

Forum 6: Energy-efficient industrial drives and their dependence on rare earths

## Analysis of rare earths: permanent magnets used in industry in Baden-Wuerttemberg



Baden-Württemberg

MINISTERIUM FÜR UMWELT, KLIMA UND ENERGIEWIRTSCHAFT

# Agenda

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- Background
- Permanent magnets used in industry
- Estimation of quantities of magnets
- Recycling potentials
- Avoidance strategies
- Outlook: Measures for supporting the recycling chain

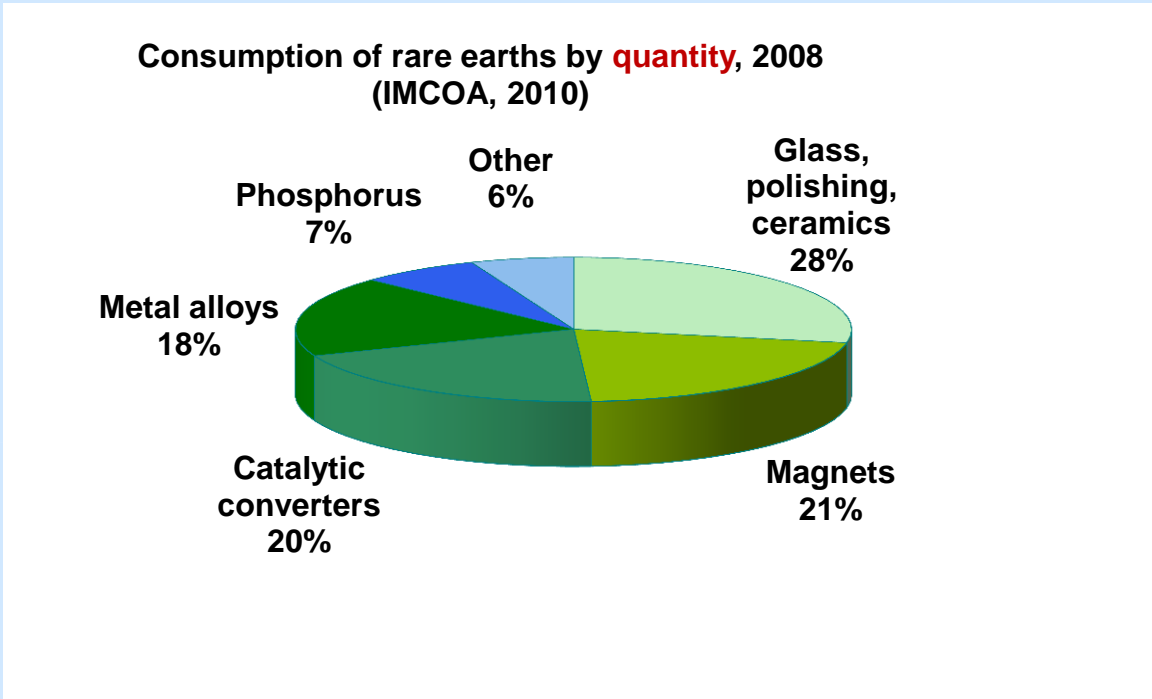
# Background



## Rare earths

- Rare earths (RE) are essential for the **security of supply** of many industry sectors and for many future technologies.
- The rare earths neodymium, praseodymium and dysprosium are **mainly used** in neodymium-iron-boron permanent magnets.
- The **growth rates of magnet use** are higher than with other uses of rare earths.
- The diverse industrial uses reflect a **conspicuous gap in knowledge** about permanent magnets and rare earths.

# Uses of rare earths



Magnets have the highest growth rate

2008: 64,000 t NdFeB magnets (Luo 2008)

2012: 120,000 t NdFeB magnets (Gutfleisch 2013)

# Uses of NdFeB magnets in industry



## NdFeB magnets

- Permanent magnets are **widely used in industry** (e.g. e-motors of many different sizes are used in diverse sectors; magnets are used as lifting equipment and in metal recycling sorting plants).
- Permanent magnets used in industry are significantly **larger** than those used in, for example, notebooks.
  - Better recycling
  - Opportunity for business-to-business contacts that are comparable to industrial catalysts (precious metals)
- Permanent magnets used in industry generally contain a higher share of valuable **dysprosium**.

# Oeko-Institut's study on uses of NdFeB magnets in industry



## Analysis

### Analysis:

- Bottom-up analysis of questionnaire-based survey of companies (supported by LVI/BDSV)
- Top-down analysis of production statistics

### Results:

- Industry users usually know little about the technical details of their equipment/motors.
- Synchronous servomotors – the **most significant use** of permanent magnets – are not included in official statistics (e.g. Eurostat).



