MISALIGNMENT OF EXPECTATIONS AND POLICY FAILURE? JAPAN'S PHOTOVOLTAICS INDUSTRY, 1974-2018

Maki Umemura

Cardiff Business School

Andrew Smith

University of Liverpool
Management School

OUR PRESENTATION

1) Statement of research aims/relevant literature
2) Overview of evolution of industrial policy in Japan
3) Reasons we characterize this policy as a failure
4) Policy prescriptions to be derived from our work

RESEARCH AIM

We need a better understanding of the precise circumstances in which industrial strategies are likely to be successful.

Since industrial strategy is forward-looking, it is logical to examine the makers of industry policy form estimates of the future.

There is an extensive body of research on how competing estimates of the future shape the strategies of R&D-intensive firms.

We build on the existing small body of literature on how futurology informs **national** industrial policy.

CONCEPTUAL FRAMEWORK

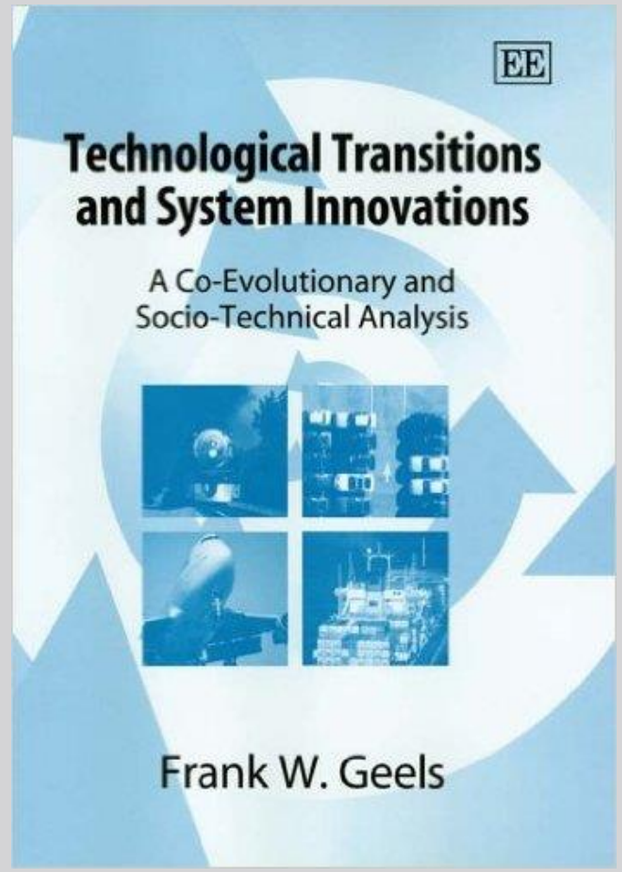
- Within the context of **social technical systems** (Geels 2004)

  - Niche innovations are the *seeds of change* toward system transitions (such as. energy transitions)

  - Builds on innovation studies (Breschi and Malerba 1997, Malerba 2002) and technologial (Carlsson and Stankiewitcz 1991) innovation systems, as well as large technical systems (Hughes 1983, 1987, Summerton 1994, Coutard 1999)

  - Considers demand side (e.g. distribution and usage of technology; **change in expectations**) in addition to supply side of the system

  - Recent studies of expectations in innovation studies (Borup et al, 2006, Budde et al 2012, Bakker, et al 2012, Garud)



EXISTING RESEARCH

Carlo Pietrobelli and Fernanda Puppato. "Technology foresight and industrial strategy" *Technological Forecasting and Social Change* 110 (2016): 117-125.

3 types of national technology assessment organisations:

1. the advice model (as in Canada)
2. a Finnish-style coordination model
3. joint-planning model

There is a substantial literature on national technology assessment agencies, but only a few papers look at how expectations inform policy.

Even these papers say little about **the relationship between different forecasting systems and policy performance** (success/failure).

PROXIMATE RESEARCH

Kameoka et al. (2004) showed how from 1977 the Japanese government used the Delphi method to try to determine when home fax machine technology would be ready for widespread adoption

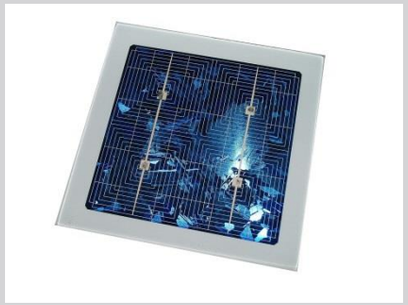
Rongping and Zhongbao (2008) showed that the Delphi method of technology forecasting came to be used by the Chinese government in the 1990s.

