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外部视角和建议

Enhancing the Institutional Model for District Heating Regulation – Outside Perspectives and Suggestions

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Annex

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CURRENCY EQUIVALENTS

(Exchange Rate Effective July 31, 2010)

Currency Unit	=	RMB
RMB 6.8	=	US$1
US$ 0.644	=	SDR 1

FISCAL YEAR

January 1 – December 31

Acronyms and Abbreviations

BLS	Building Level Substations
CBB	Consumption-based billing
CEE	Central and Eastern European
CHP	Combined Heat and Power
DH	District Heating
DRC	Development and Reform Commission
DSM	Demand Side Management
ECL	Energy Conservation Law
EPC	Energy Performance Contracts
ESCO	Energy Service Company
ESMAP	Energy Sector Management Assistance Program
FCA	Finnish Competition Authority
GEF	Global Environment Facility
GS	Group Substation
GJ	Gigajoule
GWh	Gigawatt-hour
h	hour
HAO	Heating Administration Office
HOB	Heat-only Boiler
HRBEE	Heat Reform and Building Energy Efficiency

HVAC	Heating, Ventilation, and Air Conditioning
kW	Kilowatt
kWh	Kilowatt-hour
MLS	Minimal Living Security
MOC	Ministry of Construction
MOHURD	Ministry of Housing, Urban-Rural Development
MW	Megawatt
MWh	Megawatt-hour
NCC	National Control Commission for Prices and Energy
NDRC	National Development and Reform Commission

Executive Summary

1. District heating is one of the last vestiges of the welfare state in China, characterized by slow and uneven implementation of reforms that aim to modernize the sector, introduce incentives for efficiency, and promote innovation. A National District Heating Regulation (Tiaoli) is being considered by the Ministry of Housing, Urban-Rural Development (MOHURD) as a way forward to promote district heating (DH) sector reform. It requested the Study Team to offer suggestions on the scope and issues the new Regulation could address. Suggestions on metering, pricing methodologies and initial scoping of the Regulation (also reviewing DH laws in other countries) were already provided through previous ESMAP-supported and other World Bank supported studies.[1] This report, based on joint work conducted with a local group of experts hired by MOHURD, seeks to go one step further by reviewing strengths and weaknesses of the current institutional model for DH regulation (See Annex 1) and providing suggestions on how it could be further developed to accelerate the Government's DH sector reform objectives.

Strengths and Challenges of District Heating Sector Regulation

2. Strengths of the current system are apparent. Following China's urbanization trends, DH successfully maintained a compound annual growth rate of 12 to 13 percent in the past 5 to 6 years and is 50 percent larger in floor area coverage than in 2005. This growth rate is unsurpassed globally for the district heating sector. Internationally, it is second only to Russia in installed pipeline length (110,490 km) with Sweden a distant third (about 20,000 km). China's administrative system has overseen this remarkable growth. Moreover, the central Government since 2003 set out a clear DH reform agenda, which has subsequently led to strengthened local building energy efficiency codes in many cold climate cities, interim national guidelines for a two part heat tariff, general guidance on concessions, largely completing transferring payment responsibility of the heating bill to consumers from work units and former in-kind wages transformed into transparent wage supplements to pay for heating, and a trend towards consolidation.

3. However, the sector remains a source of concern. There is a diversity of approaches at local levels to implementing reforms that has led to a reform agenda that is largely unfinished. There is uneven enforcement and application of sector reform guidance (including two part heat tariffs), overlapping responsibilities and coordination difficulties, lack of sufficient institutional capacity and resources to carry out regulatory functions, difficulties with access to information, transparent decision making and reporting, and challenges to monitoring and ensuring compliance. The main institutional barriers to accelerated sector reform raised by counterparts include:

- *Lack of consistency in regulation*. In China DH is considered a monopoly requiring regulation, as it is, for example, in Central-Eastern Europe countries (CEEC). (See Chapter

1.ESMAP Heat Regulation Scoping Report (2006/2007), ESMAP China: Development of National Heat Pricing and Billing Policy (2008), JP Building Engineers and Center for Energy Efficiency in Buildings (China) in collaboration with World Bank and China's Ministry of Construction, Heat Metering and Billing: Technical Options, Policies and Regulations: Chinese Demonstration Projects and International Experiences (August 2002).

2 and Annex 4) but it lacks a unifying national legal framework for regulation. There are unclear ownership and management responsibilities for heating facilities, unclear allocation of functions and division of responsibilities among institutions, national and municipal levels and between government agencies and DH providers. Institutional capacity in sector monitoring and management varies widely particularly among approximately 329 municipalities where DH is required by law.

- *Lack of consistent sector planning, high market fragmentation, and high variability in operator qualifications.* There are no national guidelines for DH sector planning, heating resources are usually not hydraulically integrated, and there is high fragmentation (e.g. Beijing alone has over 2,700 providers), which are a source of inefficiency and impedes capturing scale economies. The sector exhibits inadequate management and qualifications of DH providers, high variations in service quality, and highly variable permitting / licensing practices. Updated technical standards are needed to keep pace with rising demands for better services from consumers, whose expectations will only increase as they increase their standard of living and start to pay for their own heat bills based on the meter.

- *Economic regulation and pricing have significant room for improvement.* Consumption based billing (CBB) — payments for DH based on a heat meter — has been promoted for nearly ten years but still remains in a pilot phase. Flat rates based on floor or heating area remain the norm. Some CBB pilots also deviate from well accepted CBB practices (i.e. billing according to indoor air temperature). Under these CBB pilots, two part heat tariffs are subject to local interpretations, e.g. most capacity charges are based on floor area rather than ordered heating capacity. Heating enterprises are run on commercial principles (although in some cities they are owned and operated by government entities), but management and government remain close to each other in many cases. Companies complain that tariffs are kept too low for too long to address affordability concerns. The tradition of applying one city-wide heat price prevents differentiated pricing that could more closely reflect costs of supply. Additionally, there is a lack of competitive market access.

- *Underdeveloped consumer protection and social assistance.* Consumer protections, dispute resolution mechanisms, etc., and social assistance schemes vary widely. While heating assistance is available to the poorest (dibao), observations in at least one province show that heating expenditures are also high for the near-poor, those not eligible for assistance. Welfare heating tendencies persist – many cities prefer to address affordability through low heat tariffs to the detriment of financial sustainability.

- *Weak orientiation toward energy efficiency.* Incentives for utilities to operate efficiently, and for consumers to use energy wisely for heating, are weak, especially due to the pricing system. In contrast to national goals of reducing carbon intensity in the economy, the sector is carbon intensive (91 percent of district heating is fueled by coal, about 4 percent is gas), representing between 5.3 and 6.1 percent of national coal consumption over the past five years. (In Europe, for example, where DH exists it presents a cost effective alternative for fuel switching and integrating renewables for space heating and domestic hot water.)

4. In summary, the balancing of the interests of government, DH providers, and consumers remains a major challenge for the current institutional framework, given that it is a vital service for cold climate regions, where it has traditionally been considered to be a vestige of the welfare state as it had been in the former Soviet Union. (See Annex 4)

Structure of This Report

5. Chapter 1 introduces the paper and briefly summarizes the main reform objectives and issues for DH in China. Chapter 2 presents relevant alternatives and lessons learned on approaches to regulatory practices in district heating internationally. Chapter 3 presents key findings and options for enhancing the institutional framework for DH regulation. Several Annexes complement the chapters by focusing especially on special topics raised by the MOHURD during this technical assistance activity. Annex 1 elaborates on Chapter 1, providing an overview of the current situation in China. Annex 2 introduces options for monitoring and benchmarking. Annex 3 discusses various methods for cost allocation of Combined Heat and Power (CHP). Annexes 4, 5 and 6 complement aspects of analysis on pricing and equity issues, a summary of options for competition among DH suppliers, and an example of red line impediments to energy efficiency innovations.

Enhancing Clarity in Regulated Activities

6. A National District Heating Regulation (NDHR), supported by implementing regulations, can address challenges encountered within the current system, allocating functions to different institutions and identifying responsibilities and rights of DH providers. The NDHR is an opportunity to provide a stronger legal mandate for related institutions to undertake reform and modernization of the sector and to carry out regulatory functions. The following summarizes the outside perspectives in this paper on some issues that could be addressed through the NDHR and subsequent implementing regulations.

7. *Clarifying asset ownership and management.* In the areas of service delivery, regulators can specify numerous obligations at the technical and the commercial level to protect consumers' interests. When defining the rights and responsibilities of providers, one of the first steps is to address ambiguities stemming from the various and complex forms of ownership and possession (the difference between possession and ownership has important consequences for management of DH facilities, see Annex 1) in the DH market. In practice currently, management rights and responsibilities appear to be somewhat separated from ownership. Clearly defining the rights and responsibilities associated with asset ownership and management of heating companies and consumers (building owners' indoor facilities and secondary networks) is needed especially to encourage high quality and efficient investment. For example, ownership boundaries in CEEC and European Union set the basis for establishing responsibilities for maintenance and operation. (See Chapter 3.2.1)

8. *Clarifying market entry and exit.* Clarification of rules for competition for the market and within the market, as well as market exit, would help to establish a more even playing field, encouraging efficient investment. These could be addressed in provisions of the NDHR because currently the nature and comprehensiveness of existing rules vary significantly. In China, the

market is growing while at the same time the central government has clearly indicated a need for consolidation. Clarifying rules for competitive market access can also make consolidation more wide reaching. Consolidation offers opportunities for addressing institutional barriers to achieving greater efficiencies, such as: addressing red line issues, e.g. by requiring new franchisees to take over secondary networks, introducing third party access for heat producers, and exploring different governance forms of a consolidated franchise.

9. *Harmonizing quality of service and technical standards.* For the sector to move towards consumption based billing (CBB) and two part heat tariffs, it is critical for consumers that service performance is assured and harmonized technical standards are adopted. As different cities/provinces may currently have different standards and deliver different qualities of service, a transition should be developed for the DH sector to evolve, guided by a national technical and performance standard, underpinned by the NDHR. The NDHR should establish the principles and roles of municipal administrations in establishing detailed standards during the transition, and how these will be reviewed from time to time. The national and local governments should eliminate or review regulations or practices that hamper the adoption by DH providers of modern and efficient technologies, and establish compliance with technical and quality of service standards as a license qualification and condition. To create incentives for DH providers, performance and technical standards could be linked to tariffs. Eventually, once the sector is stronger and consolidated, China could consider moving towards performance-based rate setting (see Chapter 3).

Enhancing pricing procedures

10. Tariffs are a lynchpin for incentivizing efficiency of investment, operations, maintenance, and energy use. Tariff reform has been moving slowly, although recently there has been a push to implement two-part pricing and CBB[2]. Three subjects need further development:

- Implementation of CBB, including metering;
- Organizing heat companies to respond to the pricing and regulatory requirements; and
- Responsibilities and procedures for establishing tariffs

11. *Implementation of CBB.* Making CBB mandatory for all consumers (buildings) is a key step toward achieving a modern and efficient DH sector. This would be complemented with two part tariffs, establishing an energy charge (which reflects variable costs) and a capacity charge (which reflects fixed costs).

12. In turn, achieving wide implementation of CBB requires important reforms in the area of metering, including (a) a mandatory installation of heat meters complying with a minimum standard (e.g. one meter per building, or one per staircase for larger buildings), (b) the possibility of establishing correction factors when several units are metered simultaneously and the procedures for calculating them, and (c) regulating meter quality and standards for maintenance and calibration.

2.See suggestions in the ESMAP publication "China: Development of National Heat Pricing and Billing Policy, ESMAP/World Bank, 2009)

13. *Heat companies organization.* The implementation of new pricing methodologies requires a good knowledge of regulated companies' costs. This can be accomplished by (a) establishing and implementing a uniform and standardized accounting system to permit meaningful cost comparisons and even-handed price regulation, (b) introducing cost forecasting for DH providers complemented by NDHR-required guidelines for preparing such forecasts, and (c) requiring reporting inputs and outputs in physical terms for heat flow quantities in order for the regulator to have critical elements for establishing pricing procedures.

14. *Responsibilities and procedures for establishing tariffs.* The main responsibility for establishing prices would be allocated to the municipality, as it is now, which would follow guidelines required by the NDHR. Alternatively, responsibilities could be allocated to the provincial authorities, as proposed further below.

15. Enhanced statistics would be the main tool for sector monitoring, which could evolve into benchmarking, and, once established, could be used for tariff setting (see Annex 2). Benchmarking could be accomplished by grouping DH systems with similar characteristics and would become a tool for monitoring companies' performance based on their cost and physical flow reports, as noted above. The enhanced monitoring system could be streamlined by establishing a cascading reporting system, which routes information from municipalities to provinces and to MOHURD.

16. Tariff setting should envisage procedures for addressing affordability issues. As China moves toward CBB, a decoupling of social assistance from heat pricing will be needed. In this sense, assistance delivered through lowering prices (i.e. general subsidies) is neither efficient nor equitable (See Annex 4). Subsidies should be targeted towards those households which need them, and should encompass not only strata such as dibaohu (formally recognized low income households) but also other strata where heating bills could constitute a large share of income.

17. Allowing flexibility for DH providers to choose billing methods can also be important to assist customers with meeting obligations for payment, improving collection rates and increasing overall customer satisfaction. Matching billing patterns to consumption patterns more closely will also contribute to energy efficiency.[3] (See Chapters 2.5.3 and 3.2.3)

Enhancing Regulatory Tools - Licensing

18. Licensing could be a key regulatory tool for achieving unified regulation. To unify the diverse permitting and licensing practices currently in place, the NDHR would require all qualified companies to obtain licenses and that licenses follow a "National District Heating Licensing Standard" issued by the MOHURD as described below. While it is understood that in China pricing and sector regulation are separately administered, international practice suggests that the agency responsible for licensing should also be assigned responsibility for tariff setting. (See Chapter 2.2.2)

3.In addition to references in this paper, a detailed description of billing and metering options is addressed in JP Building Engineers and Center for Energy Efficiency in Buildings, China, in collaboration with World Bank/Ministry of Construction, People's Republic of China, "Heat Metering and Billing: Technical Options, Policies and Regulations: Chinese Demonstration Projects and International Experiences", August 2002.

19. The "Licensing Standard" could, among others, describe the general licensing process; identify activities subject to licensing and exceptions; establish principles for the granting, monitoring, and revocation (or suspension) of licenses; and define general rights and duties, including (i) the obligation of DH providers to supply information and reporting to licensing institutions, as well as to allow auditing, inspection, and other mechanisms for the monitoring of compliance; and (ii) the rights and powers of licensing institutions to monitor, take the necessary enforcement measures, and suspend or revoke licenses, contingency plans to protect heat supply security, in particular, to manage bankrupt DH providers. The granting of licenses should require DH providers to demonstrate their technical, managerial, and financial qualifications. Small companies would be exempt from licensing. At the provincial and municipal levels, detailed implementation rules and regulations would be established to reflect and adapt to local conditions. (Box 2.2 provides an example of responsibilities for licensing in Lithuania)

20. The current administrative operating license (permission to operate) system should be strengthened by clarifying and further developing two separate obligations for one service (a) *a regulatory license,* very different from the currently used administrative operating license, which would qualify the company to provide heating services and compel it to abide by stated conditions, obligations, and requirements regarding the provision of information; and (b) *a franchise or concession* that would award the provider market access to a specific territory after winning a transparent and competitive selection process. The two can be combined in a single legal document. Whichever legal approach is taken, the objective is to clarify obligations, rights, and responsibilities at the national level so as to have a more harmonious development of the sector at the local level across the country.

21. The municipalities could issue the regulatory licenses (the Study Team suggests MOHURD consider whether an alternative to the municipalities is currently suitable – see the next recommendation on *enhancing provincial-level functions in DH sector reform and development* below). Existing municipal permits (administrative operating licenses) systems in China would apply to small DH providers (with a size to be determined by MOHURD).[4] In addition, the municipality's department responsible for heating supply would be responsible for monitoring all DH providers within its territory and for ensuring supply security.

Enhancing Provincial-level Functions in DH Sector Reform and Development

22. Supervising the implementation of the NDHR and monitoring sector development are essential tasks for MOHURD. Systematic reporting is essential to guide policy making and assess progress of sector reform. However, direct monitoring of the 329 cities across 15 provinces where DH is provided is impractical. A provincial role in monitoring sector development and supervising the implementation of NDHR is recommended. While MOHURD would remain responsible for overall supervision, it would be able to rely on 15 provincial entities, rather than 329 municipalities, to provide closer supervision and report on progress. The provincial-level institution would be

4. The annexes of the Scoping Report include a review of the heat laws in other countries. These laws specify, among other things, the size of regulated companies.

responsible for consolidating and reviewing information of all DH providers within the province and facilitating information exchange between DH providers and cities within a province. Ideally, the provincial institution would receive information directly from the licensed DH providers and from municipalities for smaller DH providers. It would also be responsible for tasks such as benchmarking performance and monitoring sector development.

23. Even-handed and consistent adoption of the Licensing Standard across the sector will be one of the major challenges under the above-proposed enhancements. A provincial level licensing system could help to accelerate proper implementation of the new regulatory license. If such a function cannot be adopted now due to capacity constraints at the provincial levels, this licensing authority can be transferred in the medium term to a provincial level institution as it gains credibility in its new benchmarking and monitoring function. The exception would be for small DH providers that could be licensed by municipalities.

Enhancements to Monitoring and Enforcement

24. Enhancements to the monitoring systems need to be further developed to help supervise sector development within the province and help to efficiently and effectively monitor progress of national sector reform. Data collection and especially verification has been identified as a constant difficulty encountered at municipal levels. An enforcement mechanism to ensure data and reporting are provided in a timely manner and include accurate information should be an explicit obligation in the regulatory license. Performance and efficiency indicators also need to be disclosed to demonstrate the DH providers are fulfilling obligations. The monitoring process could involve: (a) technical and economic reporting procedures for DH providers; (b) audit procedures by the municipal or provincial institutions; (c) monitoring of progress towards implementation of DH targets at the municipal level; (d) follow-up, benchmarking, and reporting on implementation of national targets by the provincial institution; and (e) assessment at the national level of progress related to overall targets. Annex 2 elaborates in detail on the challenges to implementing an enhanced monitoring system, including benchmarking, due to special characteristics of district heating systems and outlines a step by step approach to addressing them (noting the Finnish District Heating Statistics system as good example of technical monitoring contemplated for a first step – but only after good quality data collection can be assured).

25. Eventually, when the regulatory license regime is in place and rules of the game are clear, only qualified companies will receive regulatory licenses and the regulatory authority will have license revoking authority. Regular reporting on the situation of DH providers and supply security would enable to plan and take effective actions on time and ensure the quality of heat supply services. Even-handed enforcement could include: public disclosure of non-compliance and comparisons between companies and municipalities; warning notices for non-compliance; non-compliance penalties (and sanctions for repeat non compliance or non compliance that causes significant impacts on supply security or consumers) or, if owned by the municipality, removal of DH provider's management. Ultimately, DH providers that fail to comply with license obligations should have their licenses revoked, and their business transferred to another qualified company. Implementation of this procedure is rare, but the existence of such a legal measure provides an

incentive for suppliers to comply with their obligations, alleviating some need for very close supervision. Such procedures should be elaborated because municipal authorities may find it difficult to be fully objective in enforcement, given the many interests to be balanced within the municipality.

Dispute Resolution Enhancements

26. NDHR offers an opportunity to strengthen dispute resolution mechanisms. Under the proposed system disputes would be handled at the municipal level, as they are now. As heating is commoditized (metered) and the sector attracts a greater number and type of investors, the nature of disputes may change requiring additional skills and an effective system to resolve them. Experiences from other countries show that administrative courts have difficulties in assessing and resolving technical and commercial complaints. Therefore, the NDHR needs to clarify the dispute resolution process; a suggested process is elaborated in this paper. (See Chapter 3.5) MOHURD could consider whether it is suitable to establish an appeals function at the central level or at the provincial level as a final decision maker.

Consumer Protection

27. To adequately manage consumer complaints, the obligations of the DH provider, and consumer rights, would be included in the license. One of the best tools for consumer protection is to put in place effective mechanisms to promote awareness of consumers' and DH providers' rights and responsibilities. Measures that can assist are (a) dissemination of information on DH in general, consumer rights, heat price-setting methods, payment options, etc. and (b) fFormal rules and a description of the relationship between DH providers and heat consumers should be developed. The rights and obligations of both parties should be formulated and made public.

Enhancing Planning and Investment Reviews

28. Shared roles between government authorities responsible for management of the sector and the regulatory authorities, such as pricing bureaus, often intersect at the planning and investment approval stage. At the national level, MOHURD (in coordination with appropriate other agencies) could issue "National DH Planning Guidelines" that support consistent application of national energy policies and targets, establishing the objectives and guiding principles that would apply to all city DH planners. If suitable, the appropriate level institution could mandate specific targets for municipal heat planning. Examples of considerations and objectives that could be included in the DH planning guidelines include: promotion of efficient CHP technology and use of cleaner fuels, according to availability and specific conditions in each city; promotion of municipal waste utilization plants for combined heat and electricity production (with appropriate consideration of solid waste management); prioritization of usage of fuel types according to availability and national strategy; and establishing targets for usage of renewable energy.

29. *Improve the quality of investment review.* Under the current institutional framework and cost-plus pricing regulation, municipal institutions responsible for the planning of heating supply should continue to review and approve investments in the DH sector, except for small investments

up to a specified ceiling. The planning function, combined with the DH investment approval process, should not only aim to ensure heat supply security but also protect consumers from unreasonable costs resulting from over- or under-investment. Feasibility studies could be required by approval agencies to look objectively at alternatives based on sound project economic and financial evaluation. Carbon intensity reducing alternatives could also be evaluated to align large DH investments with national initiatives to develop low carbon cities. As DH reforms mature, consulting services for DH will also need to evolve. Training and promotion of such a broader range of consulting services to DH is suggested so as to develop modern, more comprehensive solutions to future issues in a reformed DH sector.

Promoting Energy Efficiency

30. Perhaps the most important contribution district heating sector reform could make to energy efficiency is the implementation of CBB, using a two-part heat tariff and ideally following incentive regulation. MOHURD could consider the following additional measures:

- *More strictly apply regulations listed in the Energy Conservation Law (ECL) to strengthen energy conservation management of key energy-consuming enterprises.* Key energy-consuming enterprises are defined clearly in the ECL as those consuming more than 10,000 tons of coal equivalent (tce). Local administrations are allowed to also include enterprises consuming 5,000–10,000 tce. Many DH providers would fall under this category. Key energy-consuming enterprises are under a number of obligations that could promote greater technical and managerial energy efficiency in DH, such as appointing qualified energy managers, implementing energy management systems, etc.

- *DH providers could be required, through the NDHR, to advise customers on energy efficiency and potential savings.* In turn, MOHURD could also consider supporting the existing energy conservation supervision and monitoring system to ensure relevant agencies have the necessary technical skills to optimize energy conservation measures in DH. There also is scope for heating companies to engage in demand-side management measures through implementation of alternative metering and billing systems (i.e. building/staircase meter and heat cost allocators) or by signing contracts with property management or property ownership to maintain internal heating systems.

- *Addressing 'red line' issues dividing infrastructure responsibilities between DH providers and building owners to open doors for more efficient applications of technologies (i.e. building level substations) and network configurations.* Moving responsibilities of the DH provider up to the building level will redefine responsibilities between real estate developers and the DH providers, change calculations of connection fees, etc. – this will require coordination by local leadership.

- *Implementation of consumption-based billing and retrofitting might best be closely linked, with the former implemented first, and completed as a package within a reasonable time frame.* Some municipal authorities require that retrofitting be undertaken before consumption-based billing can proceed, arguing that it is unfair at this stage to saddle

residents of older, particularly leaky apartments with higher heat bills. This impasse will likely slow down progress on consumption based billing. Without implementation of consumption-based heat billing, homeowners gain no financial benefit from energy-efficiency retrofits.

Enhancing Financial Resources and Human Capacity

31. The new enhancements to the institutional framework for DH regulation will raise the standard of competence for the regulatory authorities. Adequate capacity and resources for each agency, including compliance and monitoring, should be available. In some countries fees are levied on license holders to pay for the operations of the regulator, which is seen as best practice to ensure to some extent the independence and, importantly, the objectivity of the regulatory authority.

Regulatory Agency

32. MOHURD has given explicit guidance to the Study Team that a separate Regulator with responsibilities and powers as those recommended by the joint World Bank-Institute for Economic System and Management (NDRC) Report on gas regulation[5] (See Chapter 3) is not currently possible under the government's administrative system. It is understood that policy formulation and regulation in China are within the government administrative system. However, it should be recognized that, despite very rapid growth in fixed assets over the last five years, a lack of an autonomous regulator with clearly defined roles, powers, budget, etc., could be considered a key reason for the uneven and relatively limited modernization of the DH sector. While there is significant scope for improvement as elaborated in this report, international experience in DH regulation suggests that sector reform could be considered incomplete without addressing this issue.

33. It is recommended that when considering a first-order legislation like the NDHR, that such an entity be envisioned as an option. If it is desired, then detailed work is needed to decide what to include in the NDHR to form a proper legal basis for such an entity, its source of funds, proposal and approval of budgets, reporting, appeals on its decisions, and other potential issues such as qualification of regulator(s), obligations on conduct/conflict of interest, removal and immunities from civil actions as a result of their duties, obligation not to disclose commercial secrets, powers to make rules, etc.[6]

34. If there is scope to consider that such an institution could be established at the provincial level in the future, the national framework should clearly establish (a) the limits of licensing and regulatory responsibilities between the provincial institution and the municipalities, as well as the information exchange between the two; and (b) the reporting and information exchange rights and responsibilities between the national level and the provincial institution.

5. *China: Regulatory Framework for Long Distance Gas Transmission and Urban Gas Distribution* (World Bank, The Institute of Economic System and management, NDRC, 2003)

6. Ibid.

Chapter 1: Introduction and overview of current District Heating organization

1. The paper is organized into three sections:

- Chapter 1 introduces the paper and briefly summarizes the main reform objectives and issues for DH in China.
- Chapter 2 presents a relevant alternatives and approaches on regulatory practices in district heating internationally that offer alternatives and lessons learned.
- Chapter 3 presents the findings and options for strengthening the current institutional model that may be applied at a national scale.
- Several annexes complement particular aspects of the analysis by focusing especially on special topics raised by the MOHURD.
    - Annex 1 provides an overview of the current situation in China.
    - Annex 2 introduces options for monitoring and benchmarking.
    - Annex 3 discusses various methods for cost allocation of Combined Heat and Power.
    - Annex 4 elaborates on pricing and equity issues
    - Annex 5 summarizes options for competition among DH suppliers
    - Annex 6 provides an example of red line impediments to energy efficiency innovations

2. District Heating (DH) is developed in China's 15 Northern provinces where it is required by law. The DH sector has represented about 5.3-6.1 percent of total coal consumption in China since 2003, the year the central government clearly defined the key directions of DH reform. In 2008[7], the heating sector consumed 145.4 million tons of raw coal and this represented about 91 percent of total energy supply to the sector, followed by petroleum products (5 percent) and natural and other gas (about 4 percent). Coal consumption may be underreported because it does not include heat provided by Combined Heat and Power Plants, which are counted in thermal power generation in the energy balance, and by small distributed boilers. Due to its seasonal nature, coal for DH is consumed in a short period of time during winter months and has significantly contributed to local air pollution. As the torrid pace of urbanization continues in China and citizens require a better quality of life, the effort to minimize carbon intensity of DH is an essential part of low carbon development strategies for cities in China's 15 Northern provinces where heating is required by law.

7.China Energy Statistical Yearbook 2009, State Statistics Bureau.

3. DH is considered a monopoly by Chinese authorities and sector policy, regulation, and governance are organized through China's top-to-bottom government administration. At the national level, the Ministry of Housing, Urban-Rural Development (MOHURD) and the National Development and Reform Commission (NDRC) are the main line ministries broadly responsible for the sector. In practice, cities regulate and administer the DH sector. Provincial level agencies do not play an active role. In any given city, the Heating Administrative Office, usually under the Construction Commission, the Infrastructure Construction Department and Pricing Bureaus have an active participation in DH management.

4. Except for assets inside buildings, and the secondary networks in most new residential buildings, most assets in the DH system are owned by the Government or by state-owned enterprises. There has been a limited private sector participation and some provinces have opened their DH markets to private investors. The assets themselves can be operated by a DH provider under different contracting options such as concessions, leases, licenses, permissions; there exists no general approach towards applying the different options, some of which differ mainly due to accounting considerations.

5. Market entry and exit is an important consideration because, although the market is growing, there is a need for consolidation (for example, Beijing has over 2,700 DH providers). Consolidation is important as it opens up the opportunity for technological change by attracting larger producers. Market access is a critical component of DH reform which can be addressed by the issuance of administrative operating licenses; however, there is no uniform approach to guide market development.

6. There are no national guidelines for DH planning. Municipal heating plans are managed and overseen by local Planning Bureaus, under the mayors of different cities. An important difficulty consists of harmonizing heating planning with the city master plan because of the different authorities involved. Planning is an area where important improvements can be achieved by taking into account consumer preferences and feedback.

7. Municipal Pricing Bureaus are responsible for setting tariffs to apply to heating consumers. In principle, DH tariffs are based on a cost-plus approach, but in practice tariff setting is disconnected from its full costs. The recommended pricing schedule for DH consists of a two-part tariff which reflects fixed and variable costs, but its application has been limited. Also, there is a problem with billing actual heat consumption: although commoditization of heat services has been recognized as an important goal, in practice heating service continues to be billed in many places by the area being heated, independently of actual consumption. This gives rise to considerations regarding the lack of efficiency incentives and the incentive for wasting heat resources. A few pilots for consumption-based billing are using different approaches which remain to be assessed for effectiveness.

8. The views of different stakeholders indicate that regulation guided mostly by local circumstances has not achieved an efficient modernization of the sector. There have been previous attempts to provide national-level licensing directives but they were short lived (e.g. Directive No. 51 of 1996, repealed in 2004). Although the Central Government has issued different regulations

and guidelines, they are not applied consistently within the country. MOHURD, through its Department of Urban Development and Department of Building Energy Efficiency, Science and Technology has confirmed the need for a National District Heating Regulation (the Regulation or in Chinese Tiaoli) to guide district heating on a sustainable development path. Several implementing regulations and guidelines have been promulgated since 2003, the year the central government defined clearly the key directions of DH reform. However, DH reform has been slower than expected and the MOHURD has undertaken an assessment of barriers to implementation. A Tiaoli is considered necessary to provide a legal basis and more structured guidance for reform. It invited the World Bank through its Energy Sector Management Assistance Program (ESMAP) to implement a two phase technical assistance project on special topics it has chosen to assist in the development of the Tiaoli.

9. This paper addresses one of the MOHURD's selected topics——the strengths and weaknesses of the current institutional model for DH regulation and suggestions on how it could be further developed to facilitate the government's DH sector reform objectives.

10. The paper is part of a collaborative effort with MOHURD, which has mobilized a local consultant team supported by the China Heat Reform and Building Energy Efficiency (HRBEE) Global Environment Facility (GEF) grant project. The assessment, findings, and recommendations are based mainly on

- the ESMAP Heat Regulation Scoping Report (the Scoping Report) prepared in 2006/2007 (As part of a Phase 1 of this project);
- the ESMAP China: Development of National Heat Pricing and Billing Policy (2008)
- kick-off workshop and interviews in June 2009;
- the document and survey results prepared by the consultant team (Beijing Gas and Heating Engineering Design Institute) hired by the MOHURD on the current situation in China DH and validation of the Scoping Report conclusions (the Briefing Paper, 2009-2010);
- workshop and interviews in April 2010, reviewing the draft Briefing Paper and presenting initial suggestions for the institutional models paper;
- other technical assistance in China DH provided by the World Bank (for example, the GEF Heat Reform and Building Energy Efficiency Project supported city pricing studies in Dalian, Tangshan, and Urumqi); and
- international experience and good practice regulation in DH and other service sectors selected by the World Bank team.

11. After completion, this paper will be used as an input to a Policy Paper that will be prepared by the local MOHURD team. The Policy Paper will be a basis for drafting the National District Heating Regulation. The National District Heating Regulation shall be drafted by the Legislative Affairs Department of MOHURD.

1.1 Scope of Paper

12. MOHURD, as the main audience for this paper, has recommended that the DH institutional model to be supported by the new NDHR be adequate to advance the China heating reform process without major changes in existing institutions but following, as much as possible, international good practices. The team's assessment and international experience show that it would be difficult to achieve the objectives of DH reform without undertaking some constructive changes to strengthen the current institutional framework. The team has taken into consideration MOHURD's advice that there is currently no practical possibility of establishing a separate, autonomous, regulatory authority and that this paper's suggestions should stay within the current general institutional framework. The paper tries to follow this advice but also highlights, as did the Scoping Report, best practices that could gradually be implemented to strengthen the DH sector and improve its sustainable and efficient development.

13. For this paper, the institutional model is defined as the system of government organizations and sector participants carrying out regulatory functions in the DH sector. The institutional model describes who (which government institutions) does what (which functions), in particular clarifying the roles, rights, and responsibilities that belong to the national level, the provincial level, and the local or city level. The institutional analysis was organized around the following themes: (i) sector organization and governance, (ii) sector planning and development, (iii) technical standards and service quality, (iv) economic regulation and pricing, (v) energy efficiency, and (vi) consumer protection and social assistance. Is the institutional model working in unison to achieve common objectives? How could it be strengthened? The recommendations are structured around a number of principles, together with examples of well-performing DH sectors in other countries.

14. **International Experience.** The paper presents a review of the experience surrounding DH in other countries. Many suggestions originate from countries in Central and Eastern Europe (CEE) where severely cold weather conditions are comparable to those encountered in China. In contrast to many Western European countries, where DH is not regulated, several of the CEE countries provide experiences with regulation, which should be applicable to the current conditions in China. The desirable attributes of the regulatory approach are examined, together with the alternatives available regarding regulatory instruments and the options for economic regulation (including cost-based and price-based regulation, and yardstick competition). Under these topics the paper examines the experience to be derived from approaches to ownership and management rights, market entry and exit, planning and development of DH systems (investment decisions, design and technical standards), consumer protection and complaint mechanisms.

1.2 Objectives of District Heating Reform

15. In July 2003, eight Chinese ministries (the Ministry of Construction, the National Development and Reform Commission, the Ministry of Finance, the Ministry of Personnel, the Ministry of Civil Affairs, the Ministry of Labor and Social Security, the State Taxation Administration, and the State Environmental Protection Administration) jointly issued "The Guidelines for Experimentation in Urban Heating Restructuring in Selected Places." (2003

Guidelines) While later government notices included other measures and encouragement to speed up reforms, this document provides direction for the ongoing heating reform.

16. The goals outlined in the heating reform guidelines issued by the government of China are to transform heat supply into a commodity and to enhance heat supply security and efficiency. Although issued prior to the 11th Five Year Plan, the 2003 Guidelines are fully consistent with the current central government initiatives that place energy conservation at the center of energy policy and that advocate resource savings and emissions reductions in all sectors.

17. According to these guidelines, the general goal of heating reform is to establish new institutional systems for the DH sector that respond to specific Chinese heating needs and meet the requirements of a market economy, promote energy efficiency and environmental protection, promote sustainable city development, and improve residents' living standards.

18. The specific reform targets include:

- *Consumers pay.* Changing the practice whereby employers pay employees' heating bills to consumers, thus treating heating as a commodity instead of as welfare benefit.
- *Transform the subsidy system* from the nontransparent, implicit subsidy paid by employers into a transparent, explicit wage supplement and introduce a new subsidy to protect poor consumers;
- *Reform heat metering and pricing* by implementing a more scientific heat metering and pricing system that reflects the quantitative relationship between supply and consumption, by introducing metering and billing based on consumption, promote consumer control of heating and building energy efficiency;
- *Strengthen heating providers:* speeding up the reform of heating providers by introducing competition and creating and standardizing the district heating market;
- *Consolidate the industry* by promoting DH as the main heating source, while using other heating choices to supplement DH, and building up economical, safe, clean, and efficient DH systems; and
- *Improve energy use in heating* by promoting energy efficiency in buildings and technical renovation of heating facilities, improving energy utilization efficiency, including more strictly enforce the government's energy-efficiency standards for all new residential buildings, and improving air quality in urban areas.

