Regulation Policy and Economics of Regulation Class No. 9 (file 8): Features of Electric Power Market, and Regulatory Reform

Objectives of Today's Class

(1) To understand basic characteristics and problems of the electric power market

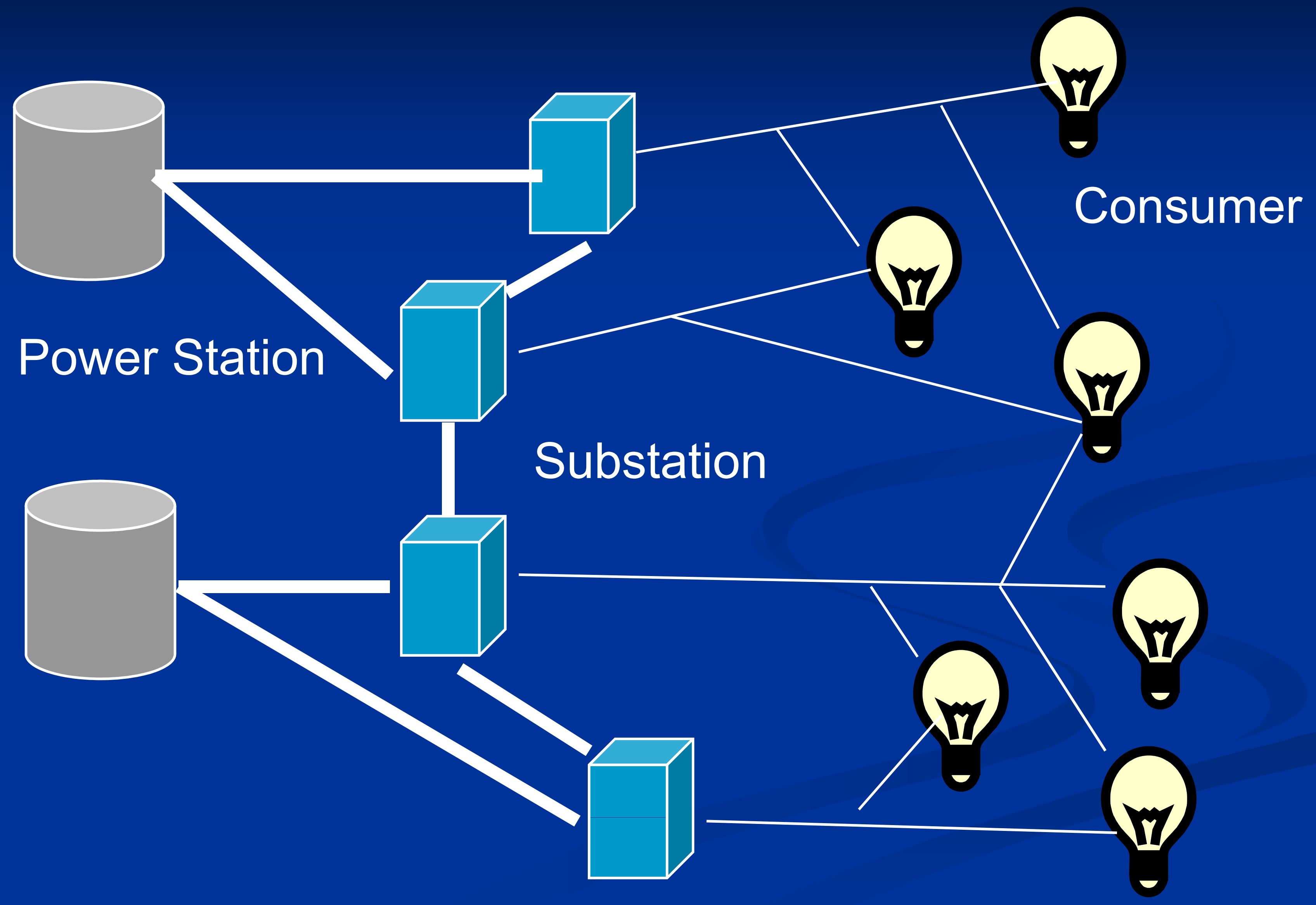
(2) By taking the electric power market as an example, to reaffirm basic mechanism and effectiveness of the rules leaned up to now

Regulations for Electric Power Market

Features common to the markets of electric power and city gas

- Public service industry
- Network type industry and having bottleneck facilities
- Energy market
- Regional monopoly
- Competition limited within the confines of the country
- Partial liberalization, gradual reform, symmetry regulation
- Vertical integration
- Interregional competition being limited (infrastructure not in place)

Electric Power Industry



Four Factors of Electric Power Industry

(1) Generation of electricity~ wholesaling

(2) Power transmission: system operation, maintenance of power grip

(3) Power distribution

(4) Retailing

Producers of electric power → Wholesale market → Sales agencies → Consumers

System maintenance: voltage support, judgment on actual transmission of electricity

History of Electric Power Industry Viewed from Aspect of Power Generation

(1) Thermal power generation on a small-scale located close to a region in demand

