Reforming Japan's Power Industry

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Outline

- Outline of the talk

  1) Brief introduction of Japan's electricity industry

  2) Key issues for reforming Japan's electricity industry

  3) Smart grid and dynamic pricing experiments in Japan

Four key points to understand Japan's electricity industry

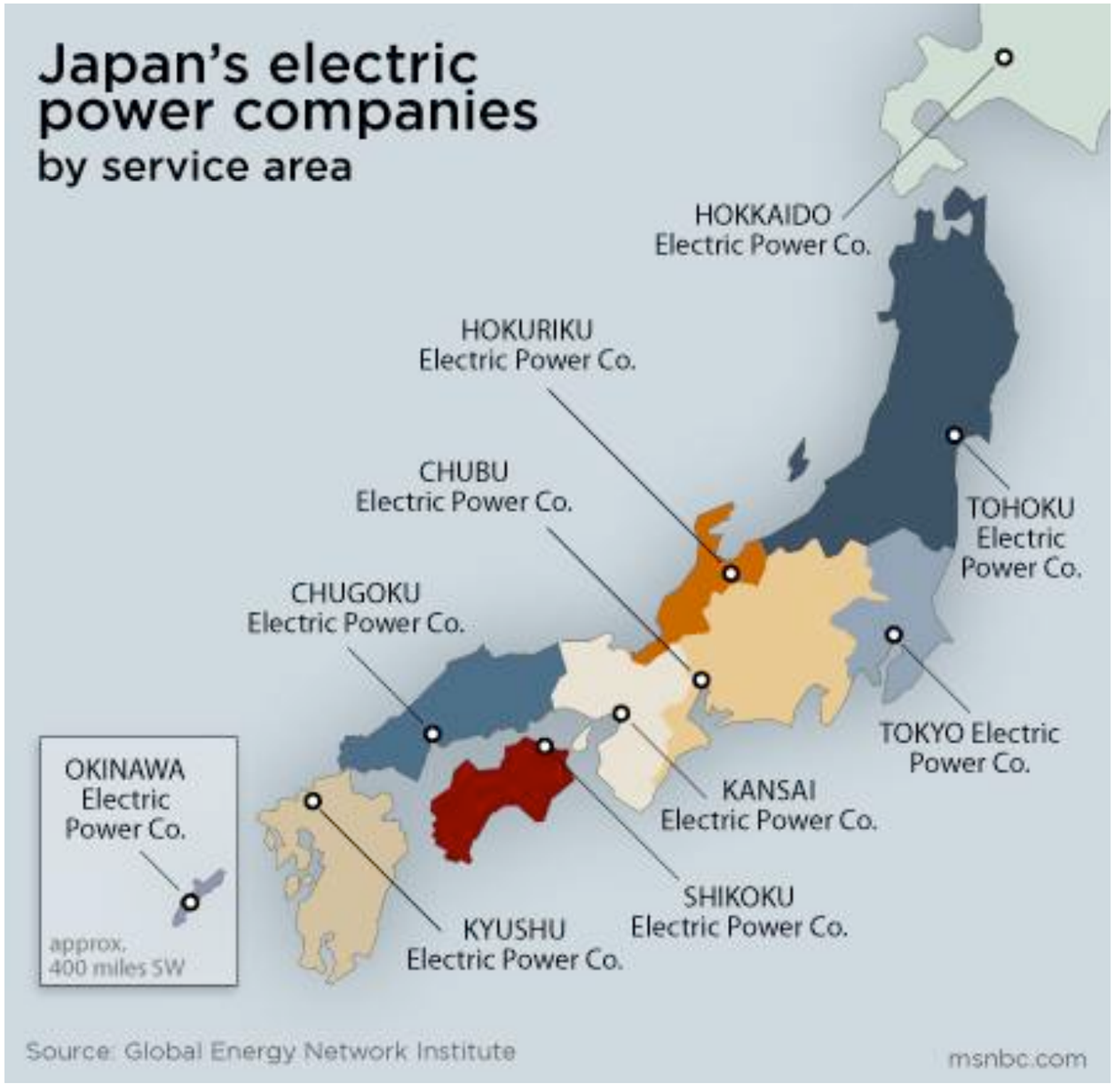
1) Regulated regional monopoly

2) Vertical integration

3) Partial deregulation since 1990's

4) Adequate & stable supply until 3/11 and few demand response policies

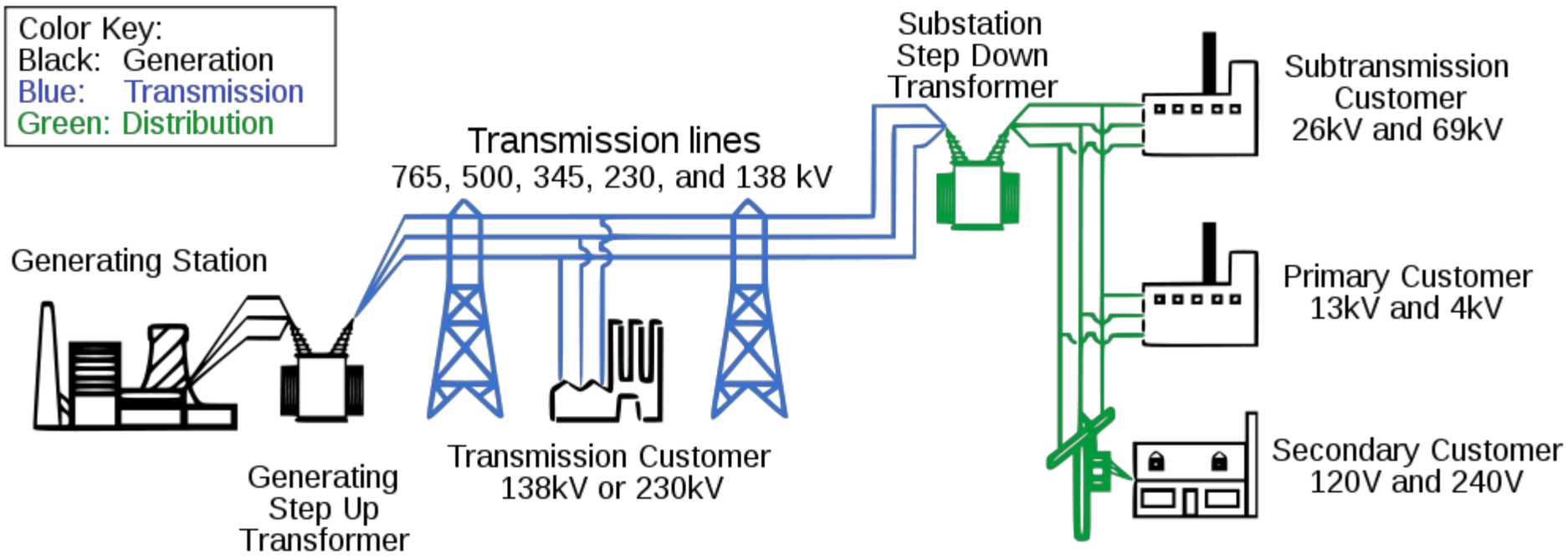
1) Regulated regional monopoly - 10 regional electric utilities



Source: msnbc.com

- Partial deregulation in 1990's
- But each region is still almost entirely covered by a regulated monopolist

2) Vertical integration - the electricity industry is not yet "unbundled"



Vertical integration

- Generation
- Transmission
- Distribution
- Retailing

Source: http://www.chem.ucla.edu/C125/Week1-1.html

- Before 1990's: Vertical integration in most countries
- After 1990's : Transmission and distribution were unbundled in many counties
- In Japan, transmission and distribution were not yet unbundled
- Regional monopolists own and operate the four parts almost entirely

