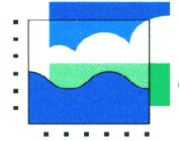


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# Resources for the world: an industrial ecology approach

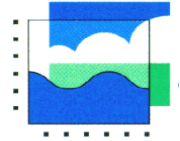
3rd Eco-Efficiency Conference  
“Eco-efficiency for sustainability”  
June 9 – 11, 2010, Egmond aan Zee  
Ester van der Voet  
CML Leiden University



# Industrial Ecology Analysis

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- Industrial Ecology tools for analysis: effectiveness and side-effects ...
- ... but are limited in their scope
- integration of perspectives: toolbox or supermodel
- global scale: linkages and scenarios

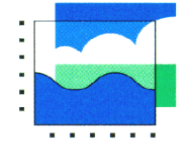


# Industrial Ecology Analysis

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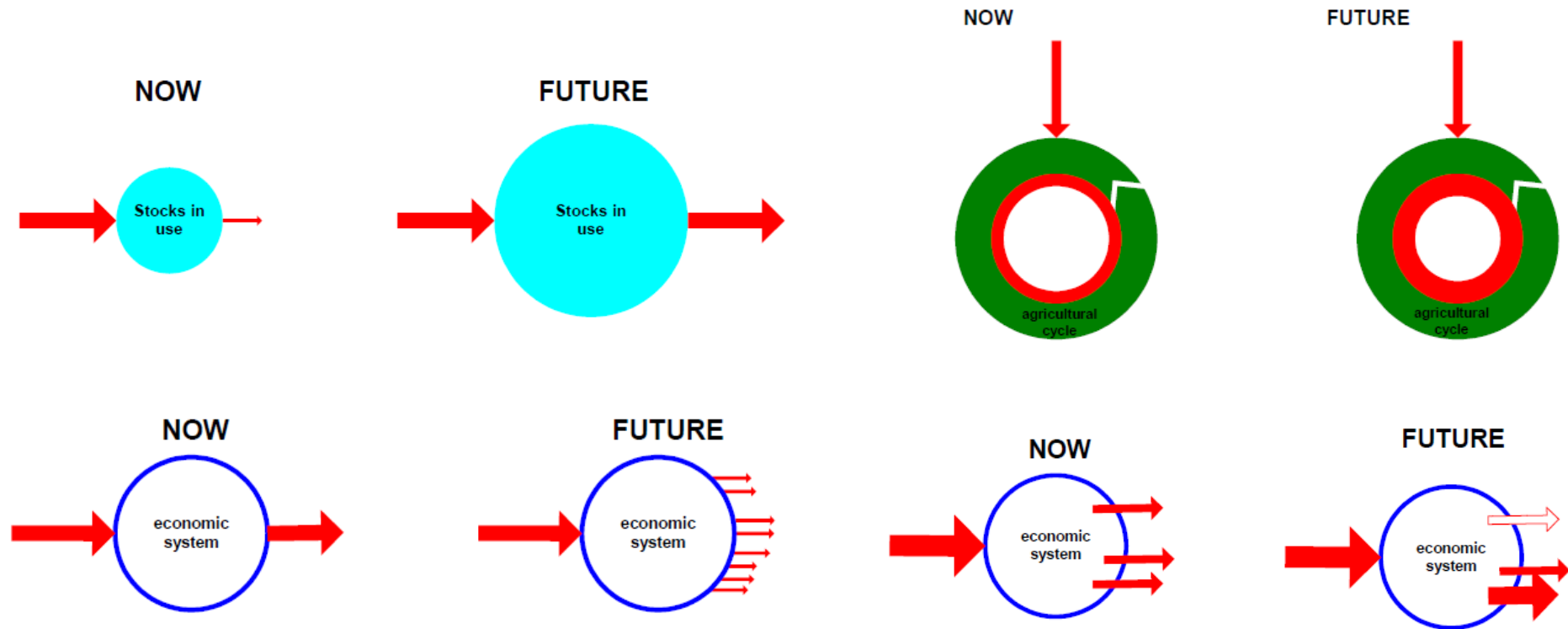
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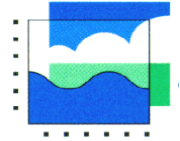
- Industrial Ecology tools: Material Flow Analysis
- describes societal metabolism of substance / material / mass ...
- .. and shows effectiveness as well as side-effects of options for change ...



