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# ***Research and Technology Competence for a Sustainable Development in the German Innovation System***

**South African – German Dialogue on Science for Sustainability  
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# Content

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- Background and heuristics of innovation system
- Overview of empirical results
- Results for the sustainability technology fields
- Conclusions



# Megatrends require sustainability innovations

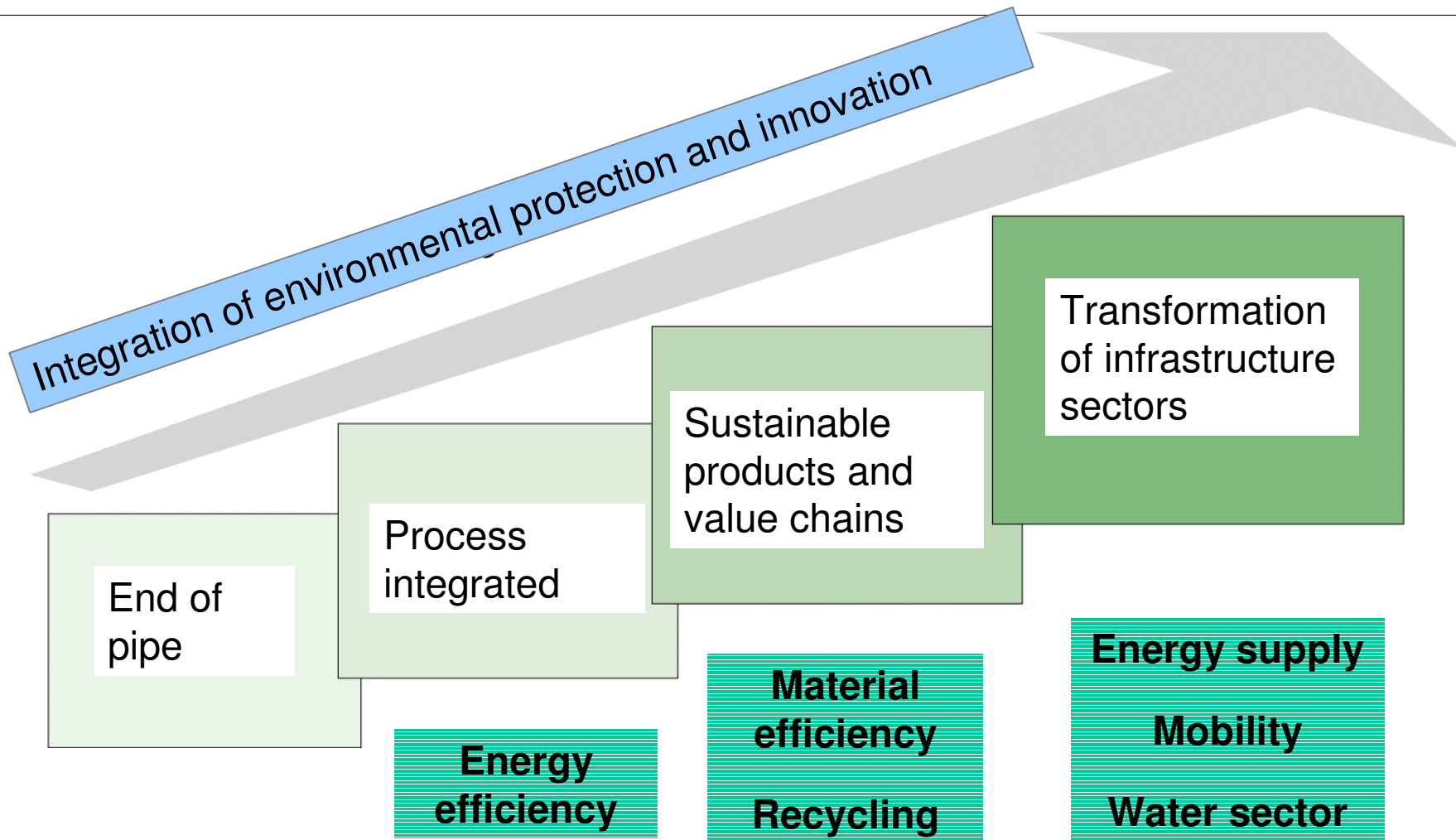
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- Environmental problems increasingly global challenges
- Limited resource availability and systemic risks of infrastructures call for resource efficiency and new paradigms
- Globalisation and fast growing economies accelerate problems
- Economic sustainability requires that environmental technologies become more efficient

=> High innovation dynamics of sustainability technologies required




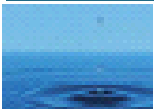

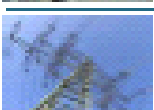
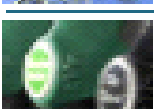

# Technological sustainability strategies




# Sustainability technologies: fast growing technology market

Figures in billion €/a!!!

CAGR<sup>1)</sup>  
2005-2020p

	Energy efficiency	450 → 900	5%
	Water technologies (supply and sewage)	190 → 480	6%
	Transportation and mobility	180 → 350	5%
	Electricity, renewable energy	100 → 280	7%
	Material efficiency, renewable	40 → 130	8%
	Waste, recycling technologies	30 → 50	3%

1) CAGR = Cumulated average growth rate

 2005 Source: Roland Berger 2007



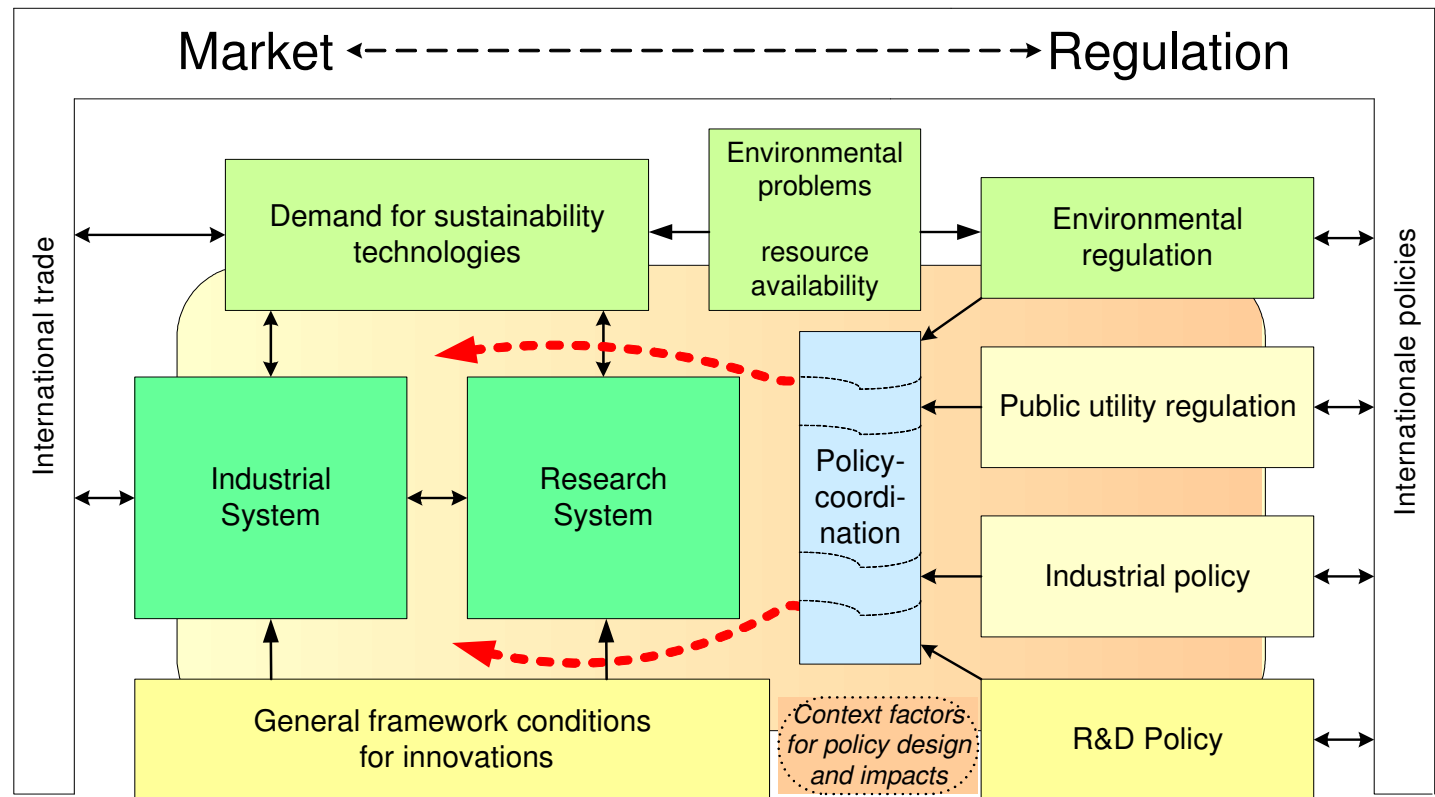
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# Strong system of sustainability innovation required

