Opportunities and Challenges by 2008 Beijing Olympic Games: Energy and Transportation

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ABSTRACT The Olympic Movement's Agenda 21 is the Beijing's guideline for hosting the 2008 Olympic games. One of the mottos for Beijing 2008 is "Green Olympics". Energy consumption and transport are two of main reasons of air pollution in Beijing. In this paper, Some of the considerations are presented on Energy and transportation for Beijing 2008 Olympic games, including Energy Development and Energy Mix Readjustment plan, Guidelines for Environment Protection in Olympic Construction Projects——Energy Conservation of architectures application of Distributed Energy System, Prevention and Control of the vehicle emission pollution are introduced.

The Olympic Movement's Agenda 21 is Beijing's guideline for hosting the 2008 Olympic games. One of the themes for Beijing 2008 is a "Green Olympics". Hosting of the games in Beijing will serve as a "catalyst" for environmental improvement and help to promote sustainable development in Beijing and even in China. By the time the Olympic Games opens in 2008, Beijing will have met the required environmental quality standards. A new Beijing of fresh air, beautiful environment and sound ecosystem will emerge in the eyes of the people of the world.

In order to achieve Green Olympics, Beijing has made the Sub-plan for Environmental Protection. The sub-plan proposed the objective of ambient air quality, which is shown as follows: By 2008, the main air pollutants should meet the national standards based on the remarkable regional ecosystem improvement. During the Olympic period in 2008, concentration of SO_2, NO_2 and O_3 in urban area should reach the WHO guidelines and the particles should be comparable to that in the major cities in the developed countries [1].

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Energy consumption is one of the main reasons of air pollution in Beijing[2]. So the coal-dominated energy mix must be overhauled and the energy efficiency should be increased so as to establish a clean, energy-efficient and market-based quality energy supply system[3]. Vehicle emission is another main reason of air pollution in Beijing, so it is also very necessary for the prevention and control of the vehicle emission pollution. Beijing’s plan about two above aspect will be introduced in this paper.

1 Energy Development and Energy Mix Readjustment Plan

In order to improve the urban air quality, highlight the urban modern civilization, rebuild impressive images and boost the city's competitiveness and strength, the coal-dominated energy mix must be shifted to establish a market-based quality energy supply system, so as to ensure the sustainable development of Beijing's social economy.

1.1 Guidelines

- Adherence to the sustainable development strategies, with the central objectives of improving the urban air quality to meet the environmental requirements in the run-up to the Olympic Games.

- Development and deployment of clean energies in a more cost-effective manner to phase in the fuel switch from coal-dominance to more shares of clean energy types such as natural gas and electricity.

- Acceleration of the industrial and product restructuring so as to mitigate the growth rate of energy consumption.

- Promoting the application of new and high technologies for energy supply and consumption, so as to increase the energy efficiency and help to build Beijing into an energy-efficient, clean and beautiful international metropolis.

1.2 Primary objectives

Air environmental Quality: In line with the environmental quality requirements established by the central authorities and the municipal government, as well as the environmental commitments made in the bidding report for the Olympic Games 2008, the urban atmospheric quality should be improved to reach the national grade-2 standard in 2005 with ever declining pollutant discharges from now, and approaches the WHO-issued standard or the average level of big cities in the developed countries by the year 2008.

Limited growth rate of final energy consumption and energy conservation: During

2001 and 2008, annual growth rate of the total final energy consumption will be limited under 1.4%, and the annual growth rate of industrial energy use will be kept within 1.0%. By the year 2008, the energy saving rate per unit GDP will reach 6% over, while the energy intensity per unit GDP and per capita will meet 0.865 tce per 10 thousand Yuan and 3.318 tce per person, the advanced domestic levels over the same period.

Energy mix readjustment: The share of clean and efficient energy in the final energy consumption mix in 2008 will account for 80% over, while the share of coal and coke in the final energy consumption mix and fuel consumption mix would be kept below 20% and approximately within 48% respectively. The total amount of coal consumption should be controlled within 15 million tons in the whole Beijing and 8.5 million tons in the planned urban area by 2008, where coal will no longer be burnt as fuel in final use sectors. By then, the clean and efficient energy types should play a dominant role in energy mix, to help to achieve the goal of a world-level top urban air quality.

Energy supply security: By using all possible sources of clean energy supply through market mechanism, the diversification of energy supply will be promoted, and adequate and stable energy supply security system will be ensured.

