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Advancing Near-Term Low Carbon Technologies

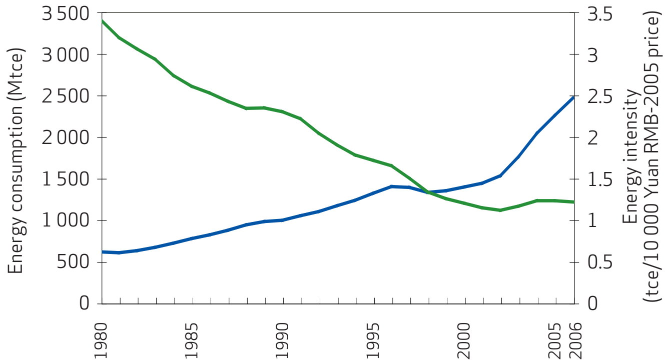
# CHP and DHC in China: An Assessment of Market and Policy Potential

China is the second-largest energy consumer and carbon emitter in the world.[1] As a result of economic development, China's energy consumption has been growing rapidly in recent years and energy and environmental issues have become a key challenge to China's sustainable development. As a result, the Chinese government has begun to pay unprecedented attention to energy efficiency and emissions reductions, proposing an ambitious target to reduce energy intensity by 20%. As important energy efficiency technologies, combined heat and power (CHP) and district heating and cooling (DHC) have received a good deal of attention by the Chinese government. Over the past several decades, China has issued a series of policies to promote CHP/DHC; as a result, China has become the second-largest country in terms of installed CHP capacity. In 2006, CHP capacity in China increased to over 80 gigawatts (GW), providing 18% of nationwide thermal generation capacity. However, in spite of high-level government attention, China has a much greater potential for developing CHP and DHC. This report contains the International Energy Agency's recommendations for addressing existing barriers so that China may realise the future benefits of CHP/DHC, contributing not only to China's energy efficiency and emission reduction targets but also to global greenhouse gas (GHG) emissions reductions.

## Energy and Climate Change Overview

In recent years, with unprecedented economic growth and improvement of the standard of living, annual energy consumption in China has increased rapidly. During 1980-2000, annual energy consumption in China increased by 780 M tonnes of coal equivalent (Mtce), while the annual energy consumption during 2000-2006 increased 1 080 Mtce, as shown in Figure 1. In addition, as coal accounts for approximately 70% of China's energy mix (as shown in Figure 2), resulting emissions of sulfur dioxide and greenhouse gases are rising rapidly.

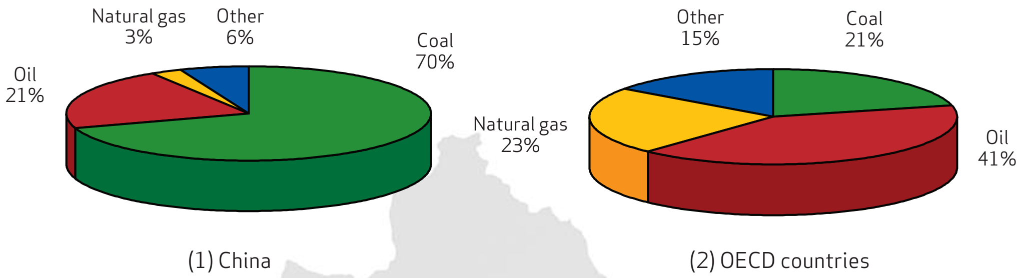
**Figure 1.**
**Annual Energy Consumption and Energy Intensity in China**
Source: IEA, *World Energy Outlook* (2007).




1. International Energy Agency, (2007) *World Energy Outlook*, IEA/OECD, Paris.

**FIGURE 2:**
**ENERGY MIX OF CHINA AND OECD COUNTRIES, 2004**

SOURCE: IEA, *WORLD ENERGY OUTLOOK* (2006).




Despite its unprecedented energy growth, China's current per capita energy consumption is just 1.3 tonnes of oil equivalent (toe), still less than one-sixth of the United States and less than one-third of OECD countries. However, from a long-term viewpoint, with its economic growth expected to continue, the resulting growth in energy consumption in China will have important impacts on regional and global energy supply and environmental issues.

As a result, the Chinese government has begun to pay increased attention to energy efficiency and GHG emissions reduction. Resource saving and environmental protection have become important national policies, and energy efficiency is the priority strategy to address these issues. The Chinese government has proposed the ambitious target of reducing energy intensity by 20% and reducing emissions by 10% during 2005-2010. To achieve this ambitious goal, the central government has rolled out a series of supporting policies.

- The Chinese government issued a series of laws aimed at promoting energy conservation and cleaner energy production, including the Energy Saving Law (formulated in 1997, revised in 2007), the Renewable Energy Law, the Air Pollution Prevention Law, and the Environment Protection Law. In addition, the government has formulated a series of energy conservation standards, such as energy efficiency standards for buildings, energy efficiency standards for appliances (including refrigerators, air conditioners, and lighting), and energy consumption quotas on some energy-intensive industrial products.

- The government has also issued a series of policies controlling new construction, including some that involve the phasing out of energy-inefficient industries. For example, the Energy Conservation Appraisal and Assessment Scheme on Project Investment evaluates the efficiency of various industrial sectors. At the same time, the National Development and Reform Commission (NDRC) has created a plan to phase out inefficient industries, which accelerates the phase-out of inefficient industries in key sectors such as power, steel and iron, cement. Under this plan, 500 MW of small coal power plants will be phased out during 2005-2010; however, CHP plants are not included.

- The government also provides support to energy conservation projects through a series of dedicated funds, subsidies, and discounted loans for energy efficiency investments.

