Impact of Renewable Energy Policy and Use on Innovation

NEUJOBS Conference

"Innovation and employment: Cornerstones of energy transiton"

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Content

1 RE-Policy and Utilization Effect (1)

- Technological Change as process from invention to innovation to diffusion *(Jaffe et al. 2001)*

- Identifying market failure and market barriers *(Mitchel et al 2011; Beck und Marinot 2004)*

  - Positive and negative externalities
  - Market power
  - Obstacles on capital markets
  - Barriers of information

- Market Mechanisms of technological change
  - „induced innovation“ i.e. market participants react to incentives (relative prices) *(Hicks, 1932)*
  - Regulatory market corrections are justified in case of market failures *(Weitzman, 1974)*
  - Factors of innovation and diffusion *(Fischer et al. 2003; Popp et al. 2010)*

    - Typ of policy instrument and stringency
    - Structure of market/ competition
    - Ability to innovate of market participants (firms)
    - Type and costs of technologies

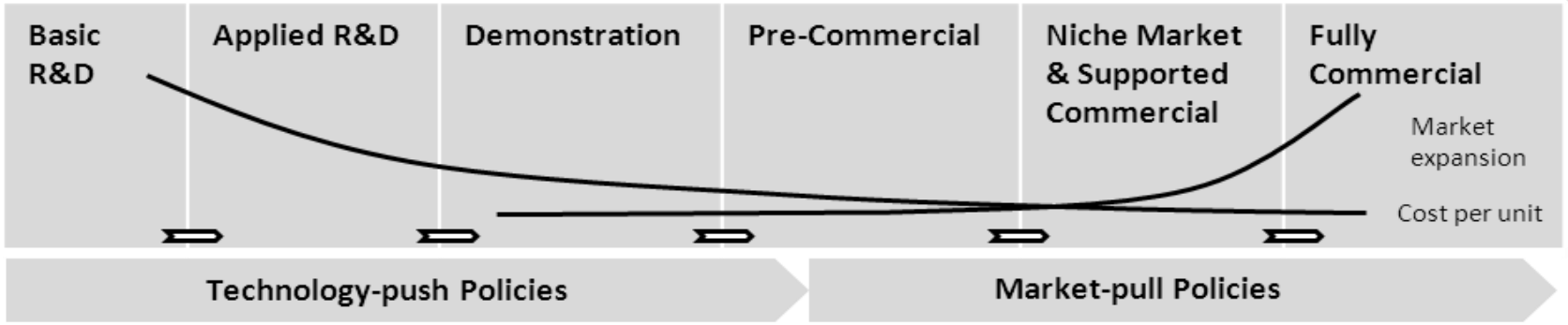
1 RE-Policy and Utilization Effect (2)

- Overview of policy instruments on innovation promotion

Market pull policies				
		Technology-specific (Direct)		**Non-Technology-specific**
		Price –driven	Quantity-driven	
Market-based	Investment incentives	• Investment subsidies • Supportive tax policy • Tender (price)	• Tendering systems for grants (quantity) • Quota (capacity)	• Environmental taxes • Emission trading
	Generation incentives	• Feed-in tariffs • Premium feed-in tariffs	• RE portfolio standards and green certificates • Tendering systems for long term contracts	
Command-and-Control		• Technology and performance standards and authorization procedures		
Volun-tary	Investment Promotion	• Shareholder and contribution programs		
	Generation promotion	• Green tariffs		• Voluntary agreements
Technology push policies				
• Public R&D spending (direct funding, grants, prices) • Tax credits to invest in R&D		• Support for education and training • Financing demonstration or pilot projects		• Strategic development policies • Technology exhibitions/fairs

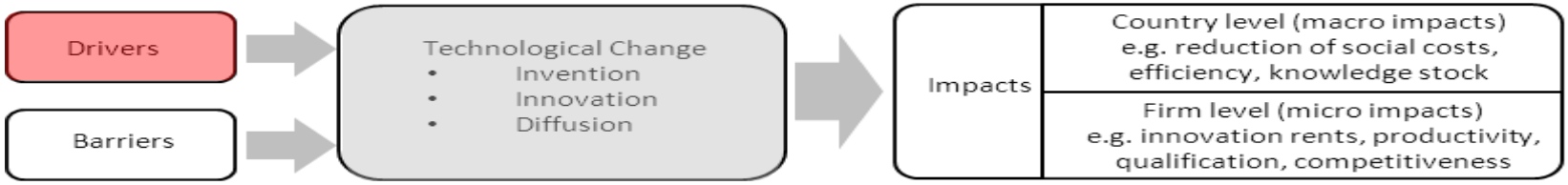
1 RE-Policy and Utilization Effect (3)

