

Presentation at the
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Industry Emergence and Public Policy: The Case of Renewable Energy in Germany and China

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Industry Emergence and Public Policy: The Case of Renewable Energy in Germany and China

Topics to be addressed

**Industry Emergence and Public Policy:
How to Create new Industries?**



**The German Innovation Model: The Corporate
Lab vs. the “Garage“**



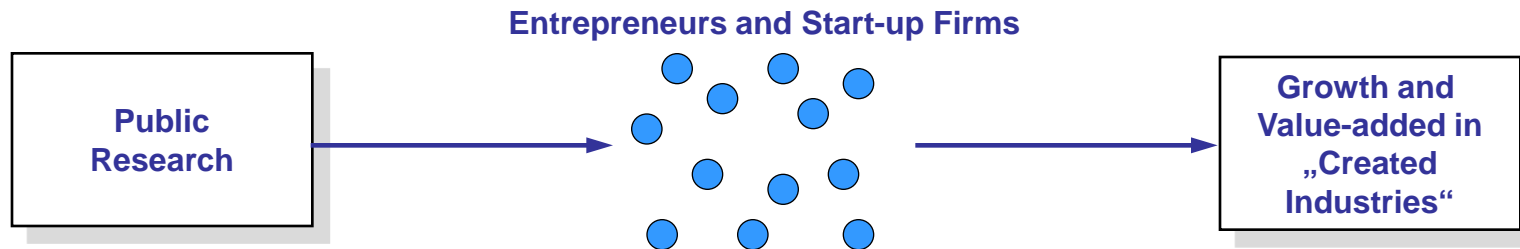
**The Chinese Innovation Model: New Industry
and Low-Carbon Growth**



**Lessons learned: Conflict vs. Cooperation
in Low-carbon Innovation Policies**

Industrial Innovation and Evolutionary Dynamics: Two Alternative Views

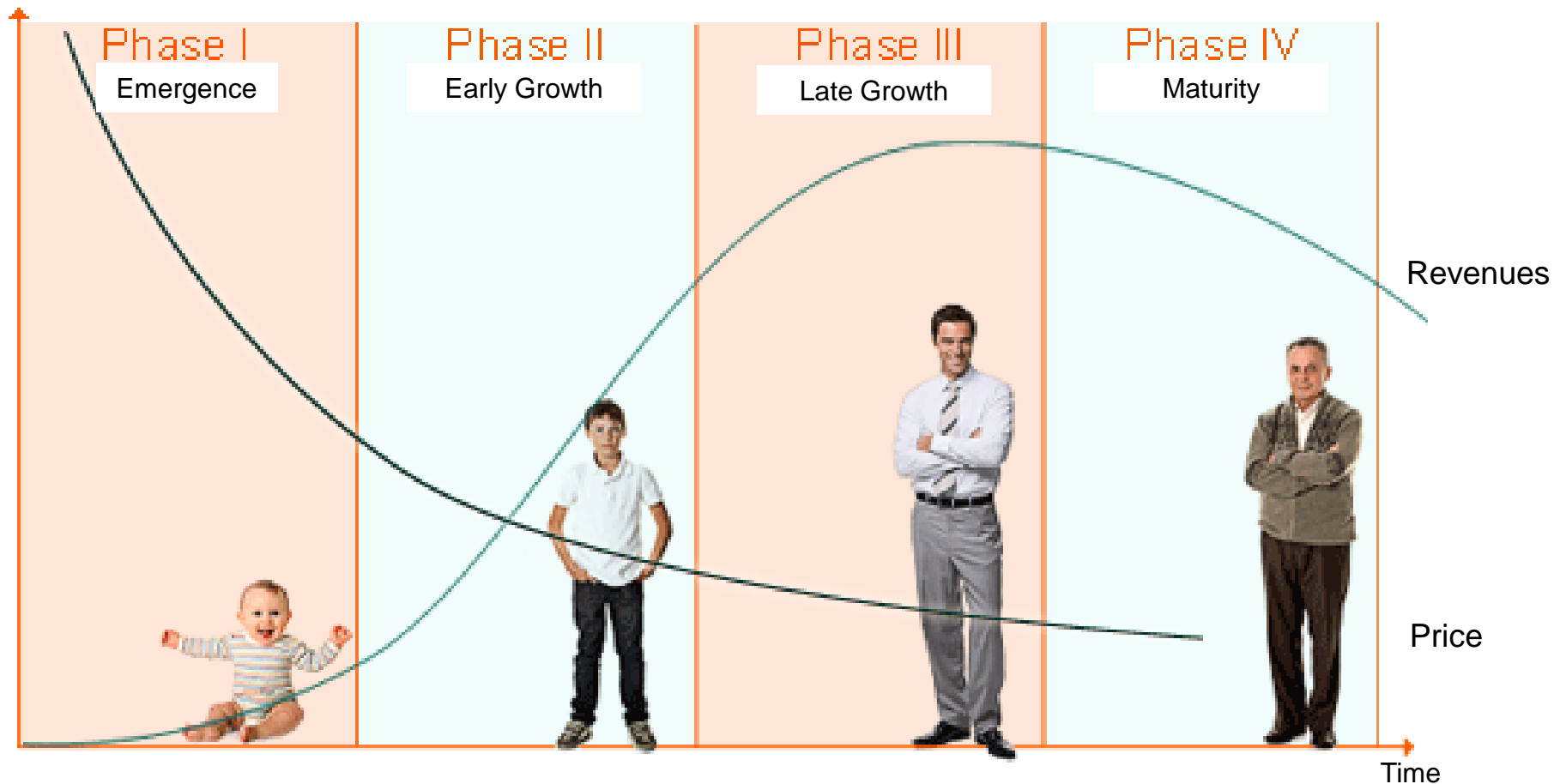
- **Creative Destruction and Entrepreneurship: The “Young Schumpeter”**
(Theory of Economic Growth 1911, 1934)
- **Later adopted as the „Cambridge, U.S. Model“ of Innovation**



- **Organized Innovation in Large Corporations: The “Old Schumpeter”**
(Capitalism, Socialism and Democracy 1911, 1934)
- **The European or „Cambridge, U.K. Model“ of Innovation**