3) Partial deregulation since 1990's

- Three main phases of deregulation (1995, 2000, and 2003)
- Main policy objective: lower electricity price
- Outcome:
  - Partial deregulation in generation (1995) and retailing (2000)
  - Failed to unbundle transmission and distribution (2003) for a few reasons
    - Opposition from power companies
    - Lack of political leadership
    - Critiques for the California electricity crisis

4) Adequate & stable supply and few demand response policies

- Adequate and stable supply until 3/11
- Annual average hours of blackouts per customer in 2007:

Japan	US	UK	Germany	France	Korea
16	292	75.7	19.3	61.6	17.2

Source: Japanese Agency for Natural Resource and Energy (2011)

- Higher electricity prices: cents per kWh (source: EIA 2008)

	Japan	US
Industrial	11.6	7
Residential	20.6	11.6

- Regional utilities build their capacity to meet any levels of max demand
- Customers have enjoyed the stable supply in exchange for the high price
- Few “demand response” policies to shift peak demand to off-peak

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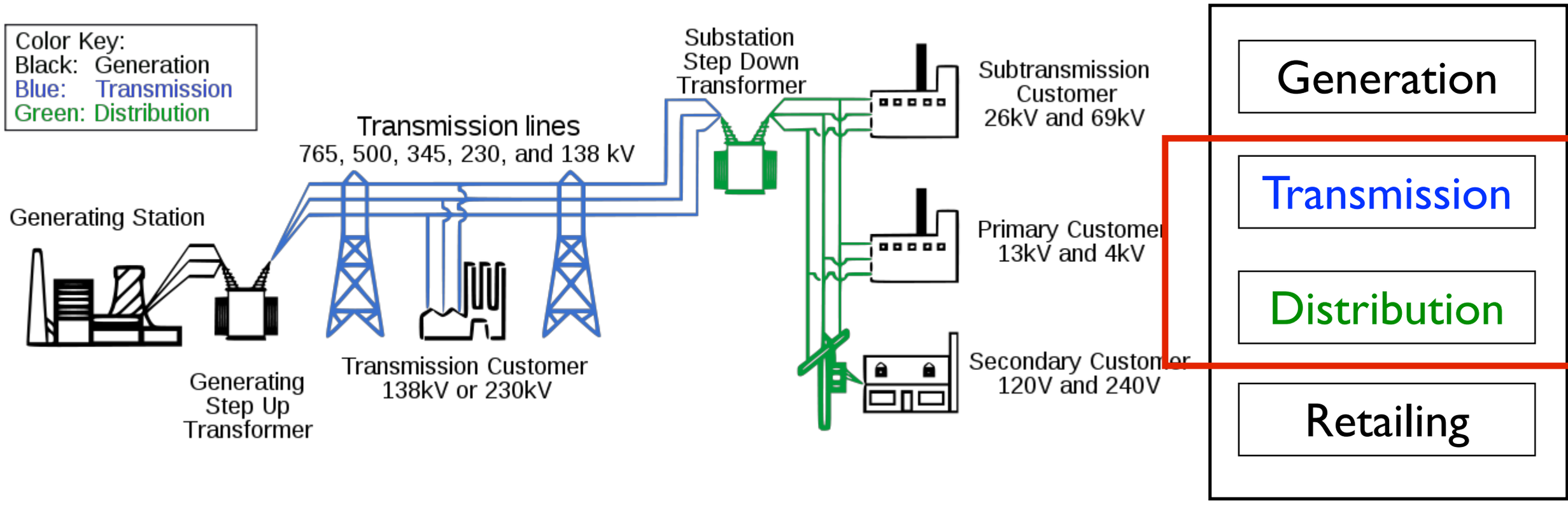
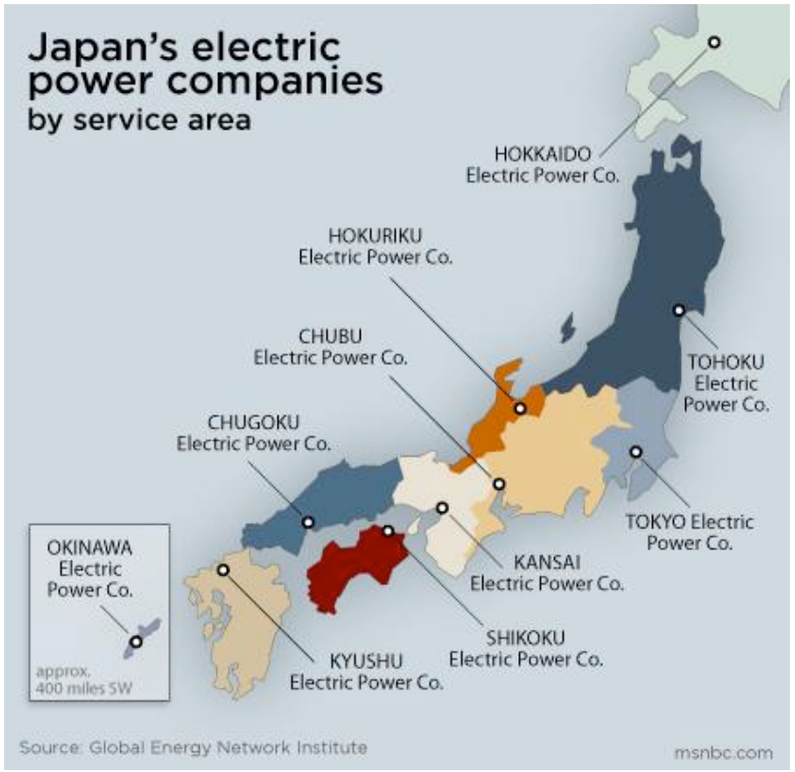
a) How to unbundle transmission and distribution?