# Industrial Ecology Analysis

## Mechanisms of problem shifting detected in SFA studies

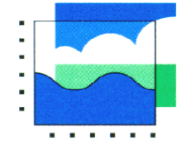




# Industrial Ecology Analysis

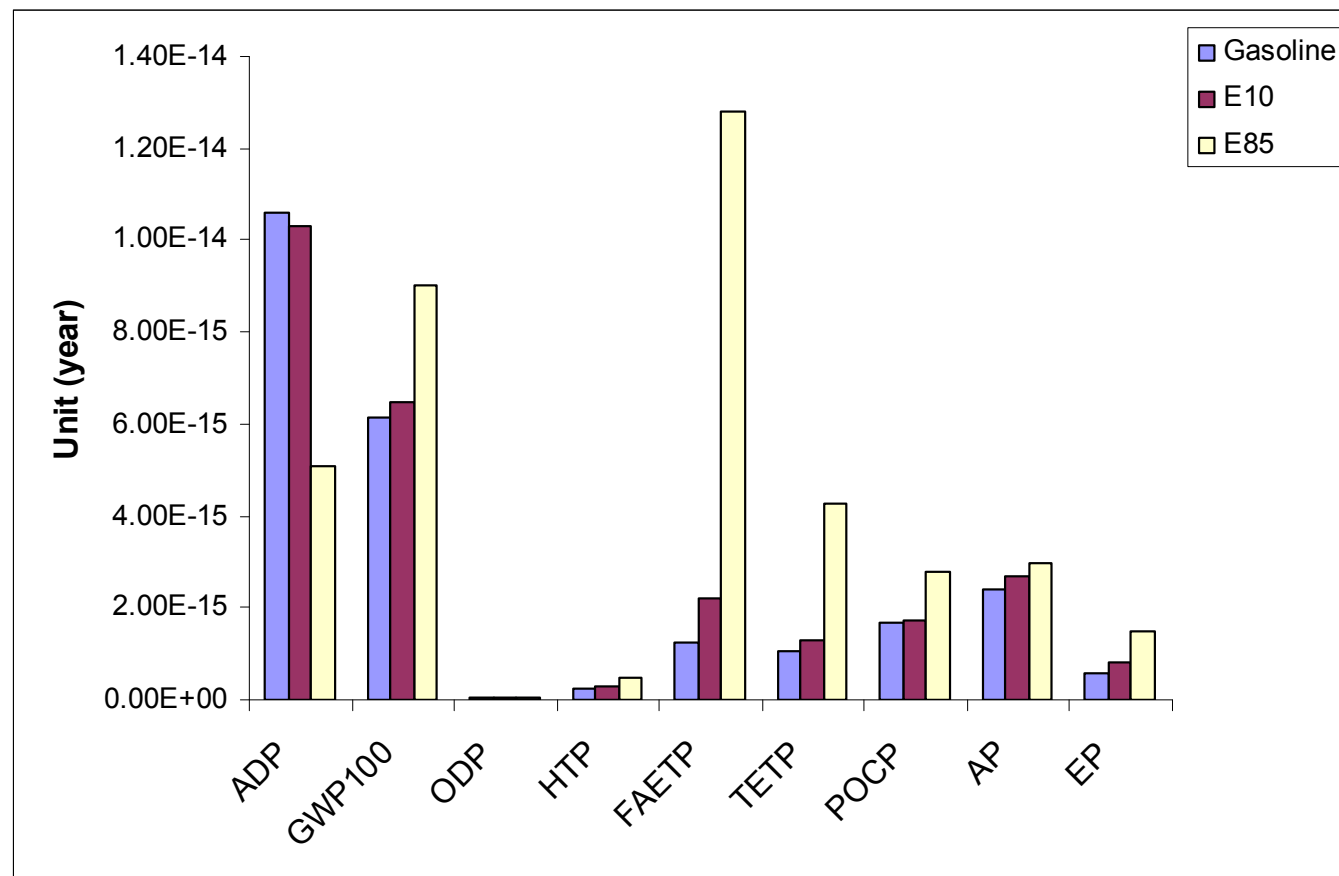
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- Industrial Ecology tools: Life Cycle Assessment
- describes cradle-to-grave environmental impacts of functional chains ...
- ... and shows effectiveness as well as side-effects of alternatives ...



# Industrial Ecology Analysis

Side-effects of biofuels: results of LCA comparison of 1 km driving with different fuels (source: Luo et al., 2009)



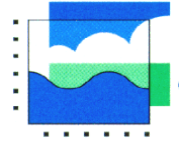


# Industrial Ecology Analysis

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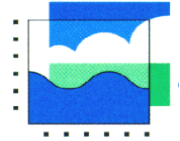
- Industrial Ecology tools: each has own focus and own blinders, all describe (very) small part of the world
- With very large changes at hand: how to get the full picture? how to be relevant for global issues?
  - do many studies
  - upscale
  - do dynamic studies



# Industrial Ecology Analysis

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- Various directions of development
  - use Industrial Ecology concepts rather than specific tools: LCSEA, apply life-cycle thinking
  - develop supermodel: EXIOPOL, linking IOA models for the whole world
  - toolbox: use tools in addition for full picture
- Will this provide sufficient information?