- Numerous feed-backs between innovation+diffusion
- Demand shaped by regulation
- Many actors, e.g.
  - Research institutions
  - Enterprises, financial sector
  - political actors, e.g. BMBF, Environment Ministry, Länder (states)
- Interaction between actors crucial factor
- Policy coordination necessary

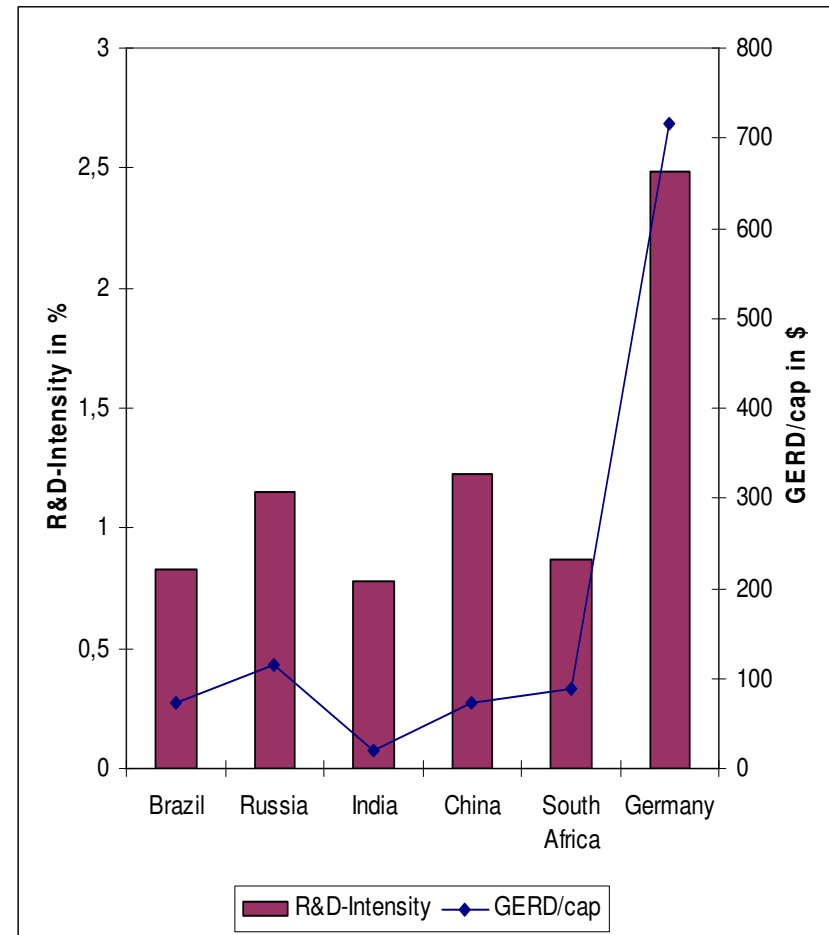
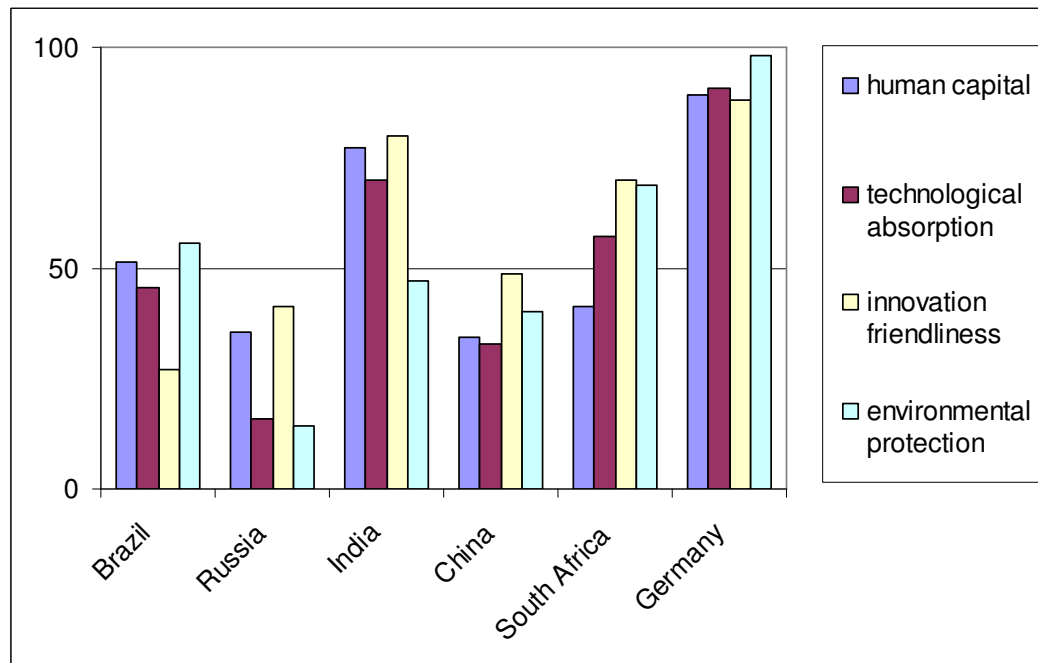
## System of sustainability innovation (SSI)



# General framework conditions for innovations

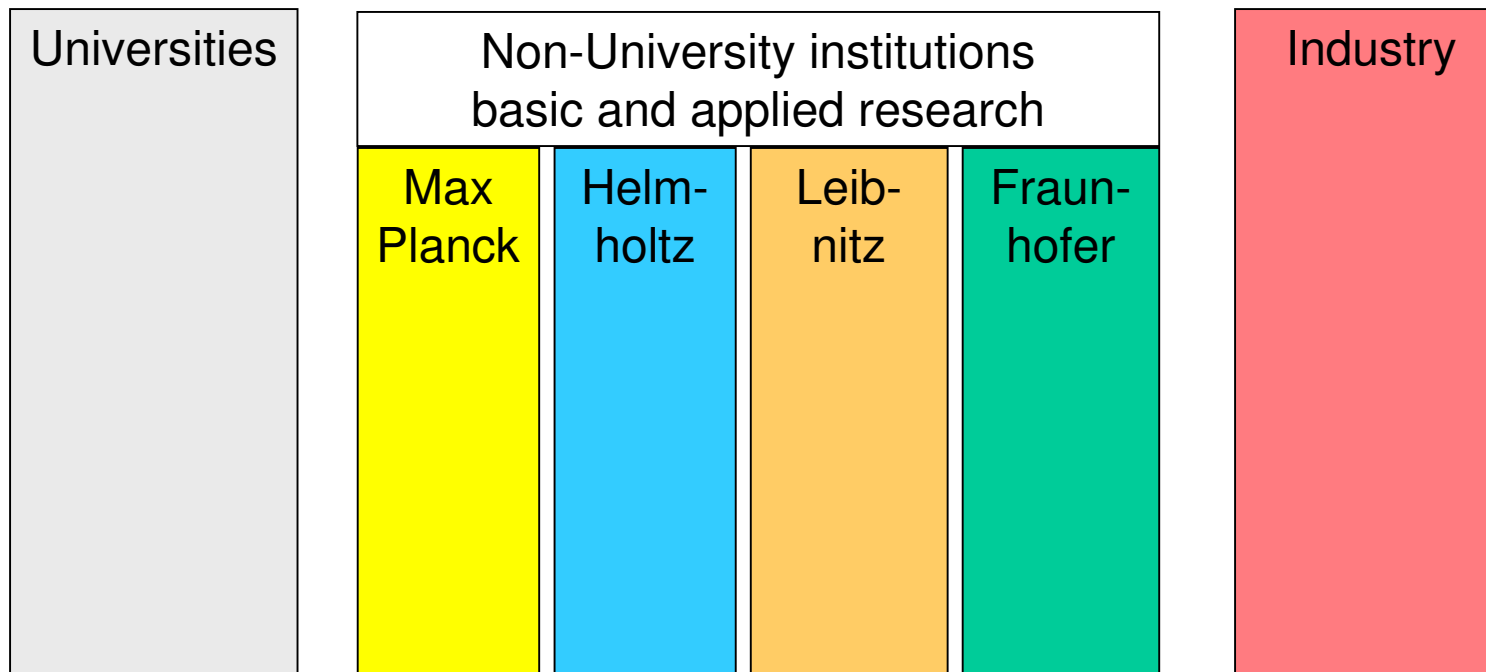
## Different approaches: R&D statistics, WEF-survey