1.3 Institutional Barriers

19. Achieving China's heating sector reform and energy conservation objectives will require substantive changes in the DH sector and enhancements in the institutional model. The Study Team understands that the following are the main institutional barriers to DH reform. These are based on the several background papers, workshops and interviews during the technical assistance

project. Annex 1 provides a summary of the team's understanding of the current DH institutional framework. The barriers are grouped into themes frequently discussed by the counterparts:

- **Sector organization and administration**
  - o lack of a national legal framework;
  - o unclear ownership and management responsibilities for heating facilities;
  - o unclear allocation of functions and division of responsibilities among institutions, national and municipal levels, and between government agencies and DH providers as well as a lack of sufficient authority, capacity, and resources to implement, monitor, and enforce functions
- **Sector planning and development**
  - o unintegrated heating resources, needing better planning, development of related policies, and simplification of administrative procedures;
  - o DH sector is too fragmented: small-scale district heating companies (DH Companies) are a barrier to increasing efficiency and lowering costs, and to ensuring heat supply security;
  - o inadequate management of DH providers
  - o inadequate qualification of heat suppliers and issues with licensing;
  - o in some cities, DH sector still largely owned and operated by government agencies and state-owned enterprises with very little private sector participation.
- **Technical standards and service quality**
  - o heat supply not responsive to the quality of service expected by consumers;
- **Economic regulation and pricing**
  - o pricing system not based on cost-reflective principles (DH providers complain that heat price is often lower than operating costs);
  - o low payment collection rates;
  - o lack of competitive market access; and
- **Energy Efficiency**
  - o pricing system not based on meters (removing efficiency incentives) and does not include incentives to improve operating efficiency

- **Consumer protection and social assistance**

    - non-uniform subsidy system with low subsidy standards.

20. Significant efforts have been made to address some of these issues. Under the 2003 Guidelines, Provinces were asked to designate Pilot Heat Reform Cities, and support has been provided, including through the GEF grant supported Heat Reform and Building Energy Efficiency Project and other donor support. Based on the latest official numbers, by the end of 2009, 150 million square meters out of about 8 billion square meters (2008) or about 2% of total heating area in Northern provinces were billed according to a heat meter. These efforts need to be sustained and clearly accelerated, but they indicate the difficult challenges of DH reform.

21. Reform will need to be supported with significant investments in modernizing the sector. Investment in renovation, replacement, and extension is needed, and efficiency improvements in existing DH systems need to be made. China also faces the need for investing in greenfield systems in new city districts, or even in new cities. How this financing is mobilized, i.e. the role the commercial sector will play as compared to direct budget support, will have a significant impact on the sustainability of the sector and this in turn depends in large part on the institutional model for DH regulation. The institutional framework for DH should strengthen the managerial and financial capacity of DH providers, and create the regulatory conditions and licensing requirements to attract the needed financing as well as to achieve the government's sector-development and reform objectives. Harmonizing the institutional model of DH regulation with the policy objectives of DH reform appears to be a key to removing the institutional inertia for implementing heat reform and building a "working system" that could support a reformed sector and help it move toward a more sustainable development path.

Chapter 2: Alternatives and Lessons Learned From International DH Regulatory Practice

22. This chapter provides MOHURD, and those working on DH reform, with some outside perspectives and ideas for further development of the institutional model for DH regulation. The review and approaches used by other countries in DH regulation are selected from those which may have relevance in China and are organized around the key themes of: (i) the rationale for regulation and its scope; (ii) sector administration; (iii) technical standards and service quality; (iv) economic regulation; (v) planning and development of district heating systems; and (vi) energy efficiency.

2.1 The Rationale and Scope of Regulation

23. Worldwide, the DH industry is either unregulated or regulated. The key questions which mold the type of approach for a given country include[8]:

- Why is regulation required?
- What activities should be regulated?
- What principles should guide regulation?
- Who should regulate?
- What process should be followed to ensure sound regulatory decision making?
- What powers and responsibilities should the regulator have?
- What way should regulation be applied?

24. Unregulated DH industry takes place in reasonably well developed district heating markets that have alternative heating methods competing among each other. This approach is used in Finland, Germany, and Sweden—Denmark is the only country in Western Europe where DH is regulated—countries that while having no specific regulations for the DH sector, do have national policies and general regulations, such as antitrust or monopoly regulations. In regulated DH industries, where regulation is required for activities where market power can be exerted to the detriment of consumers, the development of standard and economic pricing regulation has been important for implementing national policies and energy targets, such as: (i) promotion of Combined Heat and Power (CHP) and use of renewable energy sources; (ii) fuel diversification and use of local energy services; (iii) use of municipal waste and surplus energy from other sources (industry, for instance); and (iv) combined supply of heat, electricity, and air conditioning. Regulated DH industries also have similar historical starting points in the development of the DH sectors, including regulated DH prices and heavy, government-led investment. Most are in

8.Adapted from "China: Regulatory Framework for Long Distance Gas Transmission and Urban Gas Distribution", World Bank, The Institute of Economic System and Management, NDRC, 2003

the transition economies of Central and Eastern Europe. During their transitions, the rationale for modernizing regulation of the DH sector generally aimed toward optimizing investment, encouraging efficiency, improving access, encouraging competition where possible, and avoiding abuse of market power while ensuring supply security.

25. Considering the nature of district heating in China as a vital and already regulated service in cold and severely cold climate regions, and the direction of heating supply sector reform, a regulated approach to DH may be more appropriate. (See further discussion on perspectives of the nature of DH services in Annex 4). For this to take place, relevant considerations regarding standards and economic regulation that are being used in other countries are described below.

26. **Regulatory Entities.** In most Central and Eastern Europe (CEE) countries, regulatory bodies are established at the state level. Their duty is to bring competitive prices and greater choice to consumers by promoting competition and balancing the interests of energy suppliers and consumers. These countries have developed national laws and regulations, which are usually implemented by the regulator itself, local offices of the regulator, or in some cases by the municipalities.

27. Despite the established regulatory regimes in CEE countries, the scope of regulation varies. Heat price regulation—one of the key elements in DH regulation—is included in all regulatory regimes in CEE countries. Heat planning is, to varying degrees, regulated in a few countries (such as Poland, Estonia, and Lithuania) but not addressed in other countries, such as Bulgaria. Maintenance and repair of end-user installations are not regulated, as a rule. Thus, although regulated, there is usually an element of competition in the heating markets under the institutional framework in CEE countries, especially competition with other heating modes and competition related to end-user installations.

28. The regulated model has advantages and disadvantages that should be assessed for its careful design and implementation. Some of the advantages include: (i) predictable rules and business environment to foster private investors' interest in the sector; (ii) cost recovery tariffs to provide financial resources for operations and investments; and (iii) efficient mechanisms to attract private participation in new investments and renovation of DH systems. Problems that have been found in international experiences include: (i) DH providers that lower quality and reliability to try to cut costs to obtain higher profits (e.g. in the case of price-caps); (ii) social and political pressure on the regulator to delay or stop justified tariff increases and heat regulations; and (iii) high costs associated with running the regulatory agency.

29. Regulatory independence to provide balanced decisions is one of the main desirable qualities of a regulatory agency. Countries that have successfully established a competent regulator separate from the jurisdiction of municipalities and the commercial interests of DH providers give their DH sectors the best chance at balancing the interests of suppliers with those of consumers. The basic tenets of regulation consist of endowing an authority with decision-making powers with respect to investment, access, and tariffs which materialize through established and predictable rules and procedures for addressing them.

Box: 2.1 Heat Laws in Central Eastern Europe and Western Europe

The previous ESMAP supported scoping study for heat regulation in China included a comparison of various heat laws. There is no standard model for a heat law, nor is there a requirement to have one. A key question is whether exiting framework is sufficient to regulate the heating sector adequately to achieve expected objectives. Heat laws have different objectives, for example the Danish Heat Supply Act focuses on energy efficiency. The table below lists issues covered by the various heat laws reviewed in the study. Although blanks indicate no direct reference in the heat law, issues may be covered under separate legislation or regulations.

Issues	Cro	Den	Est	Hun	Lith
Licensing			•	•	•
Supervision of license conditions		•	•	•	•
Metering			•	•	•
Heat Pricing	•	•	•	•	•
CHP Cost Allocation	•	•	•	•	
Billing distribution among flats in apartment buildings	•				•
Adjustment in ordered heat capacity					
Disconnections by supplier					•
Disconnections by consumer				•	•
Promotion of Energy Efficiency		•	•		•
Service quality					•
Regulatory entities**				•	
Dispute settlement			•	•	•
Control/supervision of investment activities					•
Supply contract with heat producer				•	
Supply contract with final consumers			•	•	•
Standards/rules for billing and collecting					
Connection fees		•	•	•	•
Owernship and possession					
Service obligations	•	•	•	•	•
Service contracts (between operator and municipality)					
Private Sector Participation	•	•	•	•	•
Heat Planning	•	•	•		•
Promoting competition	•				•
Transitional rules					

**Regulatory entities are usually covered by Energy Laws in different countries. Heat Laws provide additional stipulations.
Cro = Croatia; Den=Denmark; Est=Estonia; Hun=Hungary; Lith=Lithuania

Source: ESMAP Heat Regulation Scoping Report, 2006

30. International best practice separates regulatory activities from the commercial interests of the DH providers and from political authorities to the extent possible. National or provincial/local energy regulators are established with adequate skills and resources to carry out their functions and build credibility with investors. The responsibility of regulators is to implement a pricing methodology, including efficiency and performance incentives where possible, that ensures that consumers pay a reasonable price for heat supply and that efficient DH providers remain viable. Investors receive a reasonable profit to enable and attract investment to expand and upgrade DH systems.

2.2 Management of the Sector

31. Taking into account the understanding of the administration and management of DH in China as described in Annex 1, in particular its discussion of the ambiguities stemming from various and complex forms of ownership and possession in China's DH sector, this section provides some outside perspectives and ideas on ownership and management rights, and market entry and exit.

2.2.1 Ownership and management rights: general principles and alternative approaches

32. Internationally, ownership can take different forms, as in the following examples from European countries:

- A DH provider can be a *limited liability company* owned 100 percent by a municipality, as in Gothenburg, Sweden.
- A DH provider can be part of a *municipal holding company.* In Leipzig, Germany, and Krakow, Poland, DH providers are held by holding companies that integrate gas, electricity, water, DH supply, waste collection, and public transport services.
- A DH provider can be *fully owned by a third party*, as in Espoo, Finland (100 percent owned), Stockholm, Sweden (100 percent owned), and Poland's Dolnoslaski Zaklad Termoenergettyczny (DZT—70 percent owned by Fortum, a Nordic stock exchange company, with majority public ownership).
- A DH provider can be a *joint venture established by several municipalities,* as in the Copenhagen area; or a joint venture between municipal companies, as in Lithuania (a company called NewHeat together with the Finnish Private Energy Market Fund); or a joint venture established by the national government and the municipality as in Riga, Latvia, where the city and the state each hold 49.7 percent of the capital.
- A DH provider can be owned by a larger *joint venture between the public and private sectors* for joint interests. As an example, in Finland under a cooperative system the shareholders are energy-intensive companies and producers like UPM, Stora Enso, Fortum, E.ON, and others, and many municipal-owned energy companies from all over the country.
- *Consumer-owned* DH providers are common in Denmark.

33. In Western European countries, a DH provider is usually the legal owner of the assets but the provider is fully or partially owned by the municipality. In practice, this means that the municipality can control the DH provider. However, recent trends show more private shareholder participation although municipalities try to maintain a controlling interest. An approach used in some transition countries is municipal ownership of DH networks with involvement of private operators (as in Lithuania and some other CEE countries).

34. Although the heat laws reviewed do not explicitly address ownership and possession issues, such clarity is needed to be provided through the legal system so that responsibility for asset management, for service provision, for costs of service, among others, can be established. Transparent and unambiguous rules are very important to establish cost sharing responsibilities for pipes, radiators, substations, within buildings (within flats and in common areas). For example, questions arise when a flat owner wishes to disconnect from the centralized heating system. In Lithuania, consumers who want to disconnect have to compensate the other owners for additional costs associated with internal heat distribution. In Germany, disconnections are not allowed without the consent of the condominium association. Under consumption based billing, the property line is important because it establishes a basis for who is responsible for internal building heat losses. In practice in CEEC, the property line is defined at the substation exit (in the case of building level substations) or building or staircase entrances. It is at this point that heat is metered and consumers charged accordingly, with heat costs allocated by floor area or by heat cost allocators. Thus, the type of ownership is less important than having transparent and unambiguous rules with even-handed enforcement.[9]

2.2.2 Market entry and exit

35. **Entry through Competitive Processes.** International practice shows that competition can exist in different DH market segments:

- Competition in bulk heat supply to construct new heat generation facilities due to the extension of an existing DH system (or to take over existing systems) may be effective when there is competition between heating modes (i.e. DH vs. natural gas) and DH prices are unregulated. The DH company has an incentive to find the least cost heat supply and will seek contracts from producers (be it generation companies or independent heat suppliers) with lower costs such as CHP and waste heat providers. Often, industrial companies use their own energy production units and have heat surpluses that may be used for outside production, such as DH. Competition in bulk heat supply could be possible in a regulated industry provided there is separation between generation and networks (see Annex 2).

- Competition to supply a new DH area (new construction area);

- Competition to replace existing heat generation capacity with new capacity due to the end of technical lifetime of assets, environmental emissions regulations or other reasons.

9.Discussion on this topic was also covered in the Scoping Report, June 2006.

- Competition to operate and maintain consumer installations. The downstream service after the heat meter could be opened to competition to qualified companies. Services open to competition include: (i) maintenance and repair of indoor heating installations, including pipes and radiators; and (ii) billing distribution.[10]

36. **Market entry mechanisms for new heating areas.** The following different mechanisms for market entry have been identified as international best practice:

- *Municipal tender for new heating area.* When municipal plans identify a new area to be covered by DH, the municipality can tender this area to interested and qualified DH providers. The municipality prepares the tender documents and conditions for the new DH system and organizes the competition for obtaining the license and franchise.

- *Investment by entrepreneur or customers.* A developer or an industrial company invests in new heating systems or a CHP plant to supply heat for their own needs, and may include neighboring consumers. It is a common practice that the municipality requires the DH provider within this territory to build the required DH network to connect to this new heat source.

37. Other approaches that have been used internationally as modes of taking over existing district heating systems include lease agreements, long-term concessions or purchase of shares. In lease agreements, the assets and the operations of a DH provider can be leased to a qualified party for a certain period. In Vilnius, Lithuania, the city receives an annual lease fee from the Dalkia Company, which runs the DH business. Energy Service Companies, ESCOs, can also sign energy performance contracts (EPC) with DH providers to help modernize the system and save energy. A long-term concession by the provincial and local government for the management, operation, and renovation of an existing or new DH system is another mechanism that facilitates market entry. An alternative market entry mechanism may be realized by the municipality selling its own providers or shares in its providers to new DH market participants through a competitive tender. Due to the large size of the Chinese DH market in specific areas, it is also possible to conceive the separation of heat production and transmission, with competition taking place at the production level; these possibilities are discussed in depth in Annex 2.

38. **Market exit mechanisms.** District heating is a capital intensive industry and measures to provide market exit mechanisms should be promoted. Exit barriers in the sector are high, as the asset liquidation value is low and usually there is the public obligation to maintain the heating service due to its vital nature. Thus, market exit is quite rare. Different forms of market exit in the DH sector include the following:.

- *Investor's Market Exit Decision.* The DH company is allowed to terminate its activities only if it transfers its obligations to serve its service area to another DH company. Large DH operators' market exit decisions should not impact service provision under an orderly

10. Bulgaria has several heat allocator companies which received a license to carry out heat allocator readings and distribute bills among flats within apartment blocks.

transition. For example, in Estonia the Pärnu DH company was acquired by the Swedish company Vattenfall in 2000. In 2006 Vattenfall made a decision to sell the Pärnu DH company to Fortum. The exit of Vattenfall and entrance of Fortum did not change the heat service to the customers in Pärnu. As the DH business in Pärnu was integrated to the countrywide heat operations of Fortum, this deal was subject to the approval of the Estonian Competition Authority.

- *Bankruptcy.* In countries where commercial law applies to publicly owned companies, bankruptcies of DH companies are dealt with according to commercial laws of the respective country. However, provision of the DH service is usually the responsibility of the local municipalities, and thus the municipality finds ways to secure heat supply. In Poland two companies (ZEC Chełmno and PEC Dzierzgon) have entered into bankruptcy after privatization. In some countries, like in Estonia and Sweden, there have been examples of bankruptcies of the municipally owned DH companies. Bankruptcies of the DH heating companies can happen due to several reasons. Bankruptcy could be the result of bad management, low efficiency, lack of investments, poor planning, low collections, tariffs which are below full cost recovery, etc. In China it is reported that many companies have undergone periodic restructuring with infusions of new capital from investors after liabilities are extinguished or significantly reduced, usually by municipalities. However, government bail outs risk moral hazard of raising expectations that investors will be rescued without penalty despite poor governance and operation.

- *Exit at the End of the Concession/Lease Contract.* At the end of the concession or lease contract, the management rights of the assets will be returned to the public owner. The municipality can make the decision as to which DH operation model shall be implemented in the future (municipal company, privatization, new concession or lease, etc.).

- *Termination of the Concession/Lease Contract.* The concession or lease contracts need to be designed very carefully. Among other issues, the exit strategy details for the case of poor operator performance need to be elaborated in the contract. The contract needs to specify the details as to who would take over, by when, and under what conditions the operational and ownership rights would be transferred.

- *License Revocation.* Market exit can be initiated by the regulator because of the unsatisfactory performance by the license owner, or the revocation of the issued license. The Regulator may revoke a license because of different reasons, such as: (i) submission of misleading and inaccurate data in application process; (ii) non-compliance with the requirements set for heating operators by the relevant legislation and regulations; (iii) repeated violation of tax or other laws; (iv) license holder's financial insolvency that endangers the DH supply; and (v) non-compliance with commencing activities specified in the license within a required time. Based on good international practice, the regulator must give the license holder advance notice about the non-compliance or unsatisfactory performance. Failure of the DH company to eliminate these circumstances in a reasonable time could lead to the license revocation. The regulator may also specify a time period, during which the operator shall continue to provide the services to ensure continuation of service provision.

Box: 2.2 Revocation of energy supply license in a Czech town

The revocation of an energy supply license is possible under the Czech Energy Act, in case of a clear risk of discontinuation of energy supplies. In this situation, it is also possible that certain facilities are confiscated for a limited period and for compensation. Negotiations with the license holder shall be conducted before and during the revocation procedure and depending on the results of the negotiations, the revocation procedure may be suspended. For example, in one Czech town, a DH operator refused to fulfill its financial obligations towards a leasing company, which rented the generation and distribution infrastructure to the operator. The leasing company threatened to end the contractual relationship and to take over the DH assets. As there was a danger of an interruption of the heat supply due to the dispute, the Energy Regulatory Office placed the assets under the control of another company. This new company supplied heat for about 10 days. Within this period, the disagreements between the DH operator and the leasing company were resolved and the energy facilities were taken over by the DH operator.

2.3 Technical Standards and Service Quality

39. Design and technical standards should be based on ensuring safety, increasing the efficiency and reliability of the heat supply, and thus ensuring appropriate service quality to customers. Clear design, quality, and technical standards should be established to ensure long-term safety, reliability, and service quality of DH systems.

2.3.1 Design and technical standards

40. Design and technical regulations are directly linked to the quality of service and the costs of complying with these regulations should be recognized in the calculation of justified costs for tariff setting. High quality of service may require investments in system renovation and modernization. Similarly, ignoring maintenance costs can lower short term expenses, but in the long term higher costs will be incurred to replace equipment that has deteriorated as a result of neglect. Regulated tariffs for service provision should aim to be reasonable, fair and cover the expected and imposed costs investors incur to comply with standards, energy policies, and performance obligations.

41. It is important that design and technical standards apply to DH components, systems and operation and maintenance. Standards should ensure safety, reliability, efficiency, and environmental protection of the different DH components, such as boilers, pipes, valves, and the like. Similarly, design standards should ensure that DH systems, such as boiler plant, piping network, electricity supply system, control system, and the like, work properly, and ensure safety, reliability, efficiency, and environmental protection. Operation and maintenance standards should also be developed to ensure efficient and adequate operation and maintenance of DH systems through rules or operational manuals

42. Best practice indicates that possible technical standards include:

- Minimum building heat resistances (for the calculation of the required heat flow to maintain a comfortable temperature)—although this is not the responsibility of the DH provider it is important to take into account end-use efficiency. China has made strong efforts in this area;
- Heating season (when heating should be turned on and off, specific requirements for special customers, and the like);
- Maximum number and duration of interruptions of heat supply;
- Ability to respond and continue heat supply during failures (supplier should be ready to provide alternative heat sources in a minimum specified amount of time); and
- Parameters for hot water (temperature, cleanliness requirements, and the like) ; and
- DH parameters sufficient to supply contracted or ordered heat load.

Additional standards and rules may be required to ensure the adequate maintenance and operation of existing DH systems, their safe and efficient production of heat, as well as optimal and reliable heat transmission for normal heating and hot water preparation.

2.3.2 Quality of service

43. Service quality consists of technical quality of supply (as indicated above) and commercial quality. Commercial quality standards include billing systems, number of problems and errors in invoices, number of consumer complaints and time required to respond, and dispute resolution mechanisms.

44. Quality of service can be achieved by defining standards and performance indicators and combining them with an incentive or penalty scheme. Noncompliance with performance standards guaranteed to consumers may lead to sanctions and payment of compensation to affected consumers. However, to protect the financial viability of the provider, standard practice is to limit the total maximum compensation payment to a percentage of the revenues (or regulated profits) of the service company. Rather than impose high monetary sanctions that could affect the financial capacity of the DH provider, it is recommended that to resolve the problem and improve quality of service, non-complying DH providers be required to prepare and submit for approval a feasible action plan that ensures compliance within a specified timeline. In CEE countries, standards are regulated as construction standards or heat supply rules. Only Bulgaria has adopted a service quality regulation for DH.

45. It is critical to consider the links between quality of service provision requirements and costs required to achieve them. Firms with multiyear tariffs may have incentives to reduce costs to increase profits by reducing the quality of service (e.g., lower temperatures in places where prices are based on a flat per square meter rate). International experience shows that regulation involving multiyear, performance-based tariffs (also known as “incentive-based”) should be accompanied

by regulation (obligations, standards, or targets) of the quality of service to end users.[11] Firms working under tariffs based on rate-of-return regulation[12] have an incentive to overinvest and could provide a higher quality service than customers are willing or able to pay for. Cases where over-ambitious quality of service and loss reduction targets are imposed, while approved costs or revenue requirements are constrained to avoid or limit tariff increases, may lead to the financial infeasibility of DH companies. Agreements on service quality and necessary investments should precede the implementation of the new tariff methodology, to achieve consistency between the revenue requirement and investment approval process and the procedures for setting quality of service standards and the tariff. This is an issue that needs attention so that customers, companies, and regulators all have the same service expectations and the industry as a whole can achieve them in a sustainable manner.

46. The regulated DH providers and the provincial or municipal institution need to agree on and establish a loss reduction and service improvement path that takes into consideration the related costs involved and their impact on tariffs. The provincial or municipal institution will need to have the capability to assess whether additional or more costly investments may be required by the company with the justification of achieving quality of service. Companies need to have the capability to develop efficient plans to achieve the quality or performance targets at reasonable cost.

47. Monitoring and enforcement will be critical to have an effective regulating quality of service. This will require data collection and reporting by companies, as well as data review, validation, processing, and audits from the provincial or municipal institution to ensure compliance. In CEE countries, a common practice is for the energy regulator to collect and analyze information and be responsible for supervision of the technical and economic viability of DH providers. In such cases, standards should be stipulated in the license. The central government's technical inspection unit or other similar institution supervises the operation of DH systems and is responsible for routine technical operations and efficiency. Both institutions have enforcement powers over the DH sector, allowing them to impose sanctions on companies in violation of the standards.

2.4 Economic Regulation

48. DH has monopoly characteristics which do not allow for retail competition; for example, multiple DH suppliers to the same building would not result in an efficient outcome. As a consequence, regulation is necessary to ensure that a firm supplying DH does so efficiently by charging rates which do not generate monopoly profits. However, in many countries (e.g. Western European countries, with the exception of Denmark), DH is unregulated and suppliers compete; the key appears to be the availability of alternative solutions, for example the self-supply of buildings vis à vis DH.

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11. For an overview of quality of service issues in utility regulation and the necessary steps to establish service attributes and levels, identify the sources of information, develop schemes to improve service quality, and enforce the quality of service regulation (for example, through minimum service standards, benchmarking of performance, or incorporation into price-cap formulas) see, for example, Holt 2004.

12. Under a rate of return regulation costs and tariffs are also closely linked. The regulated company charges tariffs that allow receiving no more than a regulated rate of return on its capital (or rate base). A critical issue is the allowed rate of return. If it is too low, companies will not make optimal investments. If it is too high, companies may be motivated to over-invest. This could be mitigated by ex-post investment control during the determination of the rate base.

49. Successful experiences have been based on two main regulatory tools—regulatory licensing and economic pricing. These tools act as a fulcrum that balances the various interests. Regulatory licensing, which is a term used in this paper to distinguish it from current licensing/permitting practices, establishes the general rules (rights and obligations) of DH providers (for example, quality of service) and a minimum level of competence required to be granted and keep a license, to protect heat supply security. Prices are set based on justified costs, thereby establishing economic incentives for efficient operation and protecting consumers against unreasonable prices. If either tool is weak or missing, the fulcrum does not function properly and interests will be out of balance.

50. This section addresses examples of the issues MOHURD has identified for special attention as it considers how to further develop its model for economic regulation. The topics are: (i) regulatory instruments, (ii) tariff setting and pricing methodologies; (iii) new connections; (iv) billing payment and collection; (v) subsidies to heating suppliers; and (vi) consumer protection and complaint mechanisms.

2.4.1 Regulatory Instruments: Licenses, Permissions and Franchises

51. Classical enabling district heating market tools include licenses, permissions, franchises and concessions. This section will look at the international experience regarding licensing, permissions, and franchises to lay out potential alternatives to enhance the Chinese DH regulation system.

52. **Licensing.**[13] In many countries municipal governments are commonly responsible for public utility services (heat supply, water supply, sewage treatment, waste removal, and so forth). Because failure to supply heat in winter can threaten human life and cause property damage, the operators of this service are required to be licensed by the relevant government agency. Licensing is one of the tools used by government institutions to manage heat security and guide DH development.

53. Traditionally, licenses (or permits or authorizations) have been used to authorize the building of assets or the operating of a utility service. Examples include land permits, environmental authorizations, and rights of way. Licensing systems are effective only when accompanied by effective monitoring and enforcement by the regulatory authority. As implemented in China, an administrative operating license (or permission to operate) is a legal document that grants a company the right to operate in the DH sector on the condition that it follows specified obligations and requirements. Other licensing systems exist that may help to clearly establish conditions, obligations and requirements between the DH provider and the regulatory authority.

54. **A regulatory license** differs from an administrative operating license; in addition to granting a company the right to operate in the DH sector, it establishes the relationship, rights, and responsibilities between the regulatory entity and the regulated DH provider. A regulatory license goes beyond an operating license by defining the "rules of the game" and the necessary qualifications to participate and do business in a sector. The regulatory license is the contractual instrument that establishes reasonable, predictable, and fair conditions for the regulated company,

13. Another approach to regulation used for example in the United States is a rules based approach, which depends on an evolving set of rules (laws and regulations) that can be changed in the deliberative process of the legislature and further clarified through the courts in the case of disputes.

Box: 2.3 Licensing Case Study: Lithuania

In Lithuania, heat supply is a monopoly activity requiring licensing. Heat supply licensing rules establish the rights and obligations of heat suppliers. Providers that have heat production units or heat distribution networks (or both) can obtain licenses for supplying heat from the responsible institution. If the provider can supply more than 10 GWh/year, it is licensed and supervised by the National Control Commission for Prices and Energy (NCC); if less than 10 GWh/year, by the municipality.

Rights of licensed company

- operate and sell heat in the licensed activity;
- inspect customers' systems; and
- disconnect debtor customers.

Obligations of licensed company

- provide heating services in accordance with the regulations;
- deliver the required amount of heat to consumers at suitable temperature;
- install metering system;
- ensure adequate maintenance of the system;
- buy heat from independent producers if it is cheaper than producing heat themselves;
- have insurance to cover business risks;
- within the licensed territory, connect new customers or provide a valid justified reason for not doing so;
- give debtor consumers 10 days notice before disconnection (however, disconnection of service to a block flat house debtor is not allowed;
- register and review complaints from customers;
- comply with public interest and national policies, for example, to use certain fuels;
- keep separate heat supply accounts for each DH system that supplies more than 10 GWh/year; accounts shall be kept for every system individually by activity: heat production, transmission, and sale;
- present their accounts to the NCC;
- cooperate in mandatory independent annual audits and share the results with the NCC;
- inform the NCC of existing and future management and development plans;
- present performance indicators and information for heat tariffs, benchmarking, and the like; and
- inform customers of heat supply rules and heat supply costs.

Compliance and enforcement

The licensed company is monitored. In cases of noncompliance with license conditions and regulations, enforcement measures include a warning notice requiring the licensee to address the issue and to take action to ensure compliance; the imposition of sanctions; and finally, the license can be suspended or revoked.

creating sufficient certainty for such companies to plan and finance new investment and plan and finance efficient and reliable operations. Standard good practice calls for regulatory licenses for "asset activities" to be issued for long durations (20–30 years) to allow long-term financing of the business.

55. **Franchising.** In network services, a franchise or concession gives the provider market access to a specific territory after winning a transparent and competitive selection process. A franchise awards exclusive rights in a geographic area to a single provider, as through a concession, for a period of time. Franchising and licensing can be combined—the license may grant the exclusivity rights and define the franchise area.

56. **Concessioning.** A similar mechanism is a concession contract to transfer to a company the right to operate existing assets owned by the government within an area, and it includes the obligation to maintain, rehabilitate, and expand the system. The concession may grant operating rights to a company that does not own the assets.[14]

57. **Licensing Experiences in Europe, in particular in Eastern and Central European countries.** There are different licensing approaches for DH in Europe. Where the DH sector is market driven, there may be no licensing.[15] If the DH industry is regulated, then the regulatory authority is also responsible for issuing the license (see Box 3.1).

58. Good practices in CEE countries combine price regulation and licensing into one administrative unit (municipal or national level government institution, regulator, or the like) for the following reasons:

- The design and methodology for heating pricing (reasonable tariff, justified costs, efficiency targets, and so forth) usually define the viability of DH providers.
- The tariff-setting process, results monitoring, and enforcement through license conditions create a contractually predicable framework for DH providers and their investments.

59. It is common practice to classify companies by the scale of their operations (volume of heat produced or supplied). Companies that are classified as small in some countries tend to be multiservice (providing heat, water, sewage treatment, waste disposal, and the like), and their tariffs are set by municipalities given that their income and financial viability depend on the decisions made by municipalities. Larger DH providers that supply heat—some of which may also own CHPs—have a greater impact at the national level and are regulated by government institutions at the national level or provincial/regional level, depending on the size and characteristics of the country. Where licensing and price regulation cover several small utility companies, a practical approach is to assign the regulatory role to a municipal department. For example:

- In Estonia, municipalities regulate DH providers that sell less than 50 gigawatt-hours (GWh) per year of heat.

14. A similar approach is used in Turkey, but it is called "transfer of operating rights."

15. Usually, such municipalities have access to roads and based on this access they can issue permissions to build a network

- In Lithuania, municipalities regulate DH providers that sell less than 10 GWh/year of heat.
- In Bulgaria, heat producers are licensed by a national Energy Regulatory Commission if installed capacity is greater than 5 MW.
- In Hungary, the licensing authority is divided between municipalities and a national regulator. Combined heat and power (CHP) plants are licensed by the regulator while heat suppliers producing only heat are licensed by municipalities. A license is required only if the heat output is greater than 5 MW.

60. Even if there is more than one institution assigned with licensing authority, there are national principles and requirements for licensing content and administration that apply to all government agencies that issue and monitor licenses.

2.4.2 Tariff setting and Pricing Methodologies

61. **Regulatory modes.** Tariff regulation of utility companies can be loosely classified as cost-based and incentive-based. The two approaches can be characterized as follows:

- Cost-based regulation sets prices that recover the cost of service provision based on the costs incurred by the firm, and limiting its profits to an accepted rate of return, which can be a return on assets or a return on equity;
- Incentive-based regulation encompasses a variety of methods; the most common is price-based regulation which sets a price cap for the firms' output for a period of time (usually 3 to 5 years). Other methods of incentive regulation are sliding-scale rate of return, partial cost adjustment, and yardstick competition. This analysis will dwell on price-cap regulation and yardstick competition.

62. **Cost-based regulation.** In cost-based regulation (also known as cost plus regulation or rate of return regulation, which is the predominant form of cost-based regulation) the procedure is as follows:

- The firm's costs are reviewed, and unnecessary costs are eliminated;
- The prudence of capital expenditures is evaluated;
- A rate of return which is considered fair is specified; and
- Prices and their structure are set to generate enough revenues to cover costs and provide a fair rate of return.

63. The principal criticism of this approach has been that it does not induce firms to minimize their costs, given that they are covered (which is why they are reviewed by the regulator), and that there is an incentive to make excessive capital investments, given that the rate of return is assured. Although costs and capital expenditures are scrutinized, the regulator usually lacks knowledge

about the firms' cost structure, thereby creating an asymmetry of information which is difficult to overcome.

64. In particular, specifying the rate of return is a complex subject and, although different approaches have been implemented, the lack of information regarding the cost of capital of a given firm remains an important drawback. Nevertheless, it remains a widely used approach towards regulation. Under a rate of return regulation costs and tariffs are also closely linked. The regulated company charges tariffs that allow receiving no more than a regulated rate of return on its capital (or rate base). A critical issue is the allowed rate of return. If it is too low, companies will not make optimal investments. If it is too high, companies may be motivated to over-invest. This could be mitigated by ex-post investment control during the determination of the rate base.

65. **Price-based regulation.** Under this approach, the regulator sets a price cap, together with an adjustment formula. The latter is often of the so-called "RPI-X" type where the price is adjusted according to a retail price index (RPI) minus a productivity factor (X). The regulated companies can charge for their product up to the price cap which varies from year to year according to the adjustment formula. Setting up the initial price cap can be done in a variety of ways, including an analysis of the regulated firm's current cost structure, or simply adopting the current price as the initial price cap.[16] Another approach consists of benchmarking the performance of similar companies in order to identify the least cost which is then set as the price cap. This requires a well-defined set of parameters and a monitoring methodology. Care should be taken, however, when using benchmarks for pricing, especially in situations where neither basic metering data nor detailed knowledge of assets of regulated companies are available. Based on experiences in Europe where benchmarking of German, Austrian and Croatian DH companies was carried out,[17] it appears that local conditions vary to such an extent that it makes the identification of efficient companies at the national level very difficult. An extensive discussion of monitoring and benchmarking is provided in Annex 2.

66. The principal features of price-based regulation are that it allows companies to maximize their profits, and that it encourages companies to cut costs. The regulatory challenge is to allow the firms to optimize their performance while maintaining quality of service. As to the length of the regulatory period, it should be long enough for the firm to reallocate resources used to provide service, but not so long that prices do not resemble the prices which would prevail in a competitive market. If the review period is too short, then the incentives for cost reduction are limited. At the end of the period, the price setting exercise is performed again, hopefully integrating the cost reductions achieved by the firms in the years preceding it. Typically, the regulatory period is 3-5 years for DH.

67. For either type of regulation, international best practice shows that an effective tariff setting system needs to incorporate (i) a uniform, standardized accounting system for DH providers that

16. In any case it should be ensured that investments undertaken after the (baseline) tariff approval can be recovered including a reasonable profit. If the X factor is set too high and cannot be achieved, profits could be eroded.

17. Aktion Pfennigspass, in: AGFWArbeitsbericht 2000, p. 27. See http://www.agfw.de/fileadmin/dokumente/oef/iAB2000Teil1.pdf

allow clear and transparent accounting systems, (ii) a benchmarking system for proposed costs and tariffs to be checked, as well as (iii) cost forecasts for setting tariffs. Clear and transparent rules for accounting and reporting purposes will be important for comparison and benchmarking purposes. While there are less frequent tariff approval procedures required under incentive regulation, information requirements are much more substantial for each baseline and subsequent price approvals. In addition to reviewing costs and investments, the regulator has to determine the efficiency improvements in the past and likely performance in the future.[18] In turn, benchmarking systems will shed light on reasonable, justified costs and allow for checking the resulting tariffs. Finally, since tariff setting is forward looking, it will be important to include a cost forecasting methodology.