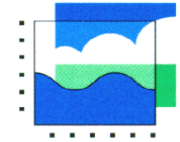


# Linkages between resources

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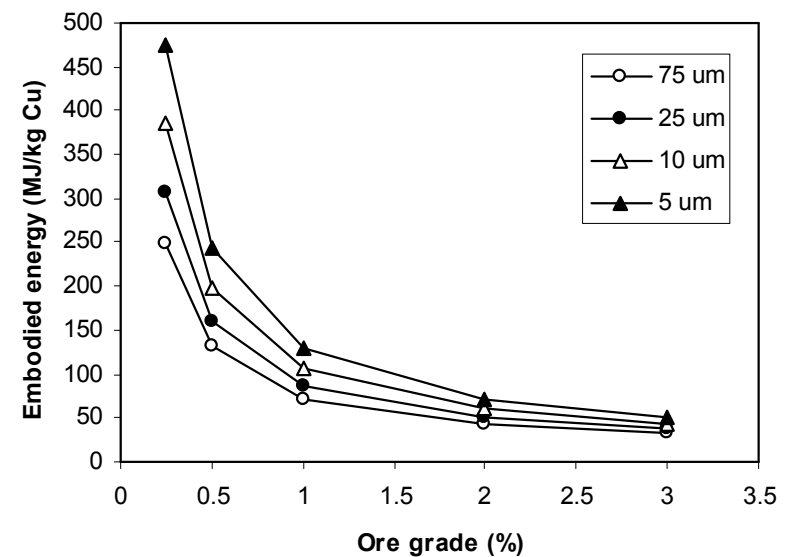
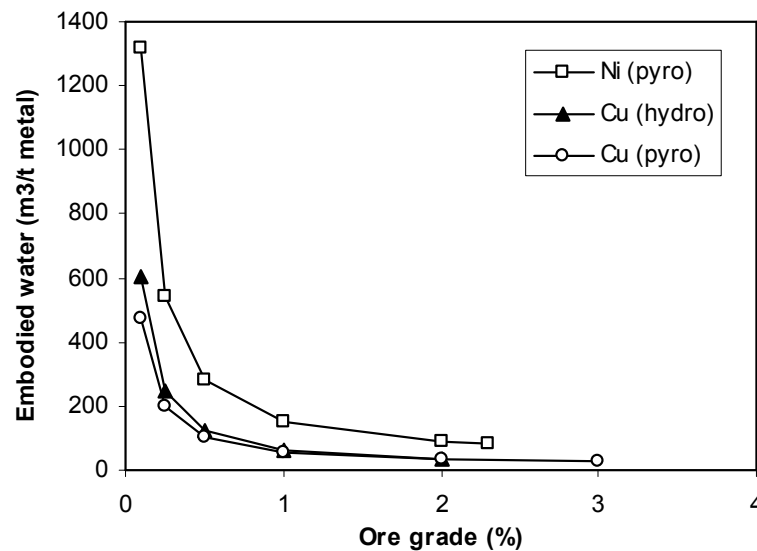
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- Global changes to be realised are very large: how to use our resources in a sustainable way, with “good life” for 8 billion people?
- Separate issues for separate resources
- Separate research communities for separate resources (energy, materials, land, water, ...)
- ... But in the real world: interdependencies and linkages, therefore cross-cutting issues and potential reinforcements and spirals not yet identified!

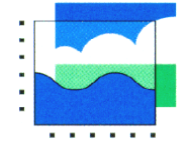


# Linkages between resources

- Materials and energy / materials and water: declining ore grades (source: Norgate, 2010)