The Life-cycle Model of Innovation and Industry Restructuring

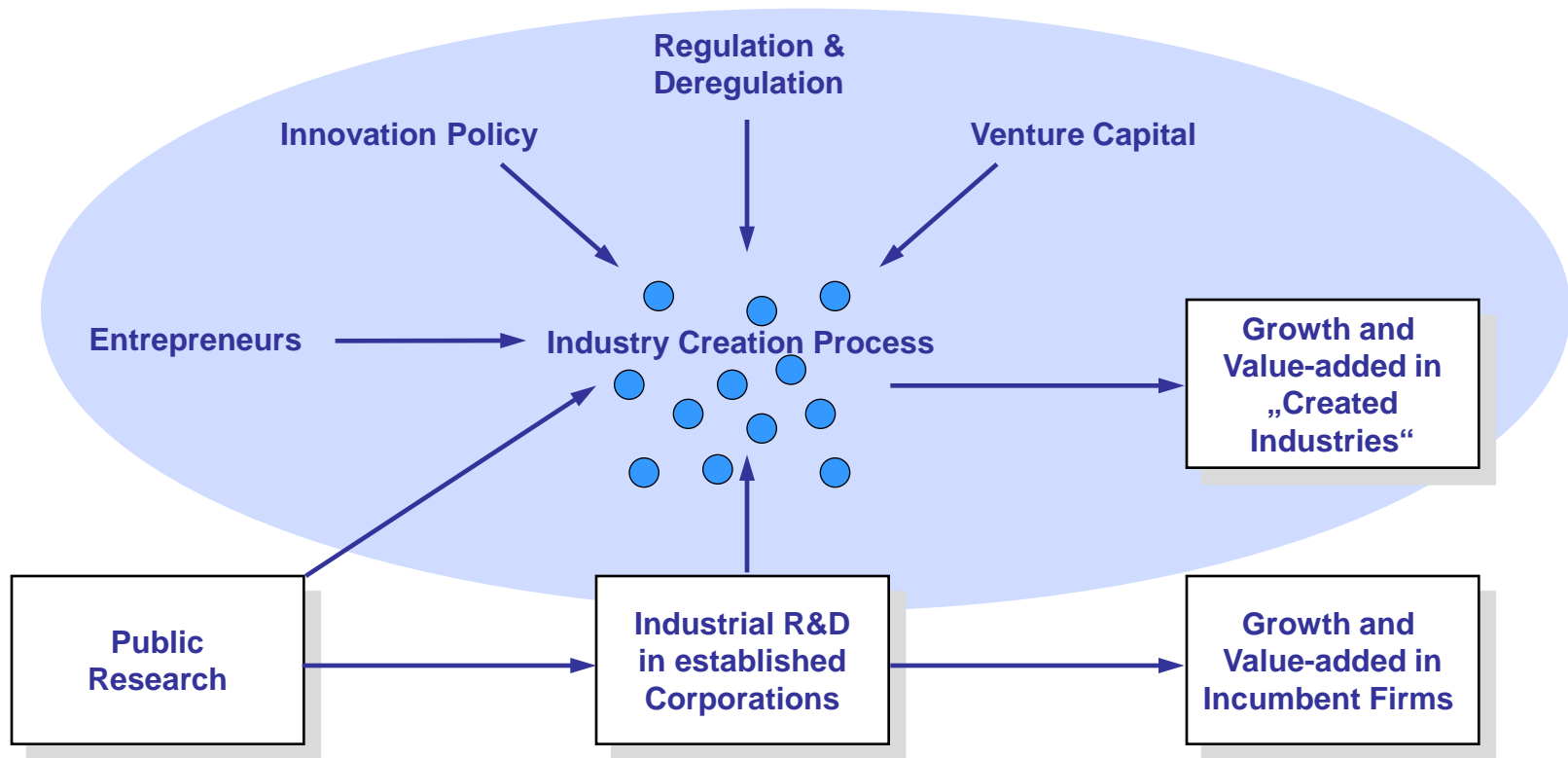
- Many Fast-growth Industries created as a social construction process



- Often strong interaction between Public policy and private Entrepreneurial activity

The U.S. Postwar Experience of Innovation and Industry Creation

- The U.S. has implemented “Creative Destruction“ and has a strong Track record of stimulating new Growth industries



- Many of these Industries with strong early support of Federal government (e.g. Computers, Semiconductors, Internet, Biomedical innovation)

Creating Emerging Industries is not enough / Criteria for building sustainable and successful (global) Industries

- **„Small innovation“ during early fluid phase – Then Transformation into „Big innovation“ during growth phase**
- **Build business fast enough / even against established Corporate groups**
- **Build Scale advantage early enough / Rapid counter-cyclical investment**
- **Global strategy from beginning / No national or European strategy**
- **Penetration pricing – as opposed to Skimming or Premium-pricing**
- **Going down the Learning curve / sequential process innovation**
- **Create and establish Entry barriers / Control Patents and IP**
- **Dominate the Architecture of the market / Define and influence Standards**
- **Sophisticated international Market and Competitive Intelligence**

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Presentation Part 2

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The “German Innovation Model“: Incremental Innovation within well-established Industries and Corporate structures

- **Strengths in Medium-Tech Industries / The central Pillars of German Export Sector**
- **Two Thirds of Business R&D concentrated on five established Industries**
- **One third concentrated on performance-improvement of High-end Automobiles**
- **Model of Large Corporate Lab drives out “Garage entrepreneur“**
- **Capital markets and Regulatory system discriminate investments into novel structures**
- **Weaknesses in High-Tech Industries and Knowledge-intensive Business services**
- **Very few Cases of building successful Emerging industries in Germany**

The Structure of Business R&D Spending in Germany

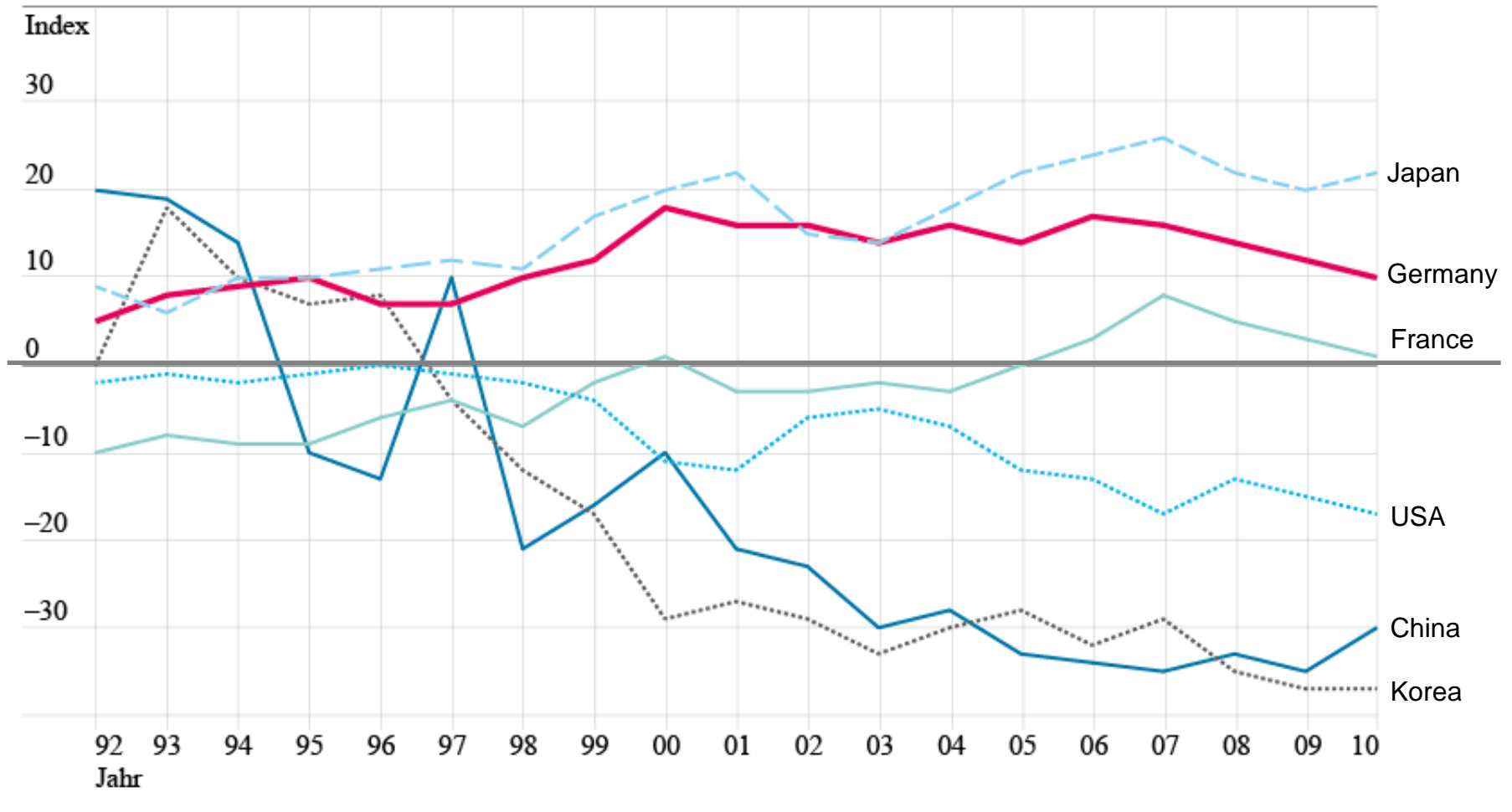
- **Germany's strong Manufacturing and Export Industries dominate R&D Spending**

| Industry | Business R&D Expenditures 2010 (million €) | Share in Total BERD in Germany (in %) |
|---|--|---------------------------------------|
| ▪ Automotive industry | 14 812 | 31.6 |
| ▪ Electrotechnical industry | 7 340 | 15.6 |
| ▪ Machinery / Mechanical engineering | 4 597 | 9.8 |
| ▪ Chemical industry / excl. Pharma | 3 124 | 6.7 |
| ▪ Metal processing / Metal products | 1 206 | 2.6 |
| | | 66.3 |