- First electricity supply

Tokyo Dento (established in 1883, predecessor of current Tokyo Electric Power) started up a thermal power plant in Minami Kayabacho and began electricity supply to the general market (1887)

Cf. electricity for the public was first supplied in 1882 in London (another view in existence)

History of Electric Power Industry Viewed from Aspect of Power Generation

(2) Development of large-scale (river kinetic) hydroelectric power generation

Expansion in Power Source

Period	Hydropower	Thermal power	
1883－1903	400kW	800kW	Mainly thermal power
1904－1914	33,500kW	14,200kW	Mainly hydropower
1915—1918	33,800kW	7,300kW	Mainly hydropower

History of Electric Power Industry Viewed from Aspect of Power Generation

(3) Policy conflict between the hydropower-led line and the thermal-power-led line

(4) Hydroelectric power generation with large-scale water reservoir vs. coal-fired thermal power

(5) Large-scale oil-fired thermal power

(6) Nuclear and gas-fired power generation, review of coal-fired thermal power

(7) Diffusion of distributed power source (cogeneration, fuel cell) and renewable power generation (solar light, wind power, biomass, wave power, geothermal power)?

Fukuda Vision:

- By 2020, to generate 50% (kWh) from zero-emission power source (nuclear, hydropower, biomass, geothermal power, solar light, wind power, wave power)
- By 2030, to increase solar light 40 times, wind power 10 times; accelerated under the government of Democratic Party of Japan

Composition of Current Power Sources

(1) Power sources tough to control ~ wind power, wave power, geothermal power, river hydrokinetic power, solar light

(2) Power source possible to control but which is not conducted ~ nuclear power (base power source: marginal cost being low)

Tokyo and Kansai Electric Power → all 8 power companies

(3) Water-reservoir-type hydroelectric power generation (seemingly low in marginal cost but quite complicated in reality; equipped with momentary controlling ability)

(4) Coal-fired thermal power, refuse power (base power source)

(5) Biogas, gas-fired power (having high momentary controlling ability, but tough to adjust due to long-term contracts: middle power source)

(6) Oil-fired thermal power

(7) Water pumping ~ Also a storage battery for the future

History of Electric Power Industy Viewed from Business Form

- Business entities on a small scale and regionally isolated; coexistence of diverse operating forms
- Development of power stations d on a larger scale; formation of high-voltage cables from distant provinces, and an expansion in its scale
- Competition among large-scale electric power businesses (electricity battle)
- Competition hindered by regulations
- Division of generation and transmission of electricity, and the state-run pool system, both in the wartime economy
- Formation of the nongovernmental and regional-monopoly models in the postwar period
- Liberalization and regulatory reform begun in 1995 → Gradual/partial reform (cf. telecommunications market: big bang, or gradual reform)

Features of Electric Power Market

- Practically simultaneous equal quantity (tough to put in storage)

Need for ancillary service

Need for building transmission network to maintain stability

Security of reserved capacity

- Societal call for demand restraint (at peak hour in particular)
- Cohabitation of economies of scale and diseconomies of scale under power transmission sector

The larger a network is, the smaller instability in voltage and frequency becomes; but extent of trouble's repercussions is likely to spread that much wide, making the network's safety control more difficult. Cf. Microgrid, community gas

Features of Japanese Electric Power Market

- Mature industry → Market where demand doesn't grow big: cf. city gas, telecommunications market (Possible to grow relatively large hereafter ~ all-electric society)
- Infrastructure provided by the private sector (cf. European electric power market)
- Peak in the daytime in summer; an inefficient load pattern
- Abrupt start of demand in the morning and after noon recess
- High stability and safety
- Fine environmental characteristics (high ratio of nuclear power at 30%, renewable power source at 10% ~ But in recent years coal's relative importance surged and nuclear power's rate of operation fell off nonetheless.

Features of Japanese Electric Power Market

- Difference in frequency within one country

Eastern Japan: 50 Hz (apparatus purchased from Germany)

Western Japan: 60 Hz (apparatus purchased from U.S.)

Greatest hindrance to the integration of markets

→ Markets being virtually divided into the mid-western Japan and Eastern Japan

- Kite-flying method ~ A company locates many power stations outside of its power-distribution areas. E.g.: While Niigata and Fukushima are the areas of Tohoku Electric Power's control, Tokyo Electric Power owns its power stations.
- Thin interconnected lines ~ The fairly independent 9 markets (possibility for the consolidation in Western Japan)

Background to Liberalization

- High electricity charges by international standards
- Concerns about inefficient operations
- Concerns about excessive quality
- Distortions in the resource allocation caused by charge differentials (low rates for industrial use vs. high rates for business purposes; relatively low rates for peak time vs. relatively high rates for off-peak time)
- Disappearance of natural monopoly in the area of electric power production in the wake of the expansion of electric power market
- Remaining nature of natural monopoly in the transmission and distribution sector

