



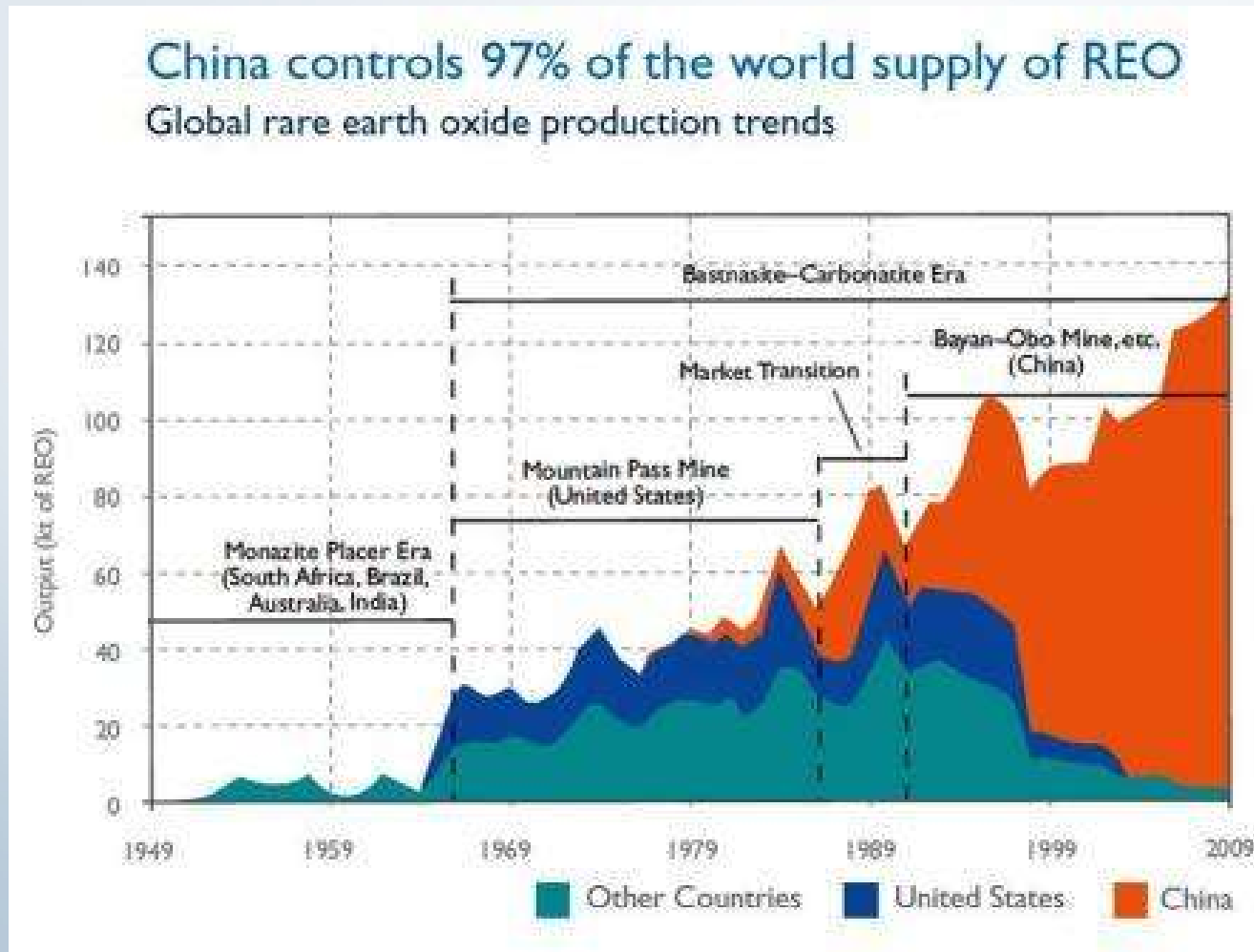
LYNAS

A sustainable non Chinese RE supplier

4th Hydrometallurgy Seminar in Oslo; March 6-7 2018

The Rare Earths production in the world

Some years ago I would probably started my presentation with this graph



The Rare Earths production in the world

This situation is over.
China is still dominating the market,
but no more in a monopoly position.

In Nov 2017, during the 14th RE
Conference, Lynas could claim that
over 20% of NdPr global supply is
marketed by them.

What is Lynas?