- Relevance of policy mix



Quelle: Grubb, 2004

- Methodological approaches to gasp technological change and policies
  - Dimensions:*(OECD 2009)*



  - Measure:

...for policies, expenditures, prices	**...for effects**
• Dummy variables for policies	• Private R&D expenditures
• Level of policy induces prices (taxes, emissions)	• Patent applications
• R&DD expenditures	• Trade with research intensive goods
• Level of scientists/ educational spending	(level, dynamics, indicators)
• Strength of patent protection	• Development of technology costs
• Pollution abatement costs and expenditures	

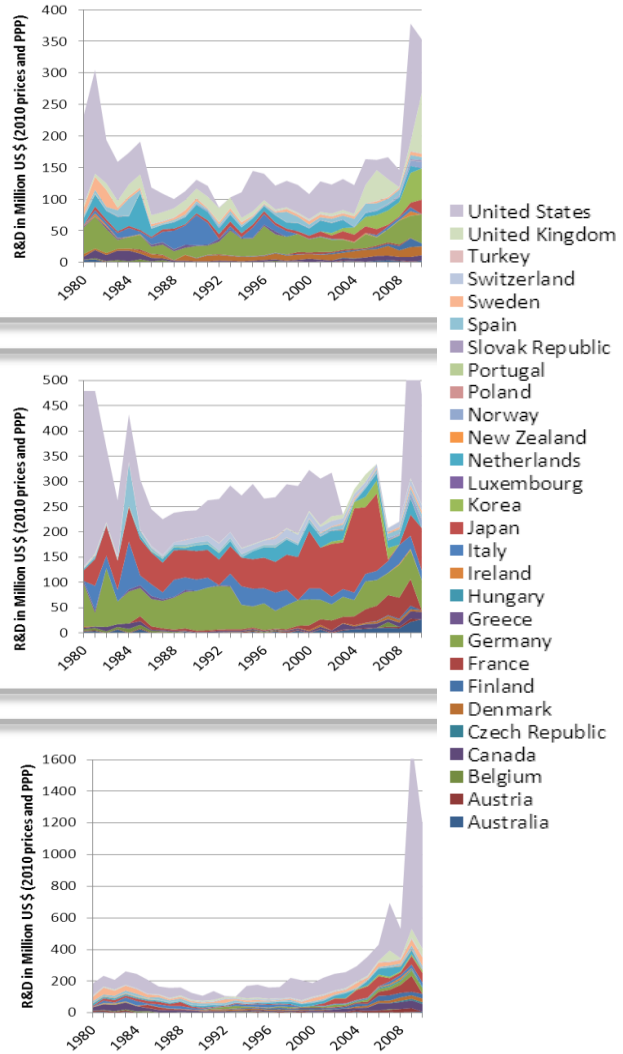
1 RE-Policy and Utilization Effect (4)

- Effects of technological change in renewable energy
  - Competitiveness and und International Trade
    - Porter Hypothesis *(Porter und Van der Linde 1995)* vs. Pollution Haven *(Copeland and Taylor 2003)*
    - Lead Market Hypothesis *(Beise 2004, 2005)*

  - Reduction of technology costs
    - learning by doing at industry level – learning or up-scaling at the unit level „learning is a descriptive label for a multi-faceted process„ (W*ilson 2012)* (knowledge generateion, application and exchange)
    - Bosten Consulting Group - experience curves, i.e. relation between cumulative production and costs (unit costs)
    - <u>But</u>: Technology costs not only caused by diffusion. Important factors are:
      - learing by searching,
      - costs of components, material, energy , labor.
      - Market characteristics and restrictions
        (Kobos et al. 2006, Junginger et al 2006, Feriol et al 2009, Zwaan et al.2012, Bolinge &Wiser 2012)

2.1 Research and Development Spending

Wind



- Highest spending: US, UK, DE (≈ 45 Mio. $)
- ≈ 6 % of total R&D spending for energy
- + 30 % since 1985 (+87% 1990), below IEA average
- Research intensity (¢/Mio. $ GDP) above IEA average

PV

- Highest spending: US, JP, DE (≈ 60 Mio. $)
- ≈ 8% of total R&D spending for energy
- only + 3% since 1985 (-27% 1990), below IEA average
- Research intensity above average.

