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A COMPARATIVE STUDY ON THE CONSEQUENCE AND IMPACT OF PUBLIC POLICIES IN FAVOR OF SOLAR PHOTOVOLTAIC DEVELOPMENT (GERMANY & CHINA)

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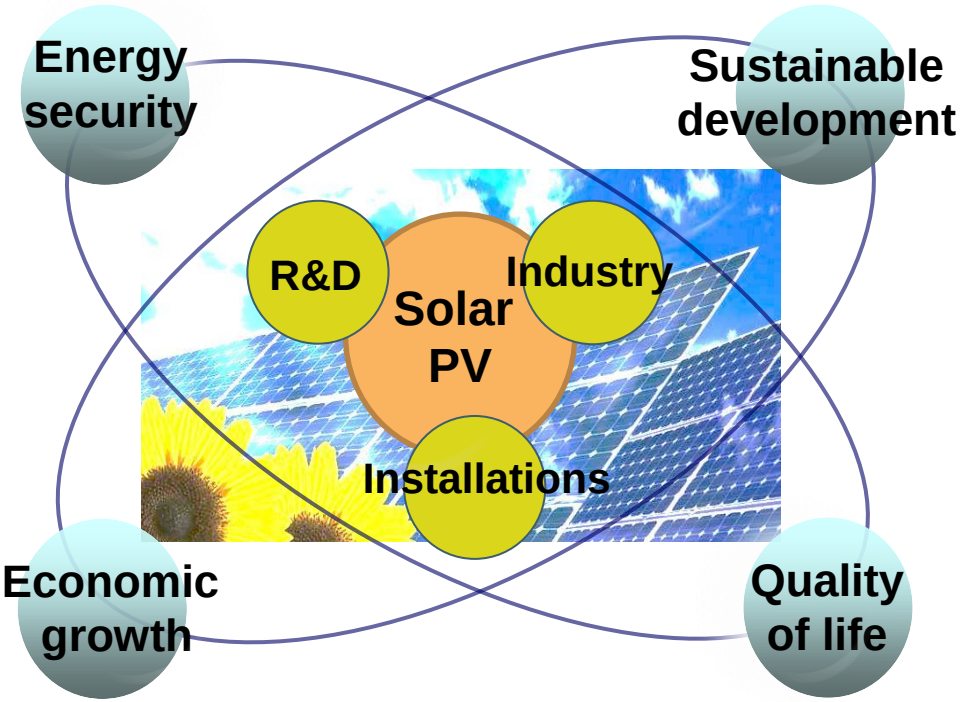
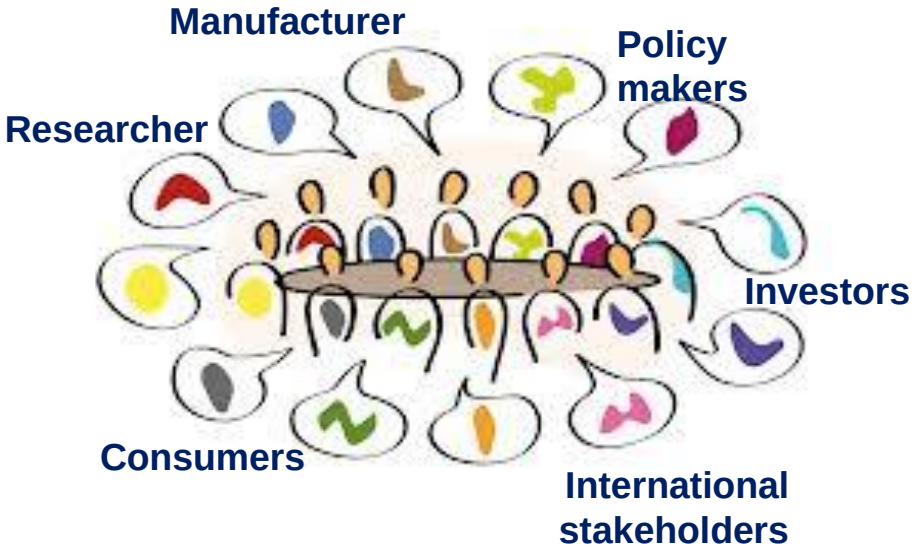
RESEARCH MOTIVATION





Cross-country analysis of PV policies ?

A standardized framework, a commonly shared communication tool?

