



**SOLVAY**

asking more from chemistry®

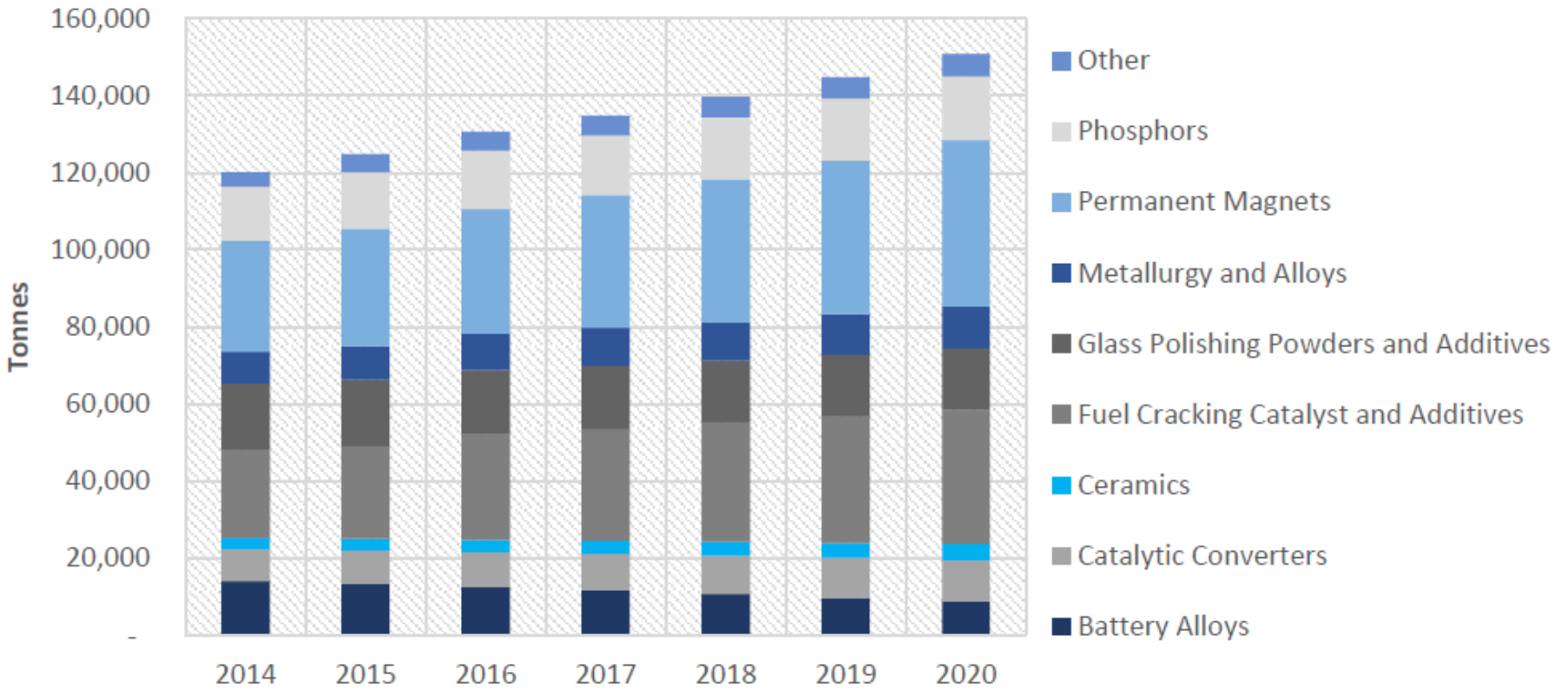
# Le marché des Terres Rares et l'évolution des technologies