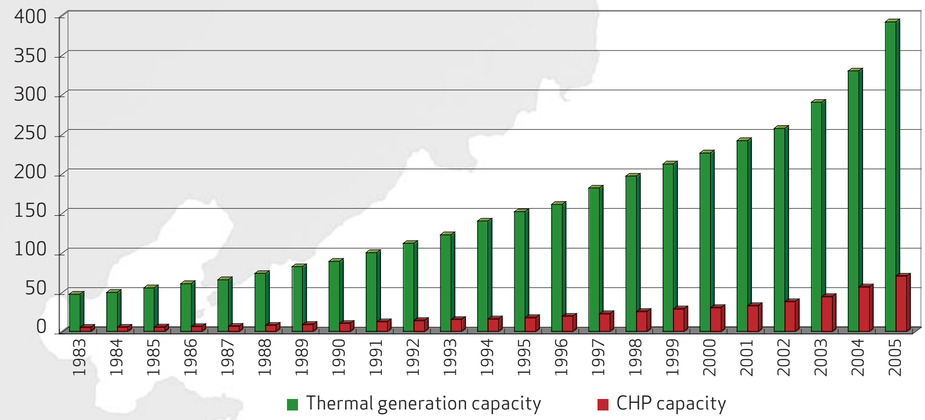
- The government supports these policies through a public information and awareness campaign which targets energy conservation and GHG emissions reduction. Activities include public awareness television programmes and outreach via other media. As a result, energy conservation and emission reduction are becoming well-known issues in China.

# CHP Status: Technology, Applications and Market Activity[2]

China views CHP as an energy-efficient and environmentally friendly energy supply option. As such, CHP use in China has grown. Due in part to government promotion, China's CHP market developed significantly in the past decades, as shown in Figures 3 and 4. At present, China is second in the world in installed CHP capacity, which increased from 10 GW in 1990 to 30 GW in 2000, with an annual growth rate of 11.6%.[3] By 2005, CHP reached almost 70 GW of capacity, with an increasing annual growth rate of 18.5% from 2001-05. During this time, the share of CHP capacity in thermal generation increased from 11.3% in 1990 to 17.8% in 2005.

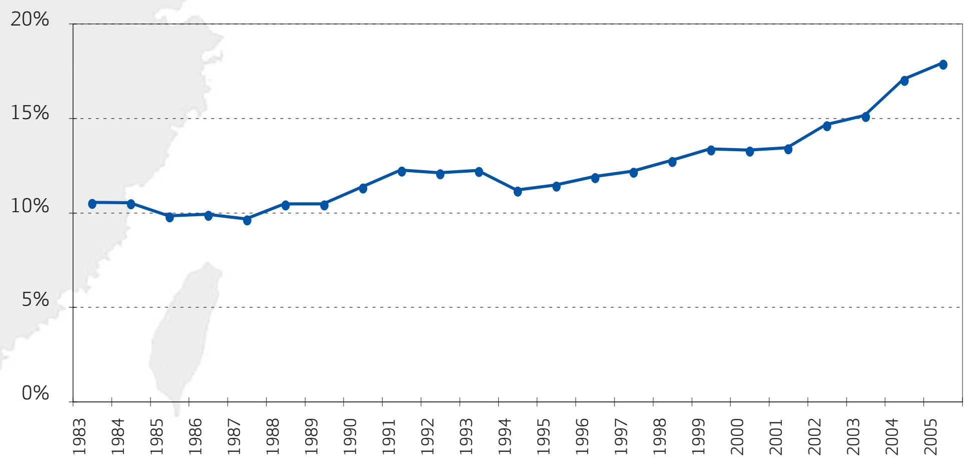
**FIGURE 3:**
**CHINA'S THERMAL GENERATION AND CHP CAPACITY (GW)**

SOURCES:
(1) *CHINA POWER ALMANAC*, CHINA POWER INDUSTRY PUBLISHER.
(2) WANG ZHENMING, *CHP DISTRIBUTED ENERGY AND ENERGY CONSERVATION*, (2004).
(3) US EPA CHP PARTNERSHIP AND ASIA-PACIFIC PARTNERSHIP (APP) ON CLEAN DEVELOPMENT AND CLIMATE, *FACILITATING DEPLOYMENT OF HIGHLY EFFICIENT COMBINED HEAT AND POWER APPLICATIONS IN CHINA*, (2008).




In 2006, there were more than 2 600 CHP units in China, representing over 80 GW, providing about 18% of the thermal generation capacity. The heating supply from CHP was nearly 2 300 petajoules (PJ), representing an 18% increase compared to 2005. The National Development and Reform Commission estimates that, compared to separate production of heat and power, CHP has resulted in energy conservation of 67 Mtce.

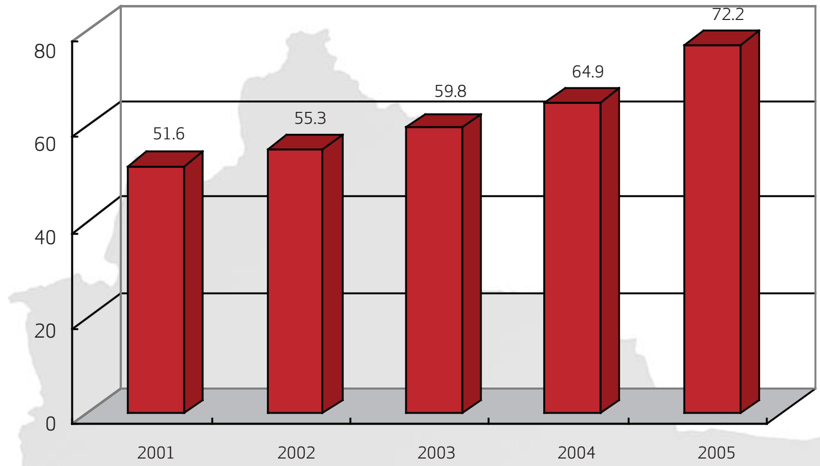
**FIGURE 4:**
**THE SHARE OF CHP CAPACITY IN THERMAL POWER GENERATION IN CHINA**




2. In China, as in many countries, CHP/DHC is not seen as a separate industry sector. As a result, there is a lack of official statistics data on CHP/DHC. In this report, data have been collected from relevant agencies and experts.
3. CHP units of single unit capacity less than 6 megawatts are not included in this report.

