http://ses.jrc.ec.europa.eu/smart-grid-cost-benefit-analysis

State, Markets, and Governance for Sustainable Energy transitions:
Smart Grid Developments in Japan and China

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The presentation contains research data which will be published soon.

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Part 1: Introduction and Background

Our research on smart grid policies

Themes:

governance for sustainable energy transition, social and policy perspectives

Research team:

- **BU, HKU, GIEC, Sciences Po, Stanford**
- **expertise: energy policies, smart grid technologies, deliberative public engagement**

Funding sources:

- Research Grant Council's Early Career Scheme, university internal grants
- In application: ANR/RGC grant

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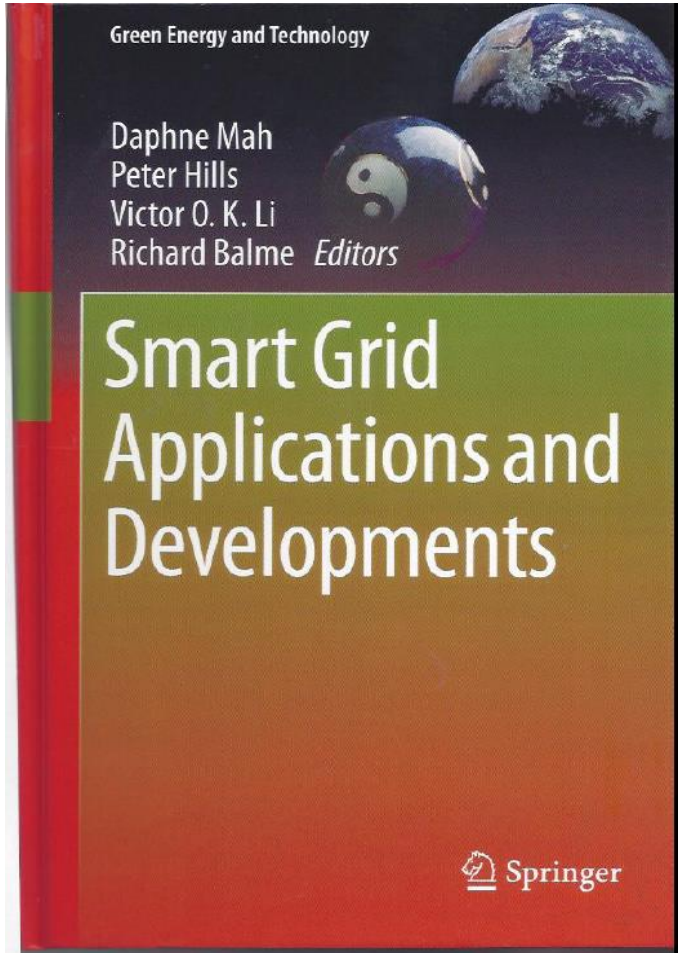
Our Research Outputs



Mah, D., van der Vleuten, J. M., Hills, P. and Tao, J. (2012). Consumer perceptions of smart grid development: Results of a **Hong Kong survey** and policy implications. *Energy Policy,* 49, 204-216.

Mah, D., van der Vleuten, J. M., Ip, J. and Hills, P. R. (2012). **Governing the transition of socio-technical systems**: a case study of the development of smart grids in **Korea**. *Energy Policy, 45*, 133-141.

Mah, D., Wu, Y., Ip, J. and Hills, P. R. (2013). The **role of the state** in sustainable energy transitions: A case study of large smart grid demonstration projects in **Japan**. *Energy Policy*. 63, 726-737

Mah, D. (2015), "The development of **smart grid business models**: A theoretical perspective and research agendas", Asian Energy Studies Centre's Working Paper No. 14, Hong Kong: Asian Energy Studies Centre, Hong Kong Baptist University.