1.3 Energy mix readjustment program

In Beijing the coal consumption was 27.03 million tons in 2000, while the coal demand in 2008 is projected as 31.60 million tons under the business-as-usual (BAU) scenario. While under the coal reduction and switch program, the coal consumption in 2008 will be reduced to 14.75 million tons; coal burned in the urban area will be reduced to about 8 million tons from 16 million tons in 2001with only high quality coal of low sulfur allowed in the city. At the same time, efforts will be made to popularize renewable energy, including solar, geothermal and wind energy.

(1) Coal used for power generation

In 2000, 7.09 million tons of coal was consumed for power generation in Beijing, and additional 0.5 million tons of coal will be used in Gaobeidian Co-generation Plant and Beijing First Co-generation Plant after the technical renovation and expansion is completed. On the other hand, Gaojing Power Plant is planning to reduce 1.60 million tons of coal use by fuel switching. Thus the total coal use for power generation will be reduced to about 6.10 million tons in 2008.

(2) Coal used for urban heating

In Beijing the coal used for urban heating were 1.71 million tons in 2000, which will turn out to be 2.40 million tons through 2008, considering that heating demand still

have to be met by full scale operation of installed capacity of the urban coal-fired co-generation plants. So no cut is planned for this use.

(3) Coal used for coking and gasification

The amount of coal consumed for these purposes was 5.50 million tons in 2000 in Beijing, and will be reduced to 1.30 million tons in 2008, since the Beijing Coking and Chemistry Plant will stop coke production or shift to other of production before 2008, and No.2, No.4 and No.5 coke ovens in the Capital Steel Mill also will stop production. Therefore reduction of coal use will reach 4.2 million tons.

（4） Coal used for final energy consumption

The final coal consumption amounted to 12.78 million tons in 2000, and is predicted to come up to 15.15 million tons by 2008 on a business-as-usual (BAU) basis. The following measures are to be taken to cut down the amount by 11.15 million tons, and only 4.00 million tons will be remained in the outer suburbs.

- *Switch to natural gas: a sum of 6.10 million tons of coal will be substituted by natural gas, of which 0.50 million tons for cooking, the other 5.6 million tons for space heating and industrial use.*

- *Switch to electricity: electric space heating will be developed to 20 million square meters, including 12 million square meters of one-storey buildings in aged urban area, resulting in 1.32 million tons of coal switch to 4000 GWh of electricity.*

- *Switch to geothermal energy and water source heat pumps for space heating: an area of 10 million square meters will be heated in these ways reducing coal use by 0.34 million ton. However, large quantity of ground water will be pumped from an aquifer and circulate through the heat pumps and returned to the ground during the operation of water source heat pumps. If the above goal can be achieved, there will be nearly 300 million tons ground water to be pumped and circulated. Once the returned water goes wrong, underground water may be polluted. Beijing is a city of serious lack of water and the water resource per person is below 300m^3, which is 1/8 of that in whole China and 1/30 of that in whole world. Therefore, the generalization of water source heat pump should be cautiously considered although water source heat pump system for heating the buildings with 10 million square meters can reduce coal use only by 0.34 million ton. Closed loop ground source heat pump should be generalized for it has no above problems.*

- *Switch to heating power from urban heating network: the centralized heating supply will be expanded by 55 million square meters cutting coal use by 0.47*

million tons.

- *Switch to LPG and light diesel: 2.92 million tons of coal will be switch to 1.15 million tons of LPG and light diesel in final energy consumption.*

The above data of the coal reduction and switch program was summarized in Table 1 to Table 3.

Table 1 Coal consumption of 2008 in Beijing:BAU and coal substitution

(Unit: million tces)

year	2000	2008	2008
	Actual consumption	Demand under BAU	Demand after coal substitution
Total consumption	**27.03**	**31.60**	**14.75**
1、Fuel coal in urban area	17.45	19.15	8.50
Power generating	7.09	7.60	6.10
Heating	1.71	2.40	2.40
Final consumption, in which	8.65	9.15	0
Cooking	0.50	0.50	0
Industrial use	2.40	2.55	0
Centralized boilers	1.45	1.60	0
Distributed space heating	4.10	4.50	0
2、Coal used as raw materials	5.49	6.45	2.25
Coking and gasification		5.50	1.30
Anthracite coal for blast furnace injection		0.95	0.95
3、Coal use outside the urban area	4.29	6.00	4.00