Trend of Regulatory Reform for Electric Power Market

(1) Bid system in the power generation market
(2) Partial liberalization of the sales market (specially high voltage) and the introduction of consignation system, separate accounting
(3) Making the bill of regulatory fares flexible
(4) Relaxation of regulations on nondedicated businesses
(5) Expansion of the scope of liberalization (high voltage)
(6) Abolition of pancake; improvement of rules on ancillary charges
(7) Improvement of the wholesale exchange, and the establishment of a neutral organ regarding power supply
(8) Failing to act on full liberalization, and strengthening of the wholesale exchange function

- Failing to act on the asymmetry regulation for existing monopolistic enterprises
- Lenient regulation as to the setup of charges

⇒Regulatory system that is more favorable to existing monopolistic enterprises as compared to telecommunications

(a) More emphasis on restraint upon an inefficient entry than on immediate provisions of competitive environment

(b) More emphasis on rule-based transparency than on administrative discretion

(c) Trend is from the emphasis on prior regulations based on the business law to one on ex post factor regulations based on competition policy

⇒As a result, the entry makes very slow progress.

Outcome of Regulatory Reform for Electric Power Market

- Charges surely on a depreciating trend despite the high market share of generic electricity-business entities

(a) Resulting from competition, it's natural that rates for business purposes go down.

(b) Small-scale charges go down as well under the continuous regulation.

(c) Reduction in charges for business entities facing no competition against new entrants

(b) - (c) Why have prices gone down?

- Small-scale charges went down only because of regulations. ~ Having equal shares
- Competition among energies and one against in-house power generation, which have worked for price cuts
- Lock-step mentality among business entities

Outcome of Regulatory Reform for Electric Power Market

Electricity charges have come down ~ Objective fact

But is it really consequences of liberalization?

Changes in environment during this period:

(1) Drop in interest rates

(2) Significant changes in price of oil (rises in recent years)

(3) Slowdown of growth in demand (demand growth being less than expected) → Decrease in investment → Drop in depreciation

Factors unrelated to the liberalization or regulatory reform influence electricity charges. (It’s highly possible that charges have come down even under the regional monopoly.)

Outcome of Regulatory Reform for Electric Power Market

To estimate a decline in prices that can be explained by fluctuations in a factor price and the slowdown of growth in demand

→An unexplainable part is to be estimated as "effectiveness of liberalization."

An idea quite similar to estimating total factor productivity

Out of the reduced power rates of some 2.6 yen per kWh, or 15%, during the past 15 years, about 40 % has resulted from the influence of the policy-system reorientation. (Estimated by Mr. Kazunari Kainou, Research Institute of Economy, Trade & Industry)

Outcome of Regulatory Reform for Electric Power Market

- Effectiveness of liberalization: Just 6 - 8%?
- Assuming monthly rates of electric light for normal household use at some 6,300 yen, is it only 400-500 yen (a bowl of ramen) ?
- Electricity is in ubiquitous use: The effectiveness ought not be measured on the analogy of a quantity one consumes directly.
- Japan’s power consumption per annum: approx. 920 billion kWh (2007)
- Cost reduction of 1.2 yen per kWh → Economic profit of about 1.1 trillion yen per annum
- Cf. The amount of money Japan spent to buy CDM during the past 5 years is about 1 trillion yen.

Nuclear Power Issue

Factors to be considered

(1) Energy security

(2) Global warming issue

(3) Maintenance of advanced technology

(4) Disposal of radioactive waste matter and safety problem

(5) Relevance to liberalization

Nuclear Power Issue

(1) Energy security

(2) Global warming issue

→ To be adopted is a policy positioning technology being neural. (e.g., an environmental tax)

= Should not exclude technologies that can resolve these issues at costs lower than one of atomic power generation.

~ In actuality it is difficult to replace atomic power generation with new energies.

(3) Disposal of radioactive waste matter and safety problem

→ Predominance of nuclear power generation ought to be verified on the basis of an accurate deliberation of its social cost.

Nuclear Power Issue and Liberalization Issue

(a) Main cost sources are expenditures on plant and equipment, and disposal of radioactive waste matter.

→ The marginal cost is overwhelmingly low.

= Predominance as a base power source and a strong competitive edge (after construction)

(b) Difficulty in power conditioning (technically possible, though)

→ Risk of being beaten down of prices attributed to liberalization

(c) High initial cost

→ Weak against violent changes in environment; to take huge risks upon itself.

Risk in Nuclear Power Generation

- Cost of disposal of radioactive waste matter → What'll happen to 2nd reprocessing plant remains undecided.
- New technology → A fast-breeder reactor being still under development
- Rate of operation: when it grows stagnant, the economy deteriorates with a low marginal cost.

Rate of operation at 90% or so is allegedly possible if used as a base power source without power adjustment; In effect, it flounders in 60% or so.

The cost surges when a nuclear power plant gets halted by the authority of a local government.

With alternative sources of power, carbon emissions increase as well.

