DEVELOPMENT OF HEAT STRATEGIES FOR URBAN AREAS OF LOW-INCOME TRANSITION ECONOMIES

Urban Heating Strategy for the Republic of Armenia

Including a Summary of a Heating Strategy for the Kyrgyz Republic

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Foreword

In accordance with its mandate to alleviate poverty, the World Bank is helping governments in low-income countries in Eastern Europe and Central Asia develop and implement strategies to improve the access of urban households to heating services that are affordable and that are supplied in a financially and environmentally sustainable manner.

ESMAP is financing the development of urban heating strategies (UHSs) for the Kyrgyz Republic and Armenia. It is supported in this with financing from other sources, primarily in the form of a Policy and Human Resources Development Fund (PHRD) grant for most of the strategy development tasks and EU financing for a household survey in Armenia.

Preparation of the strategies was initiated in early 2001 and they were finalized in mid-2002. The Government of Armenia adopted the UHS on September 5, 2002 (Decree 1384 N) and has applied for an International Development Agency (IDA) credit to support implementation of the strategy.

This report is an edited version of the consultant report "Outline of an Urban Heating Strategy for the Republic of Armenia." It includes also a summary of the Kyrgyz Heat Strategy.

Abbreviations and Acronyms

AMD	Armenian Dram
CH	Centralized Heating
CHP	Combined Heat and Power
CO_2	Carbon Dioxide
DH	District Heating
ERC	Energy Regulatory Commissions
GDP	Gross Domestic product
GEKs	
HOB	Heat-only Boiler
HTW	Hot Tap Water
IPPs	Independent Power Producers
NPV	Net Present Value
PIU	Project Implementation Unit
PMC	Private Management Company
PV	Present Value
RHSU	Rules of Heating Supply and Use
UHS	Urban Heating Strategy
UMB	Unified Monthly Benefit
WTP	Willingness to Pay
YDHC	Yerevan District Heating Company
YTPP	Yerevan Thermal Power Plant
NG	Natural Gas
LPG	Liquefied Petroleum Gas
ERM	Environmental Resource Management
ANI	
IFI	International Financial Institutions

Units of Measure

Gcal	Giga Calories
KWh	Kilowatt Hour
MWh	Megawatt Hour

Exchange Rate

US$1 = 550 AMD = 49 SOM (February 2002)

Definition of Terms

Centralized heating A heat supply system (distribution of heated water for space heating purposes) with a central heat source (normally a CHP or HOB plant) and with centralized administration, operation, and billing. Also "district heating."

Autonomous heating A heat supply system with a decentralized heat source (normally a small HOB on a micro-district or building level), administered and operated by an autonomous entity such as a private heat provider or condominium.

Individual heating Heat supply that is specific to an individual house or apartment and that is not necessarily shared with others. Apartment gas boilers and electric heaters are considered to be individual heating solutions even though the primary energy is transmitted through a collective system.

Acknowledgments

This report is based on study reports prepared by Peter Johansen, Chief Project Manager, Svend Erik Mikkelsen, Household Energy Specialist, and Jorgen Jordan, District Heating Specialist, COWI A/S (Denmark), and Anders Dyrelund, Ramboll (Denmark).

COWI carried out the development of the methodology for the heating strategies for low-income countries and then developed the Heating Strategy in the Kyrgyz Republic under funding from the Energy Sector Management Assistance Programme (ESMAP), a joint program of the United Nations Development Programme (UNDP) and the World Bank. In Armenia, the development of the Urban Heating Strategy built on the same methodology, while the work on the strategy itself was carried out by COWI experts and a national team under financing from the World Bank administered Japan Policy and Human Resources Development Fund (PHRD).

In Armenia, the Ministry of Finance and Economy headed an inter-sectoral Project Management Board for which Deputy Minister Merushan Mikaelyan provided strong leadership, and the Project Implementation Unit "Thermosupply Programs" for the preparation of the PHRD-supported "Urban Heat Strategy" provided valuable support and input throughout the study process. In the Kyrgyz Republic, a working group headed by Mr. Balkybekov of the Prime Minister's Office, and Mr. Ularbek Mateev, Director of the State Energy Agency, was the counterpart for the consultant team.

Anke Sofia Meyer, Salman Zaheer and Sumter Lee Travers were the Task Managers of the ESMAP project. Ms. Meyer also prepared the executive summaries of the two heating strategies. The project benefited from advice and comments given by Julian Lampietti, Gevorg Sargsyan, Albert Zweering, Lev Freinkman, Pedro Rodriguez, Ritu Anand, Varadarajan Atur, Loup Brefort, Natalia Pisareva, Natalia Charkova, Charles Undeland, and Marat Iskakov. The comments of the reviewers, Gary Stuggins and Amarquaye Amar from the Energy and Water Department, are gratefully acknowledged. Editorial support was provided by Poonam Chitkara, and the publication and distribution of the report was supervised by Marjorie K. Araya from ESMAP.