1.4 Expected energy mix 2008 in Beijing

By 2008, the share of clean and efficient energy in Beijing's energy mix will acount for 86% in the final energy consumption, which is shown in details in Table 4 and also described in details as follows:

Table 2 Coal substituted by following clean and efficient energy

		coal substitution (million tons)
Total coal substitution		11.15
1、Natural gas	2.64 billion Nm^3	6.10
2、Electricity	4000GWh	1.32
3、Urban heating power		0.47
4、Geothermal energy		0.34
5、LPG and light diesel	1.15 million tons	2.92

Table 3 Coal Reduction Program

measures	Coal Reduction(million tons)
Shut down in Beijing Coking and Chemistry Plant and coke ovens of Capital Steel Mill	4.20
Switch from coal to natural gas in Gaojing Power Plant	1.50

Natural gas supply will be 5 billion cubic meters, equivalent to 6.07 million tce, of which 3.8 billion cubic meters will be consumed in final sectors, equivalent to, 3.74 million tce, taking 7.7% in the final energy consumption;

Electricity consumption will be 62000 GWh, equivalent to 18.60 million tce, including 4000 GWh used for space heating, taking 44.8% of the final energy consumption;

Urban centralized space heating area will increase 55 million square meters, and total will reach 0.1 billion square meters;

Energy supply for space heating is 2.70 million tce, taking 6.5% of the final energy

consumption;

Table 4 Mix of the final energy mix in 2008 in Beijing

	2000			2008		
	Physical amount	million tce	Share(%)	Physical amount	Million tce	Share(%)
Total final energy demand forecasted		37.08	100%		42.01	100%
1、Electricity	36400GWh	12.01	32.4%		18.60	44.3%
2、Heating power		1.85	5.0%		2.70	6.4%
3、Liquid energy (excluding light diesel)		7.35	19.8%		8.50	20.2%
4、Natural gas	1.05×10^9 Nm^3	0.95	2.6%	5×10^9 Nm^3	6.07	14.4%
5、LPG (excluding that to replace coal)	3.02×10^5 tons	0.48	1.3%	3×10^5 t	0.50	1.2%
6、Artificial coal gas	1.78×10^9 Nm^3	0.87	2.4%		0.25	0.6%
7、Refinery gas	1.81×10^9 Nm^3	0.26	0.7%		0.26	0.6%
8、LPG and light diesel				1.15×10^6 t	1.64	3.9%
9、Coke and anthracite coal for blast furnace injection		4.97	13.4%	3.05×10^6 t	2.68	6.4%
10、Final coal consumption		8.34	22.5%	4.00×10^6t	3.14	7.4%

LPG and light diesel will be 1.15 million tons, equal to 1.64 million tce, taking 4.0% of the final energy consumption,

No coal as fuel directly for final energy consumption will exist in urban area, while it will be reduced by 1/3 in outer suburbs (4 million tons remained).

1.5 Main clean energy projects

The main clean energy projects listed below are aimed at to contribute to the Olympic Games, for which investment is required between 2002 and 2007.

1.5.1 Natural gas

According to the energy-mix readjustment plan mentioned above, 2.2 billion cubic meters of natural gas has been achieved in 2003. 5 billion cubic meters of natural gas will be required in 2008. The maximum annual transmission capacity of the first Shaanxi-Beijing long-distance pipeline is about 3.3 billion cubic meters, in which at most 2.4 billion cubic meters can serve for Beijing. Therefore, Beijing should initiate

the construction of the second long-distance pipeline immediately.

- Gas source. Beside the second long-distance pipeline, expansion of Dazhangtuo Underground Gas Storage Project and other new underground gas storage projects will be constructed as well.

- Urban gas distribution networks, city gas stations, pressure regulator stations, spherical gas storage tanks and other facilities will be constructed, while existing distribution networks and pressure regulator stations for artificial coal gas will be reconstructed to distribute natural gas.

- Gas stations. As committed in the bidding report to the IOC, 90% buses and all municipal vehicles (for environmental protection and postal service) will be powered by clean fuels in 2008. Accordingly, about 50 natural gas stations and 100 LPG stations need to be built. Vehicles using gas as fuel for public transport and municipal services will be purchased or retrofitted as well as taxis.