	Japan	China
Basic characteristics (2014 data)	• GDP: US$4.601 trillion • Population: 127.1 million • Economy: **high-tech industrialised**	• GDP: US$10.360 trillion • Population: 1.364 billion • Economy**: rapidly industrialising**
Electricity sector	Total installed generation capacity (2012): 225.667 GW - Coal: 24%; gas: 47%; oil and other: 19%; hydro: 6%; nuclear: 2% **10 privately**-owned, vertically-integrated **incumbent** utilities	Total installed generation capacity (2014): 1360.19GW -Thermal: 67.32%; Hydro: 22.19%; Wind: 7.04%; Solar PV: 1.95%; Nuclear: 1.46% **2** major **state-owned incumbent** grid companies (geographically monopolised) and **5 major state-owned generation companies** (under competition)
Features of smart grid developments	•**Four large-scale city-level demonstration projects** in Yokohama City, Toyota City, Kyoto Prefecture and Kitakyushu City (2010-2014) •Big Japanese corporates e.g. Mitsubishi, Toshiba •Export oriented	• Building **super-grids** across China (super high voltage; high capacity - the concept of "building a Strong and Smart Grid" proposed by **SGCC**)

Sources: EIA (2015). China. http://www.eia.gov/beta/international/analysis.cfm?iso=CHN; http://www.env.go.jp/en/focus/docs/files/20140318-83.pdf; (CSG, 2015); The World Bank. (2015). GDP (current US$). http://data.worldbank.org/indicator/NY.GDP.MKTP.CD/countries; The World Bank (2015). Total Population (in number of people); http://data.worldbank.org/indicator/SP.POP.TOTL

Part 2. Our perspectives and methodology

- **Governance for sustainable energy transitions**, using the developments of **smart grids in Japan and China** as case studies.
- **Sociotechnical regimes**
- are relatively **stable configurations** of **institutions,** techniques, and artefacts, as well as **rules, practices and networks** that determine the "normal" development and use of technology (**technological lock-in**) (Smith et al., 2005)
- **State-market interactions**

Our central research question:

The extent to which, and how **modifying state-market relationships** may speed up and scale up **SG deployment**.

- **Methodology:** **qualitative**, in-depth face-to-face interviews in Japan and Ch.

Transitions of energy systems represent many governance challenges, because…

SG will be very different from what we have today…

	Today's Grid	Smart Grid
Smart Power Grid	**Centralised** –fossil-fuel/ nuclear based; big power plants	•More **decentralised** •e.g. more renewable •**New market entrants** (e.g. RE suppliers)
Smart Consumers	•**One-way communication** between utilities and consumers •Electricity is a passive purchase (limited choices) •Electricity bills delivered days after consumption actually occurs •No visibility into decisions they could be making regarding their energy consumption	•**Two-way real-time communication** between the **consumer and utility** •**Consumer** can actively participate and tailor their energy consumption based on individual preferences (price, environmental concerns, etc) •Demand responses •**Prosumers**
Smart Renewable	•Limited •Major problem: intermittency	•**RE** can become mainstream (e.g. wind - 20%) •Through e.g. Better wind forecasting + grid technologies + **regional collaboration**
Smart Transport	Limited integration with electricity	EV as electricity storage system
Smart Electricity Services	Limited; monopolies	**New business models** Many **service providers** – providing innovative solutions for energy, ancillary services, etc.

Part 3: Research Questions and Findings

Research question 1:
Do we have a uniform Asian model?

The answer: NO

In Japan and China, sociotechnical regimes have been evolving in very different ways in response to the new SG opportunities

Japan: a government-led, community-oriented, and business-driven approach

Kyoto Prefecture

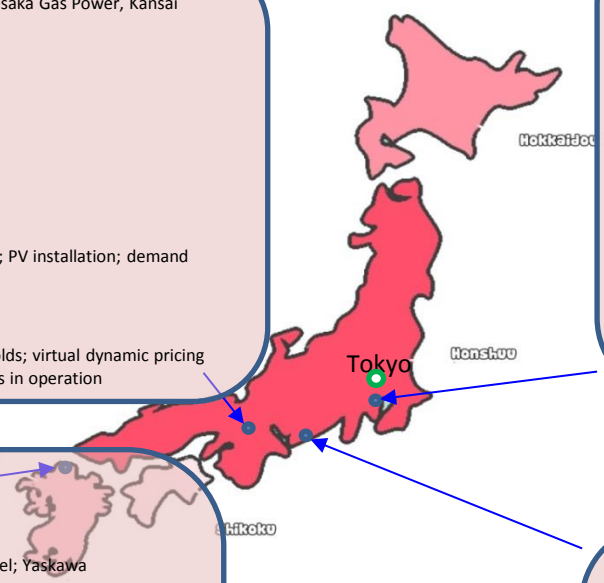
Key players
Kyoto Prefecture, Kansai Electric Power, Osaka Gas Power, Kansai Science City, Kyoto University