RESEARCH OBJECTIVES

Common knowledge basis on which to evaluate the policy decision

→A standardized framework for a comparative analysis of PV policy (a simple structure for complex issues)

The schematic PV policy system diagram

- Identifies **important measurable variables of PV policy mechanisms** at a single glance within a global perspective.
- A comparative analysis of Germany (largest installer) & China (biggest supplier) to review **characteristics and differences of policy decisions and results under different contexts**
- **Interactions of their policy decisions** and impact on the schematic map of the PV policy mechanism

→Concepts of **logic models** are taken

WHAT ARE LOGIC MODELS?

A useful way to visualize implicit information in mind how an organization believes its ideas work

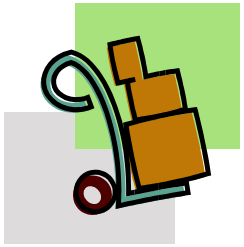
→ Practical depiction of a different pathway of PV policy

How to structure key elements ?

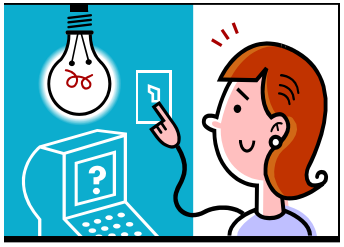
Resources

Activities

Outputs



Outcomes



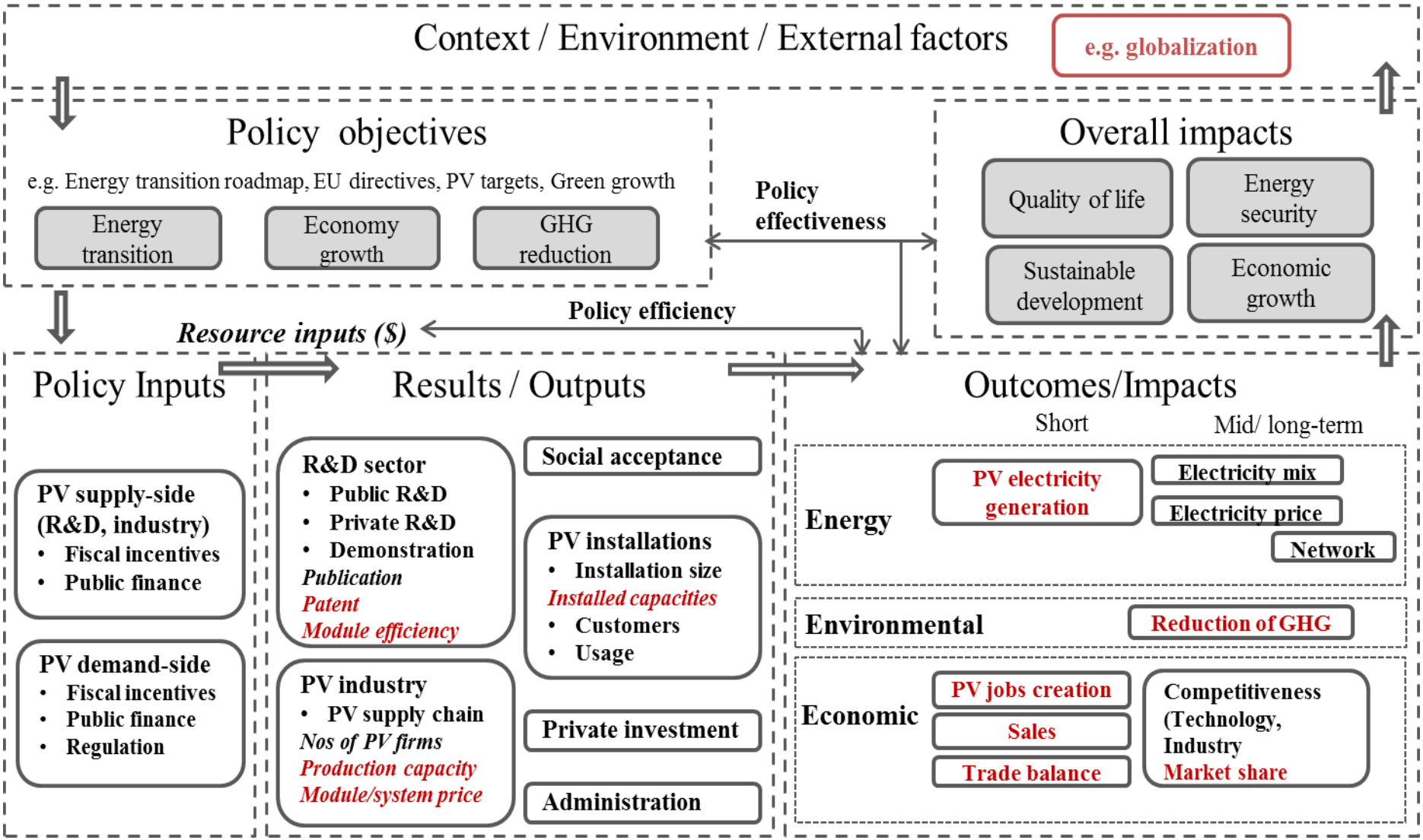
Impacts

Context

Existing practices of logic models

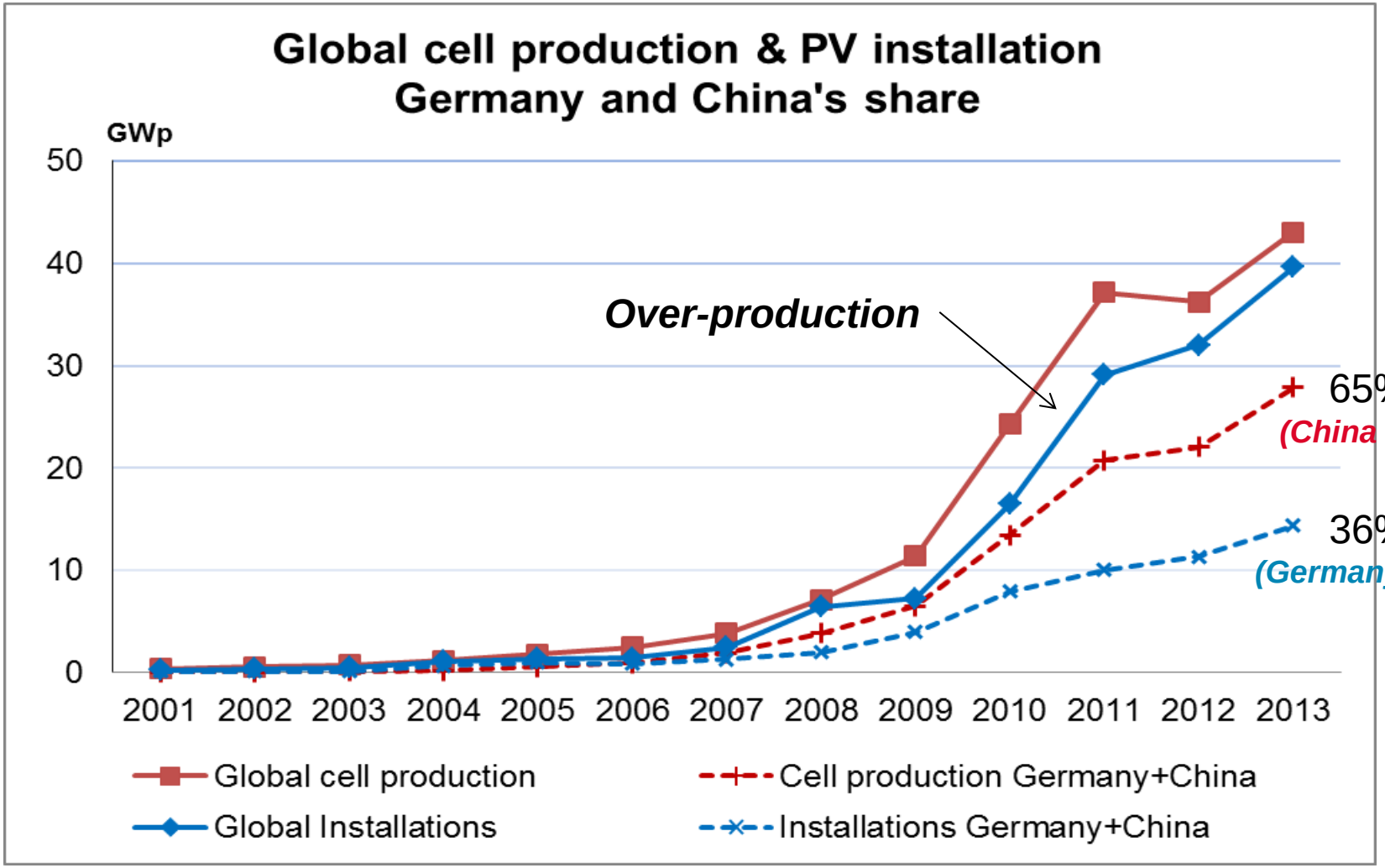
- Theoretical background of a national R&D program evaluation (South Korea's Institute of S&T Evaluation and Planning 2005)
- Evaluating EU activities: a practical guide for the Commission services (EU 2004)
- DG MARKT Guide to Evaluating Legislation (European Commission 2008)
- Historical Case Studies of Energy Technology Innovation (Wilson 2012)

