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The Business Structure of Japan's Electric Industry for 1963-2016: Analysis on the Revenues and Expenditures Throughout before and After the "Deregulation"

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ABSTRACT

The federation of electric power companies (FEPC) of Japan has long been releasing the detailed financial statements of their member corporations (on their web site). We have analyzed the FEPC's financial data over half a century and have clarified the problems and distortions built in Japan's power industry through the "dual pricing mechanism" for the "industrial use" and the "home-use" sectors. In fact the former shares two thirds of the power demand and yields only small profits or even losses; and the latter, sharing one third of the demand, yields nearly all of the industry's profits. After the full retail deregulation, however, this home-use sector (the industry's treasure box) seems now suffering diminution of profitability: Because the power majors have begun to raise a "cutthroat competition" against each other. This price-cutting war might be considered very dangerous for the sustainability of this industry because this business is highly equipment-intensive and so severely vulnerable to any revenue instability.

Keywords: Electricity Demand, Dualistic Pricing, Income Statement, Power retail Deregulation

JEL Classifications: M4, L5, L9, Q4

1. INTRODUCTION

1.1. The Context Around this Study

Since April 2016, the electricity rate in Japan was exposed to the full retail deregulation: This implies a great transition in Japan's power policy. Meanwhile, Japan's power companies have long been enjoying the advantage of regional monopoly: They have been taking previously arranged profits on the so called "Rate-of-return regulation" mechanism, enabled to avoid price cutting competitions in ordinary markets. But such a business regime has been open to various questions and criticisms.

Japan's power industry has long been carrying out a double-layered rating system, where the rates on the home-use sector (HUS) had been regulated by the government until 2015, but the rates on the

industrial use sector (IUS) had undergone a partial deregulation in 2000.^{1,2}

In the history of Japan's power policy, however, the IUS rates themselves had once been subject to the governmental regulation until 1999; and, in those years, the regulation system had fully been practicing the dual price mechanism for the HUS and the IUS. Japan's power industry, while enjoying the regional monopoly in the power service, had been conforming its business structures to this dual price mechanism; to which they had conformed all their managerial resources such as power facilities, capital investments,

1 Since 1995, Independent Power Producers has been allowed to enter the wholesale power generation market.

2 However, regulated prices apply to all small-capacity users below 50kW, including small shops and works, besides the home-use.

and personnel organizations. This historically built-in structure seems to continue virtually intact even for the new round after the complete deregulation.

1.2. The Purpose of this Study

This study tries to clarify the fundamental (and historical) business structure of Japan's power industry having developed under the above stated rating mechanism. To forward this study of structural analysis, we have had to make up an entirely novel method of analysis that enable to compute the operating incomes, the overall gross costs for earning these incomes, and finally the operating profits of this industry, respectively, by demand sector.

1.3. The Method of Analysis

"Economic assessment" of the electric power business has been carried out mainly on the basis of the levelized cost of electricity (LCOE). This assessment is obtained by dividing the total cost per power plant which consists of design, construction, operation and abolition by the cumulative lifetime power-generation.

Murota (1993) developed an epoch-making method for obtaining the LCOE. He acquired the LCOE by using "actual values" such as electricity amount and settlement amount extracted from the "securities report." As a result, the estimated values will be closer to the "actual prices" than the conventional estimates through the "model plant method" adopted by OECD (2015) and FEPC (2013) that estimates the cost on an "assumption" of the scale of power generation plant.

Oshima (2010) took over the estimation method of Murota, refining it by adding social expenses, etc. and gave analyses for a longer time-period. Matsuo et al. (2013) also used this method to calculate the power generation cost.

However, the LCOE has limitations in that the measurement targets are restricted to unit prices at the "generation end." To grasp the total cost paid by customers, it is necessary to add the expenses spent for the power transmission, transformation, and distribution in the power service.

On a due course of this study, it has been necessary to establish an entirely new approach, where we have elucidated the "actual prices" (A) that the HUS and the IUS users (clients) have paid for; and then we have compared (A) with the 'actual gross costs' (B) that the power companies have really paid for.

These analyses can be carried out explained as following. Japan's Federation of electric power companies (FEPC) has long been publishing the financial statements on its web site (FEPC(web)) of FEPC's member corporations, including the balance sheet, the actual results of power generation and transmission, supply and demand of the electricity, the relevant revenues and expenditures, the status quo of power plants and facilities, etc. We have analyzed these FEPC data and have successfully elucidated the various aspects of the electric power industry in Japan, where the most important matter is the analysis of power demands in the IUS

and the HUS and of the relevant earnings and expenditures by demand sector.

A more detailed procedure for these estimations will be explained later in close combination with the actual results of the relevant estimations.

Japan's power service has traditionally been dichotomized into the "Dento-ryo" demand (charges on households) and the "Denryoku-ryo" demand (charges on the electricity for industry), of which the former is redefined, in this study, as the HUS; and the latter, as the IUS.

By the summer of 2017, it has become possible to analyze the business activities of major power companies after the full retail "deregulation" because the all the major power companies released their "securities reports" for 2016. This paper tries to compare the business behaviors of the said companies in the two stages before and after the complete deregulation.

2. ANALYSIS OF THE DEMAND STRUCTURE OF JAPAN'S POWER INDUSTRY

2.1. Two Demand Sectors in Japan's Power Industry and its Revenues by Sector

The technical structure of the electric industry in Japan consists of (1) the generation and high-voltage power grid as a general foundation and (2) the low-voltage distribution systems, where the former (1) provides electricity to the IUS in direct; and to the HUS, entirely through the latter (2).