- **Two thirds of R&D expenditures concentrated on industries already established during the late 19./early 20. century**
- **No strong enough Diversification into High-Tech Industries and in Knowledge-based Services**

The Innovation Performance of Germany is concentrated on „Medium-Tech Industries

Specialization Index in **Medium-Tech Industries** („High-Value Technologies“) (measured by the Indicator Revealed Technological Advantage / RTA).



Source: EFI 2013, Tab. C 5-3, Calculation by FhG-ISI, December 2012, based on EPA (PATSTAT) and Questel data.

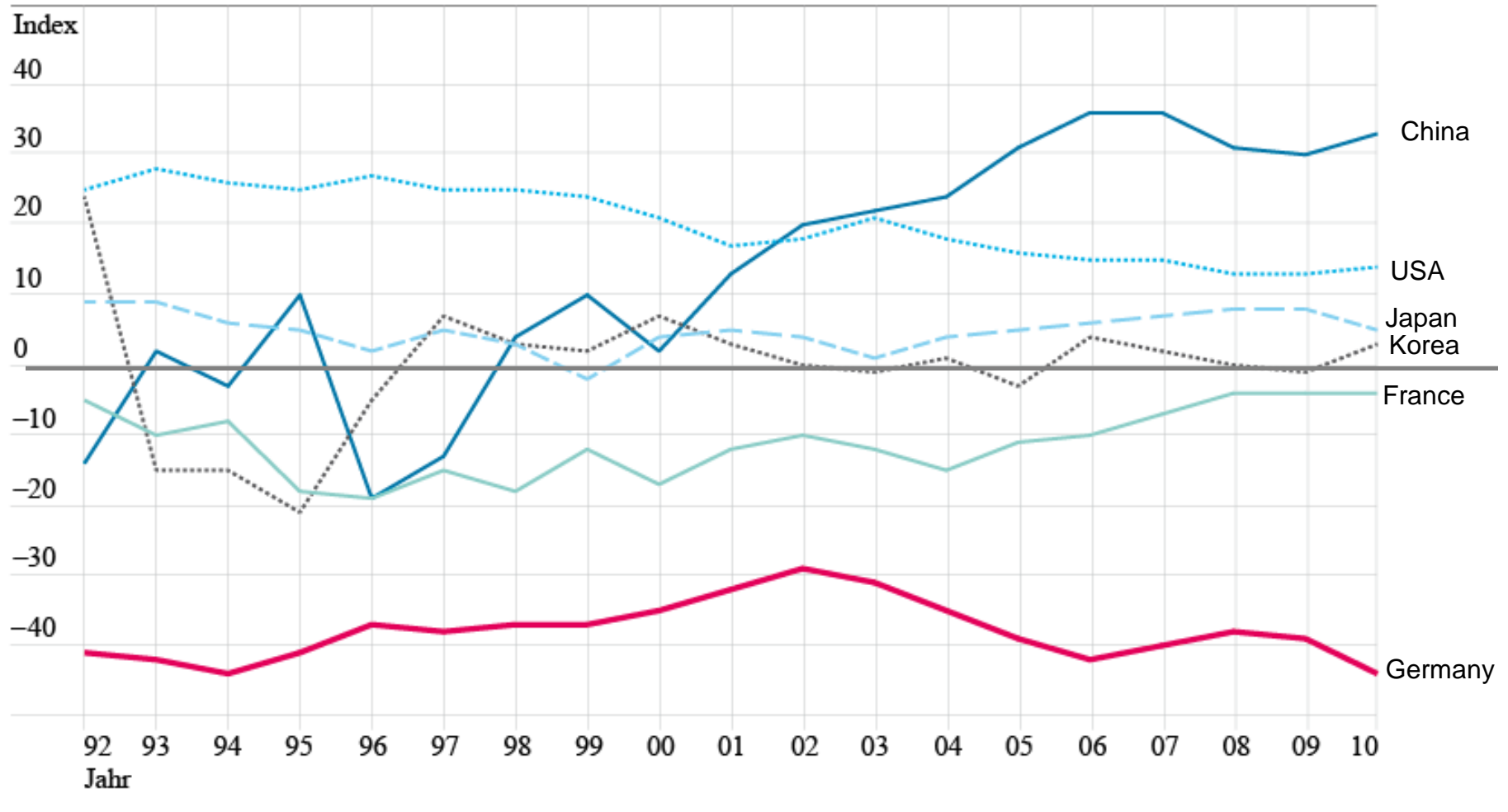
Meanwhile, other Countries have effectively managed Transformation processes based on Emerging High-Tech Industries and Radical innovation

- **Pharmaceuticals / Biotechnology**
- **Computers / Information technology / Software**
- **Semiconductors / Micro- and Nanosystems**
- **Network technologies / Internet**
- **Cellular mobiles / Smart phones / „Smart home“**

German researchers were often involved as Inventors, but much less Successful in effective Commercialization

As a result, Germany has a comparatively low Performance in High-Tech Industries

Specialization Index in **High-Tech Industries** („Leading-edge Technologies“) (measured by the Indicator Revealed Technological Advantage / RTA).



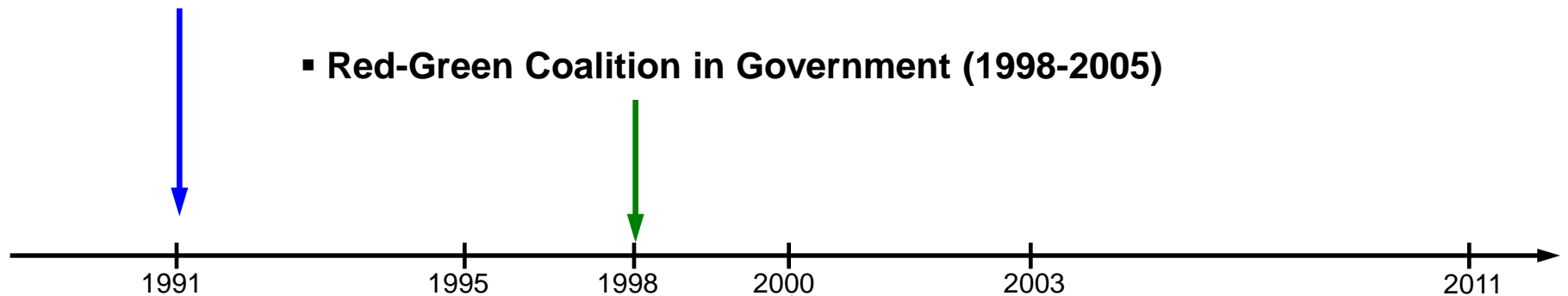
Source: EFI 2013, Tab. C 5-4, Calculation by FhG-ISI, December 2012, based on EPA (PATSTAT) and Questel data.