68. Under a price-cap approach, deterioration of the service quality in order to reduce costs and increase profits could easily occur. To protect customers, service quality criteria have to be defined as well as the means for enforcement. The quality could be defined in a supply contract to be concluded with all final customers.

69. Most countries in Central and Eastern Europe that recently became EU-members, have adopted some form of incentive-based regulation for their utility sectors, either by explicitly referring to the term "price cap" or by extending the regulatory period (see for example ASE[19] 2007 for Poland). In many countries, however, regulators allow none or low profit rates.

70. **Yardstick competition** is applied in industries where direct competition is not possible, but where there are multiple suppliers in separate markets, which can be compared. The idea behind yardstick competition is to establish an efficiency frontier determined for a given set of characteristics based on observed data from each supplier. Prices for a given supplier are then adjusted according to its performance vis à vis the rest of the field, based on recently developed techniques such as Data Envelopment Analysis. This approach has been applied, for example, to electricity distribution companies supplying different cities with varying parameters such as load density, geography, and composition of the customer base.

71. **Managing stranded costs.** An important issue is whether the tariff-setting methodology should include historical debts as justified costs, particularly when there is a change in ownership. The approach may vary from one country to another; in CEE countries, the municipality or the central government often cleared historical debts that were inherited from the former owner by new DH providers in privatization or restructuring processes. According to international experience the criteria should follow certain principles such as: (i) the responsible party for incurring the debt is responsible to solve the problem; (ii) provide debt refunding and rescheduling alternatives that will help responsible parties pay the historical debt they are responsible for; (iii) assess whether the tariff should include a component for repaying the debt; and (iv) include all relevant parties in the decision, including the creditor.

18.In practice, several methods are being applied, see chapter 4 in Jamison et al (2004).

19.ASE: *Alliance to Save Energy*

20.See for example, Meyer, A. and Kalkum, B., China: Development of National Heat Pricing and Billing Policy (World Bank/ESMAP: March 2008), Report No. 330/08).

72. **Tariff structure.** To provide efficiency signals on the demand side, past World Bank recommendations [20] have focused on consumers paying according to consumption, achieved through a two-part tariff system that includes consumption-based billing. Under this tariff design, one part of the heat tariff should recover variable costs (through the energy charge) and the other part the fixed costs through the capacity charge. The metered heat consumption will be valued and charged at the energy component of the tariff, and the payment for the capacity component should, in principle, be based on maximum heat load (also known as a demand charge). The demand charge payment by the building or dwelling covers the DH provider's investment, rehabilitation, and maintenance required to supply heat.

2.4.3 New connections and connection fees

73. The connection fee covers two different cost components:

(a) *Costs of the specific connection.* These are the costs of assets to connect a specific customer or building, and which cannot be used alternatively by other customers if later disconnected. In a building substation, this portion of the connection fee covers the costs of the building-level substation and the pipes connecting the building with the nearest distribution line. For a group substation, this component only includes the costs of the connection pipes; and

(b) *Contribution to the investment costs of the DH system,* i.e. upstream costs which may be attributable to the new connection; however, when using a two-part tariff approach, these costs are commonly covered by the capacity cost component of the tariff.

74. In Europe, the connection fee can be a standard fee for all consumers, or it can be determined by the costs of the specific connection. It is, however, a common practice for the DH provider to reduce or even to eliminate the connection fee to promote new connections because it could be a financial advantage for the DH provider to have a high connection rate in the very beginning rather than to wait for an extended period during which the revenues will only grow slowly.

75. In Europe the investment cost contribution is usually not requested as payment for new customers within an existing DH service area. However, customers of a new DH system developed to supply new construction or a new building area may be asked to contribute to the financing of the investment costs. This payment can be structured as a non-repayable contribution by the consumer (a grant contribution, which, for accounting purposes, is entered as other equity) or a repayable contribution (similar to a loan to finance the DH investment). The approach is determined by the DH provider. For non-repayable grants, the corresponding revenues have to be amortized over the lifetime of the DH equipment as it enters the income statement. A repayable contribution is reported in the balance sheet as a loan (regardless of whether interest is paid). In either case, depreciation charges will be reported in the financial statements of the DH provider and will represent justified costs for tariff setting.

20. See for example, Meyer, A. and Kalkum, B., China: Development of National Heat Pricing and Billing Policy (World Bank/ESMAP: March 2008), Report No. 330/08).

2.4.4 Billing, payment, and collection[21]

76. The common practice in Europe is to bill consumers monthly, either in equal monthly installments based on the previous year's actual consumption (with a balance payment at the end of the heating season) or monthly payments based on actual consumption. Monthly billing distributes the heating payment for consumers over the year, resulting in a smaller burden than a one-time annual payment. Moreover, if monthly billing and payment improves the collection rate, the DH provider may end up being better off. Other utilities have made this transition smoothly and the DH business, even with its special characteristics, is similar to that of other utilities that also provide important services, such as cold water, gas, and electricity.

77. **Collections and nonpayment.** There are basically two groups of non-payers: those who cannot afford to pay because of their low income and those who do not want to pay. For the first group, targeted subsidy programs should be implemented, as described in the following section. For the second group, tangible sanctions need to be applied. Sanctions can range from reaching an understanding through negotiated settlements (for example, monthly repayment of outstanding debt), closing off the heat supply (or limiting it through flow limiters to reduce the temperature in the dwelling to the minimum level for the health of consumers and the technical requirements of the building infrastructure), to suing the nonpayer to collect debts. In addition, a few DH providers internationally have resorted to publishing a list of very large debtors, especially those who can afford to pay.

2.4.5 Subsidies to heating suppliers

78. International experience shows two main types of financial support to the DH sector, budget support grants and targeted subsidies, which are described below.

- *Budget support grants.* Budgetary and other extra-budgetary government resources are allocated to a DH provider to keep heat tariffs low and still ensure sufficient funding for heat supply. Under this subsidy framework heating is considered a form of social welfare and supplier subsidies are justified when faced with a large number of economically weak heat consumers who cannot afford to pay their bill and who are unable to switch to more affordable alternatives. Financial resources can be taken from the central, provincial, or municipal government's budget, social aid programs, or other sources. This mechanism is easy to administer and was common in countries at the early stages of the economic transition.[22] However, it was gradually removed for the following reasons:
    - Subsidies can be perceived as unfair by the population which does not use DH.
    - Subsidized DH providers lack incentives to reduce costs and improve efficiency, which can lead to further increasing the need for budget support.

21. In addition to references in this paper, a detailed description of billing and metering options is addressed in JP Building Engineers and Center for Energy Efficiency in Buildings, China, in collaboration with World Bank/Ministry of Construction, People's Republic of China, "Heat Metering and Billing: Technical Options, Policies and Regulations: Chinese Demonstration Projects and International Experiences", August 2002.

22. This type of subsidy is still common in the Russian Federation and in other countries of the former Soviet Union.

  - Consumers are provided no incentive to increase end-use efficiency.
  - Public resources available for social support and other social needs are reduced.

- *Targeted subsidies*. These subsidies have an emphasis on economic efficiency and reduce financial requirements while targeting low income households. This type of support has also been used to target specific investments, such as specific installations, introduce bio-fuel, replace pipelines, and so forth. It is popular in the countries of the European Union as a tool to assist with the renovation of DH systems and the construction of new assets such as CHP plants, waste incinerators, and other important public infrastructure. There is a difference between investment subsidies and operation subsidies (i.e subsidies for running fuel costs). The first may be needed to provide the necessary financial means for investments, particularly if investments are requested by the government for policy considerations or social issues. The second provide a cushion to the heat tariffs.

79. When thinking about improving social assistance programs, international practice suggests basic issues be addressed. Generally, social assistance systems vary from country to country but require that the following be defined:

- Criteria for social support, that is, definition of consumer groups that should receive social support. As an example, the criterion could be the fraction of monthly or annual income spent by a family on heating, but this indicator requires regularly updated household surveys. This requires close coordination with existing social assistance institutions.
- Amount of social support.
- How social support will be funded.
- Forecast of future scope of social aid.
- Development of incentives for efficient use of energy, for example an obligation to participate in building renovation programs.

2.4.6 Consumer Protection and Complaint Mechanisms

80. The best way to protect consumers is to ensure they are informed of their rights and responsibilities and of DH providers' rights and responsibilities. Due to the technical characteristics of DH supply there are many variables that cannot be controlled that may cause consumer dissatisfaction and complaints. Sometimes these factors are not necessarily the responsibility of the DH provider, as heat quality may depend on other factors such as the thermal integrity of the built envelope or the buildings' internal heating system. It is important that customers have access to, among other, information regarding the system such as heat price setting methods, penalties for noncompliance with service provision, adequate maintenance, and consumer rights and obligations.

81. Managing an effective complaint mechanism is an important tool to ensure consumer protection. Some countries have gradually escalated complaint procedures with multiple steps that

ensure follow up and complaint resolution. Other countries have state institutions or associations specialized in the protection of heat consumers to assist people with the formulation of their complaints and with the overall investigation process. In China, most Heating Administration Offices have some mechanism to receive complaints. Tianjin municipality has advanced this concept with a hot line and customer service center where complaints can be addressed.

2.5 Planning and Development of District Heating Systems

82. Heat planning supports the implementation of national energy planning and policies, local level development, and is a market entry tool for DH suppliers. DH plans should be an integral part of urban development and focus on the development of the local DH system. This section will look at international experiences on planning.

2.5.1 Planning of district heating systems

83. In a regulated DH industry it is the responsibility of DH providers and their regulators to be responsive to market requirements. In some countries, multiple heating systems are allowed to be constructed and operate within the same area, and must compete for customers. This competitive market approach is used, for example, in Finland where the DH sector is well developed and alternative heating systems exist. In some former Soviet Union countries, DH had to compete with decentralized gas-based heating, with negative results for DH providers, as they were too slow to adjust their services to compete with the more convenient gas supply heating. A critical issue was the need to secure financing under a competitive scenario to invest in upgrading the DH systems. Competition affected the financial viability of DH providers and some DH systems collapsed. To remain viable the DH sector must keep up with consumers' lifestyle requirements. In China, DH is available only during a certain period, which often does not correspond to actual temperature conditions and DH cannot respond quickly to changes in consumers' heating requirements, such as switching on heating at any time. Otherwise, more energy inefficient, but possibly more convenient, methods, such as electrical heating, will appear even with strict regulation. If DH is unresponsive to the market preferences, gas, electrical, ground-source heat pumps, and other forms of heating will be successful with or without regulation.

84. In Germany, multi-service utilities are common and enable harmonization of energy planning. These utilities are mostly commercial companies owned by the respective municipalities and provide heating, natural gas, and electricity (plus other utilities). This approach allows to synchronize the development plans for the energy carriers and to determine their optimal combination. Typically, either DH and electricity or gas and electricity are provided, but not all three energy carriers.

85. Local or municipal heat planning can either be indicative or mandatory Under *indicative heat planning,* the plan shows only the desirable heating systems, but DH companies (and consumers) may decide on a path for heating development and investment that differs from this plan. The municipality can however provide incentives to favor the indicative plan. In Germany many cities have developed such plans aiming to guide and support the development of their local multiservice utilities. Under mandatory heat planning, new heating systems must comply with the solutions in

the heating plan and existing non-complying systems must be replaced in due time. Heat planning is mandatory in Denmark and Lithuania, and the Energy Law in Poland requires local energy plans. Changes in conditions or expected new construction should be reflected through updates in the heating plan. In principle, this is also the practice in China, although the urban areas grow so fast that heating needs may quickly deviate from the heating plans.

86. Several European countries are trending toward more planning and promotion of DH systems. This trend is partly related to the desire to ensure a more rational development of municipal infrastructure, energy security through fuel diversification, and reduction of carbon emissions. CHP development is an important tool for fuel diversification and reduction in carbon emissions. DH provides opportunities for fuel switching, which is important for introducing renewable sources into the fuel mix (such as biomass CHP plants or DH systems) together with energy security.

87. In China, land use development plans and designs for local public infrastructure, including DH networks, water supply, and sewage are the responsibility and a key function of municipal authorities. Heat planning is a well-proven tool for determining market entry as it provides guidance to the DH supplier and enables them to prepare the corresponding investment and business plan for any competitive or alternative heating system and suppliers. It is therefore important that municipally-led heat planning development be based on economic (least-cost) considerations, technical requirements and constraints, and environmental and other energy policy considerations.

2.5.2 Investment Decisions

88. International practices in regulated DH industries show that investment projects are reviewed and approved by the municipal institution responsible for preparing and monitoring the implementation of the DH plan. From the regulator's perspective, investment projects should: (i) agree with the approved municipal plan for guiding the DH sector's development and follow national energy policies and targets; (ii) agree with the municipality's overall infrastructure plans, and (iii) balance short- and long-term considerations.

89. Investment projects in the DH sector may target different objectives, such as:

- projects to ensure reliable heat supply and safety, and to promote environmental protection;
- technical solutions that reduce costs and increase the efficiency of the heat supply process;
- projects related to the development of municipal infrastructure; and
- projects required to implement national targets.

90. Lessons learned from international experience show that a general procedure of the approval of investments could include the following criteria:

- DH providers prepare long-term investment programs that meet the requirements of the municipal heating plan, as well as energy policies and other targets and standards of the national government on efficiency and modernization.

- Long-term investment programs identify each project and a proposed timeline. These investment programs should include feasibility studies for the identified projects, other technical requirements, description of financial resources available for the investment, and the project's impact on costs and heat tariffs.

- The municipality reviews the proposed investment projects for consistency with the heating plan, and determines if the technical and economic evaluations are sound.

- The municipality makes a decision regarding the approval of the investment proposal. If not approved, the investment proposal is returned to the DH provider with a request for modifications and improvements.

91. Monitoring the implementation of DH investments (for new development or renovation) is important to ensure the efficiency of DH and security of supply. Generally, monitoring is the responsibility of the approval institution in the municipality. In China, municipal units (HAO or other similar units) could participate in the monitoring of investments. Similarly, DH providers could be required to report the implementation status and results of investment projects to the municipality.

2.6 Energy Efficiency

92. Promotion of energy efficiency across the heating chain – from the heat source to the individual consumer – can be an important role of district heating regulatory policy. This section will look at regulatory ways to promote energy efficiency in heating systems, in particular with a focus on international experiences.

93. **Improving building energy efficiency.** There are many ways to promote regulatory energy efficiency in heating systems, such as tax incentives, investment subsidies, and the like. In addition to generally encouraging DH providers to inform customers of potential energy savings opportunities, regulators could build in incentives for the DH providers to do so. An incentive regulation usually aims at providing incentives to reduce costs, thereby promoting cost reducing energy efficiency measures. Sometimes the cost reductions are not realized and additional financial incentives such as tax relief or investment subsidies have to be provided to promote the dissemination of these technologies. International practice shows that this, however, would be the role of the government rather than of the regulator.

94. Regulatory agencies can ensure that the DH provider earns a reasonable profit on demand-side investments equal to that earned on supply-side investment. DH provider participation in end use efficiency can come in various forms, and usually demand management incentive mechanisms can be used to induce heat suppliers to install demand-side solutions to meet capacity shortages. In addition, the regulatory agency can ensure that the utility and its ratepayers share in the savings from demand-side investment.[23]

23.Mann 1997, p. 26.

95. **Building renovation.** The program for energy-efficiency renovations in existing centrally heated buildings is a particularly difficult one, and an area where administrative measures have only limited usefulness. International experience shows that key issues are less technical and more institutional: homeowners must be actively and enthusiastically involved, requiring both incentives and effective local organization.

96. International practice shows that the development of technical energy efficiency monitoring indicators, including putting standards or benchmarking systems in place, will provide ample data to understand the energy efficiency gains of DH systems. It will be important to include data on: (i) generation efficiency (heat production/fuel consumption); (ii) network losses; and (iii) total system efficiency (heat supply to buildings/fuel consumption). As mentioned earlier, good practice indicates that the actual numbers should be obtained from heat meters, rather than using standard or calculated numbers.

Chapter 3: Main Findings and Options for an Enhanced Institutional Framework for DH Regulation

97. This chapter provides the main findings, options and suggestions for addressing sector issues in an enhanced institutional framework for DH regulation. These are based on the Study Team's understanding of the applicable lessons learned from international experience as discussed in Chapter 2, the survey work conducted by the MOHURD team, from feedback received at workshops and meetings during this project, and the limitations requested by MOHURD to work within the current working system for DH regulation.

98. The findings and options are presented according to a regulation-oriented point of view, in order to support a policy note MOHURD will prepare to support the preparation of a National District Heating Regulation (Tiaoli), as follows: (a) Principles for regulation, (b) Activities to be regulated and regulatory functions, (c) Regulatory instruments, (d) Regulatory responsibilities, (e) Planning, consumer protection, and dispute resolution, and (f) Recommendations on energy efficiency.

99. Licensing and price-setting are two key areas that need to be strengthened to enhance the institutional model for DH regulation and promote sector reform. While it is understood that policy formulation and regulation in China are within the government administrative system, and even internationally it is difficult to separate policy and regulation, it should be recognized that, despite very rapid growth in fixed assets over the last five years, a lack of an autonomous Regulator with clearly defined roles, powers, budget, etc. could be considered a reason for the uneven and relatively limited modernization of the DH sector. While there is significant scope for improvement as elaborated below, international experience in DH regulation suggests that sector reform could be considered incomplete without addressing this issue.

3.1 Principles for DH Regulation

100. **General recommendations for approaching the question of infrastructure regulation.** One of the basic interests of government is to ensure high quality and efficient economic infrastructure; this can be reached when competition is feasible and market forces can determine the amount and price of infrastructure. Regulation of economic activity originates in the need to compensate for factors which inhibit competition by introducing rules that assure the protection of consumers' interests while providing incentives to an efficient supply. In 1997, the **British Better Regulation Commission** identified five principles of good regulation:

- **Proportionality:** Regulators should intervene only when necessary. Remedies should be appropriate to the risk posed, and costs identified and minimised.
- **Accountability:** Regulators should be able to justify decisions and be subject to public scrutiny.

- **Predictability:** measures taken by the regulator are applied consistently in the long term with infrequent changes (which only happen under well-justified conditions).
- **Transparency:** measures and procedures are published openly and are based on clearly defined methodologies.
- **Targeted:** Regulation should be focused on the problem and minimize side effects.

In addition to these, three more principles are commonly identified:

- **Openness:** a regulator which listens to producers and consumers and their suggestions and complaints;
- **Independence:** regulators' decisions are not constrained by the executive nor are they politically controlled; and
- **Skill:** the regulating agency is staffed with competent professionals

101. **Additional considerations for DH in China.** The balancing of the interests of government, DH providers, and consumers is the major challenge in designing an appropriate regulatory institutional framework for DH. Ambiguity in policies or in the allocation of key functions can lead to overlapping responsibilities among institutions, concentrating too many functions in one institution or overemphasizing one regulatory tool over another. This in turn may lead to implementation that is either lax or varies by location, or both.

102. An effective and efficient institutional framework for a regulated District Heating sector could be organized around the following principles:

- **A National District Heating Regulation and guidelines/secondary legislation** for its implementation ensure similar countrywide application based on the same principles and interpretation. The responsibilities of institutions, sector objectives, long-term vision (including reform), and principles should be clearly established in a national legal framework.
- **Avoid overlaps** to the greatest possible extent and where necessary ensure coordination. The institutional framework should cover the full range of key functions. If more than one institution participates in the same function, there should be effective coordination between those institutions.
- **Institutions have sufficient capacity and resources** to carry out their designated functions and responsibilities. Each institution has adequate skills, resources, and staff to perform its functions, as well as the necessary authority to make decisions and enforce compliance, as applicable.
- **Access to information and reporting.** Decisions are made transparently (including for tariff setting and new market entry). Information flows easily between regulated companies and agencies in charge of policy making and regulation, and between local government agencies and national government agencies.

- **Monitoring and ensuring compliance.** An oversight mechanism is in place to facilitate even-handed supervision and enforce compliance, as well as to identify problems in the institutional framework that require adjustments and adaptation to ensure achieving the objectives and vision in the National District Heating Regulation.

- **Local responsibility.** Up to now China has embarked on a voluntary implementation of reforms at the local level. Doing so in a timely and effective manner depends on local support and assignment of clear responsibility. Political will at local levels to support national objectives, targets, and the reform program, including changes to the way the DH industry is regulated, is necessary. Support from national and provincial levels is also necessary.

3.2 Activities to be regulated and regulatory functions

103. The objective of the regulator is to put in place rules which will ensure the most economic outcome for society when providing the service. Traditional economic theory has it that the best outcome occurs when prices are set within a competitive market and in the absence of externalities; the general approach to regulation has therefore been to provide market rules which ensure competition whenever markets can be established, or allow pricing rules which reflect as much as possible the outcomes of a competitive market.

104. Many of the infrastructure services which require regulation are associated with the provision of products through a network (which is the case in power, water distribution, and district heating). Traditionally, regulation has been applied to different levels of service, namely production, transmission, and distribution:

- Production is in many cases an activity which admits competition by allowing multiple entrepreneurs to access the market; it has been the most developed area of reform in the power sector, but still requires a regulator to provide rules for the ways the producers interact, e.g. through a wholesale market, to avoid behavior which may go against consumer interests.

- Transmission consists of the bulk transport of a commodity such as electricity or water to the major load centers; transmission is a traditionally monopolistic activity, which leads to the necessity of regulatory oversight for its prices.

- Distribution is also a quasi-monopolistic activity when consumers are reached through networks. In this case there is also a need for regulatory oversight which covers multiple aspects of pricing, but also aspects of service to the client in order to induce efficiency.

105. In order to better control the performance of enterprises involved in the different stages of service provision, sector reforms in certain industries (particularly power) have centered on a separation ("unbundling") of activities according to whether they belong to production, transmission, or distribution, which can be either corporative or accounting-based.

106. In the case of DH in China a formal requirement to separate transmission and distribution services should carefully weigh benefits and costs – it may bring about more challenges than benefits. As in other sectors, unbundling could bring more transparency to the costs of services, helping the regulator identify justified costs and set appropriate price levels. However, there is a mixed DH market structure, varying even within cities, in China. In most cases, production and transmission are integrated in one DH enterprise; although, there may be several enterprises in one city. However, generation may also be separated from transmission especially in cases where bulk heat is supplied by a Combined Heat and Power Plant. In larger systems, peak load boilers may also be separately owned. Distribution can be owned as common infrastructure by homeowners and managed by property managers. With the many market participants in one city, this can complicate the role of the regulator given the difficulty of collecting information and determining the actual costs of different providers.

107. Internationally, few efficient district heating networks use large size block substations. The networks are connected to buildings via building level substations, thus reducing needs for large size distribution networks. All infrastructure up to the building inlet valve is usually owned by the DH provider while the building level substation (building level substations may also be owned by DH providers) and internal heating network are owned by the homeowner. In some countries, the homeowners sign maintenance agreements with DH providers to care for the substation and internal heating network. This presents several advantages, including unified investment planning and financing as well as operation and maintenance.

108. Because revenues are usually thin (due to low heating prices), dividing up these revenues among many heating companies may create several challenges. For example, the costs of distribution in China are reported to be significant because of traditional designs and practices for large group substations with hundreds of meters of pipelines connecting large building blocks. Distribution companies, sharing revenues with transmission and generation, may find it challenging to raise sufficient funds for operations and maintenance as well as investment. Unified operation and maintenance and coordinated investment planning for transmission and distribution are especially important to ensure efficiency across the heat supply chain. Over time, this issue may be less important as some systems move to eliminating block substations and using building level substations as in CEEC and the European Union.

109. Although mandatory unbundling as applied in the power sector may be challenging in China, the pricing and service conditions which reflect economic investments and operations can still be established through various mechanisms; pricing regulations, for example, can be of different types while usually allowing the provider to choose the technical solution for providing the service within certain limits (for example, power sector regulators in the United States can exclude certain assets which they may consider not to be prudent investments from their price calculations).[24] In the areas of service delivery, regulators can specify numerous obligations at the technical and the commercial level to protect consumers' interests.

24. A detailed treatment of justified and un-justified costs for DH pricing is in Meyer, Kalkum, China: Development of National Heat Pricing and Billing Policy (World Bank/ESMAP, 2008).

3.2.1 Defining rights and responsibilities of providers

110. One of the first steps that could be taken is to address the ambiguities stemming from the various and complex forms of ownership and possession that currently exist in China's DH industry (see Annex 1 for a discussion on the differences between ownership and possession). The following steps could be considered:

- First, clearly defining the rights and responsibilities associated with asset management is needed to spur high quality and efficient investment. When DH providers are planning investments and arranging financing, it is necessary to establish in advance whether the new assets will be owned by the DH provider (that paid for the investment) or whether the assets will become the property of the municipality (or any other owner of the provider). If the new assets will be owned by the DH provider, the following issues should be addressed:
    - The limits and borders of ownership need to be clearly defined. In European Union and CEE countries the ownership border is usually the building wall. The practice in Europe is that indoor heating facilities are paid for and owned by the building owners. This division of property rights is important because it corresponds to establishing the heat delivery border at the building interface. It also allocates and clarifies responsibilities for maintenance and operation. All equipment outside the building is managed and maintained by the DH provider, and all indoor facilities by the building owner.
    - In China, whether the DH provider currently responsible for the maintenance of building or customers' indoor heating facilities (including the meter) could also become the owner of the assets, either by purchase or by ownership transfer, needs to be clarified.
    - The conditions, rights, and liabilities for the use of public roads and grounds by the DH provider should be clearly defined.
    - The DH provider should be liable and responsible for adequate maintenance and operation of the assets it owns.
- Second, it is important to address the management rights and obligations of heating facilities owned by building and apartment owners (indoor facilities and secondary networks). In the absence of direct ownership by DH providers, building and apartment owners should have the obligation to maintain the indoor facilities properly, either by themselves or by contracting with a third party (e.g. the DH provider). The following are possible alternative approaches in China:
    - The DH provider offers maintenance of indoor heating facilities as an additional service in exchange for the payment of a maintenance fee. Under this option, maintenance is offered as a value-added service, and there is no need to regulate the service fee if the business is open to competition.
    - The DH provider is obliged to maintain indoor heating facilities and these maintenance

costs are included and recovered in the tariff. Under this approach, the DH provider would become responsible for indoor losses and damage to assets. This approach is normally not applied in European Union or CEE countries.

3.2.2 Encouraging competition and innovation, technical standards and service quality

111. **Market entry and exit.** Developing clear market entry and exit rules will enhance competition in DH market segments, which will ultimately benefit consumers. It will be important to develop a national-level playing field on mechanisms for market entry in new heating areas, or when DH providers take over existing district systems. Similarly, developing clear measures to provide market exit mechanisms, such as exit at the end of concession or lease contracts, bankruptcy, or license revocation, can help DH companies reduce their investment risks.

112. Rules for competition for the market and within the market, as well as market exit, could be clarified based on provisions in the National District Heating Regulation. Provided there are clear rules and strengthened regulatory systems in place, various forms of competition could be encouraged. In order to determine market entry and exit mechanisms it is important to decide on: (i), the market segments where competition will be allowed; and (ii) the forms of competition in these market segments. Only after these decisions are made and specified in the Regulation, can rules for market exit and entry be written, depending on the different forms of competition and local regulations that want to be pursued.

113. **Consolidation Challenges.** Despite positive consolidation cases (See Annex 1), mostly piecemeal approaches are observed. Consolidation usually follows a decision by top city leaders who usually require very rapid implementation after the decision is made. The efficiency, and especially quality, of implementation depends on the administrative and financial resources of the city (to compensate for mandatory closures). There is a risk that short cuts will be taken to achieve targets. The new networks may have more efficient boilers, or connect to CHP, or use more natural gas rather than coal, but the investments may not be optimized or construction quality may suffer due to tight delivery schedules. As a result, positive environmental benefits may not be delivered at the lowest economic cost. This 'locks in' costs that need to be regained from tariffs or government subsidies.

114. Institutional barriers may also hamper consolidation. There is a risk of protracted negotiations with existing suppliers (who may not wish to close and require high compensation) over boiler closure as well as arguments over the new, large franchise that would replace them. The growth in demand for heat during negotiations could pressure cities into holding on to small boilers for a time and servicing new demand with a new centralized heating system. Additionally, consolidation introduces new cost structures which can, but do not often in practice, influence pricing. New centralized networks still must connect to old distribution networks, raising issues such as responsibility for substation investments, O&M of secondary networks (which traditionally have large heat and water losses). In addition to a tendency to avoid raising retail heat prices, pricing bureaus are challenged to understand new cost structures and pricing impacts also due to

the mixed ownership of DH assets (new transmission owned by a DH company, some distribution owned by homeowners and operated by property management companies). Innovative, transitional approaches, such as transforming small operators into buyers and distributors of heating in an integrated network, may be practical. However, investments will still be needed in distribution networks to improve leak and heat losses. Heat distribution prices will need to be set to take into account these investments or they will remain neglected. As discussed in the first section of this Chapter, unbundled transmission and distribution services may pose more challenges in the long run than benefits.

115. While consolidation is a positive trend in China, it could be even more efficiently managed with guidance under an enhanced regulatory system. The enhanced system could take into account the following:

- Open the consolidated franchise area to competition under transparent rules based on the new National District Heating Regulation and other regulations.
- Encourage addressing of red line issues: extend the consolidation effort to include distribution systems up to the entry of the building, and require new franchise owners (including the transmission company) to take these secondary networks.
- Municipalities organize effective plans to find alternative jobs or provide vocational training for affected seasonal and permanent work force from small operators.
- Research the viability of a holding company model for DH. Smaller operators facing cost-prohibitive environmental requirements may be offered equity in a larger DH holding company in exchange for the small operators' assets. The DH holding company does not need to own all DH assets, but could plan investments, operations and maintenance more efficiently across a large DH system (possibly with more than one franchise). To protect against the holding company exercising monopoly power, a strong regulatory system with the power to audit financial statements and to benchmark costs is needed.
- Independent auditors undertake valuations of small operators to more objectively determine compensatory issues caused by the required closures.

116. **Technical Standards and Service Quality.** As noted in Chapter 2, national institutions play an important role in the development and renovation of DH systems through the issuance of technical standards ensuring the safety, security, efficiency, and quality of heat supply. Technical standards aim at ensuring that the DH systems work properly and provide heating safety, reliability, efficiency, and environmental protection. These standards, issued by a competent authority such as the regulator, address issues such as: (i) the minimal building heat resistances; (ii) the heating season and hot water parameters; (iii) the maximum number and duration of heat supply interruptions; and (iv) the ability to respond to supply failures and maintain heat supply.

117. The National District Heating Regulation offers an opportunity to enhance setting of technical standards and quality of service through ensuring the application of a uniform methodology which addresses inter alia:

- National standards and quality of service principles defined to ensure the technical safety, reliability, and efficiency of heat supply service and to ensure its commercial integrity.
- The role of municipal administrations in establishing the detailed regulations or standards specific to local conditions and existing DH systems.
- The removal of standards and quality of service principles that hamper the use of modern, more efficient equipment and technologies; and
- The establishment of general rules for DH provider license cancellations due to non-compliance with technical and quality of service standards

118. Quality of service regulations are particularly important under multiyear incentive-based regulatory (price caps) regimes, but service standards are also necessary under cost-plus pricing, which is the current approach in China. An updated set of quality standards will be needed when transitioning to consumption-based billing and two-part heat tariffs. For example, minimum heating obligations on the heating supply company are important when ratepayers pay according to floor or heating area, but this obligation changes under a two-part heat tariff whereby the ratepayer is charged according to the capacity that is ordered by the ratepayer from the network. Currently, in China this is not possible because the capacity charge is allowed to be set based on floor or heating area.

119. New quality of service standards will also require the collection of objective information for the proper monitoring of compliance. Self-reporting of service performance by companies, through surveys completed by the companies themselves, is not likely to yield objective data. The ability to collect, verify, and analyze information will also require the development of additional skills in the HAOs. The Pricing Bureau, too, will need to develop the skills to determine whether companies' claims of cost increases for meeting these standards are justified.

3.2.3 Price regulation

120. **Tariff Setting.** In China, tariff reform has progressed gradually, given the growth of the sector. Nationally, DH tariffs are based on a cost-plus approach (justified costs plus allowed profit up to 3 percent). However, in practice tariffs are set uniformly at the city level using an average cost approach based mainly on standard costs (usually averages of estimated costs based on surveys or analysis), rather than on the actual costs of the DH provider. Although such an averaging approach may lead certain providers to profit more than others, it is in a sense an application of incentive-based regulation where prices are set according to a benchmark. However, some differentiation by technology should be provided for in order not to mix, for example, DH providers with large centralized technology with building-level ones.

121. Recently, there has been a push to move into two-part pricing and pilot cities have started to charge according to consumption. The two-part tariff structure has an energy charge component (reflecting variable costs of consumption) and a capacity charge reflecting the fixed costs of the DH provider. In practice, however, cities are charging a two part tariff arbitrarily split equally between

the energy charge and capacity charge. In other words, if the tariff is RMB 24, then the fixed charge is set at RMB12/m^2 (rather than an energy capacity unit such as Gcal/h) and the energy charge is calculated based generally on variable costs. This is perhaps a practical first step under pilot conditions, but it appears to be replicated in more cities now.

122. Key steps for moving toward the implementation of an economic two-part tariff could include the following:

- Consumption-based billing becomes mandatory for all types of district heating. This requires the installation of heat meters (See discussion of heat metering below).
- Energy units (e.g. kWh, kW, MJ, MJ/h, etc.) become mandatory for heat measurement of the heating bill as there may be some out-of-the-box initiatives suggesting alternatives, such as measurements based on indoor air temperature (See discussion on heat metering below);
- Once metering is in place, heat tariffs move to a two-part tariff system with an energy charge and a capacity charge. The calculation of the energy component and the capacity component of the tariff needs to reflect as closely as possible the respective variable and fixed costs. Some flexibility could be allowed for efficiency and improvement considerations:
    - To increase incentives to save energy, the energy charge could be set slightly above the actual variable costs.
    - If fixed costs are very low (for example, mostly fully depreciated equipment) the capacity charge could be set above actual fixed costs to support investment financing for rehabilitation and modernization. In theory, the tariff reflects the cost of supplying an additional unit of heat. When the system is at full capacity, the capacity charge takes into account the capital cost of the envisaged new plant. If the connection fee (See discussion on connection fee below) continues to be applied as it is now in China, then the capacity charge needs to be adjusted to support investment financing for rehabilitation and modernization of the existing system.

123. In turn, the tariff setting mechanism could be improved by taking the following measures:

- *A uniform, standardized accounting system* needs to be defined and made mandatory for DH providers (implemented within a deadline) and for tariff filing and approval. Establishing and enforcing a transparent and clear accounting system similar to the one used in the industrial sectors is an indispensable prerequisite for tariff setting. Although the Ministry of Finance has provided guidance that enterprises like DH providers should gradually adopt industrial enterprise accounting standards, this needs to be reinforced through regulations.
- *Cost forecasting.* The regulatory framework should require DH providers to prepare cost forecasts for the heating season to which the new tariff will apply. Because many DH providers will lack the required forecasting expertise, clear guidelines for preparing a cost forecast can be issued and their application made mandatory. Similarly, general rules for accounting and reporting (for the purposes of statistics, monitoring and eventually

benchmarking), and national principles and a general methodology for tariff setting can be established at the national level.

- *Regulations requiring DH providers to measure and report their main inputs and outputs can be issued,* so as to include an obligation to provide data not only on money flow but also on physical flow of heat supply quantities. Only if such information is available can reasonable cost control be possible. The essential inputs are fuel quantities and their heating values, electricity, prepared and unprepared water, labor (working hours), chemicals, and so on. Essential outputs are heat produced, supplied to networks, supplied to substations, and delivered to final consumers. In fact, DH providers need this information to prepare reasonable cost forecasts for themselves. To avoid doubling the burden on DH providers, the reporting should be harmonized with other reporting requirements (for example, for statistical purposes) to the extent possible.