Pilot site feature
A newly developed city

Budget
13.57 billion yen

Characteristics of pilots
Energy management systems; EV charging; PV installation; demand response

Major achievements
Net metering implemented in 64 households; virtual dynamic pricing scheduled to be tested; 69 electric vehicles in operation



Yokohama City

Key players
City of Yokohama; Toshiba Corporation; Panasonic Corporation; Tokyo Electric Power Company; Tokyo Gas Co., Ltd.

Pilot site feature
A well-developed metropolitan city

Budget
74 billion yen

Characteristics of pilots
Energy management systems; large scale introduction of renewable energy; lifestyle reforms

Major achievements
Installation of HEMS and PV-HEMS saved 20% electricity

Kitakyushu City

Key players
Kitakyushu City, Fuji Electric , GE, IBM , Nippon Steel; Yaskawa

Pilot site feature
An industrial city with a local steel company (Nippol Steel) as a major company

Budget
16.33 billion yen

Characteristics of pilots
Energy management system; real-time pricing; a decentralised energy system (a local steel company, Nippol Steel, as an electricity producer)

Major achievements

Dynamic pricing implemented in 50 corporations and 230 households, which saved 26.4% electricity at most; 7 corporations installed with smart meters.

Toyota City

Key players:
Toyota City. Toyota, Chubu Electric , Toho Gas, Toshiba, Mitsubishi Heavy, Sharp, Fujitsu

Pilot site feature:
An industrial city

Budget:
22.7 billion yen

Characteristics of pilots
Energy management systems; demand response with 70 homes

Major achievements:
29 of the 67 newly built smart houses were sold with 22 families moved in; demand response carried out in 69 households which saved 30% electricity at most.

Four large-scale city-level demonstration projects

(Mah et al., 2013)

China: an incumbent-led model

Features:

1.Central Government:

- A loose SG policy framework; absence of a SG-specific national policy
- A set of energy-related targets and plans;
- a large number of SG-related policies, pilot zones and projects (esp for solar)

2.Two state-owned incumbent grid companies:

- State-owned - ***political motivated as well as profit driven***
- SGCC in particular has been the SG **pioneer**
- Develop and implement **SG plans; invest, operate**, and manage the grids (which are getting smarter) and the **pilots**
- **Set standards**

RQ 2: *What kinds* of state-market configuration work *in which context*?

	Japan	China
Roles of government	***METI; heavy public expenditure*** – US$1.4 billion budget (2/3) for the four demonstration projects.	**Central Government:** A loose SG policy framework; but a large number of SG-related policies, pilot zones and projects (esp for solar)
Roles of incumbents	• **Toyota, Mitsubishi, Sharp, Toshiba, Fujitsu, Panasonic, NEC, Nissan Motor** (Business sector) • 10 privately owned, vertically-integrated **incumbent utilities**: (smart meter installations)	•Two grid companies
Roles of new market players	**Increasingly active** [e.g. real estate developers]	Emerging; but still very limited [solar households]
Electricity market structure	Partially liberalised: since 1995; 10 privately-owned, vertically-integrated incumbent utilities; retail liberalisation has been introduced to all but excluding household users. Tariff: flat-rate (?)	Partially liberalised: Tariff: block-rate + TOU
Political system/ Central-local relations	METI's Smart Community Policy Office+ **Project Facilitation Committee (in pilots)**	**Local implementation of national policies – vary**
Contextual factors	**Historical strengths of R&D capacity** in hybrid cars, batteries for cars: e.g. Toyota; lack of indigenous energy resources except renewable	e.g. Institutional endowments

Illustrative example: China
- Role of new market players

1. **SGCC-led SG deployment – focuses on "Super-grids"**

2. **Limited DE development**: **3%** of the national installed capacity

3. **New market participants have remained in minor roles**

– Solar PV householders

– Integrated partners who can oversee the design, engineering, and construction of these DE projects?

