Clean Fuel Supply Project

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Policy Area: Environment

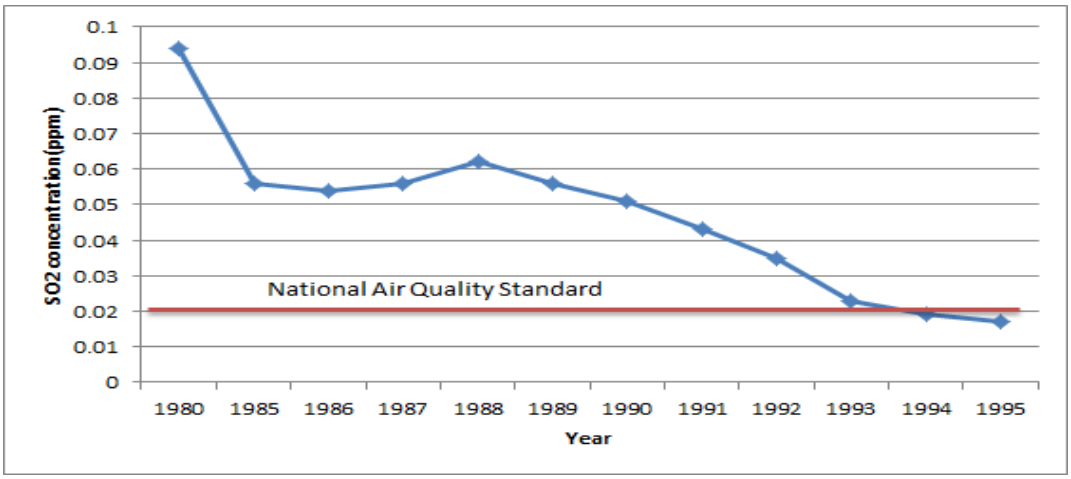
Background of Introduction of the Clean Fuel Supply Project

Due to industrial development, growth in population and the consequentially increased use of fossil fuels in the 1970s and 1980s, the air pollution in Seoul has fallen into a serious condition. In particular, SO2 pollution in Seoul reached the highest level, more than four times of the national environment standards in 1980, and even more than 2 times the standards in 1990.

The main energy source in the 1960s was cheap coal that made up around 40% of the total energy consumption at that time. After the 1970s, petroleum replaced coal and became the main energy source because the use of oil was increased dramatically as the heavy chemical industry was developed, and the standard of living was greatly improved.

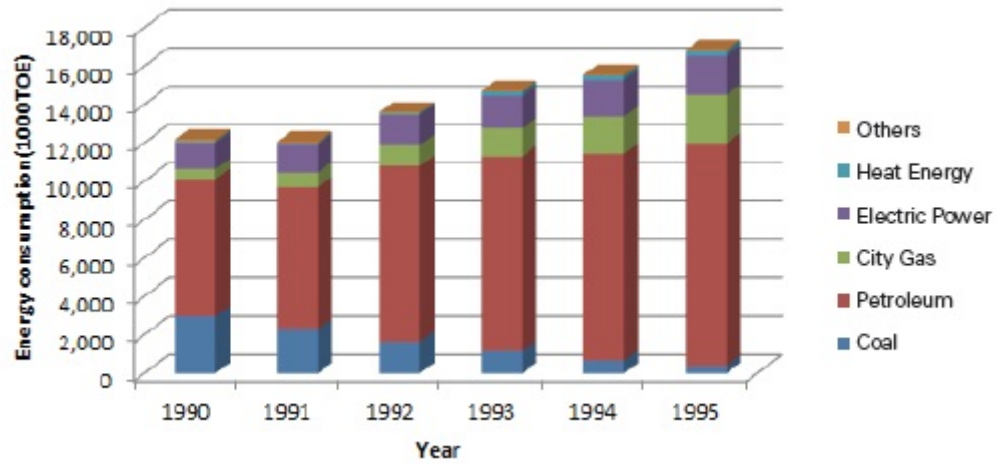
The major emission sources of SO2 were fossil fuels such as coal and petroleum. The sulfur content of fossil fuels was relatively higher than city gas and LPG. The SO2 concentration was still very high, because around 70% of the households in Seoul used coal briquettes as heating fuel in the 1990s. Accordingly, the Seoul Metropolitan Government and the central government planned to expand the supply of clean fuels and to introduce various projects in order to reduce SO2 emission.

