The Rare Earth Issue

Prof. Dr. Carlo Burkhardt

Green energy comes with a material revolution

Green mobility comes with a material revolution


Rare earths are in the centre of the material revolution

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Global REE Production 1986-2009 (kt/year)

Raw material price evolution

[Graphs showing production and price evolution]
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Raw material price evolution: Nd

Raw material price evolution: Dy

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http://repromag-project.eu/
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Electro mobility? Wind energy? Magnets for all these „Lifestyle“-Applications?
Green energy comes with a material revolution

<table>
<thead>
<tr>
<th>Industry</th>
<th>Component</th>
<th>Kg/Unit</th>
<th>Total Usage p.a.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind power</td>
<td>PM direct drive motor</td>
<td>670/MW</td>
<td>41,000 tons</td>
</tr>
<tr>
<td>Automotive (HV, EV, PHEV)</td>
<td>Drive motor</td>
<td>1-3/Unit</td>
<td>12,000 tons</td>
</tr>
<tr>
<td>Automotive</td>
<td>Power steering</td>
<td>0,25/Unit</td>
<td>3,000 tons</td>
</tr>
<tr>
<td>Electronic information</td>
<td>Mobile phone</td>
<td>0,0025/Unit</td>
<td>4,500 tons</td>
</tr>
<tr>
<td></td>
<td>Hard disk drive (HDD)</td>
<td>0,016-0,020/Unit</td>
<td>7,600 tons</td>
</tr>
<tr>
<td>E-Bike</td>
<td>Drive motor</td>
<td>0,32/Unit</td>
<td>7,000 tons</td>
</tr>
<tr>
<td>Elevators</td>
<td>Traction motors</td>
<td>10,5/unit</td>
<td>5,000 tons</td>
</tr>
<tr>
<td>Medical equipment</td>
<td>MRI, NMR</td>
<td>500-3000/unit</td>
<td>500-3,000 tons</td>
</tr>
</tbody>
</table>

~86,000 tons p.a.

A. Zhang, 2014, growth rates of >10% p.a. expected even in cautious scenarios

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“There is oil in the Middle East; there is rare earth in China.” President Deng Xiaoping 1992

“Improve the development and applications of rare earth, and change the resource advantage into economic superiority.” President Jiang Zemin 1999
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“China is making success in electric vehicles a national priority for three reasons:
• Reduce Dependence of Foreign Oil.
• Improve Air Quality.
• Take Leadership in a Key Emerging Technology”

President Xi Jingpin, 2017

Sales trends for electric vehicles (BEV + PHEV) in selected markets. Source: CAM
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Recycling of RE-materials is a must

Other technology metals (Ag, Pt, Pd) have recycling rates of 30%

Recycling rate of Nd currently <1%

RE demand and EOL availability estimations:
Thank you