First let us see the power demands and the corresponding revenues in the HUS and the IUS in the fiscal 2015 (Figure 1).

The electric energy consumed in Japan in fiscal 2015 was 797.1 Tera (trillion) Watt hours (TWh), where the home-use shared 266.9 TWh (33%) and the industrial use, 530.2 TWh (67%) of the total.

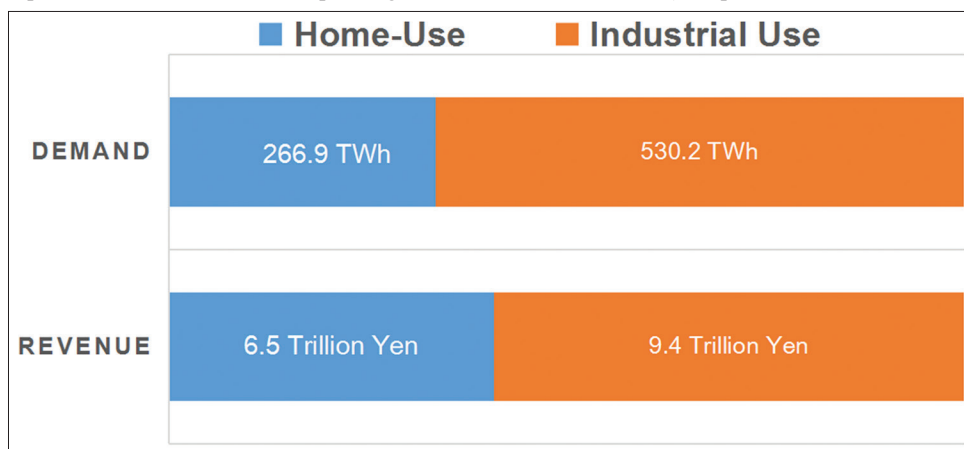
In contrast, however, the revenue from the home-use was 6.4601 trillion yen and that from the industrial-use, 9.3556 trillion yen, making the overall revenue of 15.8157 trillion yen, which implies that the HUS consumed 33% of the electricity but yielded as much as 41% of the revenue; meanwhile the IUS consumed 67% but yielded only 59%. These two sectors in contrast clearly show that Japan's power rating system has consisted of a double-standard pricing mechanism.

2.2. Decision Making Method for the Power Rates in Japan: The "Rate Making"

In short, the pricing mechanism of Japan's power industry comprises specific dual rates for the IUS and the HUS, where the latter has been bearing much heavier burden than the former.

How to decide the regulated power rates for the HUS is prescribed by the Agency for Natural Resources and Energy as follows: (ANRE, 2013) (ANRE, 2011)

Figure 1: The power demands and the corresponding revenues in the fiscal 2015 (Compiled from the FEPC data by H. AOKI)



1. To integrate the overall operating expenses by summing up personnel expenses, fuel expenses, taxes and public dues, repair expenses, depreciation expenses, power purchases from other companies, and other miscellaneous expenses; and "appropriate" operating profits, in addition to all the above-mentioned.
2. To estimate thus integrated costs by subtracting power selling to other suppliers, transmission revenues, etc. (i.e., miscellaneous revenues other than revenues on ordinary power service) from the total revenues stated in (1).
3. Firstly, to distribute (assign) the integrated gross costs abovementioned into nine divisions: The power production expenses in hydroelectric, thermal power, nuclear power, and renewable power etc.; transmission expenses; transformation expenses; the distribution expenses; selling expenses; and administrative expenses.

Secondly, to redistribute the above-mentioned costs into (A) the expenses for power production, transmission, and high-voltage distribution and (B) the other expenses concerning the low-voltage distribution alone.

Thirdly, to sum up the overall costs concerning the low-voltage distribution, to which the 'regulated' power rates are applied.

Fourthly, to redistribute the above-mentioned costs into two categories of (A) the transmission expenses and high-voltage distribution expenses and (B) the all expenses other than (A).

And fifthly/finally to sum up all the costs (C) concerning the low-voltage distribution contained in the categories (A) and (B), where the "regulated" power rates are imposed on the (C)-related demands alone.

This is the whole procedure to determine the power rates to the regulated demand sector (HUS) under the administrative rate decision prescribed by the Electricity Enterprises Law. Such a policy for the rates decision is called as "fully distributed cost method" (FDCM), of which the decision making specific for the regulated rates is officially termed as "rate making" (ANRE, 2013).

The dualism in the power pricing, i.e., the discrimination of the HUS rates and the IUS rates, can be, at least in principle, of a certain economic reason because the two sectors, HUS and IUS, have clearly different cost structures, which will reasonably lead to the dual pricing: In fact, the IUS receives the power direct from the high-voltage grid; while the HUS receives the power necessarily through the low-voltage distribution networks extended from the high-voltage grid. This surplus cost for the low-voltage distribution should naturally be imposed on the HUS rates, which are to become higher than IUS rates. This dual pricing can meet "the beneficiary pays principle" provided that the surplus cost be calculated appropriately and accurately.

There is, however, no guaranty that this cost calculation and its transfer to the HUS rates should be of sufficient rationality and justice from the economic and technical viewpoint; in fact, the actual "rate making" process has continually been suffering distortive or officious stresses and, considerably, has failed to form a fair and rational rate assignment.