<Figure 1> Changes in the Annual Average SO2 Pollution in Seoul



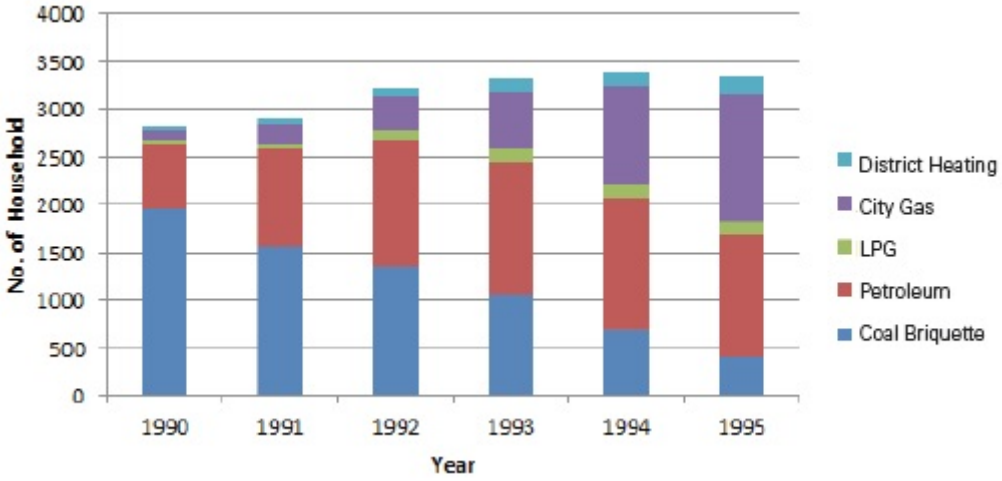
Source: The Seoul Metropolitan Government, Analysis of Air Pollution, 1995 and 1996

<Figure 2> Change of Fuel Consumption of Seoul by Fuel



Source: http://www.kesis.net/ Korea Energy Economics Institute, Energy Statistics

<Figure 3> Change of Number of Households by Heating Fuel in Seoul



Source: The Seoul Metropolitan Government, White Paper on Energy, 2002 and 2003

Main Contents of the Clean Fuel Supply Project

Supply Expansion of Low Sulfur Oil

To reduce the SO2 emitted by using fuel fundamentally, Seoul introduced the standards for sulfur content of diesel and heavy oil and applied them in the areas of Seoul for the first time in Korea in 1981. The standards have been strengthened several times and the applied areas were continuously expanded. As a result of the strict standards, only heavy fuel oils satisfying the criteria of sulfur content of less than 0.3%, and diesel satisfying the criteria of sulfur content of less than 0.1% are currently supplied.

<Table 1> Change of Sulfur Content of Heavy Oil and Diesel

	Heavy Oil	Diesel
1981	1.6%	0.4%
1993	1.0%	0.2%
1997	0.5%	0.1%
2001	0.3%	0.1%

Source: Ministry of Environment, Annual Report on Air Environment, 2004 and 2005

Regulations to Prohibit the Use of Solid Fuels

In order to reduce the emission of air pollutants, Seoul and the Metropolitan cities introduced an institution in 1985 for the first time to prohibit the use of solid fuels such as coal, coke, combustible waste, etc. Since then, the applied areas have been gradually expanded.

Mandatory Use of Clean Fuel

From 1988, it became mandatory to use LNG as a clean fuel in the facilities for business uses (including commercial and public ones) in which boiler capacities were more than 2 tons in total. The compulsory use of clean fuel or diesel was then expanded to facilities with boiler capacities of more than 1 ton in 1990, 0.5 ton in 1991 and 0.2 ton in 1994. In the case of apartment complexes adopting the central heating method, the use of clean fuel was mandated in 1990 for the first time for houses with an average area of more than 35 *pyeong* (115.7㎡). The mandatory use of clean fuel or diesel has been expanded to apartment complexes with an average area of over 30 *pyeong* (99.2㎡) in 1991, 25 *pyeong* (82.6㎡) in 1992 and 12.1 *pyeong* (40㎡) in 1997.