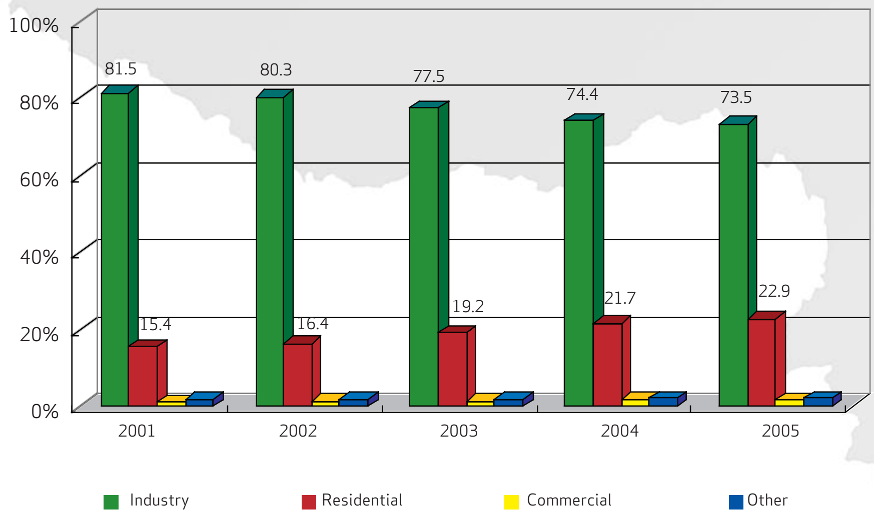
During 2001-05, China's final heat demand increased approximately 50% (Figure 5), mainly from the industrial and building sectors.[5]

**FIGURE 5:**
**HEAT DEMAND IN CHINA (MTCE)**
SOURCE: *CHINA ENERGY STATISTICAL ALMANAC*, 2001-2005.




The industrial sector is the biggest heat user, as the process of industrial production (including chemical industry, papermaking, pharmaceuticals, textiles, iron and steel and others) require heat as the basic energy input. At present, with the exception of a few large industrial CHP plants, the majority of factories in these sectors are producing heat in boilers. The heat consumption in the industrial sector increased from 42 Mtce in 2001 to almost 57 Mtce in 2005.

**FIGURE 6:**
**THERMAL ENERGY DEMAND IN CHINA**
SOURCE: *CHINA ENERGY STATISTICAL ALMANAC*, 2001-2005.




5. In China, the statistical data on heat demand is mainly for the industrial enterprises, including steam and hot water from industrial boilers, public CHP plants and export steam for CHP plants. This data does not include self-use steam in industries or steam/hot water from boilers under 2 tonnes/hour.

Residential heating is another major heat application. China's large size and varying climate conditions provide a number of suitable areas for the use of district heating. The heating period in the coldest areas is 150-200 days, in other areas the heating period is 90-150 days. The traditional heating area includes 15 Northern provinces in cold climates, occupies 70% of the national land area, and is home to 40% of the national population (Figure 7). Residential heat demand has increased from 8 Mtce in 2001 to 17.6 Mtce today, due in part to the rapid development of district heating in China.

Table 1 shows the national CHP heating supply, including the 15 traditional heating provinces during 2003-05. These 15 provinces are the main market for heat, accounting for 60-70% of demand. In the traditional heating areas, CHP provides heat for both the industry and residential sectors, and there are steam pipelines and hot water pipelines in important heating areas. CHP heat demand is also rapidly increasing in the southern provinces to meet increasing heat demand of growing industrial and residential sectors. To meet this growing demand, China has started to install large (200-300 MW) CHP units in recent years. These units have important energy saving features compared with existing smaller-scale units.

**FIGURE 7:**
**SKETCH MAP OF CHINA'S CLIMATE ZONES**


**TABLE 1.**
**CHP HEATING SUPPLY (PJ)**

| | 2003 | 2004 | 2005 |
|---|---|---|---|
| **National** | **1 484.2** | **1 657.4** | **1 925.5** |
| BeiJing | 54.0 | 50.4 | 60.9 |
| TianJin | 46.9 | 49.2 | 57.2 |
| HeBei | 117.8 | 122.7 | 138.1 |
| ShanXi (capital Taiyuan) | 41.0 | 44.3 | 53.1 |
| NeiMenggu | 55.5 | 54.4 | 52.9 |
| LiaoNing | 197.5 | 195.9 | 209.2 |
| JiLin | 88.1 | 98.0 | 101.3 |
| HeiLongjiang | 81.8 | 91.8 | 99.8 |
| ShanDong | 243.0 | 191.1 | 266.8 |
| HeNan | 36.9 | 29.5 | 40.4 |
| ShanXi (capital Xi'an) | 11.6 | 12.9 | 13.8 |
| GanSu | 32.7 | 34.9 | 37.0 |
| QingHai | | | |
| NingXia | | | 2.0 |
| XinJiang | 27.0 | 26.6 | 32.9 |
| **Total traditional heating area**[6] | **1 033.8** | **1 001.7** | **1 165.4** |
| **Percentage** | **69.7%** | **60.4%** | **60.5%** |

SOURCE: (1) *CHINA POWER ALMANAC*,(2003-2005). (2) POYRY CONSULTANT COMPANY, *CHINA'S CO- & TRI-GENERATION AND HEATING SYSTEMS POLICY REPORT AND MARKET RESEARCH* (2007).

6. In China, the traditional heating area includes 15 provinces shown in the Table in the cold and severe cold areas.

# District Heating and Cooling Applications

District heating has been encouraged by the Chinese government for several decades. China's district heating area has increased from over 276M m² in 1991 to over 1 100M m² in 2000, and exceeded 2 500M m² in 2005, with an annual growth rate of 17% (Figure 8). The growth in district heating mainly came from the Northern and the Northeast regions. In China, residential buildings account for about 70% of the total district heating area, and commercial buildings account for about 30%.

**FIGURE 8: AREAS SERVED BY DISTRICT HEATING (MILLION M²)**

SOURCE: MINISTRY OF CONSTRUCTION (MOC), *CHINA'S URBAN CONSTRUCTION STATISTIC ANNUAL REPORTS*, 2006.