Social Costs Owing to Suspension of Nuclear Power Station

E.g., a unit of nuclear power station with the capacity of 1 million kW gets suspended for a year. (Kashiwazaki Kariwa has 7 units with the total generating capacity of 8.212 million kW, the largest nuclear power station in the world.)

To substitute this with oil-fired thermal power:

Assuming an original operating rate of 90%, and a marginal cost of substituting oil-fired thermal power at 9.5 yen, then an incremental burden to be incurred would amount to 75 billion yen.

An increase of 4.32 million tons of carbon dioxide emissions (petroleum's emission factor at 0.548) ~ Considerable impact

And which, on all-Japan basis, amounts to approx. 1.2 billion tons in terms of converted volume of carbon dioxide emissions, as compared against 7.5 million tons of the volume discharged that can be saved by switching 1/3 of gasoline to bioethanol. ~ Serious impact in the environmental aspect as well

Electric Power Market and Environmental Issues

- Former problems
- ~ Atmospheric pollution, Sox, NOx, soot and smoke
- Coal → Fuel oil → Use of high-quality crude oil
- Desulfurization equipment ~ the highest level of environmental performance in the world
- Adoption of LNG
- These measures have considerably resolved the problems.
- The state of affairs is rather in a stage where an argument is about a harmful influence caused by too severe environmental assessment by local governments.

Environmental Assessment and Entry Barrier

- Strict assessment in Tokyo Metropolis and Kanagawa pref. (the prefectures in Kinki region as well) → Location development being at a stop in this area

As per the current of the times, building power stations in this area is efficient.

- A new entrant plans an adoption of LNG power generation.

→Environmental assessment for a period over 2 years

- An existing entity plans to replace a low-efficiency LNG power station with a high-efficiency one → An immediate approval

~ Proving to be barriers to a new entry

Electric Power Market and Environmental Policy

The issue should have originally been handled by an environmental tax or emission trading. As the measures failed in uniformity, a variety of problems have come into being.

Ad hoc policies have been adopted one after another that merely treated symptoms, seeking for partial optimization, only to bring about an arrangement which is just intricate with no uniformity as a whole.

Act on Promotion of Global Warming Countermeasures,

Voluntary Action Plan on Environment, Law for RPS, various subsidies, environmental regulations, Green Electricity Certificate

Possible to change with the adoption of an environment tax and emissions trading

Voluntary Action Plan on Environment

- General producers of electric power as a whole announced that they would set a goal on emission factor (20% cutback) to be attained voluntarily.

→ Though it is rather a tough target, they seem to be working hard (by means of purchasing the right to emit in the international marketplace and improving generating efficiency). ← What are their motives?

(1) Corporate social accountability

(2) Evasion of mandatory regulations

~ They anticipate that mandatory regulations are to be imposed if the goal could not be attained, or the goal and plan were lenient in the first place.

Act on Promotion of Global Warming Countermeasures and Emission Factor

To have all business entities announce carbon emissions/ quantity of electricity sold

→ Users make use of the numerical values to calculate their own emissions.

(1) Producers of electric power are competitively motivated to reduce the emissions value.

(2) Users are motivated to select producers with lower emissions.

Issues Concerning Act on Promotion of Global Warming Countermeasures

Producer A centers on nuclear power with a combination of coal. The emission factor of nuclear power is 0, one of coal at 0.9, and 0.3 on average.
Producer B centers on gas-fired power generation; an average emission factor at 0.4.

Users switch the producer to A.
→ Producer A increases coal fired power, rather resulting in an emissions increase (as its nuclear power is in full-capacity operation).
⇒ A perverted motive ~ Problem with using an average value rather than a marginal one?
~ Yet this incentive may be good in the long term nonetheless.

OM and BM

OM: a marginal emission factor to evaluate increases/ decreases in fuel to burn

BM: a long-term emission factor taking into account even power-station building

Important approaches in various contexts

- Environmental appraisal of adopting co-generation
- Environmental appraisal of adopting new energy
- Environmental appraisal of energy conservation
- Environmental appraisal of demand shifts (day → night, peak → off-peak)
- Environmental appraisal of adopting all electrification

Law for RPS

RPS (Renewables Portfolio Standard)

Law for RPS → To impose electric power producers a certain usage obligation

12.2 billion kWh, about 1.35%, in the year 2010

To increase the obligatory quantity by stages till then

To expand the obligatory quantity after 2010, with attractive rates for solar light → to count solar light double

Target Power Source of Law for RPS

Targeted energies: among renewable energies, ones that require support

Wind power, solar light, (small portion of) geothermal power, hydraulic power in small size (conduit type with 1000kW or less, targets to be changed gradually), and biomass

Dam-type large-scale hydraulic power is not included.

→ All of these add up to 10% plus in the year 2004, which exceeds the level of Germany.

Intention/Goal of Law for RPS

- Measures against global warming
- To promote spreading of diversified power sources
- Energy security
- Promotion of research and development of new energies

For these purposes, the targets have been selected arbitrarily.