- Germany with R&D intensity comparable to OECD
- Still distance to OECD-average
- Survey based results also show high good framework conditions for Germany



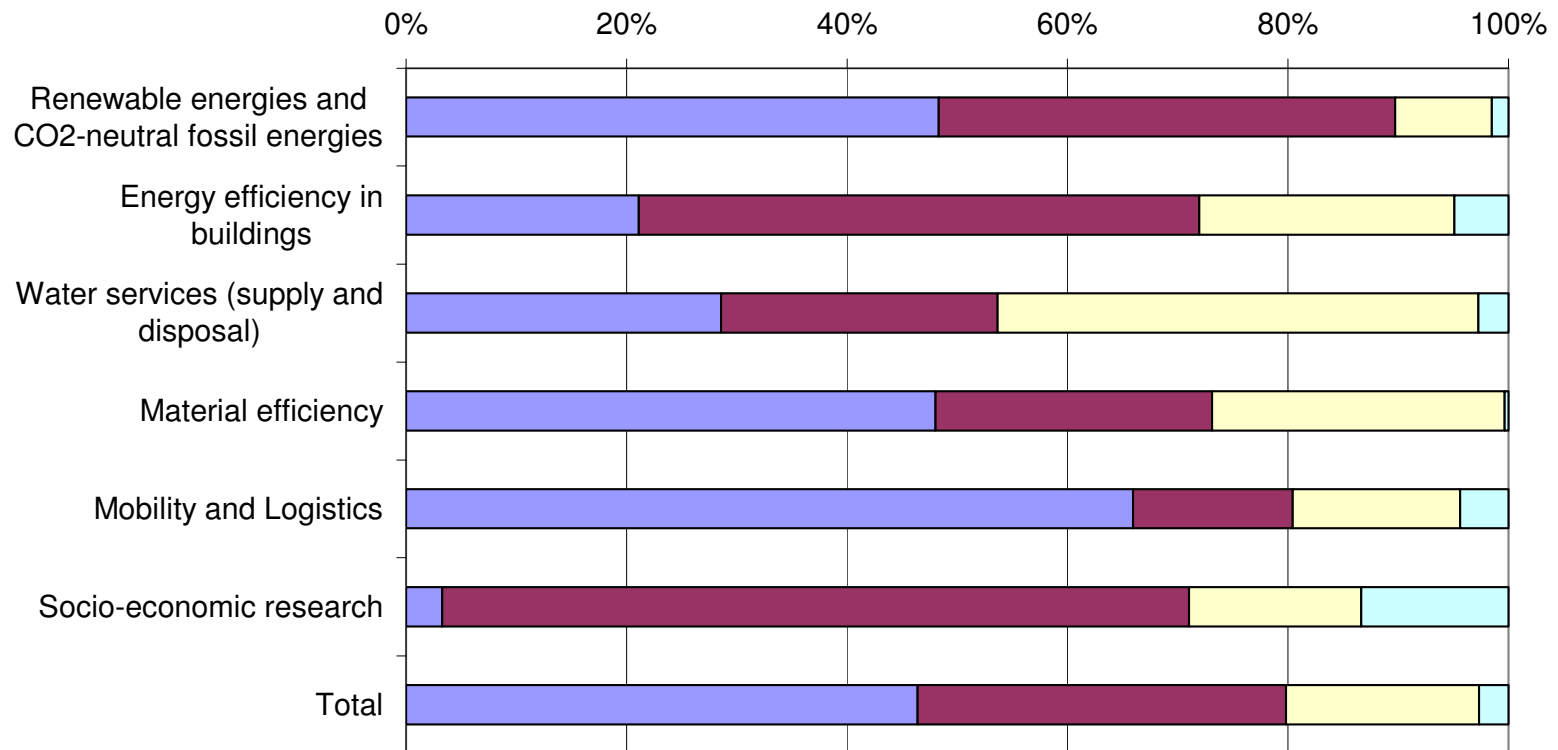
# The German Research System

Research system must link basic research with application



# Research programs in Germany

sustainability research very diversified (also outside universities)  
 But: social science oriented sustainability research underrepresented in publications



Source: ISI analysis of BMBF Foekat

Industry Non-university research Universities Others



# Measurement of sustainability innovations with indicators

Feedback loops between different phases of innovation process lead to different **innovation indicators**:

- Input indicators, e.g. R&D budgets
- Intermediate indicators, e.g. publications
- **Patents**
- Output indicators, e.g. production, **exports**

Page 10

## *ISI database on sustainability innovation indicators*

### Aggregation level

- 6 groups of technology markets
- Each market divided into product groups
- Each product group divided into technologies

### Database

- Patents: international patents (WIPO)
- Trade: UN-COMTRADE (all countries)
- Publications: SCI

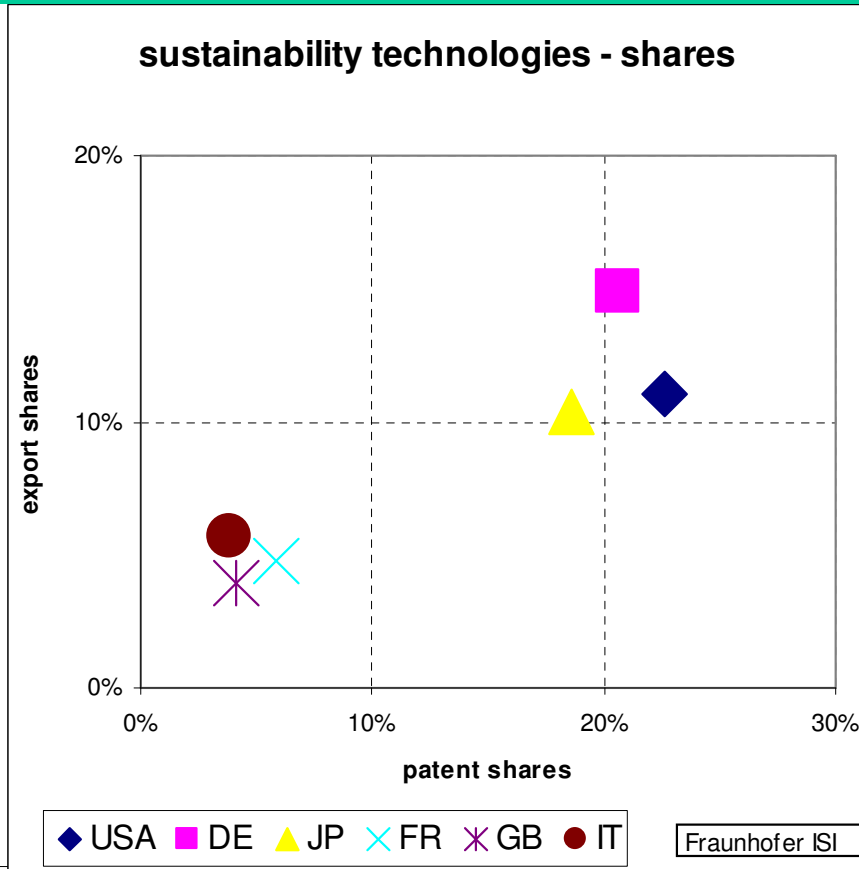
### Classification

- Detailed technology based bottom up analysis necessary to translate technologies into trade classification and patent search strategy
- Type of indicators: shares of countries and their specialisation (RPA, RXA)