**Interviews with engine manufacturers**

# Synchronous servomotors

## Servo- motors

### Production

- Production in the EU: 1.5 – 2 millions, of which 50% occurs in Germany
- Approx. 50 % of motors from DE are exported (in machines/equipment)



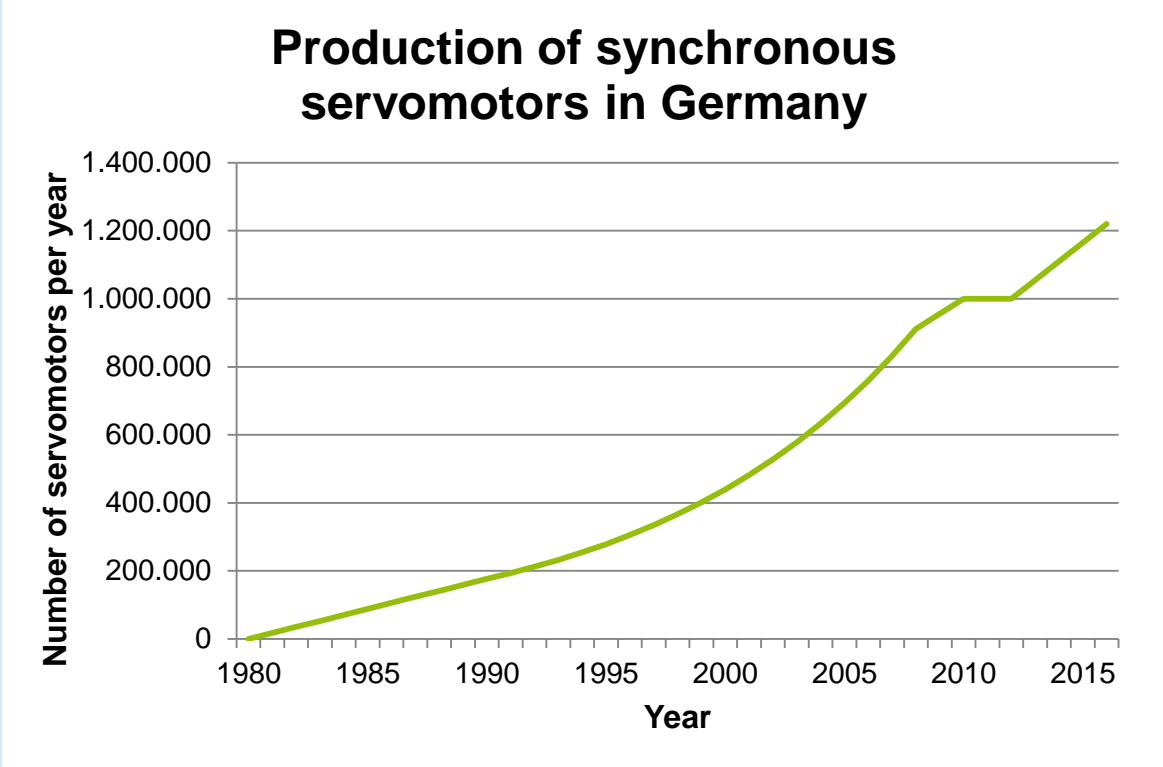
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### Magnets

- Typical weight of magnet per motor: 0.05 – 0.2 kg magnet.
- Weight of magnet can be several kg in motors used in industry.