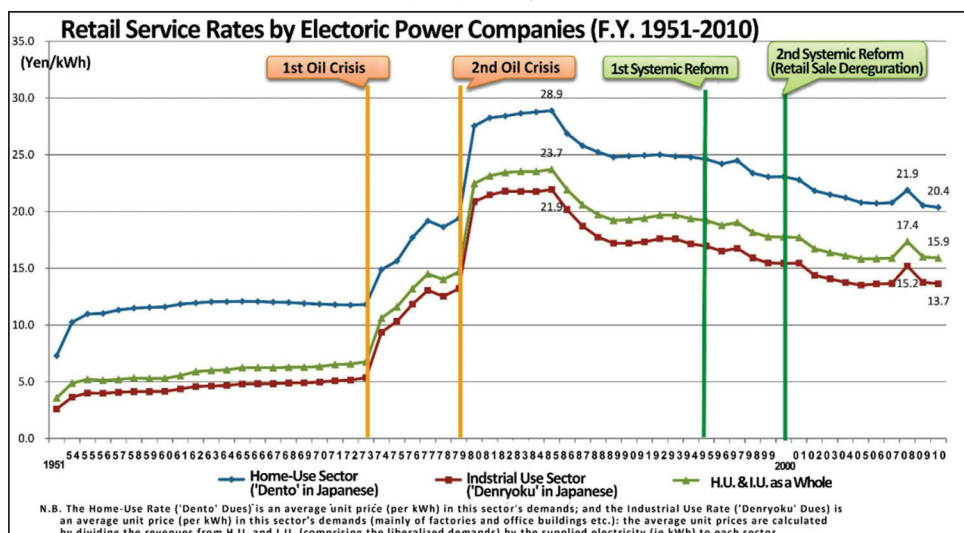
Here, we refer to a historical transition of the power rates released by the government in Figure 2 (ANRE, 2011).

Figure 2 shows that Japan's electric energy policy has been carried out on this dual price system steadily since the end of the World War Two (nearly all through the latter half of the twentieth century). Thus, the double-layered mechanism of the HUS & IUS prices has firmly been built in the very core of the business structure of this industry.

Then, to realize the industry's incomes-and-expenses structure and its historical behavior, it is indispensable to acquire not only "Price-Aspect Information" as shown in Figure 2 but also "Cost-Aspect Information" as follows.

To begin with, we have investigated the overall costs concerning power generation, transformation, transmission, and distribution to the final users; and thus, have elucidated the triad relation among the unit gross cost, the unit HUS price, and the unit IUS price, as shown in Figure 2. The results are interpreted in the following section.

Figure 2: The retail power rates (unit prices) for the HUS, the IUS, and the HUS & IUS in all for Fiscal 1951-2010: Copied and translated from the ANRE (2011) data by the authors



3. THE RESULTS OF THE COST ANALYSES

3.1. Estimation of the Unit Price on "HUS" or the "IUS" and of the Gross Unit Cost

These analyses in the present paper are fundamentally based on the said FEPC database, from which we extract the Profits-and-Losses Accounts and the demands by the HUS and the IUS (N.B. Here "unit" denotes "per kWh").

About the Profits-and-Losses Accounts for the power companies, we can calculate (1) the HUS unit price through dividing the revenue from the HUS by the demand from the HUS and (2) the IUS unit price through dividing the revenue from the IUS (and the specific large-scale users) by the demand from the IUS etc. These calculations are enforced in the same method as that adopted by the ANRE to compose the Figure 2, where the starting year is the fiscal 1963 as is the case for the FEPC Database.(FEPC(web))³ And (3) *the gross unit cost* can be obtained through dividing the operating costs (given in the Profits-and-Losses Accounts of the power companies) by the total electricity demand (consumption) comprising all the HUS, IUS, and other large-scale users.

However, it should be remarked that the operating incomes in the he Profits-and-Losses Accounts includes some miscellaneous incomes, other than the power charges, such as the sales to other companies, commission fees, equipment rental charges etc.; and, therefore, these incomes must be subtracted from the corresponding expenses like purchase from other companies, transmission expenses, equipment expenses, etc.

In addition, the subsidies from the grant by the Act on Purchase of Renewable Energy Sourced Electricity are not direct business returns and the levies for the said Act are not the actual costs

concerned with power generation or transmission. Therefore, we have subtracted the grant subsidies from the total revenues, and the levies from the gross costs.

As mentioned in the previous section, the cost structure differs between the "Industrial use" and the "Home-use." Therefore, the business analysis will require accumulating the expenses claimed to each division, comparing them with the incomes collected by each division, and analyzing the profit structure in each division.

However, such an analysis is indeed significant but is not the ultimate purpose. The true aim of this study is a historical elucidation of the basic structure of the power industry management built up under the current tariff system. To achieve this aim, it is necessary; to grasp the level of sales prices for "Industrial use" and "Home-use," and the level of costs required to the power industry in their business operation; and to assess their change over time. This is the true purpose of the present research.