Québec Mines 2015 – 23 au 26 Novembre 2015

# The world wide RE market evolution

## A global growth CAGR of 4% dominated by Magnets

Source: Adamas Intelligence Oct 2014



# *The challenges of a RE market forecast*

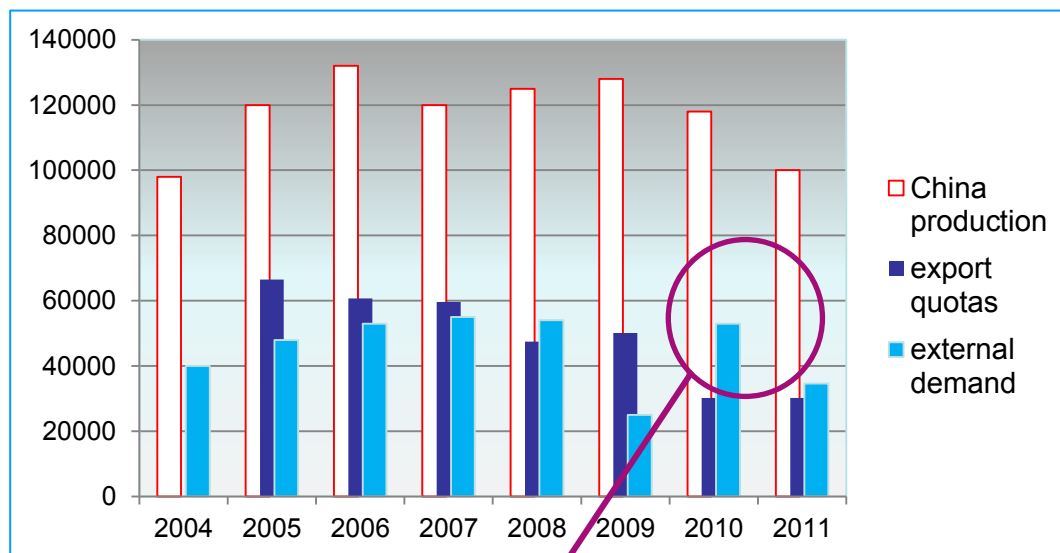
- The recent history shows that main of the previous forecasts have failed
- Actually, the RE market forecast is difficult for 3 main reasons:
  1. Uncertainty about the Chinese market and policy
  2. The difficult issue of RE equilibrium
  3. But also the quick evolution of technologies

# 1 Chinese market and policy:

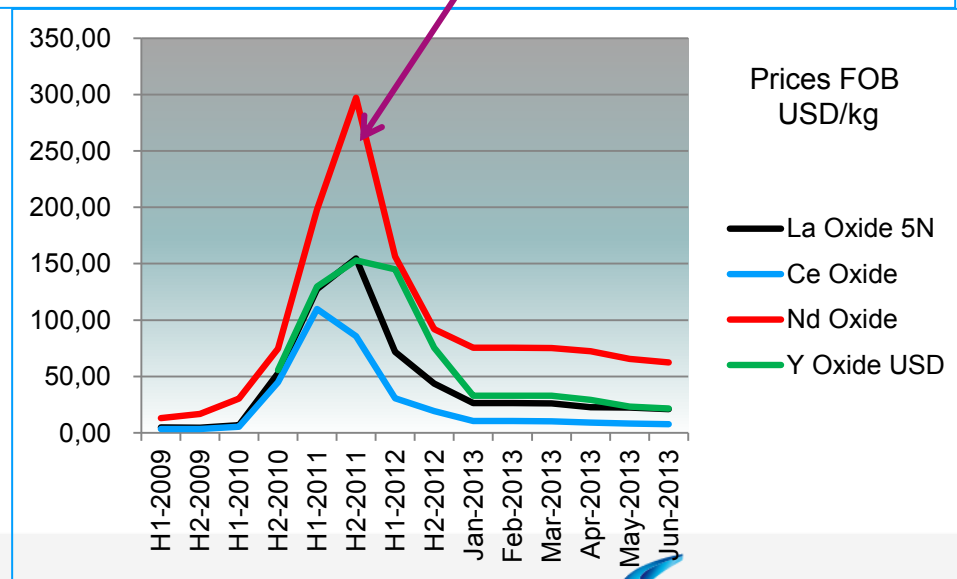
From 2005 to 2015 China has decided to limit its exports by a quotas policy ...

