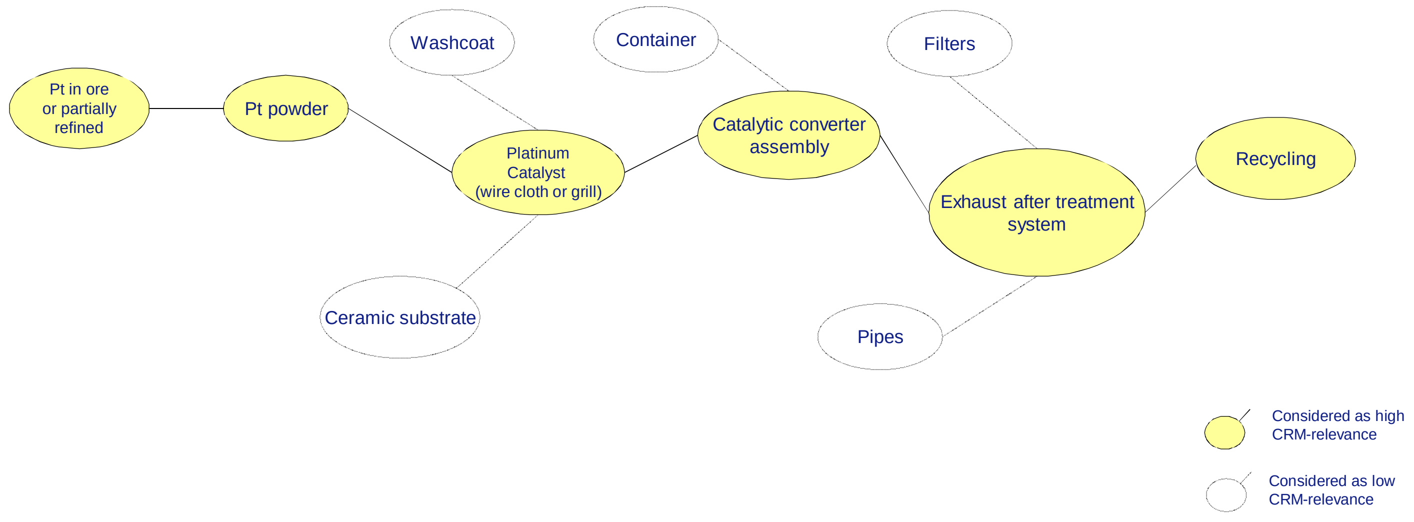
CRM Value Chain Analysis of Platinum Catalyst

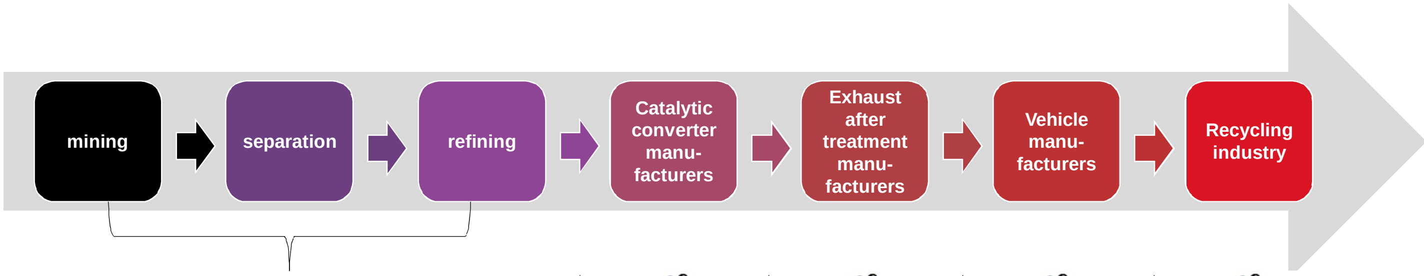
Conny Haraldsson, Deputy Head of Unit • Lisa Bolin, Researcher, SP Technical Research Institute of Sweden

Base Mat. → Adv. Mat. → Device → Assembly → System → Recycling

Product & Technology decomposition



Value-Chain Structure



Europe positioning

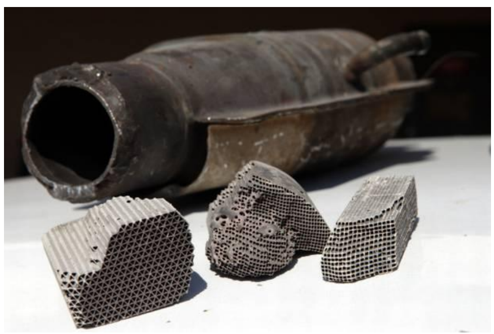
AngloAmerican
bhpbilliton
IMPLATS Distinctly Platinum
NORILSK NICKEL

Johnson Matthey
Eberspächer
HALDOR TOPSØE

DINEX
Swenox
ECOCAT

DAIMLER
FIAT
GM
Ford
PEUGEOT
VW
VOLVO
RENAULT

BASF
SAR



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CRM Value Chain Analysis of High strength low alloy steel

Conny Haraldsson, Deputy Head of Unit • Lisa Bolin, Researcher, SP Technical Research Institute of Sweden

Base Mat. | Adv. Mat. | Device | Assembly | System | Recycling

Product & Technology decomposition

Nb in ore or partially refined

Nb powder

C, Mn, P, S, Si

HSLA with Nb

Section/part of alloy steel

Other alloy steel

Bodies for motor cars, other motor vehicles

Vehicle interior

Car or other motor vehicle

Recycling

Engine system, steering system, brake system

Infotainment

Considered as high CRM-relevance

Contains CRM, but not considered in this particular value chain

Considered as low CRM-relevance

Value-Chain Structure

mining → separation → refining → Steel alloy production → Vehicle manu-facturers → Recycling industry

Europe positioning

CODEMIG

CBMM

Innovate, Respect, Compete.

IAMGOLD CORPORATION

ArcelorMittal

SSAB

OVAKO

TATA STEEL

BMW

DAIMLER

FIAT

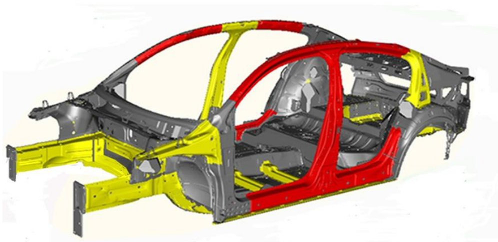
GM

Ford

PEUGEOT

VOLVO

RENAULT



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