

# Three generations of solar cell technologies in Japan – a Functions of Innovation Systems analysis

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# Introduction

- *How to understand and accelerate the development and diffusion of emerging technologies?*
- Innovation systems approach is a powerful heuristic framework
- Highlights the systemic nature of innovation processes
  - *No innovation in isolation*
- Technological development not only technical and economic but also social aspect important
- Very well diffused under policy makers (OECD etc)
- Has potential to contribute to 'joint actions on climate change'

# Innovation Systems

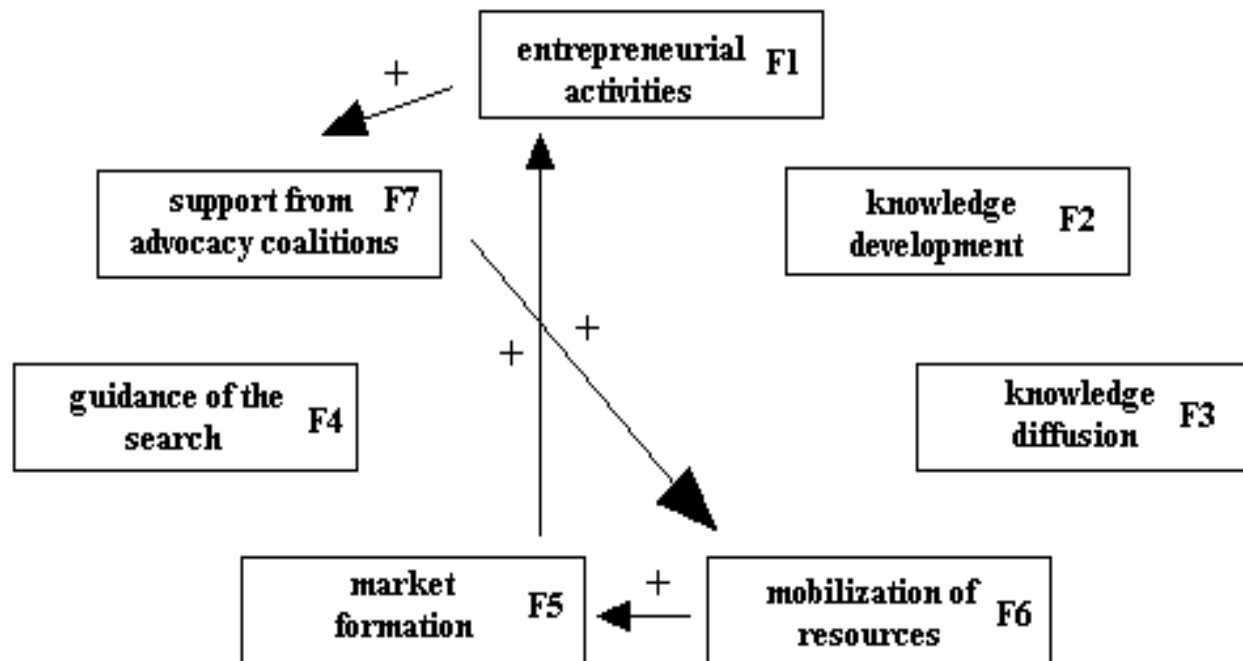
- 'Goal' of Innovation System: *to develop, diffuse and use innovations*
  - Those *factors that influence* the developments, diffusion, and use of innovations = system functions
  - System functions build up an Innovation system
  - The way all activities cumulate determines the functioning of the innovation system
- > identify functional patterns – feedback loops between functions

# System functions

- Function 1: Entrepreneurial Activities
- Function 2. Knowledge Development
- Function 3. Knowledge Diffusion through networks
- Function 4. Guidance of the Search
  - Expectations
  - Legitimation
  - Vision for future
- Function 5. Market Formation
- Function 6. Resource Mobilization
- Function 7. Counteracting Resistance to Change
  - Lobby activities

