The Outlook for Present Business Challenges Facing the Japanese Gas Distribution Industry and the Scheme for Provision of Technical Solutions through Japanese Gas Industry Organizations

~Future Prospect of R&D Activities and Funding for the Japanese Gas Distribution Industry~

Seita Shimizu, Hiroki Kikuchi

Pipeline Technology Center, Tokyo Gas Co. Ltd.

1. Introduction

Japan is dependent on imports to satisfy almost all of its energy demand. It is, therefore, not an exaggeration to state that a policy to ensure energy is a national policy and that ensuring a stable supply of energy is an important challenge directly linked to the stability of the nation. The present rising demand for energy in Asia, tight demand and rising prices caused by partial speculative market transactions are difficult for Japan to ignore, and the government and private sector are cooperatively undertaking a variety of activities to guarantee and to conserve energy in order to prevent circumstances that would have a serious impact on corporate activities and on the daily life of individuals.

It is predicted that under such circumstances, natural gas that has more abundant exploitable resources, lower geopolitical risk, and can be counted on to ensure longer stable supplies than crude oil, will play an increasingly important role in primary energy consumption in Japan. The government's long-term energy policy vision, "Outlook for Energy Demand in 2030", that it announced in June 2004 calls for a clear shift to natural gas, and predicts that the demand ratio of natural gas for all uses will increase steadily for several decades in the future.

In general characteristics of Japan's gas utilities that supply this natural gas to its end users are vertically integrated and single energy supply (gas only) and a mixture of government-owned and private sector companies. Turning to the business environment, it can be stated that under the impacts of the expansion of liberalization and a growing demand for lower gas tariff following the 1995 liberalization of the market, the falling birth rate and aging of society that have both advanced unexpectedly fast, and energy conservation policies, it is now difficult to design an idealized vision of the future based only on overall past successful experiences. Perhaps as a consequence of this, the industry has gradually but steadily been going through a reorganization, with about 30 gas utilities, or approximately 10% of the total of all Japan's gas utilities including both publicly and private owned utilities, disappearing during the past 10 years as a consequence of business transfers, mergers and acquisitions, or purchases of gas utilities by large electric power companies. It can be concluded that for this reason, in order for existing gas utilities to continue to grow in the future, they must skillfully control the impacts of the environmental changes described above to resolve a variety of management

problems.

But on the other hand, of the 228 members of the Japanese gas industry in August 2004, only about 5% were capitalized for more than one-billion yen ($10 million), and more than 20% were publicly owned companies operated by local governments. This means that because of their corporate strength and limits on the business activities of public organizations, almost no gas utilities have retained specified capital needed to overcome a variety of management challenges. Therefore, Japanese gas utilities including Tokyo Gas have joined the Japan Gas Association (JGA) that has been established as an industry organization to promote the sound growth of the gas industry and are determined to respond to changes in the business environment through its support for their efforts to overcome challenges.

The JGA covers its organizational and operating costs with contributions and membership fees paid by its member companies, and almost its entire staff are employees temporarily transferred from large gas utilities (the three companies with the highest sales). It conducts an extremely wide range of activities including summarizing requests for deregulations concerning the construction and maintenance standards on gas infrastructure, drawing up various technical standards, negotiating concerning the proposal and funding of technological development through national projects in order to resolve gas utilities' common problems, implementing projects, and providing technical support to medium and small gas utilities. It is predicted that research related to the drawing up technology standards and the promotion of national projects in particular will become increasing important in the future as the technological development investment capacity of large gas utilities tends to fall under further market liberalization and intensifying competition with electrical power companies.

As a result of an examination of the situation in foreign countries, it must be stated that because lowering gas tariff by industrial reorganization and increasingly efficient work are the key task caused by the rapid advance of market liberalization, investment in R&D activities by gas utilities tends to fall sharply, and there are no industrial organizations as large as the JGA that work to overcome these challenges.

So principal contents of this report are introductions to the organization, scale of funding, plans, and specific R&D activities through the JGA and the role and activities of Tokyo Gas in this organization in order to be a help for studies to find the best approach to R&D activities in future gas distribution industry around the world, while considering the special aspects of gas industry in Japan.

2. An overview of the Japanese energy market and gas industry

Before introducing the activities of the JGA, this report describes the gas industry and the state of the environment surrounding the energy market in Japan supported by a variety of statistics.

1) Prospects for the Japanese energy market

An outline of prospects for the future energy market in Japan leads to the final conclusion of conversion from crude oil to other energy sources and implementation of energy conservation. Needless to say these are closely related to the geopolitical risk of the Middle East, a region that Japan is extremely dependent on for imported crude oil, and to its duty to reduce green-house effect gas now that the Kyoto Protocol has taken effect.

Figure 1 shows the present state and a future image of the percentages of types of primary energy consumption in Japan. As stated in the introduction, the government has prepared a plan to lower Japan's dependency on oil by 38% during the next approximately 25 years, and the specific measures proposed by this plan are a shift to natural gas that is the most realistic solution at this time while continuing to anticipate the use of new energy (RPS) such as biomass. Regarding specific energy uses that will be supplied by shifted natural gas, the plan focuses on popularizing distributed electric power sources centered on co-generation to the level that it accounts for 21% of all electric power generated by 2030. (See Fig. 2)

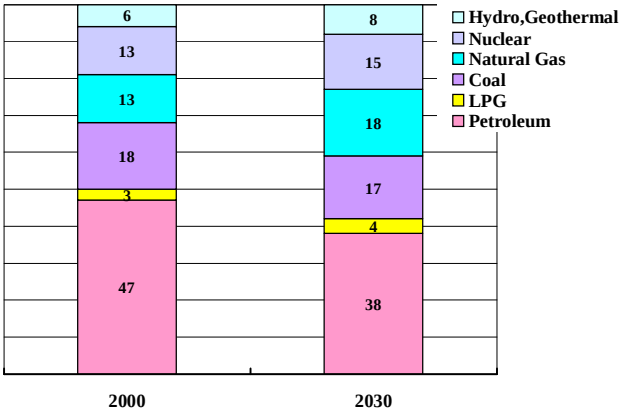


Fig.1 Primary Energy Supply Outlook for Japan(%)

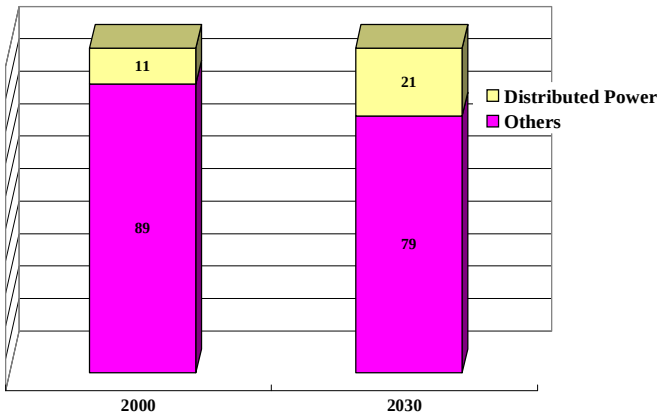


Fig.2 The Ratio of Distributed Power to Total Generation Volume(%)

The government promotes energy conservation to conserve the environment by legally requiring electric power utilities and gas utilities to work to spread the use of energy-saving equipment at end users' consumption, by studying the introduction of an environmental tax, and by developing and popularizing new technologies such as natural gas co-generation systems that contribute to reducing green house effect gas. The quantitative outlook for energy conservation is a reduction of about 10% from the 2000 level by 2030 according to the best-case scenario: a case where advanced energy technologies etc. are successfully developed (see Fig. 3). While this value appears difficult to achieve at a glance, it is predicted that even in a case where energy conservation in Japan is not backed up by technologies that can accelerate energy conservation, it will peak in 2021. This is a consequence of the fact that overall Japanese industry has matured and it is difficult to foresee large-scale new demand (internal demand), plus the birth rate is falling and the society is aging at unexpected speed, resulting a trend for energy consumers to fall in numbers (see Fig. 4).

Looking ahead to the future Japanese energy market in this way reveals that although it is predicted the shift to natural gas will progress to a certain degree, the overall market will tend to shrink in the medium and long term. For this reason, if the future domestic energy industry does not construct a new high added value business model to respond to the changes of life styles as a result of the changing composition of the population, and to the changes in industrial structure, there is a possibility that expanding liberalization will create a minus-sum game involving price competition between industry members for a limited market.