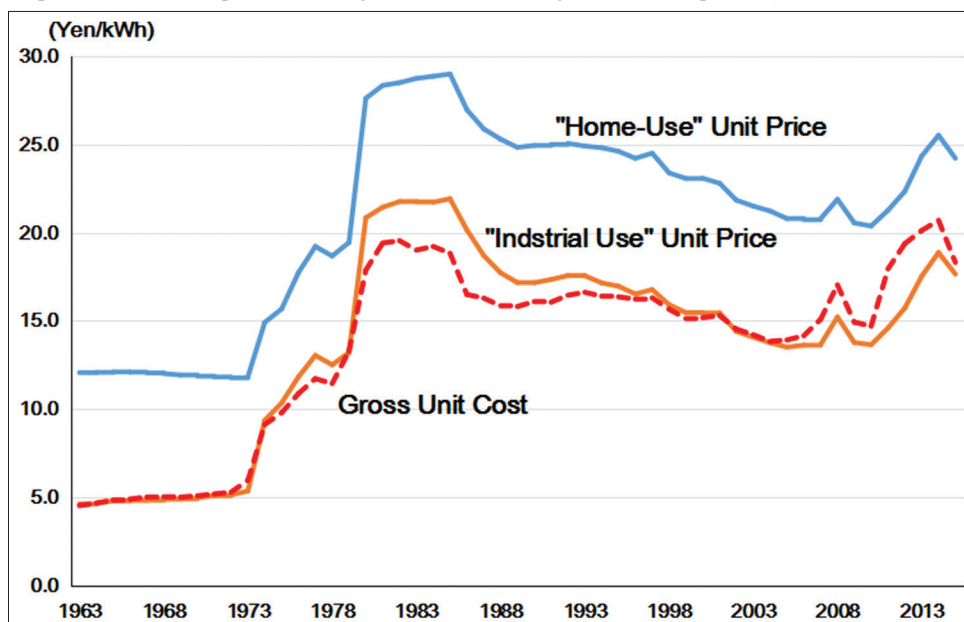
Anyway, on these minor corrections added, we can finally estimate the HUS unit price, the IUS unit price, and the gross unit cost (each averaged for all the power companies) as shown in Figure 3. The most important points shown in Figure 3 are; (a) that the IUS unit price had been nearly the same as, or only slightly greater than, the gross unit cost during the 20th century; (b) that the IUS unit price has finally come to fall below the gross unit cost since the beginning of the 21st century; and (c) that the loss in the IUS seems to have got a grave tendency to grow larger unilaterally.

Until March 2000, the IUS rates had also been regulated by the government and the 'regulated' unit price had probably been about the same as the actual gross unit cost. Taking this situation into consideration, the IUS price unit seems to have been 'regulated' in tune to (or slightly above) the gross unit cost all through the period of the full regulation, to avoid any loss making in the IUS demand.

Another important fact seen in Figure 3 is that the HUS unit price has continuously been far above the gross unit cost; and that the

³ The FEPC comprises nine electric power companies (EPCs) of Hokkaido, Tohoku, Tokyo, Hokuriku, Kansai, Chugoku, Shikoku, and Kyushu since fiscal 1963; and, since fiscal 1988, ten companies including the newly added Okinawa EPC. Therefore the 'FEPC data' used in this study implies the financial data of the said nine EPCs for 1963-1987 and, since 1988, of all the ten EPCs.

Figure 3: The HUS unit price, the IUS unit price, and the gross unit cost averaged for all companies (estimated from the FEPC data by H. Aoki)



difference between the two price systems has been nearly constant almost permanently. This fact implies that it has been from the HUS demand that Japan's power industry has gained the greater part of its profit under the legal system of the power rate regulation.

In effect, the long-term business behaviors show that Japan's electric industry has continued to hold the IUS unit price as low as the level barely to cover the unit gross cost; and, instead, to gain a high rate profit exclusively from the HUS demands. This profit- and-loss structure is just what this industry established in early 1960s and has retained firmly since then. This problem shall be discussed in more detail in the following sections.

3.2. Estimation of the Profits in the HUS and the IUS

Here we try to evaluate the profits in the HUS and the IUS respectively. A provisional method for this evaluation is to multiply the amount (in kWh) of the demand in each sector by the unit profit therein, i.e., the difference of (income per kWh minus cost per kWh) for each sector (cf. §3-1). Then summing up both the results gives the overall profits. This method, however, has a certain ambiguity because the profits by sector are the results of complicated estimation while the demands by sector are the effectually measured amounts.

It is possible, however, to remove the said ambiguity and to obtain a more precise evaluation on each sector's profits and/or losses through the following analysis. First, we assign the gross total costs per fiscal year to the cost payment by the HUS and that by the IUS in proportion to each sector's demand (amount of consumption): The results are the cost payment by sector. Then each sector's cost payments are subtracted from each sector's annual revenues: The results are the very profits by sector calculated from measured amounts alone, which are of the best possible accuracy. Thus, obtained profits by sector are shown in Figure 4.

This figure obviously shows that Japan's power industry has permanently gained large operating profits from the HUS demand;

in contrast, however, the profits from the IUS have shown no small change with the times. In 1980's they had been rather considerable, but then they became gradually thinner, and finally, they have fallen into the red since the onset of 21st century.

In short, the power sales to the HUS (ca. 1/3 of the total) had once been just one of the routes to boost up the industry's general profits but has now become the only route to gain profits and narrowly to keep the whole company in the black in compensation of the losses compelled in the IUS demand (ca. 2/3 of the total).

3.3. Profits and Losses by Demand Based on the Financial Accounts

In the previous section, we estimated the operating profits by demand sector on assigning the gross cost to the HUS and the IUS in proportion to each sector's demand; and subtracting the assigned costs from the sales amount in each sector. In this section, however, we take an ordinary financial-account approach to estimate the operating profits-and-losses, where the gross total costs are assigned to the HUS in a far higher ratio and to the IUS in a lower ratio.

These intentionally discriminated cost assignments are concerned with the low-voltage power distribution cost imposed on the HUS prices alone, exempting the IUS from sharing this cost. Because of this cost transfer from the IUS to the HUS, the HUS demand is compelled to bear far the greater part of the gross cost than the IUS. Therefore, the operating profits by demand sector rises in the IUS and lowers in the HUS due to this systemic transfer of the cost assignment.