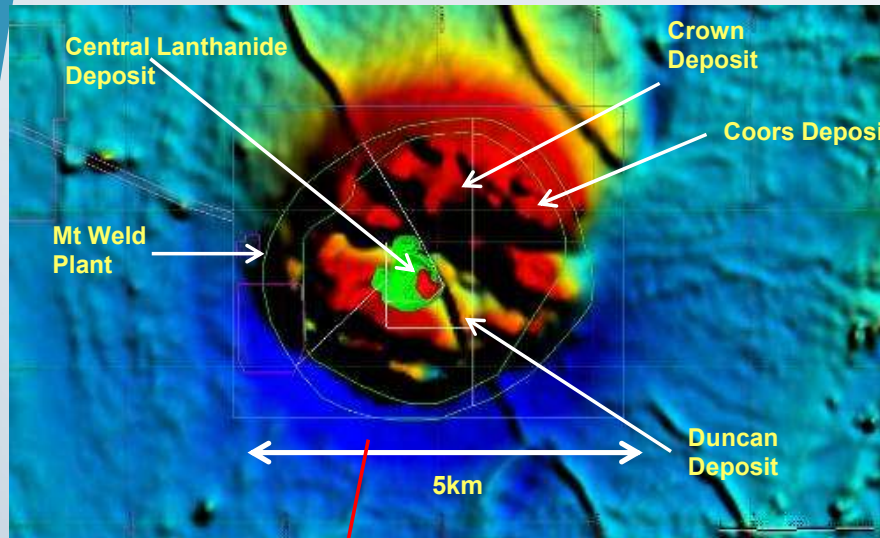
An integrated RE producer from the ore to pure oxides





Mount Weld deposit and operations

Deposits: Key Features



CLD & Duncan Mineral Resource (2.5% REO cut-off)

Category	Tonnes Mt	Grade % REO	Tonnes (kt) REO
CLD	9.88	10.7	1,057
Duncan	7.62	4.8	366
Total	17.49	8.1	1,416

- Current reserves are 2.04Mt @15.2% TLNO
- Following further drilling, reserves are expected to be updated late 2011 / early 2012
- Proven floatable process for the CLD
- Metallurgical test work underway for Duncan

Rare earth content and critical RE distribution (Magnet)

Mount Weld ore v Chinese ores

The main RE market is magnets.
The 4 critical RE for magnets are Pr, Nd, Tb Dy.

- CLD has a Pr Nd content close to Bayan Obo (main source of LRE),
- Duncan has a Tb Dy content about half of the ionic clays (main source of the HRE)

	Mount Weld		China	
	CLD Currently used	Duncan Starts in 2018	Bayan Obo Main Chinese source of PrNd	Middle Y Main Chinese source of TbDy
Mineral	Secondary monazite	Churchite	Bastnasite	Ionic clay
	(Ln,Y,Th)PO ₄	(Ln,Y)PO ₄ ·2H ₂ O	(Ce,Ln,Y)(CO ₃)F	(Al,Si)O _x ,RE
REO	10,7%	4,8%	4% to 6%	0,3%
Pr ₆ O ₁₁	4,9%	4,9%	5,0%	7,0%
Nd ₂ O ₃	16,9%	18,1%	15,2%	26,4%
Tb ₄ O ₇	0,13%	0,29%	0,03%	0,70%
Dy ₂ O ₃	0,31%	1,36%	0,09%	2,90%

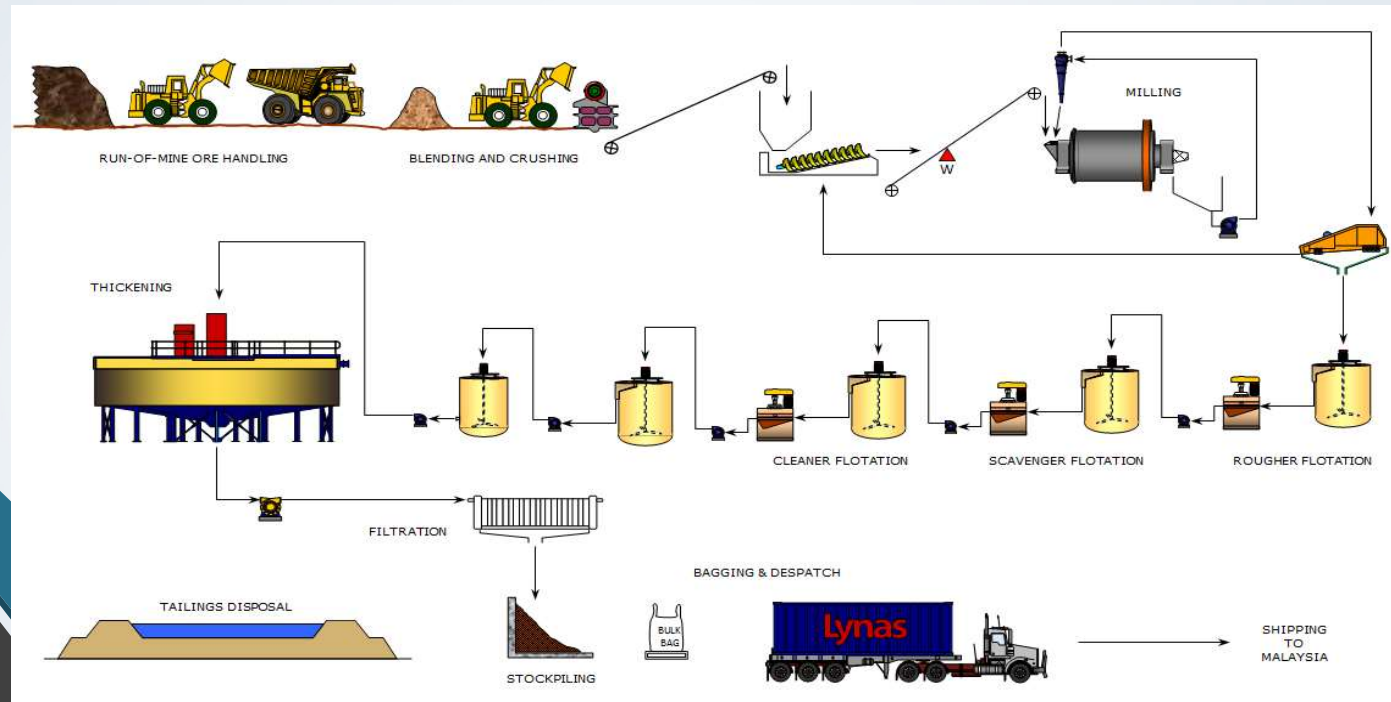
All Rare Earths minerals contain natural radioactivity