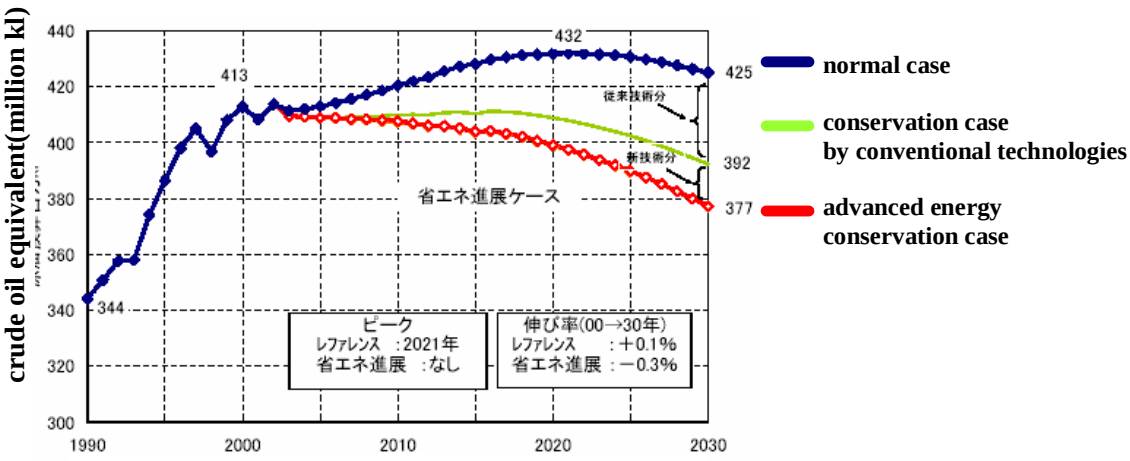


Fig.3Outlook for total energy demand and supply in 2030

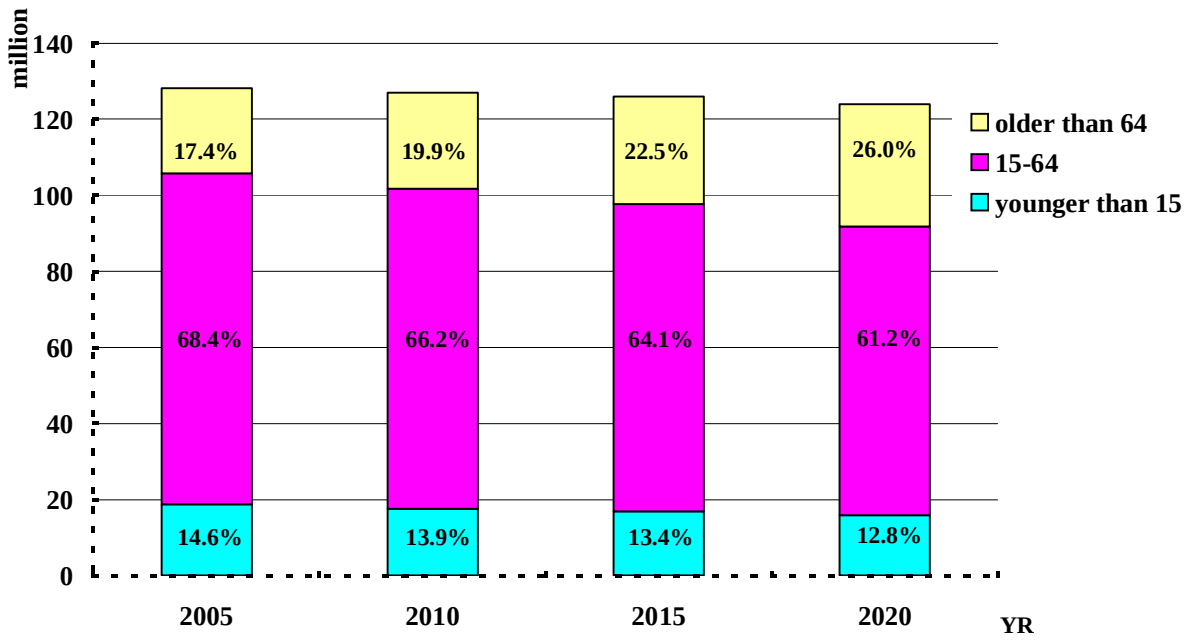


Fig.4 Dynamics of population in Japan

2) The overview of market liberalization

The market liberalization of gas supply in Japan began exactly 10 years ago, when more than 2 million m^3/year was consumed by a customer. Later energy market liberalization was carried

out through parallel discussions concerning electrical power and gas, resulting in the present situation that is shown in Figure 5. The figure reveals that because the electrical power market is larger (about 3 times as large as the gas market; see Fig. 6) and its suppliers are all large scale companies (11 companies), the expansion of liberalization under the initiative by regulatory authorities advanced more rapidly than that it did in the gas industry. As a result of market liberalization, “gas versus gas” or “electricity versus electricity” in the industrial use field and “gas versus electricity” in the commercial and residential use field intensified, and a comparison of average rate for all uses in January 2000 taking Tokyo Gas and Tokyo Electric Power Company (TEPCO) as examples reveals a fall of about 8% in gas rate and 17% in electricity rate.

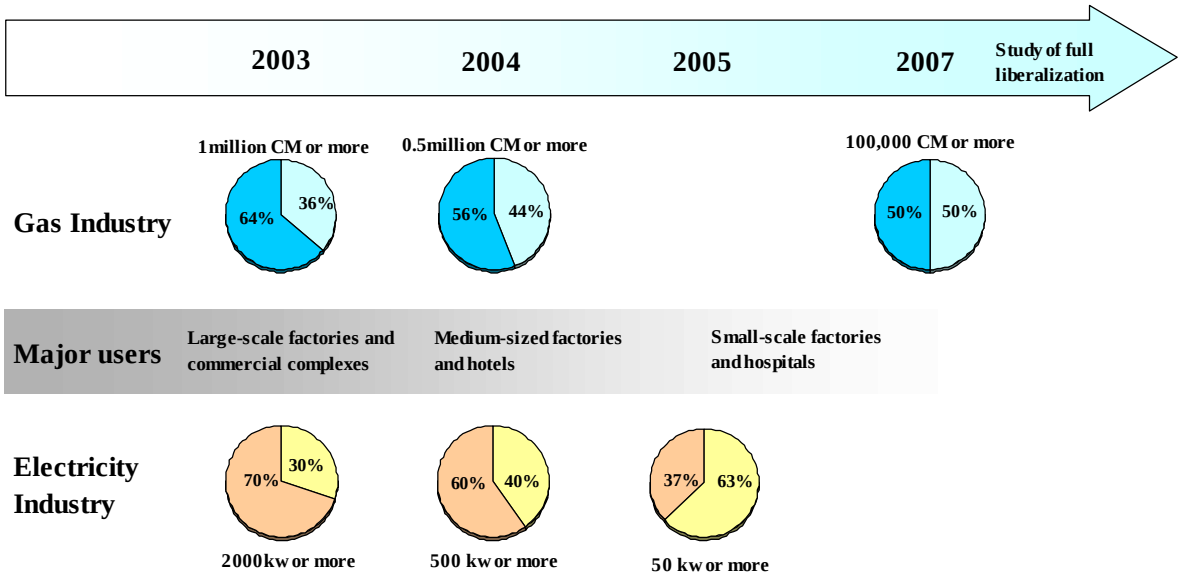


Fig.5 Market liberalization Schedule

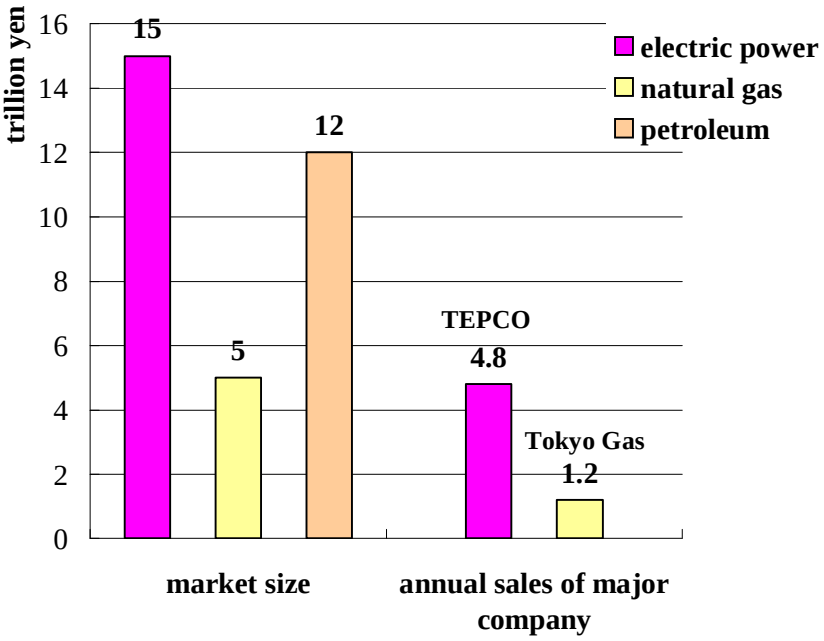


Fig.6 Japanese energy market size (2003)

There are three noteworthy characteristics of the competitive environment created by market liberalization in Japan. Firstly, some electric power utilities and relatively large gas utilities that formerly supplied only one energy source have been encouraged to provide dual energies by entering each other's markets. Secondly, there has been a sudden switch to all-electric homes in the residential use energy market. Thirdly, the first two factors have spurred price-cutting competition. And a forwarding system has been established to provide open access to pipelines, specific examples of open access pipelines have emerged, and it is predicted that their number will rise. For Japanese gas utilities, the most important approach to strengthening their business will be to establish their market superiority by planning and implementing appropriate measures to compete with the electric power utilities that enjoy greater corporate power including superior investment capacity for example, and the gas utilities are forced to operate in difficult circumstances in anticipation of further liberalization.

3) The present state of the Japanese gas industry

Overview of Japanese gas utilities

Although a revision of the law in 2004 added a new form of business called the "gas pipeline utility" that specializes in supplying large scale users (0.5 million CM or more) and other gas utilities, many of Japan's gas utilities are "normal gas utilities" that are basically vertically integrated type that operate integrated enterprise consisting of transport, supply, sales, and security. Recently some gas utilities have entered the electric power supply industry to have and hold electric power by constructing their own electric power plants, the giant gas utilities, Tokyo Gas (net sales ¥1190.7 billion) and Osaka Gas (net sales ¥975.3 billion) for example, but almost all gas utilities handle only gas supply.

Table 1 categorizes Japan's gas utilities by number of customers. It shows that in August 2004, more than 50% served less than 10,000 customers and that 23% of the utilities were public utilities operated by local governments. Although not shown on this table, 70% of the utilities employ less than 50 people, 65% are utilities with 2003 ordinary income less than ¥100 million. In fact more than 80% of the ordinary income of all Japanese gas supply industry is earned by its three largest utilities.

Number of Customers	Number of Private gas Utilities	Number of Public Gas Utilities	Subtotal	Percentage
Less than 1000	1	1	2	0.9
1001～10000	81	32	113	49.6
10001～100000	72	19	91	39.9
100001～500000	14	2	16	7.0
More than 500001	6	-	6	2.6
Total	174	54	228	100

Table 1 Number of gas utilities classified by the number of customers (08/2004)

Figure 7 shows demand by use now and during the past 2 years under the above-described utilities. The figure conspicuously reveals the results of the policy of shifting to natural gas in the industrial demand field as described in the introduction, and at the same time shows that residential demand is flat under the effects of the declining population. This suggests that for many utilities whose residential use customers account for more than half of their sales, it will be extremely difficult to increase their profits in the future if they continue to operate their business to maintain the status quo without taking measures of some kind to expand uses or carrying out restructuring to reduce costs.