Qualitative indicators used for functions – see paper

# Functional patterns - *example*

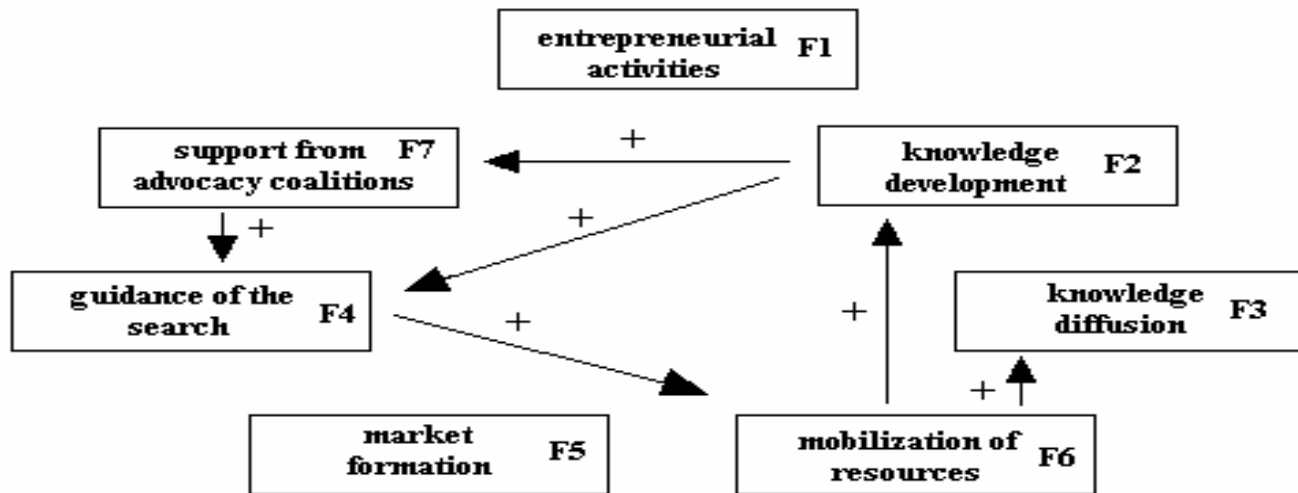


# PV innovation systems in Japan

- Japan has been very successful for decades in PV R&D, industrial development and diffusion:  
Japan produces about 40% of the world's PV; and has about 2,000 MW of installed capacity
- Goal of this research: find explanation in functional patterns of innovation systems of the three generations PV technology

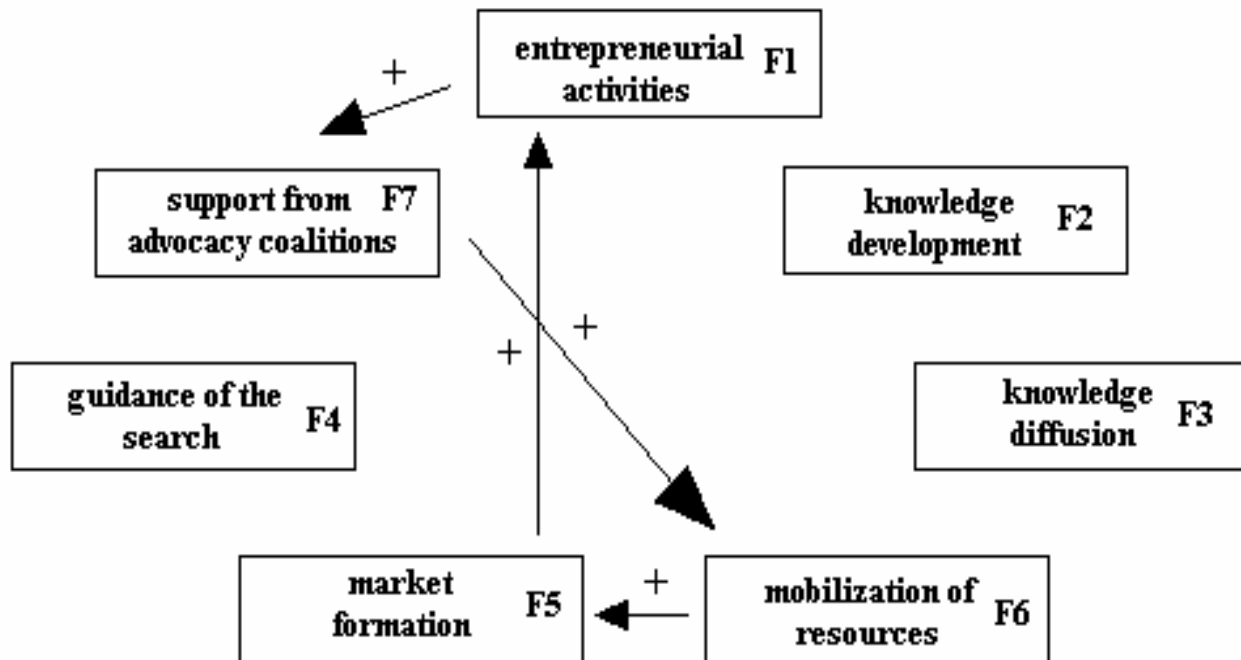
# First generation PV – *crystalline silicon PV*