Thorium and Uranium contents in the RE mines in operation

	RE Mineral	Monazite		Bastnasite		Loparite
	Deposit	Mount Weld	Orissa	Bayan Obo	Mountain pass	Lovozero
Ore concentrate	REO	38%	61,57%	60%	63%	32%
	ThO ₂	0,16%	10,50%	0,20%	0,35%	0,50%
	U ₃ O ₈	0,0029%	0,04%			
	ThO ₂ /REO	0,42%	17,05%	0,33%	0,55%	1,56%
	U ₃ O ₈ /REO	76 ppm	650 ppm			

- Although the Mount Weld ore is a monazite, its Thorium content (4200ppm ThO₂/REO) is more comparable to a Bastnasite.

Mount Weld concentration plant



- Annual throughput of 242,000tpa, producing 76,000t concentrate containing 29,000 REOt
- Concentration from 16% to 38% REO
- RE recovery 75%
- NdPr recovery 80 %

The concentrate is shipped from Mount Weld to Kuantan





Kuantan plant in Malaysia

Cracking & Leaching

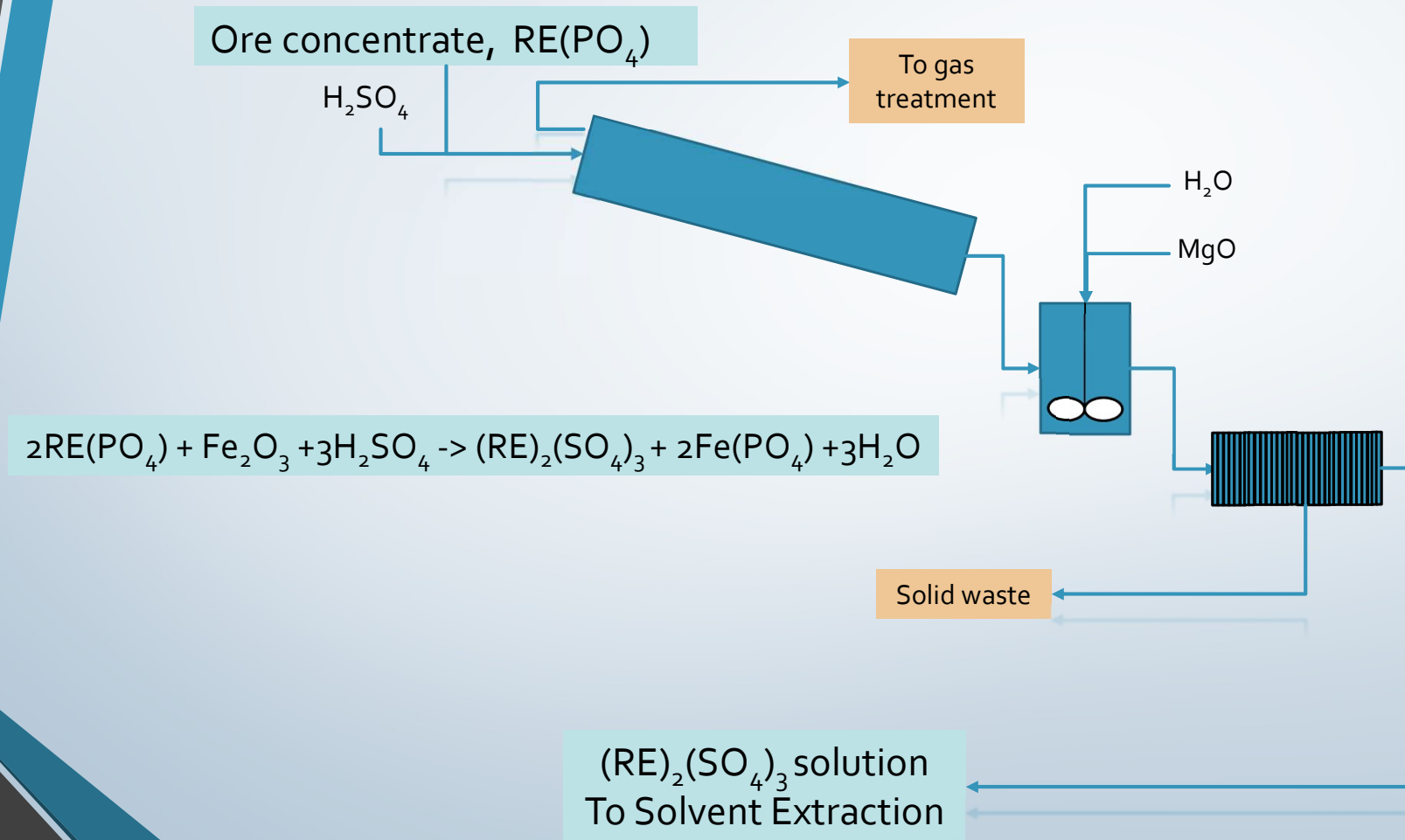
RE separation by Solvent Extraction

RE pure oxides production



Cracking and Leaching Plant

Sulfuric baking and roasted sulfate leaching



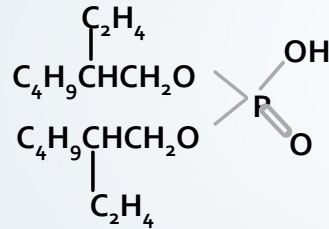


Solvent Extraction Plant

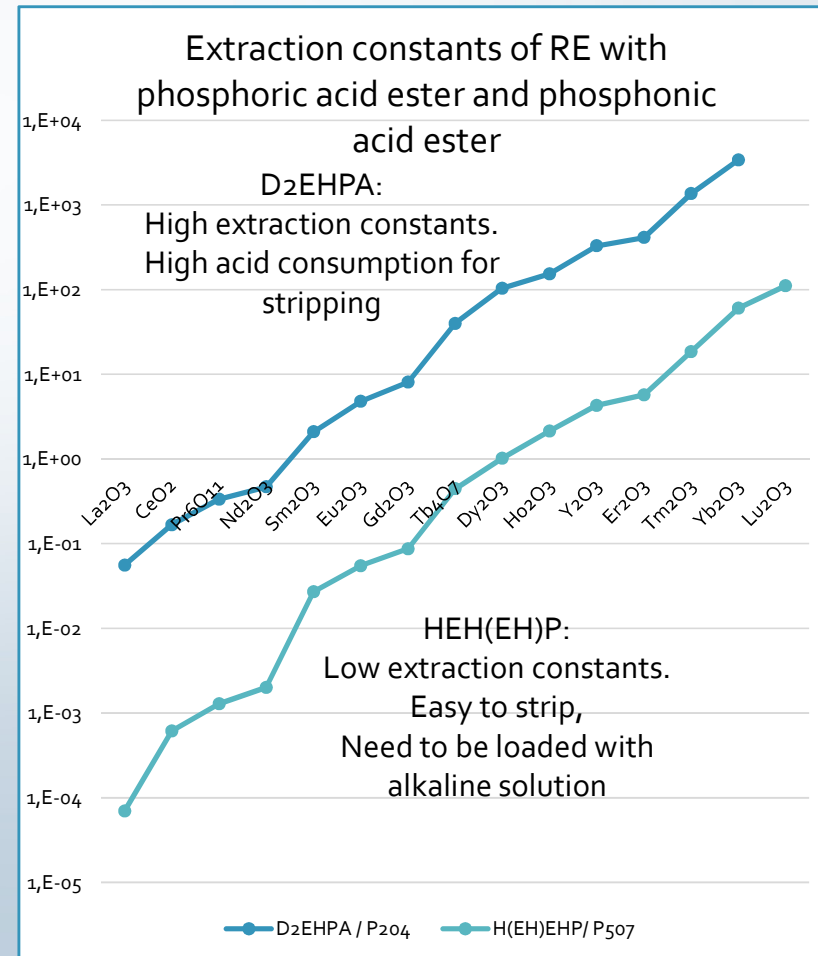
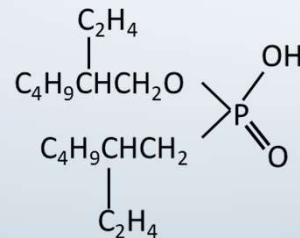
Solvent Extraction