The Process of Transformation towards Low-carbon Energy Technologies in Germany

- Gradual changes in German energy policy towards Renewable energy sources

- “1000 Solar-roof-Initiative“ (1991-95)

- Red-Green Coalition in Government (1998-2005)



- Renewable Energy Law implemented in 2000

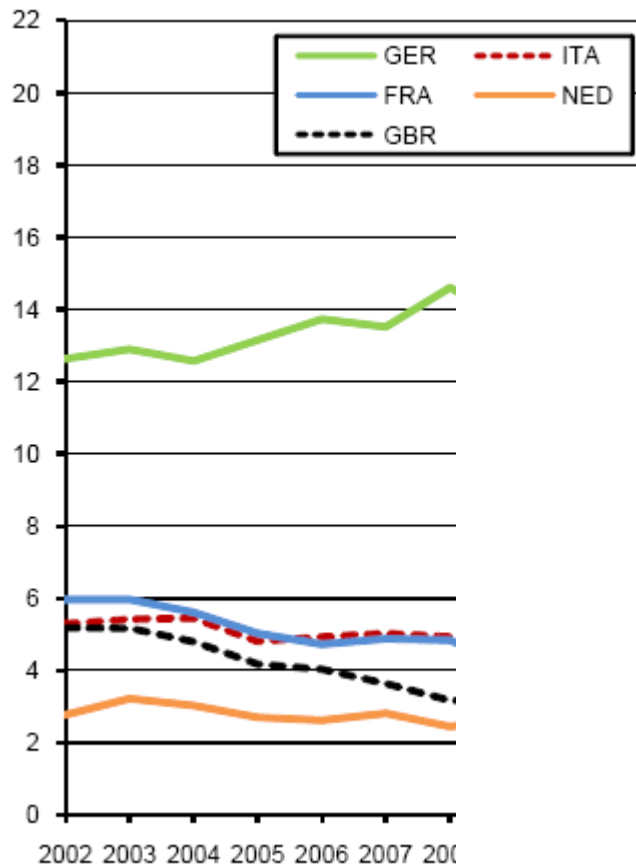
- Renewable Energy as Cornerstone of „Green Growth“ and the Formation of New Industries
- German Export Initiative for Climate-control products implemented (2003)
- Radical „Energy turning-point“ („Energiewende“) after Fukushima

Industry Emergence and Public Policy in Germany: The Case of Solar Power and Photovoltaics

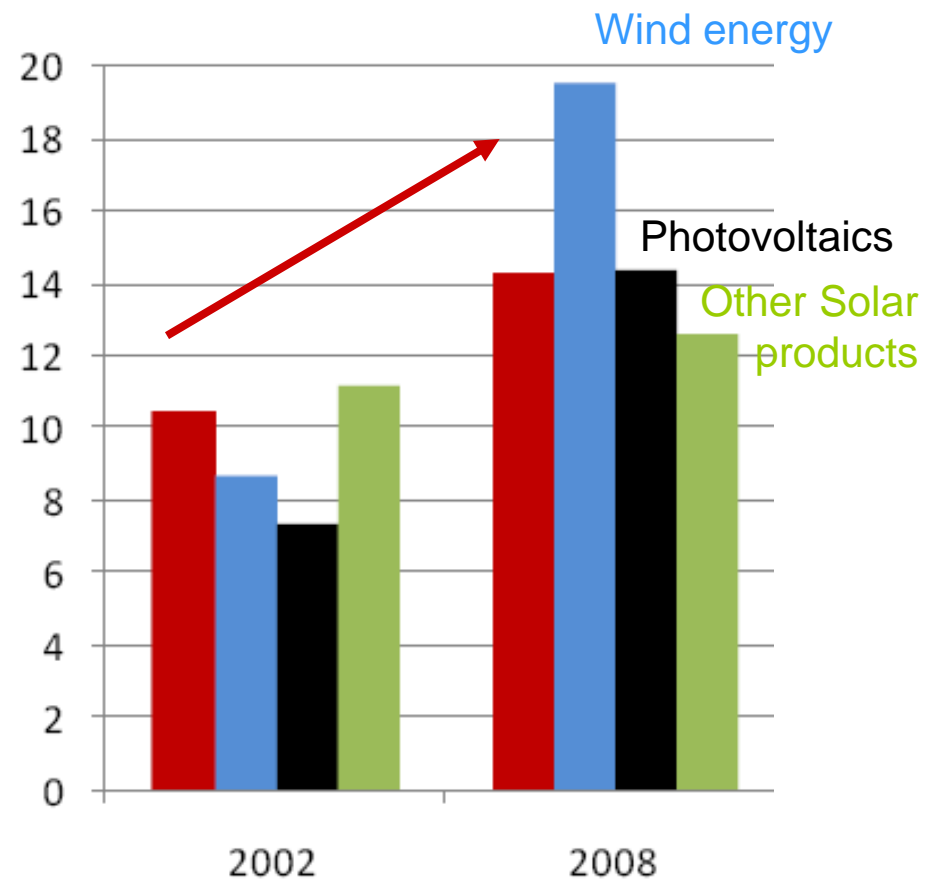
- **Stable Public research funding across many technologies in Renewable energy throughout the 1980's and 90's**
- **Strong inducements through attractive Feed-in Tariffs (FIT) since 2000**
- **Many Start-up firms in Photovoltaics / as well as supportive industries**
- **Venture Capital and „Green growth funds“ become active in Germany**
- **State-of-the-art large Factories established / Solar Valley in Eastern Germany with strong German and EU funding**
- **Formation of strong Turnkey PV Equipment manufacturers / Strength in German Machinery industry turning towards Photovoltaics**
- **Financial Bubble 2003-2007: Strong increase of Market capitalization of German PV firms / Several entrepreneurs sell out**
- **German FIT support model replicated in other countries / Export strategies of German firms primarily to subsidized countries**
- **Skimming strategies predominant / Penetration and Cost-reduction strategies neglected**

As a result, Germany was able to establish a viable new Industry between 2002 and 2009

World Trade Shares for Renewable Energy Products 2002 and 2008



German Shares of World Export for different Product groups in Renewable Energy 2002 and 2008



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Presentation Part 3

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**The Chinese Innovation Model: New Industry
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**Lessons learned: Conflict vs. Cooperation
in Low-carbon Innovation Policies**

- **First Phase Transformation (‘78-‘95): Establishment of Export-oriented Manufacturing in Low-Tech Industries**
- **2.Wave: Growth of Chinese HighTech Industries (1995-2010) (Computer, Telecommunication, Electronics)**
- **3.Wave (since 2010 / 12.Five Year Plan)**
 - *Upgrading Value-Chain in High-Tech Industries*
 - *More Indigenous Innovation*
 - *Stronger R&D and Chinese Intellectual Property*
 - *Chinese Champions in selected High-growth Industries*
- **Leapfrogging in Strategic Industries / “Non-Carbon Growth“**
 - *Solar / Photovoltaics*
 - *Wind energy*
 - *New Energy vehicles*
 - ...

