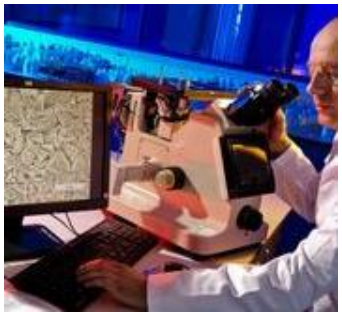
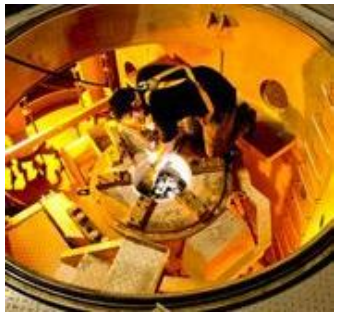
REE OPPORTUNITIES FROM THE EUROPEAN INDUSTRY PERSPECTIVE

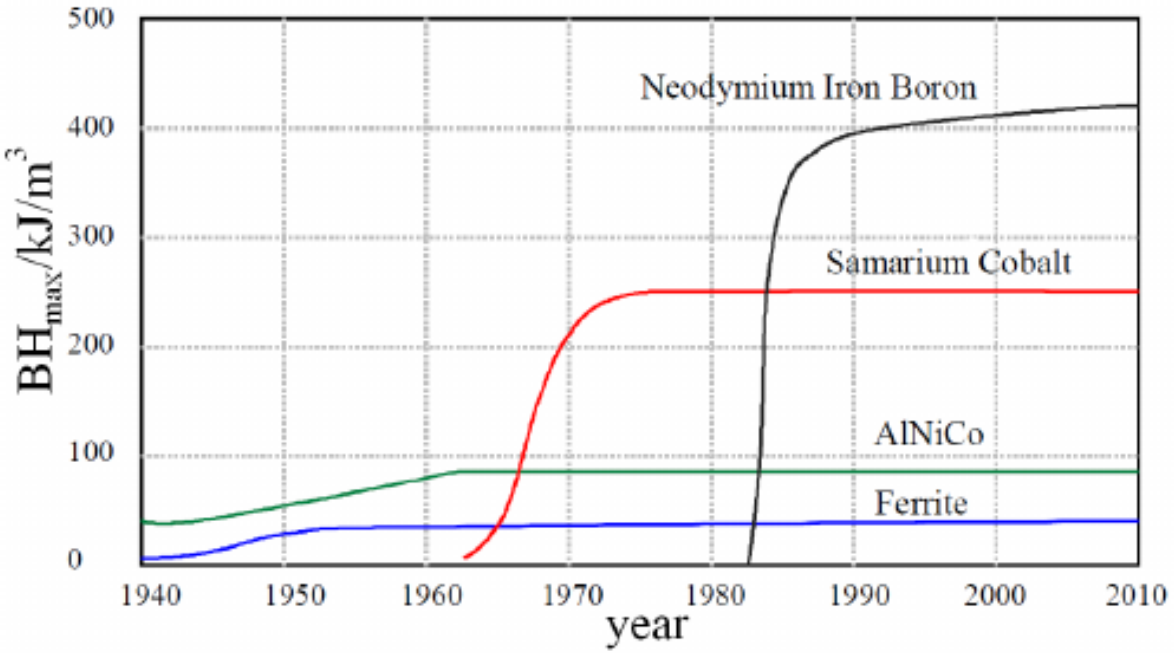
K.A. NYANIN- Technical Manager (LCM)

Less Common Metals - A world leader in rare earth based alloys and high-purity metals