- Unbundling is necessary to open the electricity market for new entrants
- After unbundling, who should 1) own and 2) operate the system?

b) How to restructure the regional electric utilities?



- Inter-regional transactions are low (5.2% in 2008) despite the deregulation
- Regional utilities have not invested much on the inter-regional transmission
- This under-investment was a reason for the limited flexibility in transmission right after 3/11, which caused rolling blackouts in Tokyo
- The central problem is, the wholesale and retail markets are still far from competitive despite the deregulation since 1990's

c) How to make the wholesale and retail markets more competitive?

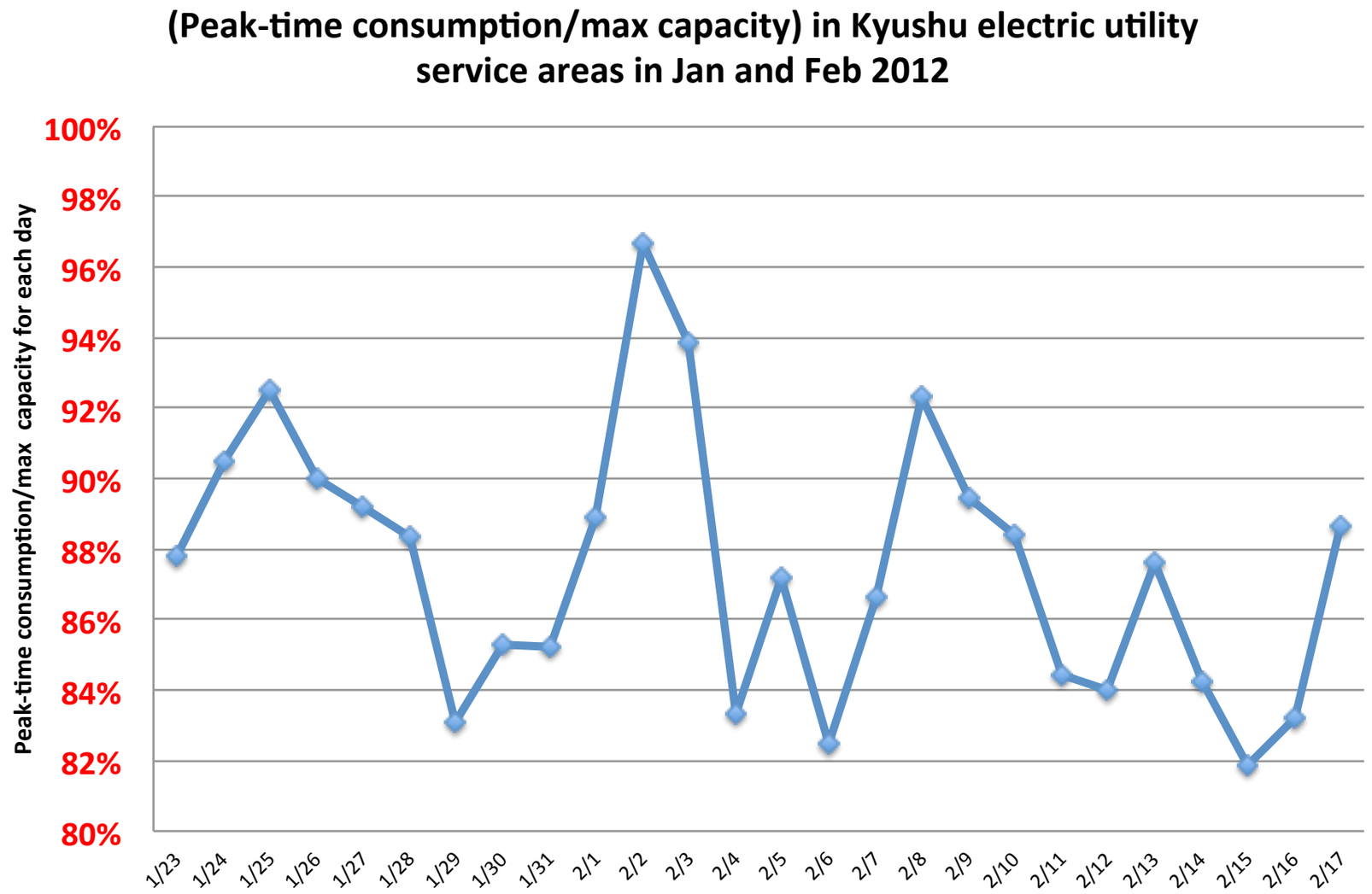
Is the wholesale market competitive now?