SCHEMATIC MAP OF PV POLICY MECHANISMS



APPLICATION OF SCHEMATIC MAP OF PV POLICY MECHANISMS WITH CASE STUDIES OF GERMANY & CHINA

GERMANY & CHINA IN THE GLOBAL PV MARKET



(IEA-PVPS)

PV POLICY OBJECTIVES

Germany: *the largest PV installer*

Energy security

Sustainable energy

GHG emission reduction

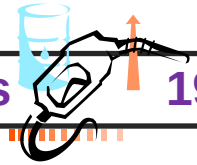
Energy transition, Mitigation of climate change

(EEG, 2000)

Economic growth

Oil shocks | **Chernobyl (1986)** | **Kyoto Protocol (1997)** | **EU 3*20** | **PV growth** | **EU PV crisis**

1970s | **1980s** | **1990s** | **2000s** | **2010s**



China: *the biggest PV manufacturer*

10th plan (01-05)

11th plan (06-10)

12th plan (11-15)

Electricity supply to rural/off-grid area

Stable energy supply
Control of air pollution

Knowledge on energy technologies

Economic growth

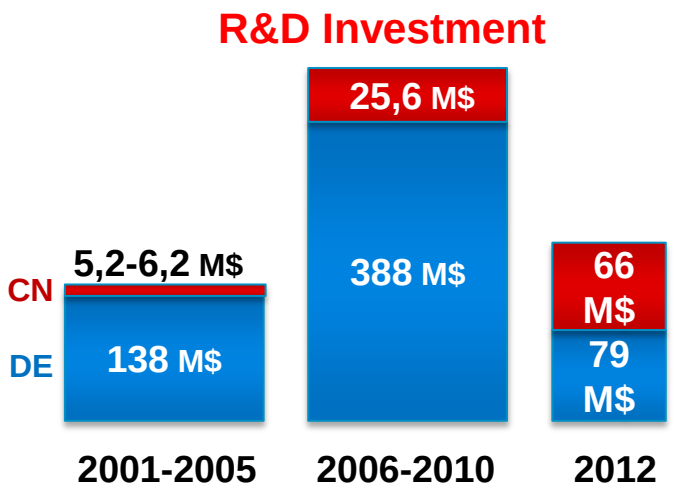
New energy industry

Energy transition using PV

POLICY STRATEGIES AND INPUTS: R&D

Germany: Technology frontier

- Important focus on **R&D activities as a technology frontier**
- R&D focus on further **reducing the production costs** of silicon-based technologies to support the German industry
- New focus to strengthen the skills in **PV components and equipment**



(IEA-PVPS)

China: Late-mover

- **Weak R&D efforts** until recently
- **Recently focusing more on R&D** to advance PV-related technologies (e.g. silicon production)
- Under its 12th plan (2011-2015), PV sector included in the list of **government-driven R&D initiatives**: e.g. *Si-cell efficiency of 20% and thin film cell efficiency above 10% and reducing production costs*

RESULTS (OUTPUTS): R&D

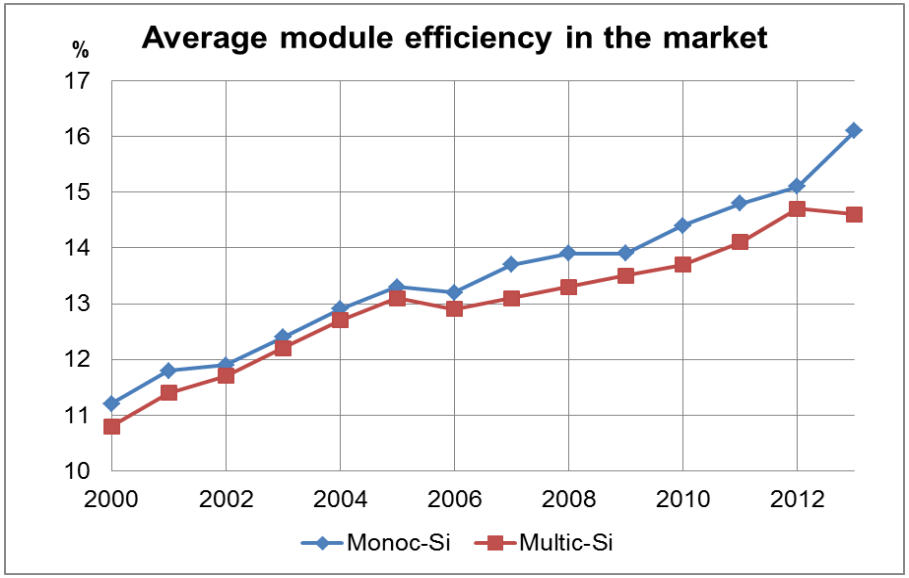
Changes in **patents and module efficiency**