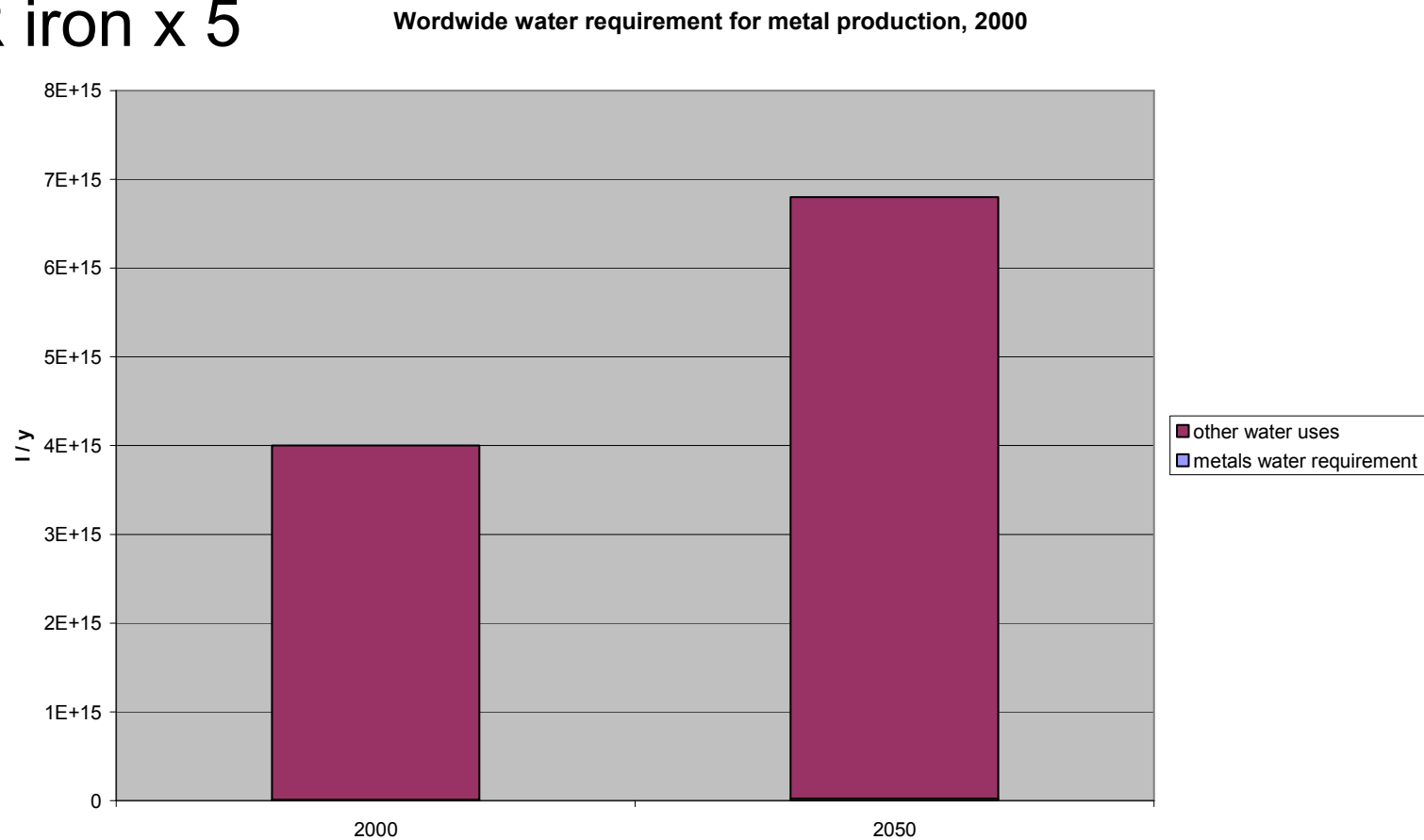


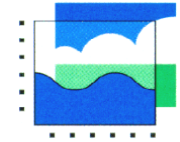
- what does this imply for worldwide water and energy demand?



# Linkages between resources

- Demand for metals in 2050 = 2 x demand in 2000,  
GWR iron x 5

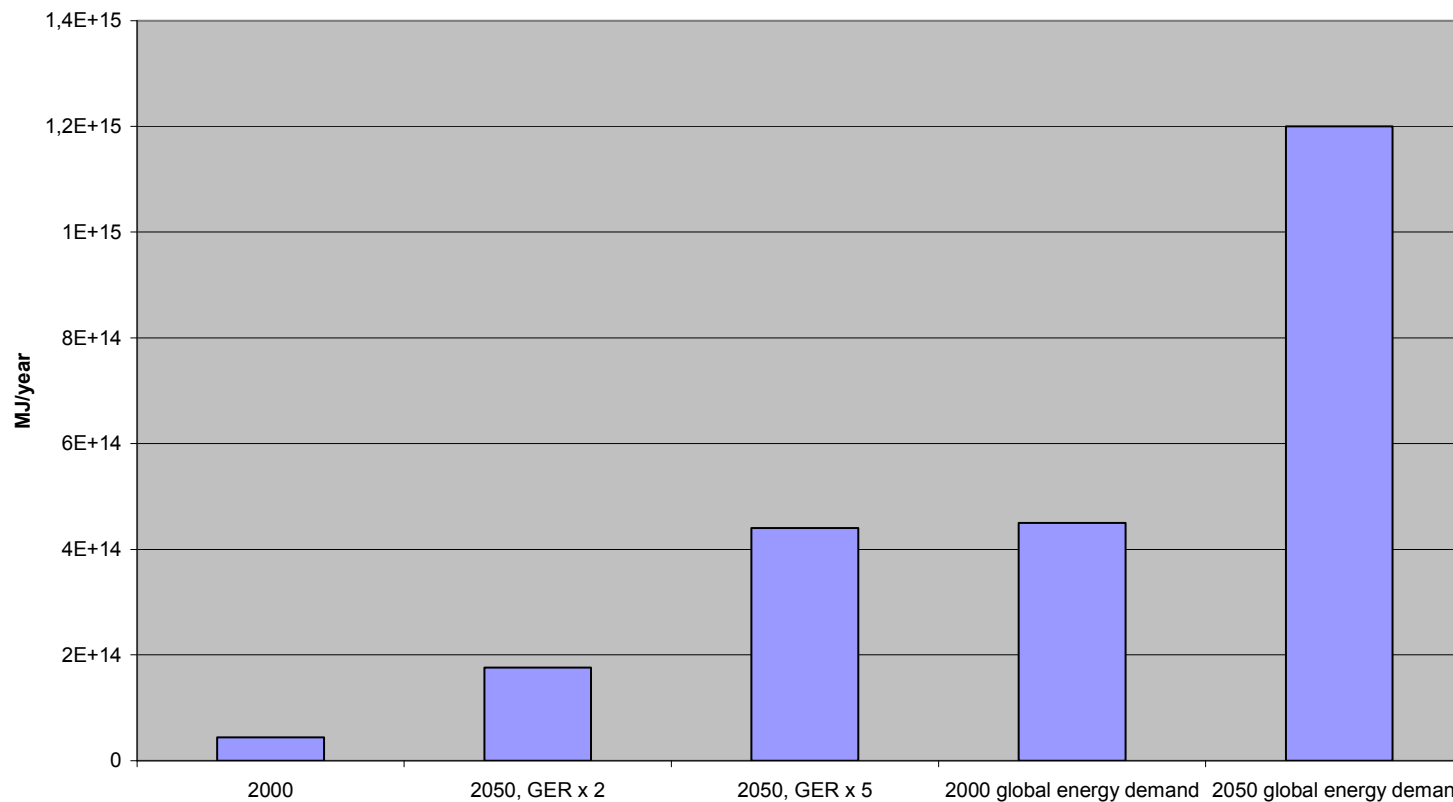


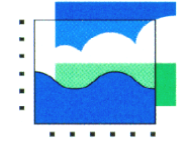


# Linkages between resources

- Demand in 2050 = 2 x demand in 2000, GER of iron, included in energy scenarios?