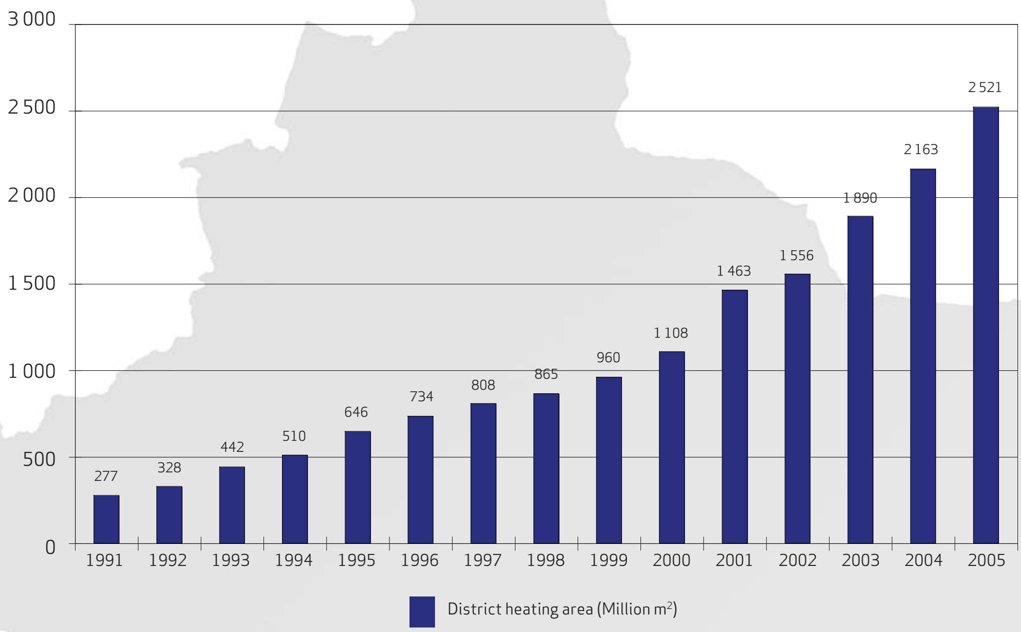



**TABLE 2.**
**DEVELOPMENT OF DISTRICT HEATING IN CHINA (2000-05)**

| Year | Number of Cities | | Heat Capacity | | Annual Heat Supply [PJ] | | Transmission Pipeline [km] | | Total Heating Building Area [M m²] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Cities | with DH | Steam [t/h] | Water [GW] | Steam | Hot Water | Steam | Hot Water | Total | Residential Building |
| 2000 | 663 | 294 | 74 100 | 97 | 238 | 833 | 8 000 | 35 800 | 1 108 | 758 |
| 2001 | 662 | 304 | 72 200 | 126 | 377 | 1 002 | 9 200 | 43 900 | 1 463 | 958 |
| 2002 | 660 | 315 | 83 300 | 144 | 574 | 1 227 | 10 100 | 48 600 | 1 556 | 1 080 |
| 2003 | 660 | 321 | 92 600 | 172 | 591 | 1 290 | 11 900 | 58 000 | 1 890 | 1 310 |
| 2004 | 661 | 324 | 98 300 | 174 | 694 | 1 282 | 12 800 | 64 300 | 2 163 | 1 508 |
| 2005 | 661 | 329 | 106 700 | 198 | 715 | 1 395 | 15 000 | 71 400 | 2 521 | 1 751 |

SOURCE: MINISTRY OF CONSTRUCTION (MOC), 2007

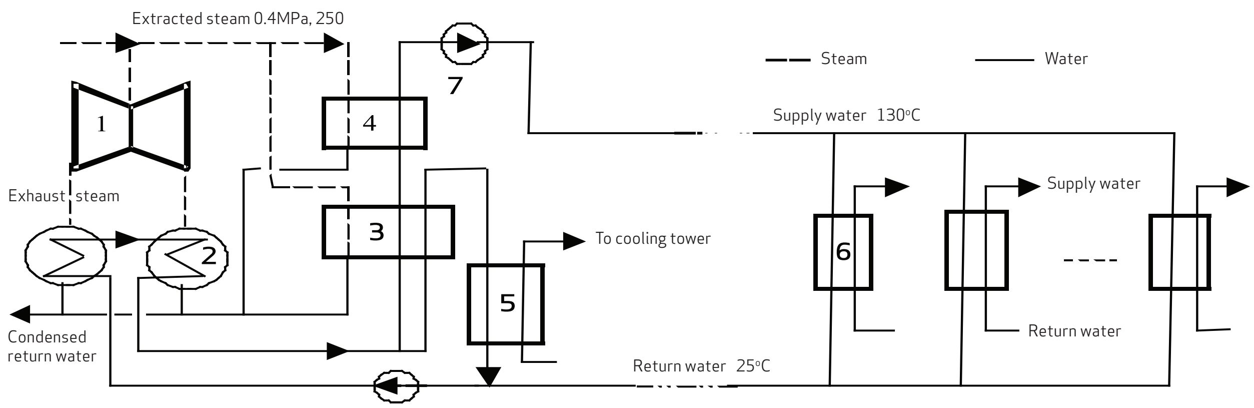
As we can see from Table 2, in 2005, 329 cities (out of a total of 661 nationwide) have district heating infrastructure in place. The total steam heating supply in China is 106 700 tonnes/hour (t/h), and the total hot water heating supply is 198 GW. The district heating area is more than 2 500M m², and hot water heating pipelines span more than 71 000 km, with steam heating pipelines at 15 000 km.[7]

By the end of 2005, district heating supply (including steam and hot water) was over 2 100 PJ; CHP accounted for 47% and boilers accounted for 51%.[8] In the supply of steam and hot water, steam supply is 715 PJ, of which CHP accounts for 81% and boilers account for 17%; the total hot water heating supply is 1 395 PJ, of which CHP accounts for 29% and boilers account for 69%. The heating supplied by CHP units and boilers are, respectively, 992 PJ and 1 086 PJ.