The Phosphonic and Phosphoric acid esters are the most selective molecules along the Lanthanide series

RE Extracting molecules:
Phosphoric acid ester
D2EHPA / P204

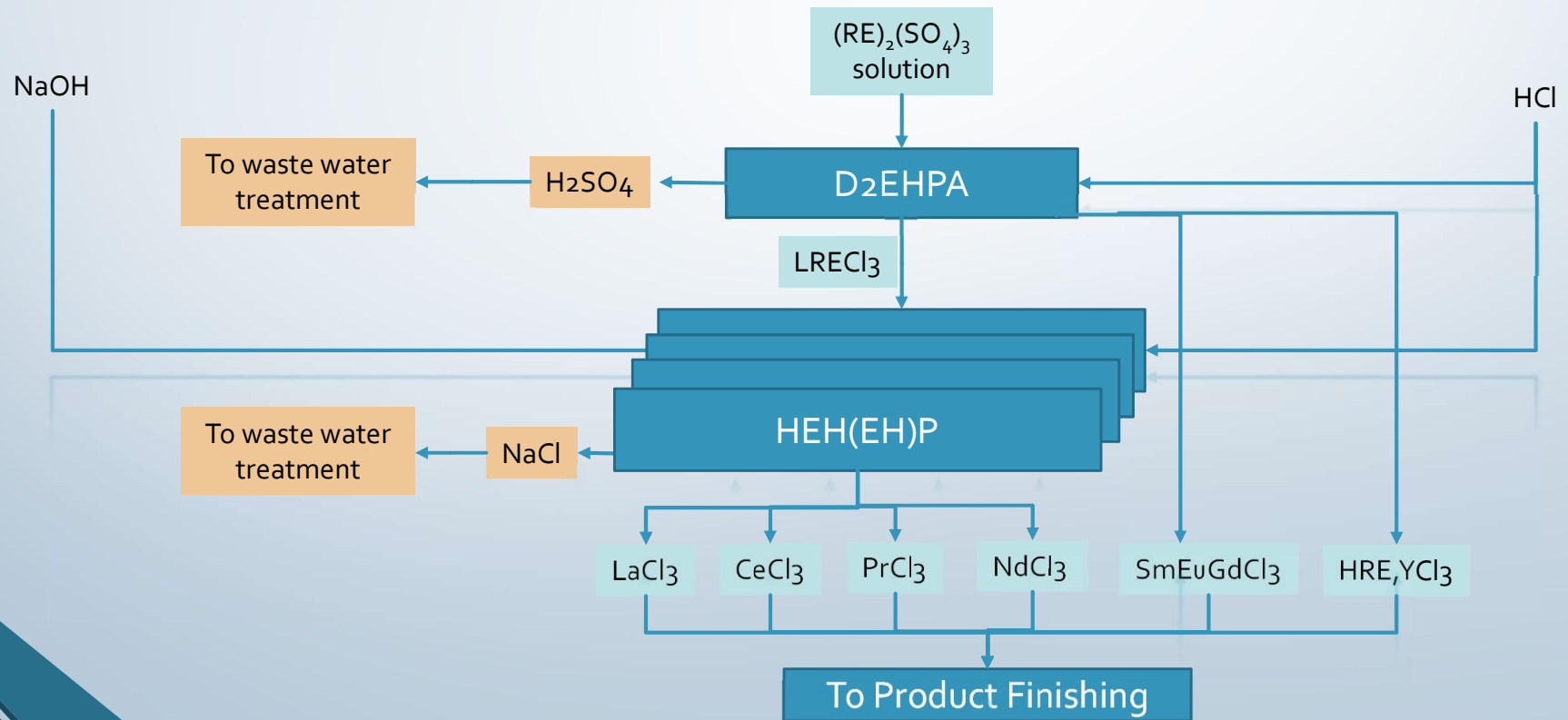


Phosphonic acid ester
HEH(EH)P / P507



Solvent Extraction - Lynas process principles

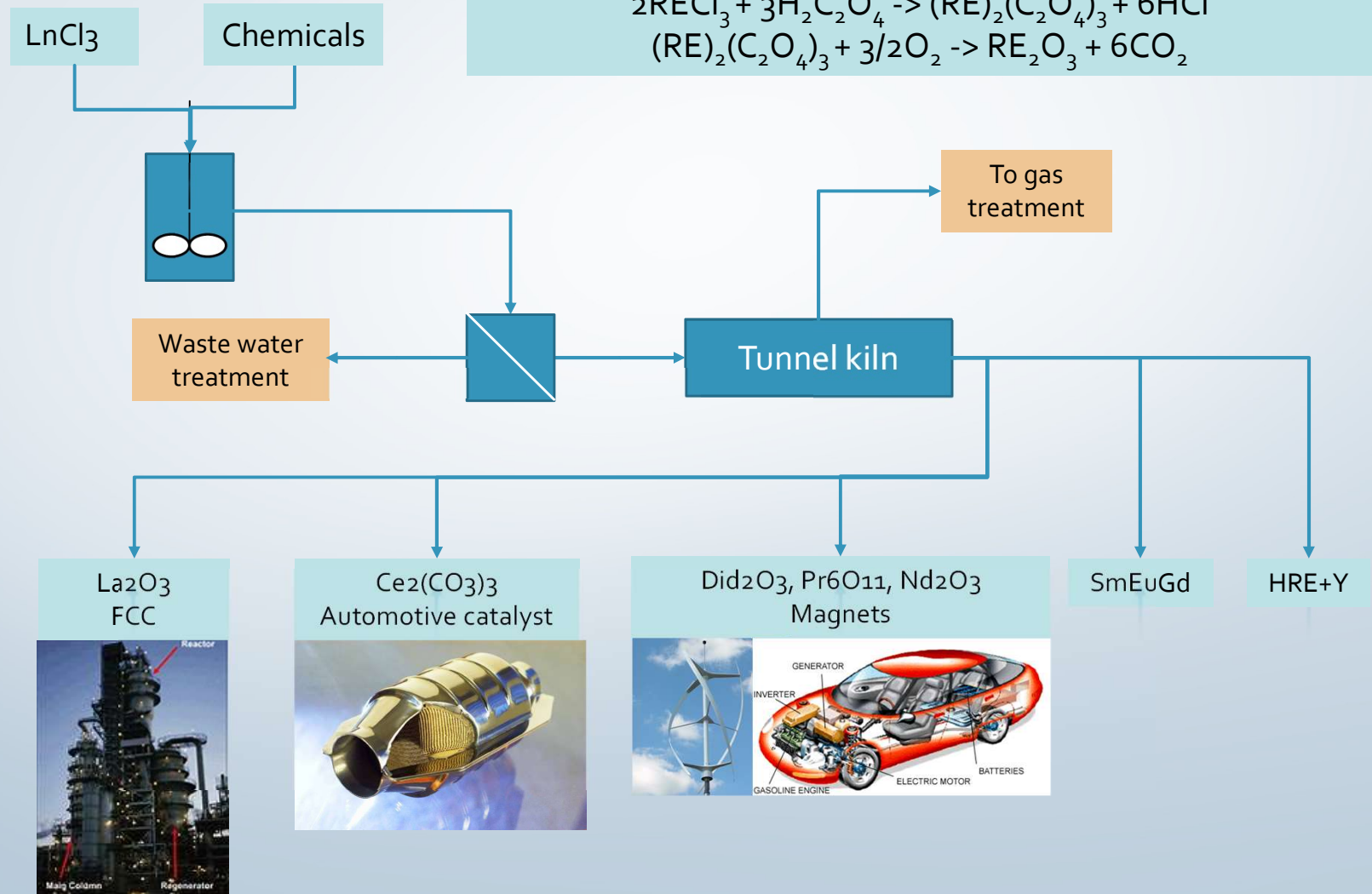
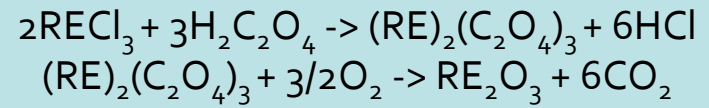
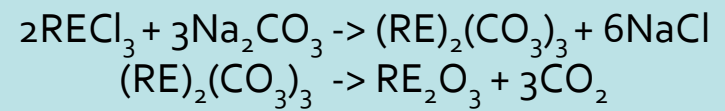
- Because of the precipitation of double sulfate $(\text{Na,RE})(\text{SO}_4)_2$, it is impossible to load the solvent with NaOH in sulfate medium. Only a strong acidic extractant is able to extract RE from sulfate medium.
- After the conversion of sulfate into chloride solution using D2EHPA, the RE can be separated using HEH(EH)P