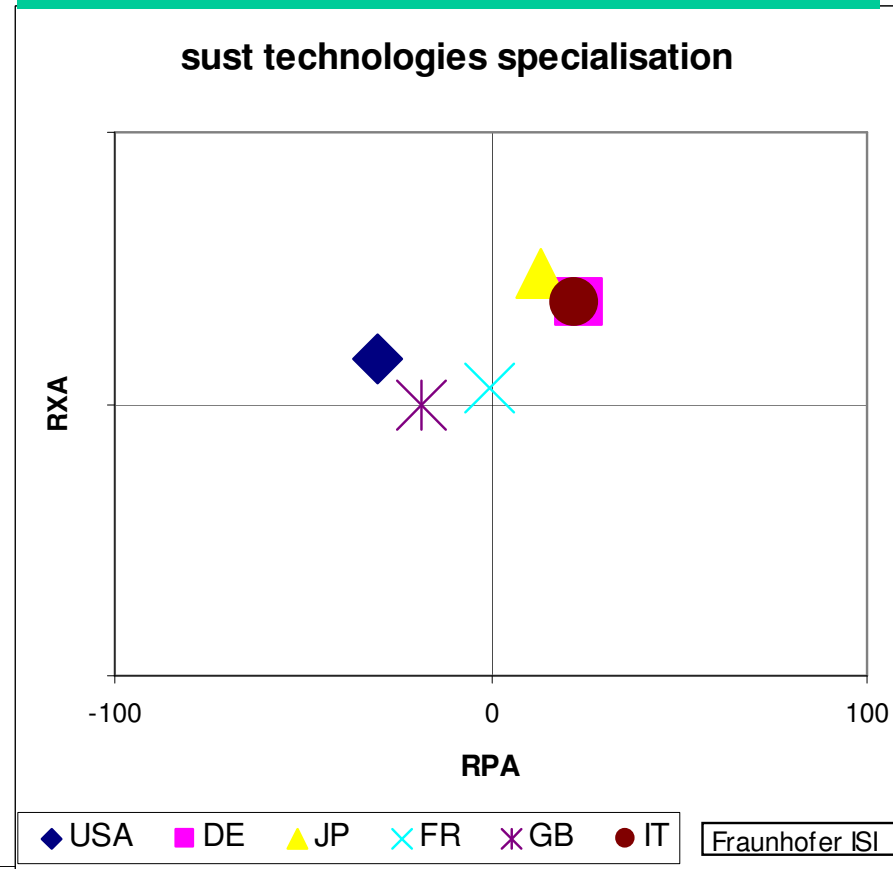


# Sustainability technologies

South Africa: 0.4 % of world exports, and 0.3 % of international patents



South Africa: positive patent specialisation



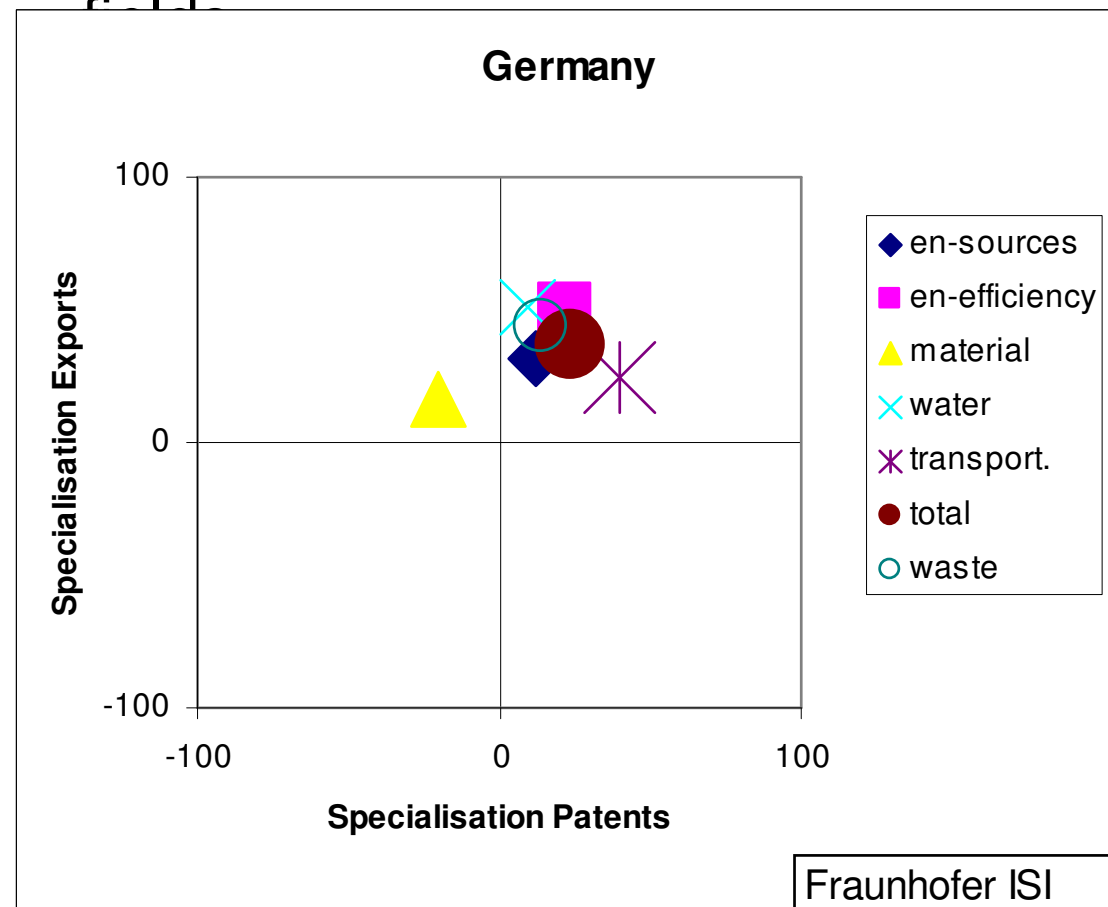
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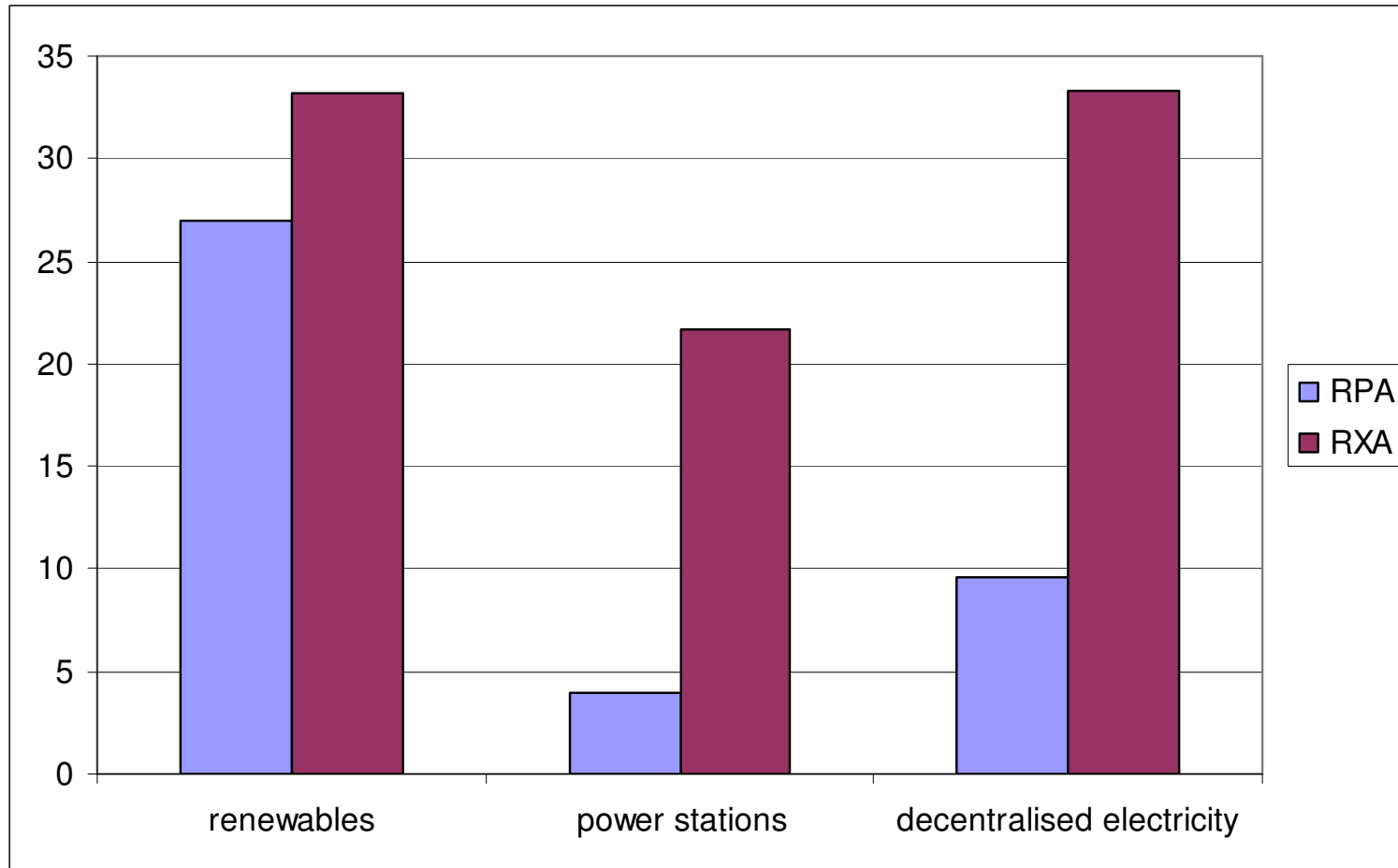
# Overview Germany