As coal is the dominant fuel in China, and many CHP/DHC facilities are quite old and inefficient, the present average efficiency of a coal-based boiler in China is 60-65%. Further, in some cities, the heat loss from district heating pipelines (as a result of poor insulation and water losses) is 20-50%, which has reduced the benefits of district heating. As a result, the Chinese government is promoting an Energy Conservation Retrofit Plan on Residential Buildings and District Heating Systems in the Northern 15 provinces.[9] In 2007-08, the aim of this programme is to provide 150M m² of new district heating areas. This measure has helped to promote the quick development of energy-efficient district heating technologies. The text box below shows an innovative CHP/DHC waste heat recovery technology with absorption heat exchanger proposed by Tsinghua University.[10]

## Case Study 1. CHP/DHC waste heat recovery technology with absorption heat exchange cycle

**FIGURE 9: "CO-AH" CYCLE SCHEME OF DISTRICT HEATING SYSTEM WITH COGENERATION**




1. Low-pressure (LP) cylinder 2. Condenser 3. Absorption heat pump 4. Heat exchanger 5.Load regulation device 6. Absorption heat exchanger 7. Pump

Today, an innovative CHP/DHC waste heat recovery technology with absorption heat exchange has been developed by the Building Energy Efficiency Centre at Tsinghua University. In this technology, absorption heat-exchange conception is adopted to form a heat network cycle called "Co-ah" cycle (as shown in Figure 9), which means co-generation system based absorption heat exchange. In the substation of the heat network system, supply water in the first network releases heat to the second network by absorption heat exchange, which makes the temperature of the return water very low (about 20°). In a CHP plant, network water is heated to a temperature of 130° by exhaust vapor in a condenser, absorption heat pump and peak load heater sequentially. By enlarging the temperature difference between the supply and return water of the heat network, the efficiency of the network improves, reducing the investment required. Further efficiency gains (approximately 50%) are realised by recovering exhaust heat from the condenser. The Co-ah method is paving the way toward a revolution in district heating in northern China. The added investment may be reclaimed in about two years. Several pilot projects using this technology will be implemented in the end of 2008.

7. This accounts for about 6% of national building area.
8. Source: MOC, *China City Construction Statistic Annual*. The DH data does not include industrial steam and hot water.
9. Organised mainly by MOC and local governments.
10. Corresponding ways: Prof. Fu Lin, Building Energy Efficiency Centre of Tsinghua University, fulin@tsinghua.edu.cn.

In addition, district heating and cooling (also called "CCHP" in China) technology also has been developed recently. Due to the rapid growth in urban energy demand, the natural gas market is growing. As a result, CCHP technology fired by natural gas is developing in some cities, such as Beijing, Shanghai and Guangzhou. Most of the early CCHP projects are at commercial buildings, such as office buildings and schools. However, there is some debate among experts about the actual energy conservation performance of CCHP, and policy barriers (including grid connection) are a barrier to the expanded development of CCHP in China. In 2007, the CCHP capacity at the early projects was almost 4 GW. The Case Study below shows a pilot CCHP project.

## Case Study 2.
## Beijing Gas Group Building CCHP Project

In 2004, Beijing Gas Group developed the first pilot CCHP project at a 32 000 m$^2$ office building, providing electricity, heat and cooling. The electricity demand ranges from 400-800 kW. The cooling demand is 500-3 000 kW in summer and 550-2 700 kW in winter. CCHP technology includes 2 gas engine generators (1×480 kW + 1×725 kW) to provide electricity. Two waste heat-fired absorption compressor units (1×1 163 kW + 1×2 326 kW of cooling output) provide 7-12$^{o}$C chilled water in the summer and 50-60$^{o}$C hot water in the winter to meet the cooling/heating demand .[11]

# Stakeholders

### Government

Government plays an important role in CHP/DHC promotion. As a result of the Chinese government's organisational reform, the role of provincial departments in CHP/DHC promotion has been changing. At present, the relevant government actors include:

- **National Development Reform Commission (NDRC)**:[12] The main agency responsible for CHP and industrial policy, energy conservation and resource comprehensive utilisation, energy price policy, and other energy policies.
- **Ministry of Construction (MOC)**: The ministry responsible for urban construction (including district heating) and building energy conservation. Some MOC policies on district heating focus on heating reform, including metering.
- **Other relevant agencies**: These include the National People's Congress, the State Council and other ministries such as State Environmental Protection Administration. These organisations mainly provide high-level viewpoints on the impacts to energy efficiency and environmental protection of developing CHP/DHC.
- **Local governments**: Some local governments also provide policies to promote CHP/DHC, such as Beijing, Shandong and Shanghai. Local actions include lowering the fuel price for CHP and providing subsidies to heating supply companies and CHP/DHC retrofit projects.

### Industry

Several industries play an important role in CHP/DHC technology development. In China, most large-scale CHP plants (>200 MW) belong to power companies (Datang Group, Huaneng Group, and others). Most of the middle scale (50-100 MW) and small scale (<50 MW) CHP plants belong to municipal companies or industrial end users. In general, district heating boilers belong to the local heating companies; however, some local natural gas companies are beginning to promote DHC (CCHP) applications.

### Non-governmental Organisations

Many scholars from universities and research agencies have active research and development programmes to promote CHP/DHC. NGOs (such as Energy Research Institute of NDRC, Energy Conservation Information Dissemination Centre of NDRC, China CHP Committee, China Urban Heating Association, Building Energy Efficiency Center of MOC, and others) have developed expertise and activities on market applications and policies to promote CHP/DHC.

11. China CHP Committee, *Development of Distributed CHP* (2007).
12. Including the newly established National Energy Bureau.

# Review of China's CHP/DHC policies

## Background

Historically, Chinese governments have included CHP/DHC as an important energy conservation and environmental protection strategy. As such, since the 1980s, a number of CHP/DHC policies have been issued, including the following. This list is followed by a more detailed discussion of the most important policies for CHP/DHC.