With 2 objectives:

- Controlling its resources,
- Promoting its downstream production



*...in 2010 a -40% cut in the quotas generated a major crisis impacting drastically the prices on the market*



# 1 Chinese illegal production

## Illegal Production of Nd & Pr in China

(With a range of demand forecasts for 2015)

### Estimation of Illegal Production of Neodymium and Praseodymium in China ( $\pm 15\%$ )

Basis of Calculations: Dr Chen's Presentations to the Metal Pages Rare Earths Conference in Shanghai in 2015 (Slide #16)' amended by DJK

Assume: Pr/Nd average content of quota production is 20% ;95% conversion REO to metal and some re-cycling (~10%)

Notes: 1. Amended to 27½% Nd+Pr to allow for Ce and Gd use in lower grade magnets, replacing Nd/Pr – (average total RE metal is 31%)

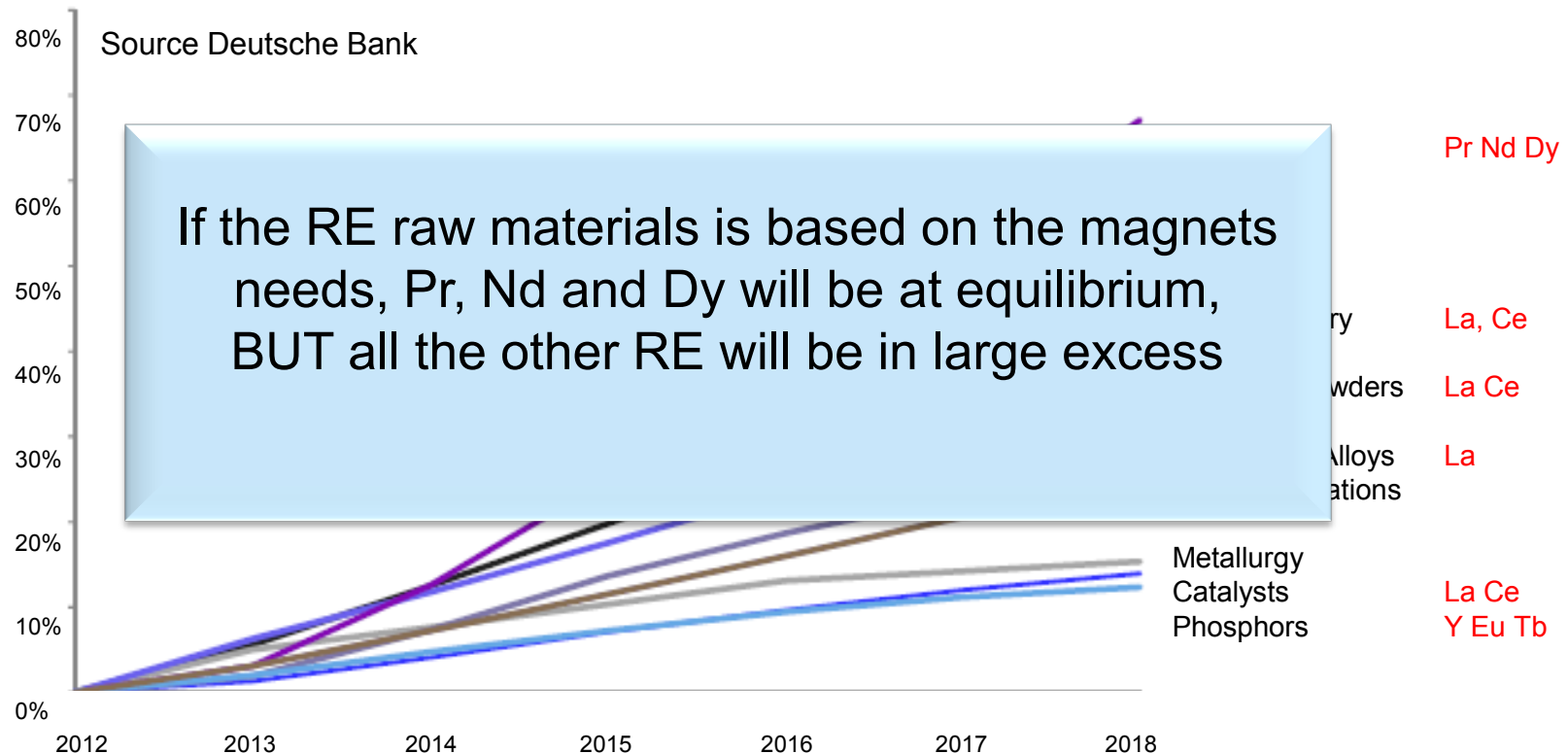
2. Amended to show demand in 2014 & 2015 based on discussions with Dr Chen and Chinese industry participants. 3. This Table excludes Nd/Pr exports and other uses for Nd and Pr, so does wholly concur with Slide #6 4. Figures have been rounded.