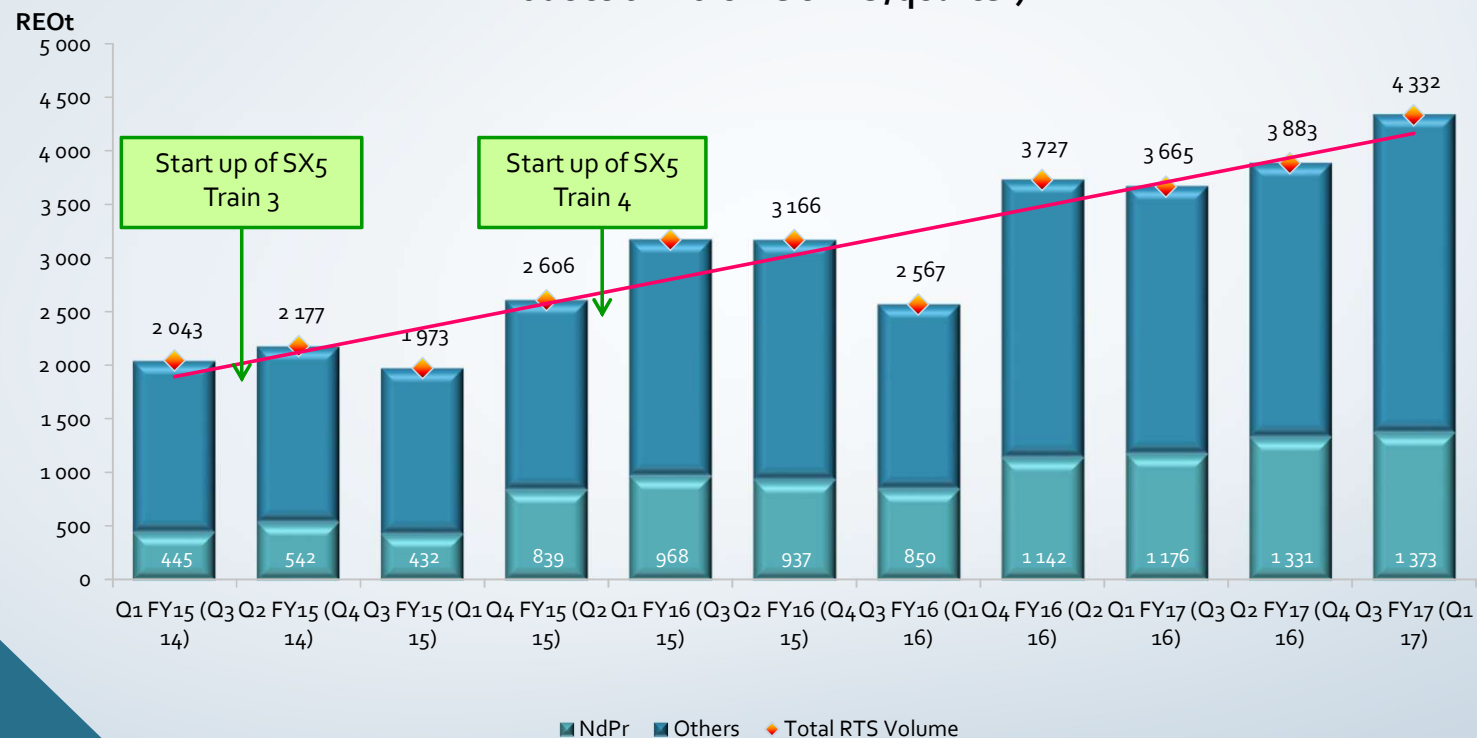
Product Finishing Plant

Product Finishing



Lynas Kuatan finished products output

Production Volume tREO/quarter)



- 100% of capacity commissioned and operating
- NdPr production above nameplate capacity; >450 tpm PrNd oxide
- Project to increase PrNd capacity to 600tpm in progress