<Table 2> Expansion of Facilities Mandated to Use Clean Fuel or Diesel

	Boiler Capacity	Area of Apartment	Power Plant
1988	More than 2 tons	-	
1990	More than 1 ton	Over 35 *pyeong*	
1991	More than 0.5 ton	Over 30 *pyeong*	All power plants
1992	-	Over 25 *pyeong*	Cogeneration plants for business uses
1994	More than 0.2 ton	-	
1995	-	Over 21 *pyeong*	
1996	-	Over 18 *pyeong*	
1997	-	Over 12.1 *pyeong*	

Source: Ministry of Environment, Annual Report on Air Environment, 2004 and 2005

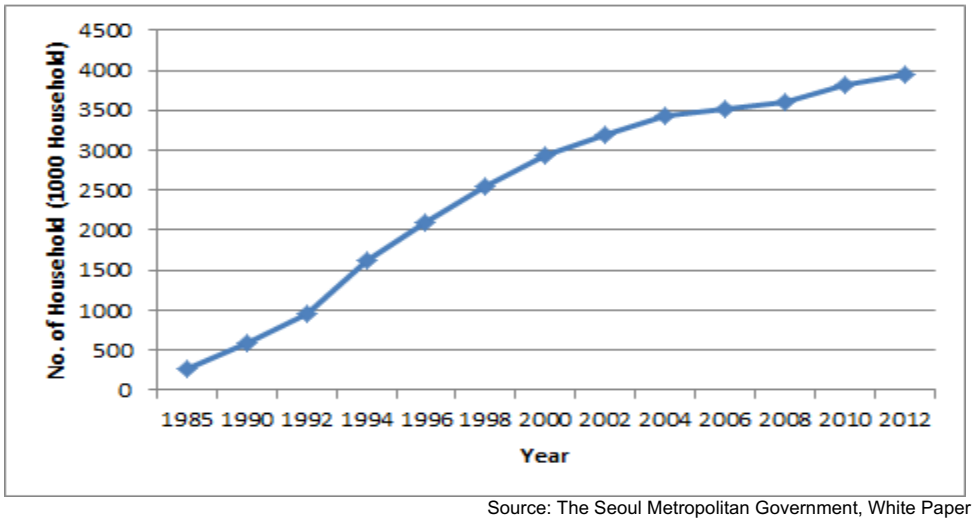
Supply Expansion of City Gas (LNG) to General Houses

Overview

Thanks to the policy to make the use of LNG and clean energy obligatory that was introduced in the late 1980s, the pipeline network of city gas was able to accommodate 260,000 households in 1985, and expanded year by year since then. The households that had used coal briquettes and petroleum in the past started using city gas with relatively less air pollutants emission as heating fuel, the main fuels were switched to cleaner fuels. Thanks to those efforts in Seoul, around 95% of households in Seoul are using city gas as heating fuel.

Seoul implemented various policies to expand the supply of city gas as clean fuel by introducing a system that imposes a part of cost on the city gas bills in order to secure the investment resource for the city gas suppliers, financing funds for the old pipeline replacement construction made for the stable city gas supply and adopting the financing system for the city gas users.