- *Notice on the Report Regarding the Work on Strengthening Urban District Heat Supply Management (1986)*, enhanced urban district heating supply management.
- *Policies on District Heating Industry Development (1989)*, proposed policies for the district heating industry.
- *Regulations for Encouraging Development of Small Cogeneration Plants and Restricting Construction of Small Condensing Power Plants (1989)*. Includes policies on technologies, financing channels, peak power regulation, fuel supply, and on-line electricity price. Proposed regulations on CHP development and the reduction of small condensing thermal plants.
- *Notice on the Report Regarding the Work on Strengthening Urban Heat Supply Programming and Management (1995)*, proposed requirements to strengthen urban heat supply planning and management.
- *China Energy Conservation Law (1997)*, CHP was listed as a key national energy conservation technology that should be encouraged.
- *Catalogue on National Key Encouraging Development Industries, Products and Technologies (1998)*, included CHP.
- *Some Regulations for CHP Development (1998)*. The ratio between heat and electricity was considered as an important indicator to define and approve new CHP plants.
- *Revised Regulations for CHP Development (2000)*, proposing specific regulations on CHP technical indicators, management practices and the relationship with the power grid. This regulation is the major regulation governing CHP development in China.
- *Pre-Feasibility Technical Regulations for CHP Projects (2002)*, included requirements on technical and economic pre-feasibility studies of CHP projects.
- *Guidance Opinion on Pilot Programmes of Urban Heating Reform (2003)*. Aimed to stop welfare heating and to promote commercial district heating. Pilot projects for heating reform were started in the provinces of Northeast China, North China, Northwest China , Shandong and Henan.
- *Technical Guide on Urban Residential Heat Metering (2004)*, proposed the technical measures to meet heat metering demand, including controllable room thermostats.
- *China Medium- and Long-Term Energy Development Plan (2004)*, CHP/DHC was an encouraged technology.
- *China Mid- and Long-Term Energy Conservation Plan (2004)*, considered CHP as an important energy conservation field and named CHP as one of the 10 key national energy conservation programmes.
- *Regulations for Residential Building Energy Conservation Management (2005)*, encouraged district heat and cooling (CCHP) technology.
- *Enhancement Opinion on Urban Heating Reform (2005)*, focused on heating price reform, promotion of gradual commercialisation of district heating, optimising urban heating resources and promoting energy conservation.
- *Implementation Opinion on Promotion Heating Metering (2006)*, proposed targets and measures for heat metering.
- *NDRC's China Energy Conservation Technology Policy Outline (2006)* includes some key recommendations for CHP/DHC, including: CHP and district heating should be promoted instead of small heating boilers; develop CHP and CCHP in areas with proper heat loads; develop CHP/DHC in large and medium-sized cities in north heating areas; and develop distributed CCHP systems under proper conditions.
- *Implementation Scheme of the National 10 Key Energy Conservation Projects (2007)*, under the 10 Key National Energy Conservation Programmes, further specifies important applications and supporting policies for CHP.
- *Industrial Guidance Catalogue for Foreign Investments (2007)* encouraged the foreign investment and operation of CHP power stations in China.
- *Urban Heating Price Management Temporary Measures (2007)*, proposed reform in the heating price, including gradual use of two components, the basic heat price and the metered heat price.
- *China Energy Saving Law (2007 revised edition)*, proposed several articles to promote CHP/DHC.

# Important CHP/DHC Policies in China

Among the policies mentioned above, some of the most important policies are described below in more detail.

## (1) Some Regulations for CHP Development (1998) and Regulations for CHP Development (2000)

In February of 1998, SPDC, SETC, MOC, and MOEP issued *Some Regulations for CHP Development (1998).* A key feature of these regulations was that, for the first time, the ratio between heat and electricity was considered an important indicator to define and approve CHP.

In August of 2000, *Some Regulations for CHP Development (1998)* was revised, and SPDC, SETC, MOC, and SEPA issued revised Regulations for CHP Development, which proposed specific regulations on CHP technical indicators, management measures and the relationship of CHP with the power grid. This is the most important regulation governing CHP development in China, and includes the following highlights:

- Requirements for local governments to produce a CHP development plan.
- Detailed CHP project approval conditions.
- CHP technical indicator requirements, including overall efficiency levels and heat and power ratios. For example, for turbine CHP units, it pointed out that the overall annual energy efficiency must exceed 45%; for CHP units greater than 50 MW, the annual heat and power ratio must be greater than 100%; for CHP units of 50-200 MW, the annual heat and power ratio must be greater than 50%; and for condensing CHP units greater than 200 MW for district heating, the heat and power ratio in heating period should be higher than 100%.
- Power management departments should provide inspection comments about grid connection for CHP.
- Guidelines that CHP projects should be sized based on available heating load, in order to maximise efficiency.
- Guidance encouraging the maximum use of waste heat, coal tailing, and other waste fuels for CHP.
- Suggestions to use CCHP to improve energy efficiency.
- In the heating range of planned CHP/DHC project, other newly-added small coal boilers projects will be restricted if the planned CHP/DHC capacity may cover the heating demand.
- A goal to implement heat metering on the basis of heat consumption by 2010.

## (2) China Medium- and Long-Term Energy Development Plan (2004) and Implementation Scheme of the National 10 Key Energy conservation Projects (2007)

In November of 2004, the State Council issued the NDRC's *China Mid-Term and Long-Term Energy Conservation Plan,* which considered CHP as an important energy conservation field, listed as one of the 10 key national energy conservation programmes that are critical to realising the energy conservation target.[13]

In 2007, NDRC promulgated the *Implementation Scheme of the National 10 Key Energy Conservation Projects*, which provided important details on CHP target applications and supporting policies, including:

- Stated Goal: In 2005-10, 45 GW of new CHP units will be constructed in the Northern heating area, and 8 GW of new CHP units in the Southern area for industrial heat applications; and
- Key Applications: Requires CHP development in the residential and industrial sectors, and encourages distributed CHP and CHP that uses waste fuels.

## (3) Temporary Regulation for Cogeneration and Power Generation of Integrated Utilisation of Coal Tailings (2007)

On January 15, 2007, NDRC and MOC issued the *Temporary Regulation for Cogeneration and Power Generation of Integrated Utilisation of Coal Tailings.* Compared with *Revised Regulations for CHP Development (2000),* more administrative regulations on CHP were proposed.

- The local government was required to stipulate a plan for CHP and coal tailing utilisation.
- Regions with severe winters and concentrated heat loads should actively develop CHP to replace small heat-only boilers. In regions with hot summers and cold winters, CHP should be developed where there are concentrated heat loads, and CCHP is also encouraged under the proper conditions.
- In areas with existing CHP plants, the regulation discourages the development of additional end-use sited CHP plants.
- Except for large-scale enterprises such as petroleum, chemical, steel, and paper industries, the regulation does not encourage the use of CHP to serve single enterprises.

13. In addition, many of the other 10 programmes – including the coal-fired industrial boiler (kiln) retrofit, residual heat and pressure utilisation, energy system optimisation, building energy conservation and government agency energy conservation – have reference to CHP/DHC applications.

