43rd LCA Discussion Forum
„Life Cycle Assessment of Electromobility“

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# Availability of raw materials and resources used in electric cars

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## Outline

1. The criticality of resources: state of the art, concepts and limitations
2. What will be the major impacts of electric cars on future raw material demand?
3. Raw material supply risks for the mass deployment of electric cars
4. Conclusion and recommendations



## Raw material supply in transition

**Value chains**

- 1970: federal government issue (Metallgesellschaft, Preussag)
- 2000: liberalisation und globalisation (e.g., NA)
- 2010: market distortions (e.g., Aurubis)

**Public discourse**

- BGR until 2008: base metals, supply & demand balance
- ISI/IZT study: minor metals, technological chance, market failure

⇒ emerging risks require new concepts

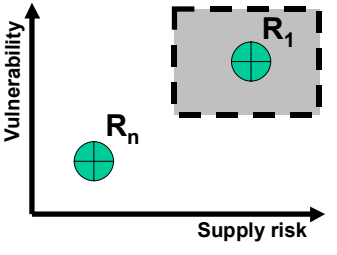


## The concept of criticality

**12 principal studies**

**4 basic concepts**

- supply/demand modeling
- multi-criterial assessments
- single risk indicators
- criticality matrices



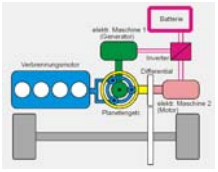

**Major limitations**

- arbitrary use of methods
- no accounting for uncertainty

Source: Erdmann & Graedel 2011

## Selected components of electric cars

**traction motors**

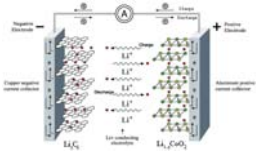


Nd
Cu

**supercaps**

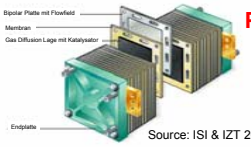
Al

**high performance batteries**



Co
Li

**fuel cells**




Pt

Source: ISI & IZT 2009



## Critical raw materials for electric traction devices

Commissioned by VDMA to IZT (2010)

**Scope**

| Components | Materials | Co | Li | Nd | Dy |
|---|---|---|---|---|---|
| Li-ion-batteries (cathode) | $LiCoO_2$ | X | X | | |
| | $LiCoNiMnO_2$ | X | | | |
| | $LiFePO_4$ | | X | | |
| | $LiMn_2O_4$ | | X | | |
| Electric machines (magnets) | NIB traction motors | (X) | | X | X |
| | NIB wind power generators | (X) | | X | X |
| | NIB servo motors | (X) | | X | X |

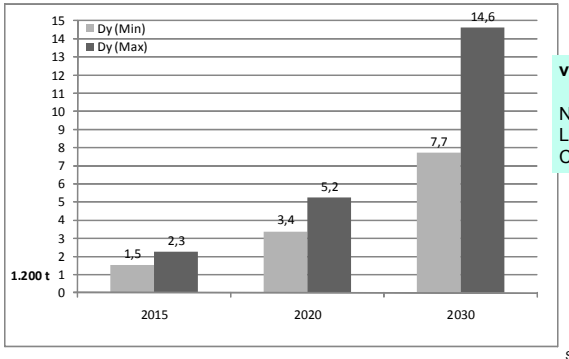
**Time horizons**: 2008, 2015, 2030

**Key variables**:

- technology demand accounting for future material efficiency
- various diffusion scenarios (IEA, McKinsey)



## Dysprosium demand by electric cars




**vgl. 2030:**

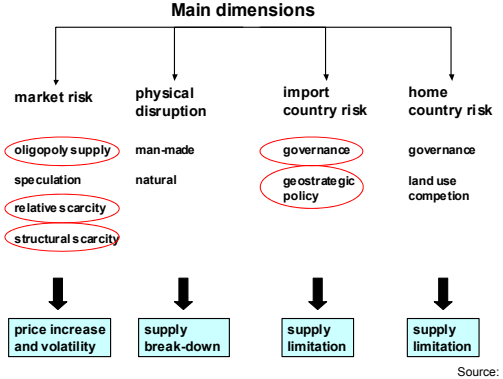
| | |
|---|---|
| Nd: | 0,9-1,6 |
| Li: | 3-5,6 |
| Co: | 3-7,1 |

Source: IZT/FVA 2010



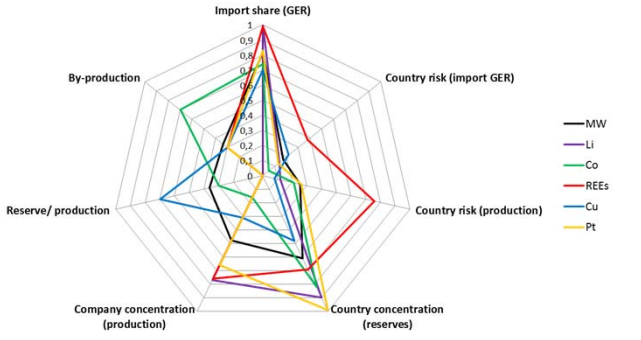
## Emerging supply risks

Criticality of raw materials GER: commissioned by KfW to IZT (2011)




Source: IZT/KfW 2011

## Supply risks for electric car materials




Source: IZT/KfW 2011



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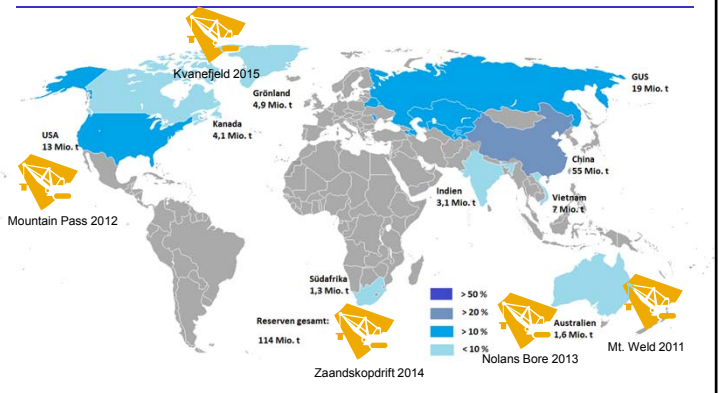
## Rare Earth projects in the pipeline




Source: IZT/KfW 2011



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## Policy suitability screening

| | Li | Co | REEs | Cu | Pt |
|---|---|---|---|---|---|
| **Operational acquisition** | short-term no major concern | short-term no major concern | **expensive, interim neccessity** | Expensive, few short-term alternat. | **expensive, interim neccessity** |
| **Strategic mine share** | **several low risk projects** | **several low risk projects** | **several low risk projects** | several medium risk projects | few high risk projects |
| **Foreign trade policy** | no restriction known | scrap exp. tax (RUS) | product exp. restriction (CHI) | product & scrap exp./imp. | product exp. tax (RUS) |
| **Substitution** | lower performance | partially available | lower performance | lower performance | partially R&D |
| **Recycling** | no processes available | pryomet. recycling | no processes available | **pyromet. recycling, high value** | **pyromet. recycling, high value** |



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## Conclusion and recommendation

### Criticality assessment

- Global SCM to Europe essential (sensitivity, substitutability, future GVA)
- considerable short- and mid-term supply concerns (e.g., REEs)
- strong effort needed to ensure mid- to long-term supply (e.g. Cu)

### Call for action

- coordinate efforts for resource efficiency (e.g. R&D, policies)
- improve assessment methodologies for criticality
- develop mass tailored policies



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