- *Human capacity to make reasonable financial, quantity, and cost forecasts over a tariff period needs to be developed.* There is a need for capacity building for both local agencies and the recommended provincial institution to assess, and DH provider to prepare this data. It is reported that such human capacity varies across cities and some have no choice but to rely mainly on forecasts provided by heating companies to set prices. Proper accounting is a necessary but not sufficient prerequisite for efficient pricing, as it shows historical past costs, while tariffs should cover future costs (i.e. costs for the next heating season). If the focus is on past costs, tariffs will already be outdated when approved by the competent authorities. Thus, the relevance of developing cost forecast capacity both at the regulatory authority and the DH providers' level.

- *Establish a benchmarking system first as a sector monitoring tool and, once sufficiently credible, as a tool for regulation.* Because DH companies and systems are diverse and are affected more by local conditions than, for example the power sector, benchmarking is challenging. As a first step, all DH providers should uniformly report their technical and financial performance (part of this reporting system could be similar to the statistical reporting requirements). This can develop experience and understanding of the terms and methods used to collect and report data, which is an essential first step toward improving the relatively poor data quality in the DH sector now. As the statistics improve and monitoring is strengthened, a benchmarking system could be used for useful analytical purposes. Benchmarks could be established by grouping DH systems with similar characteristics (for example, systems with or without CHP, those with low load densities, etc.). This may generate many groups requiring skilled analytical capacities, and require accounting systems to produce disaggregated data based on function (e.g. by generation, transmission, etc.) if financial issues are included. As the benchmarking system improves and builds credibility, it could establish a basis for the regulatory authority to request corrective measures and assist in determining unnecessary costs. If the tariff proposal is within an economically efficient range of costs and tariffs of comparable companies or the state of the art, the tariff proposal will be approved; if not, it will be approved with certain requirements for improvements. Annex 2 outlines steps toward developing a strengthened monitoring as well as the sector-specific challenges to benchmarking.

- *Consider establishing the enhanced monitoring system at the provincial level.* A provincial institution may be best placed to be responsible for an enhanced monitoring system (and eventually benchmarking). If it, or another entity, is to be given this responsibility, it needs to be given strong rights of access to information on heating costs from DH providers. (See further discussion on the provincial role in the DH sector below) Although the Development and Reform Commissions' (DRC) pricing bureaus at the municipal level have this authority, the provincial authorities, in this enhanced role, would also have the mandate to access this cost information (coordinating closely with the city pricing bureaus), and compile and report the monitoring/benchmarking results to the national and municipal authorities. In this way, the enhanced monitoring system can function most effectively, if only to have a cascading reporting system that compiles thousands of points of data from municipalities to provinces to MOHURD, and enable responsible institutions to, among other issues, assess differences in tariffs and cost structures across cities and DH providers on a scientific basis.

124. **Pricing Methodologies and Adjustments.** Currently in China city-wide tariffs and prices are implemented mostly on a year to year basis (although in practice there is little change year over year), which does not consider the actual economic and financial costs of the different DH providers, and limits the competitiveness of DH service provision. Instead, incentives for greater efficiency could be introduced: (i) tariffs could be set for each DH provider, or eventually similar types of DH providers; and (ii) both annual and multiyear tariff methods be allowed during a transition period of 5¬ to 10 years. Multiyear tariffs could be applied to qualified DH providers that have prepared reasonable business plans showing expected improvements and investments. The transition period can smooth implementation of gradual tariff increases over a longer period of time and reduce the impact on consumers. Another option is to define a category of companies of a minimum heat supply (MWh/yr) which can choose to apply a uniform tariff or to ask for an individual tariff. The municipal authorities could have the power to decide which method will be applied and decisions could be made based on the assessment of the provider's business plan. It will be important to clearly stipulate the multiyear period, its baseline tariff (including a price adjustment formula), together with guaranteed performance and quality of service requirement to avoid DH providers to lower costs by providing a lower quality of service.

125. **Managing Legacy Debt.** Resolving historical debt (which could also include pension liaibilities) is an important precondition for a sustainable and financially sound development of the DH market. In China, while the amounts are not aggregated publicly, it is an acknowledged issue and there are no clear rules on how to go about managing historic debt. Usually there is a lack of clarity on conditions and age structure of the debt, which coupled with a lack of clear rules on how to manage it, only hinders DH market development. There are certain business risks that the heat supplier has no control over, but he is nevertheless responsible for the consequences. An example may be increased fuel consumption due to an abnormally cold winter or bottlenecks in fuel supply. Such typical business cases could be addressed by the tariff setting methodology (automatic price adjustment formula). Either the coming tariff will be increased to cover these additional costs or profit margin would include such risk factors

126. Decisions on how to manage historical debt could be taken following certain principles and in compliance with certain criteria:

- First, the main principle could be that the one who caused the debt, should be responsible; that is the responsible party has to solve the problem, as in the following examples:
    - o A heat supplier who needed to buy fuel but could not pay the invoices as the tariffs were too low, is not responsible if the tariff regulator did not approve cost covering tariffs. (The important point is whether the tariff covered costs when the fuel was needed and not when it was approved.)
    - o The debt incurred for investment financed by the heat supplier in order to fulfill instructions of the local government to connect new buildings, but which were not connected or fully occupied with paying customers. Again, the heat supplier could be considered not responsible for the debts.
    - o Debt inherited from the restructuring of an industrial company as assets were spun off into independent companies.
- Second, assess whether the historical debts prevent the sustainable financial development of the company. If so, the balance sheet should be cleaned from those debts for which the heat supplier was not responsible. In case of debts for which the heat supplier was responsible, opportunities for debt refunding and rescheduling should be explored.
- Third, a decision could be taken, whether and to what extent the heat tariff would include a component for repaying the debts. If so, the corresponding part of the company's income should be blocked to guarantee repayment and avoid different utilization. If final consumers have actually derived benefits from the past debts, there is no reason not to allow the repayment in the tariff base. This would be reasonable, for example, in case of debt for fuel needed during an abnormally cold winter.
- Fourth, in most cases, a final decision can only be taken in cooperation with the creditor and this should also determine the level for decision making. Usually, the company's founder, i.e., the municipality, should take such decisions. If, however, debts have been generated due to instructions or interventions of superior governmental levels, the corresponding bodies have to be involved.

127. **New Connections and Connection Fees.** Connection fees are now paid directly by the consumer or by the building developer who then transfers the cost to the apartment. Connection fees and investment cost contributions are an attractive source of financing because they are directly linked to the investment costs and, even if interest were to be paid, the costs to the DH provider would be lower than the cost of a loan from a commercial bank.

128. To improve the connection fee system in China the following issues could be addressed:

- *Payment capacity of the new customers*. For buildings for low-income households, connection fees could be low and no investment cost contribution should be levied. Instead, the investment could be financed by a loan, which has to be repaid by the customers through a corresponding recovery charge transferred to the tariff.

- *Fairness.* To the extent possible, charges should be allocated to those that cause the cost to be incurred. New consumers who are charged a nonrepayable investment cost contribution will end up paying twice: first, through the investment cost contribution, and second through the depreciation charges recovered in the tariff. There is a fairness problem if only new customers have to pay the investment cost contribution, while those living in old buildings were never requested to pay.

- *Justified costs recovered in tariffs.* If a loan is used to finance the building, expansion, or rehabilitation of a DH system, the tariff setting process should recognize the loan (that is, the interest payments) as justified costs.

- *Avoiding double charging when two part tariffs are implemented.* If a capacity charge is levied in a two part tariff, the practice of charging connection fees should recognize this potential overlap and be adjusted accordingly.

129. **Subsidies and Social Support Schemes.** As China moves away from floor-area based billing, a decoupling of social support from heat pricing will be needed. In China, current practice is to provide general subsidies to DH, which support affordable heating services by maintaining stable heat retail prices over long periods of time and financially weak DH providers. While some municipalities claim not to provide direct operating subsidies, the subsidies are masked in different forms, including periodic enterprise restructuring and investment subsidies. From an economic standpoint general subsidies are inefficient at achieving the objective of providing social protection to low-income consumers in large part because general subsidies benefit all consumers, including the affluent. Under this scheme, in fact, high income households, with larger apartments and higher heating consumption, benefit proportionally more from general subsidies than low-income households.

130. The subsidy framework is an important element in promotion of heating sector reform. However, designing effectively targeted subsidies requires different skills and expertise than the skills possessed by traditional utility engineers, managers, and pricing and regulatory experts. In China experience has already been gained in transforming invisible subsidies into visible subsidies, and in developing municipal subsidy funds for low-income households. But issues still remain (See Annex 1). Close coordination with social assistance institutions and experts is necessary. This coordination can generate innovative new solutions. For example, one reason often given by local governments for maintaining low heat prices is the inability to properly target households for social service provision. Such issues are not new to social assistance programs and key design questions such as qualification criteria and subsidy delivery mechanisms could be addressed through collaborative efforts.

131. Moving forward, social assistance mechanisms should avoid leading to the irrational use of energy resources and thus the pricing mechanism should not be used to address affordability objectives. A pricing mechanism for consumers needs to be implemented to create incentives for savings and to increase heating efficiency.

132. A separate scheme to assist low-income consumers with their heating payments needs to be

developed. The following features of a social assistance mechanism could include:

- Low-income consumers receive social assistance for payment of their heating bills.
- Targeted support to poor consumers (those also above the official dibaohu definitions) needs to be updated upon heating tariff increases, or defined as a heat consumption indicator (or area, as applicable to the type of tariff) valued at the current tariff.
- Financing of targeted social assistance needs a secure funding base; it should be the responsibility of the government, not of the DH provider.
- As described before, introduction by DH providers of flexible, customer-tailored payment terms improve affordability and collection rates.

133. **Metering.** Current practice is to meter at the apartment level, which raises issues on: (i) how to determine losses at the building level (which is not metered); (ii) what methodologies and principles to use to allocate the building losses among apartments; and (iii) how to determine and apply correction factors to address physical differences of heat consumption; (iv) who is responsible for installing, calibrating and maintaining meters. The National District Heating Regulation is an opportunity to clarify misunderstandings, including:

- Require mandatory installation of heat meters;
- The minimum requirement for the installation of heat meters is one meter per building or, in larger buildings, one meter per staircase.
- Cities should have the right to decide whether to apply correction factors. At a later time, experiences from many cities can be compared and new recommendations could be developed about how to determine correction factors (or whether correction factors should be used at all).

134. Acceptable metering options recommended are: (i) apartment meters; (ii) centralized building meters; (iii) centralized building meters combined with individual heat cost allocations; or (iv) centralized building metering combined with apartment meters (although this is a more costly alternative).[25] If heat is only metered at the apartment without a centralized building meter, the party (DH provider or customers) that will bear the costs associated with indoor heat losses (mostly losses in the vertical pipes) must be identified, as must the party responsible for properly insulating and maintaining the internal heating system.

135. The National Regulation needs to address ownership and calibration issues. Best practice is for heat meters to be owned by the DH company, which is responsible for meter maintenance

25. See a full report on heat metering and billing options in JP Building Engineers and Center for Energy Efficiency in Buildings (China) in collaboration with World Bank and China's Ministry of Construction, *Heat Metering and Billing: Technical Options, Policies and Regulations: Chinese Demonstration Projects and International Experiences* (August 2002) and Meyer, A. and Kalkum, B., *China: Development of National Heat Pricing and Billing Policy* (World Bank/ESMAP: March 2008), Report No. 330/08).

and calibration. Calibration is generally required about every three years, paid by the meter owner. Cost of meter maintenance and calibration could be covered in the heat tariff. Generally, the customer may ask for a calibration in between periods if there is a disagreement on the meter reading. If there is no calibration issue, the customer pays for the additional calibration. From interviews, it is apparent that heat meters of varying quality are being installed by building developers and calibration processes are not yet in place in some cities, wasting investments and risking credibility of the CBB itself. One simplifying measure DH providers and cities could take would be to reduce the number of meters installed by using building level or staircase level meters for billing. There needs to be great attention paid to this relatively straightforward issue to avoid further waste of resources in poor quality meters and further unnecessary disagreements on meter readings which risks the credibility of consumption based billing itself.

136. **Billing, Payment, and Collection.** As feedback on apartment level metering has been mixed, there is room to consider whether the market could accept more than one dominant metering (provided it is based on measuring energy and not temperature, for example) and billing approach. This diversified strategy could reduce risk of slow adoption, reduce costs, and accumulate experience with different approaches. Regarding billing, current practice in China is to charge customers in advance for the next annual heating period. Although this is an advantage for DH providers as they are able to use cash to buy fuel and cover expenses, it is a burden for customers who often have to disburse a lump-sum.

137. Allowing flexibility for DH providers to choose billing methods can assist customers with meeting obligations for payment, improving collection rates and customer satisfaction. Matching billing patterns to consumption patterns more closely will also strengthen incentives for energy efficiency. Flexible payment options include:

- Consumers are billed and pay on a monthly basis, perhaps based on the previous year's consumption, with a reconciliation of the bill at the end of the heating season;
- Monthly payments according to actual consumption; and
- Advance payments with a rebate (an incentive to pay more, earlier).

138. Flexible payment terms will require management and financing strategies to support them. These strategies will need systems support in accounting, billing and collection systems of DH providers. Usually, accounting, billing and payroll systems are not fully integrated into one system, relying on excel spreadsheets and semi-manual data transfers. There are many off-the-shelf systems available that can handle multiple billing and payment methods and that automatically update the books in accounting systems. Disseminating information on good practices and approaches would be necessary to raise awareness and guide preparations for deploying these upgraded systems.

139. Financing departments will need to accommodate changes to cash flows caused by flexible billing practices. For example, new financing strategies for fuel purchases will need to be implemented. DH providers can arrange financing for fuel purchases ahead of the heating season through short-term loans if consumers prefer not to select the advance payment option. Although

the financing costs are small, the tariff should be allowed to include the costs of such loans. The rebate for the advance payments would correspond to the spared interest payments. Knowledge exchanges between advanced and less advanced DH providers on these operation issues are recommended.

3.3 Regulatory Instruments

140. **Use licensing as a key regulatory tool.** This section aims to untangle the lack of clarity that exists in practice regarding licensing, permitting and franchising. Annex 1 discusses the mis-applications of these different instruments that have led to a lack of clarity between stakeholders on rules and their obligations.

141. Licensing could be a key regulatory tool for achieving unified regulation under the new National District Heating Regulation. The current administrative operating license (permission to operate) system would be strengthened by clarifying and further developing two separate obligations for one service (a) a regulatory license, very different from the current administrative operating license, that qualifies the company to provide heating services and compels it to abide by stated conditions, obligations, and requirements; and (b) a franchise or concession that gives the provider market access to a specific territory after winning a transparent and competitive selection process. The two can be combined in a single legal document. Whichever legal approach is taken, the objective is to clarify obligations, rights, and responsibilities at the national level so as to have a more harmonious development of the sector at the local level across the country.

142. **Establish a national regulatory licensing standard.** Standard principles, general procedures, and general licensing conditions need to be established at the national level so that they apply to all licensing institutions and to all DH providers in China. Because permitting and licensing practices vary widely in quality, comprehensiveness and enforcement across cities, strengthening the current administrative procedures by introducing a national licensing standard, including features of a regulatory license as outlined above, is needed. This standard could be included in the proposed National District Heating Regulation, or, based on a new, strengthened legal mandate for the license established under the Regulation, the MOHURD (in concert with other relevant agencies) could issue a national implementing regulation. Licences can be issued for generation, transmission and, if necessary, distribution separately to make requirements clear.

143. A "National District Heating Licensing System" would, among others, describe the general licensing process; identify activities subject to licensing; establish principles for the granting, monitoring, and revocation (or suspension) of licenses; and define general rights and duties, including (i) the obligation of DH providers to supply information and reporting to licensing institutions, as well as to allow auditing, inspection, and other mechanisms for the monitoring of compliance; and (ii) the rights and powers of licensing institutions to monitor, take the necessary enforcement measures, and suspend or revoke licenses. At the provincial and municipal levels, detailed implementation rules and regulations would be established to reflect and adapt to local conditions.

144. The national regulatory licensing framework would identify and clarify:

- activities that require licensing in the DH sector, and exceptions;
- principles for the qualifications and requirements that licensed companies must fulfill;
- general rights and obligations of the licensed entity;
- management of licensing system: who issues (and when necessary suspends or revokes) the license, who monitors, who manages enforcement (sanctions and the like); and
- contingency plans to protect heat supply security, in particular, to manage bankrupt DH providers.

145. The granting of licenses should require DH providers to demonstrate their technical, managerial, and financial qualifications. Professional and management qualifications require qualification in the operation and management of the DH systems. Qualified staff is needed to ensure proper, effective, and uninterrupted heat production and distribution. Pipelines need to provide a necessary amount of heat and satisfy technological, environmental, and safety requirements. Pipeline systems need to be inspected and maintained. DH providers need to be financially strong enough to be able to purchase fuels and other resources for heat supply and to cover their operational expenses, and to obtain commercial bank loans.

3.4 Regulatory responsibilities: who should regulate?

146. **Identify agencies that carry out each major regulatory function in the National District Heating Regulation.** The National District Heating Regulation should identify the government agencies/institutions that carry out each function, as well as the interactions with, and rights and responsibilities of, DH providers. When defining the institutions with the rights and responsibility to issue licenses, the new Tiaoli provides the opportunity to assign to those institutions the mandate and the authority that is needed to properly monitor (collect data, and carry out audits and inspections) and to enforce license conditions and applicable DH regulations. In particular, these institutions need to have the authority to apply sanctions and to revoke licenses. As noted in Chapter 2.2.2, standard international practice is to exempt small companies from licensing. While it is understood that in China pricing and sector regulation are separately administered, international practice suggests the agency responsible for licensing should also be assigned responsibility for tariff setting.

147. **Implementation considerations.** A strategy for implementing a new regulatory system requires reconciling the advantages and disadvantages of a centralized, but congested, central regulator, or more dispersed regulatory decision making, which runs the risk of unpredictable and inconsistent decision making. This report's findings and suggestions follow the organization of Government in China by assigning functions and responsibilities to authorities at the national, provincial, and municipal levels. As noted before, MOHURD would be responsible for issuing the guidelines for a national licensing system, and would be responsible, in general terms, for

implementing the guidelines, which imply a country-wide application.

148. The municipalities could issue the regulatory licenses (the Study Team suggests MOHURD consider whether an alternative to the municipalities is currently suitable – see the next section on enhancing provincial-level functions in DH sector reform and development below). Existing municipal permits (administrative operating licenses) systems in China would apply to small DH providers (with a size to be determined by MOHURD).[26] In addition, the municipality's department responsible for heating supply would be responsible for monitoring all DH providers within its territory and for ensuring supply security, including development of a contingency plan to protect and ensure heat supply if a license is suspended or revoked, or if a DH provider has inadequate funding to provide heating services. Alternative measures that can be considered in designing the contingency plan include making changes in the management of the company to improve its performance, strengthening the capacity of the company, or inviting another operator to take over the service.

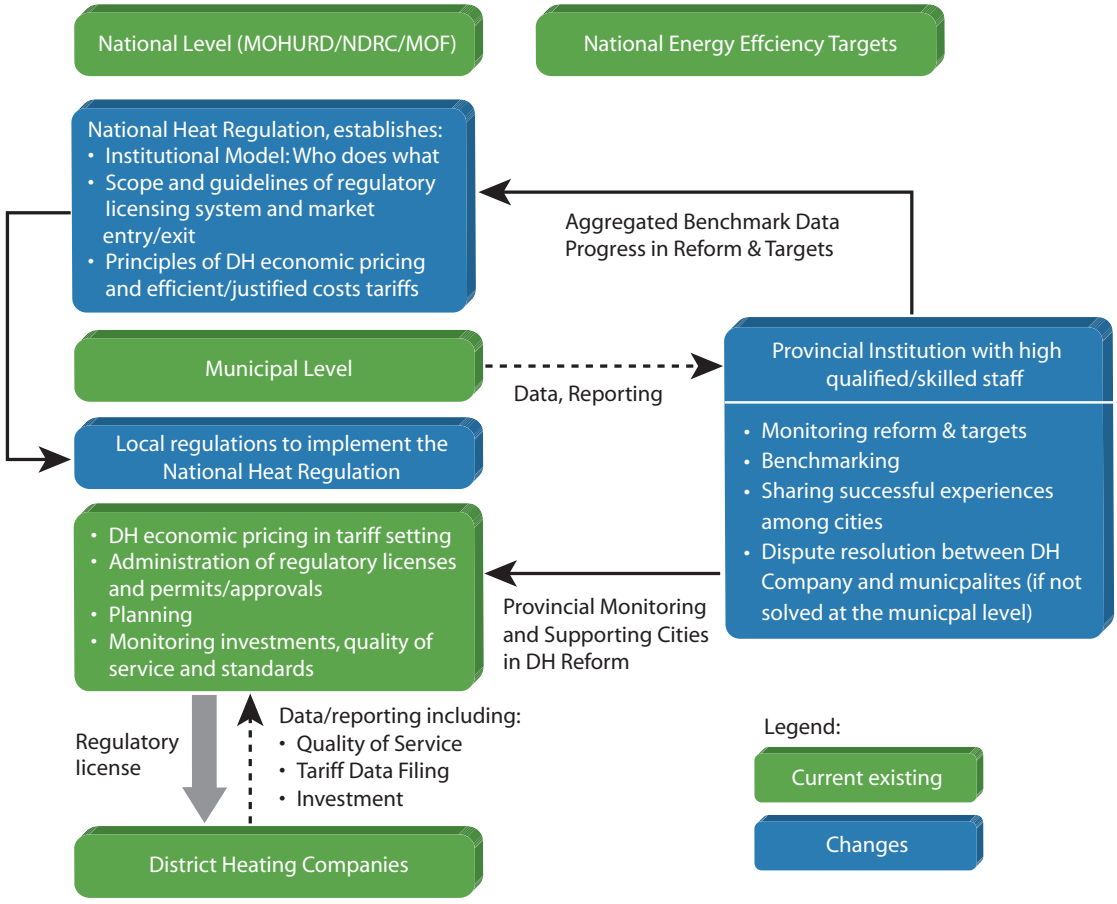
149. **Enhance provincial-level functions in DH sector reform and development.** Provincial governments are close to the local situation and can also play an important promotion, monitoring, and supporting role to ensure harmonious and scientific progress in the sector across their cities. A provincial-level institution could be given a clear sector-development and monitoring role to streamline and strengthen supervision of sector development. Because of the high degree of fragmentation of the DH industry within cities and the mixed ownership of generation, transmission, and distribution, cities may find it difficult to implement the general guidance defined at the national level. Also, local circumstances may vary and need to be taken into consideration to ensure effective implementation of the national-level rules. Conversely, providing direct support to more than 360 cities, where heating is required, is a challenge for any national institution, including MOHURD. For example, guidelines for two-part heating tariffs were issued in 2007 and allowed cities to implement the guidelines based on local circumstances, but only a few cities have put in place two-part tariffs and only one percent of total floor area was billed according to heat consumption in 2009; a provincial authority could provide the support to put in place these regulations.

150. The provincial level institution would report on sector development and reform to central government level agencies (MOHURD, NDRC, etc.) to provide the necessary information to guide policy making and assess the status of DH reform and other national targets. In this way, MOHURD can more efficiently supervise the sector and monitor progress in the 15 provinces where heating is required, rather than directly monitoring more than 360 individual cities.

151. **Potential responsibilities of a Provincial authority.** The provincial-level institution could be responsible for consolidating and reviewing information of all DH providers within the province and facilitating information exchange between DH providers and cities within a province. Monitoring (and eventually benchmarking) of various indicators measuring performance (i.e. operating and investment costs, quality of service, financial performance, customer service, etc.

26. The annexes of the Scoping Report include a review of the heat laws in other countries. These laws specify, among other things, the size of regulated companies.

Box: 3.1. The Proposed Enhanced DH Institutional Model



– examples are discussed in Annex 2) and monitoring of sector development (i.e. tariffs and heat pricing, investment issues, implementation of central government policies especially DH reform, etc.) could be the responsibility of the provincial institution. Aggregation at the provincial level[27] could bring significant value added for sector management and regulation.

152. At the provincial level, monitoring of compliance could be strengthened to identify problems earlier but more so to help DH providers solve problems before they become more costly or intractable. Information sharing beyond city borders is not a natural inclination in the DH industry, which is a localized business, although outside experience in a wide range of issues is usually relevant, even when taking into account local differences. Comparisons of performance benchmarks of similarly-sized DH companies and the monitoring of national targets and reform objectives across cities within the same province could be made. Valuable lessons can be shared if facilitated by a provincial institution, especially as reforms are more strenuously implemented.

153. Enhancements to the monitoring systems need to be further developed to help analyze sector development within the province and help to efficiently and effectively support local progress of national sector reform. The regulatory license as elaborated above could help to ensure that data can be obtained by the provincial level institution with the assistance of the municipality.

27.Higher level aggregation would make comparisons difficult because DH is significantly influenced by local factors.

License conditions should clearly establish the providers' obligation that enable monitoring and should also clarify the rights of the institutions responsible for licensing to disclose information. Standard practice is that aggregated data and benchmark results can be disclosed. An enforcement mechanism to ensure data and reporting are provided in a timely manner and include accurate information should be an explicit obligation of the regulatory license. Performance and efficiency indicators also need to be disclosed to demonstrate the DH providers are fulfilling obligations.

154. Adequate capacity and resources for compliance and monitoring would need to be available. In some countries fees are levied on license holders to pay for the operations of the regulator, which is seen as a best practice to ensure independence of the regulatory authority. Data collection and especially verification has been identified as one difficulty encountered at municipal levels. The provincial institution could receive information directly from the licensed DH providers and from municipalities for smaller DH providers.

155. The MOHURD has given explicit guidance to the Study Team that a separate Regulator, such as with responsibilities and powers as those recommended by the joint World Bank-IESM Report[28] (See Box 4-3 on Examples of Responsibilities and Powers of a Downstream Gas Regulator), is not currently possible under the government's administrative system.

156. Nevertheless, it is proposed MOHURD consider, as one step forward, whether it is possible to assign the government institution at the provincial (or large city) level the responsibility for licensing DH providers within the province following the "National District Heating Licensing System." Perhaps this enhanced licensing authority can be transferred in the medium term when the provincial level institution gains credibility in its new benchmarking and monitoring function. The exception would be for small DH providers that could be licensed by municipalities (acknowledging that "small" has yet to be defined and may differ by province). A provincial level licensing system could greatly help to accelerate even-handed adoption of the strengthened regulatory license at the local level and help to ensure consistent application of the new national licensing standard.

157. When considering a first-order legislation like a National Regulation such an entity could be envisioned as an option. If it is desired, then detailed work is needed to decide what to include in the National Regulation to form a proper legal basis for such an entity, its source of funds, proposal and approval of budgets, reporting, appeals on its decisions, and other potential issues such as qualification of regulator(s), obligations on conduct/conflict of interest, removal and immunities from civil actions as a result of their duties, obligation not to disclose commercial secrets, powers to make rules, etc.[29] The national framework could clearly establish (a) the limits of licensing and regulatory responsibilities between the provincial institution and the municipalities, as well as the information exchange between the two; and (b) the reporting and information exchange rights and responsibilities between the national level and the provincial institution.

158. Eventually, when the regulatory license regime is in place and rules of the game are clear, licenses would be issued only to qualified companies, and the regulatory authority would have license revoking authority. Regular reporting on the situation of DH providers and supply security

28. *China: Regulatory Framework for Long Distance Gas Transmission and Urban Gas Distribution (World Bank, The Institute of Economic System and management, NDRC, 2003)*

29. Ibid.

Box: 3.2. Examples of Responsibilities and Powers of a Downstream Gas Regulator

The principal duties of a downstream gas regulator are as follows:

1. Issue licenses
2. Approve (or reject) rates (tariffs)
3. Approve (or reject) terms of Access to Quality of Service
4. Approve (or reject) Codes of Conduct
5. Qualify (deny) enterprises the right to participate in gas industry activities
6. Deal with regulators in adjacent countries on border-crossing pipelines
7. Monitor and report on gas market development
8. Transitional activity (i.e. Where an existing gas industry is coming under modern downstream regulation for the first time, it is normal for the regulator to issue blanket approvals for all existing facilities, rates, and other tariff provisions, and for participation in regulated businesses. These approvals would automatically signify that the affected businesses were being brought under the regulator's jurisdiction. The regulator could then, over a period, critically examine whether to bring about changes in any of the conditions under which these business activities were being conducted.

The regulator must be equipped with a "toolbox of powers" that it can use to implement its mandate. Those powers would include those needed to do the following:

1. Gather information, including the authority to compel the provision of information by regulated entities to the (Regulatory) Commission
2. Hold inquiries about matters within the Commission's jurisdiction
3. Receive applications from regulated entities, to do things (example, build a pipeline) or to grant approval for things (example, codes of practice) that come within the Commission's jurisdiction.
4. Keep confidential, where appropriate, information gathered during the performance of the previous three activities
5. Make decisions based in part on this information gathering
6. Give orders and approvals to carry out those decisions (eg. Approval to charge a certain schedule of rates or, orders to construct fracilities on a pipeline to receive gas from a customer)
7. Put conditions in those orders and vary them
8. Enforce those orders.
9. Grant exemptions
10. Assess penalties against entities that breat those orders.
11. Deal with appeals from them
12. Work cooperatively with foreign regulators in respect of international gas pipelines.

Source: China: Regulatory Framework for Long Distance Gas Transmission and Urban Gas Distribution (World Bank, The Institute of Economic System and management, NDRC, 2003)

would enable to plan and take effective actions on time and ensure the quality of heat supply services. DH providers that fail to comply with license obligations should have their licenses revoked. The regulatory authority can then issue a new license to another qualified company, transferring the operations and the business to that provider. Implementation of this procedure is rare but the existence of such a legal measure provides an incentive for suppliers to comply with their obligations.

3.5 Planning, consumer protection, and dispute resolution

159. **Planning of District Heating.** Although the main elements for DH planning appear to exist in Chinese cities, the approaches and objectives do not seem to be systematically implemented. Moreover, the very fast growth of the DH sector limits the applicability of advance planning because conditions can change by the time the plan is approved. Municipal planning should continue to divide the territory into heating zones according to existing pipelines, heat load density, and plans for new development, particularly to guide the consolidation of small providers into larger scale DH providers.

160. For example, in the planning process and taking into consideration existing systems, new construction, and density, a municipality can divide its territory into heating zones and determine the "best" heat supply method for each zone depending on local characteristics and conditions:

- *DH zone.* A high density area, where DH is economic or required by environmental considerations. The high density of the buildings should result in DH being the most economic and efficient source of heating. With this consideration and particularly for DH systems experiencing high growth and new development, planning is essential. The planning of DH zone(s) should identify areas with existing DH systems, new developments requiring DH, and estimated heat volume that would be transmitted.

- *Gas zone.* A low density area (usually individual houses) that is not economic for DH and where gas heating is environmentally acceptable.

- *Competitive zone.* In an area where alternative heating methods are possible and reasonable, consumers should have the right to choose the heat supply method and supplier based on competition.

161. **At the national level, MOHURD (in coordination with appropriate other agencies) could issue "National DH Planning Guidelines"** consistent with national energy policies and targets, establishing the objectives and guiding principles that would apply to all city planners. Examples of considerations and objectives that could be included in the DH planning guidelines include:

- promote efficient CHP technology and use of cleaner fuels, according to availability and specific conditions in each city;

- promote municipal waste utilization plants for combined heat and electricity production (with appropriate consideration of solid waste management);

- prioritize usage of fuel types according to availability and national strategy; and
- establish targets for usage of renewable energy.

162. If suitable, the appropriate level institution could mandate specific targets for municipal heat planning, for example, in large cities production of heat from CHP plants to be greater than 60 percent, a targeted structure for fuel balance, a portion of renewable fuels (akin to renewable portfolio standards in the power sector), and the like. Under ideal conditions, this institution could be above the municipal level and could be the same as the one responsible for licensing of large systems and sector monitoring. Even if not possible, such targets could be set province-wide to ensure a degree of sector conformity under similar climactic, economic and other local conditions. Practically, such a system is hard to construct. Some possible ways to achieve similar ends could be:

- Involving DH planners in the urban planning system to incorporate DH considerations more upstream
- Establishing local integrated resource planning (i.e. local energy plans)
- Based on local energy plans, establish district heating plans
- Based on the DH plans, companies can lay out investment and business plans

163. Following the new "National DH Planning Guidelines," municipal heating plans would describe the expansion or upgrade of existing DH systems and new DH systems to develop an optimal and effective DH network. Measures that could be considered in the planning process include:

- Zoning the city for areas in which the only allowed heating method is DH;
- Establishing large DH transmission companies to hydraulically connect or connect through substations all small DH systems and all heat producers into a common network; and
- Increasing the area covered by existing and qualified DH providers.

Adherence to the municipal heating plan should continue to be mandatory for all DH providers. The municipal regulatory institution would be directly responsible for monitoring that the plan is implemented within its territory.

164. **Improve the quality of investment approval administration.** Municipal units (Heating Administration Offices—HAOs— or other similar units) undertake approval of investments based on the municipal heating plans and feasibility studies. Under the current institutional framework and cost-plus pricing regulation, municipal institutions responsible for the planning of heating supply should continue to review and approve investments in the DH sector, except for small investments up to a specified ceiling. The planning function, combined with the DH investment approval process, supports efforts not only to ensure heat supply security but also to

protect consumers from unreasonable costs resulting from over- or under-investment. Feasibility studies could play a greater role in the latter function. Feasibility studies could be required by approval agencies to look objectively at alternatives based on sound project economic and financial evaluation. Carbon intensity reducing alternatives could also be evaluated to align large DH investments with national initiatives to develop low carbon cities. In other countries, institutional issues including company management improvements are oftentimes included in feasibility studies. This is not the practice in China mainly because design institutes, whose strength is engineering design, dominate the DH feasibility study market. As DH reforms mature, consulting services for DH would also need to evolve. Training and promotion of such a broader range of consulting services to DH is suggested so as to develop modern, more comprehensive solutions to future issues in a reformed DH sector.

165. **Strengthen the consumer protection and complaint mechanisms.** One of the strongest tools for consumer protection is to put in place effective mechanisms to promote awareness of consumers' and DH providers' rights and responsibilities. This is important to manage customer expectations in terms of benefits of renovation, modernization, or adequate maintenance of DH systems, among others. The following are potential measures assist in providing general protection to heat consumers:

- *Dissemination of information* on DH in general, consumer rights, heat price-setting methods, payment options, and the like. This information can be provided through the internet, printed on heat bills, or presented individually, among other alternatives.

- *Formal rules* and a description of the relationship between DH providers and heat consumers should be developed. The rights and obligations of both parties should be formulated and made public.

166. To adequately manage consumer complaints, the obligations of the DH provider and consumers' rights could be clearly defined through the National District Heating Regulation. To operationalize the regulation, special units within the DH provider and the local level authority can be assigned to manage consumer complaints:

- DH providers can establish customer service centers with competent staff to deal with customers, provide requested information, and solve routine problems. A system for complaint registration would be useful for analysis and monitoring, and could include records of phone calls, specific forms, and the like. However, this level of service is often difficult for small companies to provide.

- A specialized department could be set up in a municipality to investigate complaints and provide social assistance and similar services to heat consumers.

167. With regard to consumer complaints, some general steps for managing them and associated disputes are described below:

- *Step 1.* The consumer files the complaint in the office of the DH provider. The DH provider

must respond within a specified time frame and make its best effort to resolve the complaint. The DH provider should supply information on DH consumers' rights and obligations when it accepts or denies the complaint. The DH provider's reporting should include number of complaints received, time until they were answered, and number of complaints successfully resolved.

- *Step 2.* If the parties fail to reach an agreement and resolve the complaint within the specified time, the DH provider (or the consumer) should transfer the complaint to the municipal department responsible for DH administrative control. The parties have the obligation and burden to prove their positions, which could be done as suggested below:
    - The consumer complaint should include, to the extent possible, a statement of facts and the consumer's rights and arguments justifying the claim, together with supporting documents that are available and any compensation requested.
    - The DH provider should provide the defense arguments and supporting documents. If the DH provider fails to support its defense, the consumer's complaint is considered valid and the dispute is resolved in favor of the consumer.
    - The municipal department should provide its decision within a specified time (number of days). Resolution may involve compensation payments, changes in processes, changes in management in the DH provider, and the like.
    - Reporting by the municipal agency to the provincial institution should include number of requests for dispute resolution received, time until response, and number of complaints successfully resolved.