- Encouraging the use of a variety of approaches to solve heating problems in medium and small cities, such as the use of biomass, solar, geothermal and other renewable energy, as well as the use of natural gas, coal gas, and other resources to implement CHP.
- The grid electricity price should be determined by provincial pricing administrative agencies and authorised city and county governmental agencies, which will make decisions based on relevant national regulations, heat cost and profit ratios.
- CHP should be given an advantage for connecting to the grid.

## (4) Guidance Opinion on Pilot Programmes of Urban Heating Reform (2003)

In July of 2003, MOC, NDRC and other agencies jointly promulgated the *Guidance Opinion on Pilot Programmes of Urban Heating Reform*. It aimed to stop welfare heating and promote commercial district heating. This regulation proposed specific requirements for district heat metering. In addition, the pilot projects for heating reform were started in the provinces of Northeast China, North China, Northwest China, Shandong and Henan.

## (5) Urban Heating Price Management Temporary Measures (2007)

In 2007, NDRC and MOC issued the *Urban Heating Price Management Temporary Measures*, which encouraged CHP/DHC, and dictated the reform of heating prices. In these measures, regulators will gradually use two price components: the basic heat price and the metering heat price. This regulation also encouraged the development of CHP and district heating and allowed non-public capital (including foreign capital) to invest, construct, and manage heating supply facilities to promote the gradual commercialisation of district heating industries. The heat tariff, in principle, is determined by the government (tariff administrative agencies at the regional and local levels), but in some regions (where conditions are suitable), the heat tariff may be determined by the market – i.e., by heat suppliers and their customers.

## (6) China Energy Saving Law (1997 Edition and 2007 Revised Edition)

In the *China Energy Conservation Law (1997)*, CHP was listed as an energy conservation technology that should be nationally encouraged. In October 2007, NPC approved the *China Energy Saving Law (Revised Edition)*. Its articles relevant to CHP/DHC include the following:

- Article 31: The country encourages the industrial enterprises to use high-efficiency energy conservation equipment, such as motors, boilers, kilns, blowers, and pumps; and encourages energy-efficient technologies, including CHP/DHC, residual heat and pressure utilisation, clean coal-fired technologies, and so on.
- Article 32: The power grid enterprises should arrange clean and efficient CHP, utilise residual heat and pressure units, and take other measures according to the requirements of the Energy Conservation Power Control Management formulated by the appropriate State Council department, the online power price executing the country concerned requirements.
- Article 78: The power grid enterprises bear liability if they do not comply with the requirement in Article 32.

# Barriers to CHP/DHC Development

In China, the government plays a key role in CHP/DHC development, through regulation, policies, and funding. As China is in the process of reform, economic/pricing, institutional and policy barriers are the most important barriers to realising the potential benefits of CHP/DHC in the future.

## Economic and Pricing Barriers

In order to become a cost-effective and attractive investment, power and heating reform policies will need to be undertaken. Some of the key issues include:

- **Energy price policy reform is a priority**. At present, in China, the coal price is based on the market, which has grown rapidly in recent years. However, electricity and heating prices are still controlled by the government, and have only slightly increased. Many countries have positive experiences with a variety of CHP/DHC incentives that could address this barrier.
- **In addition, heating reform needs to be further developed**. Currently, in most cases, heat tariffs are developed on the basis of building area, rather than the actual heat consumption, which has a negative influence on improving the energy efficiency in district heat facilities and buildings.
- **Power sector reform is also needed**. At present, the electricity produced by most CCHP (and some CHP) projects cannot interconnect with the power grid, which has strongly reduced development. The technical issues of grid connection can likely be addressed. However, there are also administrative interconnection issues, such as added-capacity charges and power grid balancing that need to be addressed. At present, the State Power Grid Group is responsible for the power grid operation. As such, more communication and coordination activities could be conducted between the CCHP industries and the State Power Grid Group.

## Policy Barriers

There also exist barriers in the area of economic support and administrative policies related to CHP/DHC, including:

- **There is currently a lack of favourable fiscal and tax incentives** to support CHP/DHC. Although the government has repeated its support for CHP in many of its policy documents, it has not followed that support with concrete incentives to support CHP/DHC projects. Many countries have positive experiences with a variety of CHP/DHC incentives that could address this barrier.
- **There is a lack of monitoring and enforcement of the government's policies related to the efficient operation of CHP projects**. Currently, it appears that some newly-built CHP projects are operating only in thermal generation mode after they have been approved, thereby reducing their energy efficiency.
- **There is a lack of targeted policy for smaller CHP units**. In order to fulfill the energy conservation target, China is attempting to increase the number of larger, more efficient power generation plants and to close down smaller, older units. While it is important that the smaller, less efficient units be closed down, some small CHP units with high efficiency are also being targeted for phase-out. Based on the goal of increasing energy supply efficiency, a different policy could be adopted. For example, in regions with low heating loads, small CHP units could provide most of their energy needs at a fraction of the cost of larger units.[14]

## Financing Barriers

There are promising energy conservation projects – particularly in the district heating sector – that could be realised if there were sufficient funds or other means available to address the gap in investment capital. In particular:

- Some planned CHP/DHC projects are not operated efficiently because they lack sufficient resources to invest in expanded heat pipeline infrastructure. Further, at many existing DHC projects, the heat loss in pipelines is high, reducing the overall efficiency of the heating system. Additional financing is needed to invest in cost-effective heat pipeline retrofit projects, which could generate sizeable energy efficiency benefits and GHG reductions.
- While energy service companies are expanding in the commercial building energy conservation arena, they have not yet entered the CHP/DHC area. There is some room for these types of third-party players to come up with innovative means to finance projects.

## Technical Barriers

While CHP/DHC are proven, existing technologies that do not require major research and development, there are some advanced technologies that could be introduced to improve efficiency and operational benefits. In addition, there is currently some debate about the relative merits of CCHP and district cooling technology. China-specific research studies could be conducted to confirm the primary energy conservation performance of these technologies.

14. According to the survey results of China Power Industry Alliance, in 2003, there were 1859 units of small CHP units under 50MW which accounted for 88% of all the CHP units, and the capacity of small CHP units under 50MW was 20.99GW which accounted for 48% of all the CHP units. These data showed that middle and small CHP units are playing important role in China's CHP market.