Scheme of Law for RPS with Consideration for Efficiency

(1) No specification as to a breakdown of four kinds of power sources

→ Allowance for selecting a power source of the lowest cost

(2) Adoption of a concept of the RPS value detached from power supply

→ Producing the same effect as tradable permits; Power sources spread in areas with low costs. ~ Secondary effect to clearly express RPS's profit (cost)

(3) Allowance for carrying forward a surplus attained in excess of an obligatory quantity to the following year or later (banking)

→ To be adoptable, in dynamics, in the most efficient timing ~ In point of fact, it did not work out.

Cost of Law for RPS

Price of RPS-equivalent quantity: Transited at just about 5 yen (per 1kWh) for the years 2003-2005; it's said to be about 6 yen now.

Under the on-going price, it'll be a burden of 75 billion yen in 2010.

(As 6 yen is the marginal cost, the burden may become less than the above amount. On the other hand, since some examples indicate a cost exceeding 6 yen to develop power Sources, this amount could be an underestimate.)

Benefit of Law for RPS

Reduction of carbon dioxide emissions

Substitution with nuclear power → Little decrease in carbon dioxide emissions (zero emissions discharged by whichever sources in a short range, about the same level as wind power viewed in a life cycle, less than a half of solar light)

Average of all power sources → Emission factor of 0.38 (just about the same level as LNG)

Substitution with oil (coal) -fired thermal power → Emission factor at 0.55 (0.82)

Emission factor: carbon dioxide emissions (kg) per 1kWh

Benefit of Law for RPS

Marginal cost under Law for RPS ~ Assuming 6 yen as the RPS value, producers are supposed to be reducing carbon discharge bearing the cost per ton of ○○ yen (case of substituting coal) ~ △△ yen (case of the average of all power sources).

Question: Fill in ○○ and △△.

Assumptions: Emission factor 0.82 (coal), 0.38 (average of all power sources), to turn out zero carbon discharge if converted to RPS-equivalent power sources

Biomass Power Generation

- A stable source among the RPS power sources
- A variety of raw materials and fuels such as woody biomass, bioethanol, biogas, and waste. (Their cost, environmental burden, and optimum power-generation scale are diverse too.) ~ Possible to be used in various ways: closely related to thermal usage, fuel production, and fuel cell.
- Not exactly a domestically produced energy
- As for a portion that is cost competitive, the development in power generation has already advance considerably.
- Possible to be utilized at traditional power stations without modification

Wind Power Generation

Fluctuation being violent → Restriction on a quantity to be adopted in the light of system stability; not a stable power source

~ Left up to the wind, and no guarantee of power generation when needed

← Stability (avoiding power failure) cannot be maintained without an extra power source for backup ~ Wind power is a source that takes more costs than it looks.

Introduction of storage battery (which raises the cost by 4-5 yen per 1kWh)

(1) To avoid short-term fluctuation (2) To shift power supply from night to the day time → an additional effect to enhance economic efficiency: ~ to the exchange after shaping

Trading of CO2-free electric power started in Nov. 2008.

Compatibility with the diversified-type small-scale power generation

Photovoltaic Power Generation

- Not a stable power source ~ Left up to the sun, and no guarantee of power generation when needed: necessary to have a backup power source: an advantage of generating more power in the peak demand season
- Secondary effect to raise energy-saving consciousness of general consumers
- This method was first adopted by Japan, but is being spread rapidly in Germany in recent years.
- While the cost has come down drastically, even in the light of the RPS value, it doesn’t have competitiveness vis-à-vis ordinary power sources and wind power generation.

Cost per 1kWh: 140 yen (in 1994) → 45-60 yen (2006) → 23 yen (possible in 2010?, target) → 7 yen (target for 2030)

(7 to10-smothing yen with traditional models, vs. approx. 10 yen with large-scale wind power)

Measures to Promote Adoption of Photovoltaic Power Generation

(1) Subsidies for the installation (The government subsidies once discontinued, came to life again.)

(2) Law for RPS

(3) Purchase by power companies (at the same amount as selling price)

(4) Green procurement, green electricity certificate, preferential interest rate

(5) System to purchase at a fixed price (Germany)

(6) Preferential tax system (U.S.A., France)

Why are interventions necessary that are discretionary and nonneutral to technology ?

← Magnitude of externalities is different.

Feed-in Tariff Institution for Solar Light

- To buy up surplus electric power of photovoltaic generation for household use at 48 yen, the price double the unit power price a household pays → Supporting the adoption of photovoltaic power generation in homes ~ A level that does not economically penalize the installation (i.e., one that doesn't limit the installation to those who are environmentally conscious in particular)
- Burden on general electricity business entities ~ Borne by users of electric power on a broad base in proportion to the amount of electricity consumption (a surcharge on solar light)
- A household's direct allotment: several tens to hundreds of yen as a monthly amount
- No big deal?
- Don't make a judgment about it based on such an amount. As electricity is used for the production of all goods (same as the discussion on benefits of liberalization), the real burden is heavier than its appearance.