The Structure of Industrial R&D Spending in China

- China has strongly increased R&D spending both in Medium-Tech as well as in Emerging High-Tech industries

| Industry | Business R&D Expenditures 2010 (million RMB) | Share in Total BERD in Germany (in %) |
|--|--|---------------------------------------|
| ▪ Communication, Computer & Electronics | 68 626 | 17.1 |
| ▪ Transport Equipment (incl. Automobiles) | 58 220 | 14.5 |
| ▪ Manufacture of Machinery | 47 221 | 11.8 |
| ▪ Electrical Machinery and Equipment | 42 510 | 10.6 |
| ▪ Manufacture / Processing of Metals | 40 539 | 10.1 |
| ▪ Chemical Products | 22 669 | 5.6 |

High-Tech Growth segments

- Very strong growth of R&D spending and Exports in High-Tech industry (IT, Computer, Telecom, Semiconductors)
- 12. Five-Year Plan determines Development agenda for both established Industries as well as for Strategic Emerging Industries

China's 12. Five Year Plan 2010-2015 focusses on the Formation and Growth of "Strategic and Emerging Industries"

1. Energy Conservation and Environmental Protection Industries

2. New Generation Information Technology Industry

3. Biological Industry

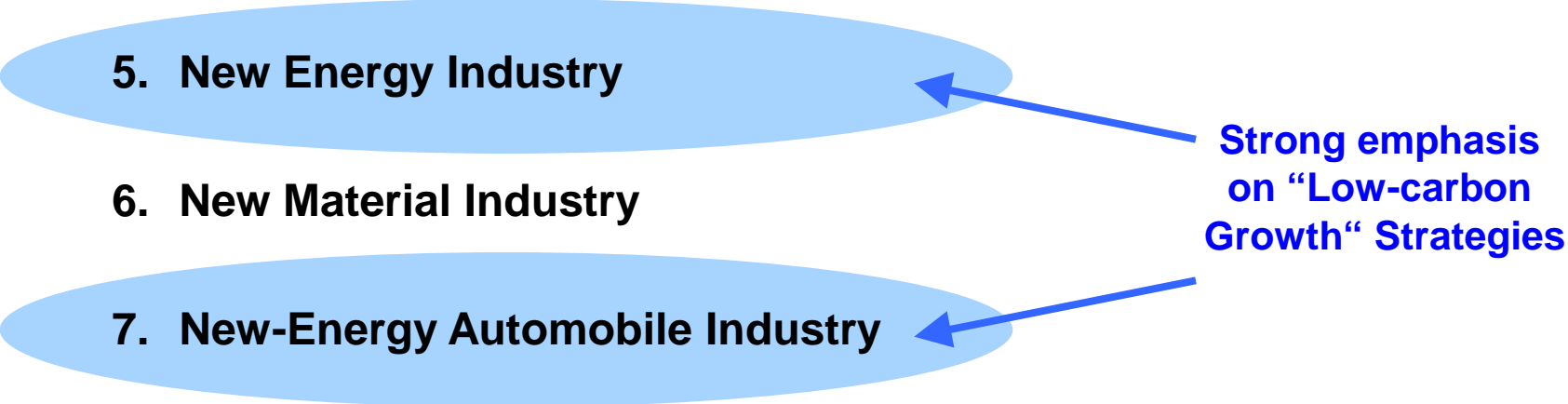
4. High-end Equipment Manufacturing Industry

5. New Energy Industry

6. New Material Industry

7. New-Energy Automobile Industry

**Strong emphasis
on "Low-carbon
Growth" Strategies**

A diagram consisting of two light blue ovals. The top oval highlights item 5, 'New Energy Industry'. The bottom oval highlights item 7, 'New-Energy Automobile Industry'. Two blue arrows originate from a central text box on the right and point towards the right side of each oval.

A major Thrust within “Strategic and Emerging Industries“: Dynamic Growth and Accessible Export Markets for Renewable Energy products

- **New Assemblies of efficient Solar Power Generation**

Solar Power

- **Solar Power and Biomass Energy**

- **Biomass Energy Conversion and Utilization Technologies**

- **Large Wind Power Generating Sets and Parts**

Wind Power

- **Large-scale Application Projects of Marine Wind Power**

- **New Assemblies for Efficient Heat Utilization**

- **Intelligent Power Grid Equipment**

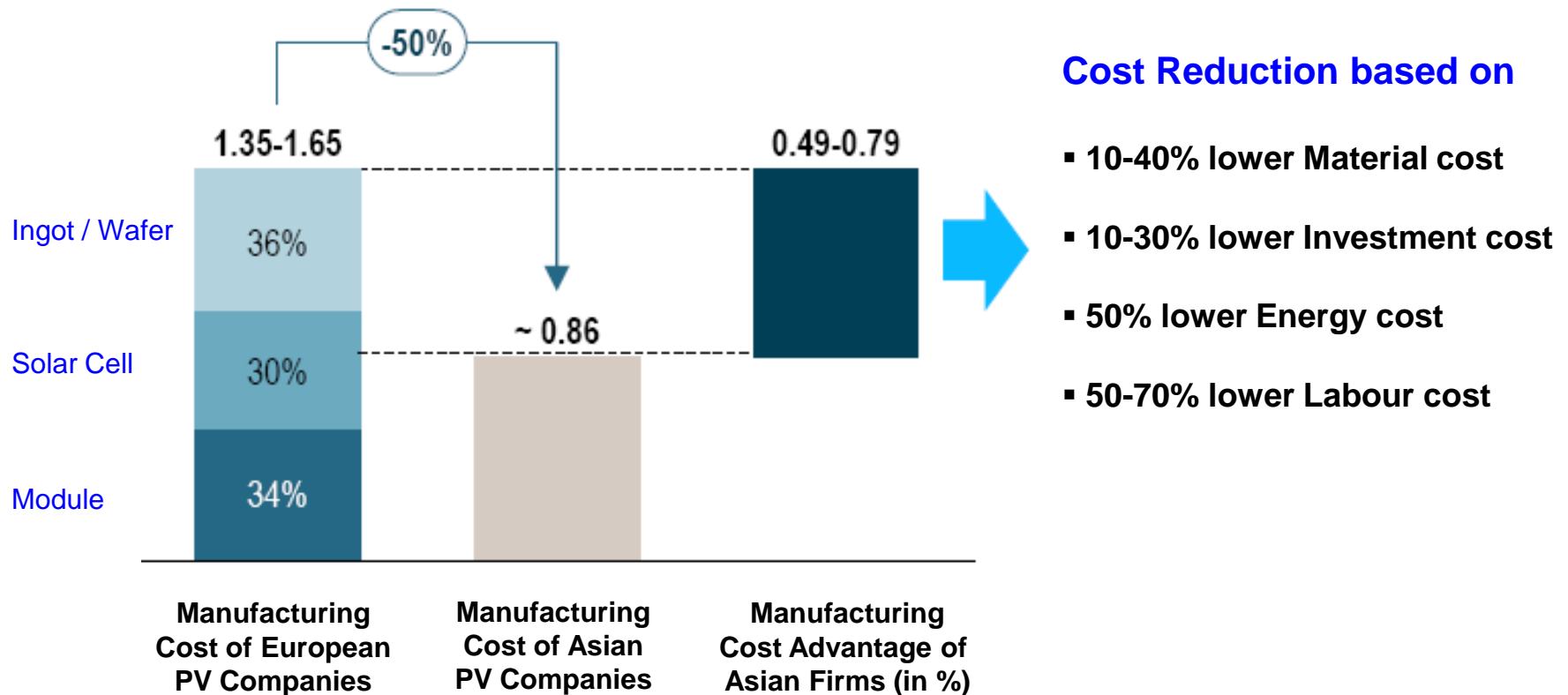
- **Industrial Bases for New Generation Nuclear Power Equipment**

- **Strong incentives since 2000 for gradual build-up of Manufacturing competence in Photovoltaics industry**
- **Attracting foreign Chinese researchers from U.S., Germany and Australia**
- **Highly-focused entry into Solar cells and modules / Strong Synergies with newly established Silicon foundries**
- **Dedicated Strategies to develop comprehensive PV value chain through upstream and downstream vertical integration**
- **Access to State-of-the-art Manufacturing through Import of Turnkey Production systems (primarily from German companies)**