- Regional utility companies still generate over 70% of total power in Japan
- The deregulation (1995) allowed IPP (independent power producer) to enter
- However, their share is still very small
- Also, most transactions are bilateral long-run contracts with regional utilities
- Transactions in the wholesale market (JEPX) is less than 1% of total volume

Is the retail market competitive now?

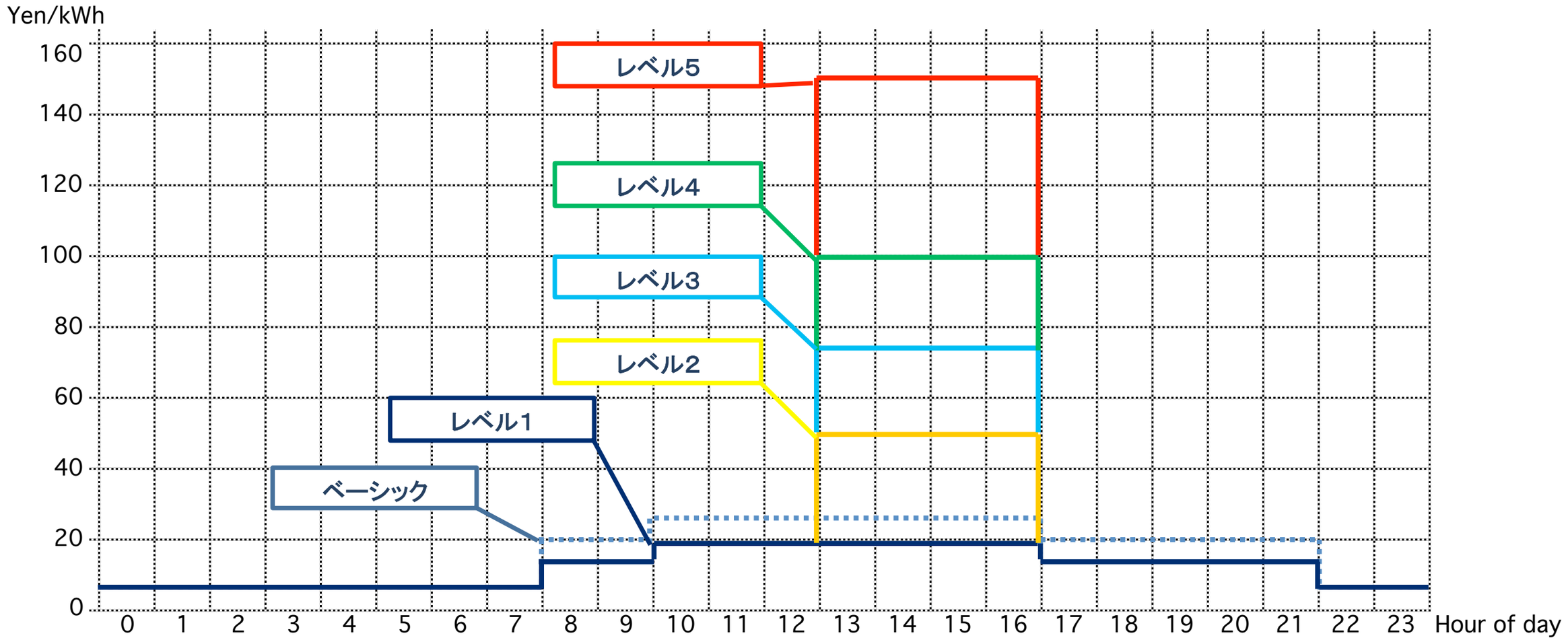
- 63% of the retail markets are now deregulated
- The deregulation (2000) allowed PPS (Power producer and Supplier) to enter
- However, their share of the market is about 2%

d) How to take advantage of "smart grid" technology?



- Peak time demand is reaching near the max capacity level this winter
- Need to shift peak time demand to off-peak
- Better to use market mechanisms rather than rationing

d) How to take advantage of “smart grid” technology?