Bakker et al. (2012) changing estimates of when hydrogen car technology would reach particular performance thresholds definitely informed US govt decisions about which particular technologies were supported.

Bakker et al., did not document how exactly the policymakers at the Department of Energy determined whether particular technologies were “faraway” or nearly ready for commercialization.

SOME DEFINITIONS

- Photovoltaics
  - Devices that convert the sun's light into electricity



Competing technologies

- First generation – fully commercial
  - single crystalline, multi crystalline
  - Co: Sharp, Kyocera, Panasonic, Mitsubishi
  - Most used, high cost (silicon)

- Second generation – partly commercial
  - Thin film: amorphous, CdTe, CIS, CIGS
  - Co: Solar Frontier (CIGS), Kaneka (s-Si)
  - Less efficient than first generation; lower cost

- Third generation – not commercial
  - Concentrated PV, organic cells, dye sensitised solar cells, other

JUSTIFICATION OF CASE

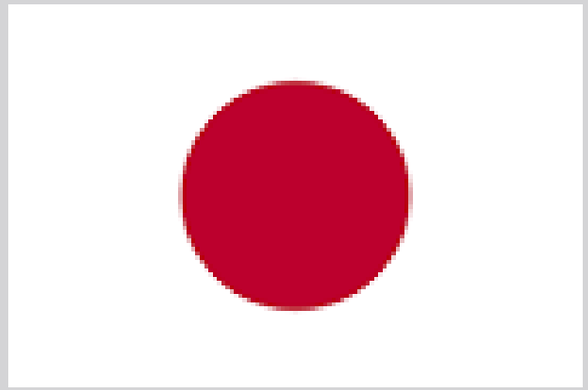
Justification of case

Industry

- Photovoltaics as an industry at the technological frontier
- Evolution over four decades
  - forum to follow technological advances and innovation networks over time
- Remains niche technology whose adoption requires interactions with existing energy system

Country

- Japan as a location where actors have made considerable efforts to pioneer the industry
- Largest producer of photovoltaics between 1997-2004; with leading global companies at the time
- One of the top three countries in the world in terms of annual and cumulative PV capacity, and PV module production



POLICY REGIME SHIFTS AND DISSONANT ESTIMATES OF THE FUTURE

- Evolution of the photovoltaic industry in Japan
  - Wave 1: 1950s-1973, Pre Oil Shock, National Projects
    - .
  - Wave 2: 1974-1993, Sunshine Policies

(oil shocks prompt new estimates of the energy future)

  - Wave 3: 1994-2005, PV residential roof programme
  - Wave 4: 2006-2011, Withdrawal of supports and relative retreat