Solar PV Householders

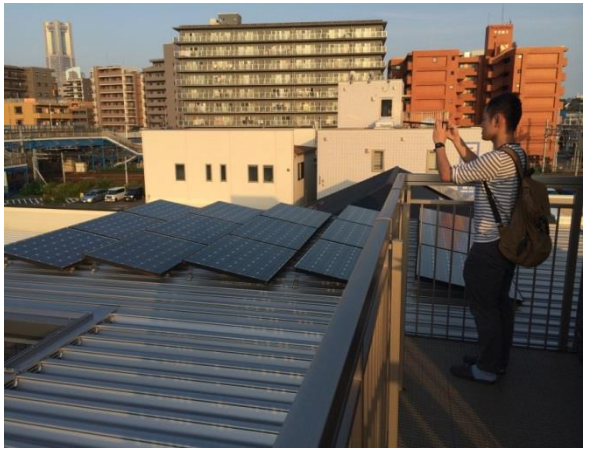
国家电网公司 STATE GRID CORPORATION OF CHINA

about **7000** households out of the **1.1 billion** end-users have produced grid-connected solar PV (2.65 GW)

中国南方电网 CHINA SOUTHERN POWER GRID

less than **100** end-users out of the more than **30 million** end-users of CSG were involved in DPV projects

Illustrative Example: Japan
Developers as new market actors in emerging business models

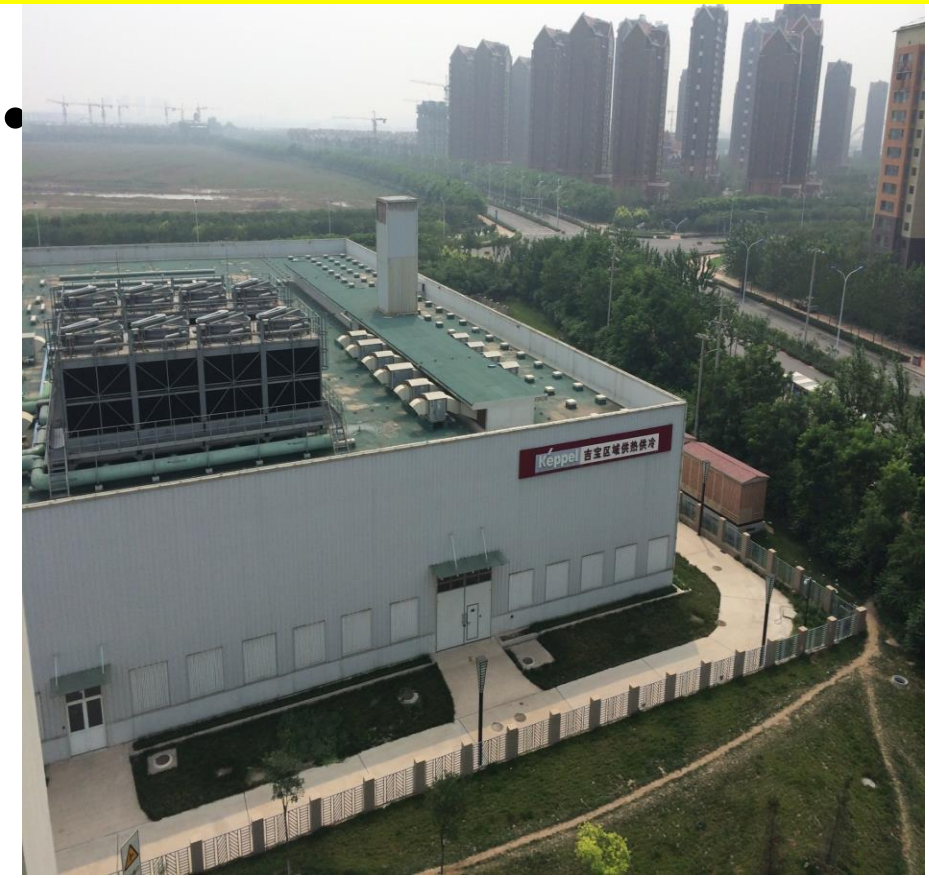


A smart home in Yokohama

RQ3: *Where* do these state-market configurations *matter*, *how* state and market interact, and *with what effects*?