<Figure 4> Change of the Number of Households Using City Gas in Seoul



Source: The Seoul Metropolitan Government, White Paper on Energy, 2008, 2007

Fund Raising and Operation for City Gas Project

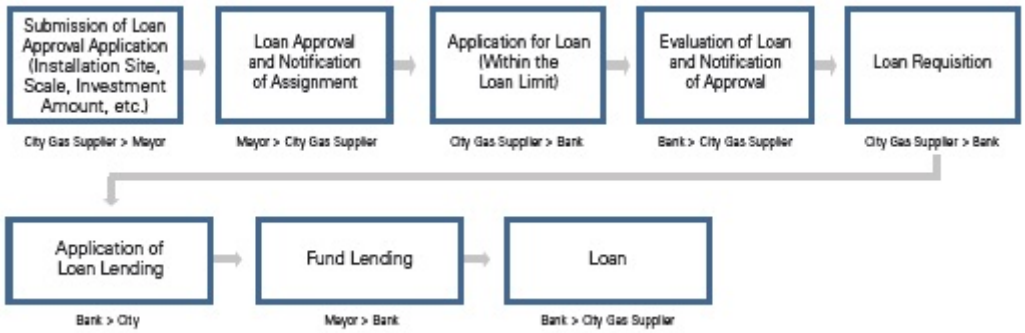
- Enactment of Ordinance: Enactment of the ordinance on installation of city gas project fund of Seoul in 1992
- Purpose of Fund Raising: To provide low interest loan to the city gas suppliers to cover a certain amount of the natural gas infrastructure installation cost necessary for the quick expansion of city gas supply
- Use of the Fund
  - Loan for the installation of pipes and monostat facilities to provide city gas to residential facilities, public facilities and social welfare facilities
  - Loan for the installation of pipes to provide city gas to public bath facilities planning fuel conversion
  - Loan for the installation of compressed natural gas stations for city buses and the related pipes
- Beneficiary of the Fund: Those who conduct business suitable for the purposes of fund as the general city gas providers
- Fund Raising Method: Contribution from the general account of Seoul and earnings generated by operating the fund
- Fund Operation and Management
  - Fund Operator: Energy Management Team of the Seoul Metropolitan Government
  - Fund Management: Consignment management (Woori Bank, Kookmin Bank)
  - Loan Limit: Up to 80% of the city gas supply facilities installation cost
  - Repayment Conditions: Level repayment in 5 years with a 3 year grace period
  - Loan Interest: Annual interest of 4.5% (annual lending interest rate of 3.8%)
- Loan Process
  - City Gas Supplier: Submission of loan application to the Mayor
  - Mayor: Review of construction results → Decision of loan amount → Notification of loan handling bank to the city gas supplier

- Loan Handling Bank: Review of construction details, etc. → Fund Lending (← Seoul City) → Loan (→City Gas Supplier)

<Figure 5> Amount of Fund and Loan Process

(Unit: KRW Million)

Year / Item	Sum	94	95	96	97	98	99	2000	2001	2002	2003	2004	2005	2006	2007
Sum	114,766.5	22,679.4	14,101.9	15,0026.5	10,846.2	10,310.8	5,793.5	7,480.7	8,366.8	5,565.8	5,195.1	3,236.5	1,898.1	2,232.9	2,030.3
Contribution from General Account	48,000	10,000	10,000	10,000	5,000	3,000	-	-	-	-	-	-	-	-	-
Loans from the Treasury Investment and Loan Institutes	10,000	10,000	-	-	-	-	-	-	-	-	-	-	-	-	-
Earnings from Fund Operation	66,766.5	2,679.4	4,101.9	5,026.5	5,846.2	7,310.8	5,793.5	7,480.7	8,366.8	5,565.8	5,195.1	3,236.5	1,898.1	2,232.9	2,030.3



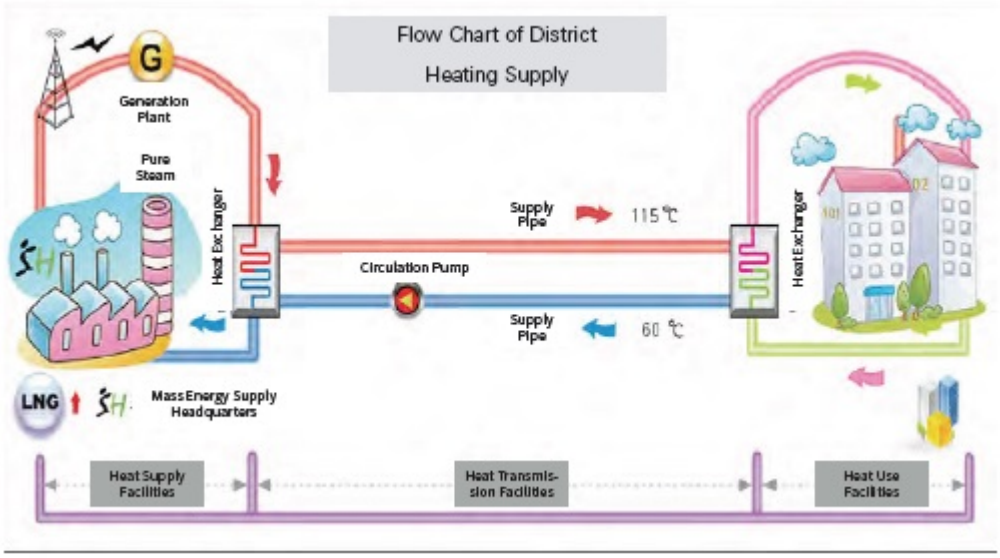
Source: The Seoul Metropolitan Government, White Paper on Energy, 2008, 2007

Expansion of Mass Energy (District Heating) Supply

Overview

The Mass Energy project aims to supply the energy (heat or heat & electricity) produced by one or more concentrated energy plants (cogeneration plants, heating-only boilers, resource recovery facilities, etc.) collectively to numerous users in residential areas, commercial areas or industrial complexes.