- High specialisation of Germany on most sustainability fields
- Only material efficiency below average
- Specialisation in both patents and exports indicates good matching of R&D and market activities
- Germany very strong in complementary industry branches
- But:
  - Even technology fields are too disaggregated level of analysis
  - Move towards technologies

Positive specialisation in most

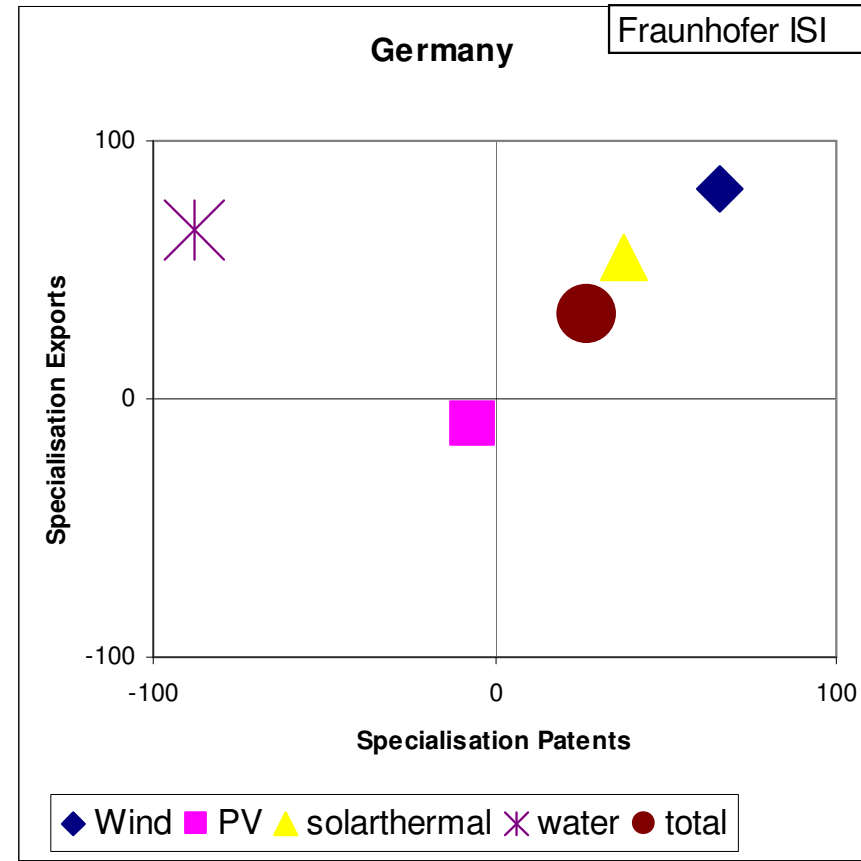
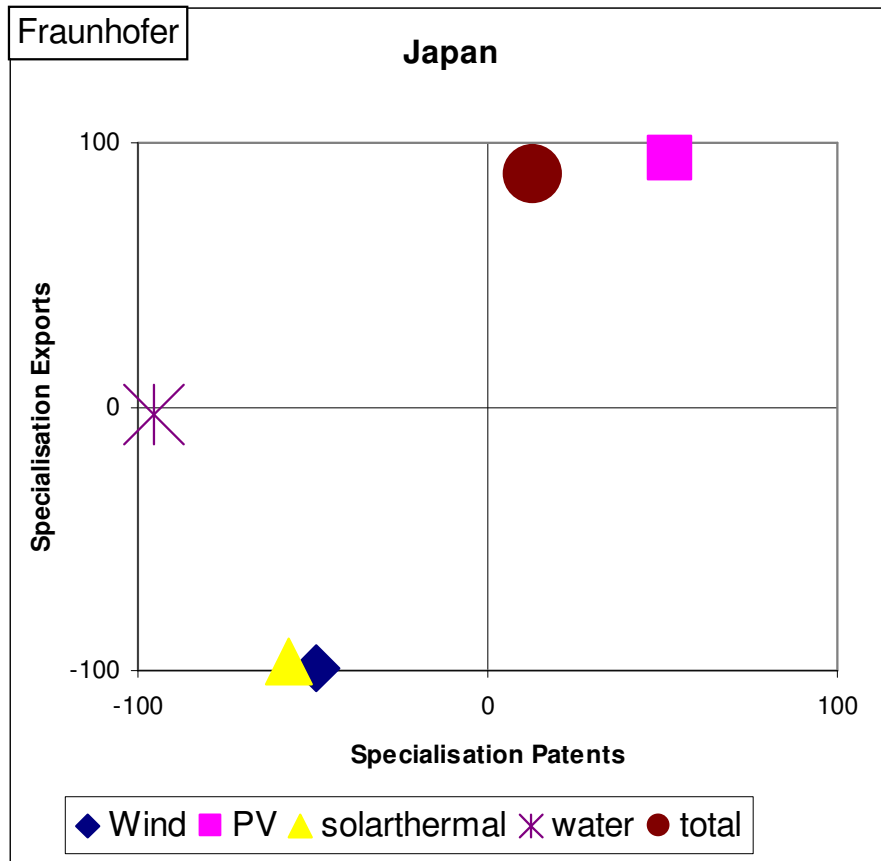


# Specialisation of Germany in the subsectors of energy sources



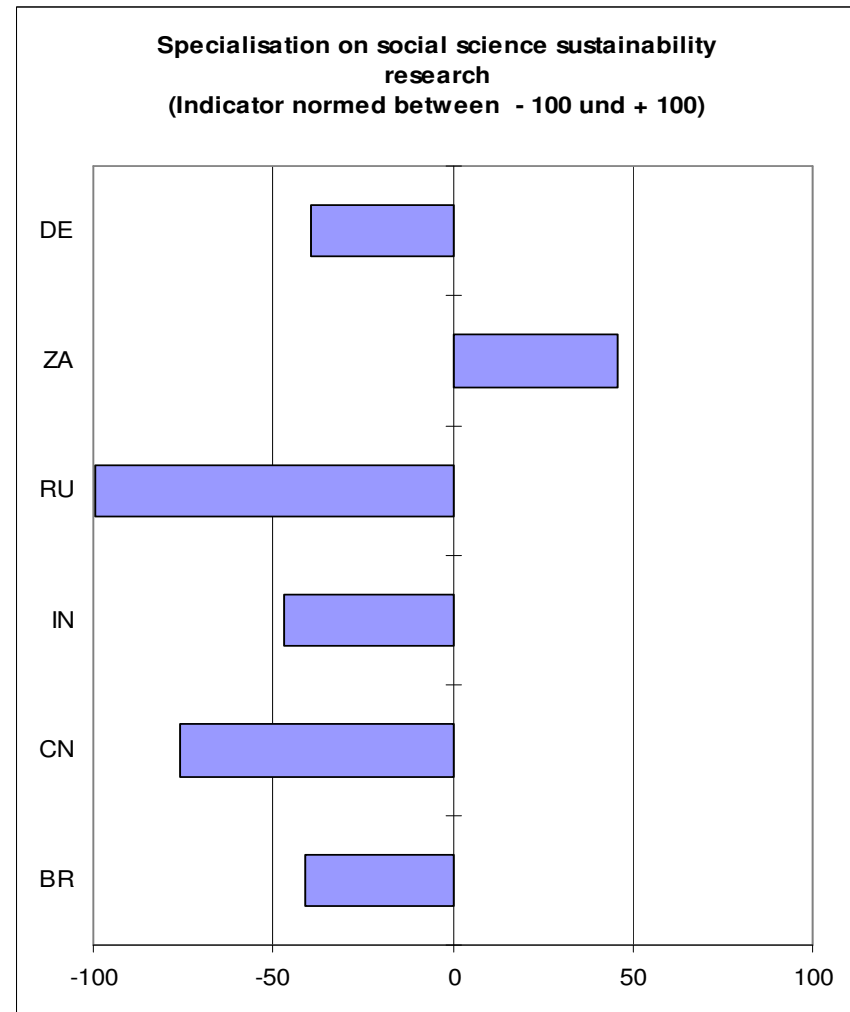
# Specialization in the different technologies in Japan and Germany

technology specific analysis necessary to account for differences



# Publication specialisation

- Publication indicator: are countries specialising on social science related sustainability research?
- Database: publications in SSCI journals dealing with sustainability issues
- Specialisation is based on comparison of share of publications in sustainability publications with total share of publications in all fields (average specialisation = 0)
- Germany has negative publication specialisation