- Fuel-switch projects for boilers. In urban area, 5000 coal-fired boilers will be retrofitted to use natural gas by 2005. The remaining 3000 coal-fired boilers in the suburbs will be retrofitted by 2007, while coal-fired facilities in countries and districts of outer suburbs will also be retrofitted if permitted by specific conditions. Gaojing Power Plant will switches to the gas-fired.

- District gas-fired cogeneration projects Tsinghua Plant, Yizhuang Plant, Dianzicheng Plant and Shangdi Plant will be constructed.

- Clean high-efficiency combustion of natural gases is another key issue in environmental energy technology. Viessmann[4] has developed a very efficient gas boiler based on so called condensing technology. With the increase of the development and thus the consumption of natural gases in China, the advanced combustion technologies of natural gases are receiving more and more attention. We have concentrated ourselves on the catalytic combustion technology of natural gases to improve the combustion efficiency and more importantly to reduce emissions for several years. Besides the extensive studies on catalytic combustion theory and various low-cost catalysts, a new type of cooking range has been also developed successfully with a emission of NO_x less than 10 ppm.

1.5.2 Electricity

- Generation projects. Caoqiao Gas-fired Cogeneration Plant, Taiyanggong Gas-fired Cogeneration Plant, and gas turbine units of the Third Cogeneration Plant (phase I and II) will be constructed. Outside Beijing, several power plants will be built such as Wangtan Power Plant (phase I), Zhenglangi Power Plant (phase I) and Daihai Power Plant (phase I) in Inner Mongolia, and Xiahuayuan

Power Plant (phase VI).

- Transmission projects The transmission projects to be constructed consist of building or upgrading 500kV and urban 220kV power grids, replacing the overhead lines with underground cables along key urban streets and around Olympic Games fields, upgrading electric facilities in Olympic stadiums and relative areas, and upgrading electric distribution for reconstruction projects of dangerous and aged dwellings in downtown.

- Electric space heating projects in Old City Reserve Zone Necessary electric construction and renovation will be completed to guarantee the space heating for the one-storey buildings in the reserve zone within the Second Ring Road.

1.5.3 Heating power

Shuangyushu Heating Plant will be expanded and Caoqiao Gas-Fired Cogeneration Plant will be built. The accessory projects of outside heat supply network for Gaobeidian Cogeneration Plant and other heat-supply networks will be completed. The heat-supply system in Olympic Park and surrounding area will be constructed and renovated.

1.5.4 New energy and new technology for energy-use

- Space heating with geothermal energy and water source heat pumps There will be 160 geothermal wells completed in the city by 2008. The construction of geothermal heating project in Olympic Garden will be completed to serve 0.40 million square meters in the stadiums and gymnasiums for space heating.

- Solar energy. To devote major efforts to promote energy solar utilization, 3MW solar cells will be constructed in Olympic Park as a demonstration project, where 90% hot water were produced by solar energy. Solar photo electricity application project and solar thermal utilization project in Olympic Park are constructed.

- Wind power. The existing and planned wind power capacity is 50MW in the outer suburb areas of Beijing, which can supply mainly 20% of the electricity demand of Olympic Park as committed in the bidding report to the IOC. Efforts will be made to purchase wind power from the neighboring provinces during the Olympic games. The feasibility of wind power development in Yanqing, north west of Beijing, is also under investigation.

- Biomass energy Quality of rural energy will improve, leading to improvement in rural energy use, air and water environment and comprehensive utilization of agricultural wastes. Main measures include biomass gasification projects for centralized biogas supply and large-scale biogas energy-environment projects

- Fuel cells and electric vehicles Efforts will be made in research and development of fuel-cell-driven and power-driven vehicles aiming to mitigate the pollution induced by transportation[5].

2 Guidelines for Environmental Protection in Olympic Construction Projects——Energy Conservation of Architectures

37 venues will be used for Olympic competitions, 32 of which in Beijing and 5 of which outside the city. Of the 32 venues in Beijing, 19 will be newly-constructed (including 6 temporary sites) and 13 are existing facilities to be renovated or expanded. The venues and related facilities for the 2008 Olympic Games will be designed and constructed in accordance with the technical requirements of the International Olympic Committee and the International Sports Federations and in line with China's national conditions and Beijing's actual development. Guidelines for Environment Protection in Olympic Construction Projects have been issued by the Environmental Activity Department of the Beijing Organizing Committee for the Games of the XXIX Olympiad (BOCOG)[6]