Germany: Important contribution

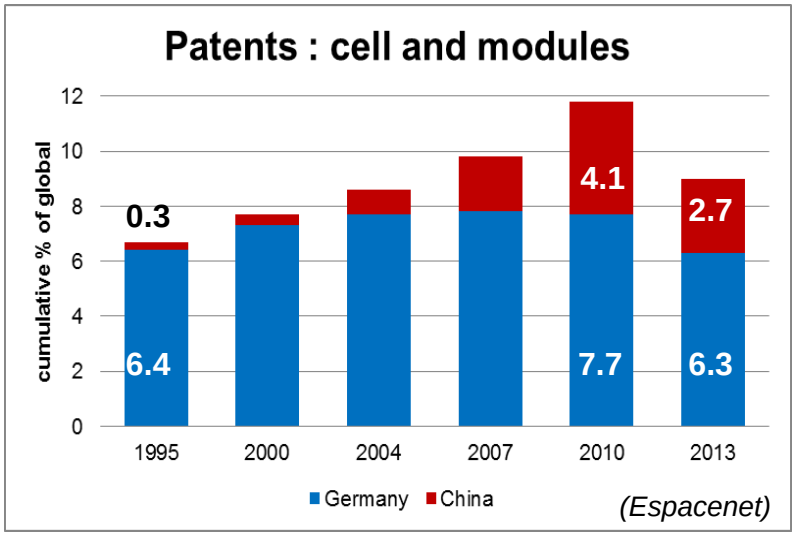
- Responsible for a significant proportion of the global patents

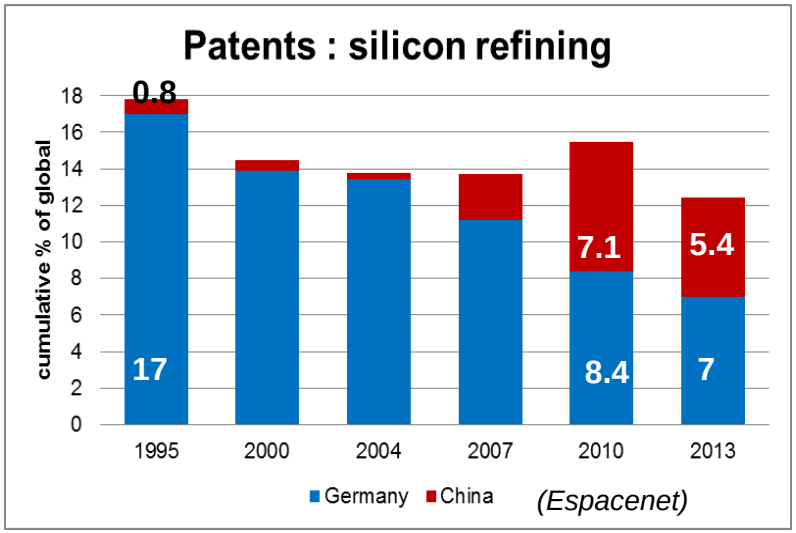
China: Recently visible

- Only recently gained visibility in terms of producing international patents



Photon international





Patents for cells & modules and patents for silicon refining- unit: cumulative % of the global patents (Espacenet)

POLICY STRATEGIES AND INPUTS :INDUSTRY

Germany: Research to industry

- **R&D to industry** (demonstration & commercialization)
- A policy mix of **technology-push & demand-pull strategies**
- A **close network** between research centers, universities, and industry

→ ***Funding, grants, cash incentives, reduced-interest loans, public guarantees***