- **Export strategy und systematic Targeting of FIT-supported Lead markets in Europe (1.Germany, 2.Spain, 3.Italy ...)**
- **Dedicated Cost-reduction strategies based on Economies-of-scale / Manufacturing Cost advantage of 50-60% vis-à-vis European suppliers)**
- **Strategy of Lead-Manufacturer for Export markets, no internal Lead-market for PV until 2011**
- **Chinesische PV-Suppliers attain 50% World market share in 2009**
- **Only 2% of all PV-Installations worldwide in China / Introduction of demand-side support policies just started in 2011**

Chinese Photovoltaics Producers have a Manufacturing cost advantage of At least 50% over European Manufacturers

Manufacturing Cost Advantage of Asian Manufacturers (Calculation based on Euro per Wp; resp. Percent)

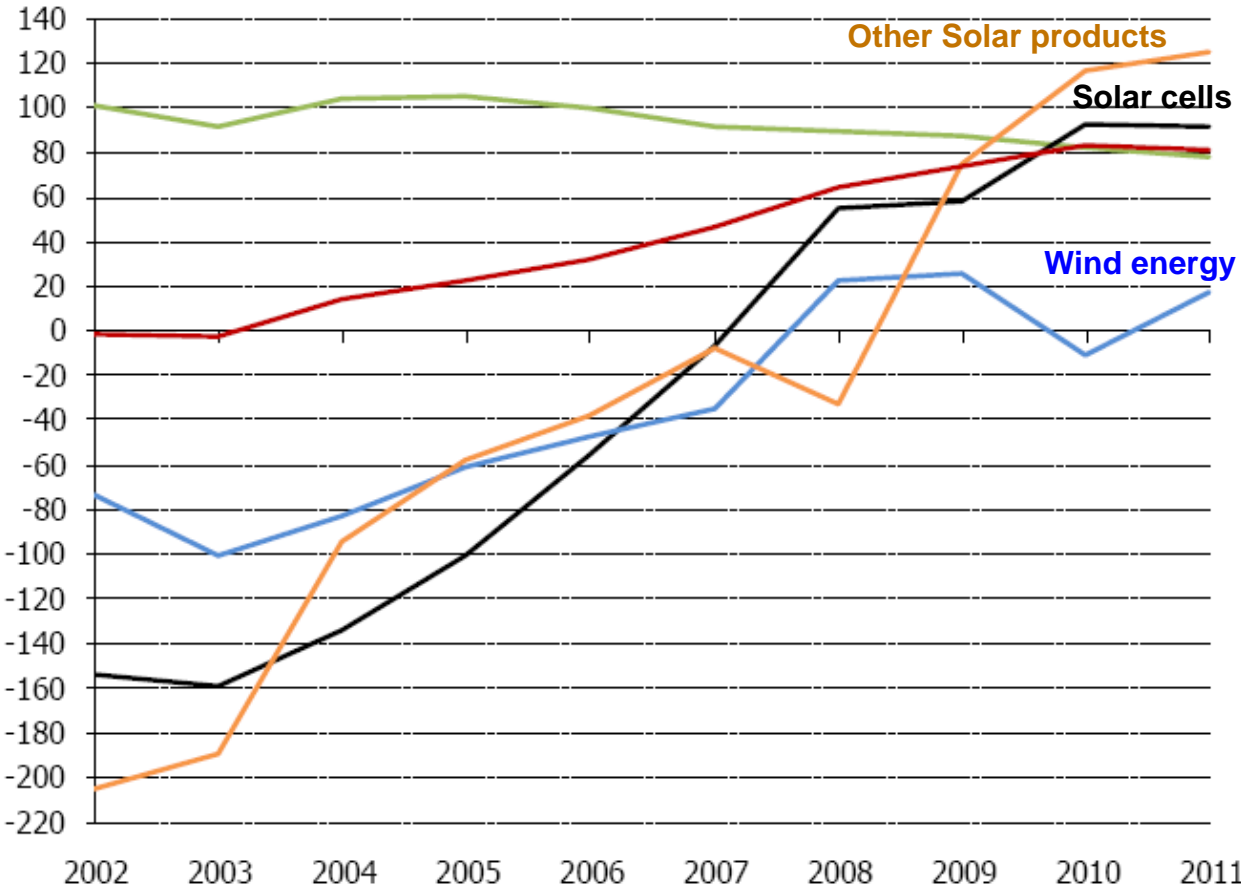
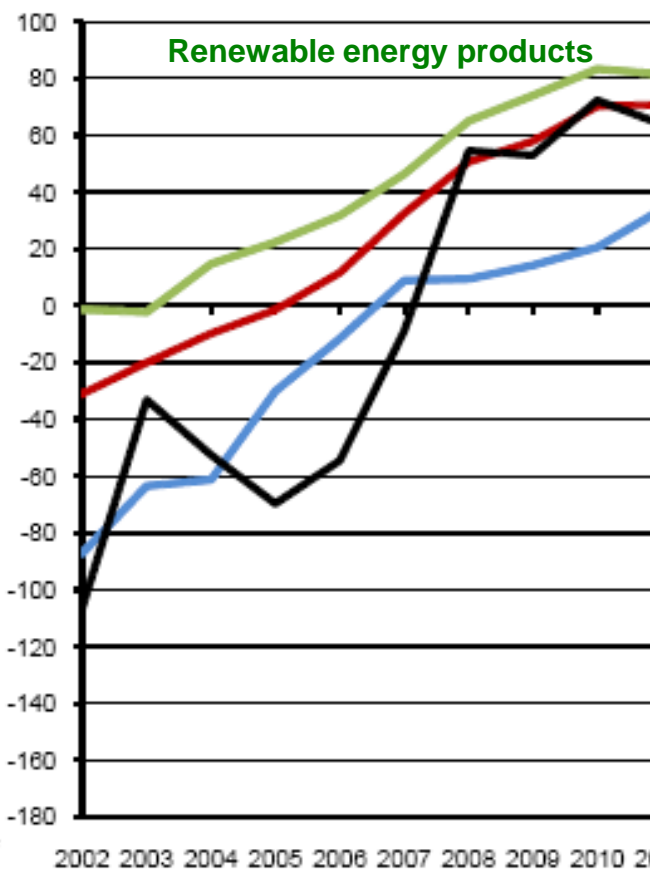


Source: Roland Berger (2010)