# CHP Potential and Benefits

Although China's CHP market is growing, there are still several provinces that do not have CHP. With the fast development of China's economy and the related improvement of living standards, the heating demand in both the industrial and residential sectors is expected to grow. By 2010, China's CHP capacity is anticipated to increase from almost 70 GW in 2005 to about 120 GW. Over 50 GW of new CHP will be built in 2005-10.[15] Compared with the separate production of heat and power, these CHP units will result in about 40 Mtce of energy conservation.

In the meantime, there is strong potential for retrofitting existing units to CHP. Currently, NDRC estimates that between 135 and 300 MW of existing condensing power units (comprising 86 power plants with 244 units and 63 GW capacity) can be retrofitted to CHP.[16] The NDRC's analysis showed that for retrofit projects, the technology is attractive under proper investment costs (130-220 Yuan RMB/kW) and retrofit period (2-3 months). If these projects are realised, NDRC estimates the energy conservation benefits at approximately 50 Mtce. In addition, a portion of the existing heating boilers also can be cost-effectively retrofitted to CHP/DHC. If China achieves the retrofit of 30% of existing industrial boilers and 20% of residential district heating boilers, about 20 Mtce of energy conservation can be achieved.

In summary, enhancing China's CHP/DHC market by developing new CHP/DHC projects and retrofitting existing units could bring significant energy conservation benefits of more than 100 Mtce, making a positive contribution to China's energy conservation targets and global greenhouse gas reductions.

# Realising the Benefits of CHP and DHC in China

Over the past 25 years, China has seen its CHP capacity grow from almost nothing to today's 70 GW. This was due in part to favourable high-level policies that have consistently recognised CHP and DHC as leading energy efficiency and GHG reduction strategies. However, vast potential remains, which is not being developed because of a number of pricing policy, grid connection, financial and informational barriers that exist. This section summarises the IEA's recommendations for overcoming these barriers and realising the potential of CHP and DHC in China.

16. Energy Research Institute, *Study on China CHP/DHC Development Strategy* (2004).
17. Survey report organised by NDRC (2007).

# Summary Policy Recommendations

**(1) Deepen the Relevant Pricing and Energy Reforms, Including Grid Connection for CHP**

CHP/DHC investments must take place against the larger backdrop of China's energy growth and the resulting evolution of policies and institutions. However, in order to realise the benefits of CHP, and other conservation measures, it is recommended that the government promote further power reform, including stream-lining connection to the power grid for CHP and CCHP.

The government has made important progress in implementing heating reforms, including metering reforms. However, it is also recommended that the government pursue further heating reform, in order to rationalise the energy prices for CHP, particularly for residential and commercial district heating.

**(2) Strengthen CHP/DHC Capacity within the Government**

While China has seen dramatic growth in CHP/DHC over the past two decades, this has been in the absence of a government agency responsible for all aspects of this important technology. Other countries have seen tremendous benefits from the creation of a special government department responsible for CHP/DHC. Therefore, it is recommended that the government create a dedicated CHP/DHC department, and give it the responsibility and funding to collect data, perform technical analysis and stipulate China's medium-term and long-term CHP/DHC development plan, including the creation of targeted financial incentives.

It is also recommended that the government (possibly through this new government department) enhance monitoring of new CHP/DHC projects through certification or a similar approach. This type of regular certification would enable the government to limit any financial incentive support to only those projects which have proven their efficient operation.

**(3) Target Inefficient District Heating Systems for Financial Support**

A large number of existing district heating schemes in China are poorly managed and have low overall efficiency. Further, there is currently a lack of financing available to retrofit these projects. Therefore, it is recommended that the government provide targeted financing opportunities – perhaps working with ESCOs or via GHG financing through the Kyoto Protocol's Clean Development Mechanism – to advance these projects.

**(4) Enhance International Co-operation on CHP/DHC**

In order to learn from international experience, Chinese government has underway many large-scale international co-operative energy efficiency projects with international agencies, and has realised important achievements. Unfortunately, there has not been a similar co-operative project in the field of CHP/DHC. As CHP/DHC is an important energy efficiency technology for China, it is recommended to increase international co-operation on CHP/DHC between the Chinese government and international agencies, so government policy makers can learn from relevant experiences of policy and administration from developed countries. This will also introduce Chinese experts to advanced CHP/DHC technologies, and encourage greater foreign investment. The IEA and other international agencies are eager to foster this information exchange.

# Abbreviations

| | |
|---|---|
| CHP | Combined Heating and Power |
| CCHP | Combined Cooling Heating and Power |
| DHC | District Heating and Cooling |
| GDP | Gross Domestic Product |
| IEA | International Energy Agency |
| NDRC | National Development and Reform Commission |
| MOC | Ministry of Construction |
| MOF | Ministry of Finance |
| MOEP | (former) Ministry of Electric Power |
| OECD | Organisation for Economic Cooperation and Development |
| SBS | State Bureau of Statistics |
| SC | State Council |
| SETC | (former) State Economic & Trading Commission |
| SEPA | State Environmental Protection Administration |
| SPDC | (former) State Planning Development Commission |
| NPC | National People's Congress |
| MOP | Ministry of Personnel |
| MOCA | Ministry of Civil Affairs |
| MOLSS | Ministry of Labor and Social Security |
| SAOT | State Administration of Taxation |
| SERC | State Electricity Regulatory Commission |

# The International CHP/DHC Collaborative

The **International CHP/DHC Collaborative** was launched in March 2007 to help evaluate global lessons learned and guide the G8 leaders and other policy makers as they attempt to assess the potential of CHP as an energy technology solution.

The Collaborative includes the following activities:

- collecting global data on current CHP installations;
- assessing growth potentials for key markets;
- developing country scorecards with data and relevant policies;
- documenting best practice policies for CHP and DHC; and
- convening an international CHP/DHC network, to share experiences and ideas.

Participants in the Collaborative include public and private Partner organisations and other government, industry and non-governmental organisations that provide expertise and support. The Collaborative Network, the larger group that is informed about meetings, publications and outreach, has over 350 participants.

If you are interested in participating in the Collaborative, please visit www.iea.org/G8/CHP/chp.asp.

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