Year	'New' Magnet Demand: REO Requirement			Production Quota		Shortfall Pr <sub>6</sub> O <sub>11</sub> + Nd <sub>2</sub> O <sub>3</sub>	Required Production Quota and Shortfall		
	Sintered + Bonded	Pr/Nd Metal @27½%	Pr <sub>6</sub> O <sub>11</sub> + Nd <sub>2</sub> O <sub>3</sub> @85% oxide	Tonnes REO	Pr <sub>6</sub> O <sub>11</sub> + Nd <sub>2</sub> O <sub>3</sub>		Tonnes REO	Shortfall	Per Cent Illegal
2013 <sup>o</sup>	80,000	20,000	25,000	95,000	19,000	6,000	125,000	25-35,000	24%
2014 <sup>o</sup>	90,000	22,500	28,000	105,000	21,000	7,000	140,000	30-40,000	25%
2015 <sup>f</sup> Low	100,000	25,000	31,000	105,000	21,000	10,000	155,000	45-55,000	32%
2015 <sup>f</sup> High	120,000	30,000	37,500	105,000	21,000	16,750	175,000	65-75,000	40%

Source: D Kingsnorth IMCOA 11t RE Conf Nov 2015

## 2 The difficult issue of RE equilibrium

- A global growth of 5% / year between 2012 and 2018
- The magnets growth (7%) is much important than all the other markets



- *Individual REE have their own lifecycle on the market but they are linked in the raw materials with a limited flexibility.*

Processing costs are significantly impacted by REE without market and the Magnet market cannot bear all the surplus costs