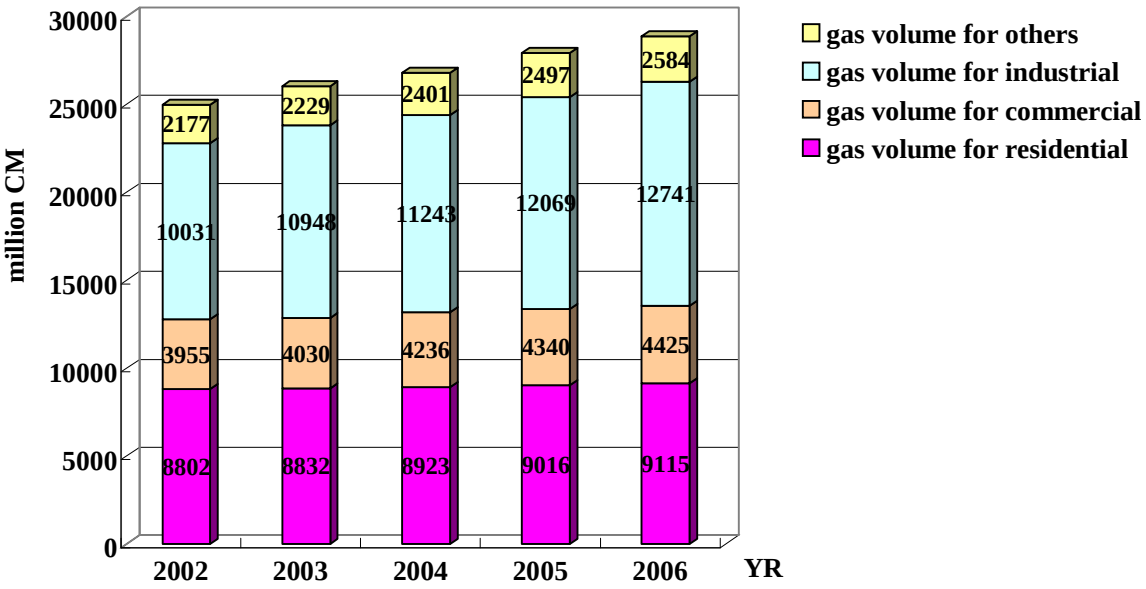


Fig.7 Plan for gas demand and supply in Japan

The amount of pipeline

Table 2 shows the total length of pipeline by pressure category with the degree of development of the gas supply industry in Japan as the index. Because most of the natural gas that is supplied in Japan is LNG, high-pressure pipelines used for transport purposes are undeveloped. On the other hand, for many utilities, major customers in terms of their numbers are residences and other small scale users, and the burying environment is mainly" Class 4", resulting in the percentage of all pipelines that are low pressure pipeline being extremely high at 86%. And the percentage of polyethylene pipe used as low-pressure pipeline is about 25%, so one future concern will be the aging over time of pipelines made of old materials.

Table 2 The amount of pipeline in Japan "2003"(thousand km)

	P≧1MPa	0.1MPa≦P≦1MPa	P≦0.1MPa
Steel	**1.6**	**23.7**	**87.9**
Cast Iron	**0**	**5.6**	**59.3**
PE	**0**	**0**	**47.0**
Others	**0**	**0**	**0.9**

Total	**1.6**	**29.3**	**195.1**

3. Current challenges facing Japanese gas utilities

The state of energy industry and present situation among gas utilities in Japan has been explained above, but below, efforts to clarify and overcome challenges faced by gas utilities in Japan, and the role of the JGA in efforts that are the major themes of this report are described.

1) Key challenges facing Japanese utilities

The key challenges facing Japan's gas utilities can be categorized as those that are sustainable growth and those concerning security, and understanding their contents is extremely significant in efforts to understand the need for and effectiveness of planned measures to overcome these challenges in Japan. Here challenges are selected as those common to all gas utilities and an outline of each is presented.

Competition with electricity to satisfy residential demand

The most typical challenge that Japan's gas utilities must overcome to expand their profits is, as stated above, the aggressive tactics of electric power utilities in the residential demand sector that have suddenly appeared as a result of advancing market liberalization. The appearance of such a competitive situation is a result of limitation to the penetration of the "best mix of electricity and gas" in residential use energy demand, resulting from two facts: that Japan's electric power utilities and gas utilities primarily handle only one energy source and that both conduct vertically integrated business that include supply and sales. The aggressive sales method that electric power utilities have implemented in recent years in order to expand demand for electricity is all-electric housing in which the kitchen, heating, and hot water supply are all electrically powered systems. Table 3 shows the percentage of new housing starts that are all-electric housing. The table shows data for 2003, but it is assumed that the electric power industry will continue its battle to electrify homes with the all-electric home as its weapon. In the Kanto where the most new homes are being constructed, the goal of the electric power utility in that region is to make 24% of new construction starts all-electric houses by 2010. There is a growing possibility that if the electrification of home use energy demand continues to advance at its present rate, pipelines that are the gas utilities' biggest asset will be nonperforming assets. So this is a challenge that is extremely difficult to ignore.

Table3 all-electric new housing ratio"2003"

	Housing starts	Number of all electric housing	all-electric new housing ratio(%)
Hokkaido region	50724	6756	13.3
Tohoku region	64102	12143	18.9
Kanto region(Tokyo)	505441	23000	4.6
Chubu region	133901	23000	17.2
Kansai region	181174	46660	25.8
Kyushu region	101897	34000	33.4
Others	136410	35935	26.3
Total	**1173649**	**181494**	**15.5**

Expansion of gas sales per customer

As shown in Figure 7, although gas sales to satisfy industrial demand will tend to rise in the future in Japan, sales for residential use will remain flat. The former has benefited from the policy of shifting to natural gas, while the primary factors affecting the latter have been the spread of energy conservation policies and the falling population. Table 4 that shows the customers profile of Japanese gas utilities reveals that of the total of 26.96 million consumers, about 94% are residential users. Therefore, residential use not only makes a large contribution to total sales of Japanese gas utilities, it is closely related to personnel planning by vertically integrated utilities that also handle security and sales. Therefore in the competitive environment described above, not only is it essential to at least maintain the number of residential users in order to prevent the sudden appearance of surplus employees, it is also vital to increase total sales to and profits earned from each customer that will probably be limited as a result of population decline in order to search for growth strategies. Gas utilities are now trying to overcome this challenge through strategies such as completing its products that realize expansion of uses such as residential use fuel cell cogeneration systems, and expanding the range of its commercial activities with new services such as residential use ESCO or home security etc.

Table4 Breakdown of number of customers and gas sales

	Number of customers "2004"(thousand)	**average individual annual sales volume "2004" (CM/41.8605MJ)**
residential	**25338**	**423**
commercial	**1295**	**4195**
industrial	**63**	**242,424**

Others	**265**	**11,216**

Safety and disaster countermeasures

As shown by Table 2 above, the percentage of Japan's low-pressure pipelines that are aged pipes is definitely not low, and they will continue to age in the future. Table 5 shows the remaining length of aged pipes by pipe material in March 2003. In-house pipes are included in the table because in Japan the law stipulates that gas utilities are responsible for the security of pipes that are the property of customers and that the cost of their improvement is borne by the customer, but the gas utilities are responsible for implementing improvement measures (see Fig. 8). This is one of the reasons why it is difficult to undertake aged pipe measures in Japan, and it is difficult to state smooth progress is being made nationwide in the implementation of house pipe countermeasures. The execution efficiency of main pipe and service pipe measures is kept low because of hindrances such as legal restrictions on working hours and the fact that customer density is more than four times as high as it is in the United States (calculated based on number of customers per 1km), resulting in these measures imposing an unavoidable heavy cost burden (¥120,000/m in down town areas).

Table5 Total remaining length of aged pipes

		Remaining length	Reduction in the past five years
Main/ Small main	Gray cast iron	8,000km	-2,300km
	Galvanized /AS	35,000km	-5,250km
Service pipe		1,973,100 pcs.	-225,100 pcs.
House pipe		3,090,500 pcs.	-613,200 pcs.

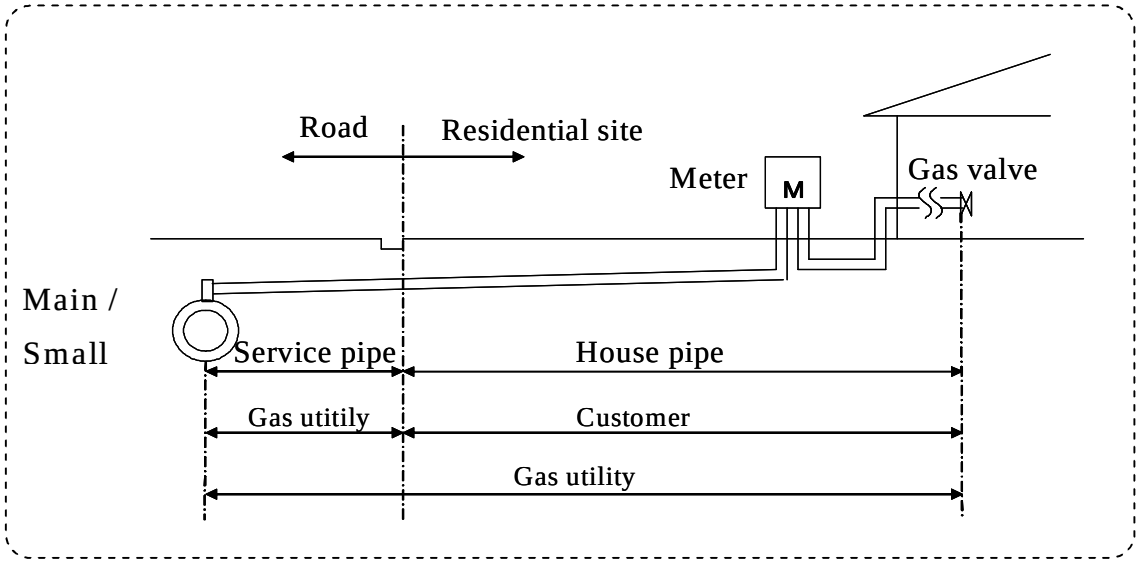


Fig.8 Assets classification and safety responsibility assignment

Turning to disaster prevention measures, Japan is one of the world's most earthquake prone countries (see Fig. 9), and as companies that provide public benefits, gas utilities bear the social responsibility to reduce damage and carry out rapid restoration in an emergency. This forces them to make investments to create infrastructure such as disaster prevention systems and equipment that are resistant to earthquakes. Three earthquakes in the magnitude 7 class were observed in Japan during the past year, and it is predicted that there will be a demand for the implementation of more earthquake countermeasures by regulatory administrators.