<Figure 6> Flow Chart of District Heating Supply



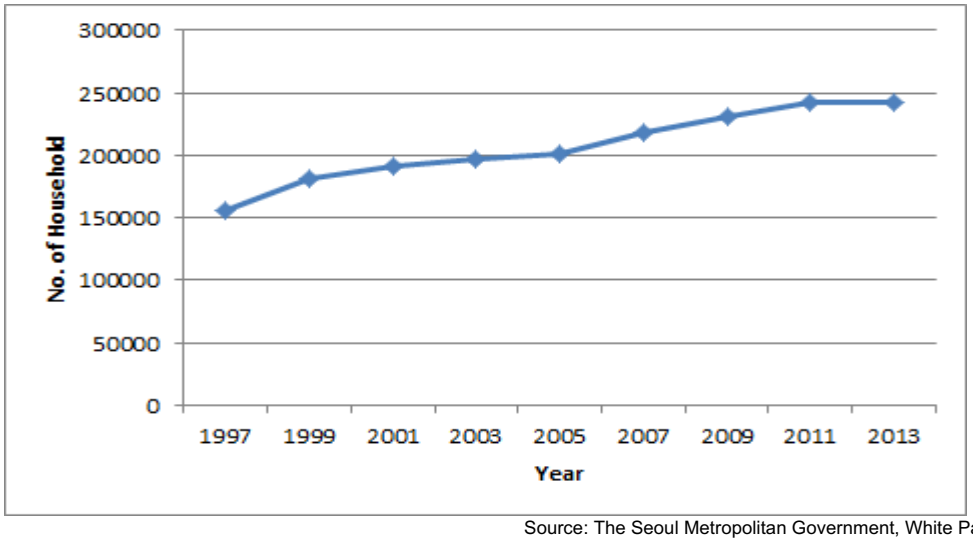
Source: The Seoul Metropolitan Government, White Paper on Energy, 2011 and 2012

Project Process

When confirming the development plan for the Mok-dong new town in 1983, the Seoul Metropolitan Government adopted the heating method for the first time in Korea in which a portion of electric energy is provided from the cogeneration plants and the residual heat is used as the source of district heating for the new town. In order to implement this heating method, Seoul installed the “Mok-dong District Development Office” exclusively for the development of Mok-dong new town and made a business consignment agreement for the entire construction project and operation with the Korean Energy Management Corporation which was able to provide professional and specialized technical manpower. Seoul also consigned the design, construction, supervision and facility operation for the Mass Energy supply project to the SH Corporation. Under the scheme, the cogeneration plants in Gangseo region and Nowon region were constructed.

In 1984, Seoul provided around 26,000 households with heat. The number of households using the group heat energy provided by Seoul exceeded 240,000 in 2013.

<Figure 7> Change of the No. of Households Using the Group Heat Energy Provided by Seoul