Buy-up of Surplus vs. Whole

Is it just an excess left over from captive consumption (surplus buy up), or all quantity of electric power generated (whole buy up), that is to be purchased in the subject institution?

E.g.: the generation of 10 units of electricity when the sun shines, and the consumption of its 5 units during the same time frame

Surplus buy up: 5 x〈buy-up price〉, to be paid to a household

Whole buy up: 10 x〈buy-up price 〉— 5 x〈retail price〉

Which is more efficient, reasonable?

→ A serious distortion to be incurred with the surplus buy up

Problems of Surplus Buy-up Institution

- A person who consumes less electric power in the daytime has a greater incentive to adopt photovoltaic generation.
- Only when photovoltaic power generation is in operation, does this institution make an incentive for saving energy significant.
- The institution creates artificial economy of scale.

In addition to all these, viewed from perspectives of economic efficiency , system stability, and power distribution measures (and even from an impartiality standpoint), the surplus buy-up is an outrageous system.

Why was this outrageous institution adopted?

- Problem with an economist gotten involved? ← There is a limit to what an economist can do; the scholar's opposing opinion alone cannot exert an influence on the policy.
- Problems with the meter (and which is often used as a pretext when an atrocious system gets adopted)
- The surplus buy up seems to be a more powerful measure to promote the adoption in appearance. ~ Assuming a surplus ratio at 50% (endogenous as it is), the surplus buy-up price of 48 yen has the same effect as paying 36 yen on the whole buy-up basis. → It looks to purchase at a higher price on the surface. (A policy with a raised bottom looking down on the general public)

Does the public burden increase with the whole buy-up system?

Keeping a buy-up price at 48 yen, the change from the surplus buy up to the whole buy up brings about an increase in the essential amount of subsidy for photovoltaic power generation only to raise the public burden. ~ Which is equivalent to lifting the surplus buy-up price to 72 yen (assuming a buy-up ratio of 50%).

And which merely states that, either in the surplus buy up or the whole one, if the purchase price is too high, the burden goes up. ~ It is not the problem of the whole buy-up system, but one of the buy-up price.

Is the buy-up institution unfair for being preferential to the wealthy?

It is those rich who live in specious detached houses that can easily adopt photovoltaic power generation: It's preferential treatment of the rich to provide them with a subsidy at the burden of all the people, and which is unpardonable?

Utterly nonsense. The original purpose of a buy-up price is to change the situation till now— where those who are environmentally conscious adopted photovoltaic generation taking no account of profit—to the very limit of profitability.

→ Basically, those who adopt photovoltaic generation are not likely to make money (except for the portion of a differential land rent). ~ If the price is so high to yield big profits, it's logical to call that price level to be unfair.

It is not the problem of the buy-up system, but one of the buy-up price.

Stability (Frequency)

The simultaneous equal quantity: the necessity that a generated output matches an amount of consumption

A generated output □ an amount of consumption

→ Decline in frequency → Dropping out of generators → Massive blackout

Need to generate power in conformity with an amount of consumption ~ Necessary to have reserved capacity

Securement of reserved capacity

- Retention of power generation capacity exceeding a demand assumption
- Demand blocking (a demand-supply adjustment contract), the application of which lags behind in particular

The generating equipment surpassing the demand: normally low operating (nonperforming) assets ~ No one owns them without some kind of compensation mechanism.

Simultaneous Equal Quantity for 30 Minutes

To coincide the output generated by a new entrant with its customer's amount of consumption (a quantity for retail) in the unit of 30 minutes

What is this regulation for?

(1) Without a simultaneous equal quantity, it practically becomes a wholesale rather than a retail.

(2) By having a new entrant follow in load change (fluctuation in an amount of consumption), to lighten a burden on providers (electricity business entities in general) of ancillary services, thus decreasing the risk of power failure

Stability (Power Transmission Cable, Thermal Capacity)

- Need for an adequate capacity for power transmission
- Power transmission surpassing the capacity → Expansion of power transmission cables → To raise the possibility of a large-scale disconnecting accident
- Response to accidents: Double-tracking of circuits ~ To build 2 lines running the same route
- → Design to prevent a large-scale accident even when one line breaks down
- An accident of the 2 lines broken down ~ A route accident (N-2 accident)
- ⇒Devising to minimize impact even in such a case
- It is difficult to maintain incentives to induce an investment in such indispensable facilities. ⇒ file 7, 9, 10

Stability (Voltage)

Maintenance of voltage → Need for an ample supply of reactive power

Need for an investment for that matter

⇒ It is difficult to maintain incentives to induce an investment in such indispensable facilities. ⇒ file 6, 9, 10

Ancillary Imbalance Supply

To maintain stability of power supply by sustaining a simultaneous equal quantity

Discrepancy between a generated output and an amount of power consumption Rise or fall of frequency

→ Services to adjust such fluctuation without delay

In Japan, general electricity-business entities basically perform this role.