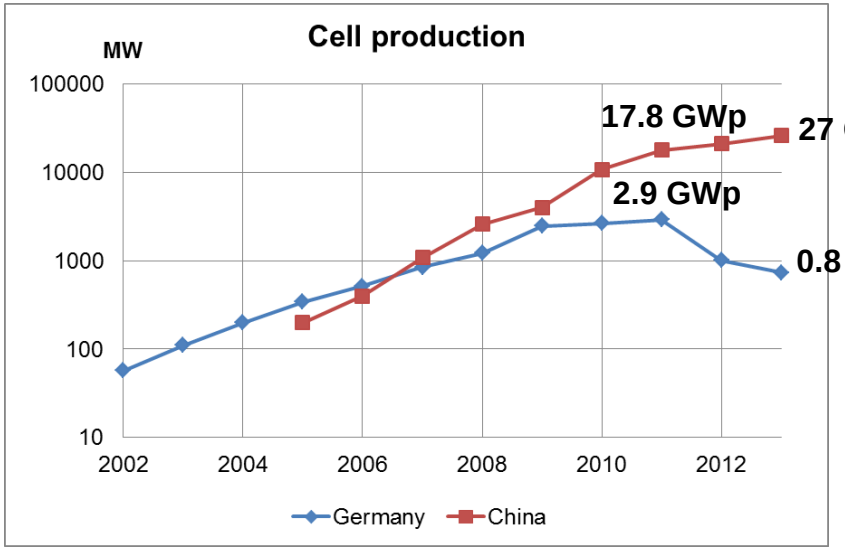
China: Industry growth first, export-oriented

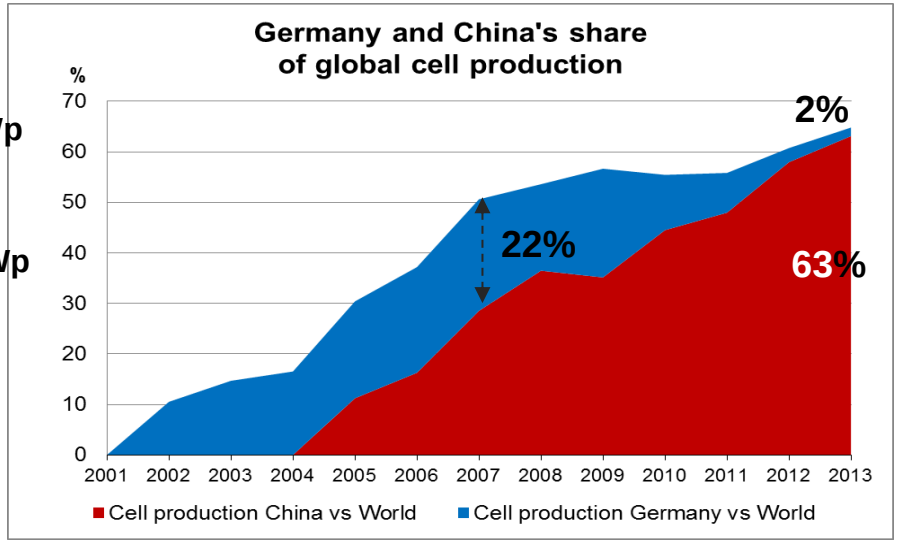
- **Easy-to-follow technology industry** (manufacturing of labor-intensive cells and modules) to **higher-skilled, more capital-intensive upstream** (silicon purifying, ingots shaping and making thin wafers)
- **Price competitiveness** through economies of scale
- **Export-oriented policies**

→ ***Innovation funds for small technology-based firms, regional investment support policies (local), simplified loan and credit conditions (national)***

RESULTS (OUTPUTS & OUTCOMES): INDUSTRY

Changes in the **manufacturing capacity** and the **module production cost**
Economic benefits via **jobs, sales and trade**
Competitiveness of the PV industry via the **market share**





Germany

- 128 thousand direct PV **jobs** in 2011 & 100 thousand in 2012
- **Sales** valued at US$ 21 billion in 2011
- **Exports** to US$ 7.3 billion in 2011
- Cell production **market share** from 22% in 2007 to 2% in 2013

China

(IEA-PVPS)

- 500 thousand PV **jobs** in 2011 & 300 thousand in 2012
- **Sales** US$ 48 billion in 2011 (0.6% of the Chinese GDP)
- **Exports** totaled US$ 17.5 billion in 2012
- Cell production **market share** from 16% in 2006 to 63% in 2013