Fig.9 An example of the damage caused by an earthquake in Japan

Challenges related to security and disaster prevention measures that Japan's gas utilities face have been introduced above, but there is one more related challenge that should be considered. As stated above, the cost of maintenance investment in Japan is high, and besides it there has been a tendency for number of employees of gas utilities that are responsible for security tasks to fall. It is no exaggeration to say that it is an extremely important business challenge that must be overcome: namely to find ways to learn how, in a competitive environment, to implement these measures cheaply with labor-saving, in other words, how to optimize these measures. As a result, this field is one in which the immediate effectiveness of providing solutions through R&D activities is counted on to make the best contribution to filling the gap between the ideal effectiveness of measures and the allocatable limited management resources.

2) Influence of market liberalization on gas utilities

This chapter introduces the ways that various changes in the business environment explained above and challenges these changes create have resulted in changes among Japan's gas utilities. Three changes in particular are discussed: M&A and the transfer of business enterprises, more efficient operations in order to lower gas rate, and shrinkage of R&D expenses.

M&A and the transfer of business enterprises

To begin with an explanation of trends in the reorganization of the industry through M&A, etc., takeovers and mergers in Japan's gas industry through TOB or an exchange of shares on the stock market are not being carried out at a very high rate at this time, although it cannot be determined whether or not this is the action of an either-or situation: the duty to restore profits to regional consumers as a public business or the duty to restore profits to specified shareholders. There have only been about 10 cases in the last 10 years, including cases based on the transfer of business enterprises. The transfer of public utilities by local governments is now being done extremely frequently: about 20 times in the past 10 years. The main reason for this is assumed to be a tendency for profitability to fall in the competitive environment, as a result of prohibiting public corporations to conduct aggressive sales activities to increase income because of the basic concept of "prohibiting public enterprises from putting pressure on private enterprises," in addition to the present government's policy of privatizing public enterprises. Therefore, we believe that this trend will continue in the future by involving private utilities that lack adequate management organizations.

Operational efficiency improvement

This report seems to have stressed only the present harsh conditions, but many gas utilities have adopted a policy of striving to improve their work efficiency and adapting to change in order to survive as market liberalization and decline of the working population continue. Figure 10 shows changes of gas sales per employee during a 10 year period with 1992 considered to equal 100. Although the change of the customer profile represented by a rise in industrial use where a large volume is used by each customer is having an impact, this figure reveals that the work efficiency shown by the volume of gas sales during this 10 year period increased by about 1.9 times. It is assumed that future restructuring will be centered on the transformation of the industry to one better able to produce profits by cost reduction of plant and equipment investment and of operating expense, distributing with a low fixed ratio, promoting profitable services with high added value etc. and lowering the break-even point.

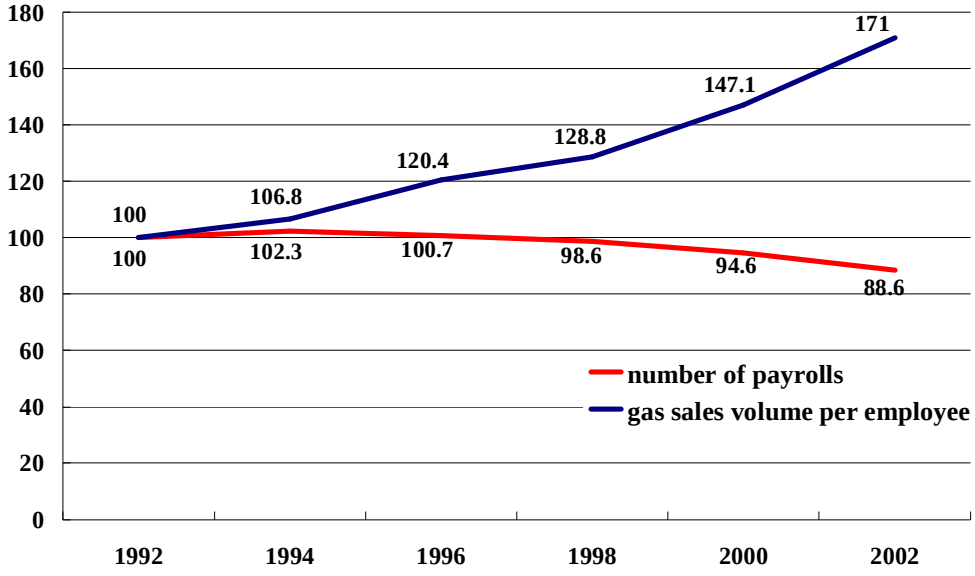


Fig.10 Changes in operational efficiency of gas utilities

Shrinkage of R&D expenses

Figure 11 shows changes in the total amount invested in R&D by Japanese top three gas utilities (that account for more than 95% of investment by all utilities) during the past five years. The graph shows a gradual fall in both the amount of investment and number of researchers (the slight rise in the number of researchers in 2001 was a result of a reorganization of the R&D division at Tokyo Gas); a trend that will presumably continue in the future.

Although a scale of investment larger than in Europe and America has been maintained in this way, the impact of market liberalization has increased urgent challenges such as falling gas rates, resulting in conspicuous precursors of an inversely proportional relationship, "advancing liberalization and falling R&D investment," in Japan. The breakdown of R&D investment shows a growing shift to products that can directly become weapons in competition and to technologies that permit the early achievement of cost reductions, and medium and long term challenges such as the formation of infrastructure with greater integrity are declining. But when the goals of R&D investment are categorized by "gain" (desirable outcomes) and "pain" (outcomes that should be avoided), there is fear that recent circumstances marked by a conspicuous shift to gain represented by attractive gas appliances etc. will cause a decline of adjustability to sudden equipment problems etc. Therefore, in order to avoid pain to completely fulfill the social responsibilities of a company considering the frequency of serious problems caused by aging of equipment in other infrastructure industries and the shortage of investment in safety measures in recent years in Japan, there has been a trend in Tokyo Gas to discuss the proper amount of R&D investment needed to maintain and strengthen the foundation technological abilities that is necessary to manage pipelines etc., Tokyo Gas has organized the "fundamental technology department" to undertake the above role since April 2006.

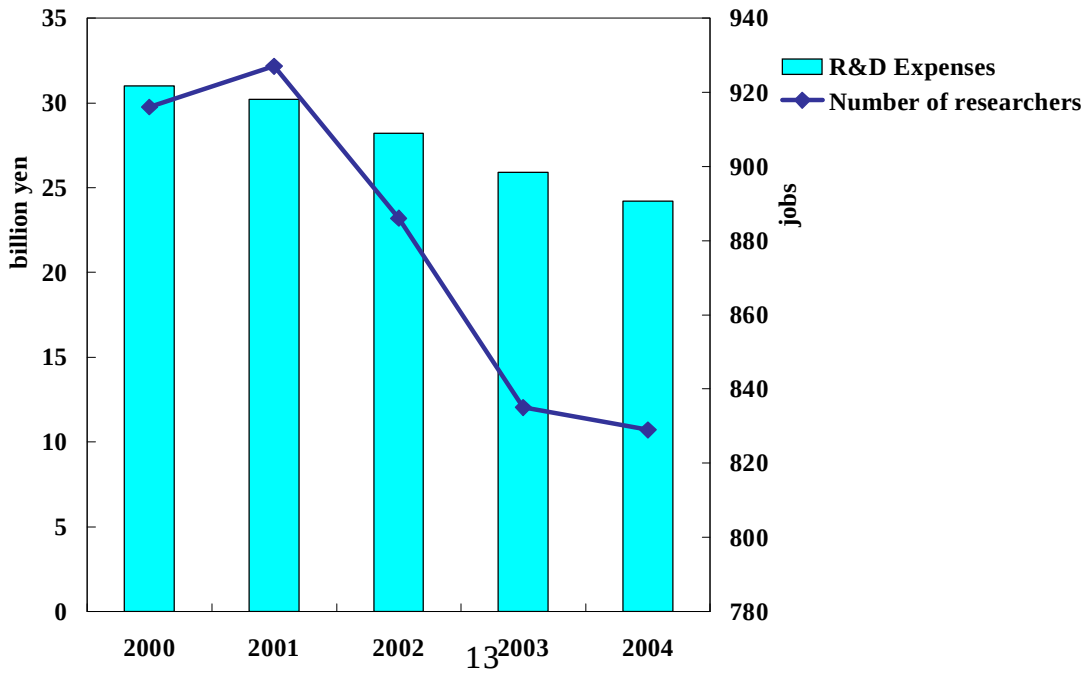


Fig 11 Shifts of resources related to R&D investment

3) General plans for overcoming the challenges

At the same time as a number of challenges that Japan's gas utilities now face were introduced, it was explained that many utilities do not have adequate investment capacity to overcome these challenges. But it is very important to overcome these challenges from the perspective of the survival or failure of utilities and the future popularization of natural gas, and it can be stated that it is essential to overcome them by devising strategies such as forming alliances or obtaining external resources. Therefore a variety of frameworks have been established by Japanese gas industry to overcome these challenges in order to achieve the goal of expanding the overall industry. This section introduces outlines of these frameworks by dividing the challenges into challenges unique to specified utilities and to challenges shared by the entire gas industry. But judging from the main theme of this report, the contents that are introduced are linked to the provision of solutions through technology development etc. and those related to the administrative responses such as gas rate reductions or lobbying activities directed at regulatory development are minimized.

Systems to resolve specific or short-term challenges

Typical individual challenges facing specified utilities include the introduction of systems for efficient management of work and lowering the cost of the large investment in infrastructure construction and maintenance. Utilities facing this type of challenge can obtain technology development support from the Japan Gas Association (JGA) and expertise from utilities with R&D functions. Figure 12 and Figure 13 show outlines of schemes that are used to provide expertise from the JGA and utilities.