China has established a strong Export-oriented Renewable Energy Industry

Revealed Comparative Advantage (RCA) for China's Low-carbon Energy products

Revealed Comparative Advantage (RCA) for specific Product groups



Source: NIW (2013); EFI-Studie zum Deutschen Innovationssystem

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Presentation Part 4

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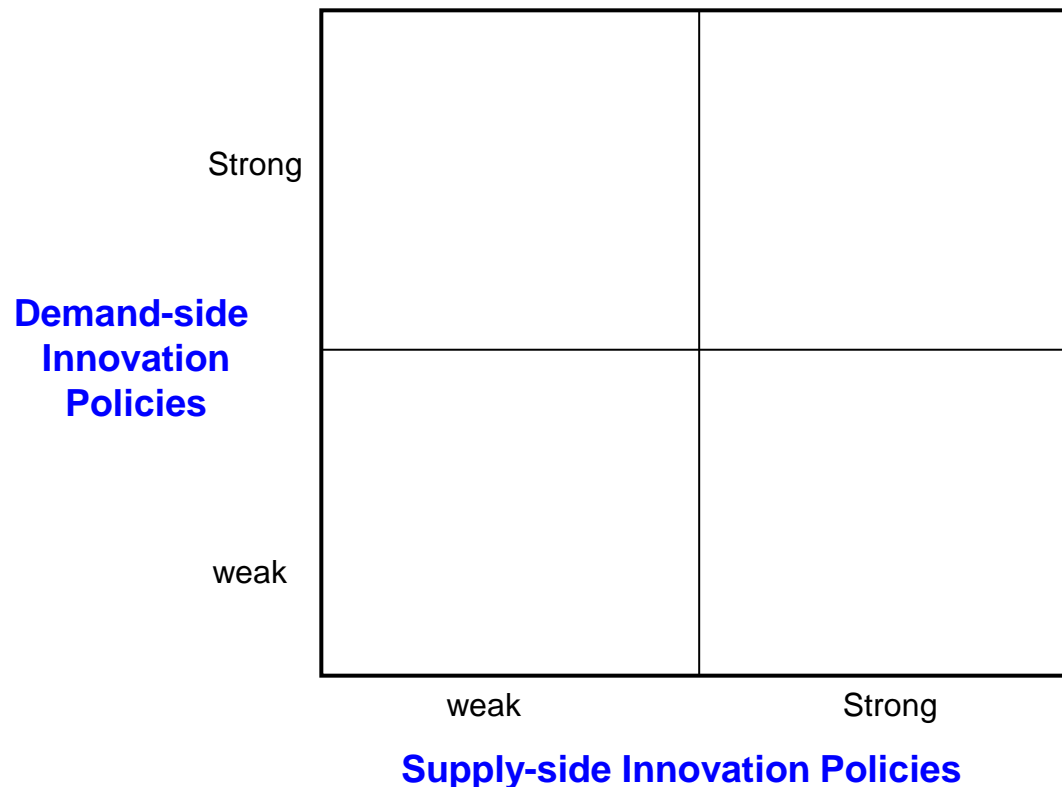
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The Argument of Unbalanced Industry Support Policies between Germany and China

- The Formation of a new Industry can be supported through Supply-based Innovation Policies and / or through Demand-side Innovation Policy

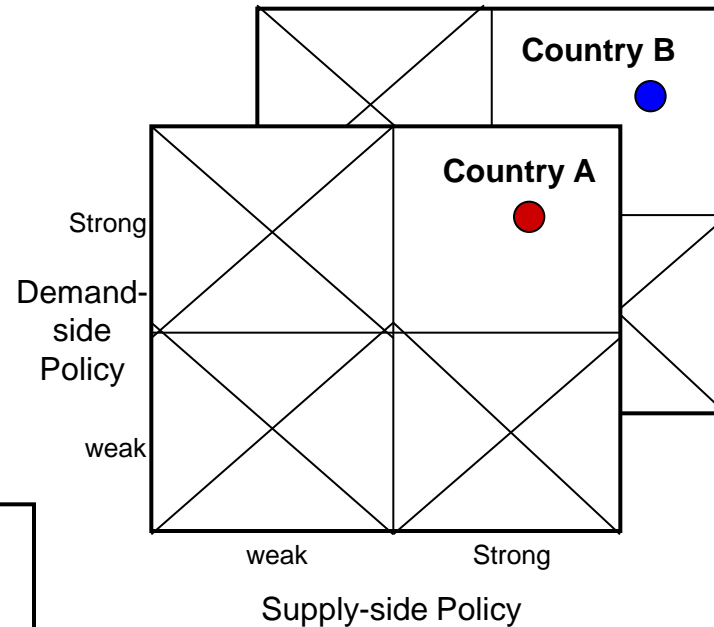


- A Combination of both types of Policies is often a Formula for success, at least during early phases of Industrial development

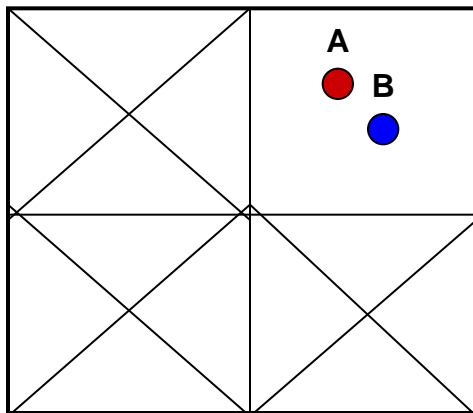
In an Open Economy, the Support Policies of Rival states must be taken into consideration

Smart Specialization

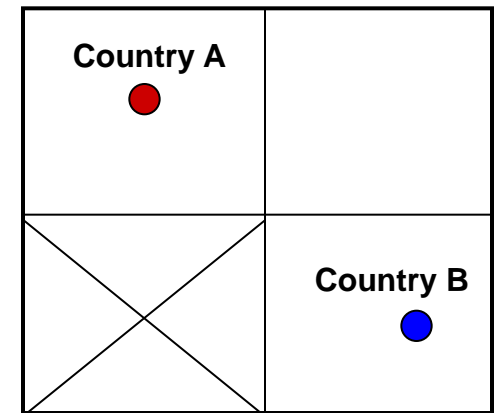
Two countries specialize on two different products and build up Trade relationships



Create direct Competitors



“Dumb Specialization“

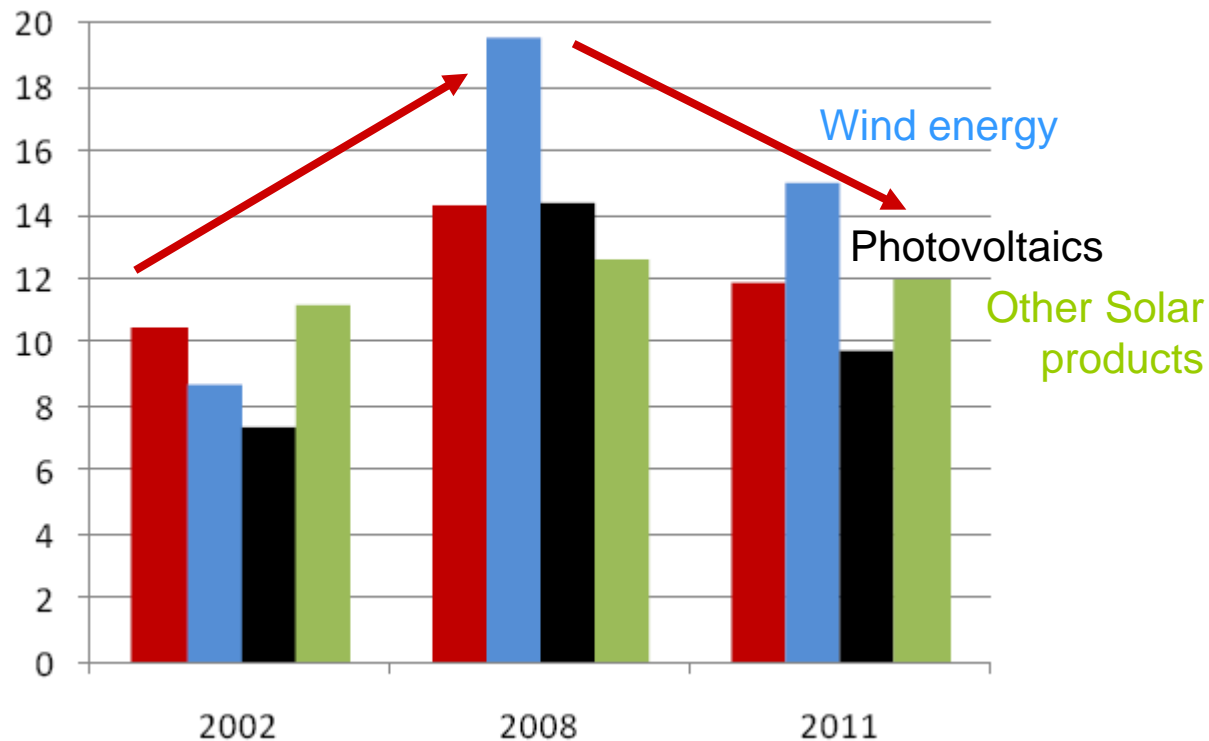


Smart Specialization vs. Dumb Specialization: Stimulating Markets without Capturing Value