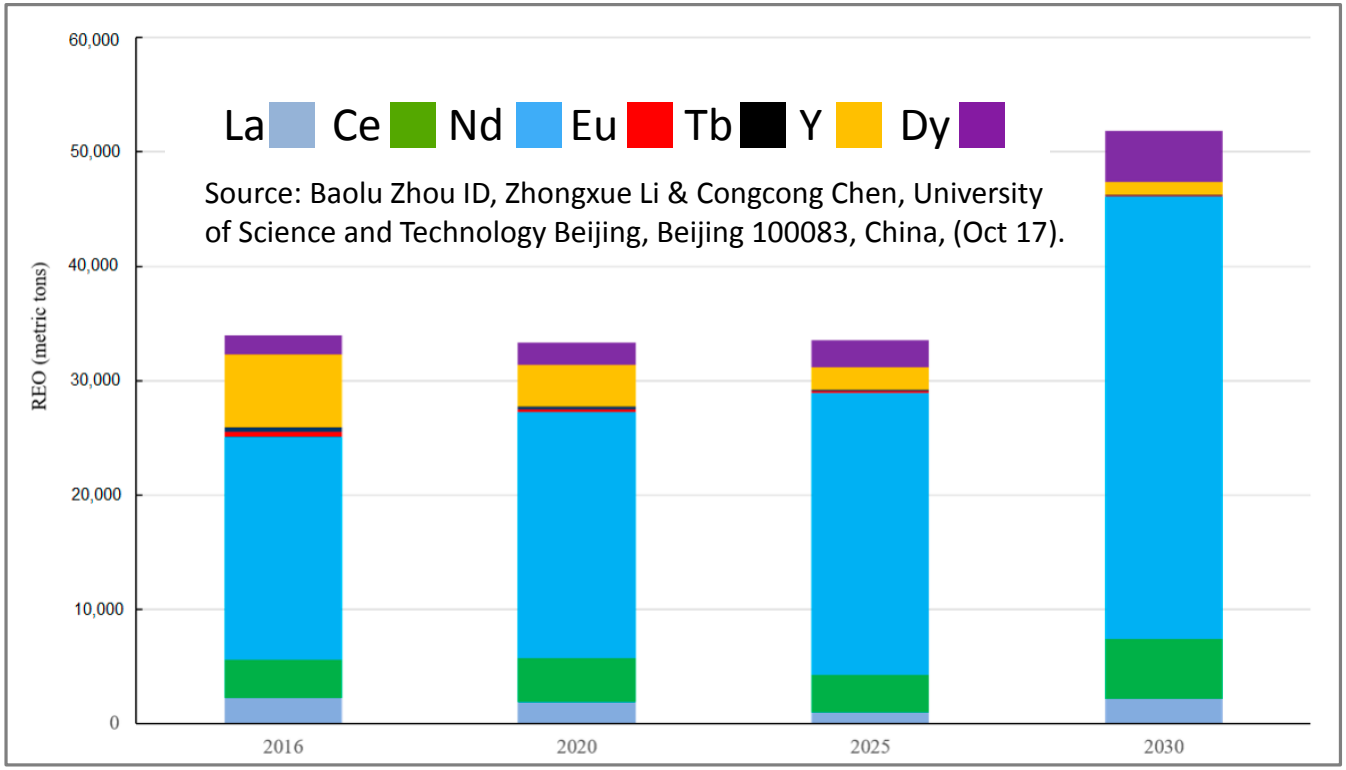
Why the interest in rare earths?

- Many and varied uses
- Often in high-tech industries
- Essential and irreplaceable in many everyday applications



Global Clean Technology Demand to 2030

Year	Wind Power (MW)	Lighting			Electric Vehicles		Batteries	Catalytic Converter
		LFL	CFL	LED	Electric Cars	Electric Bicycles	NiMH Batteries	
		(Million Cps)			(Car)		(Battery)	(Million Cars)
2016	63,350	2142	2903	2675	750,000	35,000,000	580,125	95
2020	79,005	1604	1491	4828	2,140,000	35,500,000	1,251,900	100
2025	76,810	1116	662	5874	7,953,375	36,200,000	715,803	111
2030	107,488	776	294	7146	29,530,323	37,000,000	2,657,729	117



Current situation in Europe

- Huge level of knowledge and experience in downstream processing of rare earths for production of rare earth magnets
  - However, Europe remains dependent on China for raw material supply
    - The few non-Chinese options focus on supply to far-east producers
- Requirement for magnets also dominated by low cost supply from China
- Prospective new upstream suppliers face huge fundraising challenges
- Mantra is “Stable and Secure Supply at Realistic Prices”