JGA has prepared two methods: technology development support and providing opportunities to obtain information concerning expertise from other utilities. The first approach is adopted in cases where there are no other utilities with the expertise needed to overcome the challenge, and the challenge is shared, either actually or potentially, by a certain number of other utilities. After it has been decided to obtain development support from the JGA, the utility conducts development in an alliance with a specialized manufacturer while following the advice by the JGA. The results of the development are reported to the JGA in detail and the contents are released to utilities that face similar challenges.

In the latter case, exhibitions or symposiums are held with utilities with R&D functions acting as the exhibitors who bring the results of research and development that can be released. Utilities gather information about the latest technologies by attending these exhibitions and obtain those technologies that are useful for a fee. Such exhibitions and symposiums are held throughout Japan about 6 to 8 times per year, unfailingly attracting large numbers of visitors.

The provision of expertise for a fee by specified utilities is generally performed by gas engineering subsidiaries of the utility. Engineering companies collect information about challenges facing other utilities through the above exhibitions and symposiums or their daily business activities to provide solutions. But, in cases where the gas utility that is the parent company does not have technology suitable for the challenge, in principle, only action in the existing menu is taken instead of taking supplementary actions.

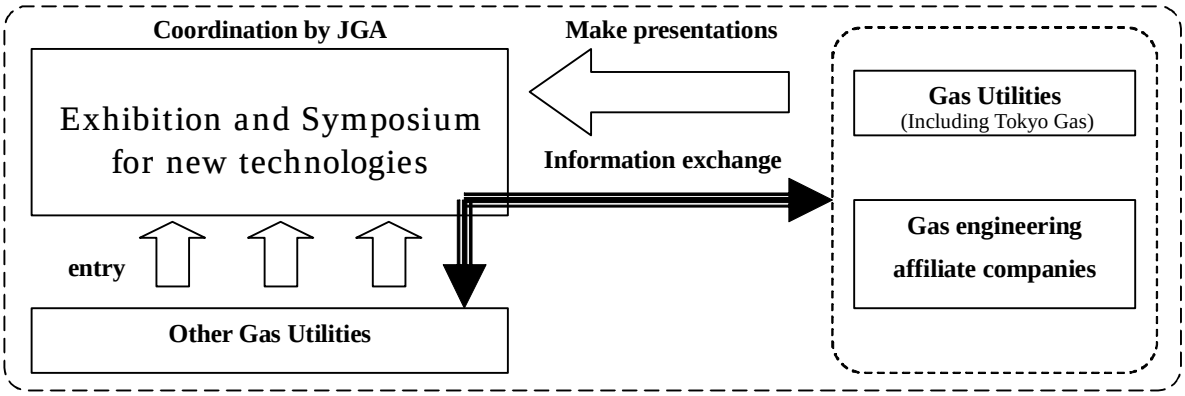


Fig.12 The scheme of technical support through JGA

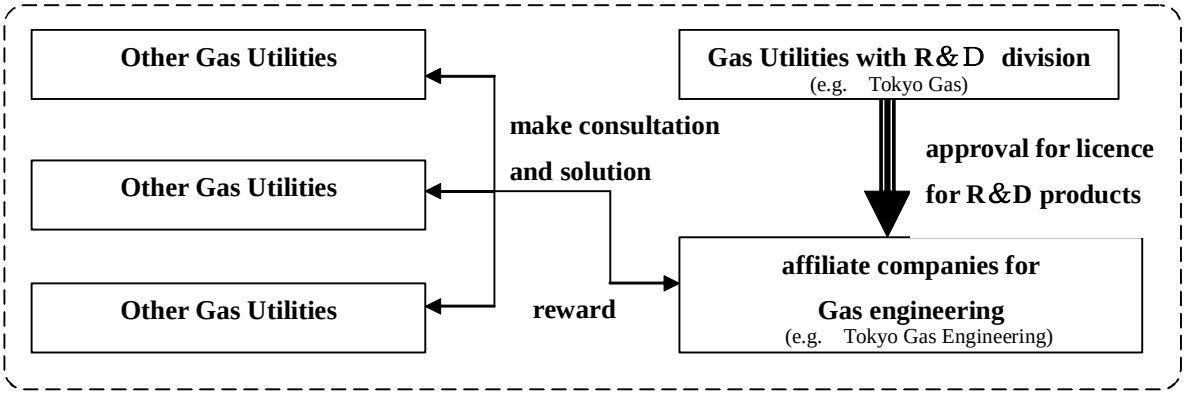


Fig.13 The scheme of technical support not through JGA

Solution scheme for overcoming common or long-term challenges

The following four frameworks are established to meet medium and long-term technology challenges such as common challenges and high technological hurdles facing some utilities and the high cost of investment to overcome these challenges.

The first framework is the pattern: utilities with specified R&D functions independently performing development. This pattern is adopted in cases where the marketability in the gas industry of methods that can resolve the challenge is recognized to be extremely high, and it is focused on technologies that will presumably make an extremely big contribution to profits of pioneers that make their company's specifications the de facto standard and by employing patent strategies and to the improvement of the company's presence in the gas industry. Specific development cases include

residential use fuel cells (PEFC) and remote operating systems for gas appliances and equipment, and other utilities resolve similar challenges through the paid provision of the development products.

The second framework is the pattern: two or three utilities with R&D functions conduct development through an alliance. This pattern is adopted mainly in cases where, although overcoming the challenge will have a great impact on the improvement of gas sales and operation efficiency, the marketability of the product is not very high, and in cases where there is a high possibility that the unification of specifications through an alliance will draw out bargaining power. A specific development example is gas meters.

The third framework is the pattern: to disseminate new technologies and new technological knowledge developed by a utility with R&D functions among all utilities, the JGA further develops the new technologies etc. to the general purpose stage and sets their standards. This pattern is adopted only when it is implemented according to the needs of utilities and the investment burden required to develop it to the general purpose stage is relatively light. Specific examples are mainly constituent elements of infrastructure such as pressure regulators, valves, and pipeline materials.

The fourth framework is the pattern: the JGA collects utilities' needs concerning medium and long term challenges and proposes a project to METI to obtain approval of it as a national project in order to promote development funded by the government. This pattern is the type of technological development for all utilities and that requires the largest budget, and it is implemented through extremely strict procedures including deliberations to decide if it can be introduced as a national project or granted project, management of progress of development, and evaluation of the finished product after completion of the project. Evaluation standards are mainly the degree it will contribute to the expansion of the use of natural gas and qualitative and quantitative evaluations of the related benefits to the people.

Table6 General scheme of solving the issues among Japanese gas utilities

Type of scheme	Promoted	Cost burden
Original R&D effort	By a certain gas utility	Private expenses
Joint R&D effort	By a few gas utilities	Private expenses
Exhibition and Symposium	By JGA	JGA and donation from some gas utilities
National project	By METI and JGA	National expenditure

The above are the frameworks for overcoming challenges that are now seen in Japanese gas distribution industry. When an approach that will immediately overcome a challenge cannot be found, there are cases where the JGA or a large gas utility, for example Tokyo Gas takes the leading role in establishing an organization to study countermeasures, but the details must be regretfully omitted because the scope of this report differs. But as stated above, technological development investment by

individual utilities has gradually declined in recent years, and the selection and concentration of development themes has advanced. Therefore, it is thought that the results of the first framework will not necessarily comply with the needs of all utilities in an increasing number of cases. So with the trends to greater competition and the reorganization of players in the future gas industry predicted, the role that the JGA should play in technological development is expected to become increasingly important. So beginning in the following paragraph, this report will primarily introduce an outline of the JGA and national projects that play a major role in providing technological development solutions: specifically the flow from initial proposal to conclusion and the results of past development.

4. The role of the JGA in providing technological solutions

The activities of the JGA are extremely wide-ranging and it is an organization that combines the functions of the AGA and the GTI of the United States, making it an extremely rare organization in gas industries around the world. As stated in the introduction, its specific activities include aggressively contributing to the revision of laws concerning the deregulations, funding and implementing technological development that will improve security and expand the use of natural gas, leading efforts to revise various technological standards, helping overcome management challenges faced by small gas utilities, and handling negotiations with administrations concerning the provision of subsidies to projects that spread the use of existing technologies and that promote the improvement of safety. A big difference between the JGA and other industrial organizations is that in addition to negotiating administrative bodies, it aggressively promotes research and development and is closely involved in implementing this research and development and popularizing its results.

1) Outline of the JGA

An outline of its role and its organization

Figure 14 shows an outline of the organization of the administrative office of the JGA. The administrative office consists of managing directors, 13 departments and 40 groups. It manages the expert committees (described later), handles liaison between the industry and administrative bodies and other related industries, etc., conducts national projects and projects subsidized by the national treasury, and enacts technological standards. Its eight local branches have been established to manage projects that can more easily consider the benefits for all utilities.

Of these organizations, the departments that deal with various technological challenges are the technology department that gives advice concerning the enactment of technological standards and technological policies concerning security and plant operation and the technology development department that proposes technological development policies and manages national projects, and both of these are divided into groups that conduct activities intended to achieve specific goals.