- **Germany has implemented Demand-side Policies without strong support of the Supply side**
- **Meanwhile, China implemented strong Supply-side support of the PV Industry with very few Demand-side incentives**
- **Very generous Feed-in Tariffs attracted foreign suppliers, particularly from China**
- **Chinese PV firms targeted subsidized Export markets with a dedicated Penetration strategy**
- **German PV firms followed a Premium strategy and did not invest in cost-reducing Process innovation**
- **Downstream Solar firms in Germany were increasingly sourcing from Chinese suppliers**
- **When FIT were eventually reduced in Germany, only Chinese suppliers were able to supply the price-sensitive German market**

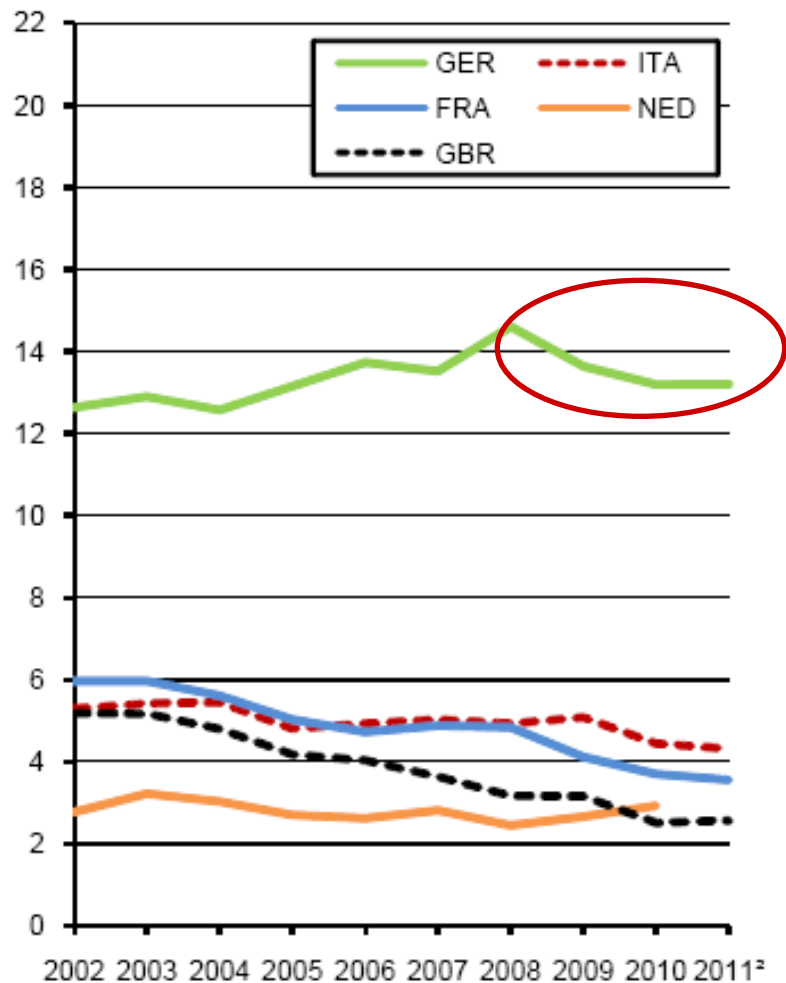
While Germany has increased the Export Performance for Renewable Energy Products until 2008, Export shares started to decline between 2009 and 2011

German Shares of World Export for different Product groups in Renewable Energy 2002, 2008 and 2011

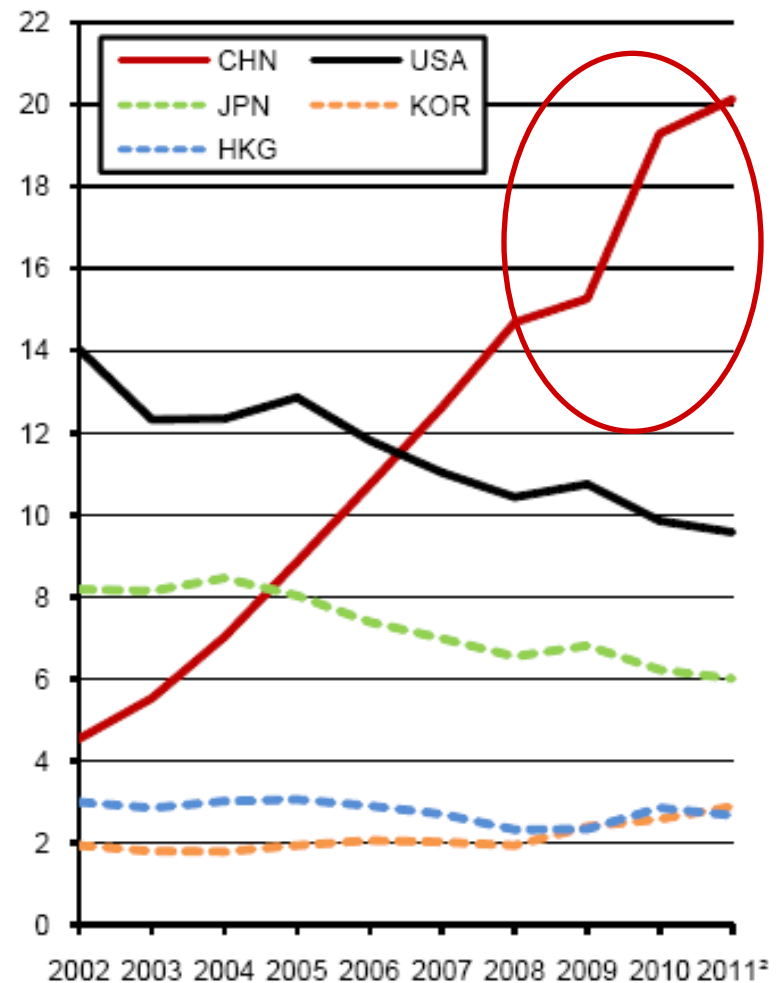


China's World Export Shares for Renewable Energy Products rapidly increasing, Particularly after 2008

Germany and selected European Countries



China vs. U.S. and Japan



Lessons learned?

- **R&D and Innovation Policy has positive impact on Climate-control, no matter who pays the bill**
- **Uncoordinated innovation policies can be very expensive / Very high levels of duplication in Renewable energy investment worldwide**
- **Prevent uncoordinated “Race for Renewable Energy Industries“**
- **Countries implementing Demand-side stimulation should also enhance R&D and capture the value chain**
- **Better Balancing of Feed-in-Tariffs and R&D Policies**
- **Provide greater Stability and clear signals to market participants in Renewable energy policy**
- **Formation of Renewable Energy Multinationals / Overcome existing “Adolescence Trap“**

The EU Case of Trade Barriers against Chinese Solar Modules

- **U.S. Government implements Anti-dumping policy against Chinese Photovoltaics firms in 2012**
- **Initiative of Pro sun promoting similar Anti-dumping policy in Europe**
- **European Commission decides on June 4 to impose a temporary Tariff of 11,8% on Chinese PV modules**
- **This tariff shall be raised to 47,6%, if further negotiations with Chinese government fail**
- **Four Countries in Europe support this policy, including France and Italy**
- **German government “against trade war with China“ / Press release during visit of Chinese Prime minister in Berlin**
- **Chinese retaliation: Import duties on Wine from Europe; later to be extended to other European products**