Biofuels

- DE ranked sixth on spending (≈ 35 Mio. $)
- ≈ 4% of total R&D spending for energy
- + 5900% since 1985 (+1200% 1990), above IEA average
- Research intensity substantially below average.

<u>But:</u> No Data for BRICS, Korea and private R&D spending

2.2 International Trade

- "*Green*" technologies decisive meet climate change challenges.
- Trade as mean for technological transfer.
- Limited literature and market studies.
  - Porter Hypothesis
- Strongly increasing global market dominated by OECD countries.
- Export markets are high income countries, limited exports to others..
- **Empirical Analysis**:
  - Effect of RE-Policies on trade in export and importing countries.
  - Effect of trade costs.
- **Results**:
  - trade theory confirmed.
  - Policy in importing countries significant.
  - strong RE policy support increases exports.
  - Innovation is an important element.

Figure: Development of solar PV Technology components *Source:* authors' calculations based on UNCTAD Comtrade 2012

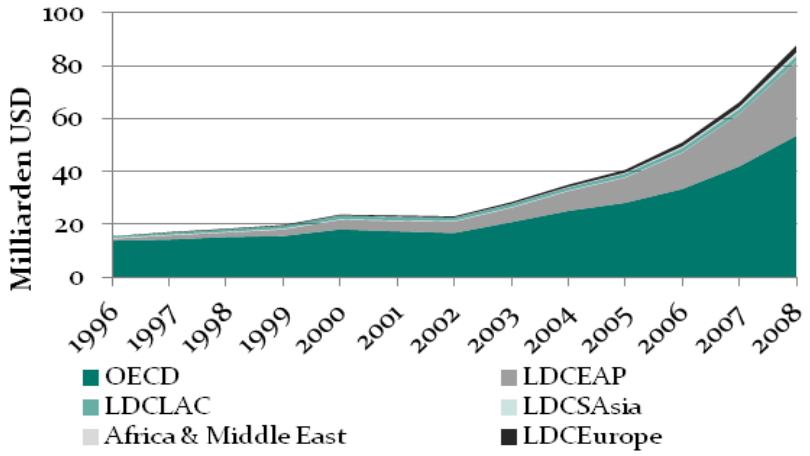
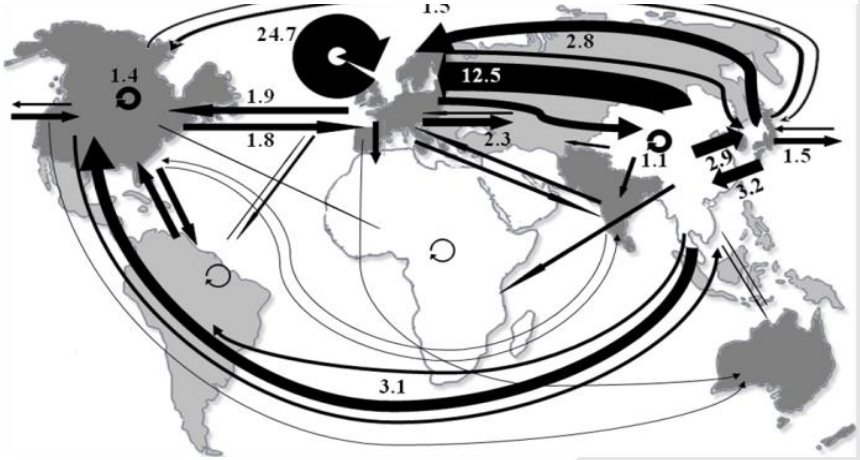
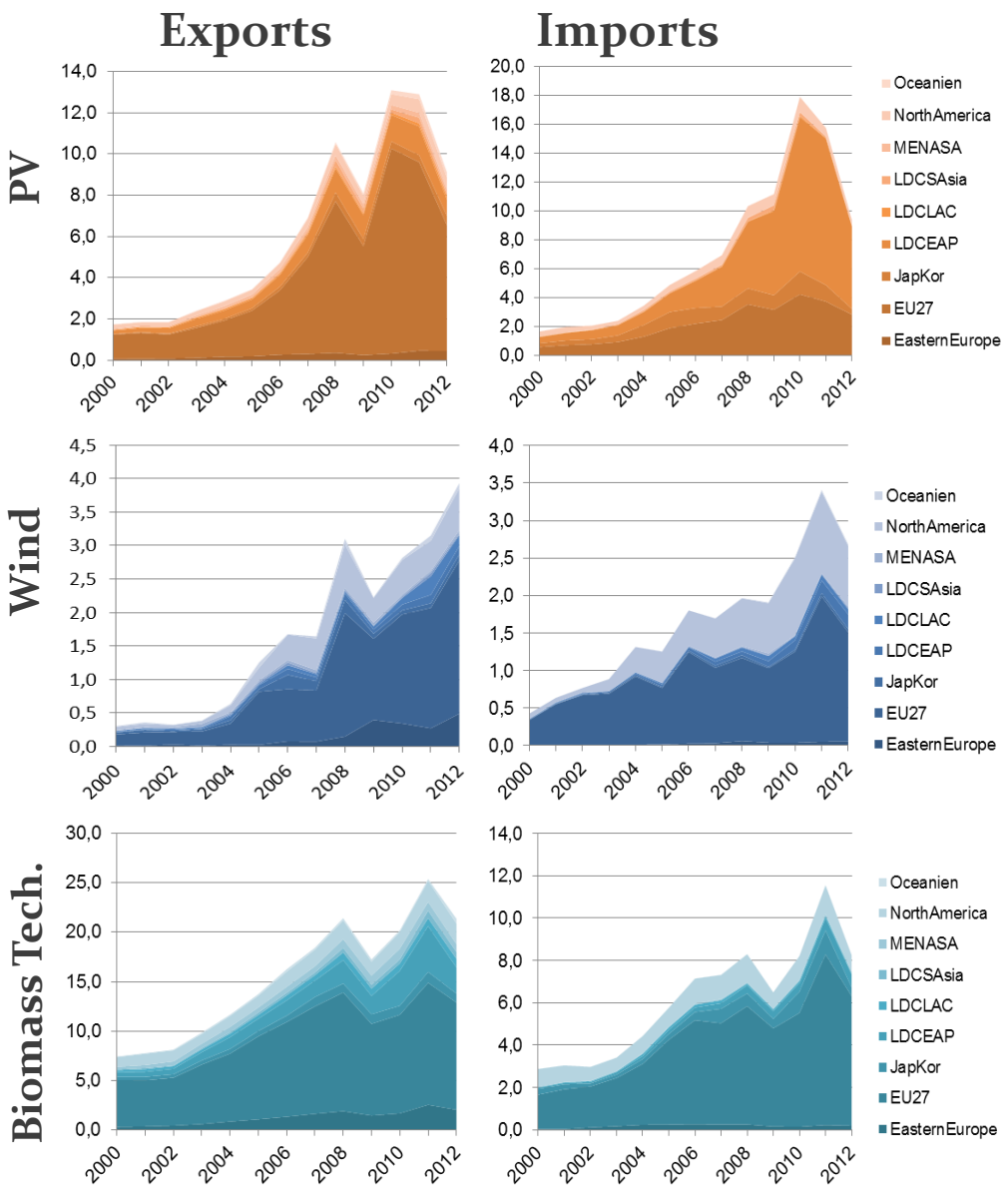