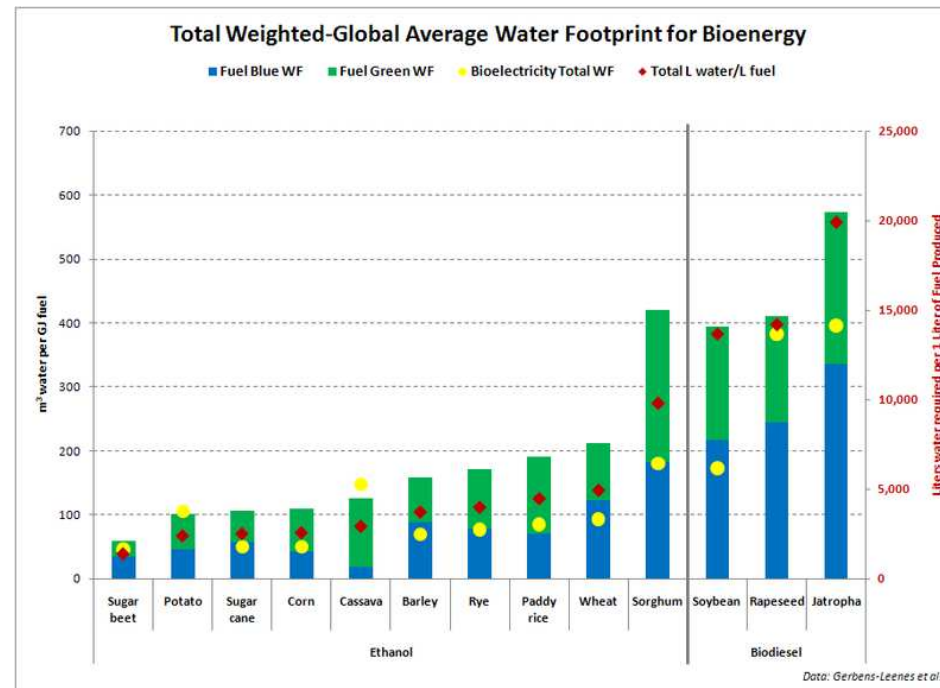
Energy requirement of metal production compared to global energy demand



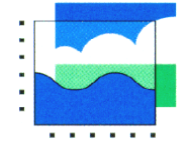


# Linkages between resources

- Energy and water: water footprint of biofuels (source: Gerbens-Leenes et al., 2009)