And the profits-and-losses calculations based on such a rule for treating costs must have been ordinary routines for the power companies, which, however, have never been disclosed open. Recently, however, the Agency for Natural Resources and Energy (ANRE) noticed the results of these calculations on their website because the open notification was obliged by the "General electric utility sector balance calculation rules" ANRE (2016).

However, the ANRE data covers no more than the newest fiscal years, 2011-2015. So, we have derived the additional evaluation for fiscal 2006-2010 (about the ANRE's paper sent to the Cabinet Office Consumer Commission (ANRE, 2012): Figure 5 shows the resulting data covering the ten serial fiscal years.

To sum up the foregoing investigation, even in Financial Accounting-based analysis, IUS has not made much profit as compared with HUS (except in 2015). The IUS has become a serious loss-producing division even in the financial-account-based analysis from 2011 (when the Great East-Japan Earthquake occurred) to 2013. An essential cause for such a situation is that, as already stated, the IUS unit price has fallen short of the gross unit cost.

3.4. Business Structure after Complete retail "Deregulation"

Let us first look at the situation after deregulation in countries which executed deregulation earlier than Japan. In Germany, electric power companies tried to reduce costs by abandoning

surplus power generation facilities etc. As a result, electricity rates fell sharply shortly after the full liberalization in 1998. However, the price began to rebound in 2000 and continued to rise sharply. (Abe and Tatsumi 2006) In addition, the price manipulation by oligopoly was pointed out, and the federal government proceeded with revision of the cartel method (Ise, 2007).

In France, even a customer who was subject to liberalization, there remained a system that allows contracted operators to continue with the regulated fee contracts. Besides, the regulation fee had not been raised regardless of the market price. As a result, the electricity rates did not rise (European Commission, 2007).

In the United States, except for factors such as the rise in fuel prices, there was an analysis that the liberalization reduced retail fees for home use and industrial use by 5-10%. (Joskow, 2006). However, there was also another analysis that the competition by liberalization could not be confirmed that the price reduction had really occurred (Taber et al., 2006).

Figure 4: The operating profits by demand sector of the power industry (calculated from the FEPC data by H. Aoki)

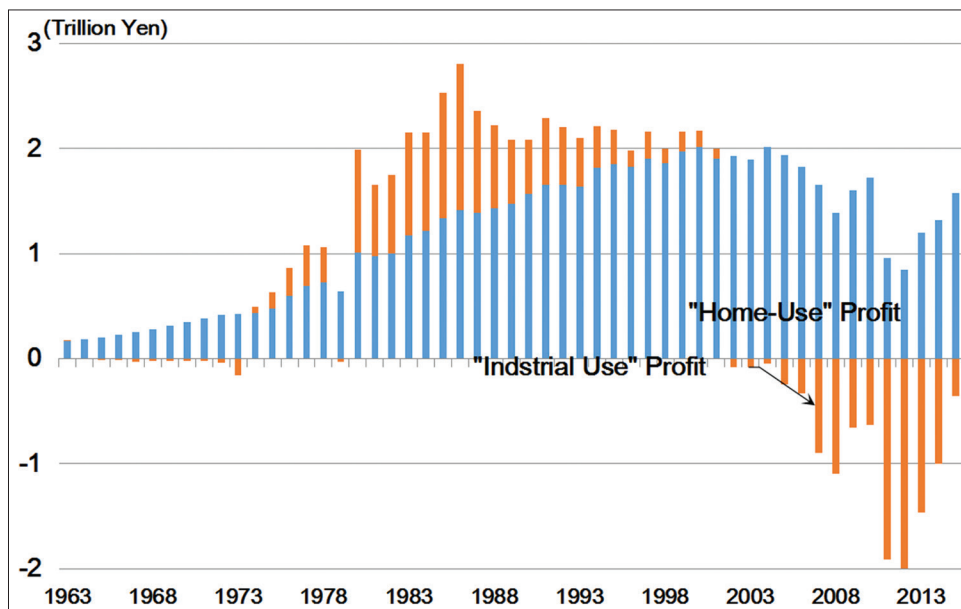
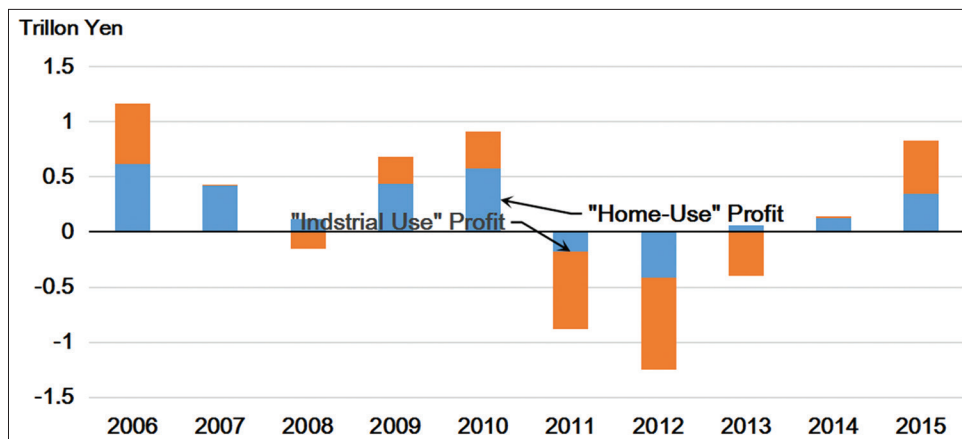


Figure 5: Profits by the HUS and the IUS on the accounting base averaged for all the companies (calculated from the METI data by H. Aoki)



What kind of change occurred in the power industry of Japan since April 1, 2016, i.e., the enforcement of the full deregulation? To clarify this problem, let's compare the basic business data of 2015 and 2016.⁴

The unit price for "home-use" became 21.1 yen/kWh from the former 24.2 yen/kWh, which means a significant fall of 3.1 yen/kWh. In contrast, the unit price for "industrial use" fell to 16.0 yen/kWh from 17.6 yen/kWh: Only 1.6 yen/kWh fall. The weighted-average price became 17.8 yen/kWh from the former 19.8 yen/kWh. The overall price decrease was 2.2 yen/kWh.