Source: The Seoul Metropolitan Government, White Paper on Energy, 2013 and 2014

Process of Gangseo Region Project

- May 1983: Confirmation of New Town Development Plan in Mok-dong (Adoption of District Heating Method)
- Oct. 1983: Submission of Mass Energy Supply Project Plan (Draft) for Mok-dong Area
- Dec. 1983: Public Announcement of the Ordinance on Implementation and Consignment of Mass Energy Supply Project
- Dec. 1983: Consignment Agreement for the Mass Energy Supply Project for Mok-dong (Consignee: Korea Energy Management Corporation)
- Mar. 1984: Commencement of Design Service Contract
- Aug. 1984: Acquisition of Permission for Heat Supply Project
  - Supply Target: 26,629 Households in the New Towns in Mok-dong and Sinjeong-dong
  - Facility Scale: Heat Transmission Pipe (20㎞), Cogeneration Boiler (1 Unit of 100 tons/h and Turbine/Generator 21㎿), Heating-only Boiler (2 Units of 140 tons/h, 2 Units of 80 tons/h and 3 Units of 10 tons/h)
  - Project Period: Dec. 1983 ~ Dec. 1987
  - Project Budget: KRW 36,199 million
- Nov. 1984: Commencement of Construction of Waste Incinerator (Completed on Dec. 31st, 1986)
- Jan. 1985: Commencement of Construction of Cogeneration Plant (Completed on Dec. 31st, 1987)
- Oct. 1985: Commencement of Construction of Heat Transmission Facilities (Completed Nov. 30th, 1987)
- Nov. 1985: Start of the 1st Phase Heat Supply (Mok-dong Apt. 1 District, 1,882 Households)
- Aug. 1990: Confirmation of Mass Energy Supply Project for Gayang and Banghwa·Apt. 1 District
  - Supply Target: 24,314 Households in Gayang and Banghwa Apt. 1 District
  - Facility Scale (Linked to the existing Mok-dong Cogeneration Plant): Heating-only Boiler (2 Units of 110 tons/h), Heat Transmission Pipe (31.6㎞), 1 Site of Booster Pump Site
  - Project Period: Aug. 1990 ~ 30 Nov. 1993
  - Project Budget: KRW 30,603 million
- Apr. 1993: Confirmation of Mass Energy Supply Project for Deungchon and Banghwa Apt. 2 District
  - Supply Target: 14,365 Households in Deungchong and Banghwa Apt. 2 District
  - Facility Scale (Linked to the existing Mok-dong Cogeneration Plant): Heating-only Boiler (1 Unit of 110 tons/h, Heat Transmission Pipe (11.4㎞)
  - Project Period: Apr. 1993 ~ 10 Jan. 1995
  - Project Budget: KRW 8,961 million

Process of Nowon Region Project

- Oct. 1991: Service Agreement for the Basic Plan for the Mass Energy Supply Project in Nowon Region
  - Use of Burning Heat from the Sanggye Resource Recovery Facility
- Jun. 1992: Confirmation of Mass Energy Supply Project for Nowon Region
  - Supply Target: 104,968 Households in Nowon-gu, Dobong-gu and Jungnang-gu
  - Facility Scale: Cogeneration Boiler (1 Unit of 150 tons/h and Turbine Generator 37,000㎾), Heating-only Boiler(4 Units of 150 tons/h), Heat Transmission Pipe (80㎞)
  - Project Budget: KRW 80,760 million
  - Project Period: Jun. 1992 ~ Dec. 1996
- Jul. 1993: Permission for Mass Energy Project
- Dec. 1993: Commencement of Construction of Nowon Cogeneration Plant
- Dec. 1993: Commencement of Construction of Heat Transmission Pipe Installation
- Dec. 1994: Start of Heat Supply (3,420 Households in Gongneung 1 Land Development District)
- Dec. 1996: Completion of Nowon Cogeneration Plant
- Oct. 2009: Completion of the Fuel Cell (2.8MW) Generation Plant in the Nowon Cogeneration Plant

<Figure 8> Status of Consignment for the Mass Energy Supply Project

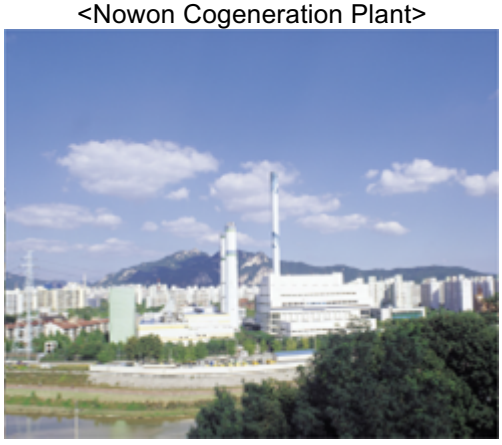
- Dec. 20th, 1983 ~ Dec. 31st, 1998 (Consignor: Seoul Mayor, Consignee: Korea Energy Management Corporation)
- Jan. 1st, 1999 ~ Dec. 31st, 2001 (Consignor: Seoul Mayor, Consignee: Seoul Energy)
- Jan. 1st, 2002 ~ Present (Consignor: Seoul Mayor, Consignee: SH Corporation)