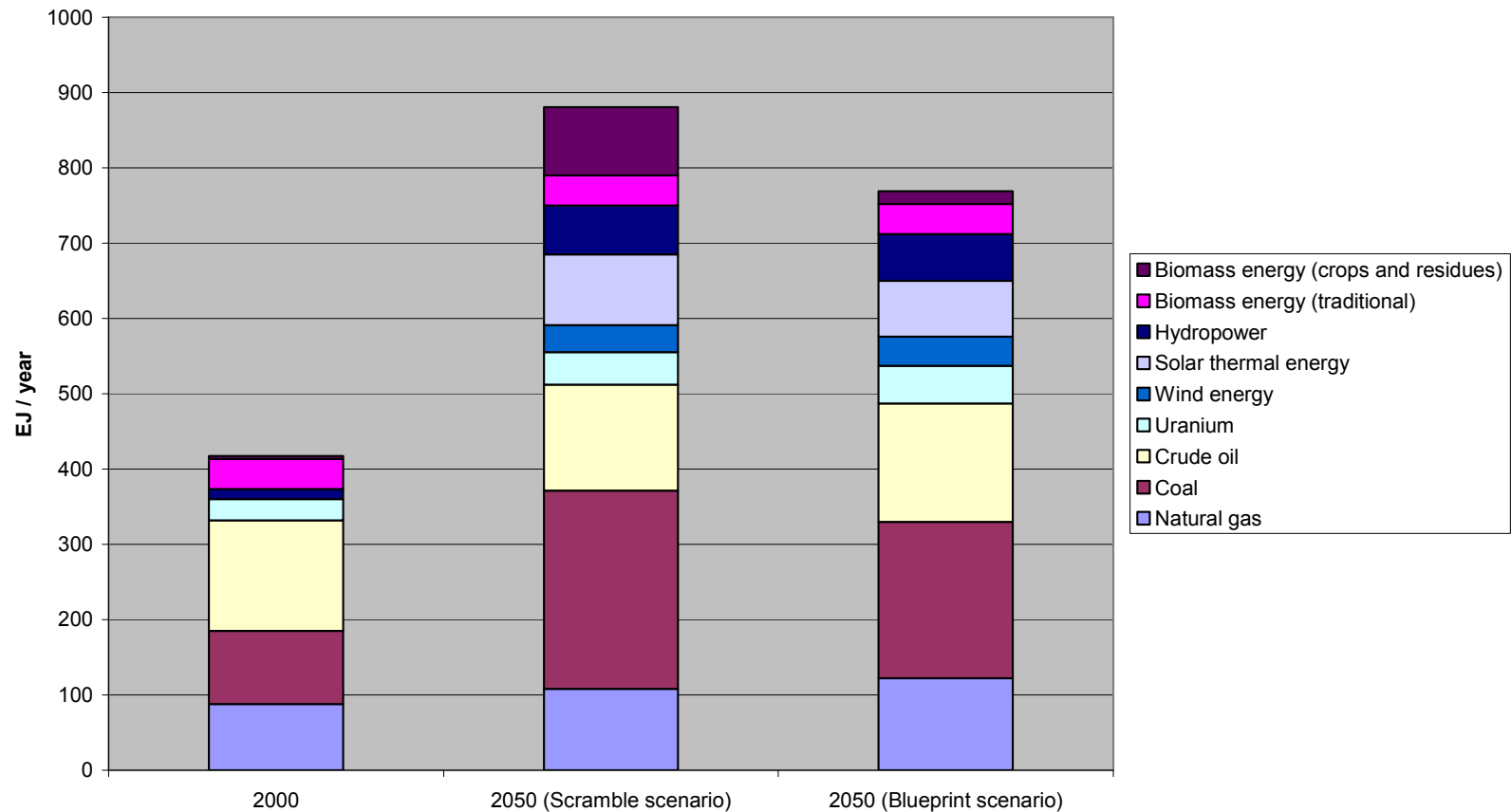
- what does this imply for worldwide water use?