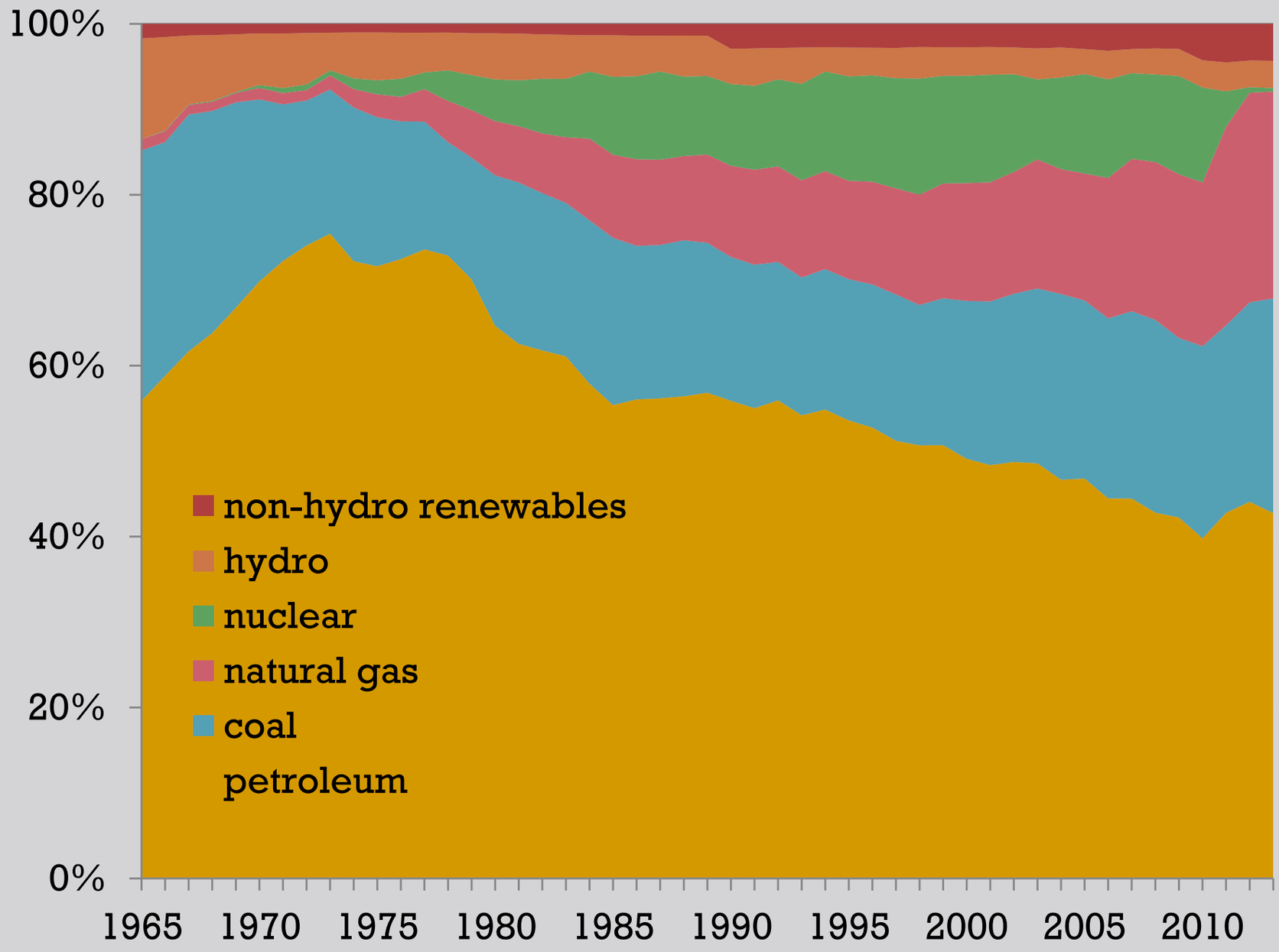
(sharp differences between actors' estimates of the future)

  - Wave 5: 2011- Post-Fukushima

(Fukushima accident shifts, helps bring together estimates of the future)