# Conclusions

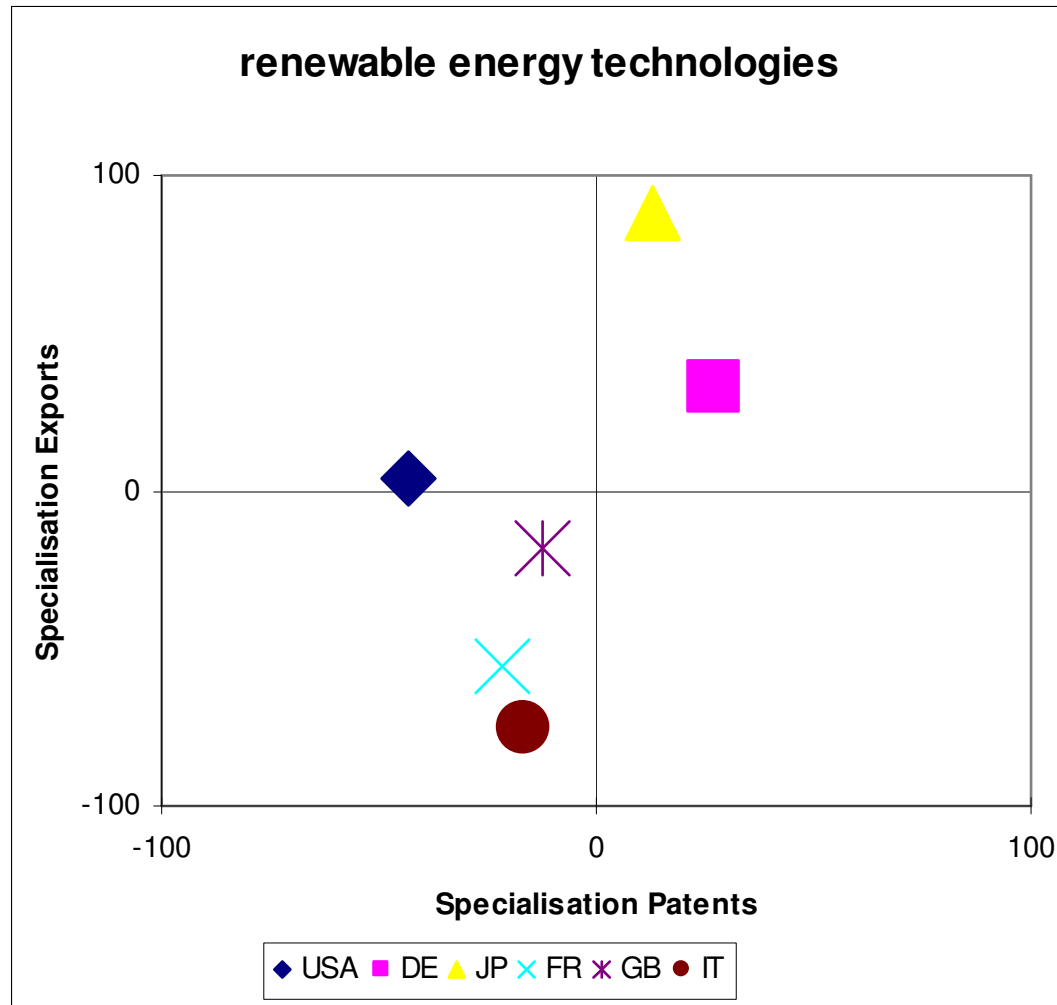
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- Excellent starting position for Germany
  - Patent specialisation matches markets
  - Advantage compared to US and Japan especially strong in energy efficiency and water
  - Advantage in strong complementary sectors
- New competitors are entering the market
- Further need to strengthen German base
  - differences on the disaggregated technology level
  - material efficiency
  - action oriented social science sustainability research
- Internationalisation of sustainability research
  - within Europe
  - open up to the wide world
- Policy coordination between R&D policies and environmental policies