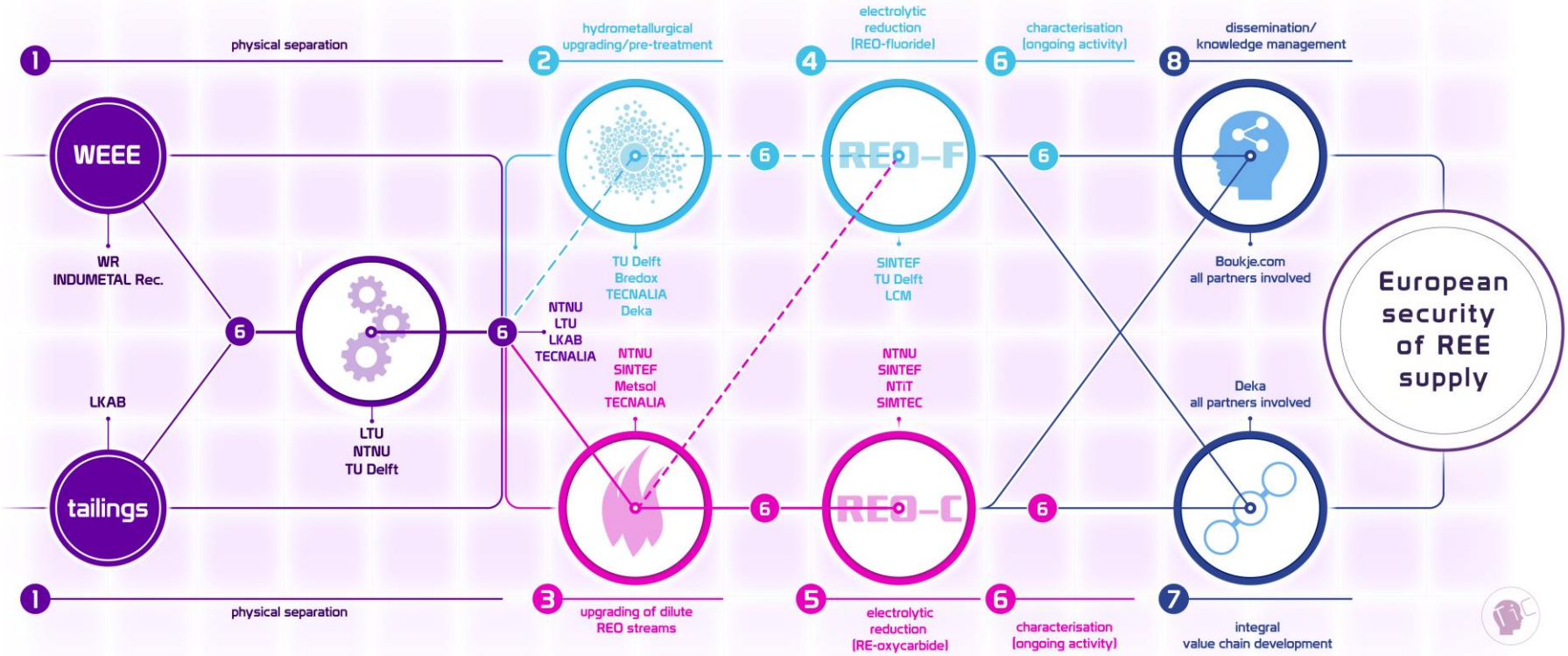
Introduction to LCM

- High quality manufacturer of rare earth alloys for 26 years
  - Main products – alloys for permanent magnet production
- Commercial producer of neodymium metal since 2017
- Long history of co-operation and development with customers and suppliers
- All operations carried out to highest standards of Quality, Environmental and Health & Safety Stewardship
- Participation in European projects gives new opportunities:
  - Establish new all European supply chains.
  - SecREEts project is especially interesting, though not recycling based.

REECover Project Objectives (2014-2017)

To recover Tb, Dy, Nd & Y from two types of industrial wastes:

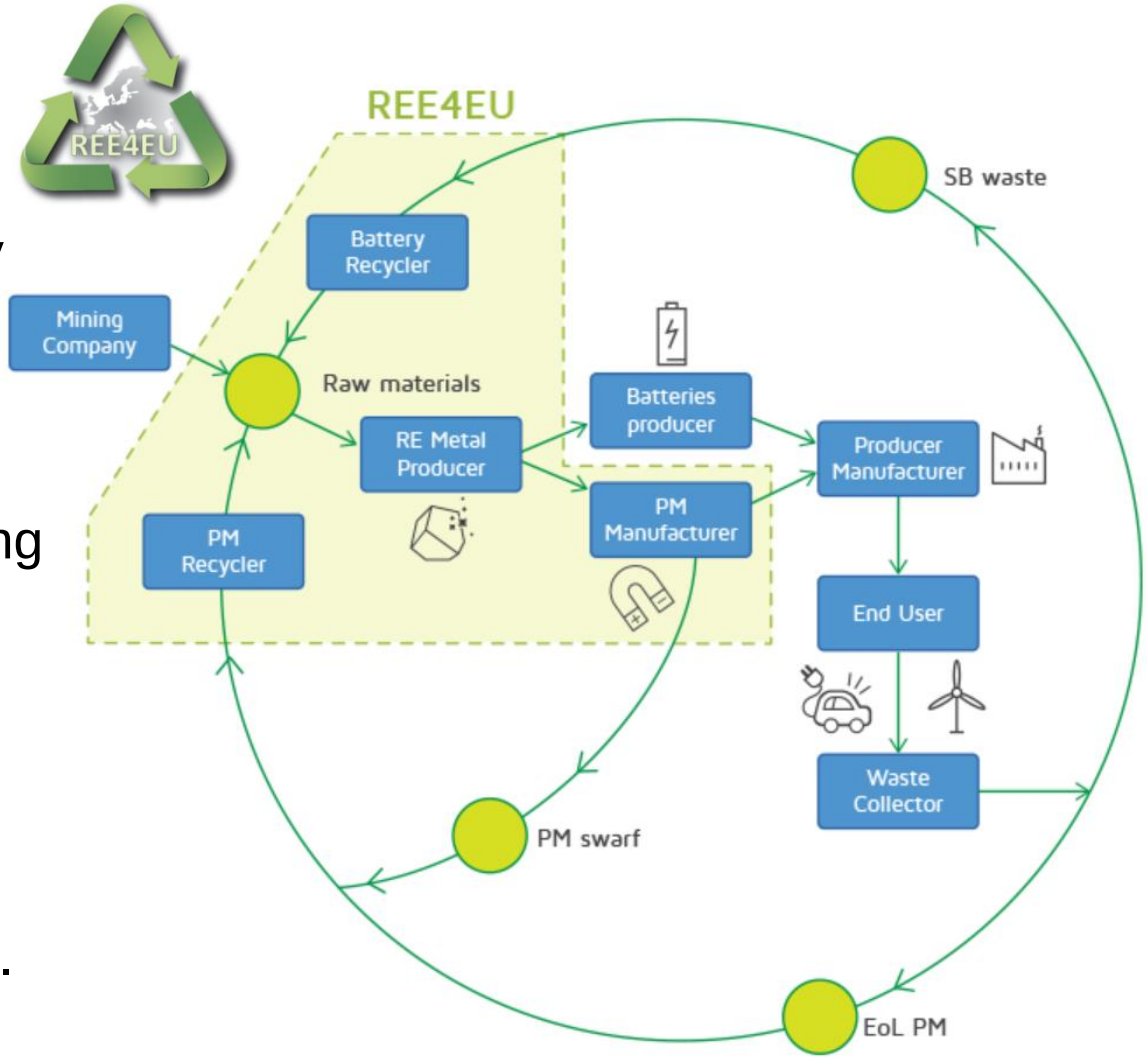
- Tailings from the iron ore industry: representing high volume, but low concentration of REE.
- Magnetic waste material from WEEE recycling industry: representing low volume, but high concentration of REE.



REE4EU Project Objectives (2015 to 2019)

To develop, validate and demonstrate in 2 industrially relevant pilots:

- An innovative Rare Earth Oxide (REO) mixtures extraction technology using ionic liquids.
- A novel direct Rare Earth Alloys (REA) production route for Permanent Magnets (PM) and Secondary Batteries (SB).



LCM in REE4EU

- LCM's role to demonstrate efficient and clean production of Neodymium-Dysprosium-Iron master alloy from oxide generated from the PM stream.
- The fused salt electrolysis cell developed for REECover was modified for master alloy production.
- NdDyFe master alloy was produced and used to produce strip cast alloy which was supplied to Vac for magnet production.
- Magnets produced by Vac demonstrated the technical viability of REE recycling in Europe.

LCM Cell for Master Alloy Production

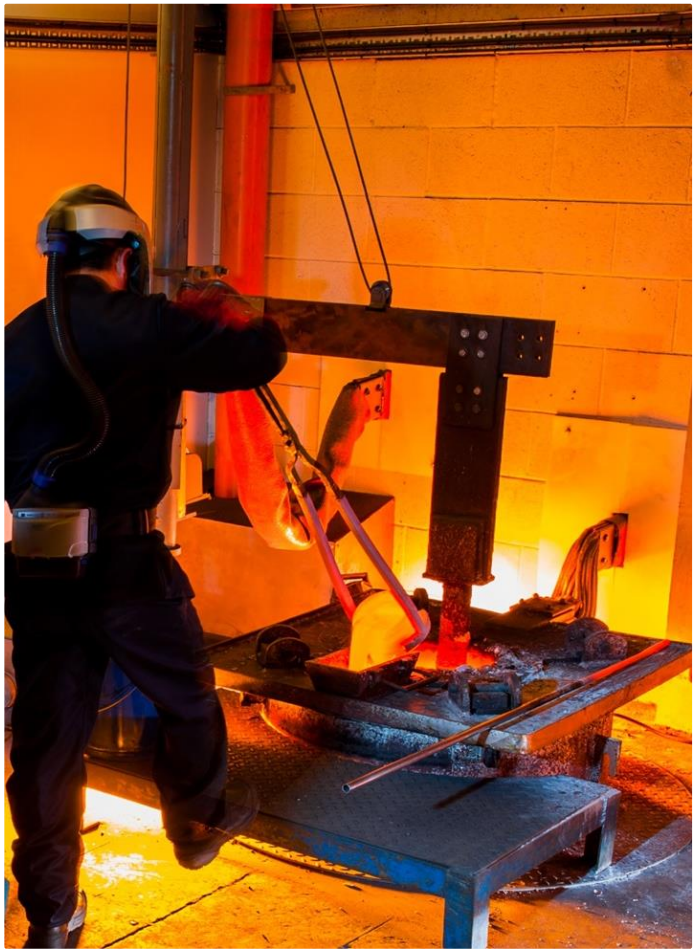
SecREEts (2018-2022)