***Figure 2*:** Export flow of solar PV technology components 2008 by region in billion US Dollar. *Source:* Authors calculation and illustration based on UN Comtrade 2012



2.2 International Trade: Germany

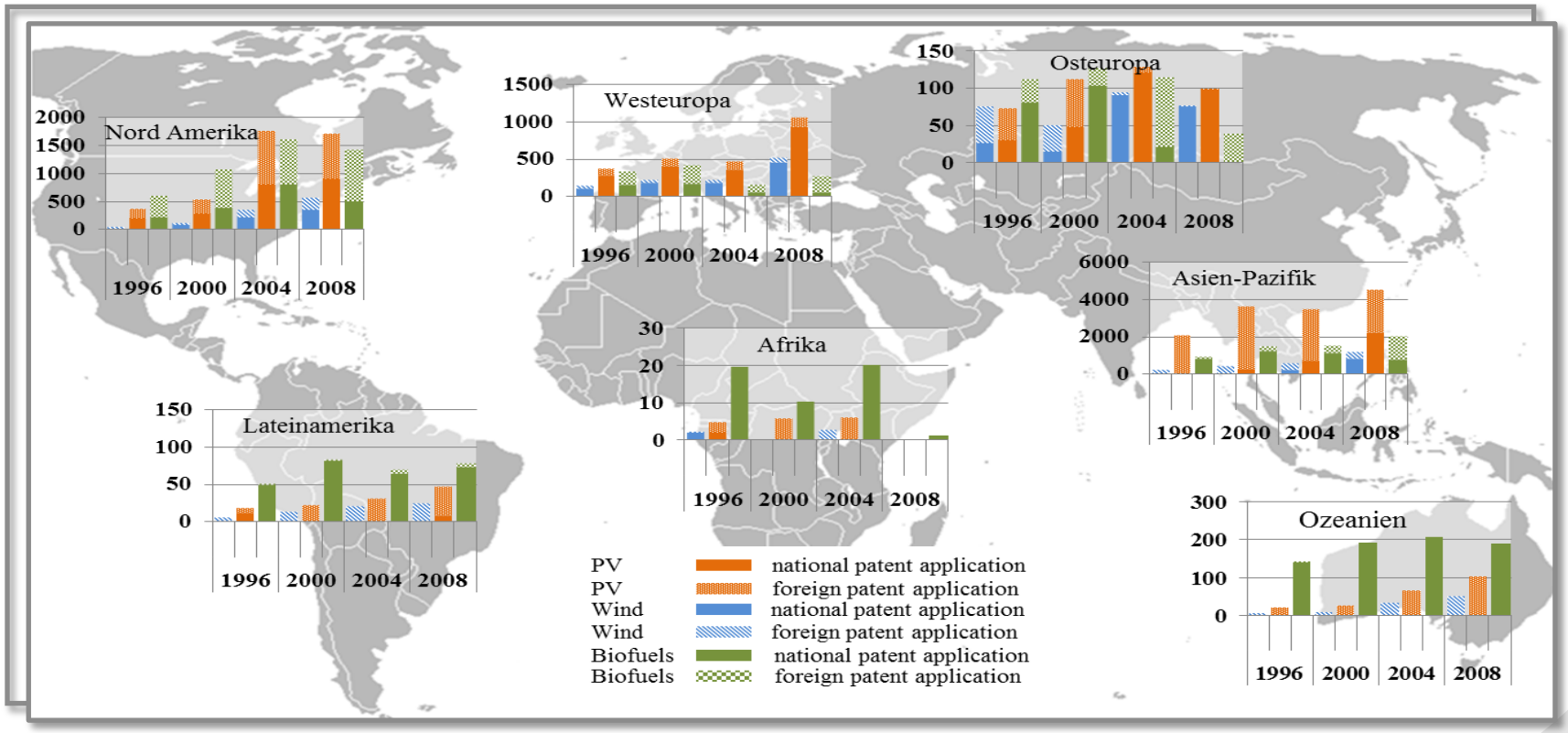


- Largest exporter & importer of respective goods since 1990`s.
  PV +700%, share: 12%; Wind + 900%, 13%; Bio: + 300%
- Import and export decrease in 2012.
  (data and EEG-Amendment on PV)
- OECD/EU main export market.
- China and OECD main import markets.
- Limited exports to developing countries.
- Increasing export specialisation/ Increasing relevance for total exports .
  (RET 3,9% from total exports in 2012)
- But, constant relevant trade position → increasing imports.
- Export-Import relation (export specialization) increasing disadvantage.