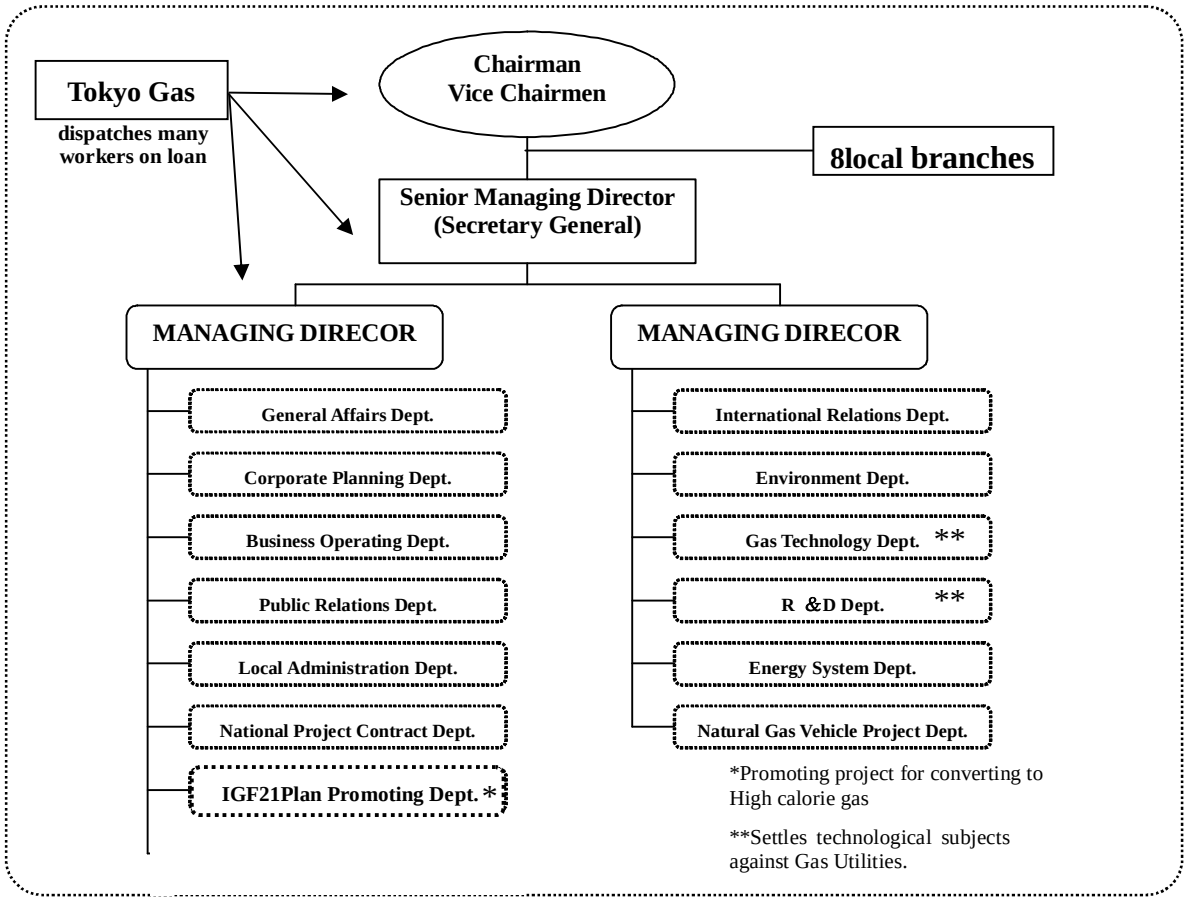


Fig.14 Staff organization of JGA

On the other hand, JGA project plans and other proposals, national projects and research and development on technological standards etc., action plans to promote the wide use of technologies it creates, and almost all work conducted by the administrative office are successively examined by third parties to assess their appropriateness and handling. Specifically, expert committees formed by academic experts and executives of gas utilities for each purpose and for each field carry out evaluations in preparation for final decisions. Figure 15 is an outline of the committees. The Standing Committees, that examine items concerning the regular business operations of the gas industry, handle fundamental challenges facing the gas industry; public relations on behalf of the gas utilities, environmental problems, and other technological problems etc. The Committees for Specific Issues, that are committees that mainly evaluate the state of the progress of national projects and their results, are formed mainly by executives of gas utilities. The Special Committees are committees consisting mainly of academic experts that examine the same items as the Committees for Specific Issues. The differences between the two types of committees are that the former evaluates the effectiveness of the products of the development and their conformity with the needs of all utilities from the perspective of gas utilities that actually conduct the gas business, while the latter evaluates the products of

development to decide whether they are suitable from the viewpoint of customers and scientific knowledge.

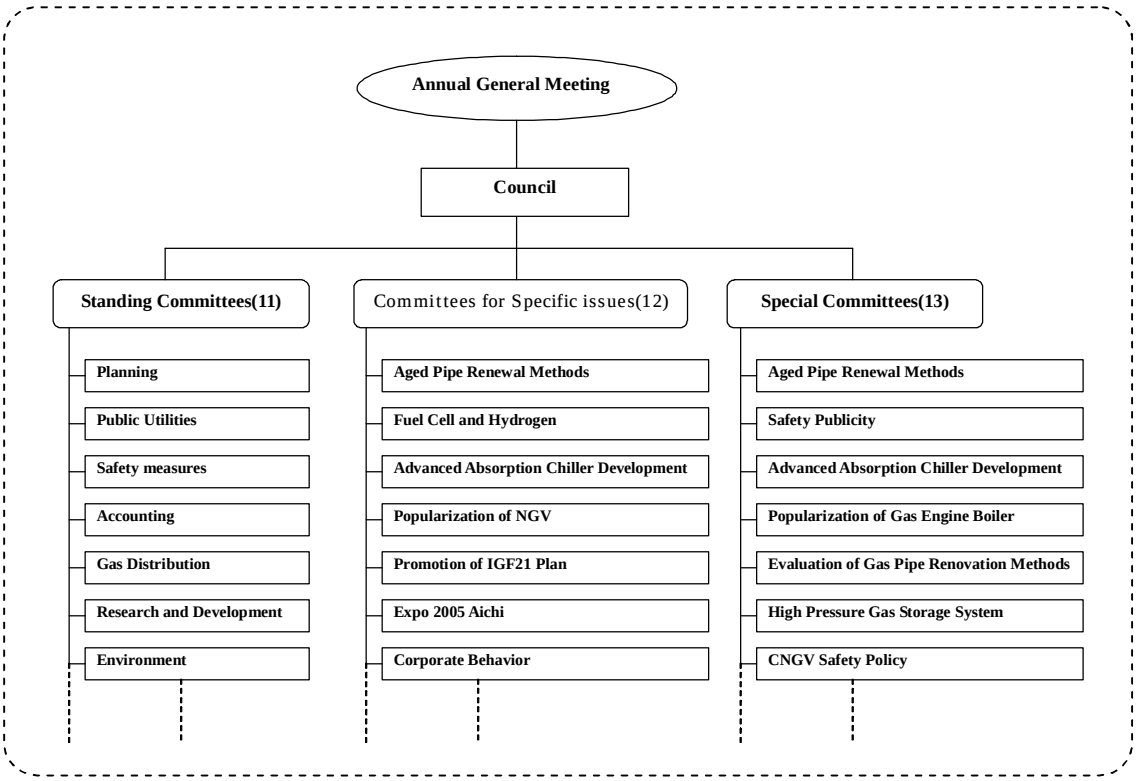


Fig.15 Committees of JGA for decision-making

Features of the operation of the organization

The characteristic features of the operation of the organization of the JGA are that management of the work and the evaluation of the content of the work are completely separate and the method of procuring management resources needed to run the organization.

The advantages of completely separating the management of the work and its evaluation are that in addition to increasing transparency of the business management similar to U.S. style corporate management, it can prevent its work from being biased towards overcoming challenges and industrial ethics at specified gas utilities.

Next, the procurement of management resources that is its biggest concern, specifically, how it obtains the personnel that actually conduct its organizational activities and the way it handles the financing of its activities, are introduced. Although the JGA has its own personnel, almost the entire staff of its technology related departments and the technologists who conduct national projects are employees of large gas utilities that loan them to the JGA for limited periods or assign them to perform JGA work along with their normal tasks. Because personnel sent to the JGA are paid by the gas utility that is their actual employer, the JGA only has to pay the salaries of its regular employees (see Fig. 16). The cost of its normal operation including personnel expenses is covered by membership fees and by investments based on total gas sales paid by gas utilities and companies in gas related

industries that are members of the JGA. Specific research and development activities are financed by contracted costs paid by the national government for each project and by contributions from large gas utilities. The costs of work other than national projects and granted projects, that includes the reevaluation or revision of technological standards and other work that is suddenly necessary to comply with regulatory authorities and must be completed quickly, is normally financed solely by funds contributed as needed by gas utilities (see Fig. 17). Tokyo Gas provides many funds and workforces on loan for these organizational operations, contributes to them notably as the leader of Japanese gas distribution industry.

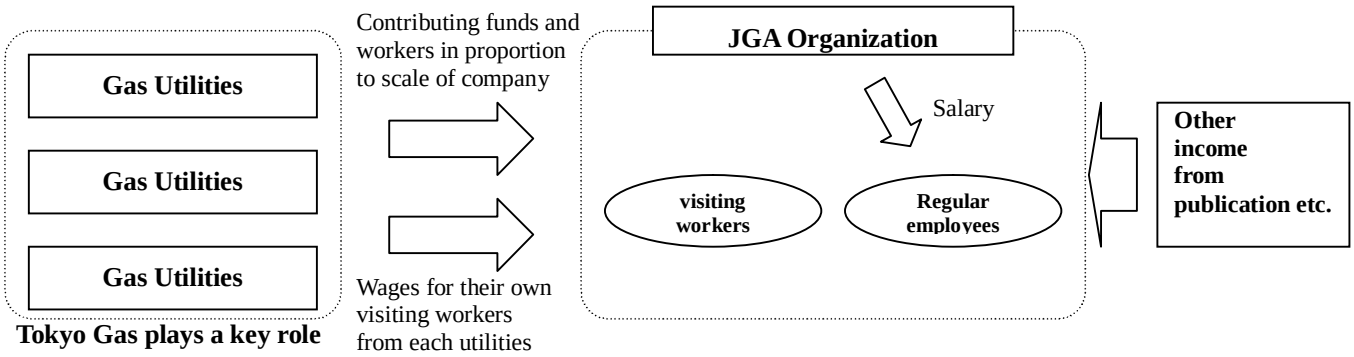


Fig.16 The system to keep JGA Organization

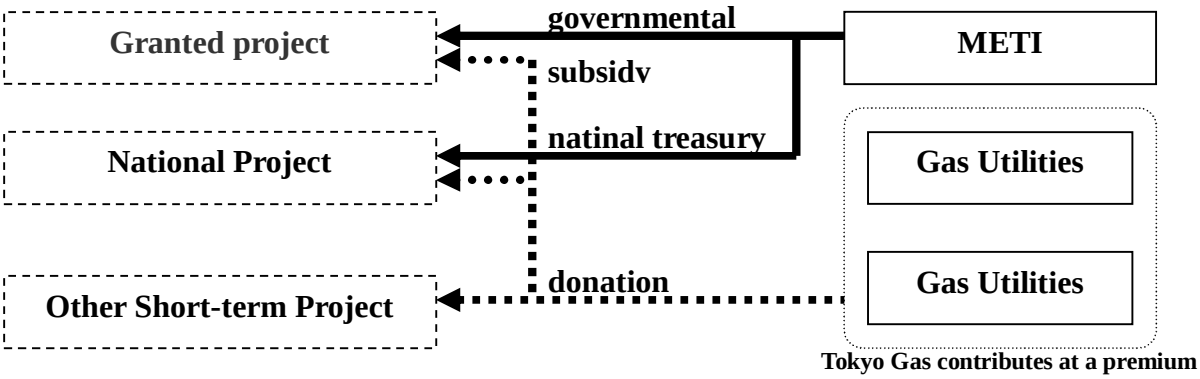


Fig.17 General scheme of funding for every project

2) Subjects dealt with by the JGA

As already stated, the R&D activities of the JGA are undertaken to create benefits for the people of Japan by resolving challenges such as those described above to expand the use of natural gas. Technological development that is selected is, therefore, examined extremely carefully to make sure that it will be an effective solution to challenges, and both during and after completion of a development project, its products are strictly evaluated by the committees introduced above. Below, the flow from the selection of a technology development theme to the conclusion of the development work is introduced.