Secure European Critical Rare Earth ElemenTS

- €17m Horizon 2020 project aimed at creating integrated value-added supply chain for rare earth permanent magnets fully within Europe
- Main participants
  - Yara - Global fertiliser producer with significant levels of RE bi-products
  - REEtec – Norwegian SME with novel separation technology for rare earth elements
  - Less Common Metals – UK rare earth metals and alloy producer
  - Vacuumsmelze – Europe's main producer of permanent magnets
- Advisory panel includes Siemens

LCM in SecREEts

- LCM's role is to demonstrate efficient and clean production of Neodymium and Dysprosium-Iron master alloy from oxide generated.
- New commercial scale fused salt electrolysis cells will be designed and employed in the project.
- RE metals and master alloys produced will be used to produce strip cast alloy to be supplied to Vac for magnet production.
- Magnets produced by Vac demonstrate the technical viability of the integrated European supply chain.



Commercial Neodymium Metal Production at LCM

less common metals

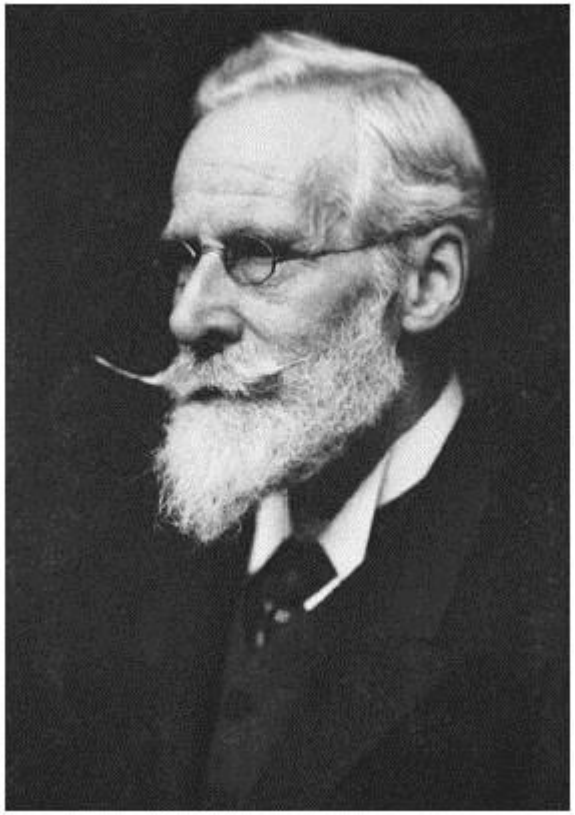
Future Options for new Supply

Rare Earths – A Perspective

"**These elements perplex us in our researches, baffle us in our speculations and haunt us in our dreams. They stretch like an unknown sea before us - mocking, mystifying and murmuring strange revelations and possibilities**“

Sir William Crookes

Address to the British Association, 1887



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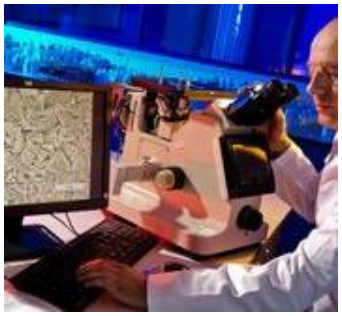
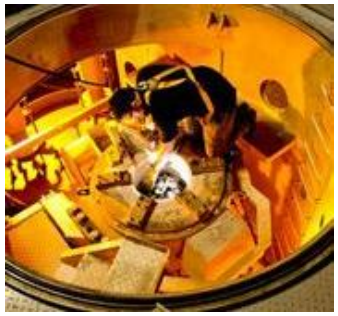

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