POLICY STRATEGIES AND INPUTS: INSTALLATIONS

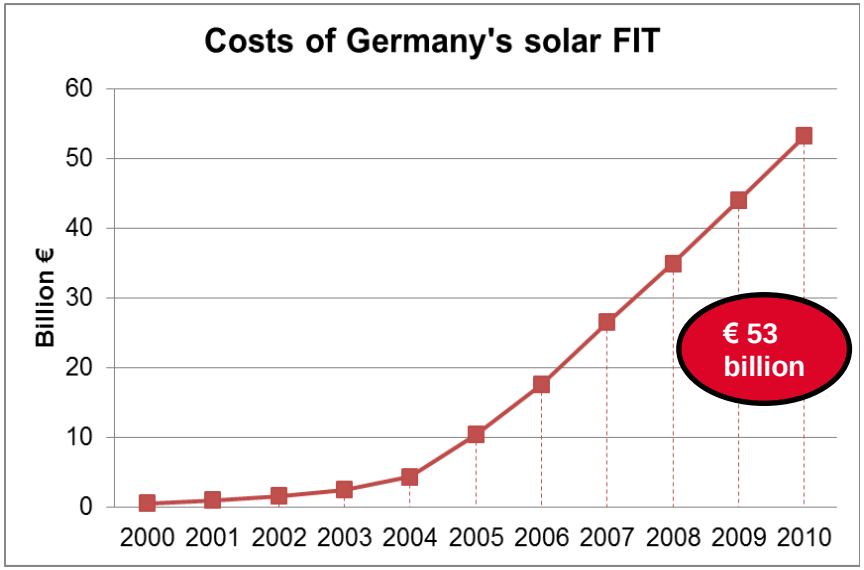
Germany: Constant commitments

- Installation subsidies :

1000 Solar Roofs Initiative' (1991-1995)
The '100,000 Solar Roofs Initiatives' (1999-2003) : rapid increase in PV system installations in the early 2000s

- Germany's energy transition (EEG, 2000)

FIT scheme from 2000 : German solar PV boom from 2004



(Lütkenhorst et al. 2014)

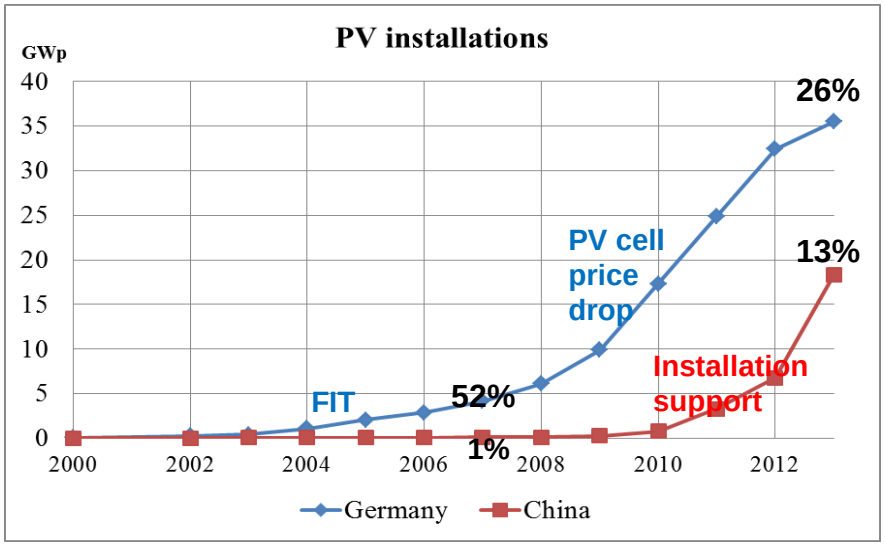
China: Recent event

- Off-grid rural electrification programs: the Brightness Program (1996), the Township Electrification Program (2000).
- Mid-2000: The serious PV deployment promotion policy with the renewable energy law (REL, 2006): central government subsidy programs such as the Rooftop Subsidy Program (2009), the Golden Sun Demonstration Program (2009), and the Solar PV Concession Program (2009)
- In 2011, **the national FIT scheme to support domestic growth**

RESULTS (OUTPUTS & OUTCOMES): INSTALLATIONS

Direct change in **installed capacity**

Impacts on the energy transition (**electricity generated, electricity mix**), environmental aspect (**GHG avoided**), & economic benefits (**business values**)



Cumulative installed capacities of PV in Germany & China *(IEA-PVPS)*

2012	Germany	China
Cumulative installation	32.5 GW in 2013 (26% of the global)	18.3 GW (2013) (13% of the global)
Business value	US$ 17,520 million	US$ 6,143 million
Electricity production	> 5% producing 28 TWh (2012) ← 0.03% with 0.2 TWh (2002)	0.1% producing 5.2 TWh (2012)
CO_2 emissions	10 million metric tons avoided (2011)	Impact is poor; rather it increased