- Virtuous R&D cycle:
- PV2030 roadmap – triggered R&D, wide support and high expectations on PV



# First generation PV – *crystalline silicon PV*

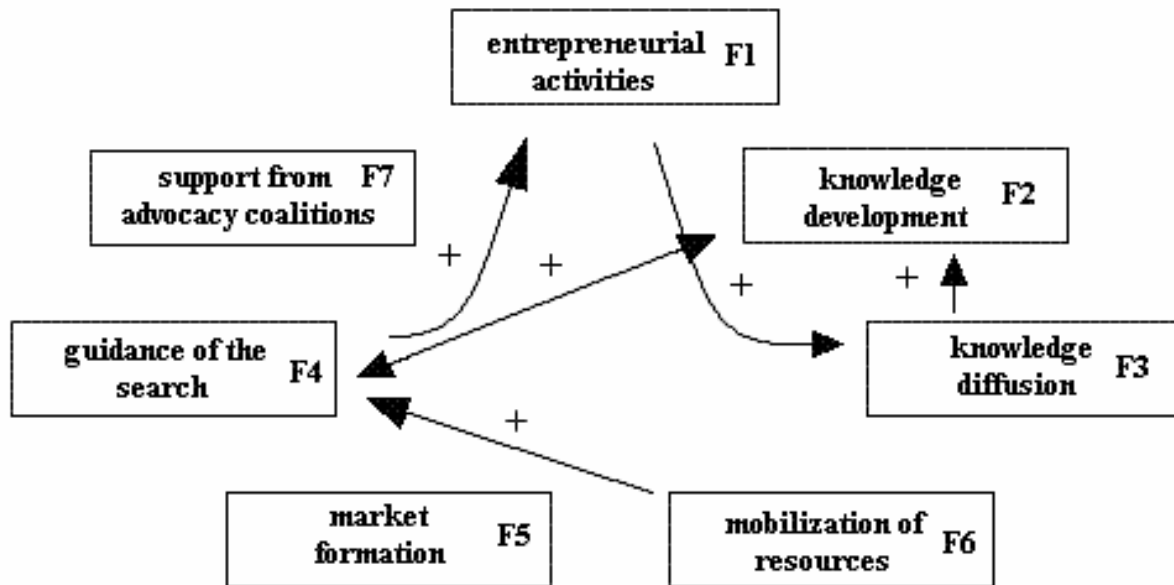
- Virtuous diffusion cycle (until 2005):
- Residential Dissimination programme triggered entrepreneurial activities -> lobby for more resources, market grew and attracted more entrepreneurs
- These continue to lobby for more resources and support