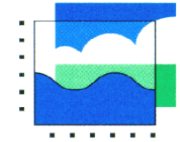


# Linkages between resources

- Energy and water: water footprint of energy scenarios

Energy sources in 2000 and 2050, Shell scenarios Scramble and Blueprint

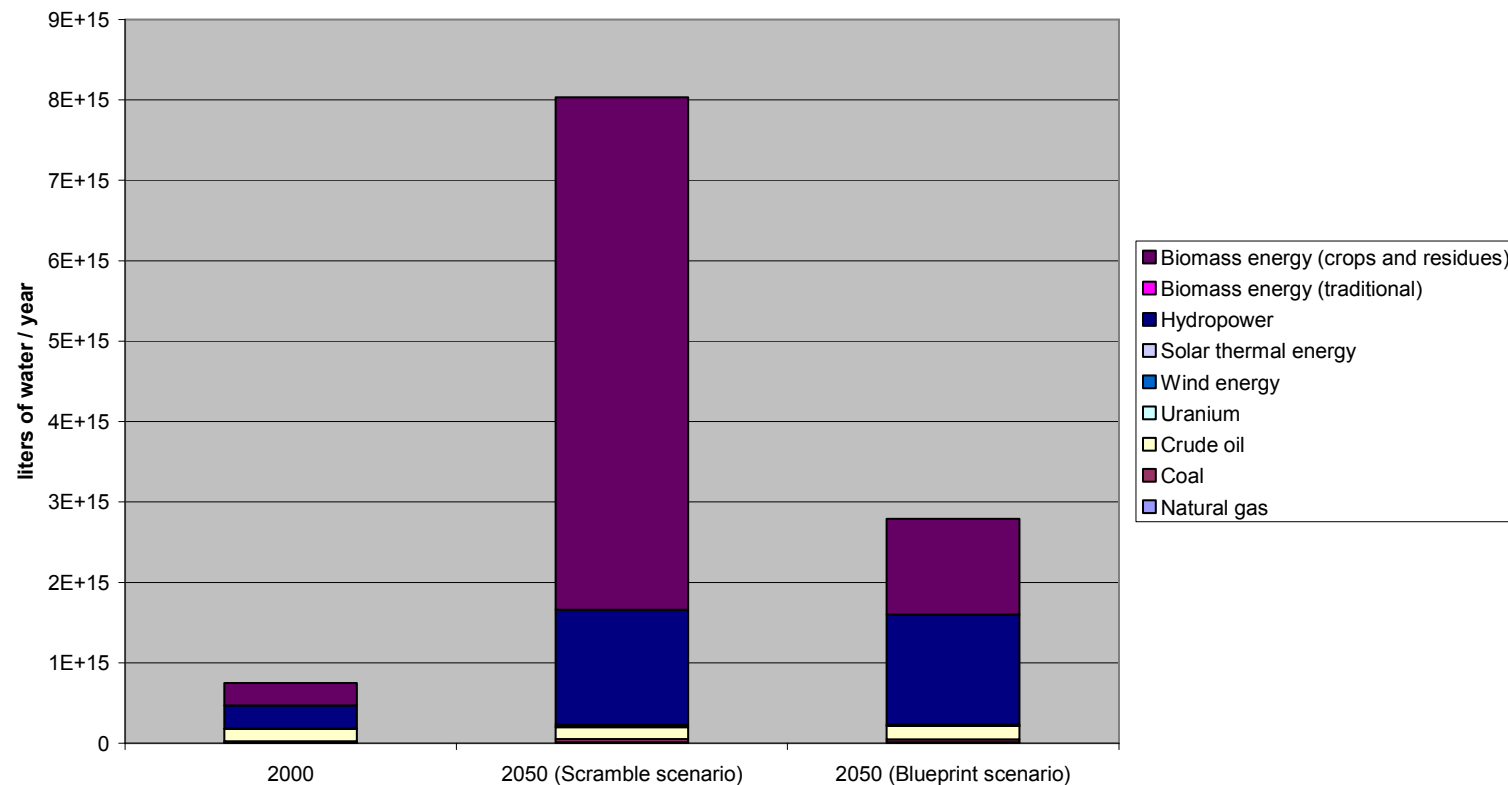


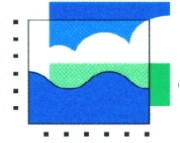


# Linkages between resources

- source: Shell scenarios and De Wever, 2010

Water use related to energy generation in 2000 and 2050 (two Shell scenarios, Scramble and Blueprint)

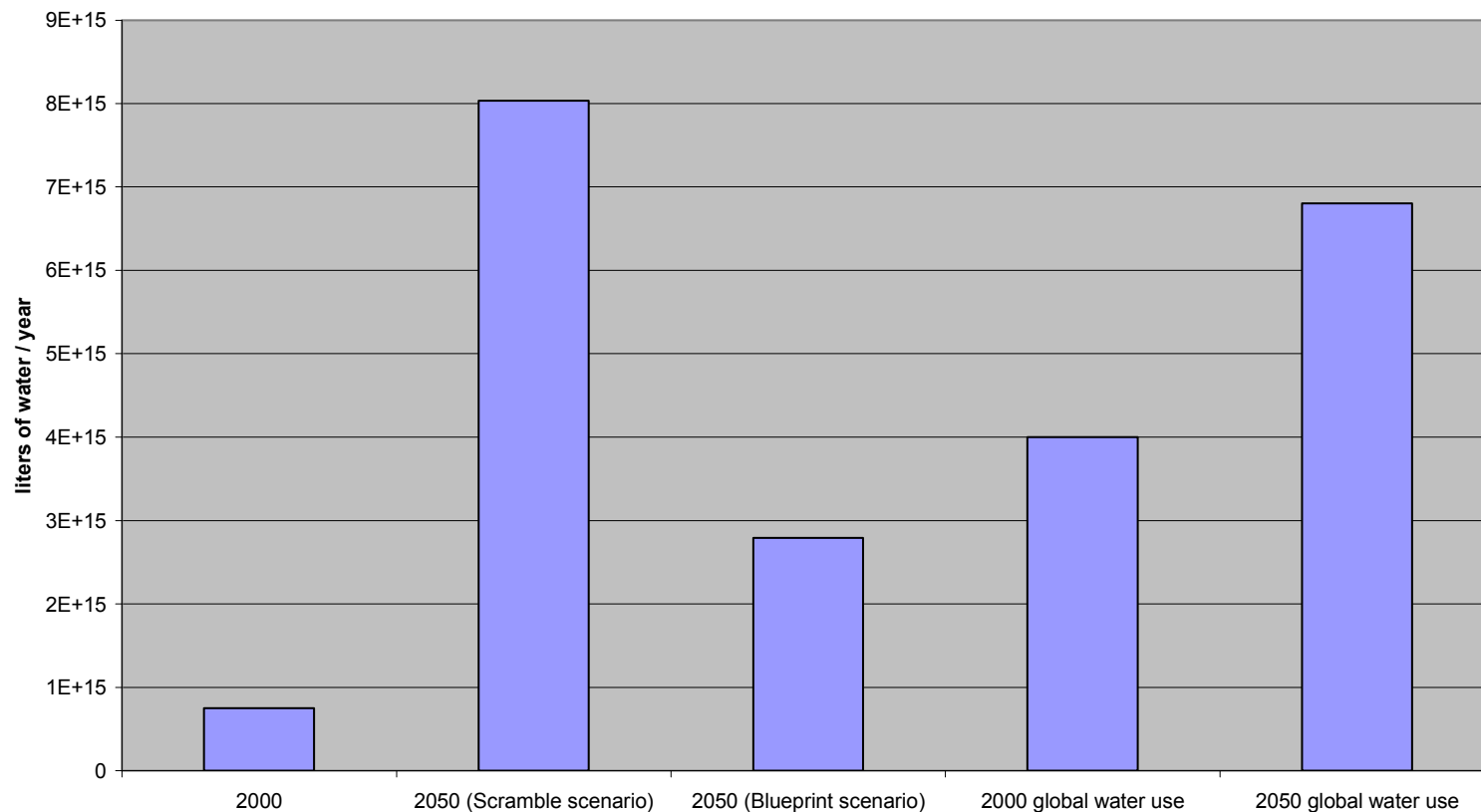


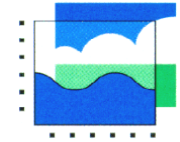


# Linkages between resources

- modest water footprint of 70 m<sup>3</sup>/GJ assumed for biofuels: included in projections of (future) water use??