2.1 General requirements for energy conservation of Olympic projects

(1) Adopting advanced energy conservation technology of enclosure structure: advanced thermal insulation technology of exterior wall and external sunshade technology may be used to improve the thermal insulation and to reduce the heat transfer coefficient of enclosure structure resulting in the reduction of conventional energy consumption;

(2) Taking full use of the local available renewable energy sources, such as solar energy, geothermal energy, wind energy, adjusting and optimizing energy consumption structure of architectures to minimize the energy consumption;

(3) Adopting advanced indoor air processing technology for reasonable control of fresh air flow rate and adopting heat recovery technology to increase the energy efficiency of heating and air conditioning system;

(4) Advanced heat pump technology: ground source/water source heat pumps will be applied for heating and air conditioning to improve energy efficiency;

(5) Combined supply technology of heat, power and cool: combined supply technology of heat, power and cool shall be actively popularized to maximize the efficiency of energy source, such as natural gas;

(6) In the architectural design, technology of natural ventilation shall be fully utilized to decrease energy consumption of air conditioning. In spring, autumn and the transitional seasons, natural ventilation shall be relied on to

maintain a comfort indoor condition and build a healthier living environment;

(7) Green lighting technology: lighting is usually about 30% of the energy consumption in commercial buildings. High efficiency green lighting technology include:(a) natural lighting shall be fully considered for efficient utilizing natural light source and advanced technology of light pipe shall be used to introduce sunlight into rooms[7];(b) adopting all kinds of high efficiency energy conservation light sources;

(8) Indoor air purification technology: Using latest advanced photocatalytic technology to air cleaners and construction material with the performance of self cleaning, sterilizing and degrading harmful gases, such as ceramic tiles, floor tiles, sanitary ceramics and wall papers, to improve indoor air quality[8].

(9) Application of advanced heat and cool storage technology shall be encouraged to lower energy consumption cost of architectures.

(10) Strengthening (operation) management of architecture energy consumption system to improve energy efficiency.

2.2 Energy conservation requirements for the residential buildings in the Olympic Village

(1) Energy conservation index of the residential buildings in the Olympic village

Table 5 Energy conservation index of the residential buildings in the Olympic Village

Standard	Heat Transfer coefficient ($W/m^2.k$)			Heat consumption index（W/m^2）	Cold consumption index（W/m^2）
	roof	external wall	window		
JGJ24-86[9]	1.26	1.70	6.40	/	/
JGJ26-86[10]	0.91	1.28	6.40	/	/
JGJ26-95[11]	0.80, 0.60	1.16, 0.82	4.00	20.6	~11.0
Olympic Village	0.56, 0.46	0.81, 0.57	< 2.5	< 15*	< 7**

*The heat consumption given by JGJ 26-1995 is calculated according to the average temperature of 16℃ of all rooms. It is apparently low for the Olympic Village, which is calculated on the basis of 20℃, then the heat consumption shall not be higher than 12W/m^2 other than 15 W/m^2.

** Cool consumption index is not given in JGJ26-1995, Data here is calculated assuming that heat transfer coefficients in winter and summer are approximately the same and the temperature

difference between indoor and outdoor in summer is half of that in winter in Beijing.

(2) According to the index, besides executing the general requirements for energy conservation of Olympic projects, the Olympic Village shall realize the following:

- High-level insulation for enclosure structure: further reasonable designing and optimizing the enclosure structure to lower 30% of energy consumption on the basis of JGJ26-1995 Standard so as to approximately approach to the requirements of current architecture energy consumption levels in the developed countries. For instance, for residential windows, multi-layer window, hollow glass, low emissivity glass, filling inert gas shall be adopted to lower the heat transfer coefficient of the whole window to 2.5W/(m^2 .K) and below; for exterior walls, insulation shall be reinforced and exterior insulation shall be particularly used to lower heat transfer coefficient of exterior walls to 0.5~0.8 W/(m^2 .K); with insulation of enclosure structure to facilitate the storage of indoor energy and adjustment of room temperature.

- Adoption of advanced energy supply technology and full utilization of renewable energy, such as advanced heat pumps technology (including ground source heat pump technology, water source heat pump technology), heat and cool accumulation technology, solar energy sunlight utilization (lighting) and heat supply technology, reducing energy consumption in heat and cool delivery, increasing combined supply of heat and power or combined supply of heat, power and cool; heat recovery technology and variable flow rate technology.