Executive Summary

1. The primary objective of the Armenia Urban Heating Strategy (UHS) is to facilitate access to affordable, safe, and environmentally sustainable heating services. It aims to do this by creating the market conditions for the commercial provision of these services. A secondary objective is to stimulate residents of apartment buildings to organize themselves in such a way as to facilitate the commercial provision of communal services.

2. The UHS provides the strategic framework for the short- and medium-term development of the Armenian urban heating sector. The overarching tenet of the strategy is that the state must get out of the business of providing heat and other communal services and must abandon both its direct operation of heating companies and the extensive subsidization of their services. The role of the state should be to regulate and supervise service providers, provide information to enable the creation of markets, remove bottlenecks in the creation of markets, and support low-income families. The formation of operational and active condominiums in the cities in which the UHS will be implemented additionally is a precondition for the provision of any form of communal heat service.

Background

3. Prior to the 1990s, district heating systems supplied winter heating and year-round hot water to Armenia's towns and cities, serving at least 50 percent of the country's population. The economic blockade of the early 1990s saw most of these systems fall into disrepair. The national and urban authorities have since restored district heating to eight municipalities, but the service now reaches less than 10 percent of the population. Despite the efforts of the authorities also to cut supply costs, to charge cost-reflective tariffs, and to enforce payment, even this restricted supply is provided in a noncommercial manner. The fiscal burden and asset depletion associated with the service have been reduced, but cost recovery remains unsustainable, with virtually no accountability for supply or consumption (there is no metering of the service) and weak mechanisms for enforcing payment. Until a few years ago nonpayment amounted to about US$10–12 million annually (about 0.5 percent of GDP), resulting in the central government having to clear arrears owed by the heating companies to their fuel suppliers.

4. The more than 90 percent of the population that is not served by district heating uses mostly individual heating solutions, such as electric heaters or fuelwood stoves. In rural areas these fuels are supplemented by dung and waste. Electric heating, however, is expensive and payment is to a high degree properly enforced, with the result that the urban poor often are obliged to burn fuelwood. Where they do so in apartment buildings that are constructed without chimneys there clearly are detrimental health implications; the practice furthermore also accelerates the deforestation of already strained forestry resources. On the positive side, consumption of both electricity and wood can be easily controlled according to income constraints and comfort preferences.

5. *Methodology for Developing an Urban Heating Strategy*. Recognizing that heating is a local issue, the requirement for which varies according to climatic conditions, housing density, and natural, human, and financial resources, the government selected four cities—Yerevan, Charentsavan, Gyumri, and Jermuk—for which it would develop individual heating strategies. From these strategies it would crystallize a national urban heating strategy. The cities lie in different geographical zones of the country, Yerevan having the mildest climate and Gyumri and Jermuk the coldest.

6. The methodology for developing the heating strategy had three components, as follows:

a) An assessment of household coping strategies. A demand assessment was carried out on the basis of two household surveys conducted in 1999 and 2001. A second survey concentrated on the four target cities and included an environmental and a health component (ERM 2001).

b) A technical-economic assessment of heat supply options. This was carried out in two phases:

– A baseline was established, estimating the costs of providing heat in the short and medium term using just the existing infrastructure without any additional investment. Also investigated was the institutional environment in which heat supply takes place and which constitutes a powerful barrier to the sustainable provision of heat. The results were presented and discussed at national workshops and a consensus reached before the second phase was started.

– The costs were estimated of different options for providing heat over the long term, including necessary investments in heat and gas supply infrastructure. The different supply options were then assessed for their ability to provide affordable heat, as revealed through the consumer surveys, to a large part of the population.

a) Outlining of a phased implementation strategy. The strategy recommended actions—and especially those that can be taken in the short and medium term—to eliminate the institutional and information barriers that are preventing consumers from accessing affordable heating services and that are preventing suppliers from offering these services in an innovative, safe, and sustainable manner.

Specific challenges to be overcome

7. The effort to provide access for the Armenian urban population to a sustainable heat supply faces problems on many levels. The most significant of these are as follows:

– Little more than 10 percent of the urban population in Armenia is connected to a functioning district heating (DH) network. Where connections do exist, they tend to be relatively evenly spread across income groups. Of those households not connected to a functioning DH network, the poorer households are most likely to use wood, dung, or other relatively "dirty" fuels and the non-poor cleaner fuels such as electricity and natural gas. People not on DH networks typically also heat less of their living space and choose lower room temperatures.