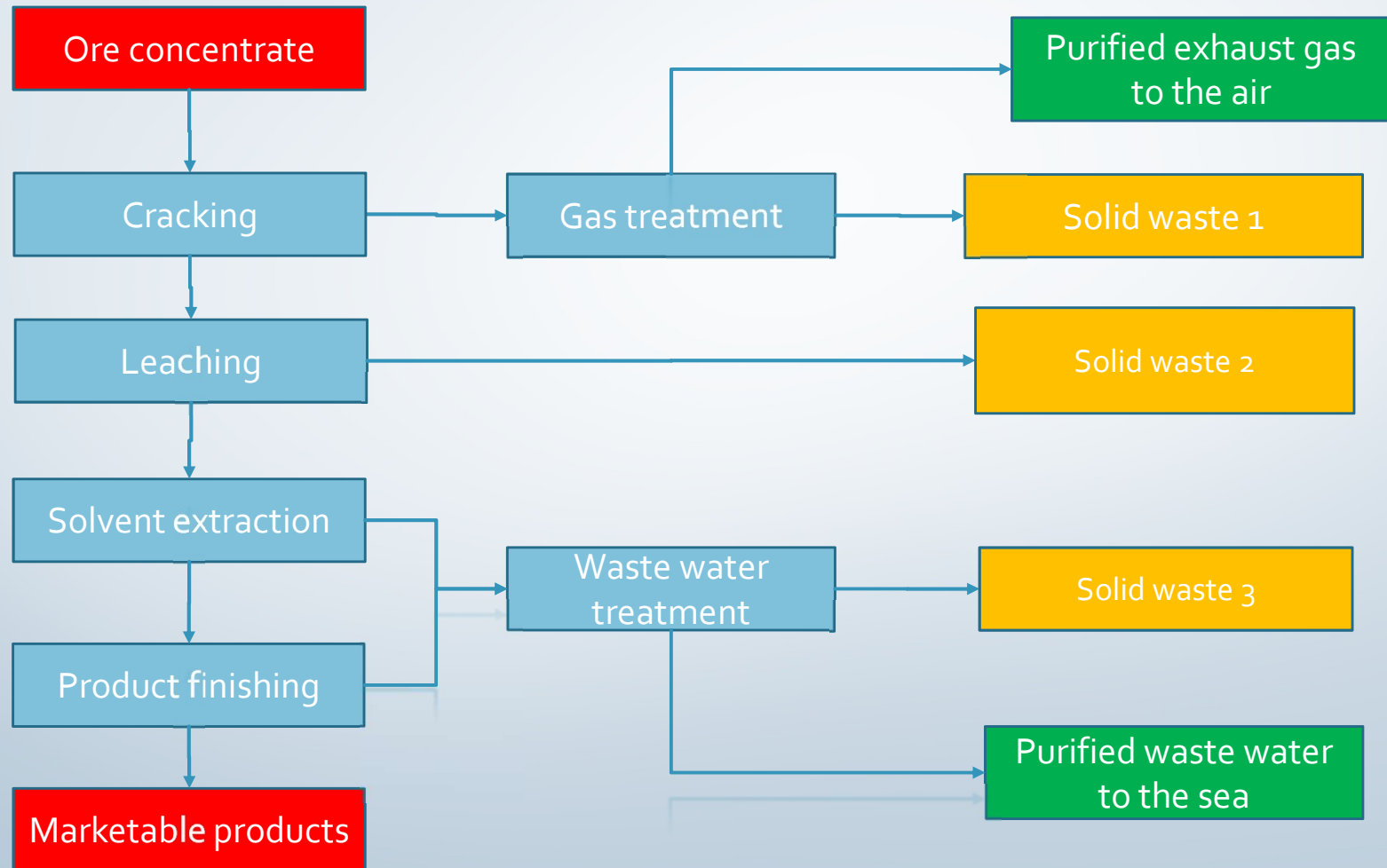


Waste management

Mount Weld Environment key issue: Water management

- Fresh water consumption already reduced from >50 to 20m³/ton of concentrate using Ultrafiltration and Reverse Osmosis treatment of tailings decant water
- This year the consumption will be further reduced to 10m³/ton of concentrate (equivalent to the aquifer recharge rate) using Dissolved Air Flotation

Kuantan plant waste management



Gas emission control



Potential Impact of RE Processing

- Without treatment, Kuantan would emit as much SO_2 as a 1GW coal power plant in USA.

Kuantan plant treatment

- 2 dedicated plants treat all gases from cracking
- 5 stage gas scrubbing facility to eliminate harmful gas emissions
 - SO_3 - SO_2
 - Dust and mist
 - HF (Lynas ore carries only traces of Fluorine, whereas bastnasites contain up to 7% Fluor)

Waste water Treatment



Kuantan plant Treatment

- Neutralisation processes remove acidity, metals and other minerals
- Sodium based reagents, no use of ammonium chemicals
- Activated sludge bio-treatment removes the traces of organic coming from SX

The waste water contains mainly NaCl
The effluent quality measurements are all significantly below permissible limits

Solid Wastes



- The natural radioactivity is not concentrated during the process. Solid wastes with a very low natural radioactivity are stored on site.
- The company is working on long term solutions for the recycling of these materials into agricultural application.

Radiation Monitoring



The data are publicly accessible

The IAEA mission (2014) conclusions are:
"Lynas have satisfactorily implemented all the recommendations formulated by the review team of the 2011 mission ... it became evident that the radiological risks to members of the public and to the environment associated with the operation of Lynas Plant are intrinsically low. »

From the public data available there is no increase in back ground radiation at 5/10/20km from the plant

A global assessment of the environmental impact of RE industry is mandatory

- While the RE are necessary for the green technologies, the image in the public of the environmental impact of the RE industry is very bad:

Baotou pond in inner Mongolia



Ionic clays leaching in Jianxi



- There is no global Life Cycle Assessment study available for the RE industry.
- Lynas has launched a LCA of the RE industry in cooperation with EU (Demeter Project)
 - Results available by mid 2018.



Thank you for your attention