	Japan	China
Market building (new players; new energy technology, products and services)	**Medium:** • **Large-scale** demonstration projects • Competition among technologies: e.g. an **annual fund bidding** system	**Low: Two grid companies**: lack of competition; disincentives to DE; Utilities not taking up much new role as **distributed system platform providers**
Market regulation	**Medium/ low (?):** (e.g. new rules to rectify utilities' disincentives) ??	**Low:** New market players – are they eligible? [Tianjin]
"managing public goods" - Industry standard setting , regulating privacy issues, basic R&D (public goods)	**Govt is active:** METI's "International Standardisation **Road map** for SG" ; "**Working Group** on International Standardisation of Smart Grid"	**Slow progresses**: Grid companies – major role in standardisation; but slow and insufficient
Networks/ Partnership	**Extensive and intensive** • **Govt: steering and coordinating** roles • Partnership: 1/3 budget of four pilots comes from private sector; Resource consolidation	**Spare external networks**: grid companies – through in-house expertise and their own subsidiaries - Low level of resources pooling
Business model innovation	**Medium:** **Government policies (solar) + business innovation** [e.g. real estate developers; Toshiba]	**Low:** - Grid companies lack new expertise, knowledge
Policy learning	**High/medium** • Demonstration projects - a process of socio-	**Low: grid companies - dominating** expertise, technologies, and

Illustrative example: China
- new market players emerging; but are they eligible to play?