# Synchronous servomotors – development of production

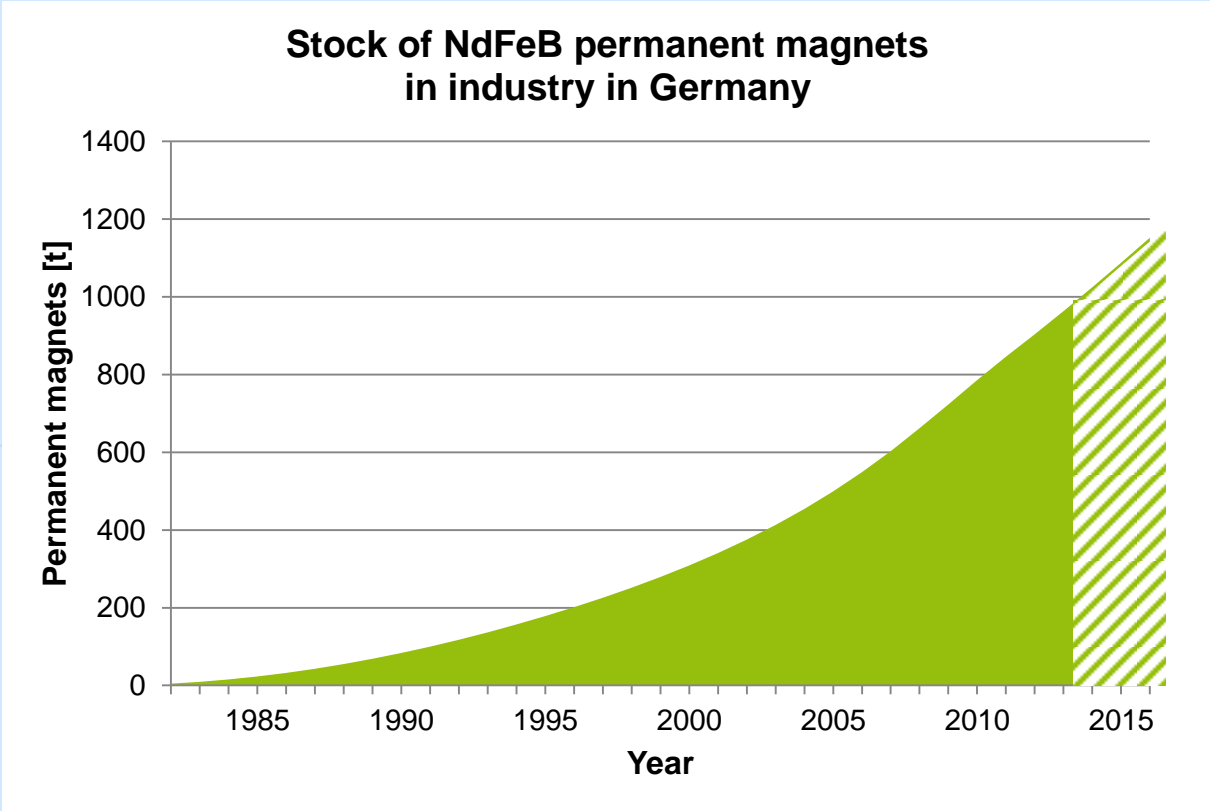
**Servo-  
motors**





# NdFeB magnets – development of stock

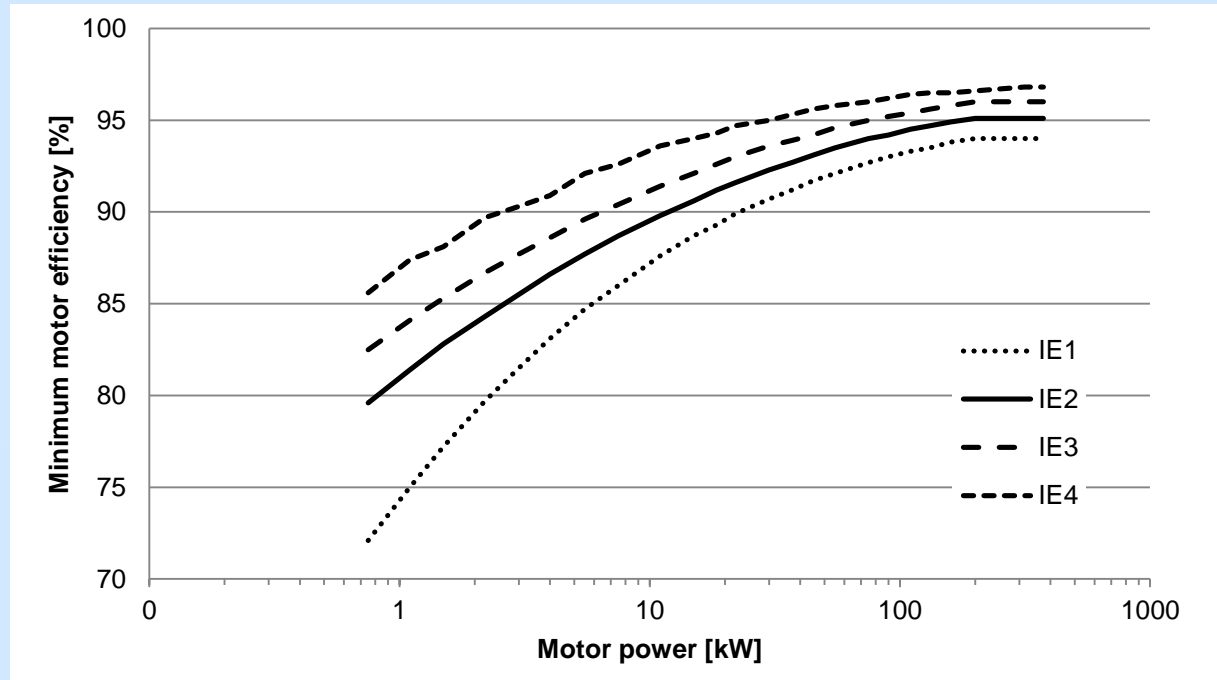
**Stock**



**of which approx. 20% in Baden-Wuerttemberg**

# Drivers of energy efficiency standards in EU

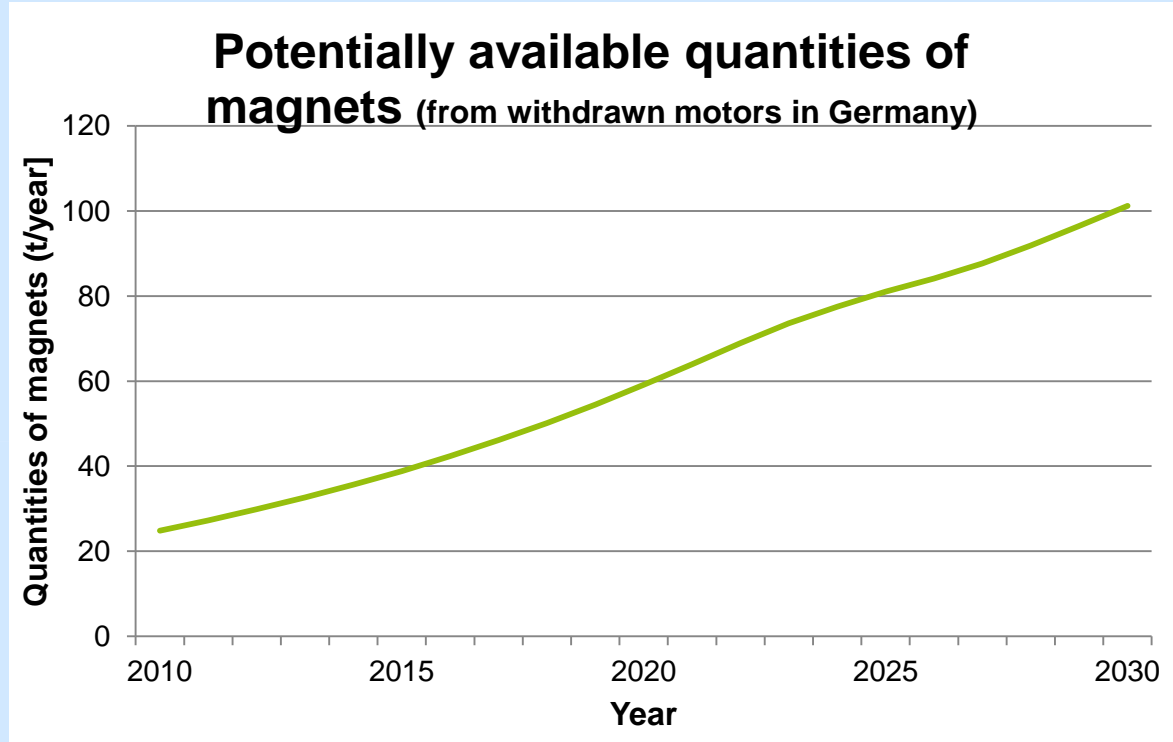
## IE classes



The tightening of energy efficiency standards for electric motors in the EU increases the tendency towards energy-saving servomotors with NdFeB magnets.

# Potentially available quantities of NdFeB magnets per year

**Quantity potentials**



**But:** Withdrawn motors and machines / equipment are frequently re-sold abroad.

# Avoidance strategies

## Alternatives

- Use of SmCo magnets instead of NdFeB magnets
- Reduction of RE content of magnets, esp. Dy
- Use of other types of motors without RE, e.g. reluctance motors
- Re-use of used rotors

High-price period for rare earths in 2010/11 was too short to bring about long-term changes!

# Current recycling situation I



## Recycling

- Motors are very durable and can be used for a long period of time (~ 15 years).
- Rotors with magnets seldom need to be repaired.
- In terms of recycling, motors with NdFeB magnets are already accumulating today (early models and motors with an under-average life cycle).
- Indications that the first recyclers and motor engine manufacturers are separating and storing NdFeB magnets from withdrawn motors until recycling solutions are implemented in economic terms.

# Current recycling situation II

## Recycling

- In the long term, motors are often exported as part of equipment withdrawn from Germany (e.g. Eastern Europe, Central Asia, India, China).
- What happens in the long term to the magnets used by motor manufacturers and in industry is little known.
- Presumably the rare earths ultimately end up with metal recyclers abroad, in steel recycling or in residual waste.



Recycling of electric motors in Nanjing, China  
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# Recycling management



## Recycling management

- The Dy content makes magnets from industrial motors attractive from an economic perspective.
- Total quantity of available magnets from industrial motors makes them attractive in the medium term.
- Recent research shows that it is possible to recycle rare earths from used magnets.



**To tap the secondary RE potentials of magnets used in industry (and elsewhere), it is urgently necessary to establish a Europe-wide recycling infrastructure for permanent magnets!**



**Important: Simple labelling of in motors is needed, e.g. “NdFeB”, “SmCo”.**

# Thanks for your attention!

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