# The RE market evolution: The view of the market analysts

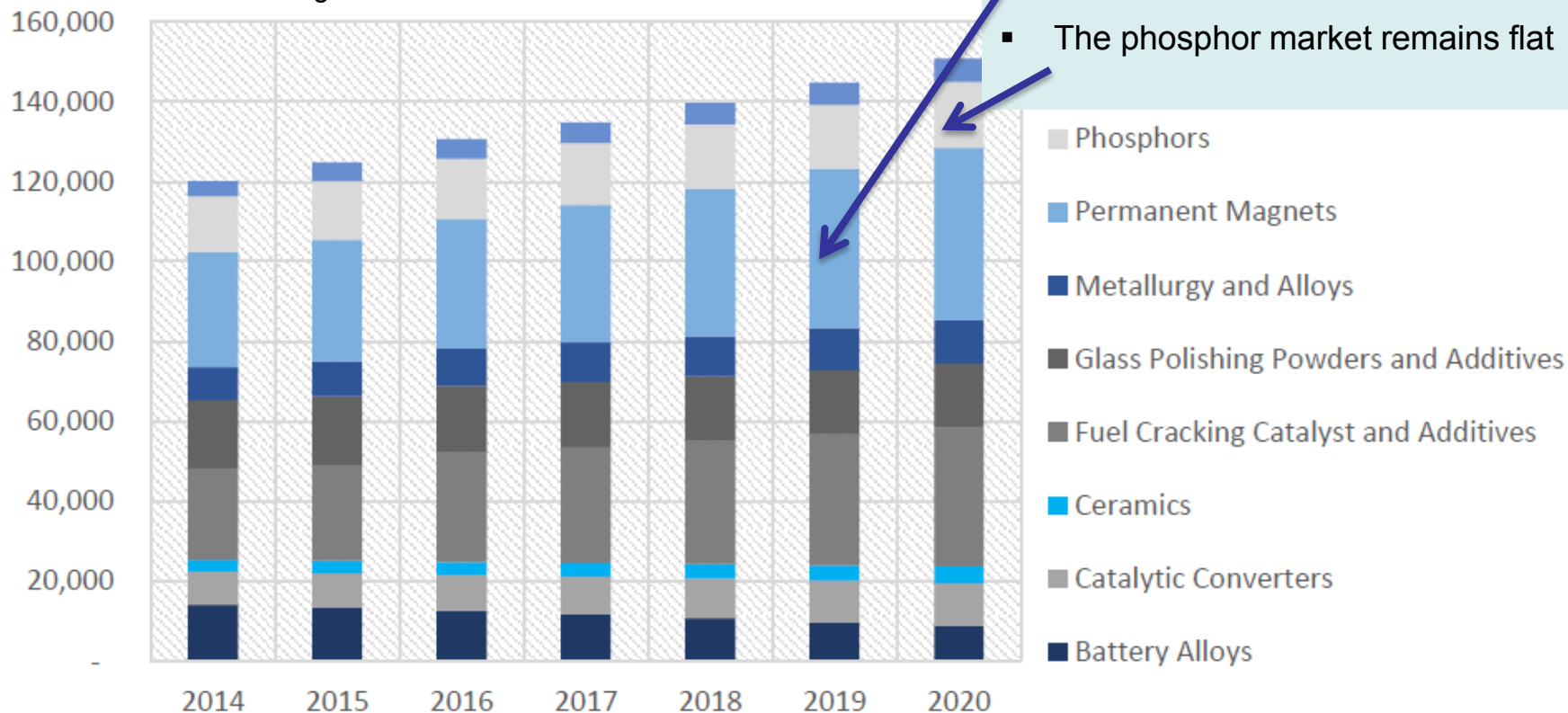
*Adamas Intelligence, October 2014*

# The world wide RE market evolution: a global growth dominated by magnets needs

Data from Adamas

- A global CAGR of 3.9% between 2014 and 2020
- Magnets are the main driver (CAGR of 7%)
- The phosphor market remains flat

Source: Adamas Intelligence Oct 2014





# *How the RE market can be totally modified by a technology change.*

- 1. The magnet market and the strategy of magnet makers and wind turbines producers**
- 2. The phosphor market and the penetration of LED**

