Wuppertal Institute
for Climate, Environment
and Energy

# Resources for the Energiewende – examples on the German level and need for policy action & research

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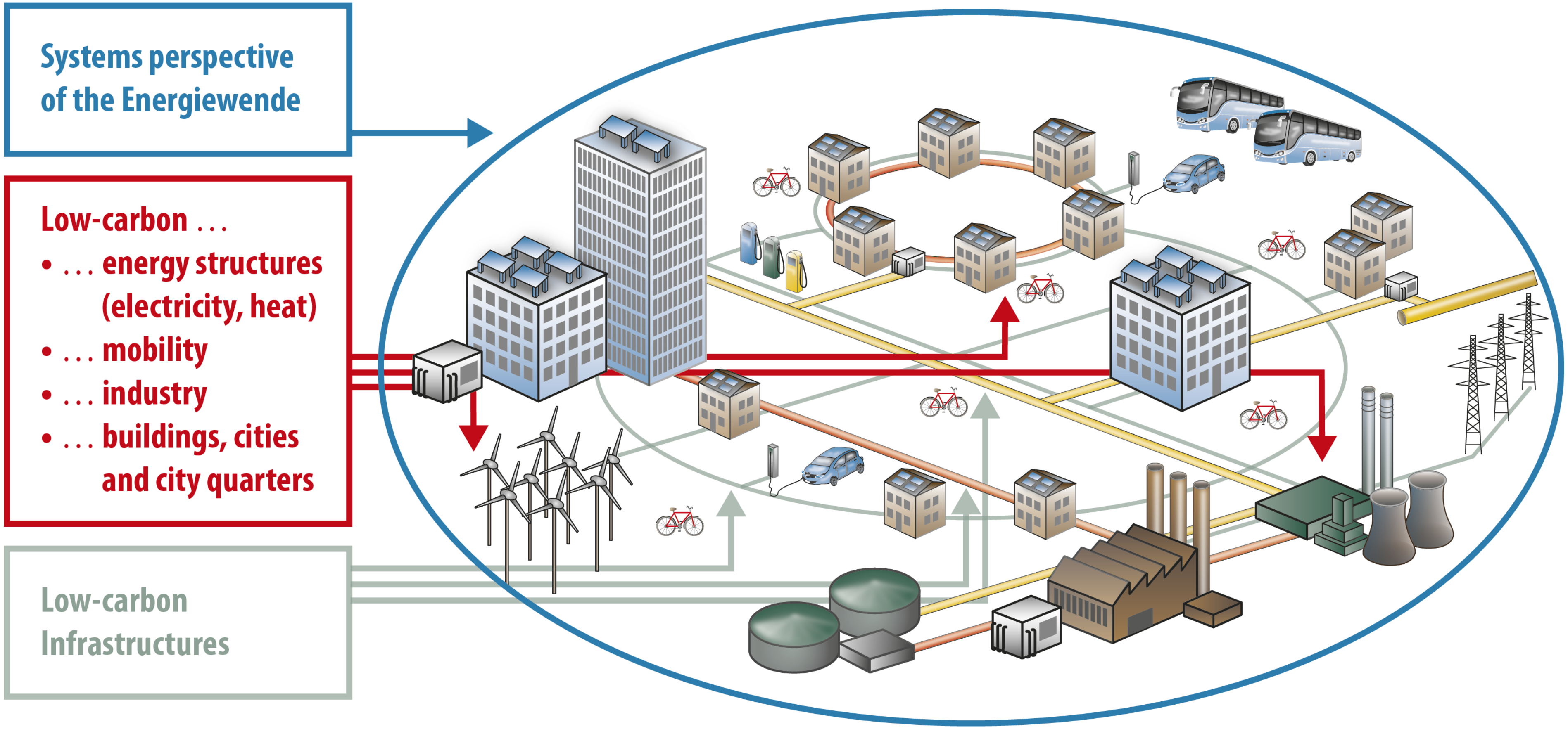
# Content

## Energiewende and existing approaches

# Dimensions of the Energiewende




Source: WI

Energiewende and existing approaches

# Long-term energy and resource scenario analysis of the Energiewende

| | Resource focus | Efficiency | | Renewable | | Fossil | |
|---|---|---|---|---|---|---|---|
| | | Static | Dynamic | Static | Dynamic | Static | Dynamic |
| **Electricity sector** | **CritMin** | | | | KRESSE (2014) | | |
| | **TMR** | | | Single figures | | Single figures | |
| **Heat Sector** | **CritMin** | | | | KRESSE (2014) | | |
| | **TMR** | | MaRess (2009) | | | | |
| **Mobility sector** | **CritMin** | | | | STROM (ongoing) | | |
| | **TMR** | | | STROM (ongoing) | | STROM (ongoing) | |
| **Integration (Energiewende)** | | | | | | | |
| **Integration (all sectors)** | | | | | | | |