168. **Dispute resolution needs to be clarified in the National Regulation.** Under the proposed system disputes would be handled at the municipal level, as they are now, with the intervention of the local government. It is important to note, though, that as heating is commoditized and the sector attracts a greater number and type of investors, the nature of disputes may change requiring additional skills and an effective system to resolve them. Experience from other countries shows that administrative courts have difficulties in assessing and resolving technical and commercial complaints. Therefore, a National District Heating Regulation needs to clarify the dispute resolution process following the steps described in the section above.

169. MOHURD could consider whether it is suitable to establish an appeals function at the central level or at the provincial level as a final decision maker. The possible steps for managing disputes between DH providers and municipalities are described below:

- If the parties fail to resolve the dispute at the municipal level within the specified time, the DH provider can transfer the dispute to a higher level institution (e.g. provincial).
- If one party fails to provide the supporting documents and justification, the dispute will be resolved in favor of the other party.

- The higher level institution should inform the parties of its decision within a specified time frame (number of days).
- Resolution of technical conflicts may require inspection of the physical facilities.
- If the parties agree with the dispute settlement, the process is complete. If the parties still disagree, they can proceed to the courts.

Reporting by the higher level institution assigned an appeal function should include the number of requests for dispute resolution received, time until response, and number of successful resolutions.

170. **Enhancing compliance monitoring and enforcement measures.** Incentives need to be created to promote compliance, thus reducing reliance and burden through close and detailed monitoring. The suggested monitoring process includes:

- Each DH provider collects data for and periodically reports on technical, economic, and other indicators, and fulfills other reporting obligations in a standard form. Reports are provided to the municipal administration unit (such as the HAO and pricing bureau) and the proposed provincial institution.
- As needed, the municipal or provincial institution can require a technical and economic audit of any licensed DH provider, subject to a maximum of one audit per year. The conclusions of the audit are presented to the municipality and to the provincial institution.
- The municipality uses the reported information and audits to monitor the DH provider's technical and management qualifications and its ongoing viability as well as its progress toward the implementation of municipal targets and other issues related to its territory and system.
- The provincial institution uses the reported information and audits to monitor the implementation of national targets and policies and to develop and report performance indicators, and perhaps later benchmarks, that include performance and tariffs of different cities and DH providers. The performance monditoring/benchmarking results and monitoring of national targets are reported to the national level and shared with municipalities and DH providers within the province. A summary of the evaluation of the DH provider could be presented to consumers as well.
- The national institution analyzes the reporting from the various provincial institutions to assess the status of existing policies and targets as well as to inform and initiate changes to the policies, targets, and institutional framework.

171. **Enforcement Measures.** If the municipality is the owner or has the authority to influence DH providers' performance and compliance (to be stipulated in the license), possible enforcement measures could include:

- participation on the board of DH providers;

- appointment and replacement of top managers;
- permissions for construction, renovations, and other capital undertakings;
- direct orders related to municipal infrastructure and its services;
- tenders for heat supply to new territories; and
- subsidies, donations, and other financial assistance.

172. However, because the administration of DH providers depends significantly on municipal involvement, the municipal institution may not be fully objective in its decisions or in enforcement. The many interests to be balanced within the municipality can make it difficult to make scientifically based, objective tradeoffs. Measures that could promote and ensure even-handed enforcement include:

- public disclosure of information about DH providers' noncompliance, and comparisons between different companies and municipalities;
- penalties on DH providers or, if owned by the municipality, removal of the DH provider's management;
- warning notice directing the DH provider to end the noncompliance;
- special sanctions on licensed DH providers for repeated noncompliance or noncompliance that causes significant impacts on consumers and heat supply security; and
- suspension or revocation of a DH provider's license, which requires replacement of the provider.

3.6 Enhancing Energy Efficiency

173. Perhaps the most important contribution district heating sector reform could make to energy efficiency is the introduction of consumption based billing, using a two-part heat tariff and ideally following incentive regulation. The lack of incentives for end-users and DH providers alike to reduce energy waste for heating significantly reduces impacts of administrative measures and other mandatory approaches. Consumption based billing would not only provide a price signal to end users, it would also move up the supply chain creating economic incentives to reduce energy waste throughout the district heating system.

174. MOHURD could consider whether to more strictly apply regulations listed in the Energy Conservation Law (ECL) to strengthen energy conservation management of key energy-consuming enterprises. Key energy-consuming enterprises are defined clearly in the ECL as those consuming more than 10,000 tons of coal equivalent (tce). Local administrations are allowed to also include enterprises consuming 5,000–10,000 tce. Many DH providers could fall under this category. Key energy-consuming enterprises are under a number of obligations that could promote greater

technical and managerial energy efficiency in DH, such as appointing qualified energy managers, implementing energy management systems, and the like.

175. DH providers could be required to advise customers on energy efficiency and potential savings, and this requirement could be included in the National District Heating Regulation. In turn, MOHURD could also consider supporting the existing energy conservation supervision and monitoring system to ensure relevant agencies have the necessary technical skills to optimize energy conservation measures in DH. In addition, red line issues can become barriers to technological innovation and energy efficiency. Local levels need to be aware that barriers to reforms and energy efficiency could come from a need to re-define normal ways of developing real estate and the infrastructure that serves it. An example regarding administrative obstacles to introducing advanced energy efficient technologies (Building Level Substations) is illustrated in Annex 3.

176. Although building energy efficiency (EE) is beyond the scope of this report, building energy efficiency is essential to an economic and efficient district heating sector. Reducing energy waste, together with consumption based billing, makes heating more affordable not only for those households which undertake the renovation but also for newly connected households. The DH company can release incremental capacity that is no longer needed due to reduced heat load and to some extent avoid costly upgrades to connect new consumers. As noted above, DH providers could be proactively supporting these efforts. However, asking them to participate financially in retrofits should be approached with caution, including for equity considerations. Alternative financing methods can be utilized outside the revenue streams of DH companies. In Lithuania a method allowed subsidies to be used to pay for low-income households' contributions to financing of the EE retrofit. Subsidy levels were held at pre-retrofit levels and the subsidy difference between actual consumption and pre-retrofit consumption, up to certain limits, was used to pay for the household's contribution. Once the household's financial obligation was fully paid, the subsidy was adjusted to reflect actual energy consumption.

177. Without implementation of consumption-based heat billing, homeowners gain no financial benefit from energy-efficiency retrofits. Some municipal authorities require that retrofitting be undertaken before consumption-based billing can proceed, arguing that it is unfair at this stage to saddle residents of older, particularly leaky apartments with higher heat bills. This impasse will likely slow down progress on consumption based billing. Government subsidies may, in principle, provide financial incentives to help overcome this problem, but if they are the only form of financial incentive to homeowners the levels of subsidy needed to foster the levels of organization and enthusiasm required for real success are likely to be exorbitant. Implementation of consumption-based billing and retrofitting might best be closely linked, with the former implemented first, and completed as a package within a reasonable time frame. However, this imposes greater requirements on the effectiveness of local organization.

178. Finally, (as in the metering section above) there is scope for heating companies to engage in demand side management measures through implementation of alternative metering and billing systems (i.e. building/staircase meter and heat cost allocators) or by signing contracts with property management or property ownership to maintain internal heating systems.

Annexes

Annex 1: Overview of the Current District Heating Institutional Framework

1. This annex summarizes the key aspects of district heating's current situation in China.[30] It is divided into sections based around key themes discussed with the counterpart as shown in the following table.

Key Themes of DH Reform	
Themes	Issues
Structure and administration of the district heating sector	- Ownership and management of rights to assets (property rights) - Licensing, permits, and franchise - Market entry and exit - Compliance and enforcement
Planning and development of district heating systems	- New connections - District heating planning - Approval of investments
Technical standards and service quality	- Design and technical standards - Quality of service - Monitoring and enforcement
Regulation and pricing	- Pricing methodologies and tariff setting - Metering - Billing, payment, and collection - Subsidies to heating providers - Managing historic debts
Energy efficiency	- Energy efficiency in buildings
Consumer protection and social assistance	- Managing consumers' complaints - Social support (subsidy) schemes - Dispute resolution

The institutional framework for the district heating (DH) sector is defined by

- the institutions which are responsible for policy; regulation and oversight; and ownership, investment, and management functions; and
- the regulatory approach, and the practices and arrangements for each function and activity involved in supplying DH.

30.Based on survey work conduced under the GEF-financed Heat Reform and Building Energy Efficiency Project.

Structure and Administration of the District Heating Sector

2. Sector Structure. District heating is developed in China's 15 northern provinces where heating is required by law and regulation. Typically, each municipality has numerous different DH providers, from small units to the big DH providers. In Beijing, for instance, there are nearly 2,800 different DH providers. Coal is king in the district heating sector, consuming about 145 million tons of raw coal in 2008, about 91 percent of total energy supply to the sector, followed by petroleum products (5 percent) and natural and other gas (about 4 percent).[31] Unlike district heating services in Western and Central/Eastern Europe, hot tap water is rarely supplied by district heating. Traditionally considered a luxury service, hot tap water is produced predominantly by electrical, gas and solar water heaters.[32]

3. DH providers in China can be grouped into three categories: (i) heating providers (companies) registered with the Industrial and Commercial Administration where shareholding and ownership varies (government, developers, private investors, enterprises); (ii) heating agencies under the ancillary departments of various institutions (i.e. a department in a large enterprise — or government—responsible for housing and related services for employees); and (iii) heating agencies of the nongovernmental developers, including real estate developers/property managers. Ownership of district heating assets is of different forms, spanning state-owned enterprises (for larger district heating companies in a city), limited liability shareholding companies, state property (in the case of some government employee housing, for example), private individual ownership, and including concessions/lease arrangements.

4. The typical case is that a building developer, or a group of building developers, constructs the building (or buildings) and the heating systems (external and internal pipelines, radiators or other heating elements, thermostats, meters, etc.) associated with those buildings. The low temperature heating pipelines supplying hot water for space heating to the buildings (the "secondary network") are connected to high temperature centralized district heating networks (the "primary network") at a substation. The substation typically serves a group of buildings (known as "group substations"). The primary network and group substations are usually constructed and operated by a district heating company, usually a first category provider. The secondary network, including internal building pipelines, is operated by a building property management company[33], a third category provider. Heat is usually supplied from heat-only boilers (HOBs) or from Combined Heat and Power Plants (CHPs). The HOBs and some CHPs are usually owned by the same district heating companies which own the primary network. CHPs are usually owned by power companies who sell heat to the primary network operator. Second category providers usually own and operate the entire district heating system but these are typically diminishing in number. There are exceptions to all of the cases above: HOBs may be owned separately from primary networks; district heating companies may have taken over operation and/or ownership of secondary networks; some group

31. State Statistics Bureau, 2010.

32. China is a world's leader in the use of solar water heaters for hot tap water production.

33. Building developers usually 'hand over' building maintenance to property management companies after commissioning and substantial sale of the apartments. The property management companies may or may not be affiliated to the developer.

substations are constructed by real estate developers and operated by the property management companies. In some cities, such as Tangshan and Jilin, the DH providers operate and maintain the whole DH system, including the secondary network. Consumer installations typically belong to the property owner Ownership is addressed in more detail in the next section of this report.

5. Although the district heating market is not a competitive market in northern China, in some cities natural gas supply networks have been established in existing DH service areas. In the commercial heating market, consumers such as hotels and shopping malls can also use electrical heating, ventilation, and air conditioning (HVAC) systems. Several regulations and standards must be followed in HVAC applications in civil public buildings (hotels, shopping malls, and the like). HVAC systems are allowed in China only if certain energy-efficiency and energy-conservation conditions are fulfilled, such as in the case of ground source heat pumps.[34] Geothermal district heating is also used where resources are available, such as in Tianjin and Xian municipalities.

6. Under the current DH setup, quality of service and operational efficiency vary widely, depending significantly on the size and corporate form of the DH providers. The DH providers registered with the Industrial and Commercial Administration Bureau usually operate on a higher professional level, and their operational efficiency and service quality typically are better than that of small DH providers, including operators of secondary networks. Typical problems of the small DH providers, especially those in the second and third categories, are unprofessional operations not run according to commercial principles, low levels of investment planning and lack of investment, high operation and maintenance costs, low efficiency, and a lack of awareness of environmental issues and energy efficiency issues. Although many DH providers are well aware of environmental impacts and the potential of energy-efficiency improvements, they either do not have incentives to make those improvements or do not have information on best technologies and design approaches.

7. **Consolidation.** As part of the ongoing heating sector reform, the consolidation process of DH providers began gradually several years ago and continues today. Although it has many economic and energy efficiency advantages, consolidation is largely driven by local environmental concerns—typically, district heating systems were built step by step following heat demand growth, driven by China's rapid urbanization. As cities grew, heating plants became surrounded by higher population densities, increasing population exposures to related air, noise and other pollution caused by the heating plants. Technologies and approaches to district heating also changed, increasing capabilities for longer networks and lower emissions. Thus, most consolidation in the sector involves the reduction in the number of small boiler and primary network operators. Integration of the management and operation of primary and secondary networks has not been a large part of the consolidation trend. Currently, use of CHP for base heat load with peaking HOBs in a large primary network is a popular new approach.

8. **Administration.** DH is considered a monopoly by Chinese authorities and sector policy formation, regulation, governance and support programs are organized and implemented through

34. The most important regulations defining these conditions are "Regulations on Energy Conservation in Civil Buildings" issued by the State Council effective October 1, 2008, and "Design Standard for Energy Efficiency of Public Buildings" issued by the Ministry of Construction (effective July 1, 2005).

Box: A1 World Bank Support for DH Consolidation in Liaoning

In 2008 the World Bank extended a $191 million loan to six medium sized cities in Liaoning province to construct and rehabilitate their district heating systems. This supported the cities' plan to replace use of of 317 small, polluting boiler plants with a capacity totaling 2,693 MWth capacity.

This offered an opportunity to also promote district heating reform by (i) installing variable flow for both primary and secondary networks so the DH system respond more efficiently to end-use controls, like thermostats; (ii) establishing a metering regime across the heating chain (at boiler plants and substations); and (iii) piloting technical approaches in network design through use of about150 building level substations and installing building level meters in pilot areas. Technical Assistance is planned to analyze meter data to prepare better forecasts of heat demand, a key input for setting two-part heat tariffs, and to identify areas to reduce energy waste in the network. Liaoning and its participating utilities agreed to measure energy consumption, water consumption, SO2 and Dust emissions (per connected floor area) as key project success indicators. The combination of these features will greatly enhance the ability of the participating utilities to implement downstream reforms, including consumption based billing.

Source: World Bank Project Appraisal Document "Liaoning Third Medium Cities Infrastructure Project", April 21, 2008, Report Nr. 42393 and Team contributions.

Box: A2 China's Multi-level Government Structure

All of China's provincial governments (including province-ranked municipalities and autonomous regions) report directly to China's State Council, the government's highest executive body. Central government ministries, commissions, and bureaus also report to the State Council. Ministers and provincial governors are of equal rank. The basic setup is repeated within provincial governments: Prefecture directors report to the provincial governor, as do provincial-level departments, commissions, and bureaus. The setup is further repeated yet one further level, whereby directors of China's more than 4,900 counties report to prefecture directors, as do prefecture-level departments, commissions and bureaus.

Source: Accelerating Energy Conservation in China's Provinces (World Bank, June 2010)

China's top-to-bottom government administration. While the State Council and many ministries and agencies influence the sector at various levels, at the national level, the Ministry of Housing and Urban-Rural Development (MOHURD)[35] and the National Development and Reform Commission (NDRC) are the main line ministries broadly responsible for the development of the DH sector. Other ministries also influence sector development, including the Ministry of Finance and the Ministry of Environmental Protection, which sets emissions standards. The main functions of MOHURD are to (i) to formulate the principles of city planning, municipal utilities' development

35.MOHURD replaced the Ministry of Construction in 2008

strategies, medium- and long-term development plans, and general implementation of the sector's administration; (ii) to formulate the national engineering construction standards and supervise and guide implementation; and (iii) to provide guidance for urban and suburban development; and to formulate policy reforms for urban water saving and for gas and heating supply.

Box: A3 Responsibilities of the Municipal HAOs

Beijing. The Beijing Municipal HAO is a professional office subordinated to the Beijing Municipal Administration Commission. Its responsibilities are the following:

- administering the heating industry in Beijing;
- researching and compiling local policies and regulations on the DH sector;
- developing, organizing, and implementing heating programs and annual plans;
- reviewing and approving feasibility studies; and
- approving the construction of heating projects.a

Tianjin. Responsibilities of the Tianjin Municipal HAO:

- administering and supervising the municipal heating industry;
- compiling the special heating development programs and the annual construction plan;
- administering franchising and market entry;
- formulating service quality standards for the heating industry; and
- promoting the reform of heating institutions.

Dezhou. Responsibilities of the Dezhou Municipal HAO:

- ensuring the development of the detailed municipal heating plan and the annual professional development plan;
- licensing DH providers;
- evaluating service quality;
- collaborating with the Municipal Pricing Bureau on the definition of municipal heating tariffs, subsidies, service fees, and related economic policies and control measures; and
- implementing, supervising, and inspecting measures in the DH sector.

Note: In fact, the feasibility study, review, and approval of heating projects are under the jurisdiction of the Beijing Municipal DRC. The Beijing Municipal Administration Commission only participates in the process. The final acceptance of the construction design is under the jurisdiction of the Engineering Quality Supervision Office of the Municipal Construction Commission. It is responsible for setting up standards and codes for the DH sector (in the areas of technology, operation, management, and service), and for supervising and inspecting the safety management of DH providers.

Source: MOHURD Consultants' Survey Report.

9. The NDRC[36] is involved in heat pricing policy formulation in coordination with MOHURD, and setting energy policy (also through the National Energy Administration), especially the energy efficiency and renewable energy policy directions and the programs that support them and influence the development of the DH sector. In practice, cities regulate and administer the DH sector. Provincial level agencies do not play an active role and usually staffing for DH tasks is located at the city level. In the cities, the main government agencies involved in DH are the Heating Administrative Office usually under the Construction Commission (See Box A3), the Infrastructure Construction Department of the Development and Reform Commission and the Pricing Bureaus, usually under the Development and Reform Commissions.

10. Interviews of various stakeholders suggest that regulation guided mostly by local conditions has not achieved harmonized, efficient modernization of the DH sector across China. The central government has issued a number of regulations and guidelines for functions in the DH sector, such as planning, pricing including consumption-based billing, and a franchise system for entering the sector. However, many studies and surveys show that implementation varies among cities. For instance, the franchising system is implemented in different ways, the percentage of consumption-based billing is very low, and pilot programs have also made little progress, partly because they are still in a learning mode using a trial-and-error approach. Some provinces have issued regulations on management methods for the heating sector tailored to local conditions. Despite these efforts to harmonize at the provincial level, each province has a different approach, generally not fully harmonized with national policies and guidelines or regulations. This is due also to the general lack of capacity at the provincial level administrations and tradition of regulating and managing district heating services at the municipal levels. Municipalities sometimes may also be too closely involved in operations and commercial functions to be able to balance the interests of investors and consumers independently of pressure from interest groups. While DH networks are by definition restricted to specific cities or city districts and thus city-level oversight is critical, day to day oversight functions do not necessarily require that regulatory functions be concentrated at the municipality level, nor does the important role cities play in sector development confer to each city the right to implement different regulatory approaches.

Ownership and Management Rights

11. **Types of Ownership.** Given the particularities in China, it is important to clarify the difference between ownership and linkages to management rights and responsibilities, although in practice the expression "ownership" is usually used for both concepts in China. Unless specified otherwise, this section uses the expression ownership both when it refers to legal ownership and when it refers to possession. According to the Chinese Property Rights Law the definition of legal ownership and possession is the following:[37]

36. The main functions of the NDRC are as follows: (i) to formulate and implement the strategies for national economic and social development, including annual plans and medium- and long-term development plans; (ii) to study and analyze the economic situation and economic development, both at home and abroad, and provide macroeconomic forecasts; (iii) to summarize and analyze the country's fiscal and financial situation, and to participate in the formulation of fiscal and monetary policy; (iv) to study major issues concerning the restructuring of economic systems and opening up to the outside world, and to guide and promote overall economic system restructuring; and (v) to recommend the fixed assets investment and to prepare plans for key projects.

37. The Chinese Property Rights Law of 2007 also distinguishes between the two terms.

- Legal ownership includes the exclusive right (conferred by a lawful claim or title, and subject to certain restrictions) to occupy, possess, rent, sell, and use an item of property. In principle, this definition applies to DH assets that have been invested in by municipalities or commercial investors. The municipality or commercial investor remains the legal owner of the assets, even if a different DH provider operates the assets and thereby becomes the possessor.

- A person has possession of a property or assets if the person has physical control of the property or assets, or has the power and intention to control the property or assets. This is usually the case when a DH provider operates assets and sells heat using assets that are legally owned by the municipality. Possession can be obtained in different ways, for example, by actual use and custom or by a particular contract. In this case, DH providers are typically not allowed to sell or destroy any asset without prior consent of the legal owner.

12. The difference between possession and legal ownership has important consequences for management of DH facilities (boilers, pipes, substations, and the like). A legal owner of assets can delegate powers to other entities, can lease the assets or delegate their management, and can even sell the property. In the DH sector, the local government can be the legal owner of the assets and can delegate management rights and other responsibilities to DH providers. In such cases, the DH provider becomes, by delegation, the possessor of the assets. The possession right is linked to the obligation to operate and maintain the assets, the right to prepare and collect bills, and other responsibilities. In contrast to the legal owner, the possessor is not allowed to sell the assets, and even the right to purchase new assets might be restricted. For the purpose of financial management and tariff setting, the possessor can be allowed to report the assets in financial statements and to include the corresponding depreciation charges, even though the provider does not have legal ownership of those assets.

13. Except for assets inside buildings, and the secondary networks in most new residential buildings, most assets in the DH system in China are owned by the government or by state-owned enterprises. However, private investment has grown in some cities, and ownership of DH assets varies widely across cities. Some provinces have opened their DH markets to private investors, and in Changchun and Jilin it is reported the private sector accounts for up to 60 percent of the DH market.

14. If the DH assets are operated by a DH provider but owned by the municipality, the options for asset management are:

- *Concession.* The DH provider operates the DH business as if owning the assets but does not have the right to sell or decommission the assets. Depreciation charges are included in the financial statements of the DH provider and accepted as justified costs in tariff setting. The issue of the municipality requesting a concession fee from the DH provider is not in itself important. From the perspective of consumer interest, the payment of a concession fee would increase the provider's costs and justified tariffs.

- *Operating Lease.* The DH provider uses the assets for daily operations. Depreciation of the assets is not reported on the books of the DH provider. Therefore, the DH provider should pay an operating lease fee covering depreciation, at a minimum, to provide financial resources for the legal owner (the municipality) to replace the assets under normal wear and tear. The lease fee should be accepted as a justified cost in setting the tariffs.

15. Different types of ownership apply to combined heat and power (CHP) plants and to DH systems (consisting of HOBs, the primary urban heating network, substations, the secondary network, and indoor equipment):

- *Heat production by power generation.* CHP plants are typically owned by electricity-generating companies and industrial enterprises that deliver and sell all or some part of the heat produced during electricity generation (usually hot water) to the local DH system. Major CHP plants are owned by the power generation companies, and smaller CHPs may belong to the municipal heating companies. However, some DH providers own CHPs (all the heat supplied by a CHP plant is not necessarily produced in proper CHP mode.) Heat can also come from hot water boilers installed in the CHP plant or from hot water produced by steam extracted from the steam boiler before entering the turbine.

- *HOBs* and transmission networks are typically owned by local DH companies. However, in some cases heat can also be supplied by boilers owned by an industrial enterprise.

- *Heat distribution networks.* Primary networks are owned by DH providers, although in some new areas primary networks may be developed by electricity generators that own CHP plants. Secondary networks can either be owned by the DH provider or by the building owner (or developer). There have been difficulties in determining the ownership of indoor heating facilities, both for those installed in common areas (such as staircases) and those installed in privately owned apartments. In many cities, DH providers are responsible for operation and maintenance of those secondary facilities and the costs are recovered though a charge included in the pricing. This situation seems to support the assumption that DH providers are also the legal owners of these facilities.

16. Despite the different types of ownership, DH in China faces difficulties in determining ownership and this is consistently raised as an issue needed to be clarified in the sector.

17. **Allocation of Management Rights.** Management rights and responsibilities appear to be independent of ownership. Similar to ownership rights, management rights of DH providers in China are restricted. Strategic and other important investment decisions that affect costs and revenue requirements are made by government agencies:

- Investment proposals by DH companies are reviewed and approved by the local government.

- Investment decisions are the result of plans prepared by the heating office of the local government.

18. The management rights and responsibilities of DH providers in China are limited to operations, maintenance, billing and payment collection, and the internal organization of the provider. Heating planning and investment approval are the responsibility of central and local governmental entities, and DH providers are obliged to follow the government's plans.

Licenses, Permissions, and Franchises

19. **Licensing** is a tool ensuring that the licensed company has the business, management and technical qualifications, and to enable government entities or regulators to access the company data. In DH, security of the heating supply is protected by relevant government entity monitoring of investment, maintenance, and quality of service. Licenses are based on local regulations.

20. DH providers are granted an administrative operating license (or permits or authorizations to operate) to operate existing systems as well as to construct new systems on the condition they follow specified obligations and requirements. This licensing is similar to what is internationally understood as operating licenses.[38] These administrative operating licenses are required, except for those cases where the heat is supplied by the units themselves. The administrative operating license (or permits or permission, as different expressions are used) is usually granted by the local Heating Administration Offices (HAOs) within the Municipal Construction Commissions. The HAOs also evaluate the DH providers annually to decide whether to renew or revoke the administrative operating license.

21. Currently, China has no national-level operating licensing regulation. Issuing of the licenses in the Chinese DH sector was regulated by the Ministry of Construction's (MOC's) Directive No. 51 of July 1, 1996, entitled "Administrative Regulation on Qualifications of Urban Fuel Gas & District Heating Enterprises." The specific qualification requirements DH providers had to meet to attain licensing were detailed in an annex to the regulation and covered technical standards, safety, and capacity building to ensure qualified personnel. The MOHURD (then MOC) annulled Directive No. 51 with its Directive No. 127 of June 29, 2004. No successor policy was unveiled to replace Directive No. 51 for the qualification of DH providers to be licensed to operate, and since that time there has been no country-level licensing regulation.

22. In the last few years a number of local heating regulations have been issued at the provincial level. These regulations include qualification requirements for the licensing of DH providers. For instance, Article 3 of the "Administrative Measure for Heating Operations in Shandong Province" (effective March 1, 2006) stipulates that DH providers must obtain heating operation licenses issued by the competent governing authority at the provincial or municipal level. The "Heating Regulation of Yinchuan City, Ningxia Autonomous Region" (effective September 1, 2005) also stipulates in Article 6 that competent government agencies must choose heating companies that have obtained heating qualifications before the municipal heating project can be implemented. Thus, any new DH project can be implemented only by a company that has fulfilled the qualification requirements and has obtained a license to operate by the provincial authorities.

38.Operating licenses are different from internationally used regulatory licenses as described later in this paper.

23. When licensing for the registration and operation of DH Companies at the local level, an administrative operating license is needed, but use and role of licensing varies widely among the different municipalities. For instance, Beijing has not yet adopted regulations for the licensing of its DH providers. Tianjin has prepared, but not yet implemented, detailed requirements for managing qualification of heating providers.

24. Thus, administrative operational licenses and permits are not uniform and do not appear to specifically list homogeneous conditions, obligations, and requirements. A national licensing standard could establish the basic framework and principles, with detailed regulations tailored to local conditions.

25. **Franchising** has been developed as the mechanism to promote competition for the right to operate in a specific DH area. Franchising has been developed through a number of regulations. In April 2004, the MOC issued the "Management Measures on Franchise of Urban Utilities." The document encourages private and foreign enterprises to operate urban public utilities under a franchising system. MOHURD regulations open almost all urban utility services to franchising, including heating supply. Under these regulations, the municipal government would grant the franchise based on the market principles of transparency and fairness and through competitive methods such as public bidding and tenders.

26. In Beijing, Tianjin, and Xinjiang province, detailed regulations have been issued on granting franchises for municipal public utilities. These regulations stipulate that, for new heating systems, franchises are authorized through tenders or 'recruited'. Heating franchise contracts or certificates assign franchise areas. The regulations allow for franchises to be granted directly to qualified companies or temporarily to unqualified operators. Although the franchising mechanism has been used in China mainly for competitive entry, there have been concerns on awarding franchises to firms without adequate qualifications.

Market Entry and Exit

27. In China, market entry and exit is a challenge because the market is growing while at the same time the central government has clearly indicated a need for consolidation. In Beijing, for example, there are over 2,700 DH providers. Some national guidance on concessions has been provided and some provincial and municipal governments have issued additional market entry rules. Market entry and exit tools include the issuance of administrative operating licenses, by which provincial and/or municipal authorities grant that a DH provider has the established qualifications. Some cities and provinces, for example, Shandong, Hebei, and Liaoning provinces, have issued market entry regulations. However, the nature and comprehensiveness of the rules varies significantly and in practice incumbency is reported to be an important determinant in gaining market access.

28. Other market entry mechanisms used in China include municipal tender for new heating areas. A municipality may want to tender a new area to be covered by district heating to interested and qualified DH providers. The tender usually involves the granting of the administrative operating license and franchise area.

29. Market access is a critical component of DH reform. However, the various and different license qualifications existing at the provincial and municipal level may hinder market entry and exit. For example, yearly review of licensing requirements, currently not required, is crucial for renewing or revoking it. Provision of a national guidance on licensing, concessions and franchising may be required to improve a clear level field for market entry and exit of DH providers.

30. **Consolidation approaches.** A significant challenge in China is the consolidation of large numbers of small DH providers into larger scale commercial companies that can ensure supply security at the required quality of service and technical standards, and can develop and implement efficient and modern management practices. Several cities in China have used a combination of administrative measures to consolidate small operators, usually to comply with stricter environmental standards. For example, consolidation in two of Urumqi's districts (Shayibake and Shuimogou) totaling 14.74 million m^2 of heating floor area, supported with a $100 million World Bank Loan, predicts a savings of about 187,000 tons of coal equivalent annually with an increase in total system efficiency to 72% from 58%.[39] Municipalities have initiated direct negotiations with small operators to take over assets and franchises and much experience has been gained. Options they have considered to drive the necessary increases in scale include the following:

- Issue new environmental regulations and require DH providers to maintain their compliance or lose their administrative license. This can be also combined with a targeting of DH providers which do not have a license (i.e. enterprises that have set up boilers to provide heating to apartments of workers).
- Establish heat transmission companies to interconnect small DH networks and create bigger DH systems.
- Entry to new territories is allocated to neighboring DH providers to increase their scale.

31. In some cities, like Beijing, Harbin, Dezhou, and Tianjin, the consolidation has been implemented through mergers of the existing DH providers. In some cities, such as Shenyang, small HOBs have been closed and their service areas have been absorbed into existing larger networks. Special plans were drawn to help optimize the system and integrate heat resources, usually involving construction of large scale heating sources that replace small, polluting boiler houses. In Shenyang, several years ago, it took three years to remove 1,200 heating plants, reducing the number of heating enterprises to 410 from 1,062, and increasing the share of central heating supplied to buildings in the city to 80% from 55%.[40] However, other than environmental benefits, there is no detailed information publicly available about the economic or administrative considerations taken into account in formation of consolidation plans.

32. Consolidation of existing DH providers opens up the opportunity for technological change by engaging larger producers to enter the market. In particular CHP systems where feasible are candidates for introducing economies of scale, together with improved technical systems and

39. Project Appraisal Document, *Uruqmi District Heating Project,* Report #60014-CN.

40. Center of Science and Technology of Construction, World Bank *Study on Chinese Heating Sector Regulation and Heating Law* (Scoping Report), 2006.

more efficient facilities. CHP technologies present a particular problem of cost estimation, which requires differentiating between power production and heat production in order to allocate costs which ultimately will be reflected in tariffs. Annex 4 provides an illustration of a methodology for addressing the problem.

33. Economic and carbon intensity reduction objectives may also open doors to alternatives to district heating such as distributed generation. Distributed generation is enabled through penetration of natural gas networks, through use of electricity/geothermal heat pumps, and others. The pricing of externalities, such as local air pollution costs and possibly future carbon taxes may significantly change the economics of district heating. Box A5 below illustrates the current advantages and disadvantages of district heating compared to alternatives, under certain assumptions of costs and technical efficiencies.

Planning and Development of District Heating Systems

34. These activities are the responsibility of municipalities, which determine to a large extent how DH systems develop, including consumer connections and investments

35. **New Connections in Existing and New DH networks.** Based on the Urban Development Plan, the HAOs develop plans for the DH networks, whether existing or new. Within existing heating supply service areas, DH providers can connect new customers provided heating supply

Box: A.4 Consolidation of Urumqi District Heating Sector, 2010-Ongoing

Due to traditional design approaches and low environmental standards enforcement, space heating (supplied about six months in the year) is estimated to contribute 16% of annual average concentrations of SO2 and 8% of PM10 and NOx respectively in Urumqi city. Urumqi city is promoting expanded use of Combined Heat and Power Plants and larger district heating networks as part of its overall plan to reduce air pollution dramatically and also reduce the energy and carbon intensity of the city.

To do so, it has banned the production of independent heat only boiler supplied district heating in a large part of the city and identified zones for gas supplied heating where district heating is not feasible. The Urumqi District Heating Company, the main state-owned municipal heating enterprise, is identified as the operator of the expanded and consolidated primary network.

The circulars (UMG Administrative Regulation # [2010] 127 and Urumqi Heating Guideline # [2010] 043) establishing this program contain, generally, four options offered to the companies possessing the boilers:

i. Boilers or the entire company will be purchased by the Urumqi District Heating Company (UDHC) and their staff will be hired by the UDHC. It will be a commercial transaction.

ii. The boiler companies will stop their business. The Urumqi Municipality will purchase their assets and their staff will be transferred to the UDHC (current estimate is 4 in UHN) that will close the boilers and install substations.

iii. Boilers will be closed and the companies will become distribution companies (DISCOs), purchasing heat from the UDHC instead of generating heat from their own boilers.

iv. For small boilers held by companies whose core business is not district heating (i.e. that are not licensed to provide heat services to the general public and that produce heat only for their own staff), the boilers will be closed and UDHC will install heat exchange stations in these locations and provide heat to these staff.

In the latter two cases, the municipal circular contains: (a) a mandate that the companies close down their small boilers and leave space for the installation of the heat exchange stations; and (b) allows them to keep their land and change the zoning.

The city also has in place a policy to re-employ and/or retrain both permanent and seasonal workforce affected by the small boiler closure program.

Source: Authors.

Box: A5 Comparison of Heat Pumps, Heat Only Boilers and CHP

The following is an illustrative example using figures from documents for the preparation of a DH modernization project.

Heat Pumps (Baseline)—in the baseline scenario, 2,376 MW of peak load heating is used for a period of 1,200 hours per year. The emission coefficient for coal is selected to represent a typical and rounded value, 320 g/kWh of coal. Electricity generation is assumed to take place with coal in large condensing power plants, in which the fuel-to-power ratio is assumed to be 3, and where there is CHP.

Heat-only-boiler case—as the alternative to the heat pumps, the large heat-only-boilers using coal as fuel and district heating network would provide the same amount of heat energy to the customers as the heat pumps, taking into account network losses and the boiler efficiency.

CHP case—the CHP and district heating system firing local coal was simplified to assume it is the sole source of heating in the community. The electric power of CHP generation is assumed to be 60 percent of the CHP generated heat.

The table below summarizes the estimates of CO_2 emissions of the baseline and both alternative options.

Options	CO_2 emission per year	
	('000 tonnes)	
Heat pumps	2580	
Heat-only-boilers with DH	2855	11 %
CHP with DH	1770	-31 %

Therefore, in the short term, the heat-pump base case is more environmentally competitive to the heat-only-boiler option. However, heat-only-boilers offer an opportunity to develop the

heating systems towards CHP option, which is superior in general terms. CHP allows the most optimal use of fuel, including renewable fuel such as biomass and biogas, compared to any other technology, especially given its high efficiency of 90-94 percent. However, the application of CHP plants is limited to only regions/areas with existing heating loads (e.g. district heating network or industrial steam consumption).

Source: Arto Nuorkivi, World Bank Consultant, 2010; also see Sustainable Low Carbon Cities in China (World Bank 2012)

capacity is sufficient and the connections are in compliance with the plan. The case is different for new connections that require the heating system to be extended and for the connection of new construction areas or buildings. The local government decides which DH provider will operate the DH system under those circumstances. The layout and design of the heating system have to be approved by a competent body of the local government (for example, the Heat Management Office in Tianjin).