On the other hand, what has become of the "gross unit cost"? This has also decreased from 18.3 yen/kWh to 16.7 yen/kWh, resulting in the fall of 1.6 yen per kWh. Noticeably this fall is accurately coincident with that in the "industrial use" price (Figure 6).

As a result, the extant electric power industry has lost part of large operating profits formerly earned from the HUS until the deregulation. Yet the electric power industry is somehow able to secure a necessary profit, by abruptly reducing the total cost. The full deregulation gave such a serious impact on the sales structure of the industry and that immediately.

However, what is the reason of such a rapid cost-down? Take Kansai Electric Power Co., Ltd. for instance, the main factor of the cost reduction turns out to be a timely (coincident) lowering of the fuel price for thermal power generation: From 6.8 yen/kWh to 5.5 yen/kWh. This decrease is considered due to the then temporary slump in the energy resource prices of natural gas, coal, and crude oil (Figure 7).

Furthermore, a significant price down in the "home-use" did not necessarily benefit "households." According to the Ministry of Economy, Trade and Industry, as of March 31, 2017, 1 year after the deregulation, 5.53 million contracts switched. This corresponds to 8.8% of 62.53 million "home-use" contracts which the main power companies held at the end of March 2016. <Switching from the major companies to new power companies> was about 2.95 million (2.7%), and <switching of contracts within the major companies> (the regulation mode to the deregulation mode) was about 2.58 million (4.1%) METI (2017).

Among these contract changes, <changes within the contracts held by the major companies> (fit for regulation to fit for deregulation) caused a significant cut in the selling prices. The so called "home-use" factually includes "industrial use" of low voltage demands smaller than 50 kW (see footnote 2). Tokyo Electric Power Company (TEPCO) and Kansai Electric Power Company (KEPCO) played a spectacular "discount battle" over the procurement of large-scale (yet low-voltage) customers (such as "Japan Post" and major convenience store chains). In the

competitive bidding around "Japan Post," the final bid showed an astonishing cut of ca. 30% to the price of the previous year (before the deregulation) (NBOL, 2017). There was such a serious circumstance around the fall of the price for the "home-use."

4. DISCUSSION

4.1. Limits to the "Small Profits and Quick Returns" Policy

Thus far we have analyzed the business structures of the power industry by fully using the financial account database publicized by the FEPC. Recently, however, there are occurring far serious problems in this industry.

In the IUS demand, for example, the sales figures themselves have come to show a diminishing tendency. The power industry has permanently been providing the IUS with a preferentially low unit price throughout regardless of the regulation/deregulation. After all, the power industry cannot but resort to the 'Small Profits and Quick Returns' policy, regardless of the price regulation, to secure their profitability. Yet this SPQR policy has recently fallen in a danger because 'scale merits' are now getting extremely hard to achieve.

In fact, the major power companies are being severely deprived of their demand by newly emerging Power Producers and Suppliers (PPSs) since March 2000 (the enforcement of the price deregulation for large-scale users). Meanwhile, from the deregulation to 2015, the PPSs have successfully taken over 84,000 new contracts, or the power contracts of 15 million kW (corresponding to 15 nuclear plants of one million kW class).⁵

Hence, toward the complete retail deregulation, TEPCO and KEPCO (the big two) began to take a drastic price-cutting policy to bind their own large-scale customers. But why they went for such a disadvantageous competition?

Considerably it is because that the power companies must obey the supreme imperative to keep up the capacity utilization as high as possible and that incessantly. In fact, they cannot, even for a moment, idle their gigantic fixed capital for generation and distribution. Essentially, the electric power is not storable but can exist only in circulation except for battery charging. Therefore, the power generation must follow any demand fluctuation within a millisecond or even less, which calls for an ample buffer equipment freely controllable.

On the other hand, the power companies need to maintain a high rate utilization of facilities *including* the buffer system: Thus, they must *always* retain a maximum demand attainable. Thus, they are destined to confront an antinomy between "permanent securing of the scale merit" and "immediate response to demand fluctuation." Under these contradicting pressures, they are deprived of all the discretionary means for business development except stubborn share-holding by price-cutting. And they began to practice this last resort. The results are critical and unsound; the price-cutting war is going to bring a prolonged damage to the industry's balance sheet and profitability as following.

⁴ The data for the fiscal year 2016 correspond to the average on 9 companies excluding TEPCO. Actually, TEPCO became "spin-off" companies in 2016; since then TEPCO ceased to announce the business data of the group companies except the very financial statements of TEPCO Holdings were announced, and the data of the whole was not disclosed.

⁵ *Chunichi Shimbun* (Newspaper): Sept. 5, 2015 (Morning ed.)