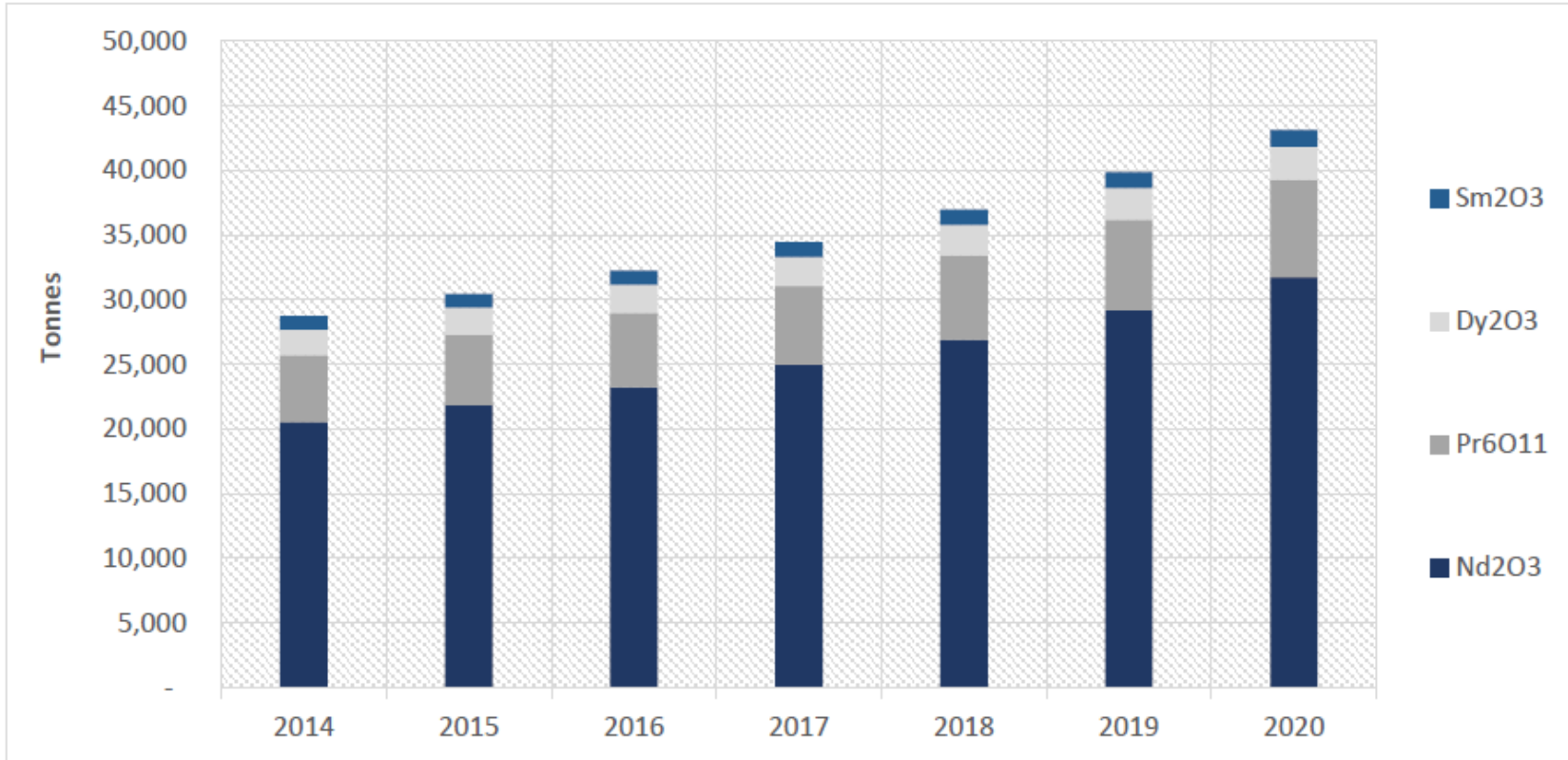
# How the RE market can be totally modified by a technology change

## The Magnet case

# The magnet market – Adamas forecast October 2014

In October 2014 Adamas forecasted an increase of RE demand for magnets from 30kT in 2015 to 42kT in 2020 with a quite stable composition of Dy of around 9%.