Water use for energy compared to total global water use

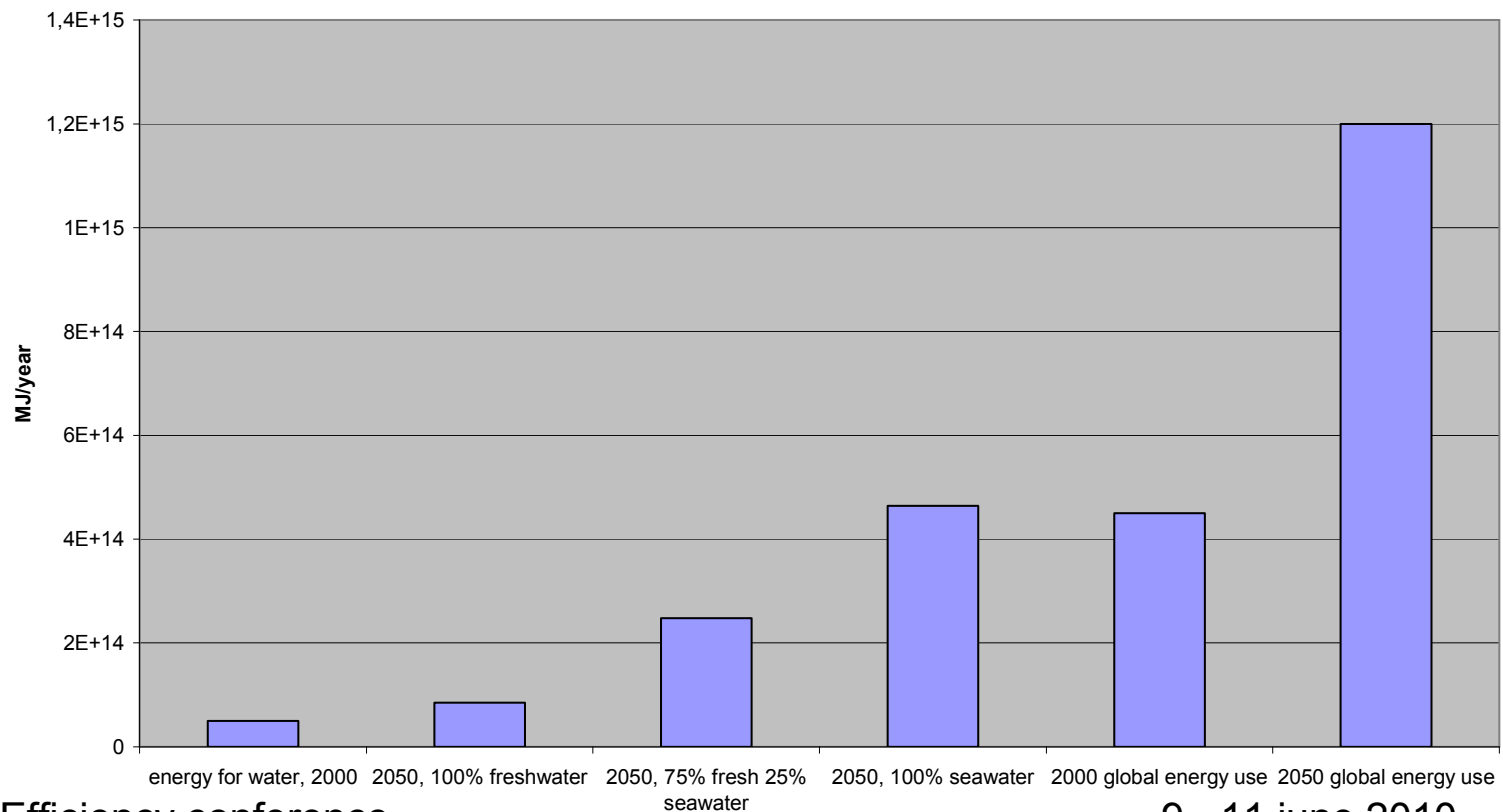


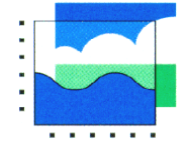


# Linkages between resources

- Water and energy: energy footprint of water supply (desalinisation and WWT: De Wever, in press), included in future energy demand scenarios?

Energy use for water supply compared to total energy demand in 2000 and 2050





## A resource research agenda for the future

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- Resource research agenda: how to meet future demand in a sustainable way?
- Industrial Ecology tools remain very important but should be expanded to include the global scale and future, and especially the issue of linkages
  - Dynamics of supply and demand of individual resources
  - Identifying linkages, quantifying linkages, identifying feedback loops and understanding their dynamics
  - Cooperation between research fields, build-up of truly multidisciplinary body of knowledge
  - Comprehensive, multi-resource scenario development