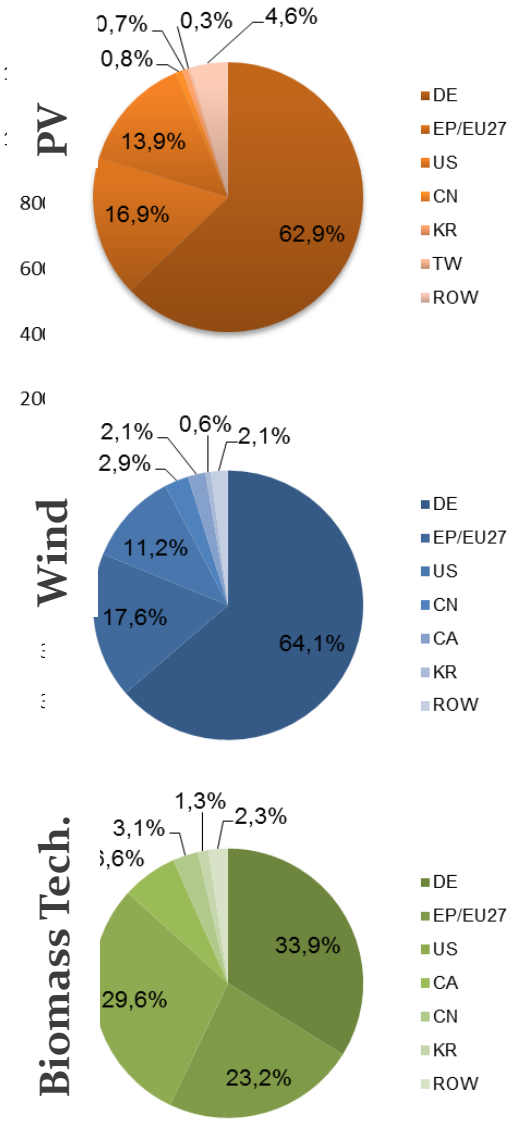
2.3 Innovation

- Strong increase in global innovation for renewable energy technologies
  (all patents. ≈ 30%; PV ≈ 300%, Wind. ≈ 600%)
- Strong regional differences.
- Difference in target markets and innovating countries.

Figure: Regional Dispersion of patent applications by regions



2.3 Innovation: Germany



- Development substantial larger than global average
  - **Total:** Large share of global patent applications
    (EU 2008 PV: 53%; Wind: 47%; Bio: 37%)
    (Global 2008:: PV 23%; Wind 20%, Bio: only 12% → US Dominance)
  - **Dynamics 1990-2008:** Substantially stronger than in other EU countries.
    (PV: 510%; Wind: 925%; Bio: 160)
- Main target markets for innovations (Patents) from German inventors.
  - EU and developed countries
  - Developing countries marginal (but China)
- **But:** Medium research intensity per capita & per GDP

1 Conclusion

- Market failures and obstacles as motivations for introducing RE-Policies
- Regulation as effective mean to change relative prices and thus inducing technological change (innovation)
- Market based instruments more effective (efficient) than command & control instruments
    - Successful technological change need policy mix for technology and market development
    - Market structure and technology costs are essential for policy selection.
    - Policy flexibility and stringency define instrument effectiveness.

• R&DD spending	• DE low increase of spending since 1990 but research intensity above IEA average (except for biofuels)
• Patent Applications	• DE leading in patent applications in Europe and US with strong growth since 1990
• International Trade	• DE exports larger than global average but imports increase more than exports • Constantly high export market shares for PV, Wind and biofuel technology but no competitive advantage for PV but for Wind and Biofuel technologies. • Strongly increasing role of China

Thank you!

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Backup

2. Analyse zur Dynamik des technologischen Wandels im Bereich EE

- Deskriptive/quantitative Datenanalyse für die EE-Technologiebereiche
  - Photovoltaikanlagen
  - Windenergieanlagen
  - Biokraftstoffe bzw. Technologiegüter zur Bereitstellung von Biokraftstoffen

- Focus auf Deutschland im internationalen Vergleich

- Innovationsindikatoren
  - Forschungs- und Entwicklungsausgaben (IEA) (bis 2010)
  - Patentanmeldungen (PATSTAT) (bis 2008 Stand Okt. 2010)
  - Handel mit Technologiegütern (UNCTAD) (bis 2011)

- Klassifikation/Differenzierung durch Literatur und Listenabgleich

- Papier soll die Analyse in die bestehende empirische Literatur einordnen

3.3 Country Example: China(1)

Figure: Development of Chinese PV Exports and Imports

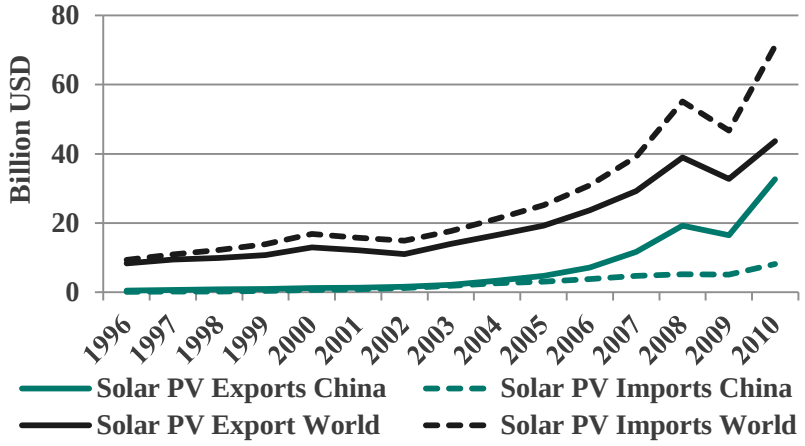
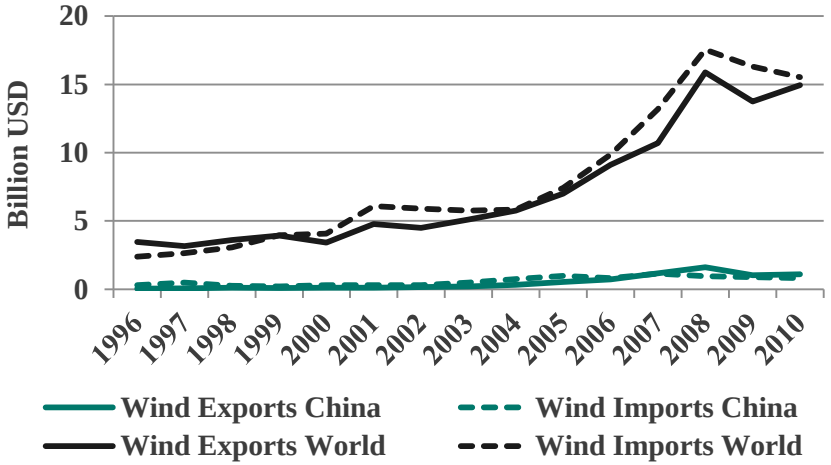