36. **District Heating Planning** National guidelines for DH planning do not exist in China. Municipal heating plans are managed and overseen by the Municipal Planning Bureaus directly subordinated to the Mayors. Municipal heating plans are prepared and updated every five years by the Municipal HAOs in coordination with the Municipal Planning Bureaus, and then submitted to the Municipal Administration Commissions for approval.

37. The criteria for planning new heating areas are the density of the population and compatibility with the urban master plan. The DH providers prepare their development plans based on the municipal heating plans and their updates. The experience of heating planning in some cities shows that it is sometimes difficult to harmonize heating planning into the city master plan because of the different authorities involved in the planning process.

38. Some cities, such as Tianjin, Shenyang, and Harbin, for example, have prepared special heating plans to improve the integration and optimization of heating resources, in keeping with the policy of the centralized heating supply providing the major portion of demand, and using alternative systems to supplement the centralized system. Other cities are preparing similar plans (see box A6).

39. For district heating planning to be a tool that guides improvements in efficiency and leads to least-cost optimization within the city plans, it is important to ensure that the planning process: (i) integrates the heating plan with the municipal master plan; and (ii) comprehensively integrates considerations of environmental impact, energy security, and resource conservation in the planning criteria and assessment. In addition, planning can be strengthened by taking into account consumer preferences and feedback. Examples of such feedback can be found in Annex 1 (results of a quality of services survey in Liaoning Province[41]) and of how to systematically collect such feedback can be found in Annex 2 (benchmarking).

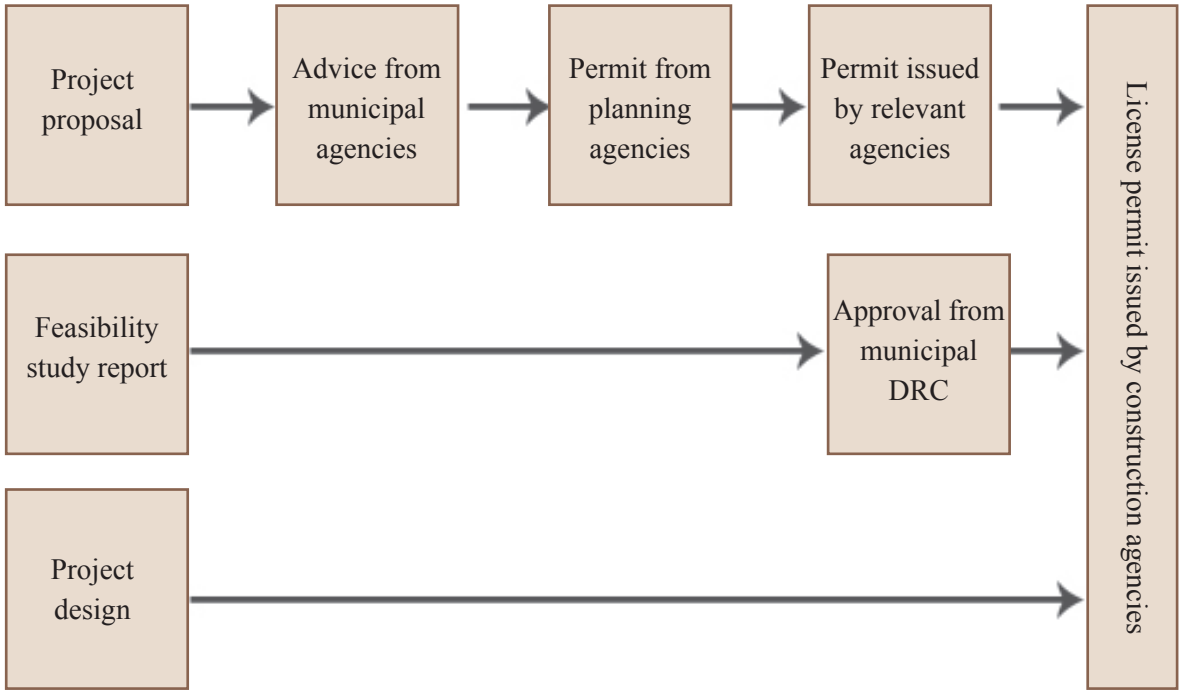
41.See also, Draugelis, G., *Social Analysis of Heating Reforms in Liaoning Province* (World Bank: November 2009)

Box: A6 Heating Plan in Beijing

In February 2007, the Beijing Municipal Administration Commission and the Beijing Municipal Development and Reform Commission jointly released the "Beijing Heat Development Plan for the 11th Five-Year Plan," which proposed to build an "economic, safe, clean, and highly efficient" municipal heat supply system. This plan promotes the development of the municipal heating industry, the implementation of key energy conservation measures and technologies, the transformation of heating systems, the replacement of old pipes, the integration of heating resources, and heat metering.

40. **Approval of Investments.** DH providers must propose DH project investments that have been specified in the municipal heating plans. The DH project is submitted to the Municipal Planning Bureaus for review and approval. The normal application procedure for DH projects is illustrated in Figure A.1.

Figure A.1: Application Procedure for DH Projects



41. In many cities, the HAO under the Construction Commission undertakes approval of investments together with the local Development and Reform Commission and only those DH investment programs approved by the relevant municipal institution can access special financing funds to support modernization and efficiency improvements, if these are available. However, in practice the current investment preparation process, guided by national guidelines for feasibility studies, leaves limited flexibility to objectively evaluate technically feasible alternatives..

Technical Standards and Service Quality

42. **Design and Technical Standards.** Currently, national technical standards apply mostly to design and operation. The Engineering Quality Supervision Office under the Municipal Construction Commission is usually responsible for establishing additional standards and codes for the DH sector at the municipal level (in the areas of technology, operation, management, and service).

43. **Quality of Service.** Municipal governments determine the start and end dates for the heating season. The basic requirement for service quality is defined by the MOHURD by the lowest permissible indoor temperature, which is set at 16°C for heated buildings (this standard may need to be revised if consumers are allowed to control heat as the DH provider cannot guarantee an indoor temperature if the consumer controls the thermostatic valve at the radiator.)

44. There are no commercial service, productivity, and efficiency indicators. Such service indicators could comprise collection rates, indebtedness, heating supply per employee, overall efficiency of heating supply, number and duration of service interruptions, and the like. Performance indicators could be used as targets for the DH providers to achieve within a certain time.

45. Municipalities in China have administrative powers over DH providers to monitor and ensure quality of service. In the DH sector, quality of service standards typically include a minimum heat temperature covered by a flat rate tariff not dependent on consumption or period of heating season. Quality of service standards are likely to evolve in China and will increasingly cover a broader range of performance measures especially as the regulated DH industry moves towards performance-based regulation.

46. **Monitoring and Enforcement of Heating Supply Quality and Standards Monitoring of service quality.** The local HAO monitors and inspects local heating quality. In Beijing, the HAO is subordinated to the Beijing Municipal Administration Committee, and Municipal Governing Committees of districts are responsible for the supervision and inspection of heating supply quality. In Tianjin, the HAO is responsible for the supervision and inspection of heating supply quality. In Dezhou, the Public Utilities Board and its subordinated unit, the Heating Administration Agency, manage the supervision and inspection of heating supply quality.

47. Various entities (subordinated to local governments) are responsible for monitoring compliance and for enforcement. However, an institutional framework is only effective if standard indicators and procedures for monitoring compliance and for enforcing adherence to the established standards are clearly and comprehensively defined.

48. **Monitoring Technical and Design Standards.** Monitoring compliance with technical and design standards is either the responsibility of the same body that approves layouts and investments (as in Tianjin) or by a different body of the local government. Under a special instruction from the MOC, Beijing formed the Department of Quality Supervision and the Inspection Center for Heating Companies at the China Academy of Building Research. Supervision of construction quality and

safety management is the responsibility of the Engineering Quality Supervision Office under the Municipal Construction Commission.

49. **Monitoring Quality of Service.** Municipal HAOs are usually responsible for supervising and inspecting service quality. When service quality is evaluated as poor, the HAO has to report to higher level administrations (Municipal Public Utility Bureaus, Municipal Construction Commissions, Municipal Administration Commissions, and the like), for example,

- Beijing—Municipal HAO subordinated to the Municipal Administration Commission;
- Tianjin—Municipal HAO subordinated to the Tianjin Urban Construction Commission; and
- Dezhou—Municipal HAO subordinated to the Municipal Public Utility Bureau.

50. **DH Association.** The function of the Chinese Urban Heating Sector Association is to introduce governmental policy to heating companies; disseminate information, technologies, and experiences among companies; and support the government in establishing standards for the heating sector.

Dispute Resolution and Managing Consumers' Complaints

51. The MOHURD establishes the general principles for dispute resolution between municipal heating suppliers and municipal administration agencies. Ultimately disputes are settled at the local government level and the ultimate arbiter is the municipal executive.

52. Managing consumer complaints has improved through local level regulations that protect the rights of suppliers and consumers. Municipal Heat Regulations (or Administrative Practices/ Guidelines) were issued in Tianjin, Jilin, Heilongjiang, Liaoning, Shandong, Hebei, and Xinjiang. These regulations strengthen the responsibility of municipal governments to protect the rights of suppliers and consumers. Tianjin has opened customer service centers to address complaints. However, this customer-oriented approach is implemented unevenly.

Economic Regulation and Heat Pricing

53. In China, municipalities have the necessary authority to regulate and to a great extent directly influence operations and management of DH providers. Departments of municipalities (Heat Administration Offices, Public Utilities Bureaus, and the like) issue construction permits, appoint the top management of DH providers that are state-owned enterprises or majority state-owned stock companies, issue operating licenses (permits), award franchises, protect the environment, and resolve disputes. Municipalities are also responsible for tariff and price setting, and therefore the economic viability of DH providers, including providing subsidies from municipal budgets. Balancing all these interests, and sometimes-conflicting issues, with the interests of heat consumers is difficult.

54. Municipal pricing bureaus are responsible for setting tariffs to apply to heating consumers. Although investment plans are not autonomously made by DH providers and good international

practice calls for regulated tariffs to allow the recovery of investment costs imposed on the regulated company, DH tariff setting in China is disconnected from the full costs of the approved investment plan.

55. This arrangement means that essential district heating management decisions that affect costs, performance, and financial viability are made externally, outside the DH utilities' organization. In the competitive DH markets in Western Europe, such decisions are usually made by company management, within conditions established under the powers of the municipalities (such as granting rights of way, which allows the city government to decide where pipes can be installed).

56. Is this distribution of rights and responsibilities reasonable? Authority for many decisions remains in the hands of the local government. Municipalities have the right to plan their local DH systems according to their urban development plans, and wield significant control over the activities of the DH provider. Therefore, in principle the DH provider should not be made to be fully responsible for the consequences of these decisions over which it has no control. A commercially run DH provider would base decisions to invest and expand its network on the financial impact (profit and financial viability). However, for the local government, financial viability may not be a priority because its most important objective is to promote the economic development of the city and security of heating supply, a vital service in cold-climate regions. While addressing affordability separately through targeted social heating assistance, a tariff methodology, applied in an even-handed way, which allows for recovery of planned investments (optimized) could greatly help to achieve both objectives of optimized investments as well as of financial viability of DH providers while achieving economic development objectives. Chapter 3 covers options for developing this in more detail.

57. **Pricing Methodologies and Tariff Setting.** The NDRC sets the heating pricing guidelines at the national level. In principle, DH tariffs are based on a cost-plus approach (justified costs plus allowed profit), and taxes are added to the approved costs. Profits are regulated and may typically not exceed 3 percent of the total approved costs. However, some DH providers contend that tariffs are set below the justified costs.

58. A city typically applies uniform tariffs for all DH providers (although the providers may have different network systems and costs). A city's uniform heating tariff is determined using an average cost approach (known as standard costs in China), based mainly on normative or standard costs rather than on the actual costs of the DH providers; thus, tariffs of an individual DH provider do not reflect the actual or the justified costs of that company.

59. Operating costs are included in the cost base for tariff setting, as are depreciation charges and financing costs. However, it is not clear whether and to what extent all assets that have to be maintained by a DH provider are included. There might be cases in which the DH provider is responsible for replacement investments for certain assets but cannot claim and report the depreciation charges.

60. Lessons have been learned in China through 10 years of work and piloting in consumption-based billing. Yet the progress has been acknowledged to be much too gradual and could be faster

even if pricing reform continued to be relegated to cities. Reasons for gradual progress are largely because the system to implement the recommended two part heating tariff is currently incomplete. The energy charge has been properly applied; it is calculated according to the energy consumed but the capacity charge has been typically based on the customer's heated area. It may be assumed that the heated area properly reflects the maximum heat load (in kW), but it could also be regarded as a legacy of the lump-sum tariff system. A capacity charge related to heating area or floor area cannot provide the signals and incentives to promote the rational determination of the maximum heat load and to thus avoid over-sizing and over-investing in the heating facilities because not all buildings have the same heating needs. For example, the MOHURD and the NDRC issued a pricing document and assigned the Pricing Bureau to set the price with the assistance of DH providers. It was decided to use floor area as the basis for the fixed charge. However, in pilot areas, consumers complained because each year there was a different price for the fixed charge.

61. During the past few years, a number of international and national experts have prepared recommendations for two-part pricing, the MOHURD has developed guidelines for its implementation, and some cities have carried out pilots. For most consumers, lump-sum tariffs based on area (RMB/m²) are still applied. For the few metered consumers that are charged according to consumption, typically a two-part tariff is applied.

62. In principle, and to be consistent with the rationale behind two-part pricing, the energy charge component should reflect variable costs (RMB/kWh) and be applied to metered heating consumption, and the capacity charge component should reflect fixed costs. However, it seems that most cities have decided that the total costs should be split equally between the two components. The capacity charge is levied per m², although a reference to the connected load would reflect the share in fixed costs more accurately. In view of this approach, half of the heating bill is still determined in accordance with the old lump-sum approach, while the other half reflects actual consumption.

63. Problems identified with the current tariff-setting practice include[42]

- nontransparent cost reporting and accounting;
- delays in tariff adjustments to reflect increases in input costs; and
- insufficient sources of financing for DH infrastructure.

64. **New Connections and Connection Fees.** Connection fees are paid directly by the individual consumer or by the building developer. It is still common practice for developers to pay connection fees per square meter of construction floor area, usually for heating plant, primary network, and group substation installations. Even if paid by the building developer, the fee will finally be paid by the consumer because these costs will be transferred by the developer to the price of the apartment.

42. The implementation of an economically efficient and fair heating pricing system in China is a key issue for the development of a sustainable DH sector. A full assessment of the pricing system, proposed two part heat tariff is in Meyer, A. and Kalkum, B., *China: Development of National Heat Pricing and Billing Policy* (World Bank/ESMAP: March 2008), Report No. 330/08).

65. New customers have to pay a connection fee determined by the local authorities. In China, connection fees are a significant source of financing for DH system development. Fees are determined as the individual customer's percentage in the total investment costs required to build the DH system plus the costs of the connection between the assets built by the building developer up to the DH network. The connection fee is usually based on normative or standard costs rather than on actual investment costs.

66. It is reasonable to differentiate between fees for new connections within existing service areas and fees for new service areas. Existing DH systems are usually designed with a certain amount of excess capacity in anticipation of future growth. Therefore, actual connection costs within existing service areas are usually low because only the connection of the building to the next substation or distribution line has to be built. In new service areas, however, costs are greater because providing the service requires developing and building an entire new DH system, which significantly exceeds the cost of the consumer's connection to the network. In China, it appears that DH providers do not differentiate between the different cases given that the same connection fees always apply to new customers.

67. **Billing and Payment and Collection.** Except for the major reform to transfer responsibility of the heat bill to individual households (reported to be accelerated over in 2009-2010), billing and payment practices have not changed during the initial years of reform. Also, collection rates are reported to be quite healthy in China; however, interviews for this report reveal a growing concern about payment for heating of empty apartments, and heating providers worry about collection rates deteriorating as a result of consumption-based billing.

68. In contrast to European countries, it is common practice in China to charge the consumer in advance for the next annual heating period. Usually, bills are paid either in cash or by bank transfer, but cash payments seem to be dominant. The advantage for the DH providers is that they receive funds with which to purchase fuel and cover other expenses. However, this method is a burden for the customers who have to lay out a large amount of money, and may lead to nonpayment and deteriorating collection rates, which is a current concern to DH providers.

69. Most consumers are still billed according to a lump-sum tariff per square meter, regardless of actual consumption. A few pilots for consumption-based billing are using different approaches. Unfortunately, a comprehensive assessment of the pilot projects is not available, and it is not possible to assess the strengths and weaknesses of the various approaches.

70. **Subsidies and Social Support Schemes.** The practice of providing general subsidies to DH allows heating services to be affordable and supports financially weak DH providers. General subsidies may be the simplest to administer, but from an economic point of view, this method is the most inefficient at achieving the objective of protecting low-income consumers. General subsidies benefit all customers, regardless of their incomes and living standards. Richer households benefit proportionally more because they have larger apartments and consume more heating. Therefore, the larger part of the subsidies accrues to the richer households and low-income household benefit to a lesser extent.

71. There is a perception that the problem of social assistance has been solved in China and based on survey reports it appears many local governments have implemented heating assistance programs for the poorest, (*dibaohu*), and have also maintained constant heat prices for social considerations. During interviews with government officials, many mentioned how prices need to kept low to be people-oriented (*laobaixing*).

72. In China, low-income residents are usually identified by Municipal Bureaus of Civil Affairs. The existing social assistance system (Minimal Living Security, or MLS) is also used for targeting heating subsidies in many locations, but rarely are the two systems administratively unified.

73. China currently practices the following forms of subsidy: (i) subsidies by the work unit transferred to the individual after individuals have been made responsible for payment of the heating bills (*anbu bian minbu*); (ii) subsidies for low income consumers following a clear definition (*dibaohu*); (iii) in some cities, direct operating or capital subsidies to companies; and (d) in some cities, restructuring of bankrupt DH providers by municipalities, usually meaning the city government has to assume a large share of legacy debt or pension obligations (or both) to attract new investors and inject fresh capital. Overall, existing schemes to protect low-income heating consumers can be divided into the following categories:

- *Heating security funds* (for example, in Shenyang, Changchun and Taijuan). Municipal heating security funds are often underfunded and can provide only limited relief to poor families.

- *Discounts and waivers of heating fees,* where the payment of heating bills is shared between consumers, government, and DH providers (Tianjin, Changchun). The problem with this approach is that DH providers have to finance a portion of the subsidies and their financial viability is negatively affected.

- *Enhanced MLS* (Beijing). The subsidy burden is significant and in some cities locally funded heating subsidies already account for a large percentage of total MLS funding (for example, Changchun at 16 percent and Harbin at 32 percent) which is, however, a national transfer program. Moreover, only a subset of needy households is included in the MLS, and low-income non-MLS households are rarely covered by subsidies.

74. Despite the existing social support schemes in China, there are still issues that could be improved. For instance, many low income households, where heating is as large as 10 percent of the share of their household income, are not eligible for any public assistance program and heating. Targeted subsidies can be especially effective in China if they can include wider eligibility criteria for poor households. Similarly, improvements in offering more flexible customer-tailored payment methods may be important to facilitate customers pay their bills and collection rates increase.

75. A World Bank study[43] found that heating expenses in selected cities surveyed in Liaoning province in 2007 constitute a significant share of household income. Household heating bills

43.Xun Wu and Gailius Draugelis, "Social Analysis of Heating Reforms in Liaoning Province," Asia Sustainable and Alternative Energy Program, World Bank, Washington, DC, 2009. (also published in Chinese)

amount to 4.2–22.8 percent of household income and an additional 4.8–24.0 percent of household income goes for other energy services. After heating subsidies, provided either by employers or the government, out-of-pocket expenditures for heating only are 2.4–10.0 percent of household income. Heating expenditure is responsible for a significant portion of household income, in particular for low income households not receiving heating subsidies. For low income households connected to heating systems, the out-of-pocket payment for heating takes about 10 percent of their annual income. According to the survey results, dibaohu who are included in the first quintile in table 3.2, on average pay less as a share of their income than do the rest of the households in the first quintile. Low income households not eligible for any public assistance program face pronounced income hardships. As a result, targeted subsidies can be especially effective in China if they can be broadened to a larger group of poor households. Based on the survey findings, it is clear that China has effective subsidy mechanisms that reduce the out-of-pocket expenditures for all households (but do the richer households need the subsidy?). The following table summarizes affordability data.

Out-of-Pocket Heating Expenditure by Income Quintile in Liaoning Province, 20078

Income group	Heating bill as % of total income	Out-of-pocket expenditure for heating systems as % of total income
dibaohu	20.6	6.5
1st quintile	22.8	10.0
2nd quintile	9.3	5.8
3rd quintile	7.1	3.8
4th quintile	6.1	3.7
5th quintile	4.2	2.4

76. In addition, the survey findings indicated that the subsidy payment method is important. The survey indicates that subsidy amounts tend to be smaller when subsidies are directly given to households compared with other ways in which subsidies are distributed (Table 2.3). Households that receive subsidies directly receive on average only 426 RMB for heating, while households that pay first and get reimbursed later can potentially obtain 1,347 RMB in heating subsidies. This disparity suggests that some employers may have reduced their financial obligations for heating subsidies when they directly gave the subsidies to employees in the form of cash allowances.

Average Subsidy Mechanism and Subsidy Amount

Subsidy mechanism	Subsidy amount (RMB)
Allowance (subsidies) transferred directly to the account of the heating enterprises	861
Cash allowance (subsidies) given directly to the household	426
The household will first pay the heating fee by himself and then go to the work unit for reimbursement	1,347

Source: X. Wu and G. Draugelis, "Social Analysis of Heating Reforms in Liaoning Province," Asia Sustainable and Alternative Energy Program, World Bank, Washington, DC, 2009, p. 30.

77. Another indication that employers may be trying to reduce their financial obligation for heating subsidies is apparent in a comparison of the subsidies received with the percentage of subsidies that should be given. On average, households reported they received 77 percent of the subsidies to which they are entitled. In one small county-level city, households responding to the survey obtain less than one-third of the subsidies they should be given. The survey also indicated that those customers who received subsidies as cash allowances tended to have higher collection rates than those whose subsidies were paid indirectly.

78. In China, few cases are known for providing ongoing operating subsidies. However during the coal price spike in 2008, retail heat prices were rarely adjusted and temporary operating subsidies to DH providers were reported. This is considered an exception rather than a rule. But despite this perception, municipalities usually take the lead in consolidation of small boiler operators, including outright purchases, prior to transferring the franchise to others. Construction projects of strategic importance also receive favorable loans from national development banks and, sometimes from national bonds. In China, investment subsidies can come in the form of direct budgetary participation or through arranging financing on favorable terms from policy banks.

79. **Managing Legacy Debt.** In the context of this report, the term "historical debt" refers to debts incurred in the past, when conditions under which the company operated were different. A typical case is an industrial company that operates a facility to produce heat, steam, or electricity, and the company has inherited debt from the previous operator. Such a situation would create problems if a DH provider requires a loan from a commercial bank or if the lender of the historical debt (or the new owner of the claim) requests payment of the debt, which could result in bankruptcy of the DH provider. Resolving historical debt is, therefore, a precondition for the sustainable and financially sound development of a company. There are no clear rules at present regarding historical debts for DH providers, although this appears to be an issue for those which accumulated large debts for the construction of their networks.

Energy Efficiency

80. Over the past few years in China, several laws have been passed that require DH to improve its environmental performance and energy efficiency, and that promote renewable energy.[44] Among the most important is the Energy Conservation Law (ECL), which encourages use of energy-efficient equipment, including in DH and CHP, and that requires connection of CHP to the grid.[45] The ECL's Article 38 also stipulates that metering and billing for centralized heating be implemented gradually in phases ("step by step") and requires indoor air temperature control and metering devices be installed in newly constructed and renovated buildings. The ECL also encourages use of renewable energy in new and rehabilitated buildings. It lays a foundation for energy efficiency across the heating chain from the heat source to the individual consumer.

44. Energy Conservation Law (1997, amended 2007), Renewable Energy Law, Air Pollution Prevention Law, Environmental Protection Law.

45. Articles 31, 32, and 78, Energy Conservation Law (as amended, 2007).

81. **Energy Efficiency in Buildings.** Energy efficiency in buildings is governed by the "Regulations on Energy Efficiency in Civil Buildings" issued by the MOC in 2003. Current DH systems hamper the improvement of energy efficiency and waste energy resources. There are about 8 billion m^2 of existing buildings in northern China, some of which have very high average energy consumption of 100 W/m^2. Heating consumption in China is three times higher than that in developed countries with similar climates and indoor temperatures. Buildings account for a reported 25 percent of total energy consumption in northern China, 60 percent of which is for heating. Common problems leading to energy inefficiency include outdated facilities, few efficient DH systems, large numbers of small coal boilers, the small scale of DH providers, and a lack of modern managerial capacity. Because heating facilities and technologies are often outdated in many cities, it is estimated that heat losses account for 30 percent of total heating consumption. Moreover, there is no temperature-controlling equipment for heating systems, so users are unable to control their energy consumption. As stated in the Briefing Paper, energy efficiency is an issue that urgently needs to be addressed.

82. Retrofitting at least 150 million m^2 of existing building area in 15 northern provinces to improve building energy efficiency is a part of MOHURD's Five-Year Plan target.[46] Each province was allocated a share of this target. Technical guidelines for building renovation have been issued at the municipal level. The central government established a formula-driven subsidy taking into account varying climatic conditions, levels of reconstruction, estimated energy conservation, and implementation progress.[47] The retrofit program received RMB 45–55/m^2 from the central government depending on the location, and some experience has been gained over the past few years. However, the scope and pace of the building retrofit has been lower than expected.

83. **Pilot Work in Energy Efficiency.** Pilot projects have been implemented in a few cities to promote energy efficiency and attempt to test heat metering and consumption-based billing. The main measures undertaken in the pilots include:

- *Issuing technical standards*[48] *for heat metering systems and energy-efficient renovation of buildings.* To improve the efficiency of existing heating systems and save energy, in the pilot cities new regulations, standards, and specifications were issued for household metering and central heating in new public buildings and new residential buildings. Regulations have also been issued for the energy-efficient renovation of buildings. These standards and specifications promote the construction of energy-efficient buildings and the implementation

46. This section is based on Robert P. Taylor, Gailius P. Draugelis, Yabei Zhang, and Alberto U. Ang Co, "Accelerating Energy Conservation in China's Provinces," Report No. 56416, World Bank, Washington, DC, 2010.

47. The formula is B = b × [(0.6 × R1 + 0.3 × R2 + 0.1 × R3) × 70% + R × Ec × 30%] × Pc, where B is the final subsidy, b is the benchmark subsidy based on climate (severe cold zone: RMB 55/m^2; cold zone RMB 45/m^2); R1 is reconstructed area of enclosed structure; R2 is the reconstructed area of the indoor heating system; R3 is the reconstructed area for temperature control; R is the total reconstructed area; Ec is an energy efficiency coefficient of 0.8, 1.0, or 1.2 for 15–20 percent, 20–30 percent, and > 30 percent or > 40 percent energy efficiency depending on whether it is measured from the heat source or the substation; and Pc is a progress coefficient where reconstruction completed before 2010 = 1.2, completed in 2010 = 1, and completed after 2010 = 0.8. From W. G. Cai, Y. Wu, Y. Zhong, and H. Ren, "China Building Energy Consumption: Situation, Challenges and Corresponding Measures," Energy Policy 2009, 37 (6): 2054–59.

48. These standards are used for new buildings. However, they are also used for heating systems planned to be renovated or replaced in existing buildings . If standards are not met, the system designs cannot be inspected and approved.

of new designs and technologies for household metering systems. In 2001, the Tianjin Construction Commission issued the "Notification for the Installation of Household Heat Metering Equipments in New Residential Buildings," which made heat metering mandatory in new residential construction. The regulation also included new technology standards, and design and test specifications, with the cost of these systems to be included in the construction cost. Similar policies were issued in Liaoning and Heilongjiang provinces. However, implementation of the regulation has been gradual.

- *Optimizing the structure of the DH sector* to encourage the development of large heating plants and the consolidation of small plants:

84. The first step was to focus on larger scale, more efficient CHP investments and central heating systems. In Harbin, 13 billion RMB were spent on eight large DH projects (such as the Daoli District Project) to build central heating for 80 million m^2 of building space. In Tianjin, a five-year plan (2006–10) was established to build five large thermoelectric plants and central heating for 100 million m^2 of building space (80 percent of the total heated area of the city).

85. As CHP was installed, the second step was the shutdown of small coal boilers with low generation efficiency (sometime as low as 50 percent). In Shenyang, it took three years to remove 1,200 HOBs and reduce the number of DH providers from more than 1,000 to almost 400. At the end of 2005, the total floor area connected to the central heating network was 14 million m^2, and the share of central heating had increased from 55 percent to 80 percent, resulting in significant energy savings.

86. **Establishing special municipal funds for energy efficiency.** In several project cities, special municipal funds were established to promote energy efficiency and were used for improving DH. In Shenyang, a special fund was established to remove old boilers and integrate networks. In Tianjin, a special annual budget of 56 million RMB was allocated between 2003 and 2005 to a reform project called "Blue Sky" to eliminate small boilers and connect networks to the central heating system. Financial support from district and county governments was also made available to remove coal boilers (or change the fuel source) and to establish new networks.

87. Household control and heat metering systems have been used mostly in new public buildings and in new residential buildings, with the expectation that these systems will promote energy savings when combined with consumption-based billing. In some pilot cities, household control and heat metering systems are beginning to be used for existing and renovated residential buildings. In Tianjin, the floor area of pilot projects reached 2 million m^2 and a mandatory "Three Stage Energy Efficiency Standard" was implemented in 2005. In Harbin, at the end of 2004, a total floor area of 11.4 million m^2 was rebuilt according to the new energy efficiency standards. In Jilin City, 75 percent of the rebuilt floor area had indoor heating control systems.

88. Perhaps the most important contribution district heating sector reform could make to building energy efficiency is the introduction of consumption based billing, using a two part heat tariff and ideally following incentive regulation. The lack of incentives for households and businesses to reduce energy waste for heating significantly reduces impacts of administrative measures and other mandatory approaches. Renovation programs have lagged behind partly from the lack of these incentives. Consumption based billing would not only provide a price signal to households, it would also move up the supply chain creating economic incentives to reduce energy waste throughout the district heating system.

Annex 2: Monitoring and Benchmarking

1. China's DH sector is undergoing an important transition from a welfare service system to a heat supply system based on commercial principles and aiming to improve the energy efficiency and reduce heating costs. Obviously, monitoring the results is extremely important to allow properly controlling the development process and to allow taking appropriate countermeasures in due time in case of unwanted developments.

2. Benchmarking goes a step further by setting benchmarks that means setting targets which the monitored company can achieve. Benchmarking can use the same indicators as monitoring. For example, monitoring could ask for the collection rate realized by a certain company and the competent authority may set a benchmark requesting an increase by 10% within one year. Setting such targets for a single company will not cause any serious problem. Problems will occur when, for example, this specific company is compared with the other companies in the same business sector. When setting a benchmark for the collection ratio based on higher collection rates of the other companies, the competent authority has to ensure that all apply the same method for calculating the rate and that the customer structure is similar (a company with mostly poor customers will normally achieve a lower rate).

Monitoring

3. Monitoring may not be confined to technical and financial issues. DH systems are being transformed from supply driven to demand driven systems. Moreover, consumers are no longer welfare recipients, but paying customers with specific rights. Therefore, monitoring should also comprise the relationship between suppliers and customers.

4. Monitoring comprises typically a number of requirements, such as

- **Financial audits:** Financial audits should not only address the financial situation at a certain point of time, but also the development over time and should investigate the reasons of any harmful development.

- **Inspections:** Inspections are required for the technical equipment to verify adherence to regulations, such as of boilers, pipes and other components. Regular inspections should be combined with surprise inspections.

- **Service quality:** The DH Company is responsible for adhering to a certain service quality. This could comprise the duration of service interruptions, quality of heat supply, adequate response to consumer complaints, assessing customer satisfaction, etc.

- **Complaint managing:** Customers will typically complain about insufficient quality of heating services and non-transparent invoices DH Companies should develop procedures how to deal with such complaints. Such procedures shall also include standard solution how to solve typical complaints. When

- **Compliance filings:** The various state institutions issue general and also specific individual instructions to the DH Companies. The DH Companies are responsible to prove that they comply with these instructions by preparing compliance filings. The competent authority should have the power to reject inadequate filings and request improvements.

- **Reporting requirements:** DH Companies have obligations for regular reporting. Reporting may cover technical issues, such as damages and breakdowns, safety problems, financial problems and financial development, development of collection rates, and other issues. The reports should be prepared in accordance with uniform guidelines and instructions issued by the competent authority. Reporting requirements should also comprise information about the staff, maintenance and investment planning's, and achievements of energy efficiency targets.

- **Consumer education:** Informed consumers are better able to deal with utilities when problems arise. DH Companies should be obliged to educate their customers on the proper use of heat regulators (thermostatic valves), the principle of heat metering, and improving energy efficiency in their homes.

- **Safety programs:** The competent entities will reviews operation and maintenance records check and reviews compliance with safety regulations.

- **Enforcement:** Monitoring activities should comprise possibilities for enforcement actions when things go wrong. This could imply penalties (e.g., in case of noncompliance with regulations), request customer refunds (in case of insufficient service quality), Rescind license and withdrawal of license in case of severe violations.

Performance indicators

5. Monitoring will be facilitated by defining performance indicators. These indicators can be used for assessing the development of a DH system or DH Company, and for drawing comparisons among companies. Harmonizing data is important:

- Comparing data covering various years should take into account climatic factors. The operational results referring to a cold heating seasons should not be compared with those of warmer heating seasons. Correcting energy data by applying the same degree days would make them comparable.

- Actual temperature data should be used instead of normative ones. For example, capacity requirements are calculated based on normative temperature data, which may be outdated nowadays due to climate change.

- Regarding comparisons of financial data over time, it has to be decided whether to use numbers based on nominal (actual) prices or based on real prices (constant prices)

- To avoid whitewashing, revenues and expenses of other (non-core) business should be sorted out, whenever financial data will be used.

Tracking company performance

6. To assess the success of a company or its various activities, performance indicators are used. Performance indicators are also well suited to check the achievement of targets. For example, the license or the concession contract could stipulate performance indicators that have to be achieved in a number of years. Each year, the company has to report to the regulator and/or owner the actual status of these indicators. The table below defines a number of technical and financial indicators. The numbers in the table serve only for illustration. The list of indicators does not claim to be comprehensive.

Market and Technical Performance Indicators (Illustrative)

Indicator		Base year
Degree days 1)	K*d	2.397
Connected load	KW	21.000
Supplied heated area (excluding disconnections)	m²	150.389
Supplied heated area residential customers (excluding disconnections)	m²	89.215
Disconnected area	m²	39.556
Disconnected area of residential consumers	m²	3.451
Conversion of existing buildings to DH	m²	
Heat supplied to the networks	MWh/yr	16.737
Heat supplied to the networks temperature corrected 3)	MWh/yr	16.000
Fuel consumption 4)	MWh/yr	20.272
Fuel consumption temperature corrected 5)	MWh/yr	19.379
Heat generation efficiency 6)	%	82,6%
Heat purchases7)	MWh/yr	
Heat purchases temperature corrected 8)	MWh/yr	
Losses 9a)	MWh/yr	
Losses percentage 9b)	%	10%
Service interruptions hours 10)	hrs/yr	
Damages 11)	No/km	
Specific heat consumption of residential consumers 12)	MWh/mˇ,yr	
Staff	cap	31
Staff productivity 13)	cap/GWh	1,85
Building connected	No	
Buildings connected and meters installed	No	
Residential buildings connected	No	
Residential buildings connected and meters installed	No	
Metering coverage I 14)	%	0%
Metering coverage II 15)	%	0%
Heat sold (total)	MWh/yr	
Heat sold to residential consumers	MWh/yr	

Metered consumption	MWh/yr	
Metered consumption of residential consumers	MWh/yr	
Coverage of consumption based billing all customer groups	%	0%
Coverage of consumption based billing of residential consumers	%	0%

1. Degree days = (Normative indoor temperature – average outside temperature during headings season) * heating days per year * heating hours per day
2. Measured or calculated at plant exit or point of delivery for purchased heat
3. Corrected heat supply = Actual heat supply * actual degree days/ normative degree days
4. Fuel consumption measured at plant entry
5. Fuel consumption temperature corrected = Actual fuel consumption * actual degree days/ normative degree days
6. Heat generation efficiency = actual heat supply / actual fuel consumption
7. Heat purchased measured at point of delivery
8. Heat purchased temperature corrected = Actual heat purchased * actual degree days/ normative degree days

9a Losses = Heat produced and supplied + heat purchased - total heat sales
9b Losses percentage = Losses/heat supplied to the network

10. Total hours of service interruption in the distribution system
11. Number of damages occurred in the DH system per pipeline length (double pipe)
12. Specific heat consumption of residential consumers = total heat supplied to residential consumers / total heated area
13. Staff productivity – Total staff / total supplied heat
14. Meter coverage I = Number of heat meters for final consumption / number of buildings connected
15. Meter coverage II _ Number of meters of residential buildings / number of the residential buildings

7. The following tables show some financial indicators. The numbers should be taken preferably from audited financial statements. However, numbers should only relate to the proper DH business and other businesses should be excluded. In practice, a clean approach would require to unbundle the accounts, i.e., one for DH and one for the other businesses (if there are any).