2.3 Demonstration buildings

Four demonstration buildings have been constructed or will be constructed in Beijing to promote the development of green building technology.

- **China-USA energy efficiency demonstration building**

The building owned by the Ministry of Science and Technology of China was constructed with the cooperation between China and USA. The building, with a floor space of 13,000 square meters, consumes only 40 percent of the daily energy used by most commercial buildings. The new building is the first “green” building in China in line with the internationally acknowledged energy efficiency criteria. The building integrated many energy efficiency technologies, such as fully utilizing natural light source, insulation technology of exterior wall and window, Heat recovery technologies, solar hot water and photovoltaic technology.

- **Renewable energy utilization demonstration building**

The demonstrating building owned by Tianpu Group was constructed with the support

of Beijing Municipal Science and Technology Commission. The building with the building area of 8000 m^2 using several advanced renewable energy technologies, including solar hot water technology, solar photovoltaic power generation technology, solar absorption heating and air conditioning technology, and ground source heat pumps.

- **Advanced energy technology demonstration building at Beijing University of Technology**

The building of 5000 m^2 will be used by the Ministry of Education "Key Laboratory of Enhanced Heat Transfer and Energy Conservation" at Beijing University of Technology. Eleven advanced energy technologies will be integrated into the building, which is shown as follows:

(1) ground-source heat pump technology

(2) light pipe technology

(3) heat recovery technology

(4) thermal energy storage technology

(5) photo-catalytic air cleaning technology

(6) advanced anti-fouling technology

(7) thermal insulation of wall

(8) solar concentrating photovoltaic power generation technology

(9) wind power generation technology

(10) advanced testing techniques for energy consumption in buildings

(11) advanced humidity controlling technology

The demonstration building has four functions:(1) Prototype of demonstration building with low energy consumption. (2) Localization of advanced environmental energy technology combined with building. (3) Database for sustainable building in China (4) Platform of international cooperation.

- **Super low energy consumption building at Tsinghua University**A super low energy consumption building of 2800 m^2 will be built at Tsinghua University. Some latest high technologies of advanced clean energy and energy conservation, such as solar energy, new heat storage technology, natural ventilation, advanced green lighting technology, new technology of insulation of enclosure constructure, etc. will be used in this international project.

3 Assessment System of Green Building of Beijing Olympics

The study of the assessment standard of green building for the Beijing-2008 Olympic Games is one of the ten “High-tech Olympics” study projects that Beijing carried out for the 2008 Olympic Games. The book *Assessment System for green building of Beijing Olympic* has been published in Chinese[12]. There were two universities (Tsinghua University and Beijing University of Technology) involved in this project.

The standards and the evaluation system are introduced to ensure optimum economy in using resources, minimize harm to the environment, and develop healthy and comfortable living conditions for Beijing residents. They sets criteria for evaluation of construction projects in terms of environment protection, energy conservation, water resources, building materials, and quality of indoor environment, natural lighting and wind proof. The standards and the system cover the complete construction process starting from project planning, architectural design, construction, check and acceptance upon completion, to final operation and management of the project.

At present, the new construction standards and evaluation system have been implemented in the construction of a number of Olympic venues, such as the National Swimming Center. They will be gradually applied to all construction projects in Beijing so as to promote environment friendly practice in the city.

4 **Distributed Energy System (DES)**

4.1 Distributed energy system specialties

It is known that the DES is a small and modular electricity generator sited close to the customer load[13]. It can defer or eliminate costly investments in transmission and distribution system and provide customers with better quality, more reliable energy supplies and a cleaner environment. The system combines of cooling, heating and power (CCHP) and has much high efficiency. The CCHP has many advantages compared with the traditional power production systems.

（1） Reliability

The DES could efficiently decline the effect to the electricity grid brought by the change of the electricity load and decrease the serious accidents. Even in the case of the natural disasters or other sudden eventualities, the electricity network may be closed down and the DES may still work. On the other hand, when the distributed generation gets some problem it may depend on the electricity grid immediately. The combination between the distributed generation and the electricity grid will promote the reliability of the energy system.

（2） High energy efficiency

Based on the principal of the energy cascade utilization, the CCHP system uses the middle and low temperature waste heat properly and makes the energy utilized more efficient than the separate production system. Actually, the efficiency of the system may be well above 80% and there is no lose in transmission for it is close to the users.