Figure: Development of Chinese Wind Exports and Imports



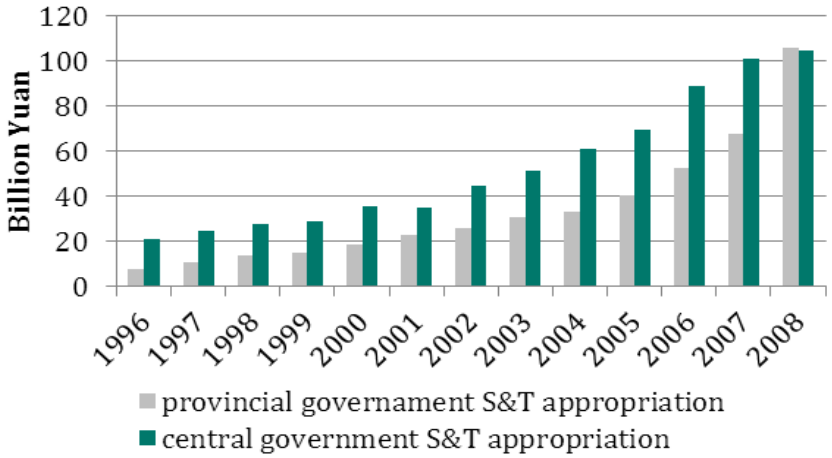
- Strong industry and export development
- Political aim: increase RE- utilisation and closing knowledge gap.

- **Recent relevance:**
  - WTO, US, EU „price dumping in Chinese PV-module industry"; increase of importing tariffs.

- **Research Questions:**
  - Identifying potential causing factors
  - Taking RE and innovation policy into account

3.3 Country Example: China(2)

Figure: R&D Spending for RE in central and povincial chinaese governments



- Policies to support innovation electricity generation
- Local market is lagging behind trade development
- Rising S&T spending and innovation
  - Relative foreign knowledge share decreases

Figure: Wind and PV electricity generation in China

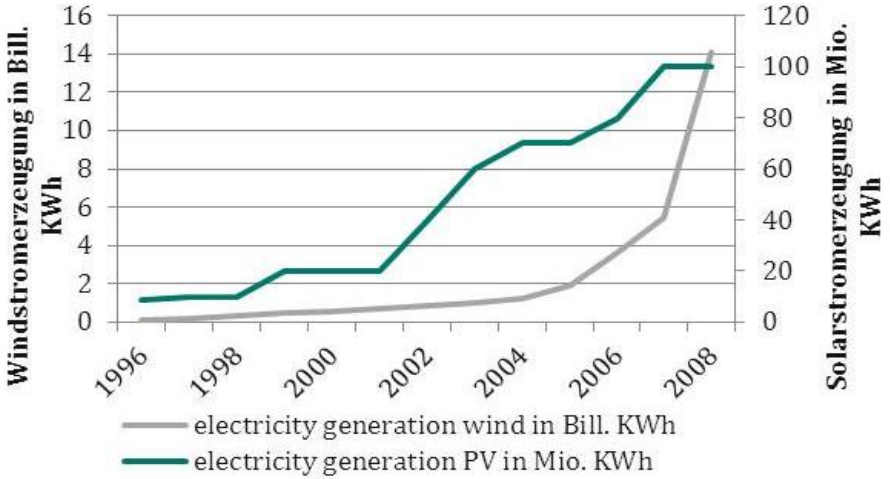
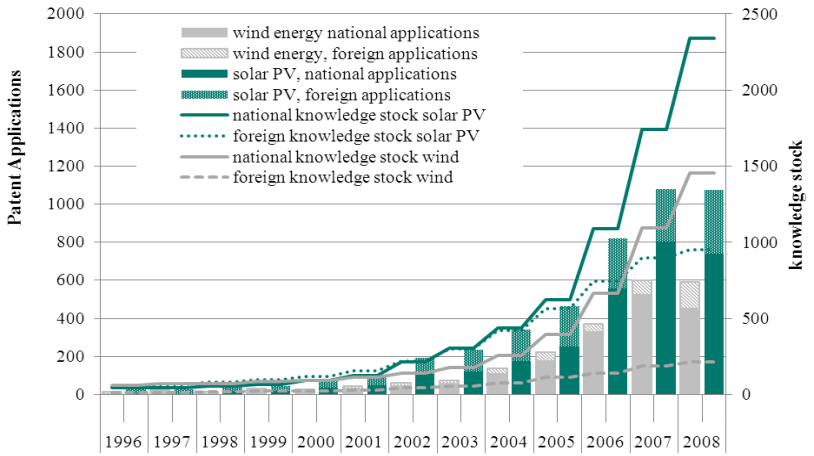