- Governor-free operation of the generator (A generator automatically makes fine adjustments reacting to rise or fall of frequency.)
- LFC (load frequency control), EDC (economic load dispatching control)
- Generator's parallel and parallel-off operations

Ancillary Imbalance Supply

- Costs of facilities and operation of electric-supply command centers
- Facilities' costs for automatic control
- Variable costs of power stations that get operated by way of precaution against abrupt changes in the amount of consumption
- Costs to secure reserved capacity

Charge/Cost of Ancillary Imbalance Supply

- Basically an overall cost method putting connection fees (consignation fees) into a bundle ~ Laid out by general electric power entities
- Simultaneous equal quantity for 30 minutes ~ As to a shortage of 3% or less, a fare to be paid based on power-generation costs
- Over 3% ~ A penalty fare (to collect a part of equipment costs of standby facilities)

Effect of Simultaneous Equal Quantity for 30 Minutes

Shortage in excess of 3% ~ A high penalty fare

→ Need to constantly grasp customers' consumption amount

⇒ Necessary to fathom consumption situation in real time, and, for the sake of seizing this, to make investments in meters and facilities for communication

Which is not required of general electricity business entities.

If supply and demand are managed as a whole by means of frequency and such, there is no need to grasp a consumption trend of house by house (economies of scale).

⇒ Practical asymmetrical regulation ~ An effect of entry regulation

(Artificially created economies of scale)

Harmful Effect of Simultaneous Equal Quantity for 30 Minutes

A sharp decrease in the consumption amount of the customer A of a new entrant #1, while that of the customer B of a general electricity business entity suddenly increases

No adjustment is necessary as there is no load fluctuation as a whole in substance.

The mechanism for the simultaneous equal quantity for 30 minutes forces the new entrant #1 to sharply decrease its output and a general electricity business entity to suddenly increase.

⇒ Useless adjustment in the light of both respects of stability and economic efficiency

Harmful effect of which is small when the size of a new entrant is large to some extent.

Problems Related to Stable Supply

All responsibilities for a stable supply, other than the simultaneous equal quantity for 30 minutes, are born by general electricity business entities.

Why can the stability be maintained with this?

~ For, the share of general electricity business entities is overwhelmingly large.

But which cannot be maintained if the share of new entrants go up.

It is more efficient to install an automatic controller like governor free in a PPS electric generator; more efficient to be positioned under electricity-supply instructions

→ A scheme for PPS to bear a part of the ancillary function's burden

⇒ By unbundling ancillary services/access charges being done at a rough estimate, the role allocation by function ought to be considered.

DSM (Demand-side Management)

Simultaneous equal quantity → Need for facilities adapted to peak load → Outrageously high (social) costs of the peak

⇒ Societal benefit of load standardization is huge.

Great profits if the demand in summer during the daytime can be shifted to the nighttime ~ A late-night reduced rate, demand development (EcoCute, Eco-ice, electric-powered cars)

These simple devices alone won't endure in the low-carbon society.

- With the spread of photovoltaic power generation, electricity will be more than enough during the daytime in summer, while that'll be in short supply in the same daytime if it rains.

⇒ Need for a painstaking control much more than ever

DSM and Smart Meter

An existing meter for household use: just to measure a cumulative electricity usage; Two-/four-value meters being available ~ To discriminate rates between day and night

Smart meter

- Capable to measure by the units of 30 minutes and one hour, and to save these data
- Interactive-communication function ~ An automatic meter inspection (users → business entities) ~ Control over demand and an independent generator for household use (such as solar light)

Within the same daytime, the value of electricity totally differs between the shine time and rain time, and a smart meter is capable to make this distinction. ← However, as such information presents competitive bases as well, electricity business entities with vested interests are most likely to stand against the device on the pretext of the system's stability.

Problems Related to Competitive Institution

(1) Problem on vertical integration

(2) Wholesale market

(3) Competition among power companies

A background common to (2) and (3):

Slight growth in demand for electric power ~ Ample capacity to produce electricity under the present conditions

Thus small room left for a newcomer to enter the market by founding a power plant

Cf. markets for communication, city gas

Vertical Integration

- A general electricity business entity ~ An enterprise that has vertically integrated all of the generation of electricity, transmission of electricity, retail selling (power distribution)
- ← A structure intentionally made up after the war ~ Being recognized as having performed a certain role in terms of a stable supply
- Merits of vertical integration: stability, efficiency (Class No. 5)
- Demerit of vertical integration: competitive neutrality (Class no. 9)
- EU's basic policies on vertical integration: separation of finances → separation of management → separation of capital
- Japan: vertical integration

Neutral Organ

How to keep neutrality of the power-supply sector under a vertically integrated structure

Foundation (in 2004) of Electric Power System Council of Japan (a neural organ) ~ The organ to tend and implement the usage rules for power transmission cables

→ The function of laying down the rules is separated from general electricity business entities. (Japanese-style vertical integration)

Membership: comprised of general electricity business entities, PPS, business entities of wholesaling and independent power generation, experienced academics (neutral commissioners)

Voting rights allotted by the group (instead of the number of members)

As to the composition of the executive board, neutral commissioners to outnumber each group's directors