（3） Environmental benefit

The DES generally uses the clean fuels, so it is environment friendly. As predicted by “American CCHP2020”, the discharge of CO_2 will decrease 19%. Moreover, the system can be combined with the small-scale low-energy-density renewable energy such as solar energy, geothermal energy, and wind energy. It provides a new way for the utilization of the renewable energy and is a new form of the DES. The development of the system is on the request of the 21st century to decrease the pollution of the environment and the discharge of the green gases, and to substitute the fossil fuels.

4.2 The distributed energy system for the 2008 Olympic games

To realize “Scientific Olympic Games” and “Green Olympic Games” the DES will be used to supply the heating and cooling and a part of the electricity. The Institute Of Engineering Thermophysics of The Chinese Academy Of Sciences, one of the main designers, is designing the DES in the “Olympic energy park”. The natural gas, solar energy and geothermal energy will be utilized in the system. Now a preliminary scheme of the energy system has been completed. The designed project gives the prominence to the specialties as follows:

- The different forms of the energy are complementary, renewable energy (such as solar energy, and geothermal energy) are fully utilized.
- The waste heat is recovered in a two-stage waste heat boiler, and energy cascade utilization is reached.
- The absorption heat pump (AHP) is used to the heating, and the city’s reclaimed water and solar energy are used as low temperature heat resource in winter.
- The recovering heat of the condenser of the AHP is applied to supply the hot water in summer.
- The heat from the decrease of the gas temperature exhaust to the environment is used to dehumidify in summer and to heating in winter.

Gas turbines (GT), high temperature and low temperature waste heat boilers, LiBr/H_2O absorption heat pumps (LiBr-AHP), NH_3 mechanical compression heat

pumps, and cold and heat storages are embodied in this system. In summer, the gas turbine generates electricity, and the waste heat boiler recovers the heat of the exhaust gas. Here the steam from the high temperature WHB drives AHP and makes refrigeration; at the same time, and the recovering heat of the condenser of the AHP is applied to supply the hot water and heating water of the natatoriums in summer. Moreover, the hot water that is from low temperature WHB is used to dehumidify. In the winter, the steam from the high temperature WHB drives AHP for heating or storing. Solar energy and geothermal energy provide low temperature heat source needed by the AHP; if solar energy and geothermal energy aren't enough, NH_3-MCHP will increase temperature of the water source or the environment, which are used to low temperature heat source of AHP. Moreover, the heat from the low temperature WHB produces the hot water used in the buildings. The energy conservation rate of the system is 34.6% at refrigeration condition, and it is 43.1% at heating condition. Furthermore, some ways could increase the reliability and the performance at the different conditions. For example, three operating GT and one standby GT, WHB with AHP may be connected by the steam piping-main scheme, etc.

5. Prevention and Control of the Vehicle Emission Pollution

Continue to give priority to public transportation, and lay emphasis on rail transportation (metro and light rails) so as to accelerate the development of the public transportation system in the urban area.

5.1 Urban railway transport

By the year of 2008, additional 154.5km urban railway will be built, expanding the total length of urban railway lines to 249.5km in the downtown areas. Some suburb railway lines will also be constructed, increasing Beijing's urban railway operation lines to over 300km in total. The urban railway system is expected to carry 1.8~2.2 billion passengers per year.

5.2 Road system

By the year of 2008, a modern urban road network will be completed, which will be rationally structured both in function and structure, and backboned by the urban expressways and main roads. The density of road network within the 5th ring road will reach about 2.62km/km^2. Priority will be given to the construction of some key urban expressways, main roads, minor roads and branch roads, the re-construction of some key intersections and the elimination of the bottlenecks in the road network. Special attention will be directed to the construction of collecting networks between the 2nd and 4th ring roads, and the construction of corridors connecting downtown areas and the 10 scattered groups. Both the road network layout and the functional

structures will be improved. Newly built and rebuilt urban roads will reach 318km, including 54.1km urban expressways, 86.7km main roads and 96km roads in central area.

5.3 Buses and trolley buses

By the year of 2008, the capacity of Beijing's buses and trolley buses transport will reach 4.5 billion passengers per year, and the number of operation vehicles will reach 18,000. There will be more than 650 public transit lines with a network density of 2.16km/km^2. The handling capacity of the city's bus services will reach 19.5 million persons per day.