Project selection decision-making procedure

Technology development themes that are judged to be promising as a result of a needs survey by the administrative office organization are each submitted to a preliminary evaluation committee of representatives of consumers organizations and academic experts that examines each one to determine if it is or is not suited for subsidization by the national government (see Fig. 18). If as a result of the deliberation, a proposed technological development is judged to be appropriate as the theme of a national project or a granted project, a project preliminary preparation organization is formed to prepare a document about project plan including specifications, cost and an annual plan etc. then after approval has been obtained by a committee etc. shown in Figure 15, it is submitted to METI. Next, the detailed budget is decided, and at the same time as the project group that will actually manage the technology developed is formed in the Technology Development Department of the JGA, a Special Committee and a Committee for Special Issue are formed to evaluate the progress of the project and its results (see Fig. 15). The project group consists of expert staff of the JGA and personnel loaned by gas utilities with R&D functions, Tokyo Gas plays the primary role of performing management tasks such as out-sourcing the development work to specialized manufacturers and controlling its progress.

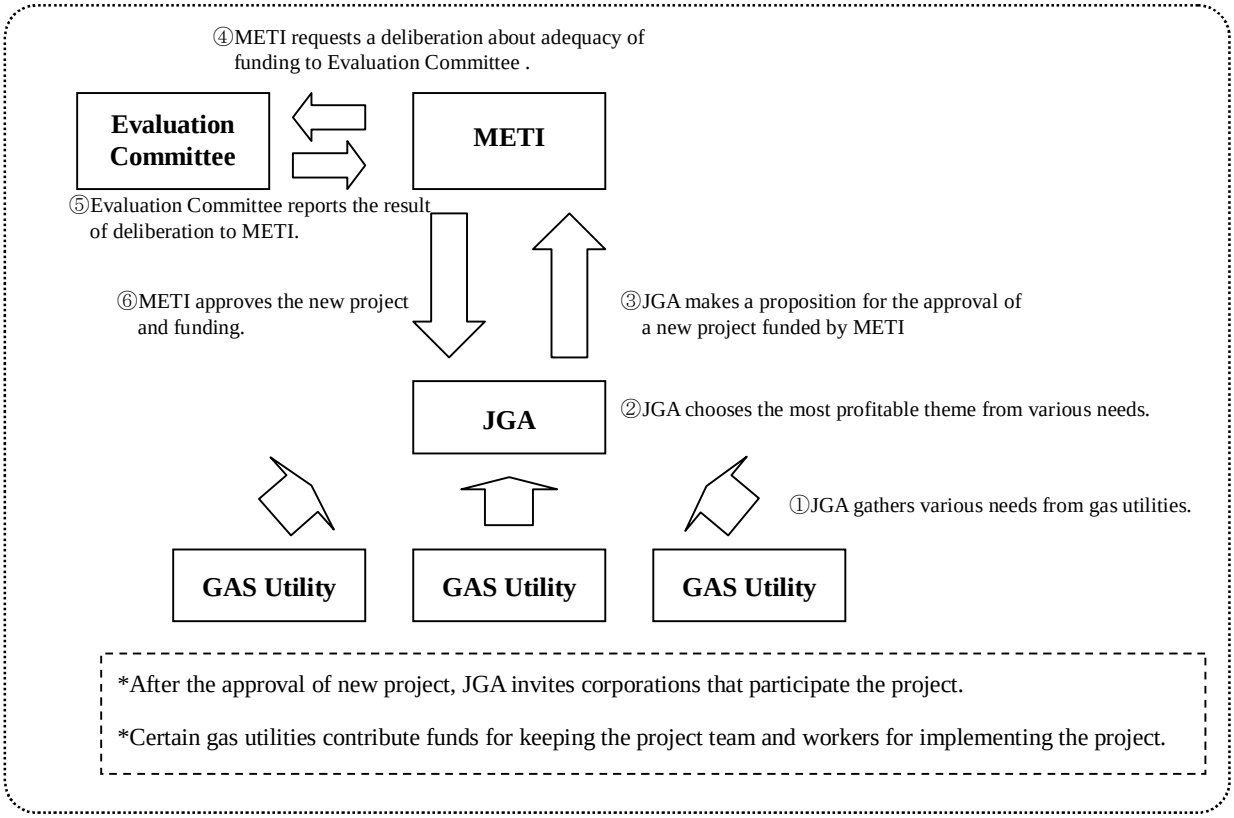


Fig.18 The general scheme of approval of a new project funded by METI

Outline of project implementation

The project is implemented by dividing its content by function and outsourcing each part to

a specialized manufacturer. Each group member is assigned to manage the progress and provide technological guidance to one specialized manufacturer. The group coordinates the overall project by having each group member submit a progress report and discuss challenges about once a month. The project is completed as reports on overall progress and the results of each year are reported twice a year to the committee to obtain its advice (see Fig. 19).

The entire process is completed when the final results are reported to the Special Committee and the Committee for Special Issue, are deliberated by a separately formed committee for ex-post evaluation, and the project results are evaluated as appropriate. In recent years, the submission of a report on the operation of the products of the completed project to the regulatory authority that provided the funding has been required in order that national funds are used effectively.

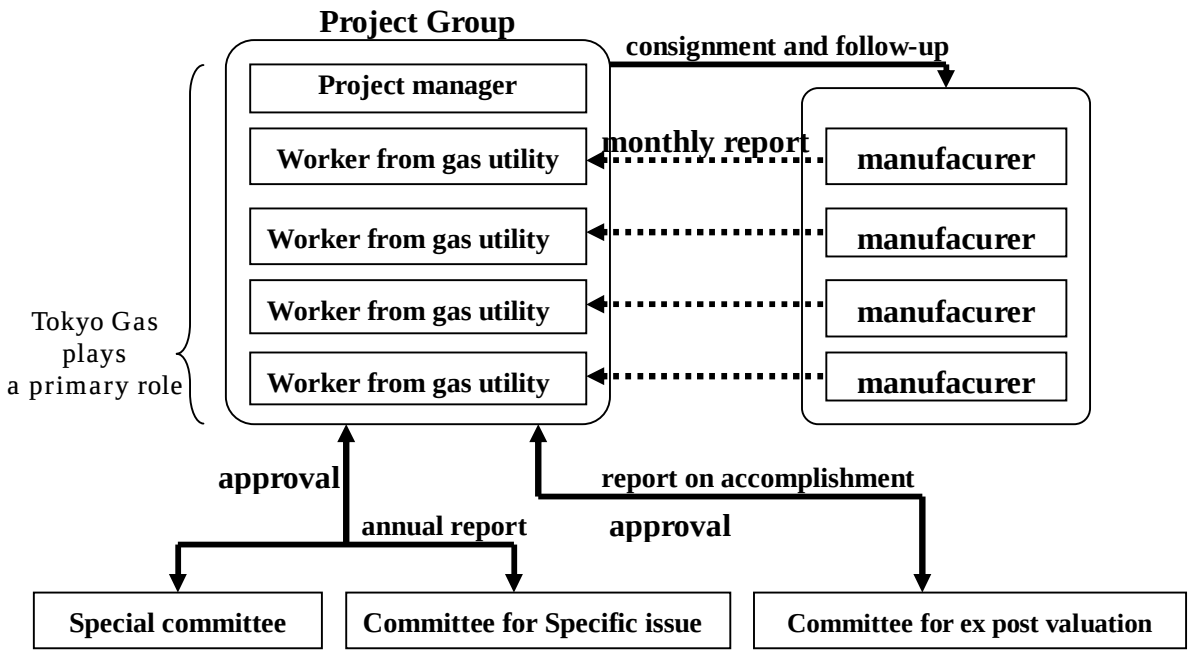


Fig.19 General workflow of a project

Practical examples of JGA's activities

Table 7 shows specific examples of national projects conducted by the JGA. Refer to the Appendix where details concerning the contents of the development and the budget of a number of projects have been summarized. And, Tokyo Gas dispatches many staffs of management and development sections to most of these projects, focuses on a smooth driving of the activities to get the win-win outcome which are the growth of Japanese gas industry and the enhancement of our company's technical capabilities.