THE BROADER PICTURE OF PHOTOVOLTAICS IN JAPAN

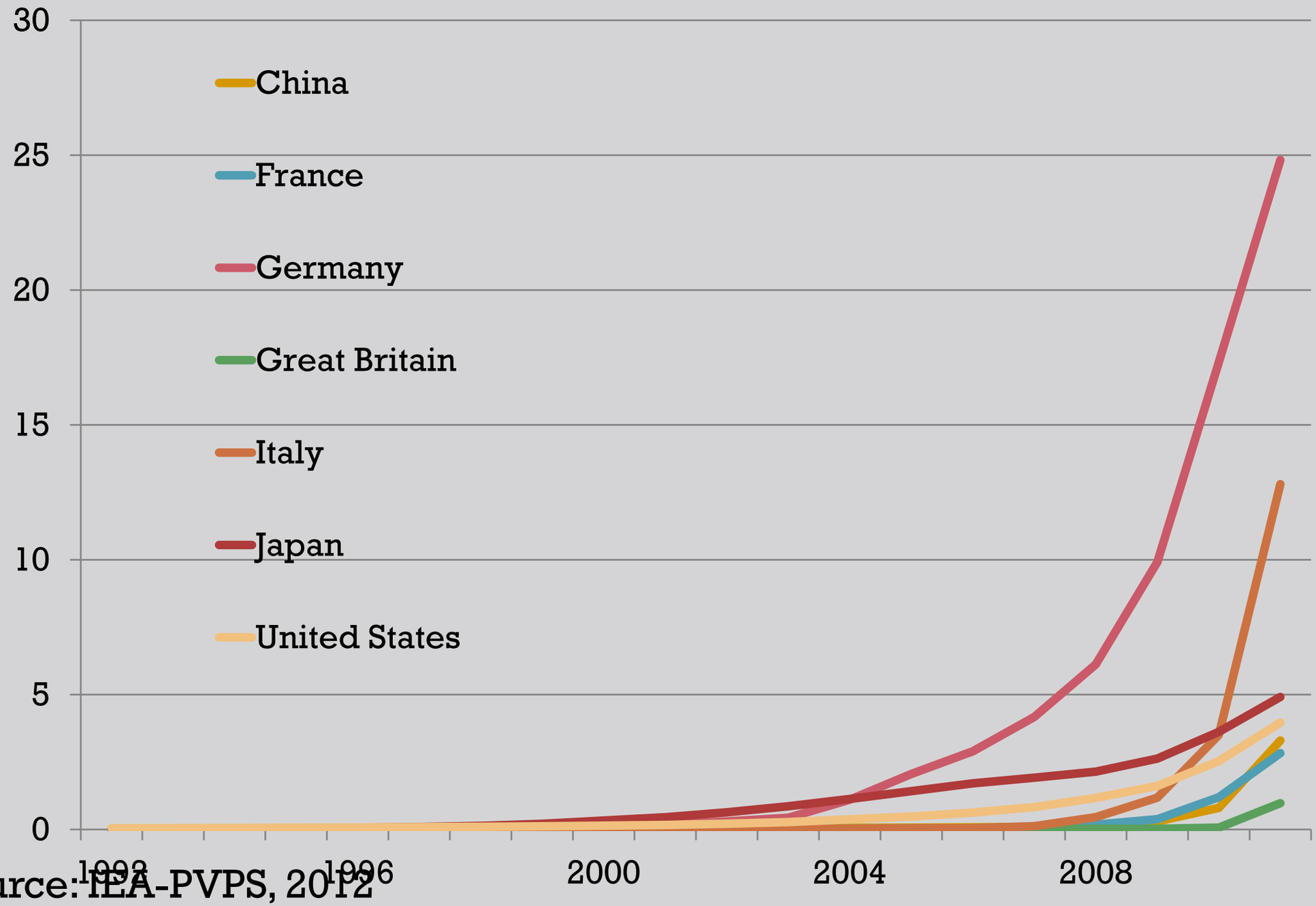
- Share of electricity production via photovoltaics, 2.6% in 2014 (IEA-PVPS 2015)



METI, Energy White Paper, various years

INSTALLATION TRENDS IN COMPARATIVE PERSPECTIVE

Cumulative installed pv systems in leading countries (GW)