Figure 6: The HUS unit price, the IUS unit price, the average unit price and the gross unit cost averaged for all companies 2016 vs 2015 (estimated from the FEPC data and the annual report of each company by H. Aoki)

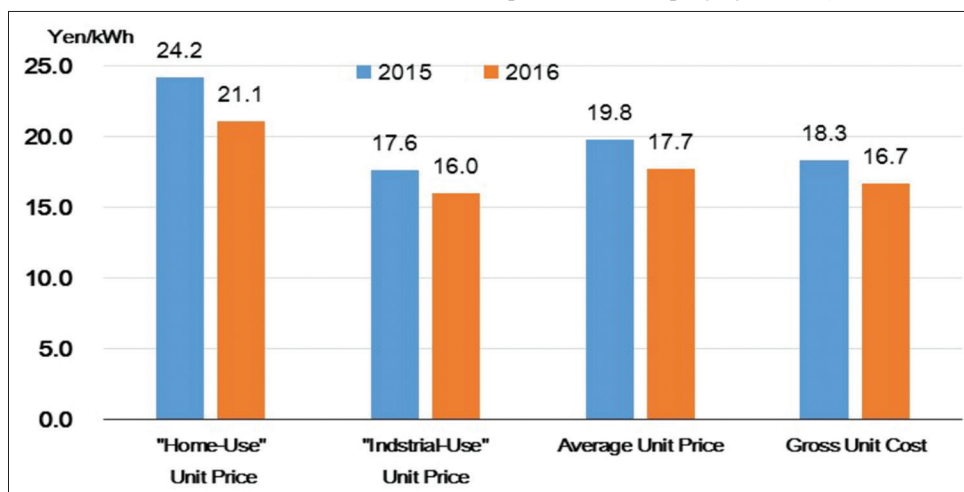
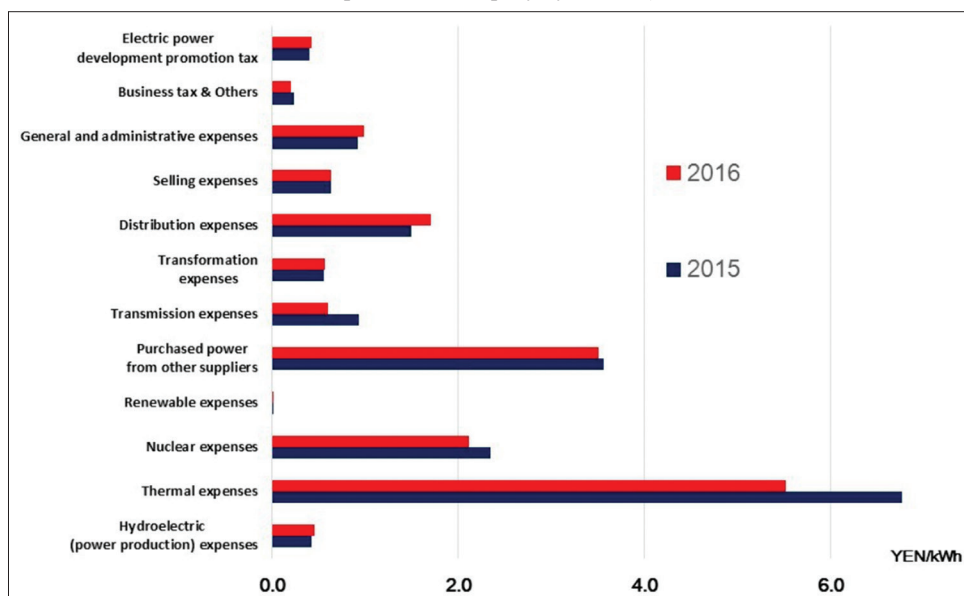


Figure 7: The breakdown of the 'gross unit cost' by cost factor for Kansai-Denryoku 2015vs2016(calculated from the FEPC data and the annual report of the company by H. Aoki)



4.2. Concerns about the Stability of Power Service

It is unbelievable that this policy of sheer discount battle be sustainable, even if TEPCO or KEPCO it is adopting the policy with intention to enclose big customers. What is worse, the sales unit price, once lowered, can hardly be raised again without harsh resistance; especially when a strongly public customer such as "Japan Post" gains a low-price contract, other customers will try to follow the case; the subsequent bidding in the power market must become lower-price oriented.

With such a risky sales strategy, can they secure sufficient/necessary capital investment for the transmission and distribution facilities? Unless they can sustain the required investment, various accidents will become inevitable, presumably resulting in enormous damages; indeed, the transmission and distribution equipment (grid system) is an indispensable "lifeline" not only for the power users but also

for all the power producers including would-be new participants into the power industry.

Even overseas, construction costs and maintenance costs of transmission lines would be covered by approved transmission fees (Asano, 2001). However, investment incentives are difficult to work because construction of transmission lines takes a long time for legal procedures, land arrangement, response to the environment and local people, and recovery of investment is long-lasting. Due to the progress of liberalization, in the EU, international transactions became popular, transactions across the state became active in the United States, new additions of transmission lines were a problem in both countries (Yamaguchi, 2007).

As to the above-said problem in Japan, a previous research has revealed that the capital investment in the transmission and distribution equipment came to be suppressed since the beginning of deregulation (1995).

Kaino (2005) analyzed, by changing the policy system twice, capital investment was reduced by 1546.3 billion yen (Power generation sector: 762.4 billion yen; · Transmission and distribution sector: 740.6 billion yen; · Operation sector: Billion yen) as the actual price in 2000.

Kinoshita (2006) said, "The total investment of power generation facilities was about 1.5 trillion yen in total for the 10 companies in fiscal 1993; but it decreased to <1 trillion yen in fiscal year 2003. Similarly, the investment in the transmission and distribution facilities also decreased from about 3.1 trillion yen to about 1 trillion yen." What is the current situation like? Let's survey factually.