CritMin = critical minerals
TMR (MIPS of abiotic plus biotic resources for economies, including import/export balances)

# Exemplary results of selected studies
# KRESSE

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit
aufgrund eines Beschlusses des Deutschen Bundestages

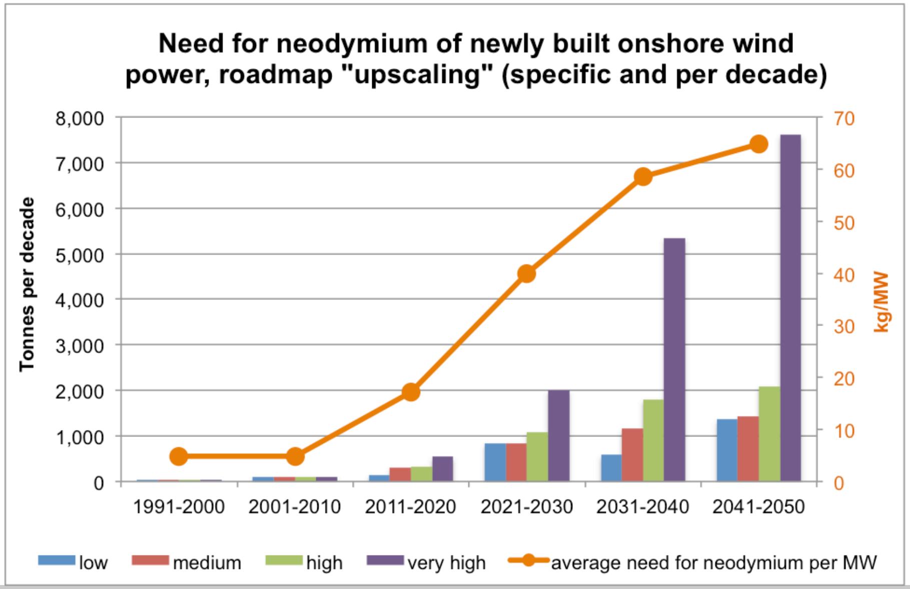
## KRESSE – Critical Resources and Material Flows during the Transformation of the German Energy Supply System

- Objective

  Assessing which critical minerals are relevant in Germany for the production of
  - technologies that generate electricity, heat and fuels from *renewable energies*
  - large energy storage and transmission systems

  and depicting potentially conflicting goals regarding the supply situation

- Dynamic perspective
  - need for new capacities based on 9 long-term energy scenarios (2050)
  - technology roadmaps estimating future market shares
    - Wind energy: “Continuity”, “Upscaling” and “HTS”
    - Solar PV: “Continuity”, “Thin film renaissance”
  - regarding specific critical material consumption over time



# Exemplary results of selected studies
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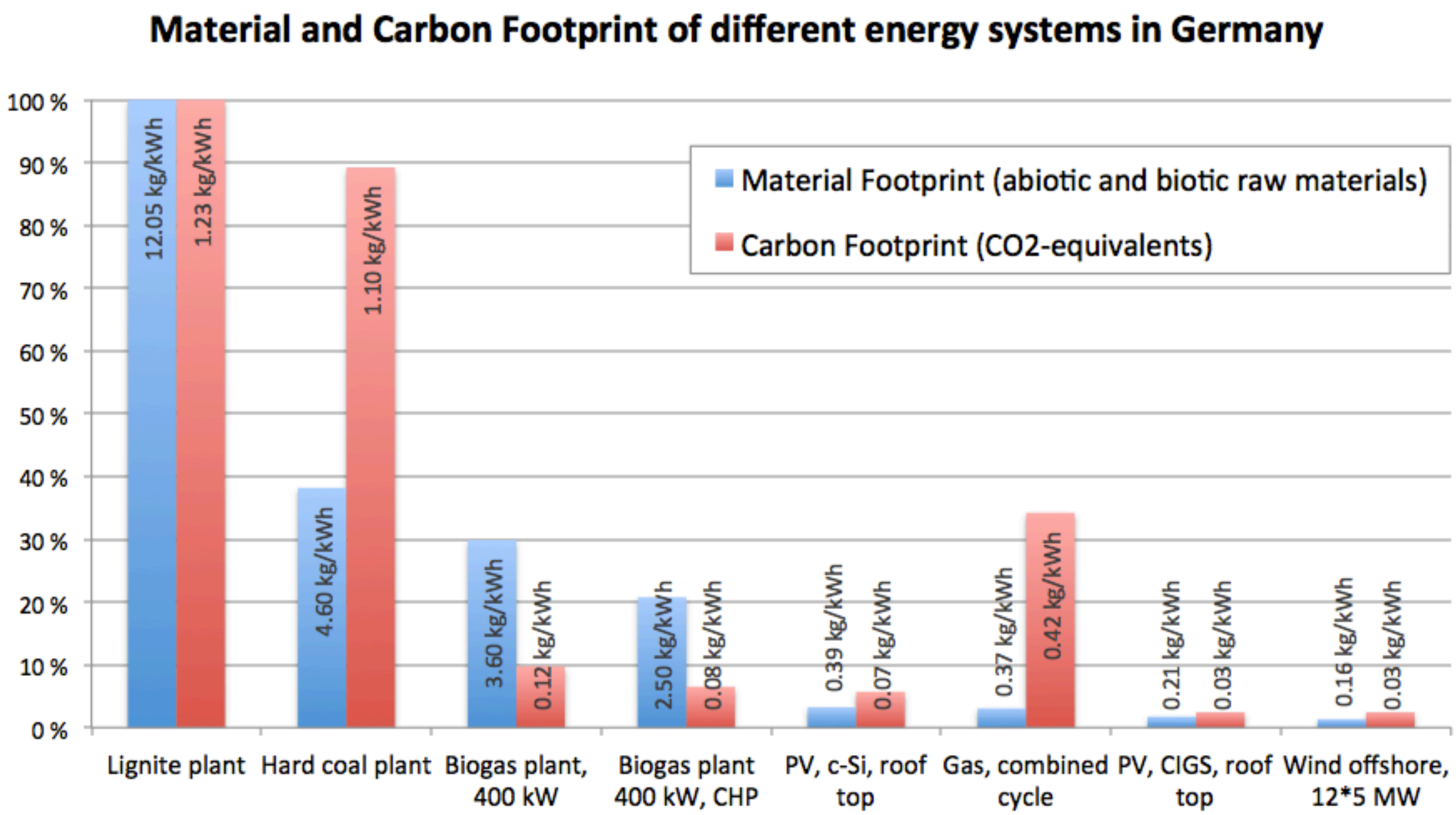
## Main Results