- Among other things, smart grid and smart meter technology can be used to:

  1) Allow customers to have dynamic (time-varying) pricing

  2) Allow customers to access real-time price and usage information

  3) Make the most use of EV and plug-in hybrid vehicles as “storage”

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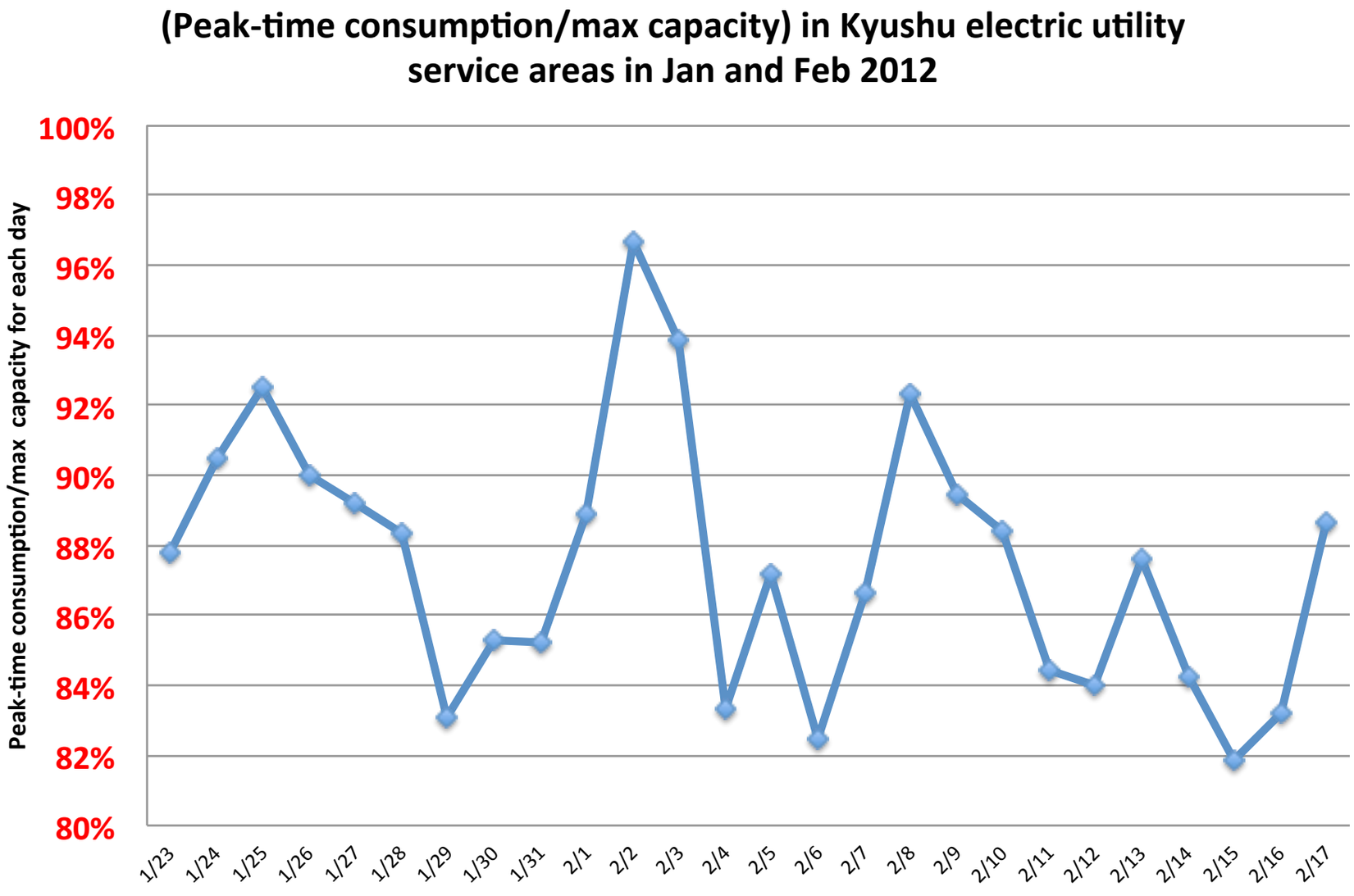
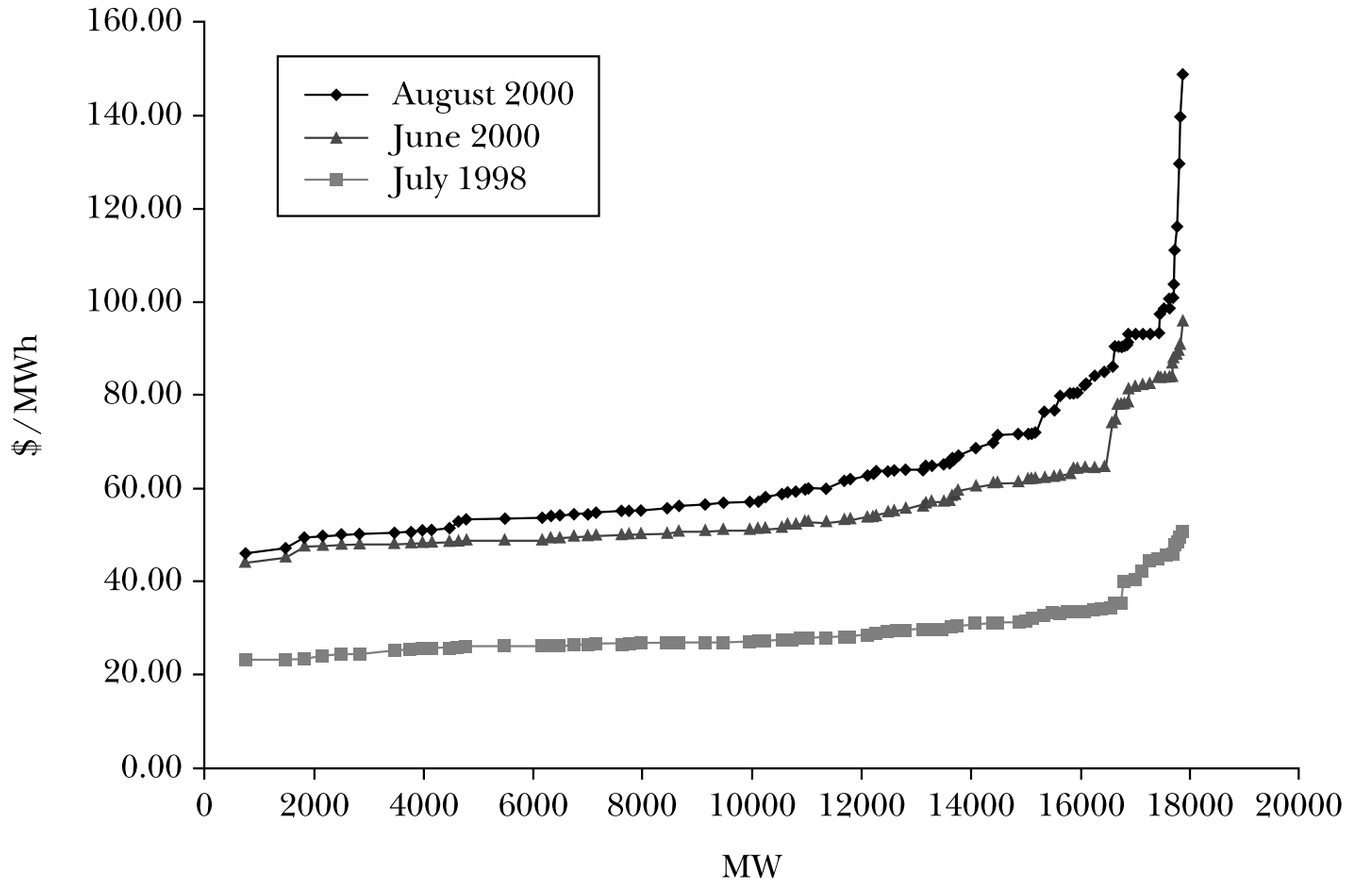
Peak time demand is reaching near the maximum capacity level