Figure 8 shows a trend of <power generation costs, transformer costs and distribution costs> per 1 kWh of electricity sales from FY 1995 to FY 2015. In addition to personnel expenses and material expenses, this expenditure also includes <depreciation expenses, which are recoveries of upfront investments>. In short, those expenses in each fiscal year reflect part of the past investment.

At first when the deregulation just started, this expenditure was 4.4 yen/kWh. It turns out, however, that this term decreased to ca. 3.3 yen/kWh during the past 7-8 years. This decrease of about 1.1 yen per 1 kWh can be assigned simply to a reduction of capital investment in the transmission and distribution network because other factors like the personnel expenses or the general price level remains almost constant for this period.

By thus overly suppressed investment on equipment, TEPCO raised a fire accident of the underground transmission equipment in Niiza City, Saitama Prefecture in October 2016 (it took more than half a day until the fire was over); and, similarly, KEPCO brought about a large-scale blackout (it took 11 h to restore) in Suita city, Osaka Pref. in August 2017. Both cases occurred because of aging or deterioration of the transmission cable. These are firm evidences to show side effects due to suppression of the maintenance costs.

Let's think about a negative impact compelled to the existing power companies due to the retail power deregulation. It can generally be presumed that the uncertainty of income will increase

in future, which means that power companies will excessively refrain from investing of capitals. Kinoshita (2006) also said that "After the deregulation, an uncertainty has enlarged, especially in the power transmission and distribution facilities, and has brought a pressure to suppress the relevant capital investments."

If the existing power companies retain free hand on management and maintenance of the transmission and distribution networks, there can occur a predicament that they suspend the necessary investment simply because they fail to secure enough cash flow on the operating revenue, not because they fear managerial "unfeasibility" or "future uncertainty" in the industry.

As for the business structure of the power industry, the generation division and the transmission and the distribution division are planned for legal split-up in 2020, prescribed by The Electricity Enterprise Law amended in 2015. Yet it is still doubtful that this step can successfully dispel any possibility of servicing instability.

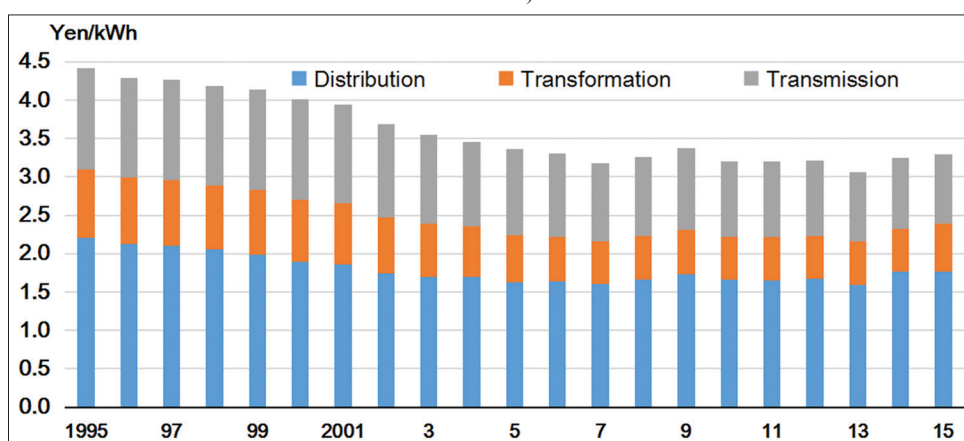
5. CONCLUSIONS

This research has clarified that Japan's power industry has historically constituted a very specific business structure: The double-layered pricing mechanism for the HUS and the IUS. However, such a dual pricing system for the electricity is not necessarily unique for Japan. For example, Germany has also been enforcing a dual pricing extremely advantageous for the industrial use; while Italy has been holding an equal-footing policy for the HUS and the IUS. And the UK's power system seems to be just in between the Germany's and Italy's (ANRE, 2011).

Since fiscal 2003 when the power prices for the IUS (and some other large-scale users) was deregulated, the revenues and expenses balance in the IUS (sharing 2/3 of the power demand) have continuously been in the red, while those in the HUS (sharing only 1/3 of the demand) have greatly been in the black and have been covering the deficit in the IUS, affording the industry to remain in the black.

The power service system makes up the essential core of the social infrastructure and underpins every social capital such as

Figure 8: Transmission, Transformation, and Distribution expenses by all the companies for 1995-2015 (calculated from the FEPC data by H. Aoki)



communications, transportations, railway transports, plumbing, medical service, etc. The industrial circles in general are also fully dependent on electricity as factory power sources. Therefore, the power supply must be stabilized always absolutely and must meet the power consumption without any time lag, e.g. of one millisecond. However, such an accurate power control necessarily requires an enormous amount of buffer equipment in power plants, high-voltage grids, transforming stations, low-voltage distribution systems, etc. To maintain and/or replace these extensive facilities, the power industry must absolutely retain the soundness of the business conditions.

On the other hand, the power prices have a strict upper limit due to the paying capacity of the national income consisting of labor incomes and capital incomes, respectively corresponding to the HUS and the IUS. Under this conditionality, Japan's power industry must keep the balance between its profitability in business and the said limitation to restrict the selling-on prices in the newly coming stage of the complete deregulation.

The power industry might resort to cut such indispensable costs for safety and maintenance under severe market pressure for "price destruction," which would cause a serious consequence: Potential instabilities in the power service. In the new regulation-free stage, the power users must pay the highest attention possible to an "appropriateness" of the power prices but never to a bare "cheapness."

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