5.4 Taxi

Taxi, as an auxiliary and assistant part of the public passenger transport system, will be governed by Beijing's passenger transport plan and brought to full function. In the forthcoming 7 years, taxi services in Beijing will be developed into an efficient, energy saving, safe, environment-friendly urban transport tools and offer good services of international standards. The vehicles used as taxies will be upgraded and conformed to the Technical Standards for Special Vehicles Used as Taxies. By the year of 2008, middle and high-class vehicles will be over 70% of the total operating taxies, clean energy vehicles will be over 70%, and all of the operating taxies will meet the environmental standards. At the same time, taxi service dispatching system will be established with integrated service modes of phone call service, station call service and roadside call service. The enterprise computer management system and Beijing taxi industry service standards system will be formed and all the taxi drivers are expected to be able to speak most frequently 100 English sentences for taxi services.

5.5. Vehicles emission control

More stringent vehicle emission limits will be introduced in the city: from January 1, 2003, the light vehicles, heavy diesel vehicles will follow the second-stage emission limits that is equivalent to Euro II, and in 2005, the third-stage limits equivalent to Euro III will come into force. Moreover, emission limits for other types of vehicles will be tightened. No new automobiles failing to meet the limits will be allowed to enter Beijing's market or be granted of licenses. On the other hand, efforts shall also be made to organize supply and sales of fuels matching the new limits. At the same time, it will be encouraged to use the automobiles powered by cleaner fuels, fuel cell vehicles, electricity-powered vehicles and other types of lower emission vehicles. By 2007, 90% public buses and 70% taxies shall be converted to cleaner energy. Almost 200 liquefied petroleum gas stations and natural gas stations will be put into use.

Measures shall be made to accelerate the elimination of aging automobiles to guarantee reduction of total vehicle emission while the vehicle fleet keeps growing. Automobiles that have been in use by the end of 1992 will be discarded by 2007; the taxies with more than 500,000 kilometers' driving age should be timely scraped. Rules for eliminating the motorcycles will be formulated and enforced and national stipulations on eliminating the vehicles for agricultural use will be strictly enforced. More simplified dyna-mometer test lines will be provided to apply this exhaust test approach to all in-use vehicles and the limits will be lowered.

Environmental label management will be strengthened; traffic control will be tightened according to different automobile exhaust levels and I/M system will be mandated. Quality of the oil for automobile shall be safeguarded. Take stronger measures in law enforcement by relying on the departments of both environmental protection and traffic control so that more than 90% of the automobiles' exhaust will come up to the limits.

On the basis of the improvement of the road traffic and the public transit systems, reasonable number of parking lots in the downtown area shall be provided with the price of parking set at reasonable level to control the traffic flow volume on the motorway in the urban area. Measures will be taken to divert transit vehicles from other parts of the country from entering the Fifth Ring Road by 2004. Moreover, other measures to reduce traffic jam and encourage people to use public transits and bicycles shall be adopted.

6. International Cooperation for the 2008 Summer Olympic Games in Beijing

The United States and China are the two largest energy consumers in the world. Energy security and environment protection are important priorities both for the two countries.

The United States and China have established 11 teams to move forward on Green Olympics cooperation since a Statement of Intent was signed between the Department of Energy and China in September 2002. Two Joint Working Group Meetings were also successfully held in Beijing in 2002 and 2003 and have developed proposals for cooperation.

Academician XU Guanhua, Chinese Minister of Science and Technology, Dr. FAN Boyuan, Deputy Mayor of Beijing Municipality and Mr. Spencer Abraham, US Secretary of Energy jointly signed on January 12, 2004 the Protocol on the Cooperation in the Field of Clean Energy Technology for the Beijing Olympic Games in 2008[14]. The Protocol has laid up a basic framework for the cooperation between the two countries in clean energy technology for the Beijing Olympic Games in 2008.

The cooperation will make its due contribution to realize the mottos proposed by the Beijing Olympic Games Committee for the "green, scientific and humanitarian Olympic Games" in 2008. Both the two sides have so far defined 11 cooperation fields relating to the efficient natural gas utilization, fuel cell, energy planning for the Olympic village, green structure demonstration, water quality, intelligent traffic system, energy efficiency, air quality, weather monitoring and forecasting, clean coal technology and making Beijing and Chicago sister cities for the sustainable development. To promote the Olympic games and Olympic Movements, international cooperation is encouraged between China and all the other counties in the world. We will greatly enhance the ties between China and EU and European counties for this purpose.

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