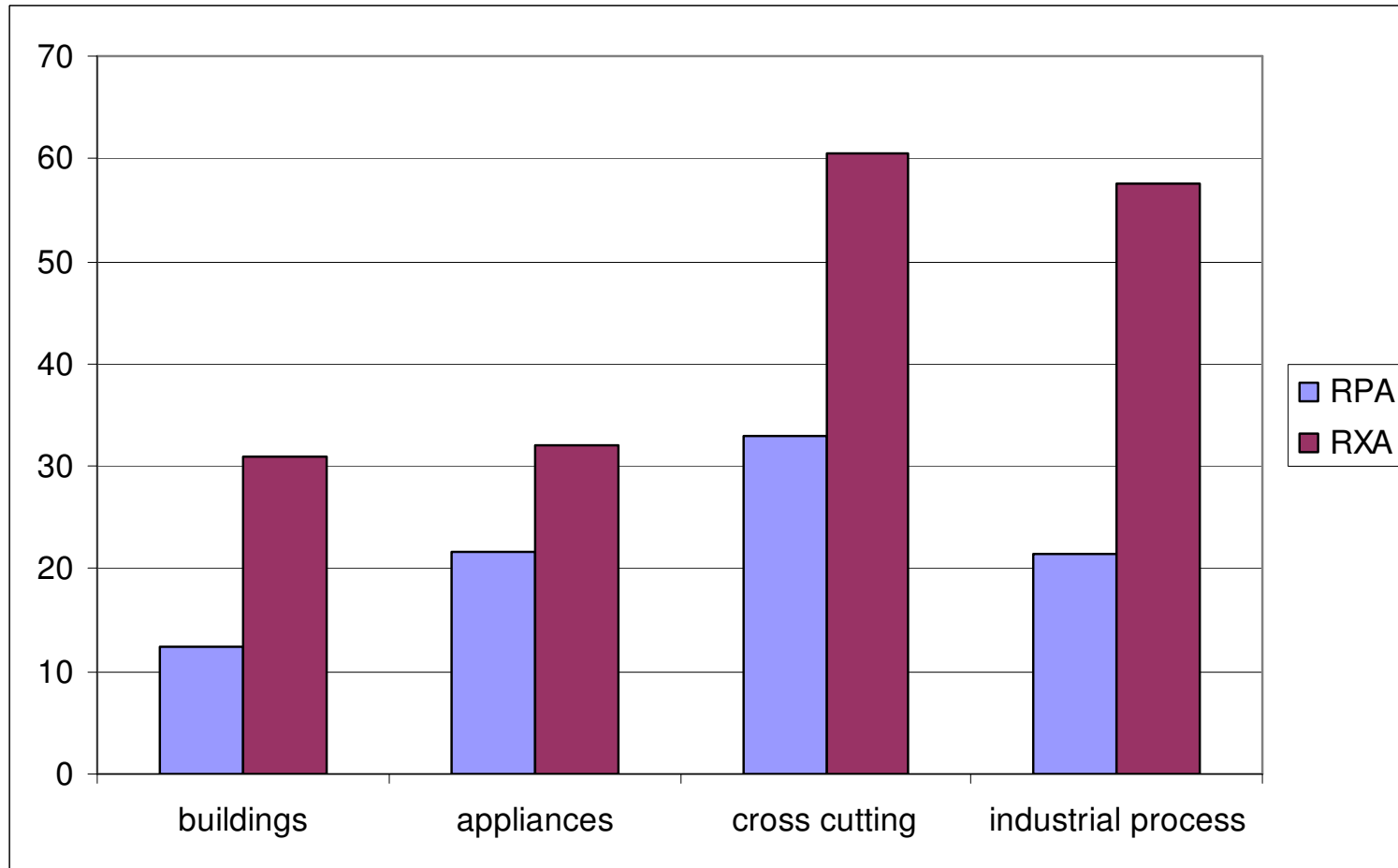


# Specialization of Countries

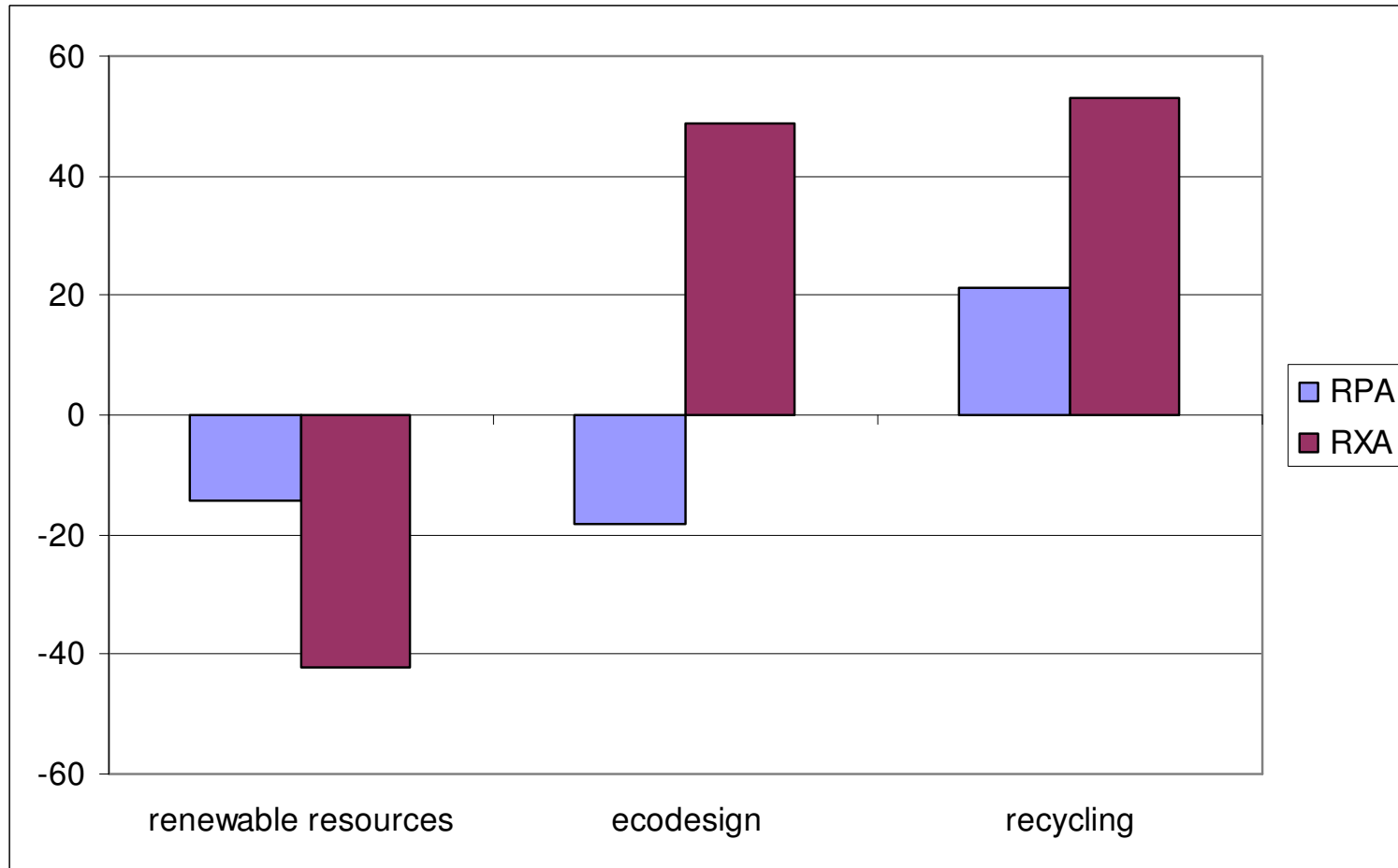
- Indicators (RPA and RXA) normed between +100 and -100
- Positive value: country is specializing on renewable energy technologies
- Japan and Germany with positive specialization



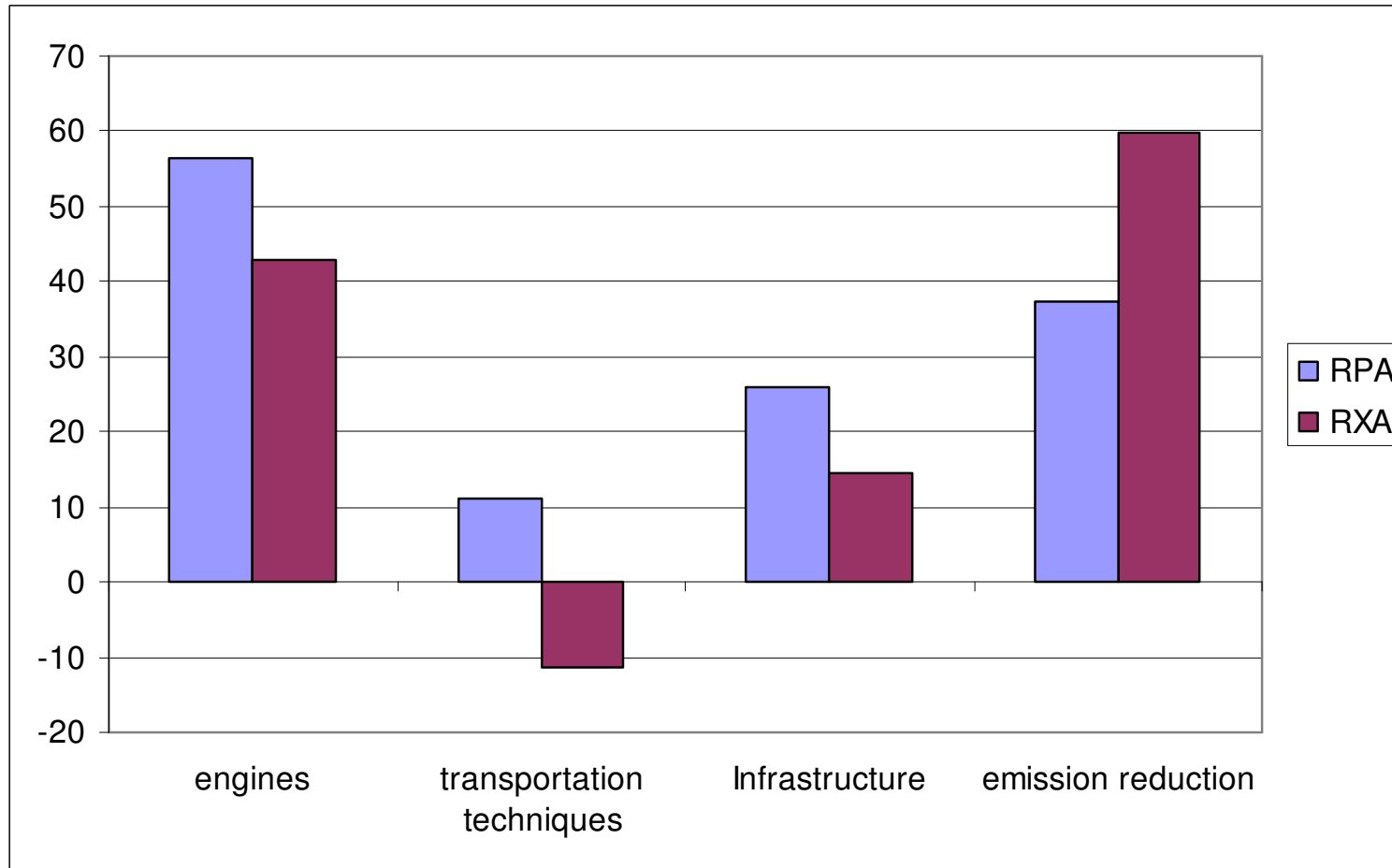
# Specialisation of Germany in the subsectors of energy efficiency