Dec. 31st 2013

Classification	Gangseo Region (Mok-dong Cogeneration Plant)	Nowon Region (Nowon Cogeneration Plant)
Location (Site Area)	Mok-dong Seo-ro 20 (Mok-dong 900), Yangcheon-gu, Seoul (53,302.4㎡)	99 Deongneung-ro 70 gil (Sanggye-dong), Nowon-gu, Seoul (24,356.7㎡)
Service Area	9 dongs in 3 districts (Gangseo-gu, Yangcheon-gu, Guro-gu)	11 dongs in 3 districts (Nowon-gu, Dobong-gu, Jungnang-gu, Uijeongbu)
No. of Target Households	114,659 Households (211 Buildings)	127,545 Households (47 Buildings)
Facility Capacity	• Turbine Generator: 30.2MW • Cogeneration Boiler: 100 tons (1 Unit) • Cogeneration (low pressure) Boiler: 150 tons (1 Unit) • Heating-only Boiler: 770 tons (7 Units) • Heat Transmission Pipe: 88.4km x 2 lines	• Turbine Generator: 37MW • Cogeneration Boiler: 150 tons (1 Unit) • Heating-only Boiler: 600 tons (4 Units) • Heat Transmission Pipe: 85.2km x 2 lines
Start of Heat	Nov. 20th, 1985	Dec. 8th, 1994

<Mok-dong Cogeneration Plant>

<Nowon Cogeneration Plant>

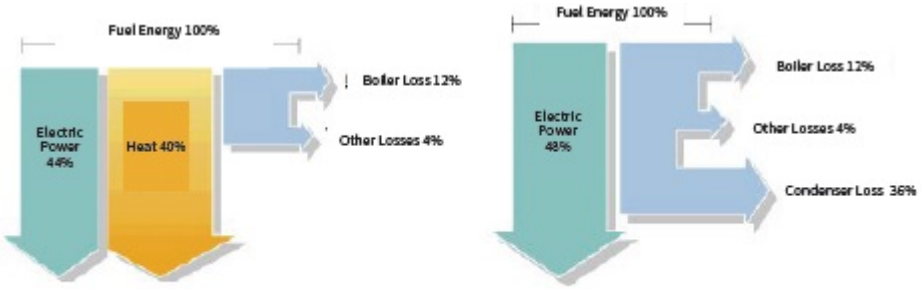


Source: The Seoul Metropolitan Government, White Paper on Energy, 2013 and 2014

Project Effects

- Large amount of energy reduction due to the enhanced energy use efficiency (20 ~ 30%)
- Reduction of SOx, NOx and fine dust emissions thanks to the air environment improvement because of the reduced fuel use and concentrated environmental management
- Contribution to solving the power plant site problems and to reducing the power transmission loss
  - Relaxation of the peak load power in the summer season by supplying the district heating
- Decrease petroleum dependency through fuel diversification and increased use of unused energy such as the waste heat from resource recovery facilities and landfill gas

<Figure 9> Efficiency Comparison of the Existing Generation Method and Cogeneration Method



<Existing Generation Method: Efficiency 48%>

<Cogeneration Method: Efficiency 84%>

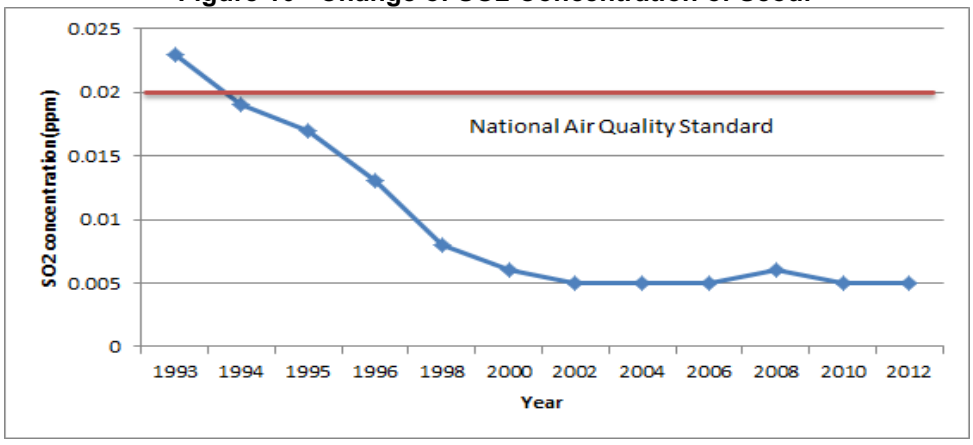
Source: The Seoul Metropolitan Government, White Paper on Energy, 2008, 2007