Source: Adamas Intelligence Oct 2014



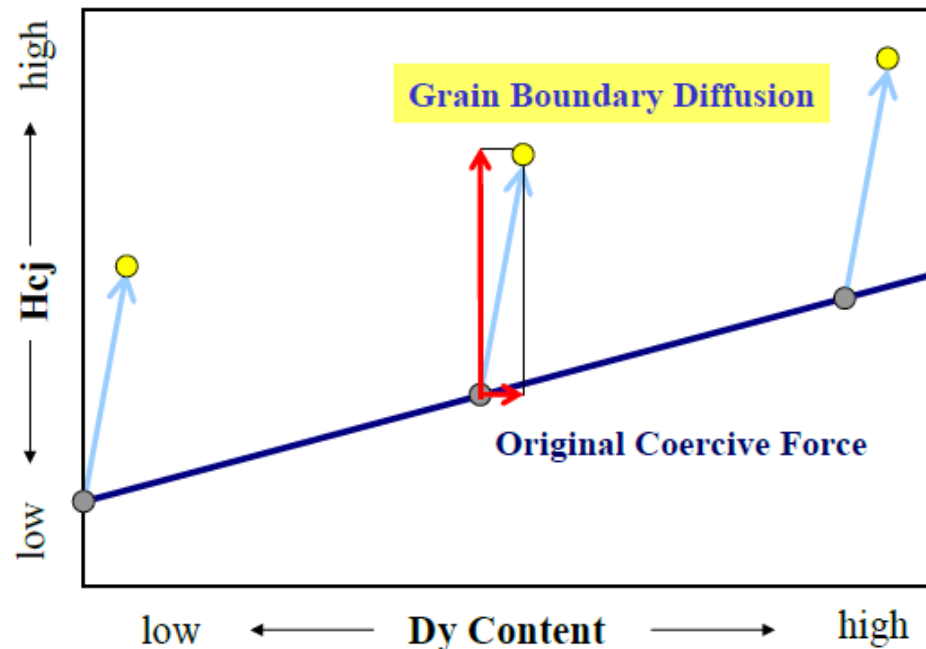
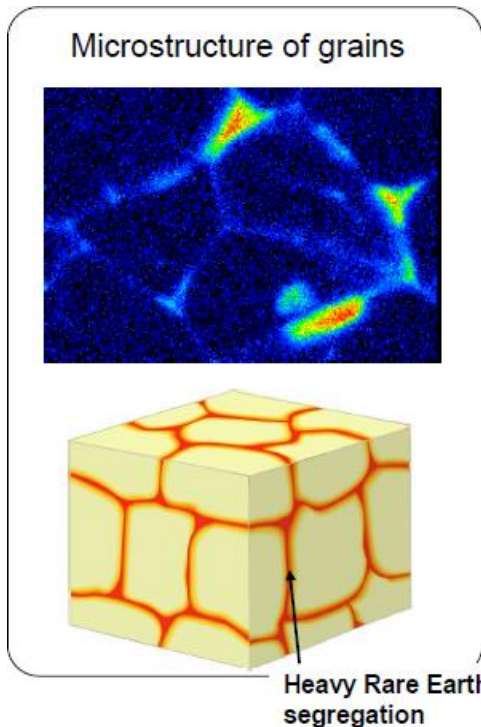
Rem: The Dy content is necessary to increase the Curie T°.

# The magnet market - How to reduce the Dy consumption: The strategy of the magnet maker

Dy is necessary to increase the Curie temperature. The target of the magnet makers is to understand how to decrease the Dy content by keeping the same Curie temperature