Source: IEA-PVPS, 2012

CURRENT INDUSTRY SNAPSHOT

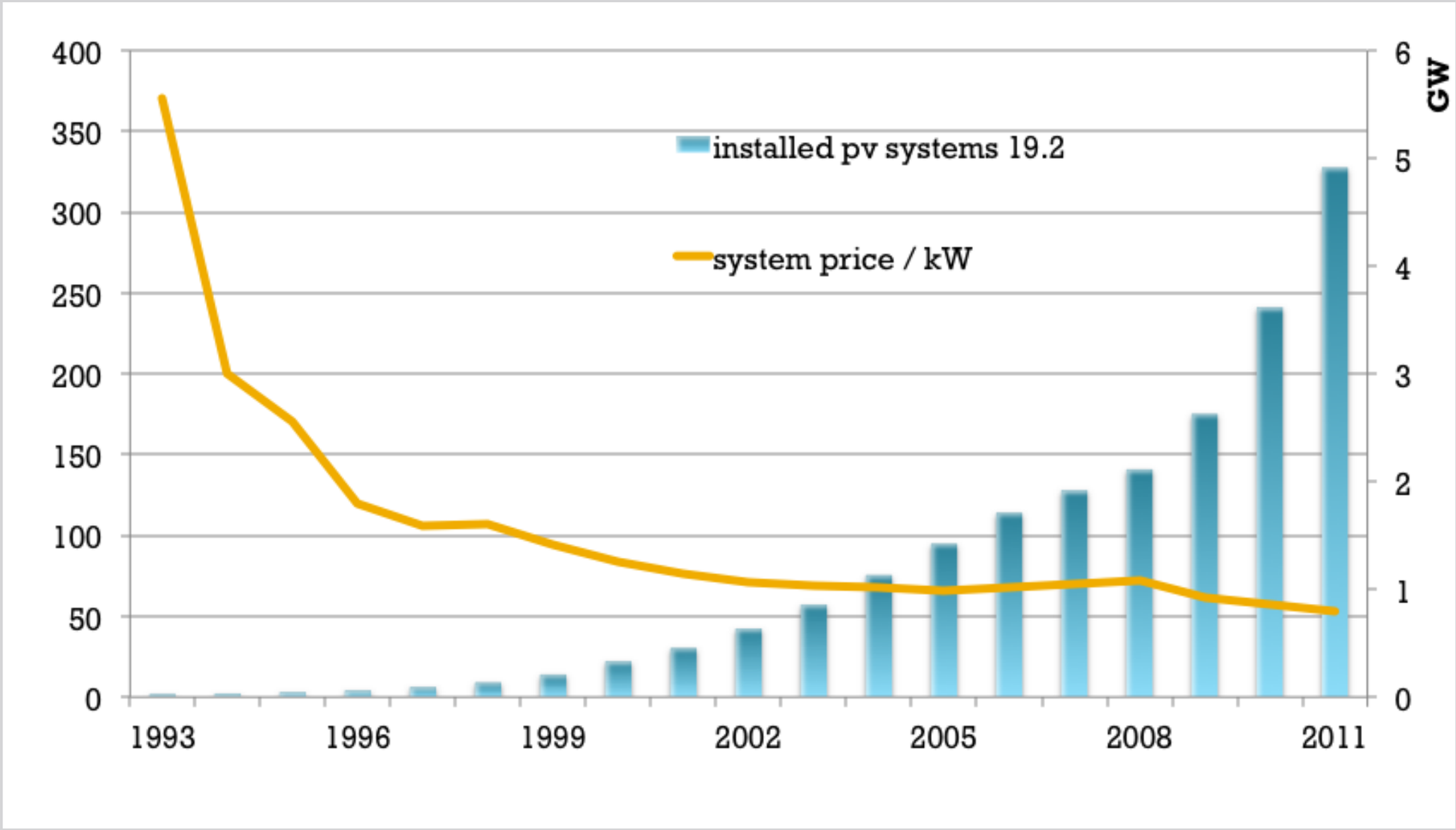
- Global photovoltaics industry grew to at least 48,1GW (2015), up from 40GW (2014)
- Leading photovoltaic market is Asia (57% of global market) led by China (15.1 GW) and Japan (11GW), then US (7.3GW)
- Total installed capacity 224.1 GW; led by China (43.6GW), Germany(39.7GW), Japan (34.4GW) and US (25.6GW)

	annual installed capacity (GW)		cumulative installed capacity (GW)	
1	China	15.2	China	43.5
2	Japan	11	Germany	39.7
3	USA	7.3	Japan	34.4
4	UK	3.5	USA	25.6
5	India	2	Italy	18.9

Source: IEA-PVPS 2016

TRENDS IN INSTALLATION AND PRICES OF PHOTOVOLTAIC CELLS

Price trends of photovoltaic systems in Japan, in millions of yen per kWH; Cumulative installed pv systems in Japan (GW)



Source: Agency for Natural Resources and Energy, METI

DATA SOURCES AND METHODS

We compare the evolution of the expectations among technical experts and the sociotechnical imaginaries of policymakers.

For the sociotechnical imaginaries of policymakers, we consulted the proceedings of the Diet (Japan's national legislature), ministerial White Papers and other reports produced by the executive branch of the government.