Conclusion and Implications

Project Effects

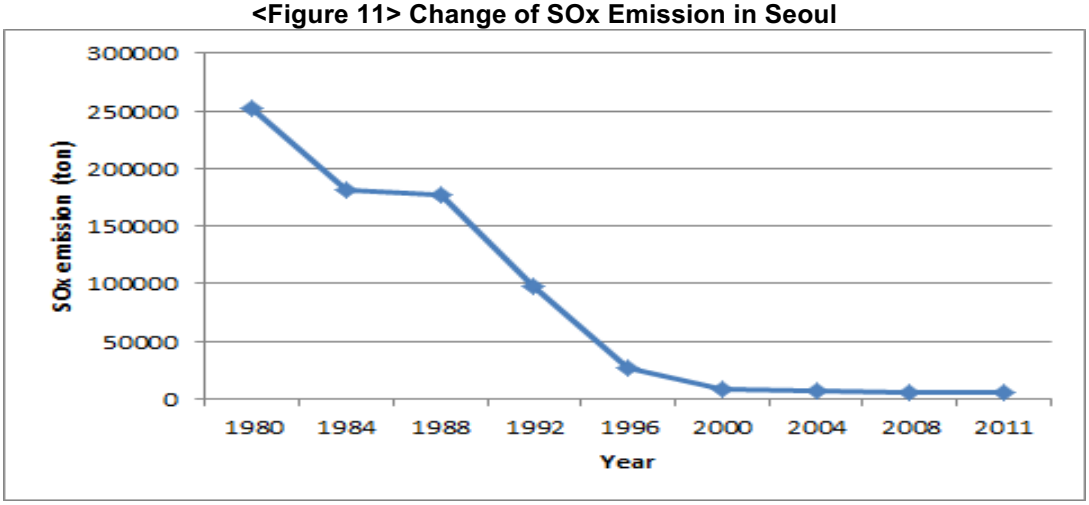
Thanks to the various policies and projects facilitated by the Seoul Metropolitan Government and the central government to provide clean fuel that emits low air pollutants, the SO2 concentration in Seoul has been remarkably reduced. SO2 concentration has been lower than the national environmental standards since 1994 and has been maintained at a very low level of around 0.005ppm stably since 2000.

<Figure 10> Change of SO2 Concentration of Seoul



Source: The Seoul Metropolitan Government, Analysis of Air Pollution of Seoul, 1995 and 1996; the Seoul Metropolitan Government, Evaluation Report on Seoul Air Quality, 2012 and 2013

<Figure 11> Change of SOx Emission in Seoul



Source: The Seoul Metropolitan Government, Environment of Seoul in 2000, White Paper on Environment, 2000; http://airemiss.nier.go.kr/ (National Institute of Envionmental Research, Air Pollutant Emission Quantity)

Future Tasks

The SO2 pollutant which was one of the main causes of air contamination in Seoul until the early 1990s have been rapidly reduced thanks to Seoul's policy to supply various kinds of clean fuels and to expand such supply actively, no longer being a cause for concern. However, the NO2, fine dusts, etc. that are generated by using the fossil fuels like gasoline, diesel, etc. still remain major air pollution problems in Seoul. In addition, LNG, which had been regarded as a clean fuel, is not free from climate change issues attracting global interests in the aspect of air quality, because it emits greenhouse gases such as carbon dioxide.

In order to address these limits, Seoul prepared and implemented plans to expand the use of new and renewable energy including geothermal heat, sunlight, solar heat, fuel cells, etc. Specifically, Seoul has focused on expansion of facilities related to sunlight, fuel cells and geothermal heat and on heat generation using wastes. As a result, the total production of new and renewable energy in Seoul has increased nearly three times from 78,000 TOE in 2003 to 233,000 TOE in 2012. Nonetheless, the production amount of new and renewable energy in Seoul is just 2.6% of the nationwide production amount of new and renewable energy and makes up only 1.5% of the entire energy consumption of Seoul. As Seoul facilitates the introduction of sunlight generation facilities as a part of policy for "Reduction of One Nuclear Plant," the weight of solar generation is expected to increase significantly.

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