- The geological availability of minerals does not generally represent a limiting factor in the planned expansion of renewable energies in Germany. However, some sub-technologies might be critical with regard to the supply of minerals:
  - wind energy
    - adequate supply of Nd and Dy can not necessarily be guaranteed for Germany
    - considering onshore facilities, the use of Nd and Dy is non-essential
    - considering offshore plants, novel technologies and recyclability should be further developed
  - thin-film photovoltaics – CI(G)S
    - demand for *indium* does not appear to be secured, not even for the current 3% market share
    - major expansion must be considered as being critical since the need for *selenium* might not be met
  - large-scale battery storage
    - supply for vanadium-based redox flow batteries must be considered as being critical
    - less critical are lithium-ion batteries (long-term), not critical physical storage facilities
- Fortunately, non-critical alternatives to these technologies generally exist.

Exemplary results of selected studies

# Material and carbon footprint of different electricity generation systems in Germany

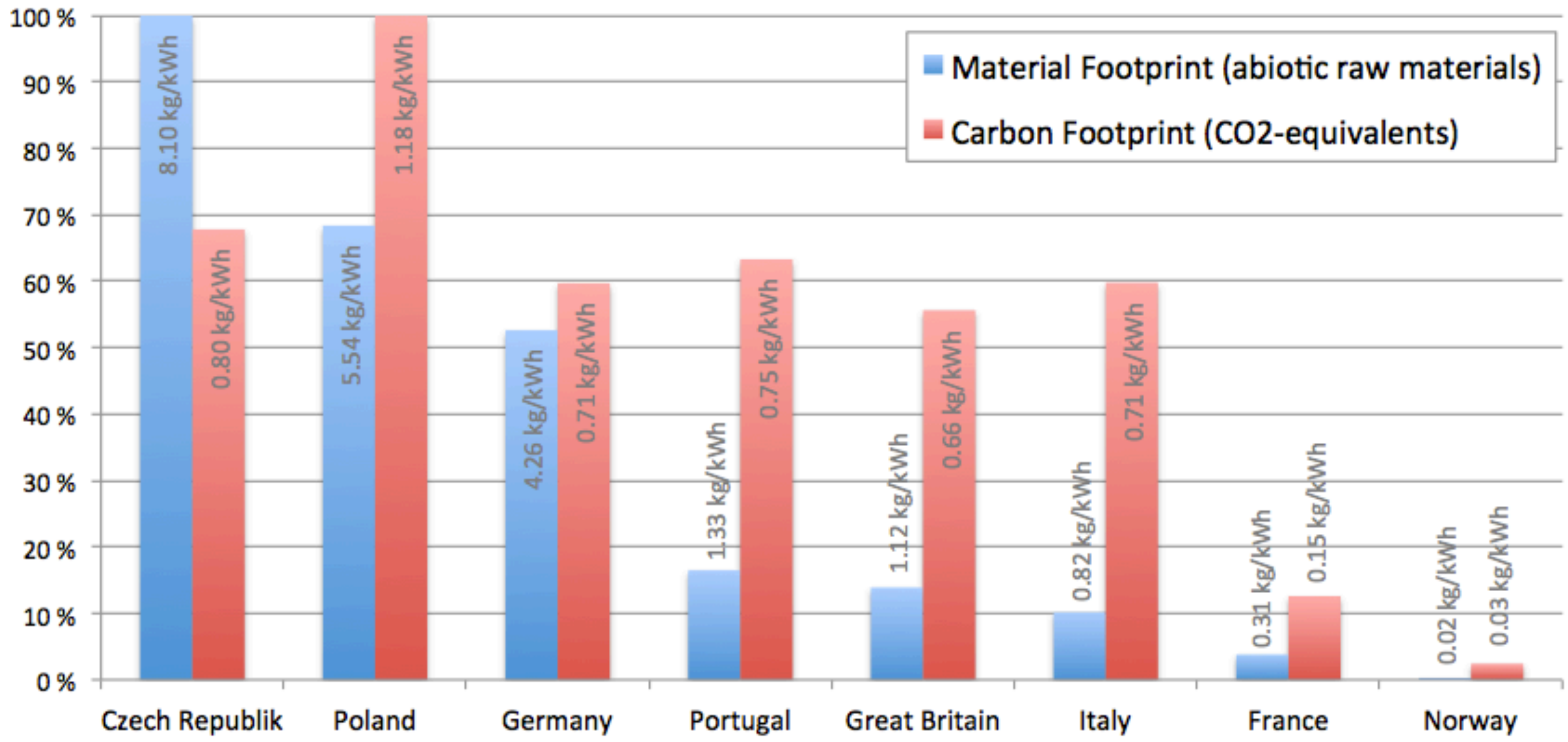



- Overall resource utilisation of an energy system is considerably lower if it is based on renewable energies rather than on fossil fuels (exception: biomass).

Calculations based on: Ecoinvent V2.2, Wagner et al. 2014, Wiesen et al. 2013, 2014, Wuppertal Institute 2014, Rausch and Fritsche 2012

## Exemplary results of selected studies

# Material and carbon footprint of different EU electricity mixes




- The higher the share of coal, the higher are both material and carbon footprint.
- High shares of gas and oil cause a low material footprint, but a high carbon footprint.
- Electricity supply mixes based on renewable energies (wind, PV) would minimise both footprints.

Calculations based on: Wuppertal Institute 2013, JRC 2014

## Outlook: need for action

# Recommendations for research

- Our results confirm that – in the electricity sector – massive GHG reduction goals combined with a deployment of renewable energies conform to massive TMR reduction and are principally compatible with the supply of mineral resources.