## The Relation between Coercive Force Enhancement and Dy Content

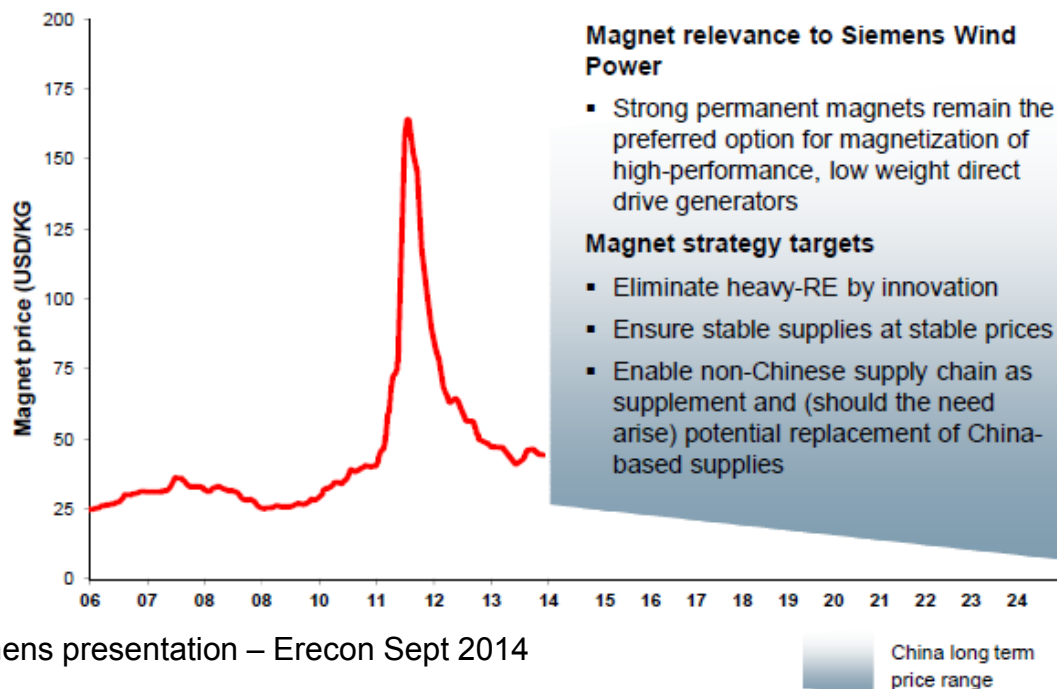


# The magnet market - How to reduce the Dy consumption: The strategy of the end user

Siemens intends to be the 1st producer for off shore wind turbines (with a 6MW generator). In Sept 2014 Siemens announced that the permanent magnets used in their new generators will be totally free of Dy by using a cooling system.

SIEMENS

**NdFeB Magnets -  
Price Stability for upcoming 10 Years required**



Siemens presentation – Erecon Sept 2014

# How the RE market can be totally modified by a technology change

## The Phosphor case

## By 2013 Phosphors were the 2<sup>nd</sup> RE market in value

	2008	2011	2013
Overall RE market	1867 M\$	7891 M\$	3021 M\$
RE Phosphors market	473 M\$	1838 M\$	616 M\$
%Phosphor/overall	25%	23%	20%

Adamas October 2014

In 2013 the RE value in Phosphors still accounted for 20% of the global RE market. More than 95% of the RE phosphors are used in the CFL and LFL

- How much this figure will be modified by the penetration of LEDs?
- What can be the consequence on the global RE market?

# *The penetration of LED is much faster than previously expected*

People have a very positive attitude towards LED lighting. This is not particularly the case for fluorescent lighting

## **LFL lighting**

- Slow start
- Greenish color
- Difficult to dim
- Long life
- Contains hazardous Hg
- Good energy saving
- Traditional, smart

## **LED lighting**

- Instant ON
- Pleasant good looking lighting
- Easy dimming
- Endless life
- Free of hazardous materials
- Great energy saving
- Modern, responsible



# The RE in Fluorescent lamps and LED or the end of life

	YEO Y <sub>2</sub> O <sub>3</sub> ; Eu	LAP / CAT LaPO <sub>4</sub> ; Ce, Tb MgAl <sub>11</sub> O <sub>19</sub> ; Ce, Tb	BAM BaMgAl <sub>10</sub> O <sub>17</sub> ; Eu
Representative Linear blend (4100K)	50%	40%	10%
Representative CFL blend (2700K)	70%	30%	



REE wt%	Y	Eu	Tb
Blend	40%	2%	4%

	YAG Y <sub>3</sub> Al <sub>5</sub> O <sub>12</sub> ; Ce	CASN CaAlSiN <sub>3</sub> ; Eu
LED Representative blend	80%	20%



REE wt%	Y	Eu
Blend	44%	2%

Ref: GE presentation: RE conf Singapore Nov 2014

- Use of REE (Y, Eu, Tb) is 15 to 20 times higher in Fluorescent lamps than LED for equivalent lumen output, even higher if you include LRE (La & Ce)
- The life time of a Fluo lamp is 10 000h to 25 000h
- The life time of LED lamp is 40 000h to 50 000h

	Fluorescent	LED
Output (lumens/unit)	3000	100
Phosphor (g/unit)	2	0.002
% REE in Phosphor (Y, Eu, Tb)	46%	46%
Mfg yield (%)	95%	50%
Lumens/g of REE (Y, Eu, Tb)	3000	54000

# *The RE market will be strongly modified by in the coming years*

1. The Dy needs for magnets will be lower than what is planned by most of the analysts
2. The Eu market will be very strongly impacted by the LED penetration and Y and Tb markets will shift to non lighting applications



**Merci pour votre  
attention**