8. Like the technical performance indicators, the numbers should be interpreted prudently and should be analyzed in the right context. For example, Company A with a small staff may have high specific personnel costs per employee, while Company B has low specific personnel costs but a high staff number.

Financial Expenses Indicators (Illustrative)

Indicator	Unit	Value
Specific heat production costs 1)	RMB/MWh	
Specific variable costs 2)	RMB/MWh	
Specific fixed costs 3)	RMB/MWh	
Specific personnel costs A 4)	RMB/MWh	
Specific personnel costs B 5)	RMB/cap	
Specific depreciation 6)	RMB/MWh	
Specific financial expenses 7)	RMB/MWh	

1) Total expenses less expenses for non-DH businesses or, alternatively, total expenses less income from other business
2) Variable expenses = expenses that vary with heat production such as fuel, reduced by variable expenses of other business
3) Fixed expenses = Total expenses less variable expense reduced by expenses of other business
4) Total personnel costs divided by heat supplied to buildings
5) Total personnel costs divided by staff number
6) Total depreciation charges (reduced by non-DH depreciation) divided by heat supplied to buildings
7) Total financial expenses (reduced by non-DH expenses) divided by heat supplied to buildings

Additional indicators

9. There is additional information available that can be used to judge better the technical conditions and financial of a heat supply and to identify reasons for differences in efficiency and performance. The following indicators could be used for a "quick and shorthand" assessment, but should not be used offhand for regulatory purposes.

General Financial Indicators (Illustrative)

Indicator	Unit	Value
Current ratio = Current assets / Current liabilities	/ - /	0,71
Quick ratio = (Current assets – Inventories) / Current liabilities	/ - /	0,52
Accounts receivable days = Accounts receivable / Annual credit sales * 365 days	D	268
Accounts payable days = Accounts payable / Total expenditures * 365 days	d	62
Debt ratio = Total liabilities / Total assets	/ - /	0,20
Debt to equity ratio = (Long-term debt + Value of leases) / Stockholders' equity	/ - /	0
Debt service coverage ratio = Net operating income / Total debt service	/ - /	0
Profit margin = Profit (Loss) / Total revenues	%	-28%
Work productivity = (Total revenues of DH business / Average number of employees engaged in DH business)	€/cap	29.367
Bad Debts Written Off per Revenue = Bad Debts Written Off / revenues	%	14%
Cost coverage = Revenues from DH business /Total expenditure	%	72%
Collection rate 1 = total collection for heat sales in the corresponding year / Total value of bills issues in the corresponding year	%	30%
Collection rate 2 = total collection for heat bills issues in the past 12 months / total value of bills issued in the past 12 months	%	

Investments and Planning (Illustrative)

Indicator		Value
Investments	´000 RMB	
Maintenance and repairs	´000 RMB	

Customer Base (Illustrative)

Customer group		Value
Residential consumers	MWh/y	
Commercial consumers	MWh/yr	
Budgetary consumers	MWh/yr	-
Industrial consumers (excl... Steam)	MWh/yr	-
Steam consumers	MWh/yr	

Average diameter of heat transmission and distribution pipelines

10. The average diameter allows comparing the network design. Basically, similar loads would require a similar average diameter. Larger deviations need to be explained.

Average age of heat transmission and distribution pipelines:

11. This is another indicator which reflects the technical potential of the network, its reliability and possible demand for financial resources for replacement. This information is critical for the company itself in determining which parts of the network have to be intervened.

12. In a similar way as above, the average age of the other major DH components (boiler and substations) could be determined to indicate the technical status and the demand for investments. However, the age itself should not be the decisive criterion for replacement. Other relevant

Calculation of Average Diameter of the Heat Transmission Network (Illustrative)

	A	B
1	diameter in mm	Actual length in m
2	50	
3	65	
4	80	
5	100	
6	...	
7	=sumproduct(A2:A6)/B7	=sum(B2:B6)

Calculation of The Average Age for a Heat Network (Illustrative)

	A	B
1	Age of the pipes	Actual length (Lf), m
2	10	
3	15	
4	20	
5	25	
6	...	
7	=sumproduct(A2:A6)/B7	=sum(B2:B6)

indicators should be taking into account. In case of pipelines, this would refer to specific water consumption, specific number of damages per year, etc.

Heat load density

13. The heat load density D illustrates the suitability of DH for a service area. The indicator is calculated either as

D = QDh / L

or

D = PDH / L

Where

QDH = annual heat supply to the network

PDH = maximum heat load to the network

L = length of network (usually double length)

14. The higher both numbers, the more effective is district heating and the lower should the distribution costs be. However, when comparing company results, one has carefully to check the definitions:

- The meaning of "annual heat supply": total production, heat supply to the networks, heat supply to the substations, etc.
- The meaning of "maximum heat load": measure peak load, connected load, installed boiler capacity, etc.:

15. Conclusions have to be drawn carefully to avoid misinterpretation. A low value can indicate that the heat demand is too low for the existing network and therefore it might be replaced by decentralized heating system. However, it could also show that parts of the network are idle and actually no longer used for operation. Vice versa, a high value may indicate an excellent suitability for DH but could also hide big losses (or over-capacities) in the system. That means, additional information is needed to explain the numbers and draw the right conclusions.

Energy Efficiency

16. The energy efficiency is likely the most important technical performance indicator. It is defined as percentage of total energy input to a machine or equipment that is consumed in useful work or heat and not wasted as useless heat.

17. In the DH sector it is common practice to calculate the energy efficiency for the various functions and also for the whole system, such as:

- Energy efficiency of heat generation (heat produced and measured at the plant exit) divided by fuel input. Usually, the own heat consumption should be excluded.

- Energy efficiency of heat transmission/distribution: heat measured at substation or building entries divided by heat measured at the plant exit. If there are no meters in the buildings but only in block substations, the efficiency of the secondary network could be determined by dividing the heat supplied to the buildings divided by the heat measured at the substation entry.

- Energy efficiency of heat supply: useful heat measured in the buildings divided by the heat energy measured at building entry. This indicator is difficult to determine as the useful heat is usually not measured and heat losses in the indoor facilities (indoor pipes, temperature regulation by windows) is usually not measured, but has to be calculated and estimated.

Specific electricity consumption

18. Electricity consumption is another important efficiency indicator. The specific electricity consumption illustrates the efficiency of the electric equipment, but also the proper dimensioning of the respective components. Like in the previsions section, the specific electricity consumption can be determined by functions, such as:

- Specific electricity consumption for heat production: total electricity used for heat production divided by heat measured at plant exit

- Specific electricity consumption for transmission and distribution; total electricity consumption for transmission and distribution divided by heat supplied to substations

- Electricity consumption for secondary distribution

- Overall specific electricity consumption: total specific electricity consumption divided by the total heat supplied to buildings

Specific water consumption

19. As in the case of the previous indicators, the specific water consumption could be determined by functions and the whole system. The most interesting indicator is the specific water consumption in the transmission and distributions systems, as it illustrates their technical status. While the value would be close to zero in a new, well installed network, it will be high in an older system with many leakages.

20. The indicator can be calculated as dividing the specific water consumption by the heat supplied to the buildings. In addition, the refilling ratio can be calculated. It is calculated by dividing the annual water consumption by the network water volume; it should be below 1 for new networks.

Load duration hours

21. The load duration hours illustrate the effective use of the DH equipment. Basically, it is calculated by dividing the heat produced or supplied by the boiler capacity. The capacity could be the installed capacity, connected load, or peak load.

22. The load duration hours would amount to 8760 hours a year, if the respective equipment would be fully used all over the year. In EU countries, the load duration hours can reach more than 2500 hours per year because usually domestic hot water is delivered all over the year and capacities are usually sized in accordance to the real demand. In oversized systems without domestic hot water supply the number is usually far below 1000 hours per year.

Productivity

23. The productivity can be measured by dividing the heat quantity by the staff number. Ideally the heat quantity should show the heat supplied to buildings. In absence of verified consumption numbers, the heat measured at substations or plant exit may be used as the second best approach.

24. The lower the number, the higher the productivity. In modern Western European DH Companies the number would be above 10 GWh/cap. In addition, the productivity could be determined for the various functions, such as number of staff per MW boiler capacity.

Benchmarking

25. Benchmarking can be described as follows[49]:A measurement of the quality of an organization's policies, products, programs, strategies, etc., and their comparison with standard measurements, or similar measurements of its peers.

26. The objectives of benchmarking are usually:

- To determine what and where improvements are called for,
- To analyze how other companies achieve their high performance levels, and
- To use this information to improve performance.

Accordingly, the specific objectives for applying benchmarking can be very different and before establishing such a system, the objectives need to be defined, for example:

- If used for regulatory purposes (tariff setting etc.), data quality has to be excellent and the methodology has to be carefully defined and tested.
- If used for assessing the development of the DH sector, requirements may be lower, as long as this does not affect the financial or technical performance of the individual company (that means, e.g., no impact on the tariffs).

49.http://www.businessdictionary.com/definition/benchmarking.html

Advantages and problems of benchmarking for DH

27. In China there are many heat supply companies of different sizes, ages, applied technologies, ownership, customer base, and many other differences. In view of this diversity of properties of DH systems and heat suppliers, it is extremely difficult to identify the most efficient companies which are those who supply a good heating service of high quality at lowest costs (economic and financial costs).

28. Ideally, a benchmarking system would allow identifying inefficient companies, finding reasons for inefficiency (by comparing the various cost items), penalizing inefficient ones, or setting targets for improvements.

29. However, as indicated above, a number of typical problems have to be taken into account.

- Availability of data: A reasonable benchmarking systems will make use of the available statistical data, but may not be limited to them.
- Data quality in the DH sector is typically poor and has to be improved. There are hardly any metered data related to the energy flows available. Data are often only estimated or based on standards or norms.
- Statistical data are mostly confined to technical issues, but also financial data and other information is needed.
- Methodology to compare the companies: There are various methods, each with its own pros and cons. Evaluators have to be aware of them and should know the consequences.
- Data adjustment: DH systems and companies are very different (see introduction above). Due to the large diversity of DH systems, a number of subjective assumptions have to be made to allow a reasonable comparison.

30. The DH sector is actually characterized by a large diversity. In contrast to the electricity sector, service units and companies are usually small, while in big electricity service structural difference in specific areas will be balanced to a certain extent by properties of other areas. Therefore, regarding DH, such differences will have an essential impact on the benchmarking results. To illustrate this problem, let us assume two companies A and B:

- Company A supplies an area with mostly high-rise buildings. Accordingly, the heat load density (MWh/km of pipe) will be high, compared with Company B supplying low-rise buildings in a less densely populated area. It is obvious that Company B will have higher distribution costs.
- Company A, which is serving mostly new buildings with rich customers, cannot offhand be compared with Company B serving poor customers living in old buildings.
- Company A has inherited big debts from the old industrial owner, while company B is

without debts as being recently established by the municipality.

- Company A has inherited a huge staff from the former industrial owner, while Company B is new with a small, efficient staff

- Company A is mostly supplied by a local CHP plant, while company B uses its own coal-fired boilers.

31. In all these cases company A should be more efficient than company B. Even if this happens in practice, the question arises to what extent favorable conditions have produced the results or to what extent good management contributed to the results. These favorable and unfavorable conditions are mostly caused by external factors, which cannot be removed by good management at least in the short term. Accordingly, the evaluator (or regulator) has to make some assumptions as to what extent the unfavorable conditions have influenced the results.

32. Finally, a reasonable benchmarking systems needs:

- A reliable and comprehensive database. To the extent possible the database should make best use of the (official) DH statistics to avoid double work. The data should be updated at least once a year. Submission of data sheets could be combined with the application for a new tariff. If the data sheet would comprise not only data of the previous year, but also those of the last 2 or three years, plausibility checks would be eased.

- A methodology describing the benchmarking system, i.e., how to make use of the data. As described above, it is not sufficient to compare single parameters. In order to take account of the diversity of DH systems, several parameters have to be combined to allow drawing reasonable conclusions as to whether the companies can achieve the benchmarks.

33. A conceivable approach would be to group the DH system according to the properties. That means, there would be one group with small DH systems, based on coal-fired boilers, low load densities, no automation, etc. In practice, this would require a big number of groups. It would be more reasonable to disaggregate the DH systems by functions (e.g., generation, distribution, supply) and to define groups with similar properties. However, such disaggregation would also require disaggregating the accounting systems if the benchmarking system shall comprise financial issues. For the time being, costs are not disaggregated by functions. For drawing reasonable inter-company comparisons and to perform benchmarking, disaggregated accounts would be indispensable.

Benchmarking and tariff setting

34. For regulatory purposes, benchmarking is often used to draw inter-company comparisons, to compare costs, and to define the costs of a rational operation. Based on this, tariffs could be settled based on the results of benchmarking assuming that each company should be able to supply heat at least at the same costs.

35. A major challenge is to identify the company with the rational operating costs, which could either be defined in different ways, such as:

- by average production costs
- by lowest production costs
- by normative production costs.

36. It can be assumed that all the other companies should be able to reduce their production costs in compliance with the "rational production costs". However, such an approach would work in case that all participating companies have very similar characteristics, but in real life DH systems and companies are extremely diverse and such a simple approach would "compare apples and oranges".

37. An article published by NERA, which has been quite active in this field, analyses also the problems of this approach[50]. The article identified a number of fundamental problems based on international experience gained by NERA:

- The methodology is often ad hoc, inconsistent and dependent on the available data material.
- Data often have to be adjusted on the basis of usually subjective assumptions.
- In general, therefore, benchmarking rarely produces robust results.
- It is not guaranteed that a company whose charges are fixed as a result of benchmarking can cover their costs.
- The uncertainty which this causes increases the investment risk of the regulated supply company.

Rationale for a benchmarking system in China

38. The Chinese DH sector is in general characterized by:

- Low efficiency and accordingly relatively high production costs
- Large number of heat suppliers, which does not allow benefiting from economies of scale and synergy factors.

39. The Chinese government has emphasized the need to improve the efficiency and performance of the DH sector and this includes also the consolidation of the heating sector, i.e. actually the reduction of the number of DH Companies.

40. In a market economy the efficiency of a company is usually determined by its financial status. Simply said, a profit generating company is regarded to be efficient and a loss-generating one as inefficient, which will finally be ousted from the market. Obviously, such a view cannot be applied for DH. As a result the heat supply system would collapse. In the regulated Chinese heating market profits cannot be the decisive criteria for measuring efficiency and performance. For example, even

50. Dr. Enese Lieb-Dcczy and Graham Shuttleworth," The Sense and Nonsense of Benchmarking", published by NERA, 2002.

a well-managed, efficient company can generate high losses, if tariffs are not determined properly. An appropriate benchmarking system would allow determining the efficiency and performance independently from the specific financial results. However, the way to establish such system is laborious and time-consuming.

A two-step approach towards benchmarking

41. A reasonable benchmarking system requires a robust, reliable, and comprehensive data base containing all information required for this activity. For the time being, the data quality for the heating sector is relatively poor, because:

- Important data is not metered.
- There is likely no common understanding of the terms and methods to collect data. It has to be ensured that such data are collected by utilizing the same rules and methods.
- The database is (likely) incomplete particularly regarding non-technical data (such as financial data).
- important information, particularly on financial issues is mostly missing.

42. Therefore, in a first step, statistics should be improved and a proper monitoring system should be implemented. A good example regarding the technical aspects is the Finnish District Heating Statistics (which are available on the web). Financial data should be taken directly from the financial statements provided that uniform approaches and forms are used.

43. In a second phase, the benchmarking system for regulatory purposes could be established. Benchmarking for analytical purposes could of course start earlier (during the implementation of the statistical system) provided that the results will not be used for regulatory purposes. As long as the benchmarking system is not based on a clear methodology and well established and tested, it should not be used for regulatory purposes.

44. Starting to use the benchmarking system only for analytical purposes provides the opportunity to learn more about the special particularities of the DH sector and to understand the reasons for differences between the various heat suppliers better.

Annex 3: CHP Cost Allocation

1. Introduction

1. Combined heat and power (CH) is the simultaneous production of electricity and useful heat from a common source, either in the form of hot water or steam. Various technologies can be used for CHP. This annex will focus on the most common technology in China, i.e. heat extraction steam turbines. It addresses the issue on how to allocate costs of a CHP process between electricity and heat supply. The cost allocation problem stems from the fact that the consumption of inputs (such as fuel) cannot be allocated unambiguously to either of the two products (electricity production or heat supply) as can be done in a one-good production process. Various cost allocation methods have been developed internationally and have been in use for several years. There have been discussions on which is the "best method". The simple answer is that the "best method" is the one that allows achieving sector objectives. These objectives have to be defined by policy makers who decide on the development of CHP and district heating (DH).

2. To simplify the discussion, the following discussion will focus on hot water production, but the same methodologies, principles, and recommendations can be used for steam production.

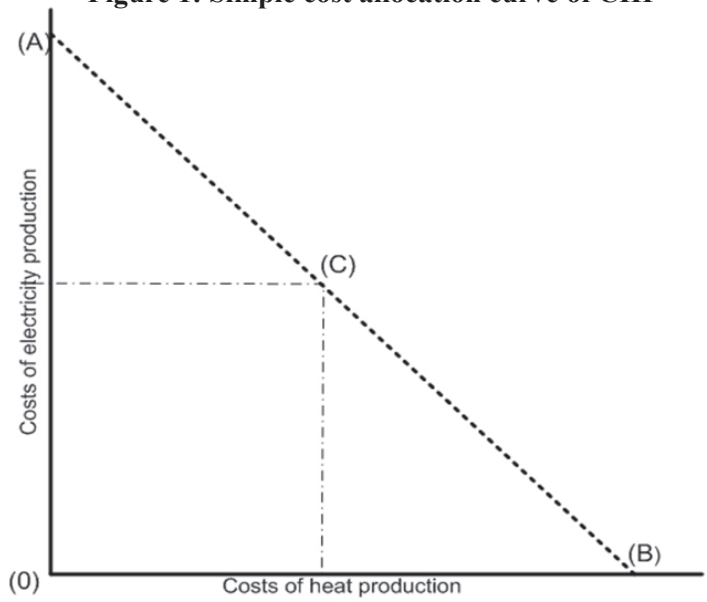
3. The content has the following structure:

- "**Costs in a CHP Plant**" covers the cost structure and explains the difference between direct costs, which can directly be allocated to either product, and "common costs". A transparent CHP cost allocation methodology should only deal with the common costs.
- "**Cost allocation methodologies**" discusses some common methodologies
- "**Criteria for choosing the right cost allocation method**" discusses reasonable criteria to choose the most suitable methodology
- "**Factors affecting cost of heat and electricity production in a CHP plant**" that significantly impact CHP costs and that should be taken into consideration when choosing the methodology.
- "**Sample calculations**" shows an example with the results of calculating heat and electricity costs

2. Costs in a CHP Plant

4. The figure below shows the illustrative representation on how CHP costs can be divided between the two products. The x-axis corresponds to the costs allocated to heat and the y-axis the costs allocated to electricity. The sum of costs allocated to heat and to electricity is always the same. Point (A) shows the case where all costs is allocated to electricity, while point (B) corresponds to all costs being allocated to heat. The curve that connects point A and point B represents the combination of cost allocations between the two products without changing the total costs.

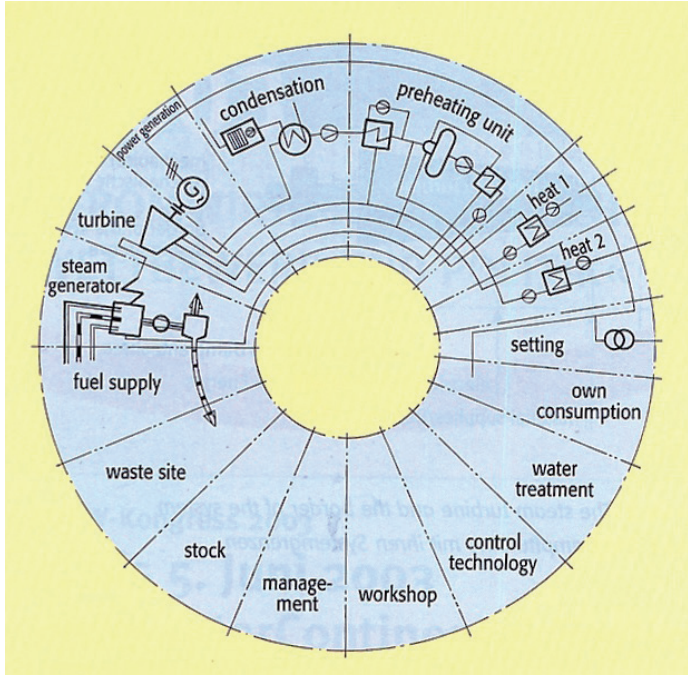
Figure 1: Simple cost allocation curve of CHP



5. However, the diagram above is a simplification. It includes all costs, although only the so-called common costs cause the CHP allocation problem. The bulk of the CHP costs are common costs, but some costs can be directly and unambiguously allocated to either electricity or to heat. For example, the generator is only needed for electricity production while the heat exchanger station converting the extracted steam to hot water is only needed for hot water production. On the other hand, the boiler and the turbine are needed both for electricity and heat.

6. To identify the direct and the common costs, the production process can be organized by cost centers so that one part of the cost centers cover those costs that can be allocated directly to either

Figure 2: Cost centers in a CHP plant

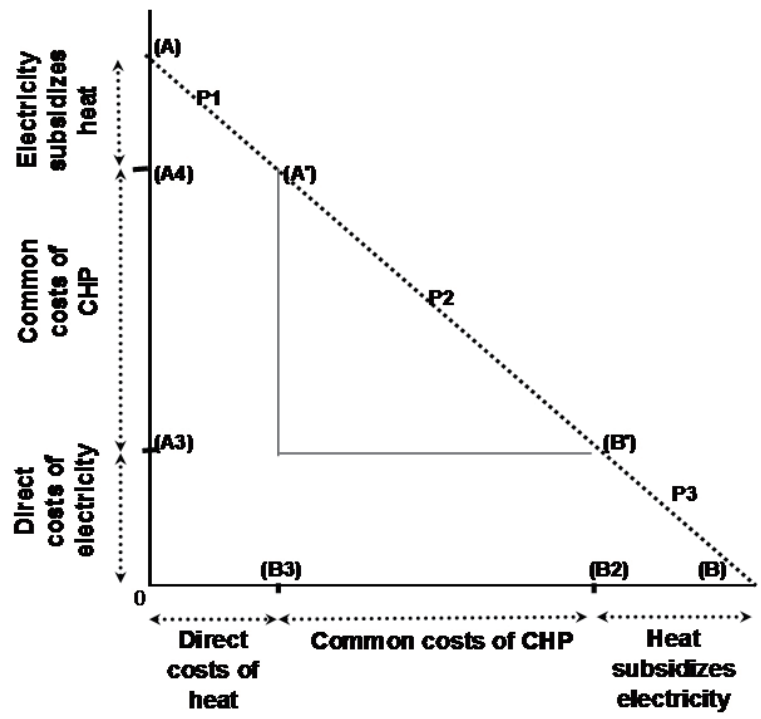


Source: Schenk (2003)

product to the extent possible. All other costs would then constitute cost centers containing common costs. The figure below shows an example on how cost centers could be defined in a typical CHP plant.

7. Accordingly, before allocating the CHP common costs, the direct costs should be identified. The figure below shows the cost allocation problem after direct costs of both products have been identified and sorted out. Points (A) and (B) represent, like in the previous diagram, the total costs of CHP, i.e., the values of (A) and (B) are equal. However, (A3) shows the direct costs of electricity and (B3) shows the direct costs of heating. Accordingly, only the costs that are represented by the segments (A)-(A3) and (B)-(B3) have to be distributed between electricity and heat.

Figure 3: Realistic cost curve



8. Three different cases are worthwhile to be discussed:

- Costs are distributed according to point P1. Electricity would bear most of the CHP costs, while less than the direct costs of heat are allocated to heat. This means that electricity subsidizes heat.

- Costs are distributed according to point P3. Heat would bear most of the costs, while less than the direct costs of electricity are allocated to electricity. Therefore, heat subsidizes electricity.

- Costs are distributed according to point P2: Total costs are allocated in a way ensuring that at least the direct costs of each product are allocated to it.

  Accordingly, any cost allocation point on the segment (A')-(B') would ensure no cross subsidies.

Therefore, the questions arises, how to allocate the costs along segment A'–B'. As already mentioned, a CHP cost allocation method should not change the total costs. Therefore, any cost allocation method has to fulfill the following conditions:

$C(tot) = c(el) * Q(el) + c(th) * Q(th)$
$c(el) = C(tot) * f(el)$
$c(th) = C(tot) * f(th)$
where
C(tot) total CHP costs
c(el) specific direct costs of electricity (€/MWh)
c(th) specific direct costs of heat (€/MWh)
Q(el) electricity production net (MWh)
Q(th) heat production net (MWh)
f(el) cost allocation parameter for electricity
f(th) cost allocation parameter for heat
and $f(el) + f(th) = 1$

The problem reduces to determining the cost allocation parameters f(el) and f(th).

3. Fixed costs and variable costs

9. The description in the previous chapter refers to total production cost and it did not distinguish between CHP fixed and variable costs. If a two-part tariff will be used, fixed and variable costs should be differentiated. In theory, various criteria can be used to separate variable and fixed costs, but for the purpose of CHP cost allocation, the following definition should be used:

- Variable costs vary in direct proportion to the quantity of output. Examples of variable costs include mostly fuel costs, electricity and water costs. However, also parts of other costs, such as labor and maintenance costs, will usually depend on the level of output.

- Fixed costs do not vary with the output. By definition, all other costs that are not variable costs (provided that they are justified costs for CHP) are fixed costs.

10. The cost curves for variable and fixed costs are different because (i) total variable and fixed costs will be different, and (ii) the respective direct costs will also be different. Variable costs are mostly common costs (such as fuel), while significant part of the fixed costs will be direct costs (such as equipment). Accordingly, the cost allocation parameters for variable and fixed costs will be different, even if the same (or similar) methods are applied.

4. Cost allocation methodologies for variable costs

11. As already mentioned, various methods for CHP cost allocation have been developed and are in use. Most of them use energy as the basis for the costing of heat and electricity. Other methodologies are based on energy claiming that it represents a better cost allocation. Some other

methods use costs and prices to allocate CHP costs. Also some methods use reference scenarios with separate heat and electricity production for cost allocation.

12. The CHP cost allocation methods can be grouped as follows:

- thermodynamic methods that use thermodynamic (energy) criteria for distributing the costs
- market-oriented methods that use financial criteria (costs and prices) for distributing the costs
- other methods

13. Thermodynamic methods include the following:

- *The energy method* (also referred to as the physical method or enthalpy drop method): Variable costs are allocated to electricity and heat in relation to the produced quantities of both products (and power-to-heat ratio). The method does not consider the different thermodynamic qualities of heat and electricity. The method is called the energy method as it refers to energy (MWh). If capacities (MW) are used as a reference, the method is often called capacity-sharing method.
- *Work method (power loss method):* Variable costs are allocated to heat according to the electricity losses caused by the heat extraction compared to condensing mode. The power loss coefficient is determined in terms of lost electricity per extracted heat unit (MWh(el)/MWh(th)). The determination of the electricity losses can also be used for the allocation of fixed costs. In this case, the power loss coefficient would have the dimension MW(el)/MW(th) measured during the period of biggest power loss per extracted heat loss. The combined approach is called "power loss method" in this document. As the power loss has to be measured in the same turbine, this method is only applicable for condensing extraction turbines.
- *Substitution method* is similar to the work method, except that the power loss is not measured in the same turbine but in a reference-condensing turbine. Accordingly, this measure is applicable for condensing extraction turbines a well as for backpressure turbines.
- *Exergy method:* Variable costs are allocated to electricity and heat in relation to the Exergy flows of both products.
- *Proportional method:* The variable costs of heat and power are determined in relation to the specific fuel consumption in separate plants of both products.

Market oriented methods include the following:

- *Substitution method:* Costs used in the CHP process are allocated to electricity and heat in proportion to the fuel consumption for the alternative energy supply forms (dedicated power plant and HOB, respectively). For example, it is assumed that the production costs in a pure condensing plant are lower than in the CHP plant. Accordingly, the incremental costs are allocated to heat. This method is similar to the residual cost method. The difference is that the residual cost method uses market prices for the validating heat, while the substitution method uses the specific costs in a condensing power plant.

- The methods of the alternative way of heat supply and electric supply (see description below) using market-prices rather than costs for calculation the distribution parameters.

14. **Other methods**

- *Method of the alternative way of heat supply:* the costs of CHP heat are determined to be at the same level as in the case of separate production of heat produced in a heat-only boiler. The rest of the CHP costs are allocated to electricity. A variant of this method is the "Residual heat cost method" that determines the heat costs as total cost minus revenues from electricity sales.

- *Method of the alternative way of heat supply:* Fixed and variable costs of heat are defined as the fixed and variable costs in a heat-only boiler (either theoretical costs or market prices) and electricity costs are the corresponding residual costs. A variant of this method is the "Residual heat cost method" that determines the heat costs as total cost less revenues from electricity sales.

- *Benefit distribution method:* the fuels used in CHP production are allocated to electricity and heat proportionally to the fuel consumption for the alternative ways of energy production, i.e., condensing turbine and heat-only boilers.

The Table below summarizes characteristics and advantages/disadvantages of some methods:

Method	Main Characteristic	Pros/Cons
Thermodynamic methods	Cost allocation parameters are determined based on technical and thermodynamic characteristics, which usually do not change during the useful lifetime of the CHP plant.	The cost allocation is independent from outside economic factors. The distribution of costs between both products is predictable.
Market-oriented methods	The cost allocation parameters are determined using market prices	As market prices fluctuate in course of time, cost allocation parameters will change. The costs of each product are hardly predictable, which does not provide planning security for investors and operators. In economies where energy prices are – at least partially – subsidized and do not reflect actual costs, a cost allocation method based on such prices will give the wrong signals to the market.
Substitution method	Cost allocation is based on the definition of reference plants, to determine the costs of alternative (separate) production	The production costs of a heat in CHP could be compared with those of a conventional coal-fired boiler or with those of a fluidized boiler, leading to different cost allocation parameters

15. As shown in the Table above, there is a clear advantage of the thermodynamic methods. The cost allocation parameters for the thermodynamic methods depend only on CHP plant-specific characteristics, will not change, and results are therefore predictable. The other methods are affected by prices, which would require frequent adjustments, and results are unpredictable in the longer run. The thermodynamic methods are the better suited when the objective is predictability, transparency, and planning security. Amongst the thermodynamic methods, the energy method and the work method are two opposite approaches.

16. The energy method allocates all benefits to electricity and the work method allocates all benefits to heat. Some experts consider that, due to this reason, both methods are not well suited. However, if a policy maker / authority wants to promote CHP-based DH systems, use of the work method could provide adequate incentives.

17. For fixed costs, both the thermodynamic methods and the financial methods could be used. Market-oriented methods can also be used, as most cost and price changes will affect both products to the same extent. Accordingly, the cost allocation parameters would likely not significantly change during the useful lifetime of the CHP plant.

5. Description of methods

18. This section provides the formulas of the methods described above. The cost allocation parameters are not shown explicitly, but can easily be derived as follows:

f(el) = c(el) / Q(tot)

f(th) = c(th) / Q(tot)

Any cost allocation method has to fulfill the conditions:

C(tot) = c(el) * Q(el) + c(th) * Q(th)

Where

C(tot) total costs

c(el) specific costs of electricity (€/MWh)

c(th) specific costs of heat (€/MWh)

Q(el) electricity production net (MWh)

Q(th) heat production net (MWh)

The calculation formulas for the most important methods are described in the following table;

Method	Formula	
Energy method	c(el) = c(th) = c = C(tot)/ (Q(el) + Q(t))	c: average specific costs (cost per MWh)
Work method	c(el) = C(tot) / (Q(el) + dQ(el)	dQ(el): electricity loss

Method	Formula	
Exergy method	c(el) = C(tot)/ Q(el) + e * Q(th) c(th) = e * c(el) = (Tm – Te)/Tm	Tm: thermodynamic mean temperature of the heat Te: average outside temperature
Substitution method A	c(el) = C(tot, cond) / Q(el) c(th) = (C(tot) – C(tot. cond)/ Q(th)	C(tot,cond): production costs in condensation mode
Substitution method B	c(th) = C(tot,) / Q(th) c(el) = (C(tot) – c(th)* Q(HoB)) / Q(el)	Q(HoB): heat production in HoB
Proportional method	c(el) = C(tot) * F(cond) / (F(cond) + F(HoB) c(th) = C(tot) * F(HoB) / (F(cond) + F(HoB)	F(cond): Fuel consumption of condensing plant F(HoB): Fuel consumption of heat-only boiler
Residual cost method A	c(th) = C(tot) – c(el) * Q(el)	c(el): market/regulated electricity price
Residual cost method B	c(el) = C(tot) – c(th) * Q(th)	c(th): market/regulated heat price

6. Methodologies for allocating fixed costs

19. Each method described and assessed for variable costs can in principle be used for the allocation of fixed costs. However, some modifications are required to adapt to fixed costs. For example, when energy (MWh) is used for variable cost allocation method, capacity (kW) should be used in the allocation method for fixed costs.

20. In case of the power loss method, the work method would be used for variable costs. For the fixed costs, the highest power loss will be used for determining the cost allocation parameter. If the turbine has various extraction points, the low-pressure outlet may be used for the base load and the mid pressure outlet for the peak load.

21. The table below shows typical combinations of fixed cost allocation methods with variable cost allocation methods. Most often, fixed costs are allocated to heat and electricity by using the method of the alternative way of energy supply or the benefit distribution method. Typically, the capacity sharing method is used with thermodynamic cost allocation methods of variable costs.

22. However, it is important to note that there is no “right” or “wrong” combination. As for cost allocation methods, the combinations of methods should be decided in the light of the objectives and consistency. For example, the combination of methods should not result in variable cost allocation where most benefits go to heat, but the fixed cost allocation method gives most benefits to electricity. If CHP-based DH systems are promoted, the capacity sharing method is not well suited, as it allocates the bulk of fixed costs to heat.

Table 5.3: Typical Combinations of Variable and Fixed Cost Allocation Methods

	Fixed costs		
Variable costs	Alternative way of energy supply	Benefit distribution method	Capacity sharing method
Energy method			•
Work method			•
Exergy method			•
Alternative way of energy supply	•		
Proportional method	•		•
Benefit distribution method		•	

Source: Regulation Of Heat And Electricity Produced In Combined-Heat-And-Power Plants. World Bank Technical Paper, August 26, 2003

7. Indicative Sample calculations

23. The sample calculations in this chapter does not intend to reflect a real case, but rather to illustrate the various methods and impacts on costs of heat and electricity.