For the expectations of experts, we consulted analyst reports. We also took advantage of a uniquely Japanese data source, the detailed Delphi survey of technical experts

DELPHI METHOD

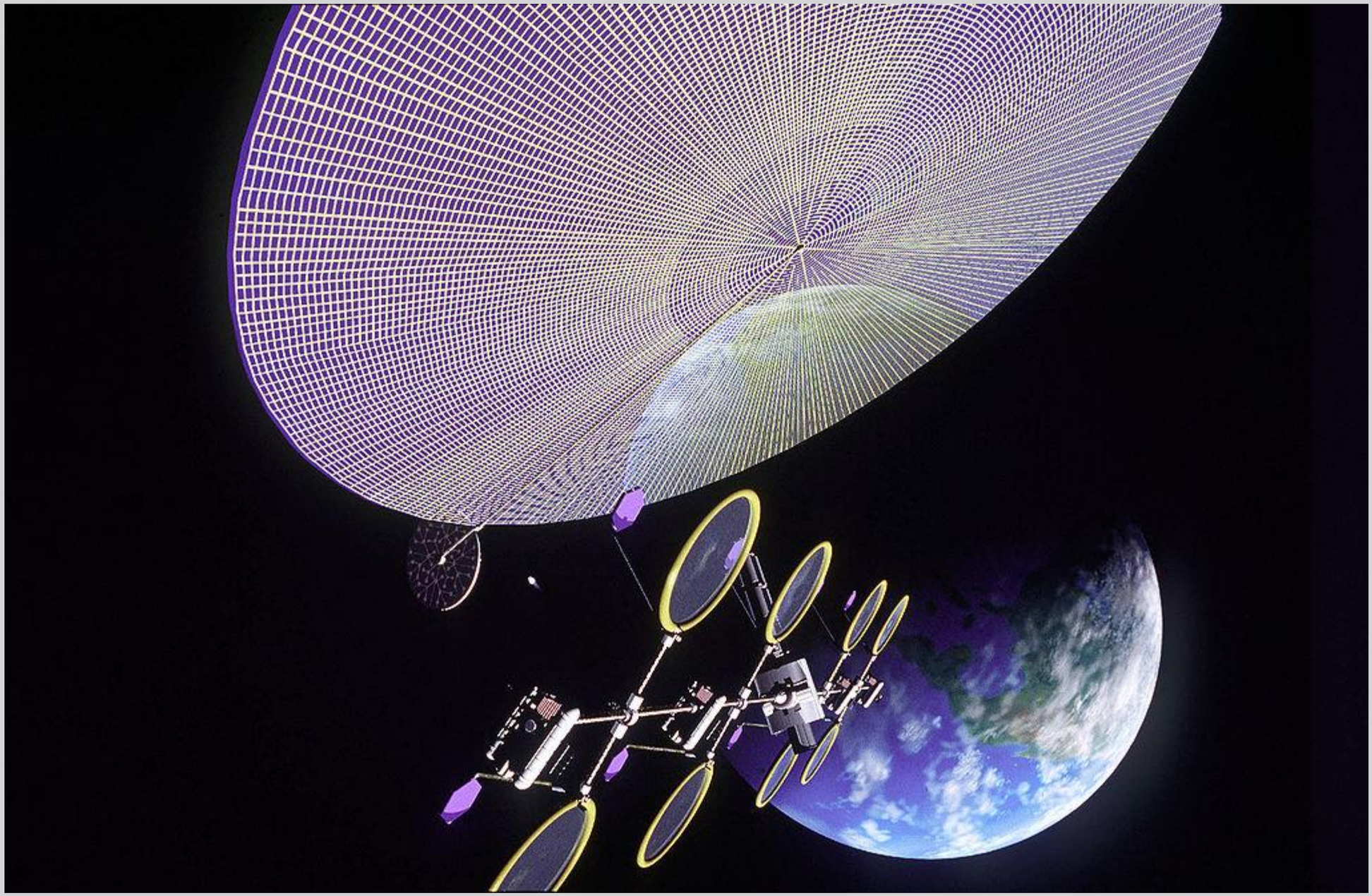
Since 1971, the Japanese government has periodically surveyed a wide variety of technical experts with a view to estimating the future of a variety of technologies, including photovoltaics.

The Delphi method, which has been used by the Japanese government's Science and Technology Agency (STA) since the 1970s, was developed at the Rand Corporation in the 1950s.

Surveys of large Ns of experts, who respond anonymously to a questionnaire in the first instance, after which they respond again after receiving the statistical results of the group response (Helmer - Hirschberg 1967).

Although the reliability of the Delphi method has been questioned by advocates of competing methodologies, it remains in widespread use.

QUESTIONS ABOUT PHOTOVOLTAICS IN DELPHI SURVEYS



KEY FUTUROLOGICAL ISSUE

Early surveys asked experts questions about both space-based and rooftop solar power.