- However, critical minerals for the Energiewende must be evaluated on an integrated, long-term level, also considering other economic sectors and major economies.
- For instance, first results of STROM show that an electro-mobility strategy might lead to supply problems of dysprosium.
- Integrated energy and resource scenarios are needed to combine resource and low-carbon targets.
- Material footprint indicators, e.g. MIPS, should be adapted to future situations (dynamic approach) and data should become internationally validated.

| | Resource focus | Efficiency Static | Efficiency Dynamic | Renewable Static | Renewable Dynamic | Fossil Static | Fossil Dynamic |
|---|---|---|---|---|---|---|---|
| Electricity sector | CritMin | ? | | | KRESSE (2014) | | |
| | TMR | | | Single figures | | Single figures | |
| Heat Sector | CritMin | | | | KRESSE (2014) | | |
| | TMR | | MaRess (2009) | | | | |
| Mobility sector | CritMin | | | | STROM (ongoing) | | |
| | TMR | | | STROM (ongoing) | | STROM (ongoing) | |
| Integration (Energiewende) | | ? | | | | | |
| Integration (all sectors) | | ? | | | | | |

CritMin = critical minerals
TMR = total material requirement (calculated as MIPS, including economically unused material)

## Outlook: need for action
# Policy recommendations

- Even if the availability of minerals for the relevant technologies is not a problem, potential supply risks owing to dependencies on a few supplier countries and competing use should be borne in mind.
- Key elements of technology development to secure Germany's raw material supply therefore are
  - extended cooperation with companies and governments of supplier countries
  - increasing resource efficiency and recyclability strategies
- Where top-quality recycling is difficult, strategies for prolonging the useful life and life cycle of systems should be pursued alongside recycling strategies.
- In general non-critical alternatives to the identified technologies should increasingly be used in future.
- Schemes for generally minimising the use of resources, not only the critical ones, in the transformation of the energy system should be developed and included in an integrated assessment.

# Sources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# Thank you very much for your attention!


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