Figure: Wind and PV Innovation and Transfer



3.3 Country Example: China(3)

Results:

- China developed and increaseing competetive advantage
  - Exports account for larger share of total export than global average
  - Chinese industries better in foreign markets than foreign companies in chinese market.
- Major technology exporters are major component importer.
- Difference in market size for clean energy technology components
- Chinese RET-Trade follows expectations of trade theory.
- Policy and market size in importing countries is significant.
- Trade costs less important than expected.
- R&D significant effect on Chinese exports.

4 An Unusual Conclusion (2)

Policy Take-Out:

- Trade, Innovation and utilization markets have to be thought together
- Tackle barriers: Administrative, Regulatory, Finance, Socio-Cultural.
- Increase coordination between different authorities
- Increase trust among banks and investors
- Reduce asymmetric market information
- Push realistic perception of RE-costs and recognition of positive side effects
- Reduce number of authorities and further non-trade, non-economic barriers.

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Abgrenzung Patente

IPC Code	Description
Solar Photovoltaic (PV)	
H01L 27/142, 31/00-31/078 H01G 9/20 H02N 6/00	Devices adapted for the conversion of radiation energy into electrical energy
H01L 27/30, 51/42-51/48	Using organic materials as the active part
H01L 25/00, 25/03, 25/16, 25/18, 31/042	Assemblies of a plurality of solar cells
C01B 33/02, C23C 14/14, 16/24, C30B 29/06	Silicon; single-crystal growth
G05F 1/67	Regulating to the maximum power available from solar cells
F21L 4/00 F21S 9/03	Electric lighting devices with, or rechargeable with, solar cells
H02J 7/35	Charging batteries
H01G 9/20 H01M 14/00	Dye-sensitised solar cells (DSSC)
Wind Energy	
F03D	**Wind energy**
H02K 7/18	Structural association of electric generator with mechanical driving motor
B63B 35/00 E04H 12/00 F03D 11/04	Structural aspects of wind turbines
B60K 16/00	Propulsion of vehicles using wind power
B60L 8/00	Electric propulsion of vehicles using wind power
B63H 13/00	Propulsion of marine vessels by wind-powered motors
Biofuels	
C10L 5/00, 5/40-5/48	Biofuels from solid fuels
C10B 53/02 C10L 5/40, 9/00	Biofuels from torrefaction of biomass
C10L 1/00, 1/02, 1/14	Liquid biofuels
C10L 1/02, 1/19	Biofuels from vegetable oils
C07C 67/00, 69/00 C10L 1/02, 1/19 C11C 3/10 C12P 7/64	Biodiesel
C10L 1/02, 1/182 C12N 9/24 C12P 7/06-7/14	Bioethanol
C02F 3/28, 11/04 C10L 3/00 C12M 1/107 C12P 5/02	Biogas
C12N 1/13-21, 5/10, 15/00	Biofuels from genetically engineered organisms

Daten:

- EPO 2010, World Patent Statistical Database (PATSTAT), European Patent Office, Munich. DIW Access

IPC Abgrenzung:

- IPC Green Inventory http://www.wipo.int/classifications/ipc/en/est/
- Dechezlepretre (2011, 2012)