(Eurobserv'er, EPIA, Fraunhofer)

OVERALL IMPACTS OF PV POLICIES IN GERMANY & CHINA

Germany and China followed very different policy pathways

Germany until lately

Well-balanced policy mix around supply and demand

The leading position producing visible results : **technology development, economic benefits, energy transition**

China's emergence

China until lately

Industry development through export-driven strategies & large-scale production lines :**Enhance international competitiveness**

Tenuous outcomes in terms of the **energy transition and climate change**

PV crisis

Germany 2010s

Price competition: Economic damages (job loss, trade deficits)

Visible results of energy transition *(2011-2012 : **- 28000**)* *(2010-2012 : **3.5 B€** with China)*

Slowdown of PV industry, negative electricity gross price

China 2010s

Economic damage faced with PV industry slowdown (dependent on foreign demand and imported raw materials) ***49%*** *of refined silicon imported in 2013*

Stimulation of domestic demand through sustainable energy supply to respond such PV industry slowdown

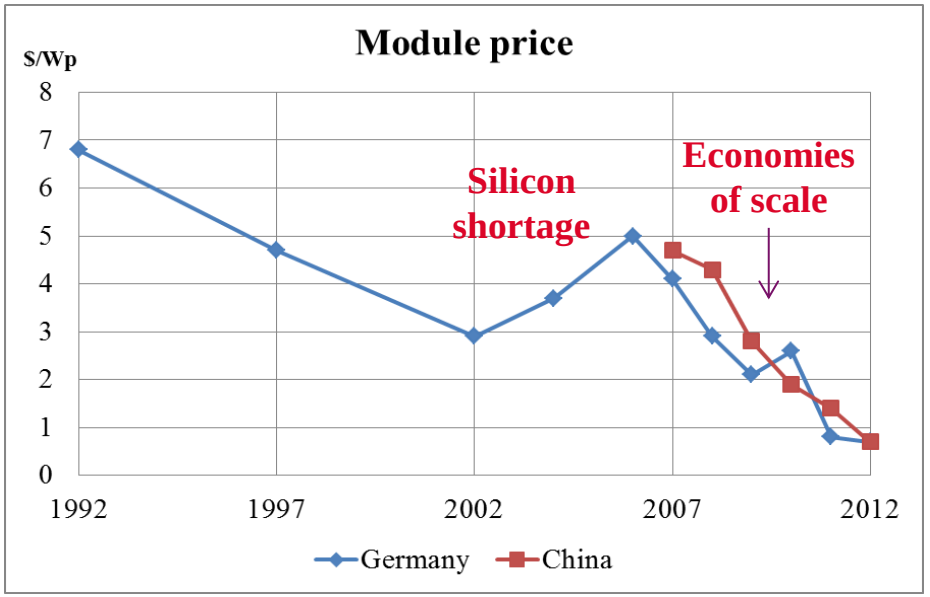
INTERACTIONS BETWEEN GERMANY & CHINA POLICY STRATEGIES

The importance of the external factor in the schematic map : globalization

China's export-oriented PV policy without domestic market development →*New conditions* contradicting the German policy assumptions

German's balanced policy mix
Assumption of German FIT scheme:
Extrapolating the drop in module prices with little global competition

China's entry (mass-production)



(IEA-PVPS)

Sharp price drop in the German PV system prices than expected : unexpected PV installations and additional policy costs
Germany to curtail the FIT scheme several times to adjust to such market changes

Global overproduction

Economic damages

Need a new policy strategy
Germany: external influencing factor (e.g. Japan's institutional barrier)
China: well-balanced policy mix
Use of the schematic map as a constant framework

CONCLUSION

CONCLUSION

PV policy design, implementation and evaluation based on a global perspective: using a tool is helpful (e.g. the schematic map)

A systematic & regular approach to monitoring any pathway changes to prepare new policy strategies under the new conditions

An optimal mix of policy instructments is important, however, **the cogitation of external factors and their possible interactions** (e.g. globalization) **are equally important** to achieve the desired benefits

The findings of case studies **can be integrated into the schematic map**

- **Germany: Institutional barriers** e.g. certification or agreements with building companies for PV integration (Japanese systems), **creation of new demands** using less commercialized technologies & new usages
- **China**: **Importance of well-balanced policies for long-term benefits**; new opportunities towards a sustainable energy system

The more input of stakeholder's practices & knowledge (feedback loop), **the more accurate schematic map!**

Thank you for your attention.

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