Reforming Japan’s Electricity System for Distributed Generations

Hiroshi TAKAHASHI, Ph.D.
Research Fellow, Fujitsu Research Institute
Evolution of Electricity Systems

Network-driven System
- Monopoly
  - Vertically integrated System
    - Limited grid access
  - Liberalized System
    - Wholesale competition: merit order
  - Smarter network System
    - TSO merger
    - Smarter grid: battery
    - Grid unbundling: Fair grid access
  - Wider/open network
    - Renewables: priority grid access
    - Wide-area system operation
    - Market competition
    - Fit: compulsory purchasing
    - Market coupling
    - Capacity market
    - Demand response
- Region-based/closed network
  - Limited grid access
  - Region-based/closed network
- Limited grid access
  - Region-based/closed network

Copyright 2014 FUJITSU RESEARCH INSTITUTE
Learning from Japan’s Rolling Blackout

Causes of Large-scale Rolling Blackout in March 2011

1. Heavy dependence on large-scale centralized generations
   ⇒ need more distributed generations: fair grid access

2. Limited interregional power flow
   ⇒ need a mechanism of wide-area system operation
   ⇒ need larger capacity of interregional grid

3. Limited use of price mechanism
   ⇒ need competitive market
   ⇒ need a smarter mechanism of demand response
Flowchart of Electricity System Reform

- **Retail**: Revision in 2014
- **Transmission**: Revised Electricity Business Law
- **Generation**: Revised in 2013

**FY2013 - FY2020**

- **FY2013**: Independent regulator
- **FY2014**: Revision in 2013
- **FY2015**: Full market liberalization
- **FY2016**: Wide-area System Operator
- **FY2017**: One-hour ahead market
- **FY2018**: Abolishment of wholesale generation regulation
- **FY2019**: Legal unbundling
- **FY2020**: Real-time balancing market

- **Abolishment of tariff regulation**

**Revision in 2014**

- **Abolishment of wholesale generation regulation**
Limited Power Flow across Regions

- 9 Utilities and Inter-regional Grid -

Area
Peak Load in 2010

<table>
<thead>
<tr>
<th>Region</th>
<th>Peak Load in 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hokkaido</td>
<td>5,790MW</td>
</tr>
<tr>
<td>Tohoku</td>
<td>15,570MW</td>
</tr>
<tr>
<td>Tokyo</td>
<td>59,990MW</td>
</tr>
<tr>
<td>Chubu</td>
<td>27,090MW</td>
</tr>
<tr>
<td>Chugoku</td>
<td>12,010MW</td>
</tr>
<tr>
<td>Shikoku</td>
<td>5,970MW</td>
</tr>
<tr>
<td>Kansai</td>
<td>30,950MW</td>
</tr>
<tr>
<td>Kyushu</td>
<td>17,500MW</td>
</tr>
<tr>
<td>Hokuriku</td>
<td>5,730MW</td>
</tr>
</tbody>
</table>

60Hz 600MW
50Hz 300MW

DC line
AC line
Purposes of Grid Unbundling

- **ownership bundled**
  - Vertical Integration (Japan)
  - ITO (France)
  - ISO (California)

- **operation independent**
  - TSO (UK, Nordic, Spain)

- **wider area**
  - RTO (PJM)

Japan’s Future?
Neutral + Wide-area System Operation

**Present: Vertical Integration**

- Generation >> Transmission >> Retail
- Generation >> Transmission >> Retail
- Generation >> Transmission >> Retail
- Generation >> Transmission >> Retail

**Post-unbundling**

- Generation >> Transmission >> Retail
- Generation >> Transmission >> Retail
- Generation >> Transmission >> Retail
- Generation >> Transmission >> Retail

OCTO: Organization for Nationwide Coordination of Transmission Operators
Design of Power Market

Japan: Vertically Integrated System

Spot Market (day-ahead)

Long-term bilateral contract

Supply obligation of utilities

kWh Market

kW Market
Design of Power Market

Post-reform: Smarter System

- Futures Market
- Spot Market (day-ahead)
- Capacity Market
- Balancing Market (real-time)

- kW Market
- kWh Market

- Demand Response
- Pumped Hydro
Proposals for the Successful Reform

- **OCTO**
  - Higher authority for interregional operation and grid expansion
  - Neutrality of personnel

- **Legal Unbundling**
  - Stricter behavioral regulation
  - Accelerated implementation
  - Transition to ownership unbundling

- **Design of Power Market**
  - Compulsory tendering of surplus capacity
  - Partial divestiture of generation capacity
  - Introduction of capacity market

- **Independent Regulator**
  - Higher neutrality and specialty
  - Higher authority to promote competition