Competition in Electric Generation Market

Slight growth in demand for electric power ~ Small room left for newly joining

Competition in the electric generation market being indispensable in order to make a competitive mechanism work under such adverse conditions

(1) Horizontal segregation

(2) Expansion of the wholesale market

(3) Competition among power companies

Wholesale Market

(1) Direct trading (2) Full-time backup (3) Wholesale exchange

The transaction started in 2005 when the wholesale exchange was established (though a private and voluntary market)

Cf. compulsory pool markets (Scandinavia, Australia, one-time UK)

The volume of transaction and the monitoring system being outshone by the West

An extremely small volume of transaction (which is less than that of a unit of gas power plant, or less than 0.1% of the aggregate volume of electricity generated)

The market structure where the market power gets easily exercised ← The system to monitor it is threadbare, too.

The matter has not reached a trustworthy level as a competitive basis.

Competition among Power Companies

Each general electricity business entity ~ Once a monopolistic business entity in each region

Holding an overpowering position in each region even now

If the whole of Japan is considered as one market, the industry structure is decentralized enough to give rise to competition. → Hopes for competition among power companies

Problems

(1) Natural features to dislike competition (?)

- Having been interdependent among the fellow traders, and which remains intact hereafter
- Lesson from the “battle between power companies” ← Danger to become uncontrollable if they ever start competing

(2) Constraints of interconnecting cables

Wholesale Exchange and Competition among Power Companies

(1) Realistically there has been only one concrete case at present. (Kyushu Electric Power Co. supplied in the Chugoku district.)

However, there is a great need for wholesale transactions.

→ Corporations spreading to the whole country wish for a lump supply of electric power.

⇒ Hopes for demand-led competition among power companies

(2) Transactions at the wholesale exchange ⇒ Substantial competition among power companies making use of PPS as a sales outfit ⇒ Even without direct competition among power companies, the problems are small as long as transactions at the wholesale exchange are brisk enough.

The problem left until last: the measure of capacity of interconnecting cables

Interconnecting Cables

The lines that connect the 9 electricity business entities: Why are there these lines? ⇒ Supply stability

- Abrupt decrease in frequency

→ Electricity automatically flows to an area of its shortage

~ Stability

Except for a risk, falling into company with it, to cause a large-scale blackout ~ To cut off the interconnecting lines in case of emergency

- Saving on reserved capacity: Upon an electricity shortage in a specific area, electric power companies give assistance to their colleague covering this area → To be able to cut down on reserved capacity required

Originally being the arrangements for the supply stability

To be the key to making competition work under liberalization → file 9

Capacity of Interconnecting Cables

- Adequate room of capacity being left in the west Japan on the whole except for Kanmon (the lines interconnecting Kyushu and Shikoku)

→ Possibility for the areas/west of Central Japan to operate as a single market

- *Soma-Futaba* (the lines interconnecting Tohoku Region and Tokyo) is not congested as of now but may run out of capacity sometime in the future.
- *Kitamoto* (the lines interconnecting Hokkaido Prefecture and Tohoku Region), being equipped with small capacity, has particularly no room of capacity for the transmission to Hokkaido.

~ Hokkaido Electric Power Co. is not exposed to direct competition.

- FC (the lines interconnecting Tokyo and Central Japan) has extremely small capacity: East and West of Japan are practically separated markets.

Calculation of Interconnecting Cables' Capacity

Space of capacity = Operating capacity - Margin - Planned tide

Available measure ~ Operating capacity - Margin

The measure of operating capacity to be determined by the severest conditions of the following 4 factors:

(1) Thermal capacity (2) System stability (3) Voltage support (4) Frequency support

- Able to maintain stability when a large-scale accident takes place within a region
- Able to maintain voltage/frequency when the interconnected lines break

Margin

3% of the system capacity, of the largest power source in a region ~ Portion to be kept cleared originally for the purpose of securing reserved capacity

Issues of Electric-power-market Reform Hereafter

(1) Vertical integration model vs. the separation of generation and transmission of electricity

(2) To redesign an access charge structure and an organization of the system operation

(3) To upgrade the electric power market, and to rationalize the price structure

(4) To secure incentives for the investment in power transmission cables (interconnecting cables in particular)

(5) To establish the confines of liberalization

(6) Competition among energies

(7) To achieve both environmental measures and security in energy

Incentive for Investment in Power Transmission Cables

- Under the regulation for the access, the incentive for the investment in conduits may become less. ← The same structure as an optical fiber (file 10)

Measures to maintain the incentive:

(a) To devise a way regarding a fair rate of return ← In consideration of risks involved

(b) To exempt the open access for a certain period of time

Incentive for Investment in Interconnecting Cables to Link Regional Power Grid

- Technological merits:

  (a) Improvement of stability ⇔ Being a demerit concurrently

  (b) Saving of the cost to maintain reserve electricity

- Aspect to promote competition

→ Which brings forth societal benefit even if unused as a result.

This point will be discussed in full in the lecture on city gas (file 9).