Table7 The list of National Projects promoted by JGA

(Including final themes)

Categories (Basic goals)	Project Name		Project period '02	'03	'04	'05	'06	'07	'08	'09
Advancing distributed energy technologies	Developing technologies related to Polymer Electrolyte Fuel Cells (PEFC)	Provision of the foundations for the spread of fixed type PEFC (Millennium Project)								
		Development of technologies for effective use of PEFC output								
		Development of hydrogen making technology based on the new PSA method								
		Development of hydrogen separation type reforming technology								
		Corroborative trial of a fixed type fuel cell								
		Project to Provide Common Foundations for the Construction of Hydrogen Companies: Fixed Type Fuel Cell System Foundation Provision (newly enacted)								
	Development of a triple effect high performance absorption type hot and chilled water machine									
	Development of high efficiency compact natural gas cogeneration technology									
	Hydrogen Supply System Safety Technology Survey Project (newly enacted)									
Protecting the environment and conserving energy	Development of practical high efficiency super low polluting natural gas automobiles									
	Next Generation Low Polluting Automobile Development Promotion Project: Development and trial manufacture of super low polluting large trucks									
	Survey of supercritical methane technology									
Strengthening the foundations of the city gas industry	Development of gas pipeline leak countermeasure technology									
	City Gas Safety Information Publicizing Project									
	Survey of Bedrock Storage Technology									
	Development of next generation natural gas high pressure storage technology (ANGAS)									
	Project to Develop Countermeasure and Renewal Technologies for Aging Pipelines on Customer's Property									
	Survey of the provision of safety standards for natural gas pipelines									
	Super High Pressure Gas Pipeline Bursting Safety Survey Project									
	High Efficiency Natural Gas Supply System Safety Technology Survey Project (newly enacted)									

* Plans after 2005 are predicted at this tim

5. Conclusion and Future prospects

This report concludes with future prospects for R&D activities in Japanese gas industry. In addition to the restructuring of the gas industry, the growing ability of stock holders representing individuals and foreign financed funds etc. to express their views, deflation that remains severe and other changes in economic conditions in Japan continue to have severe impacts on R&D investment by gas utilities. Specifically, the immediate effectiveness of the results of research and development and its investment efficiency are being harshly assessed as a result of investors' strong desire for profits, and the products of R&D are required to be price competitive to a certain degree. Utilities must, therefore, make R&D investment based on strategic concepts , rarely seen during the period that gas rate is determined by the multiple costing method ,to meet market needs. In the past, there was a strong tendency for R&D investment by gas utilities to be directed to the upstream end of the value chain, but the intensification of competition will increase the quantity of investment towards the downstream side, customer services and sales activities for example, pushing R&D towards the front.

It is assumed that under such circumstances, future R&D activities of gas utilities will tend to pursue somewhat short-term profits. On the other hand, it is also thought that research and development to provide the foundations for the medium and long term gas business will be driven by the creation of new markets that may impact the existing infrastructure, disasters of a scale never seen before, the appearance of innovative technologies, and other changes in the external environment. Assuming, therefore, that the gap between R&D by all utilities conducted through the JGA and investment in R&D by individual companies with priority on distinguishing themselves from their competitors will become increasingly marked in the future, individual utilities including Tokyo Gas will be forced to develop their ability to assess the needs of their customers and the market more accurately than in the past.

This report has introduced the present state of Japanese gas industry, challenges it faces, the role of R&D in overcoming those challenges, the involvement of the JGA in this process and our company's contribution to the organizations. We hope that this report will support studies of the appropriate way for the world's gas utilities to conduct R&D activities in the future.

6. References

1) Tokyo Gas Investors' Guide
2) Tokyo Gas Annual Report
3) Osaka Gas Annual Report
4) OUTLINE OF THE JAPAN GAS ASSOCIATION
5) Japanese Gas Industry Enchiridion
6) Ministry of Public WEB-SITE
7) Ministry of Economy, Trade and Industry

Appendix

Example of National Projects related to Gas Distribution promoted by JGA

1. Project to Develop Renovation Countermeasure Technologies for Aging In-House Pipe

1) Background

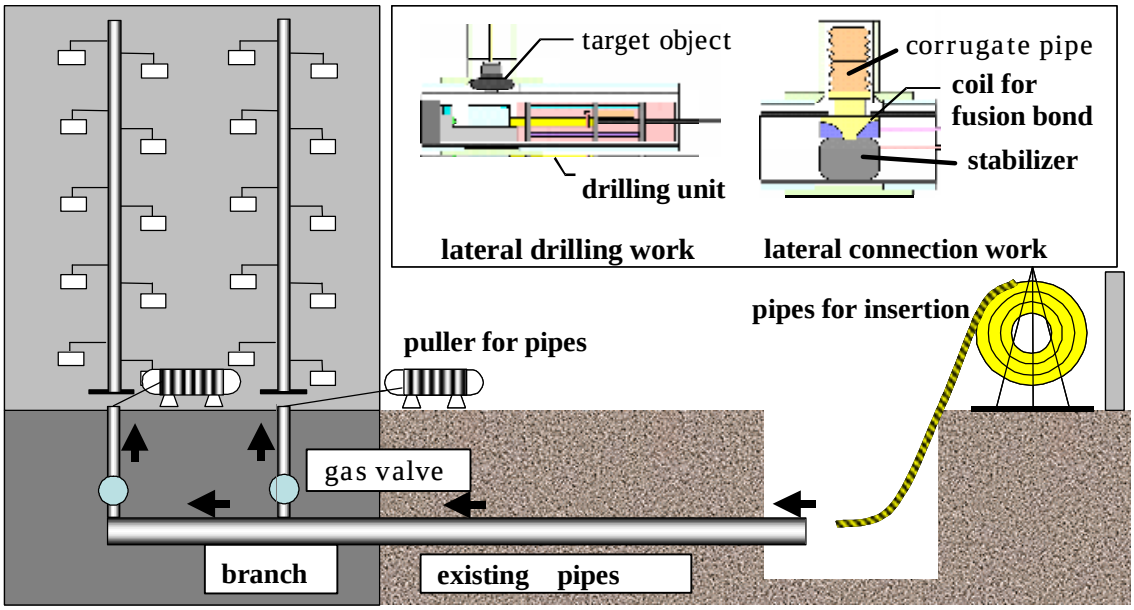
City gas utilities are working eagerly to introduce countermeasures for aging pipes buried under customers' land, i.e. In-House Pipes, but gas utilities must request that customers pay the cost of repairs of pipelines that are their property buried on their land, but obtaining approval for an order for such works is extremely troublesome. This is because the average work cost at this time is about ¥100,000 for a detached home and is as high as ¥1 million for an apartment building.

This project is the development of a "construction method executed by inserting a new pipe that can serve as a gas pipe inside an existing pipe with bends and branches" in order to reduce improvement work costs to half their present level.

2) Outline of the Project

The method which is under development is a pipe-in-pipe method with corrugate pipes.

It is the most important feature of this renovation method that it can be applied without excavation of branch points. The outline of this method is shown in a figure listed below.



3) Activities Plan of the Project

The development span and cost is introduced below.

	2001	2002	2003	2004	2005
Development span	←				→
Development cost	¥226million	¥438million	¥706million	¥598million	¥255million

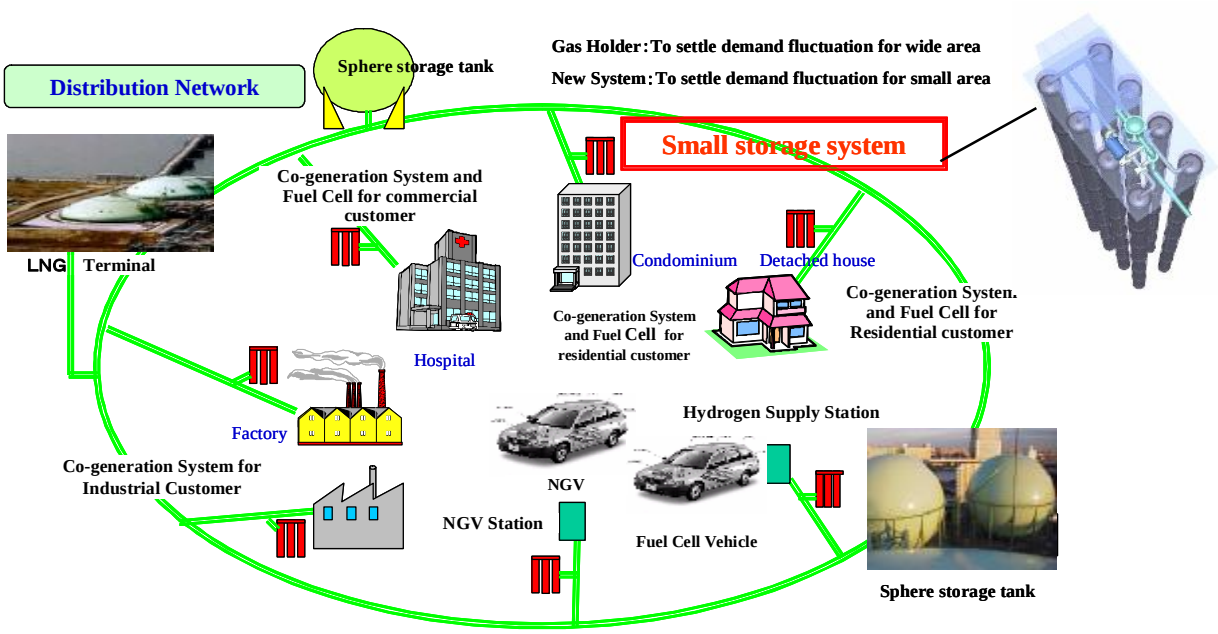
2. Technology Survey Project on High Efficiency Natural Gas Supply System Safety

1) Background

To develop practical residential use fuel cells, natural gas cogeneration systems and other types of distributed energy systems and to promote their wide use, it will be essential to utilize pipeline networks more effectively than now to efficiently and stably supply natural gas. So data concerning technology related to the safety of underground installation type compact gas storage tanks developed by modifying the above-ground cylinder type gas holders now in use in Europe so they can be installed underground in Japan will be collected, design and maintenance technologies established, and regulations for compact gas storage tanks proposed to contribute to improved gas security and safety.

2) Outline of the Project

At this moment, the goal of this Project is to build up a pilot design for a small gas storage system for gas distribution network. The main frame work of this project consists of technical investigation, fundamental data gathering for safety, and establishment of safety measures/standard.The outline of this system and a conceptual design of unit are introduced in a figure listed below.



3) Activities Plan of the Project

The development span and cost is introduced below.

	2005	2006	2007
Development span	←		→
Development cost	**¥73million**	**¥277million**	**¥250million**