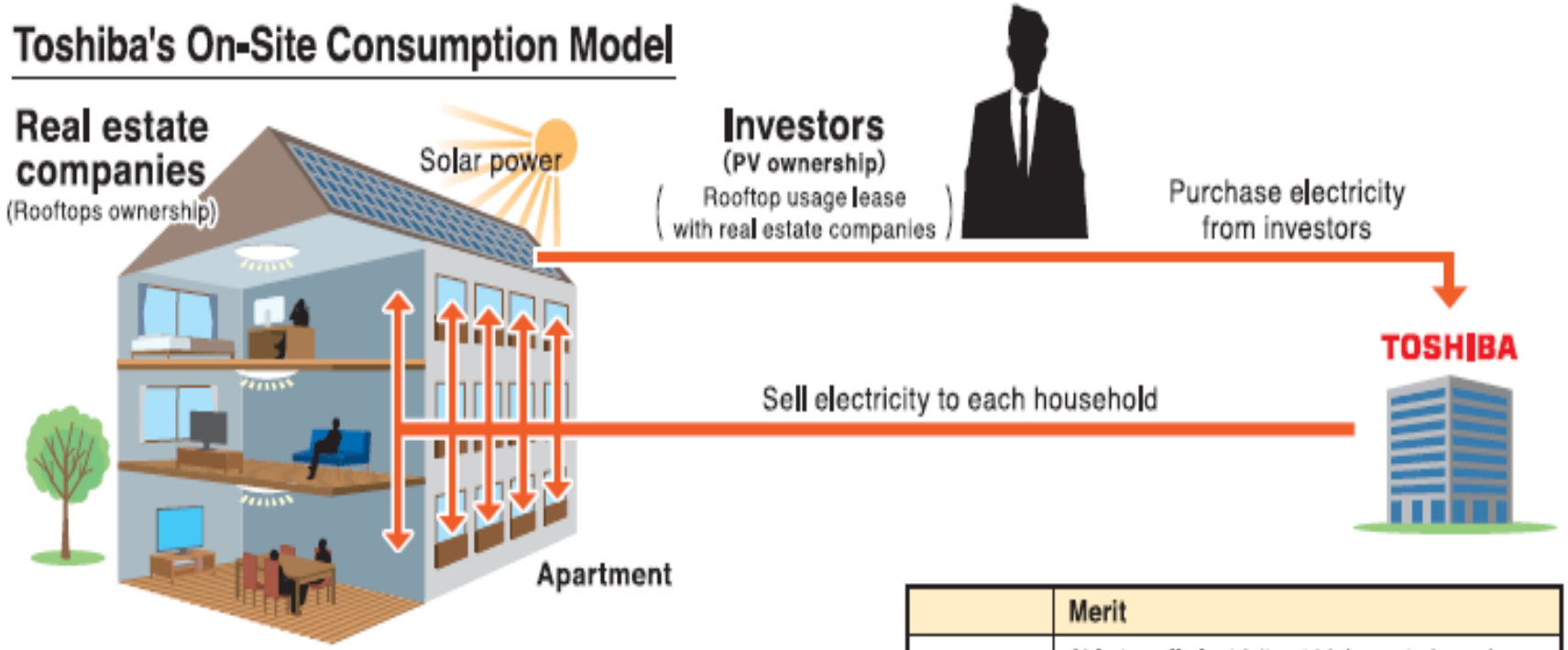


Current status: An energy services company has already provided water, gas, and heat for the Sino-Tianjin eco-city and invested in a solar project.

Prospect: this company may serve also as a professional **third-party**, helping prosumers (households or other endusers who also produce RE) to **sell electricity to grid companies**

Challenge: **lack of regulatory support** – are they **eligible** to sell electricity in China?

Illustrative example: Japan
- Toshiba is moving into SG businesses



For regions that have achieved grid parity, the benefit is that electricity produced from solar power is available at lower rate for use, instead of having to purchase from electric companies which are more costly. Toshiba is proposing the self-consumption model as an electric retail business solution to investors, real estate companies and each residents, for regions that have achieved grid parity.

	Merit
Investors	Able to sell electricity at higher rate based on FIT pricing.
Residents	Able to purchase electricity at lower rate compared to electric companies.
Real estate companies	Able to attract residents by promoting benefits such as lower electricity rate and an environmental friendly image.

http://www.toshiba.co.jp/sis/en/solar/pdf/catalog01_en.pdf

A customer service centre of Toshiba, Tokyo

Installing rooftop solar PV is as **convenient** and as **simple** as buying your electric appliances??

- Toshiba's Solar assessment service

Illustrative example: Japan
– the four pilots as a process of socio-technical learning

National Policy Unit
(directly under the Prime Minister)

↓

Policy-making Meetings of
Innovative Strategy for Energy and Environment
(members: vice-ministers or above)

↓

Agency for Natural Resources and Energy
(under METI)

Feedback from business sector

Administrative departments

- Minister's Secretariat
- Policy Planning and Coordination Division, International Division
- Energy Saving, New Energy
- Electricity, Gas

Scrutinising and Deliberation Committees
(Investigation and advisory)

- Advisory Committee for Natural Resources and Energy, Fundamental Issues Subcommittee

Research committees

- Next generation energy and social system
- Business model strategy
- Tariff

Independent studies

Expert advice

Pilot results

Project Facilitation Committees
- Local governments
- Corporations
- Research institutes

Annual review conferences for SG demonstration projects

Policy evaluation

(Mah et al., 2013)

Conclusions

1. In Japan and China, **different socio-technical regimes** have emerged to deal with different interactions between state and market.

2. We specify the state-market relationships: "**where**" these state-market interactions matter; "**who**" is responsive to the new opportunities

3. No "Asian Model"; but some important tendencies:

- **Strong governments** - high state capacity in steering, mobilising; But **weak** in regulatory capacity
- **State-owned utilities/ Incumbents** – "incumbent **advantages**", but they may also be the **barriers**.

4. Better ideas about: where the state has to expand (steering, mobilising, enabling, AND ***REGULATING***…), where to shrink (e.g. China – leaving standardisation to industrial associations)