- Reasons:
  - Not only Fukushima but also other nuclear power plants were stopped
  - Cold wether hit many areas in Japan this winter

Generally, the cost of electricity is very high at the peak demand periods



- Example: the marginal cost curve of thermal plants in CA (Borenstein 2002)
- Expensive power plants have to be run at the peak time
- The social cost would be even larger (e.g. blackouts) if demand exceeds supply
- However, usually, electricity prices do not reflect these costs:
    - Most customers do NOT pay "time-varying" electricity prices

Usually, these peak demand periods are limited hours per year

Figure 2-7 PJM real-time load duration curves: Calendar years 2005 to 2009

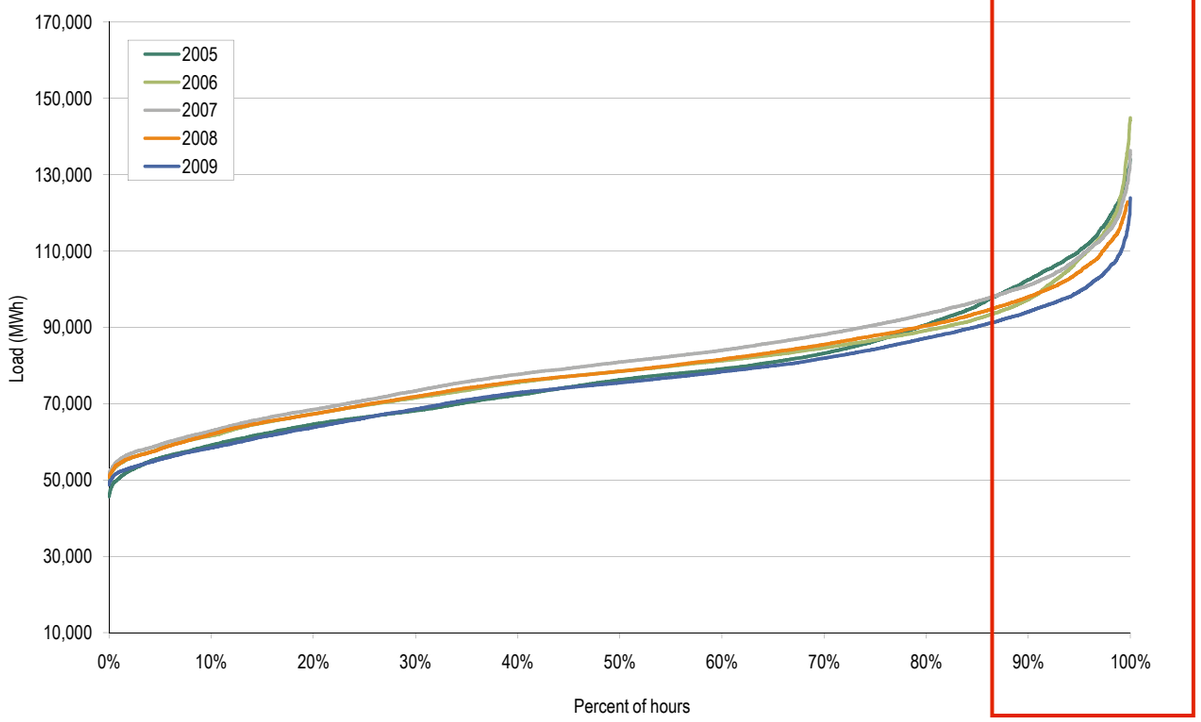
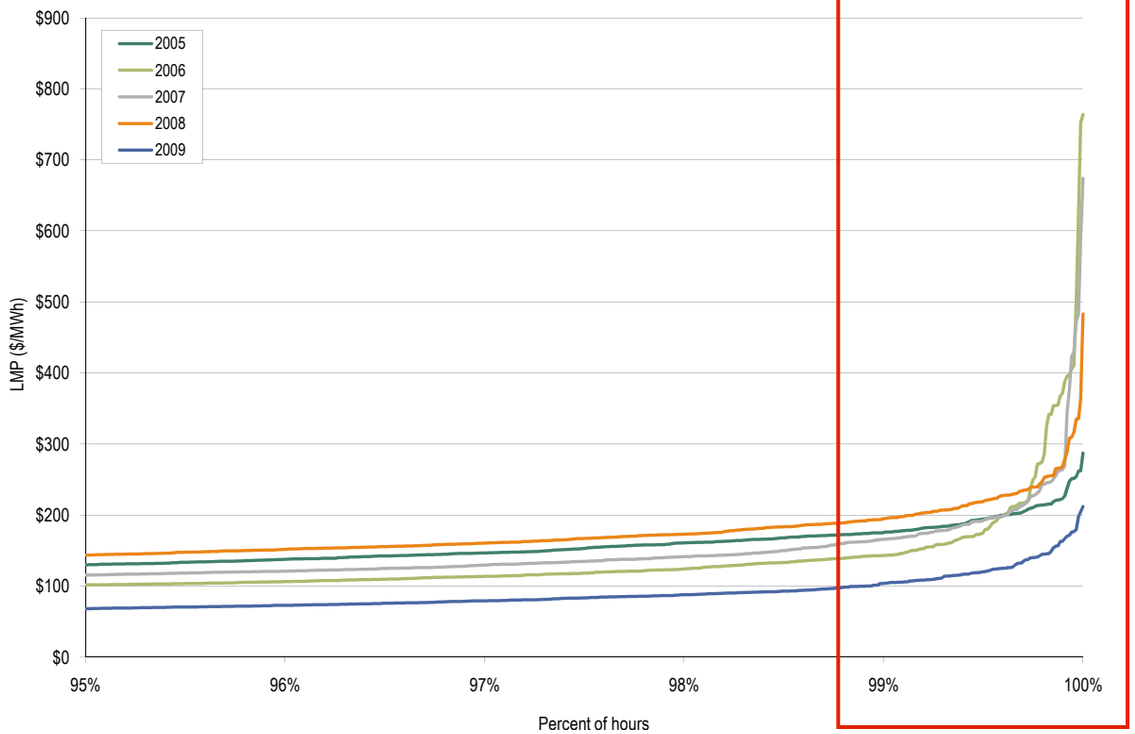