The questions related to solar energy in the Delphi surveys focused on two main questions:

Time to commercialization?

When will PV technology be efficient enough that it will no longer require subsidies to compete with competing sources of electricity?

20 % efficiency threshold

ON SURVEYS

Surveys since 1992 have consistently asked experts to predict when "large-area, thin-film solar cells with conversion efficiencies of at least 20%" would become available.

In 1992, the Science and Technology Agency's predicted that large-area, thin-film solar cells with conversion efficiencies of at least 20% would be available by the year 2004, twelve years in the future.

In 1997, the agency revised this date to 2013, sixteen years in the future.

The Seventh Survey in 2001 prompted the Agency to change the forecasted realization time to 2015, fourteen years in the future.

The Eighth Survey, done in 2005, pushed that date back to 2020.

EMPIRICAL FINDINGS

From the early 1970s, Japan's national technology forecasting agency used the Delphi method to supply policy-makers with data about the future of photovoltaic technology (e.g. , time to commercialization).

The aggregated predictions of scientists informed policy.

In 2004-5, Japanese policymakers decided to ignore what the experts were saying about the future of this technology.

They withdrew subsidies prematurely, which significantly harmed the Japanese PV sector.

POLICY FAILURE?

In 2004, Japan was a world leader in photovoltaic technology. Strengthened by generous subsidy policies that encouraged the installation of photovoltaics panels in their home market, Japanese manufacturers of photovoltaics had become world leaders, dominating the global market for rooftop systems.

In the subsequent decade, Japanese firms lost their global leadership as German and Chinese firms came to dominate the market for photovoltaic cells. Moreover, while Japan in 2004 was a world leader in the installation of photovoltaic cells for electricity production today it has fallen behind other advanced economies in the percentage of its electricity generated by photovoltaics.

In the period leading up to the fateful curtailment of support for photovoltaics in 2005, the expectations of policymakers and of experts had become *misaligned*.

MISALIGNMENT

The misalignment was visible in their divergent thinking about a crucial issue: whether photovoltaics was or was about to become a mature technology that would be able to survive in the absence of government support. Many policymakers said Yes, while most of the technical experts believed that the technology not yet mature and cost competitive with traditional methods.

The story of the rise and fall of the Japanese photovoltaics illustrates the why we should create mechanisms for ensuring that estimates of the future by policymakers and technical experts are aligned.

GENERAL MODEL

We argue that successful industrial policy requires a high degree of alignment between "sociotechnical imaginaries" and "expectations" of different groups of actors, particularly between policymakers and practitioners in firms or scholars academia.

While a high degree of alignment is not a sufficient precondition of successful industrial policy, it would appear to be an essential precondition.

POLICY PRESCRIPTION

Pietrobelli and Puppato suggest that it is better for industrial strategy to be informed by foresights generated through a "synergistic" process in which policymakers are involved rather than via "a closed-circle of experts."

We argue that the system of technology foresight to allow the opinions of experts to be articulated separately, and without interference from policymakers.

The experts need to ensure their voices are heard distinctly and clearly.

SYSTEM DESIGN

When the expectations of experts and of policymakers are misaligned, there should be a mechanism to allow the experts to speak truth to power.

Such mechanisms should allow experts to sound the alarm and inform the public that the policymakers are ignoring the advice of the technical experts.

We already have such mechanisms for other types of forecasts (e.g., responsible budgeting), but not technological ones.

SYSTEM DESIGN

We want to ensure that misalignment of the type that undermined the Japanese photovoltaic sector in the late 2000s does not recur elsewhere.

Doing so will require the creation of high-quality *alignment mechanisms* for ensuring alignment of the type we have described.

Such a mechanism would discipline policymakers into basing their technological predictions on the views of qualified experts.

AN EXAMPLE OF HOW IT MIGHT WORK

Nations may wish to consider creating a semi-autonomous organisations that fact-checks policymakers' statements about the likely future of a given area of technology against view of the majority of technical experts as revealed by technical surveys.

Such an institution might perhaps be called the Office of Responsible Technological Forecasting (ORTF).

If a given policymaker's statement about the likely future estimate of a technology was misaligned with most experts' views, a designated agency might publish a statement noting the discrepancy.