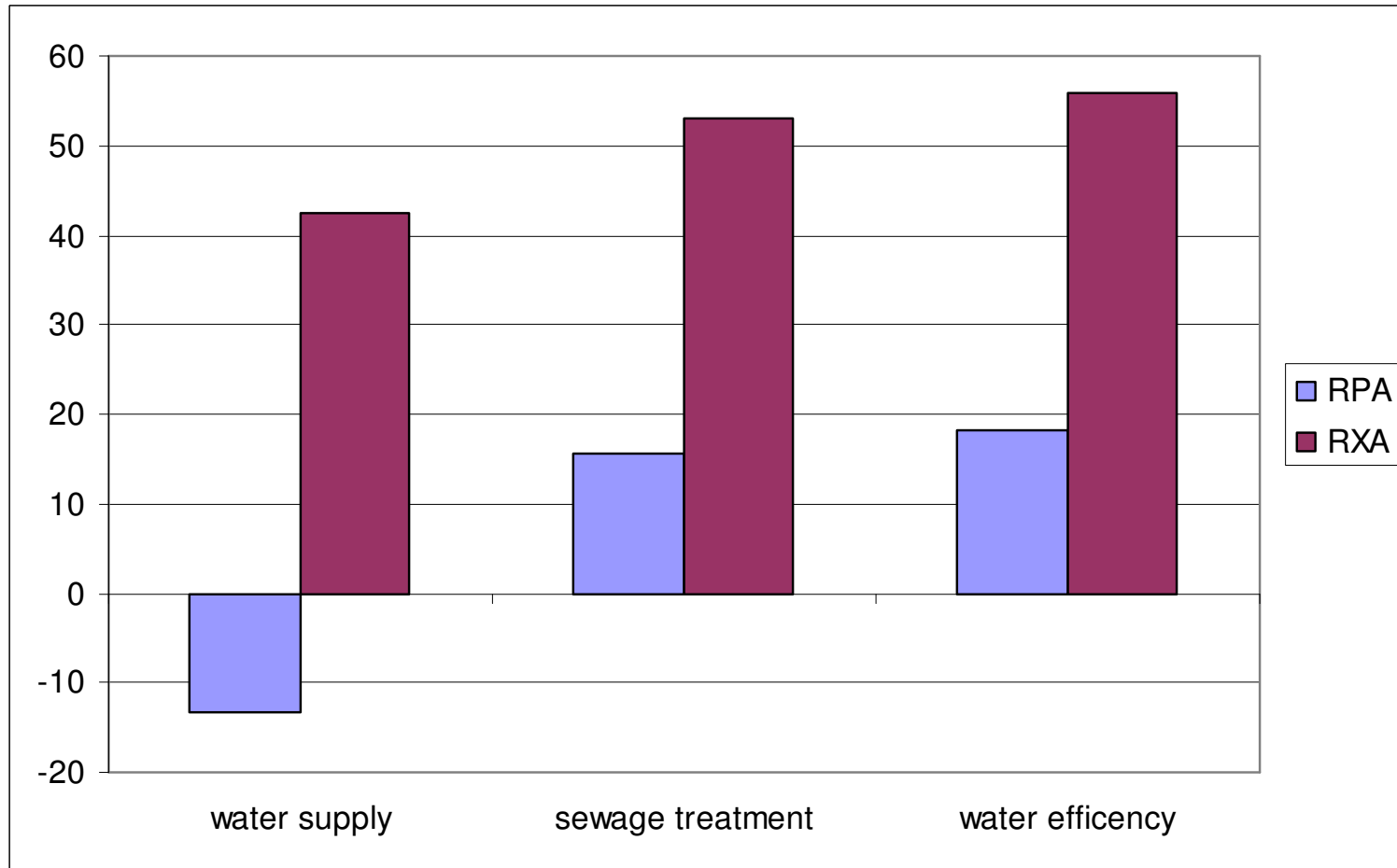
# Specialisation of Germany in the subsectors of material efficiency



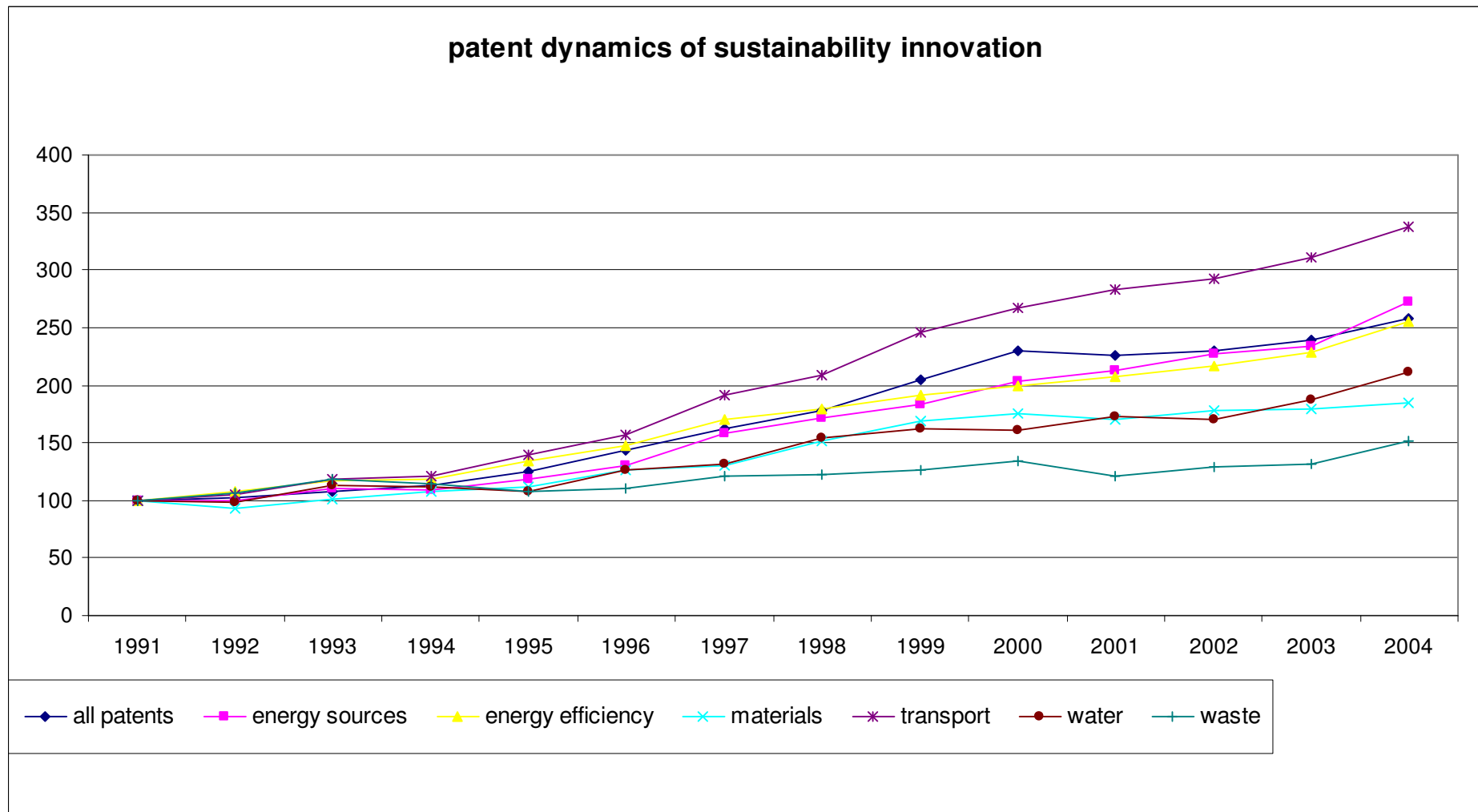
# Specialisation of Germany in the subsectors of transportation



# Specialisation of Germany in the subsectors of water



# Patent dynamics of sustainability technologies



# South Africa

- Framework conditions
  - World market performance in some areas, but problems in human resource availability
  - Modern innovation policy, with focus on biotechnology, IC, resource based industries
- no specific sustainability research, but programmes with strong links to water and transportation
- Strong trade specialisation in materials (also recycling) and biofuels
- Knowledge base above average for most fields
- Success in single technologies (e.g. Sasol in biofuels)
- Challenges: to direct scarce resources more towards sustainability

