TEPCO Initiatives to Integrate Renewable Energy Resources into the Electricity Market

Hiroshi Okamoto, Ph.D.
Managing Executive Officer
Tokyo Electric Power Company
1. Electricity Market Reform in Japan and TEPCO’s Activities
2. Challenges for Integrating Renewable Energy into the Electricity Market
3. Subjects to be Addressed and Our Perspective
Electric power system is a market place platform which matches consumptions and generations of electricity via electric power network.
Restructuring of Corporate Structure of TEPCO

As of April 1\textsuperscript{st} 2016

- TEPCO Holdings
- TEPCO Fuel and Power Co.
- TEPCO Power Grid Co.
- TEPCO Energy Partner Co.
Balancing Mechanism after the Market Reform

**Generation**

**Energy Transaction every 30 min**

**Bilateral / Spot Market**

**Retail**

**Power Pool of TEPCO Control Area**

Operator of Power Pool Responsible for Balancing and Congestion Management

TEPCO Power Grid

Adjustment
Strengthening the Energy Value Chain

- **Generation**
- **T&D**
- **Distributed Generation**
- **Customer**

- **Streamlining and Optimization of the Assets and Operation**
- **Growth in Low Carbon Assets**
- **Consolidation of Upstream**
- **Overseas Business**

- **Energy Efficiency, Energy Management O&M and Finance**
- **Innovative Services for Productivity Combined with IoT**
- **Flexibility for Balancing and Optimization**

Integrated Grid Platform
Three Issues of Renewables Integration into the Market

1. Flexibility Resource to Accommodate Variable Renewables
2. T&D Network Capacity Enhancement and Congestion Management
3. Economy of Renewables
Pumped hydro can store/generate the electricity to minimize the gap between renewable energy output and demand.

Pumped hydro is one of the major flexibility resources to integrate more renewables in Japan.

Pumped Hydro Power Storage for Flexibility Enhancement
Advanced Technologies Needed for Flexibility Enhancement
(National Project funded by NEDO)

Control Area A
- Forecast & Estimation
- Control
- Online Telemetries, Regulation Signals
- Generation Resources
  - utilization of the pumping storages
  - enhancing the flexibility of control of thermal power generators

Control Area B
- Forecast & Estimation
- Control

OCCTO*
Organization for Cross-area Coordination of Transmission Operators

RES
Renewable Energy Sources

D-1, 15～30min ahead, or real-time reduction

Variable Output

- RES energy output (MWh)
- fluctuation characteristics (long/short time horizon)

On-line and Real-time Control

Wide-Area coordination

Control

DR Resources
- Smart Meter
- Battery • EV
- HP, etc

demand side

generation side

Central Load Dispatching Office

*organization for Cross-area Coordination of Transmission Operators
Multi-area Coordination of Flexibility Resources

- Multilateral TSO-TSO coordination will maximize flexibility of the grid to accommodate further variable RES.

Inter-area ancillary service market is needed to procure and provide flexibility.
It will be difficult to maintain GTCC providing flexibility because of decrease in market clearing price and capacity factor of the unit. Capacity mechanism will be needed to recover the fixed cost of the flexibility resources.

(Ref) IEA GIVAR Report Fig 2.1
Concluding Remarks and Our Perspective

- Flexibility enhancement and transmission/distribution capacity enhancement or allocation will be needed to integrate the further renewable resources.

- The market-based and cost-effective measures will be desired.
  1. Inter-regional flexibility procurement/provision through ancillary service market.
  2. Market-based allocation of the transmission capacity

- The following issues should be addressed.
  1. Cost allocation mechanism given the desired future energy mix.
  2. Demand side measures for decreasing CO2 and increasing flexibility (e.g. Electric Vehicle, Heat Pump Hot Water Server)
  3. Sustainability of the enterprise providing the flexibility resources
Towards a Digital Utility through Three Layers of Value Chain

Market and Regulation

Cyber Space

Hardware and Devices

Generation
- (Climate Change Policy)
- Wholesale Market
- Capacity Mechanism
- Transmission and Distribution Code, Tariff

Network
- IoT (Integration of IT and OT)
- Smart Grid
- Diagnosis, Asset Management, Optimization

Customer
- Pricing
- DR
- Behavior Analysis
- Superconductivity
- HVDC
- Energy Storage
- Smart House
- EV
- Distributed Generation