Figure 2-13 Price duration curves for the PJM Real-Time Energy Market during hours above the 9
Calendar years 2005 to 2009

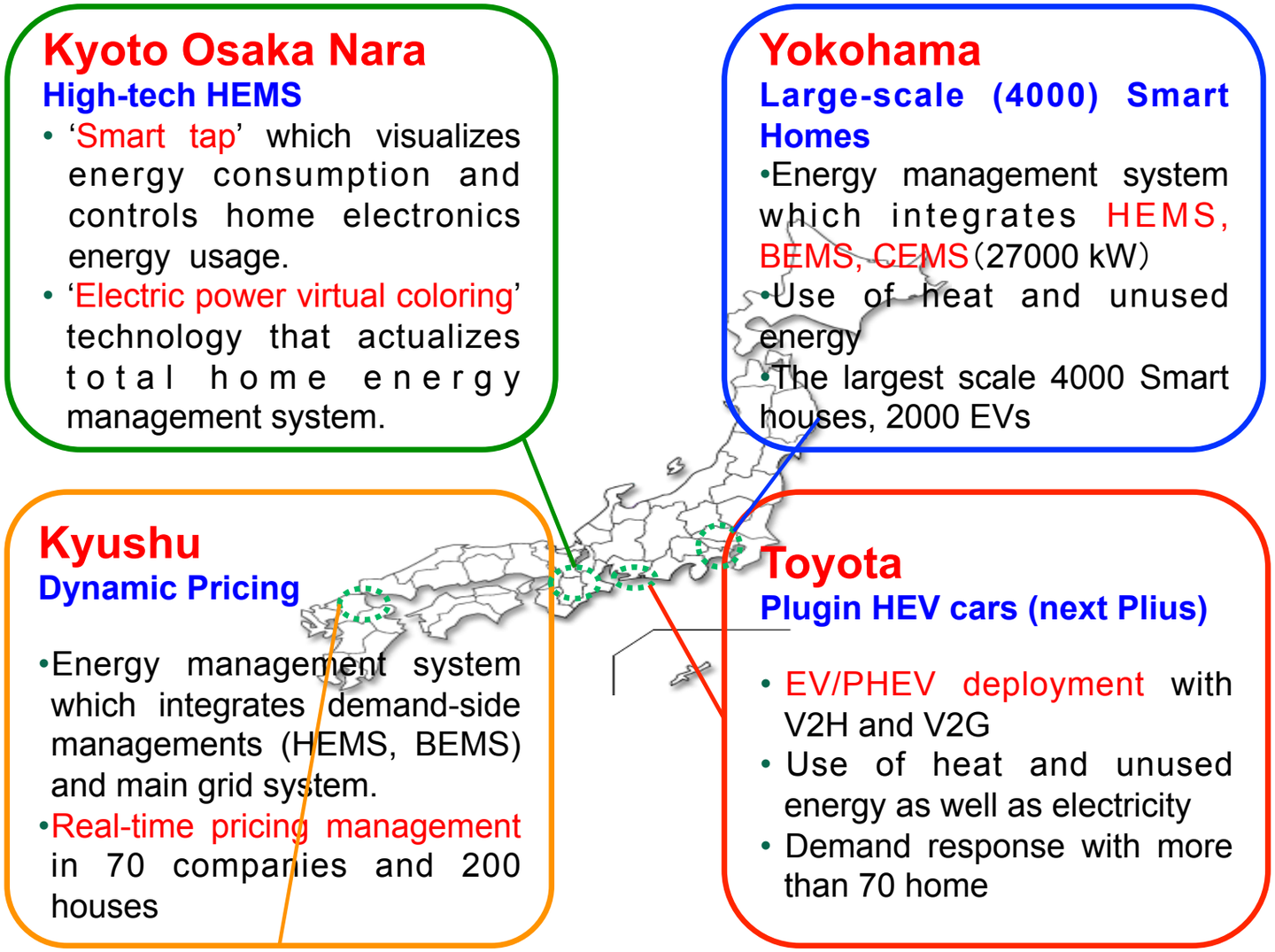


- Load duration curve (left) and wholesale price duration curve (right) in PJM
- Peak demand periods are limited hours per year
- Thus, wholesale electricity prices are very high only at limited hours per year
- Large economic gains just by shifting this peak demand to off-peak

Dynamic (time-varying) pricing can be used to mitigate the problem

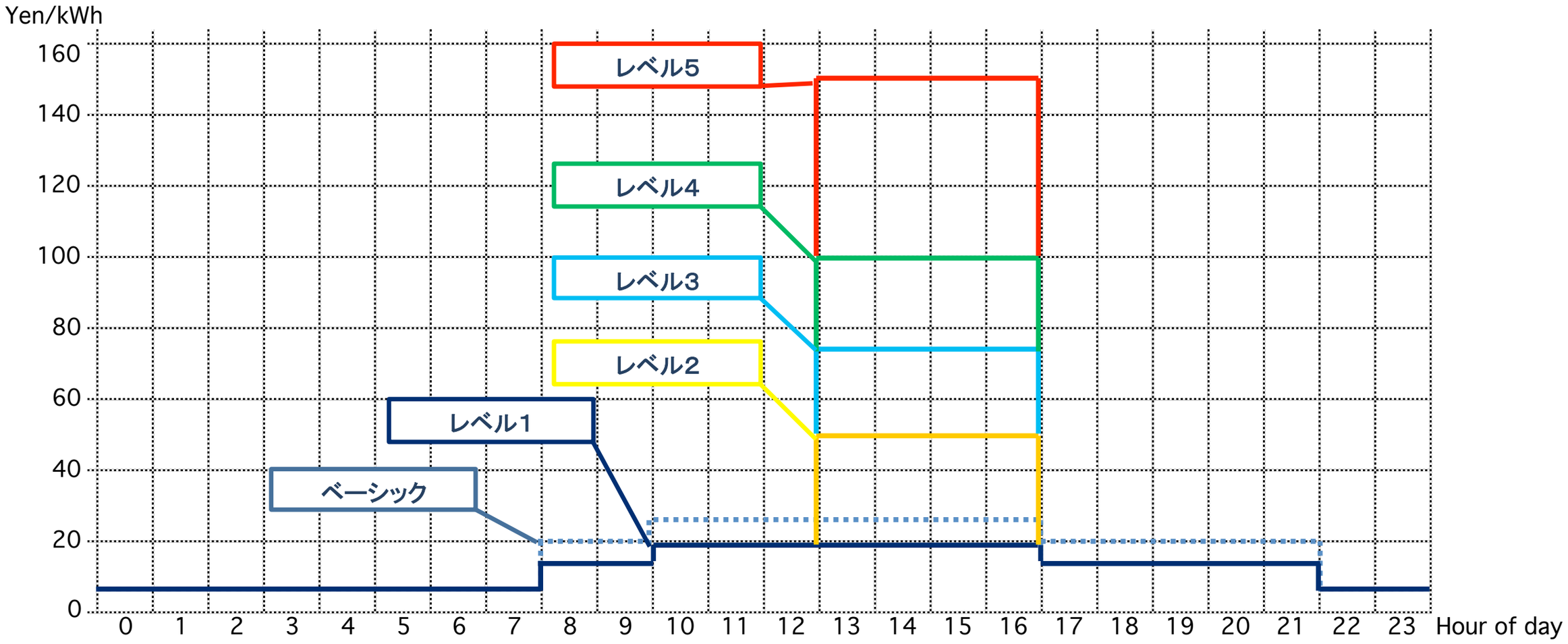
- Basic idea:
  - Set high prices only for the peak demand hours for "emergency days"
  - Lower off-peak prices
  - Customers get larger incentives to shift their peak time consumption
  - No technological barriers now with smart meters
- Several experiments in the US
  - Frank Wolak (2011) - Field experiment in D.C.
  - Finds significant peak demand reductions by dynamic pricing

Smart grid and dynamic pricing experiments in four locations in Japan



- Sponsored by the government and partnered with companies and academics
  - Current main target: residential customers
  - Different "treatments" in the four locations
  - Customers are randomly assigned to different treatment groups

Example of the price schedule for residential customers



- Critical peak pricing (CPP) with variable peak prices
  - Customers get “day-ahead” notice about the peak price for tomorrow
  - Peak hours for summer (1pm to 5pm)
  - High peak prices are announced when temperature exceeds a “cutoff” level
  - Customers get notified by phone, email, and through their information device

Treatments to be examined in addition to dynamic pricing

- Information devices integrated with HEMS (Home Energy Management System)
  - In-home display
  - Smart phone with a smart energy application
- Automated demand response (ADR) technology
  - Electric appliances with ADR in response to time-varying electricity prices
- Electric and plug-in hybrid vehicles
  - Long-time lease for free for some customers
  - EV and PHV can be potentially used as “storage”

Goals of the experiments:

- Examine what is possible with smart grid and smart meter technologies
- Create a platform for firms to explore new business opportunities