24. The main assumptions for the sample calculations are:

Boiler efficiency: 90%

Turbine efficiency: 90%

Generator efficiency: 95%

Inlet pressure turbine: 50 bar

Extraction outlet pressure: 10 bar (1.5 bar)

Condensing pressure: 0.1 bar

Variable costs: 13 €/MWh (related to fuel consumption)

Investment costs CHP Plant: 600 €/kW(el)

Heat-only boiler: 80 €/kW

25. The table below shows the typical power loss coefficients for condensing extraction turbines.

Table 1 — Typical power loss coefficients for given steam turbines and steam pressures

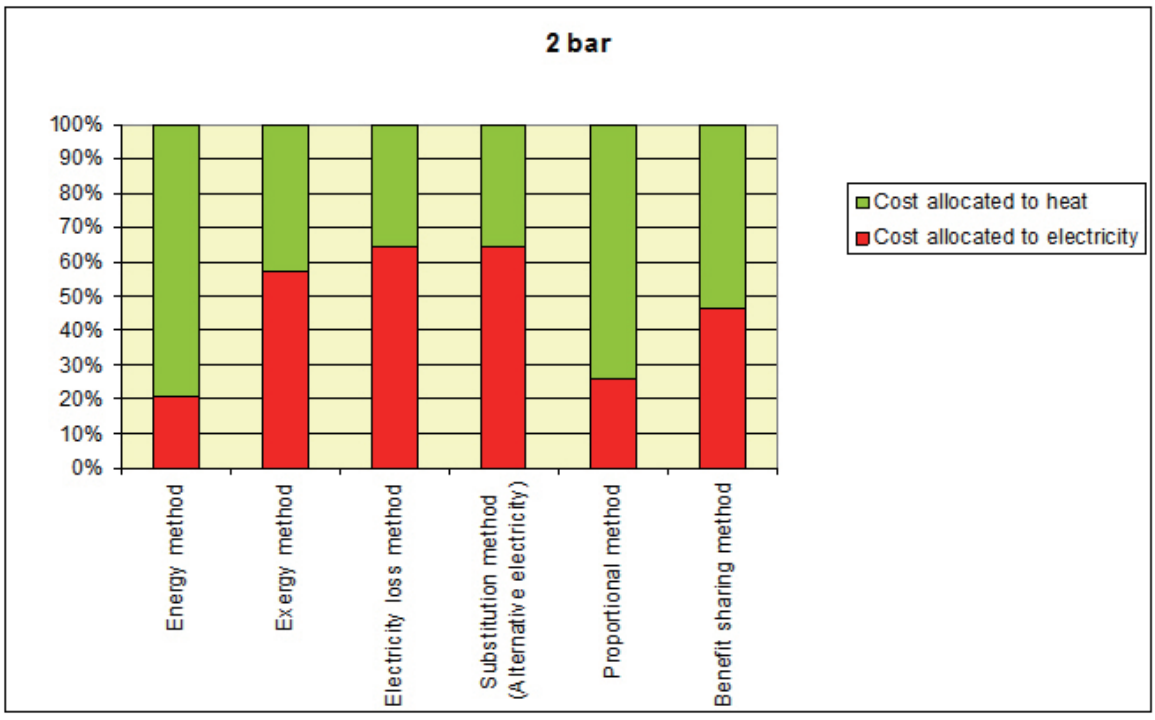
Steam turbine size range	2 to <5MW$_e$	5 to <10MW$_e$	10 to <25MW$_e$	25 to <50MW$_e$	Above 50MW$_e$
Typical thermodynamic (isentropic) efficiency	65%	70%	75%	80%	84%
Steam export/import pressure					
21.7 bar	0.200	0.213	0.227	0.244	0.256
14.8 bar	0.185	0.200	0.213	0.227	0.238
11.4 bar	0.175	0.189	0.204	0.217	0.227
7.9 bar	0.164	0.175	0.189	0.200	0.213
3.8 bar	0.139	0.149	0.159	0.169	0.179
2.4 bar	0.123	0.133	0.143	0.152	0.159

In addition, the following assumption have been made

- Fuel costs that are caused by electricity production in condensing mode are direct costs and will not be allocated to heat.
- The DH return water heated by the extraction outlet has a return temperature of 50 co and a supply temperature of 110 ^{o}C. The temperature differential in the heat exchanger is 10 Kelvin.

26. The graph below shows the allocation of costs in case of a steam extraction of 2 bar. The turbine design is good, as the steam temperature (131 ^{o}C) is close to the DH temperatures. As a result, the exergy method, electricity loss method and the substitution methods produce similar cost allocations. Results of the energy method and the proportional method are also similar. The benefit sharing method results are somewhere in between the other methods. It should be noted that the substitution method produces similar results as the electricity loss method in this example, because the reference condensing plant is assumed to have the same parameters and the same variable costs. However, in practice they will be different. If the efficiency of the reference plant is high, heat from the CHP would become more costly.

Figure 4: Cost allocation (extraction 2 bar)



27. The table below shows the results for 8 bar extraction. Such high-pressure outlet is usually used for industrial steam, but quite often also for DH. As the process becomes less efficient, heat is allocated higher costs in the exergy method, the electricity loss method, and the substitution method. Applying the proportional method and the benefit sharing method would reduce heat allocated costs.

Figure 5: Cost allocation (extraction 8 bar)

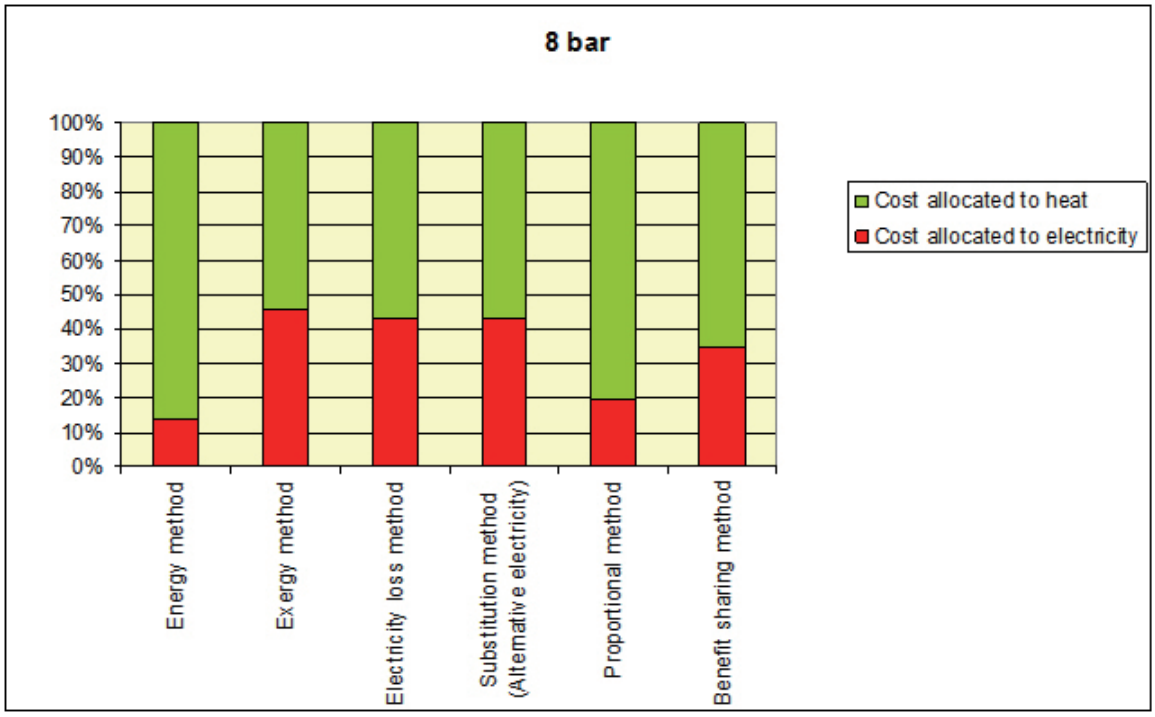
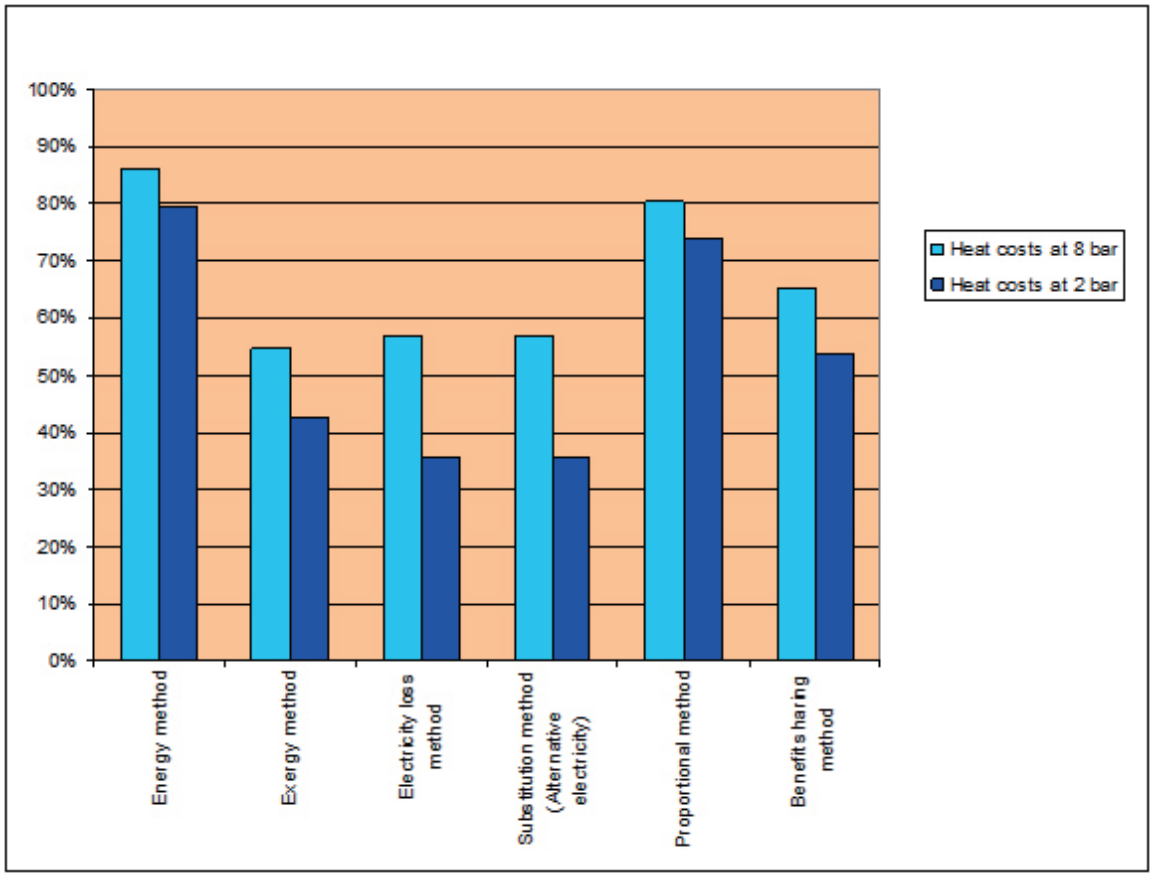


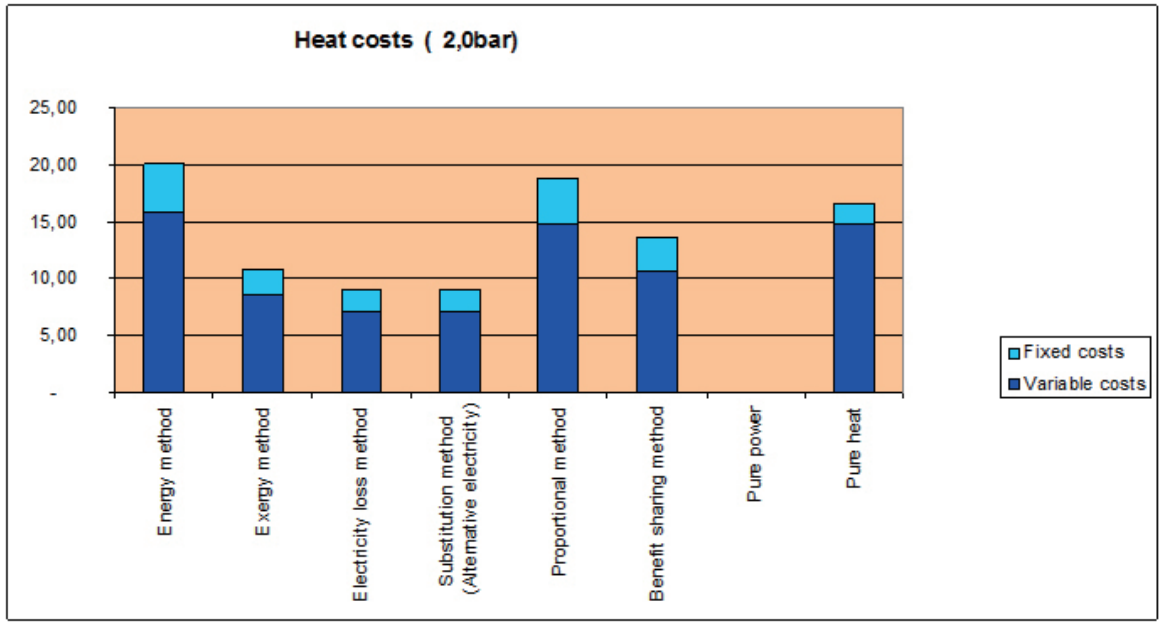
Figure 6: Heat costs extracted at 2 bar and 8 bar



28. The table below compares the two cases (2 bar and 8 bar) by showing the share of total costs allocated to heat. Under all methods, heat would benefit from energy efficiency improvements of electricity production. Obviously, the work method provides the biggest incentive for the heat supplier, to reduce the extraction pressure as far as possible as this results in the lowest heat price differential. The benefit for the CHP plant operator is the higher efficiency of electricity production.

29. The table below shows the total costs, if both the fixed costs and the variable costs are allocated by the same method. Although the investment costs are only indicative in this example, it is obvious that the fixed costs have a lower impact on heat prices. From this point of view, any combination would not significantly change the heat costs. However, as discussed before, the combination should be reasonable and consistent with the objectives.

Figure 7: Variable and fixed costs of heat



8. Measures to improve efficiency and CHP Plants

30. In order to promote the development of CHP in China, the State Planning Commission issued Notice to Prepare Urban Combined Heat and Power Plan in 1997 requesting local authorities to develop CHP plan. In 1998, the State Planning Commission, State Economic and Trade Commission, Ministry of Electric Power and Ministry of Construction jointly issued the Regulations to Promote Combined Heat and Power Development. The regulation stipulates technical guidelines for newly built and expanding CHP. All newly built and expanding CHP facilities meeting the technical requirement enjoy the preferential policy of free grid connection.

31. The share of CHP in total DH supply is still suboptimal. From the point of view of energy efficiency, 100% CHP would be the optimum but, from an economic point of view, likely 30-50%[51]

51. These numbers are only a rule of thumb. The higher the fuel prices relative to the investment costs are, the higher will be the optimal share.

(share of CHP thermal capacity in total peak load) would be the optimum. Accordingly, it would be worthwhile to promote further CHP plants to achieve an economic optimum mix of plants. Tangible incentives should be given for new plants, until the optimum has been achieved.

32. An effective promotion of CHP should include incentives to develop CHP-based DH systems on the local level. The best incentive would be a heat price significantly lower than the costs of heat produced in HoB plants. The Power Loss and the Substitution Method offer such low heat prices. To provide also incentives to investors, heat price should include a tangible return on capital (fixed assets) that is being used for CHP.

33. Under the current conditions in China, the DH Companies have hardly any incentive to improve the heat supply system, if heat purchased from CHP plants is as expensive as heat produced by own source. The supply and return temperatures have distinct impacts on the efficiency of the CHP plant.

- The lower the supply temperature, the lower can be the extraction pressure and the lower will be the electricity loss. With a given flow of the DH water, the supply temperature can be reduced by reducing the return temperature.

- The supply temperature of the DH water leaving the heat exchanger can also be reduced by a combination of CHP and HoB facilities. The CHP facility serves as a base load and the HoB as peak boiler. The CHP would, for example, supply all heat during the transition season. The return temperature of 70 oC would be heated, for example, up to a temperature of 100 oC. If more heat is required, the peak boiler would heat the water up to the maximum supply temperature of 130 oC. In this way, the extraction pressure could be lower than if the CHP facility would have to produced heat up to 130 oC.

- The lower the return temperature, the larger is the temperature differential and the more heat can be transferred by the heat exchanger behind the turbine extraction outlet. Return temperatures in Chinese DH system are typically about 70 oC. If the return temperature could be reduced, less steam has to be extracted and, correspondingly, electricity can be produced. To illustrate the affect let us assume that the extraction pressure will be reduced from 5 bar to 2 bar. The power loss coefficient (lost electricity per extracted heat) would go down by 26%. This demonstrates clearly the benefits of an optimal tuning of CHP and DH systems.

9. Factors affecting cost of heat and electricity production in a CHP plant

34. CHP will usually reduce the cost of heat and electricity production compared with separate production. This could eventually result in lower costs for both heat and electricity. Due to its advantages compared with separate production of heat and electricity, CHP can support the achievement of various objectives such as:

- Efficient use of fuels

- Reducing harmful emissions, including CO_2

- Providing reasonable opportunities for the use of dirty fuels such as coal
- Conserving natural resources.
- Lowering production costs of heat and electricity

35. Once a CHP plant is in operation, all these objectives can be achieved by CHP independently of the cost allocation method. The cost allocation method determines how production costs will be distributed amongst both products (electricity and heat) and in this way it can promote the dissemination of CHP technologies.

36. The cost allocation method becomes an important issue if prices are cost reflective. In theory, prices should cover reasonable costs plus a reasonable return on the capital. In practice, prices and costs can differ significantly not only in monopolistic markets but also in competitive markets. In regulated activities, prices (tariffs) can deviate from costs. An additional issue in CHP is that prices for electricity and for heating are regulated or monitored by different authorities.

37. Nevertheless, costs are the essential factors that will eventually determine prices, even if both do not perfectly coincide. The price/tariff regulation would be one that allows cost reflective tariff setting, including a reasonable return on capital. Conceptually, cost reflective tariffs should also include mechanisms allowing the periodic tariff adjustments to reflect changes in input prices/costs, particularly to fuel prices.

The optimal cost allocation methodology should have the following features:

- Create predictability and provide transparency of the price determination
- Contribute to the achievement of national policy and DH sector objectives
- Provide incentives for the rational use of energy within the CHP process
- Provide incentives to reduce harmful emissions

(a) Create predictability and provide transparency of the price determination

The methods described have the features of predictability and transparency. An important prerequisite is a clear and transparent cost accounting and information about the required thermodynamic features and other required characteristics of the CHP facilities.

(b) Contribute to the achievement of national policy and DH sector objectives

Heating has become an important social and economic issue in Northern China. There seems to be a common understanding that heating should be affordable, and at the same time consumers should pay in accordance to their heat consumption. These DH objectives could be achieved by allocating the benefits of CHP to heat. However, an additional issue that may need consideration is the objectives in the power sector.

Promotion of an energy efficient and cost effective economy could be another objective. Apart from industrial consumption, larger DH systems are required to make use of CHP. As long as there is no clear cost advantage for heat produced in CHP, the interest for expanding and strengthening CHP will be low, at least on the side of final consumers and DH Companies. Clear cost advantages could therefore generate effective stimuli for CHP.

It could be argued that the cost allocation principle consumers would have to pay less for heat but more for electricity. However, most of DH is used in the residential sector, so they would benefit more. Moreover, the consumption of heat is more difficult to control than electricity. Heat consumption depends to a large extent on climate and building construction and the costs of heating can only be controlled to a limited extent. Finally, it could be argued that from the thermodynamic point of view, electricity has a much higher value than heat and should be significantly more expensive than heat.

(c) Provide incentives for the rational use of energy within the CHP process

The question has to be raised whether there is any method that provides incentives for the rational use of fuel energy in the CHP process. The optimal CHP should have a high electric efficiency (n = Q[el]/Q[F] and also a high overall efficiency (Q[el] + Q[th]) / Q[F]. To achieve these objectives, the electricity loss due to the extraction of steam for DH should be as low as possible. Therefore, the extraction pressure (and therefore the corresponding steam temperature) should be as close as possible to the needed DH (supply) water temperature to minimize losses. As (relatively or absolutely) more heat at the cost of electricity will be produced, more costs will be allocated to heat. This effect will be the same for the three thermodynamic methods presented above.

The advantage of the work methods and, to a lower extent, of the exergy method, is that it provides strong incentives to utilize heat from CHP. Under the "energy method", DH prices tend to be close to own production cost in separate boilers. Accordingly there is no or handle any incentive to use heat from CHP at all or to determine the economically optimal mix of heat produced in CHP and in heat-only boilers.

10. Cost allocation methods used in Central and Eastern European Countries

38. In most Western EU countries (old members of EU), CHP and DH Companies are relatively free to negotiate the prices of heat. In Finland, the Ministry of Trade and Industry issued a decision establishing that the benefits of CHP have to be allocated evenly between both operations taking the technical and local conditions into account. The decision also established that the applied cost allocation method has to be documented in the company's annual documents.

39. Different cost allocation methods have been applied in each country. The table below presents an overview of the cost allocation methods used in Eastern European countries in 2001. The methods most widely applied are the energy methods and the proportional methods, and both allocate most of the benefits of joint production to electricity.

Table: CHP Cost Allocation Methods Applied in Eastern European Countries

Energy method	Alternative way of electricity supply	Proportional method	Benefit distribution	Other
Estonia	Latvia	Hungary	Kiev/ Ukraine	Bulgaria (residual costs)
Lithuania	Poland	Lithuania		
Russia		Moldova		
Ukraine		Romania		
		Russia		

Source: Based on ERRA 2001

11. Summary and recommendations

40. Among the methods discussed, there is no good or bad, no right or wrong cost allocation method. The better and adequate method is the one consistent with the government and policy objectives for CHPs.

41. This assessment recommends the application of thermodynamic methods, as in such methods the CHP cost allocation parameters will not change over time and are not influenced by outside economic factors. These methods have the advantage of making the cost allocation parameters predictable and providing planning security.

42. Amongst the thermodynamic methods, we recommend the work method as it results in the lowest heat prices without harmfully affecting the electricity price (compared with separate production). This will improve affordability and reduce the need for social assistance. Another advantage of this method is that it is expected to promote the use of CHPs for supplying DH systems. The work methods provide also the strongest incentive for DH Companies to reduce the supply temperature and to optimize the heat extraction system, which will also improve the efficiency of electricity generation.

43. It must be noted that, while the cost allocation methods determine the distribution of costs between heat and electricity without changing the total costs of CHP production, there are other issues that affect significantly the production costs. First, the extraction pressure for DH water should be as low as possible. Second, optimizing the mix of heat produced in CHP and HoB allows to reduce the temperature of heat supplied to the network and accordingly also the extraction pressure.

44. It could be argued that the proposed methods are unfair, as all benefits will go to heat. However, it is important to take into consideration that heat from CHP requires longer transmission pipes. Newer CHP plants are typically located outside the city centers in contrast to HoB plants that are located closer to the service areas.

45. To guarantee that the heat extraction from CHP plants will be optimized as described in this document, a close collaboration between CHP plant experts and DH experts would be required. Moreover, investment decisions should not be taken based on the investment costs, but on lifetime costs that include both investment costs and running costs during the lifetime of the plants. To provide incentives for investors and operators of power plants, a reasonable return on the capital should be added to the cost base.

Annex 4: Special Topic on Regulation, Pricing, Equity and Affordability

1. Is DH a social welfare service? From time to time, the question of the nature of DH as a welfare service is raised in China. From relevant international experience, there are two general schools of thought: One is based on the concept of heating as a part of social welfare rather than as a commercial business. The other approach is based on developing the DH industry on economic principles while providing social protection to the poor separately, in a more targeted and transparent way. The latter does not affect the DH provider's financial performance and management effectiveness, while ensuring it follows national sustainable energy development objectives.

2. DH is considered like a social welfare service, for example, in some Eastern European and Central Asian countries of the former Soviet Union. Under this system, the state maintains full and direct control of the ownership, management, and operation of the service and thus has the responsibility to subsidize DH. DH providers, as a result, are usually state-owned enterprises in this system. DH providers rely on revenues from commercial/industrial cross-subsidies and/or in the case that tariffs are not approved in line with increased input prices, subsidies from outside the DH provider (from national, provincial, or municipal budgets; from electricity sales; and so forth) to cover the costs of heat supply. Usually, heat prices are not cost reflective. Heat prices to the consumer are set by municipalities or at the state level (national or provincial) and are kept low at "socially acceptable" levels under the pretext of maintaining affordability. DH is subsidized by the state, usually through the government budget, with taxpayer funds regardless of whether taxpayers themselves receive the service.

3. This approach has several deficiencies and weaknesses especially when considering whether the commercial sector is needed to ensure industry sustainability:

- lack of incentives for efficient heat production and consumption;
- sector not attractive for private investors;
- no incentives for renovation and development, leading to earlier than necessary replacement of assets (for example, energy-intensive steel pipes); and
- low efficiency and eventually high costs to run facilities
- fiscal subsidies are needed to cover costs, subsidizing all DH consumers and inefficiencies
- the approach is perceived to be too risky for private investors. There is no certainty that the funding gap will be covered. There is no incentive to invest if this increase in cost will not be transferred to tariffs. There can be, however, incentives for efficiency / cost reductions, if such reductions address the funding gap when subsidies from government are insufficient.

4. **Unregulated DH Industry.** In contrast to the social welfare service model, district heating can be market driven and compete with other heating methods, where alternative heating methods are available and the DH sector is already reasonably well developed. This approach is used, for

example, in Finland, Germany, and Sweden. These countries have no specific regulations for the DH sector, although national policies and general regulations (for example, antitrust and control over abuse by monopoly services) may apply.

5. However, the dominant nature of DH has led to the monitoring of the sector, either by competition or by consumer protection authorities, to prevent DH from abusing its dominant position in a given market. For instance, in Finland, the Act on Competition Restrictions is a general act that applies to all arrangements contrary to competitive behavior, with the exception of the sectors of the economy that have been specifically excluded from its application. The monitoring of competition restrictions (anti-competitive behavior) and the implementation of the Act on Competition Restrictions (the Act) is the responsibility of the Finnish Competition Authority (FCA). In the FCA's assessment, DH providers are natural monopolies operating in their network areas, and having a regional monopoly.

6. Under the Act, the FCA has defined the DH market as a product market. The FCA has justified its market definition by saying that customers (properties) participating in DH cannot, with reasonable cost, change their heating choices because of the investments they have already made. The use of alternative heating channels is also affected by the distribution network required for DH; setting up competing transmission networks is usually so uneconomical that a heating distribution network is considered a natural monopoly under the criteria in the commentary to the Act on Competition Restrictions. Before a customer joins a DH network, a DH provider does not hold a “dominant position” if the customer has other technically or economically competitive choices. After a customer joins, a “dominant position” does not necessarily exist, if the customer can easily, quickly, and with minimum transfer and operating costs start using another form of heating.

7. In Finland, Germany, and in many other countries, the DH service is available to customers throughout the year. All residential consumers connected to the DH network use it for space heating as well as for hot water. Average interruption time of DH delivery in Finland is only one hour per year per customer. According to customer surveys, DH customers in Finland are satisfied with service quality. The number of complaints from customers to the FCA is usually small.

8. Some of the main advantages of the market approach are:

- With effective competition, efficiency and optimal heat prices can be achieved.
- Administrative and regulatory costs are minimized.
- Private investors find it attractive.
- Market risks are shifted and allocated from public/governmental entities to (private) investors.

9. There are, however, disadvantages:

- Sector planning can conflict with entrepreneurial decision making. This issue may not be significant in a city with low growth (although there may be stranded investments in situations

where substantial DH is already installed) and a well-developed urban infrastructure, but can be critical for fast-growing urban areas as in China. Including DH planners in the urban development planning process would inject knowledge on what constitutes an economic DH network.

- The use of DH for implementing national energy policies is limited. The EU now is pursuing use of CHPs, for example, to promote energy efficiency and fuel diversification.
- As noted above, market-based competition for heating is only feasible *if alternative heating options can compete with DH.*

10. The major competitors for DH systems in any market are forms of distributed generation – usually individual or building-level heat sources. Electricity and fuels such as natural gas, wood, oil, coal, and fuel oil are also used for heating in several countries. In addition, renewable hybrids (such as ground source heat pumps, solar heating) and pure renewable heating systems (geothermal and solar) are used. Internationally, natural gas is the major competitor to DH. In many Central and Eastern European (CEE) countries, gas companies rapidly and successfully entered the residential heat markets in the 1990s because retail gas prices were kept low relative to wholesale gas prices sold to DH companies through state control.

11. Where gas or electricity prices remain heavily subsidized while heat tariffs are liberalized or receive significantly smaller subsidies, it is difficult for DH to compete. In the early stages of market reform in the CEE countries, many individual consumers used electricity for heating because electricity was more heavily subsidized than DH, for example, in Estonia, Bulgaria, and Serbia. It was also considered more convenient because DH was not available on demand during the colder days of early Fall and late Spring. Customer service was perceived to be better in the purchasing decision. In some countries the share of DH in the residential heat market has stabilized over the last few years due to modernization efforts and price reform, and even started to grow.

12. **Regulated DH Industry.** Most CEEC countries and Denmark have opted for DH regulation. In regulated DH industries, where regulation is required for activities where market power can be exerted to the detriment of consumers, the development of standard and economic pricing regulation has been important for implementing national policies and energy targets, such as: (i) promotion of Combined Heat and Power (CHP) and use of renewable energy sources; (ii) fuel diversification and use of local energy services; (iii) use of municipal waste and surplus energy from other sources (industry, for instance); and (iv) combined supply of heat, electricity, and air conditioning. Further discussion on regulatory experiences is discussed in Chapter 2.

13. **Balancing efficiency, financing and equity objectives through regulated prices.** In China, the DH sector was operated as a social welfare service, but the central government has signaled an intention to move to economic regulation. This is in the direction of international regulatory models in the DH sector that emphasize economic considerations, assign social assistance separately, and separate administrative control and commercial interests from regulation as much as possible. Importantly, the pricing system chosen affects the institutional framework for DH regulation. Because in regulated industries prices do not come from the interaction of supply and

demand but rather from regulatory decisions, there is always a risk that the legacy of the approach to achieve equity in the welfare service model invades considerations in regulated prices.

14. In the last few years, many projects, reports, and meetings have discussed how to determine the heat tariff in China.[52] The general answer has been that the tariff:

(1) Provides signals about the scarcity of services (allocative efficiency) so that consumers use heat efficiently, and suppliers produce it as efficiently as possible (productive efficiency);

(2) Ensures that heat suppliers earn sufficient revenue to cover their operating costs and future investments (financing objective); and

(3) Ensures a fair distribution of benefits between members of society (equity objective), between service providers and consumers (for example, ensuring that the cost savings from modernization and efficiency improvements are shared and do not accrue solely to the provider) and between different classes of consumers (for example, setting prices in such a way that low-income consumers can access the service or ensuring that different consumption patterns and behavior are billed according to real costs). Moreover, a tariff is equitable if consumers are protected from monopolistic abuse and from "unjustified" costs.

15. A pricing system will best achieve these objectives if it is transparent so that consumers can easily understand their bills and react to pricing signals. Finally, regulators must pay attention to the quality of services so they are provided at an agreed level and do not deteriorate in the pursuit of efficient production and profit.

16. To achieve the equity objective it is frequently necessary to supplement pricing measures with other measures such as targeted social assistance.[53] Under no circumstances should equitability be confused with affordability; this would be inconsistent with an economically efficient tariff.[54] Affordability problems should be addressed by social assistance schemes, not by the pricing system.

52. See a full report on two part heat tariffs from Kalkum, Meyer, "China: Development of a National Heat Pricing and Billing Policy", March 2008, Energy Sector Management Assistance Program, Report 330/08, World Bank.

53. See the discussion of social assistance measures applied in the heating sector, for example, in Meyer (2003). Lifeline tariffs that are common in the electricity sector are very rarely applied in the DH sector. Bulgaria introduced a DH lifeline tariff; but since it is only marginally below the general tariff, it is largely ineffective. The basic need level for heating, to which a lifeline tariff would be applied, is lower than for full heating (see Figure 4), but in the traditional DH systems and residential apartment buildings in transition economies it would be very difficult for consumers to actually achieve such a low level of consumption. It would essentially require to disconnect or turn off all but one radiator.

54. It has been a common practice in CEE countries to deny tariff increases on social (affordability) grounds, although costs are economically justified. Such an approach opens the door for general, economically detrimental, and inefficient subsidies, which should be replaced by targeted subsidies.

Annex 5: Summary of Options for Competition Among DH Suppliers

1. While unified management of heat sources and networks are the norm, China's large DH market size, drive toward diversification of heat sources (e.g. CHPs), and elimination of small polluting boilers open up opportunities for market entry that did not exist before. For example, the elimination of small boilers usually involves a municipal taking over of the small heating network and transfer of franchise rights to another operator. However, such takeovers are financially prohibitive. In Urumqi, small heat suppliers can maintain their franchise on condition they shut down their own polluting heat source and buy heat from the new integrated network. Also in Urumqi, some boiler operators are allowed to continue supplying heat but only for peak load hours, which CHPs are now becoming base load suppliers.

2. When considering separating production from transmission the main objectives are to promote competition among producers by enabling them to have access to DH networks that they do not own and to promote important environmental objectives, such as using gas-fired peak load boilers rather than coal-fired peak load boilers. Different models are possible, among those are:

(1) *Regulated third-party access.* This form refers to unlimited access to DH networks; the network owner has an obligation to allow access to the network to other companies. The network access is called ex ante. The entry model is similar to the model for electricity market. Each production company pays the network access fee. In this scenario, it is important to separate the network from production activities. Customers will pay a network fee and a variable fee for heat. The variable fee is based on the production mix.

(2) *Negotiated third-party access.* The main difference between regulated and negotiated access is that the conditions for access are negotiated between the network owner and the company requesting access instead of set by a regulator. Because all networks are structured based on local conditions, it is important to negotiate the conditions that apply to DH. An advantage of negotiated access is that established companies have stronger positions in negotiations and take local conditions into account (for example, interested bodies can change access rules or activities). The disadvantages of this method are that there are increased transaction costs, and that the existing DH production company will be dominant.

(3) *Single-buyer model.* In this scenario, all consumers in a network have the right to negotiate contracts with all potential suppliers to the network. Only one company sells to consumers, and this company is obliged to purchase a contractual volume from suppliers that the consumers have chosen, and sell to the consumers at a price equal to the price negotiated between the producer and consumer, plus the cost of transport.

(4) *Extended Producer Market:* Heat producers sell heat to network operators. Market participants should share information and separate accounts of production and network activities. The main advantage is transparency of prices and transactions in heating market. This model has been introduced in Lithuania, where licensed DH providers have the obligation to buy heat from other producers if it is cheaper than their own. The main heat supplier has to sell heat at the unified price to promote competition among independent heat producers and find cheaper heat.

Annex 6: Example of Red Line Impediments to Energy Efficiency Innovations[55]

1. Building level substations are an advanced energy efficiency technology used widely in European DH systems. Rather than constructing a substation that supplies heating for a block of apartment buildings, building level substations are installed inside each building. The basic technology and operating principles are the same, but the differences are:

- Significantly less space (0.2MW substation occupies space of 0.9 m^2)
- Prefabricated – no on-site assembly required
- Energy efficiency (see below)
- Better suited to China's real estate development pace (see below)

2. The figure above is an example of a Chinese building complex supplied by one Group Substation (GS) or 18 Building Level Substations (BLS). The GS needs much larger pumping power to supply all 18 buildings. Because the pump is further away from the buildings, the heating supply is slower to respond to changes in the apartment thermostats. BLS is much closer to its heat load and does not need to pump so much. Although initial investment is higher, it saves electricity, heating and improves heating quality by responding much more quickly to changes in building heating needs. Moreover, BLS is modular and can be connected as buildings are constructed. GS has to be constructed for the first buildings and wait for the rest of the load to be constructed.

3. In addition, piping total investments are lower. Primary networks connecting the heat source to the GS are smaller in diameter than those of secondary networks. Secondary pipe diameters need to be larger because they carry lower temperature water compared to primary networks. When BLS is installed, the primary network is extended to the building and practically no secondary network is needed.

55.From Nuorkivi, A. and Draugelis, G. Building Level Substations, World Bank Presentation.

4. **Red Line Impediments.** Implementing BLS face organizational and implementation challenge because usually the secondary network (pipes between GS and the building) is constructed by the real estate developer. Therefore benefits from lower pipeline, pumping and energy costs are not equally shared between property owner and heating supply company. The municipality could change this practice to allow for the heating supply company to own the network all the way to the building inlet valve, thereby improving maintenance of the network and opening the door to new innovations like BLS.

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