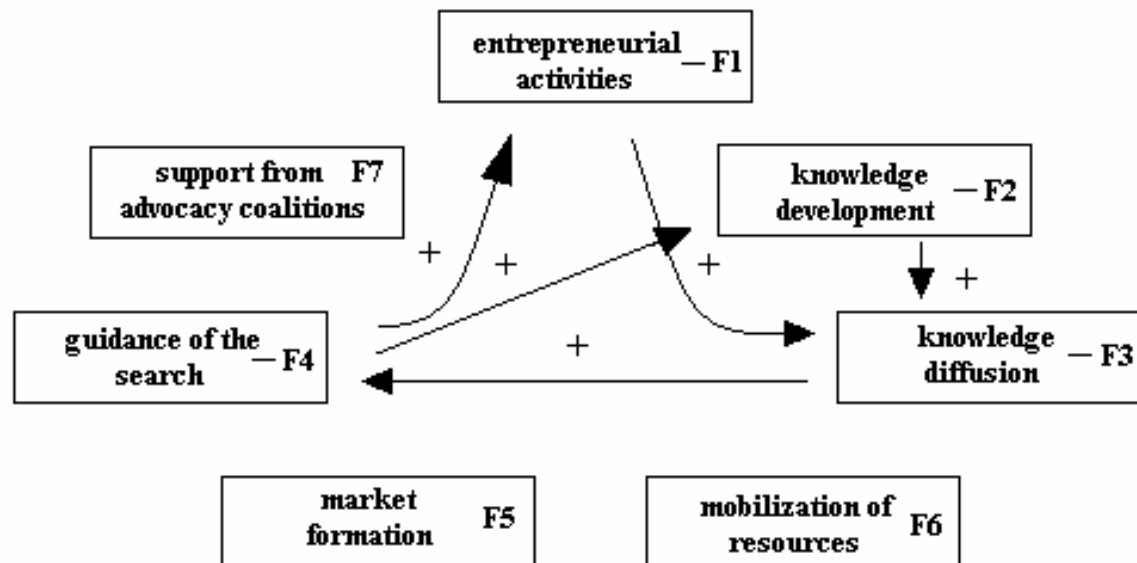
# Second generation PV – *thin film PV*

- Virtuous R&D and diffusion cycle:
- Shift away from first generation –> guidance of the search -> entrepreneurial activities -> lobbying -> mobilization of resources -> knowledge development & market formation -> more entrepreneurial activities



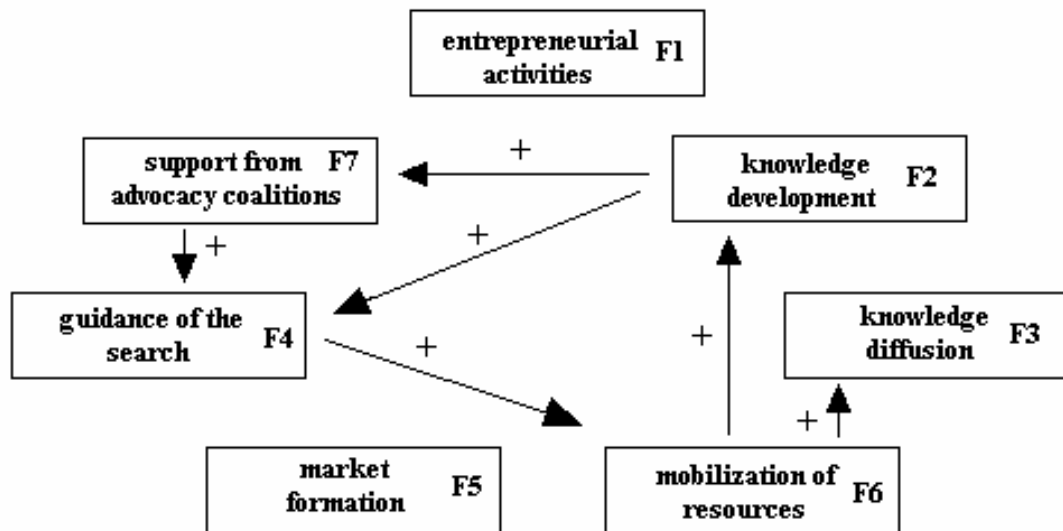
# Second generation PV – *Copper Indium di-Selenide/di-Sulfide solar cells*

- Lock-in:
- Commercialised only recently; but scattered R&D community -> low knowledge diffusion and guidance of the search



# Third generation PV – *organic solar cells*

- Virtuous cycle:
- High expectations of future low production costs -> mobilization of resources -> knowledge development -> support -> guidance of the search -> mobilization of resources



# Main conclusions on dynamics in Japanese PV innovation systems

- High expectations and guidance of the search by broadly supported government programmes are important triggers for virtuous cycles in PV innovation systems
- Lack of knowledge diffusion between isolated research communities can hamper growth of innovation system

# Implications

- More insights in these patterns may help to improve innovation policy – now instruments often strongly financially dominated
- More insights may also help to improve entrepreneurial and other actors' strategies – provide insights in how to include the innovation system in business / innovation strategy

Thank you!

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