- The energy consumed for space heating on average accounts for about 45 percent of an urban household's annual energy consumption. Heating accounts on average for about 5 percent of household spending, but the poor spend almost twice as much of their household budget on heating as do the non-poor (about 6 percent compared to 3 percent). In absolute terms, non-poor households declared spending about 16,500–27,500 Armenian dram (AMD) (US$30–50) a year on heating and poor households about AMD 13,750–22,000 (US$25–40).
- Poor households also suffer non-monetary costs. These include the health costs associated with not having enough heat and the resulting productivity losses and the health costs associated with burning dirty fuels in an inadequately ventilated environment. In addition, the heavy use of fuelwood leads to environmental costs associated with deforestation and to the opportunity cost of time spent collecting heating material, especially wood.
- Few households pay for their district heating. According to the consumer surveys, household bills for DH averaged AMD 35,000–42,900 a year, but payment of those bills recovered only an estimated AMD 22,000–26,000 per household. It is estimated that the government, through the clearance of arrears for fuel, taxes, and other payables and through the undermaintenance of assets, spends about AMD 3.3 billion (about US$6 million) annually to subsidize the ailing district heating systems in the four cities alone.
- Income levels of households within the same apartment buildings can diverge widely, making difficult the identification of and agreement on joint solutions. This situation is aggravated by the large number of absentee owners, a problem that is widespread in Armenia and unique among the countries of the former Soviet Union. Flexibility of the housing market would go a long way toward resolving these income divergence and absentee problems, but such flexibility has been slow to materialize.
- The transfer of building ownership from municipalities and the government to apartment residents has left a vacuum in which there is nobody responsible or able to maintain buildings, especially the common spaces, or to effectively organize the provision of communal services. Recent amendments mean that the legal framework is fairly advanced, but it still is not adequate to ensure the efficient operation of community associations. Contracts for communal services such as heating, water supply, and garbage removal are still concluded with the individual household rather than with an association of homeowners.
- The building infrastructure is deteriorating due to a lack of maintenance and lack of adequate heating. Buildings are badly insulated and require a large heat input for even minimal comfort. Centralized heating systems are misused by almost all consumers, who in the absence of good municipal water services resort to illegally

bleeding hot water from their radiators. The potentially clean, efficient, and affordable alternative of natural gas heating is hampered by the discontinuation of gas supply to apartment buildings because of the poor physical condition of the gas infrastructure and the poor creditworthiness of customers.

- The heat service providers typically are inflexible, inefficient, bankrupt municipal heating companies. Alternative providers have been slow to emerge from the private sector for a number of reasons: heat supply is regulated heavily by the Energy Commission, access to financing is nonexistent, potential customers present a big risk both in terms of their diversity and their attitude to payment, and the time horizon necessary to recoup investments is considerably longer than the contract periods to which customers could reasonably be expected to commit themselves.
- The extensive use of electricity for heating doubles peak demand during the winter months, thus raising the cost of electricity production and the need for investment in generation and distribution assets.

Affordable heating options: Short-term and long-term results

8. Analysis of the different heating options, as identified in Box 1, was done in two steps. A five-year short-/medium-term analysis sought first to assess the existing heat supply structure, examining the technical, financial, fiscal, and institutional aspects of supply. This analysis investigated whether the different heating options would be able to deliver heat sustainably within the affordability constraints. Minor investments only were assumed necessary for the existing heating infrastructure.

Box 1. Heat Supply Options

1. Rehabilitation/modernization of the existing centralized (district) heating systems. Heat and domestic hot water is produced in gas-based combined heat and power (CHP) plants or large or small heat-only boilers. The water is delivered to buildings through a network of hot water pipes.

2. Autonomous heating systems, employing small-capacity gas-based CHP or boiler plants to supply heat and hot water to between one and three multi-apartment buildings.

3. Individual heating of apartments and houses, based on electricity, natural gas, wood, or other available fuels.

9. The second, long-term analysis determined the costs of providing heat for all heat supply options, taking into account those investments necessary to ensure that equipment would be functional for at least 20 years and to make the necessary upgrades of the natural gas infrastructure. Two different demand levels were investigated: normative heat demand and reduced heat demand. The scenario of normative heat demand used the Armenian (Soviet) SNIP norms for heat consumption in each type of standard building, assuming the consumption of 50 liters of hot tap

water (HTW) per person per day and recognizing also that people draw hot water illegally from their radiators. The scenario of reduced heat demand was based on the pattern of heat consumption in households that have individual heating, both electricity and wood/solid fuels, and that is characterized by the heating of a fraction of the living area, with the larger part of the living area maintained at a temperature that is much lower than the "normative" comfort temperature of 20° Celsius. This entailed the reduction of normative space heating demand by 50 percent and the elimination of HTW demand, for a total reduction of around 60 percent of the normative heat demand.

10. In the short term, the existing centralized supply option, adopting a minimum investment strategy and providing heat according to the reduced demand option, would be able to supply heat at the lowest cost of about AMD 40,000 annually per household. This is not a long-term solution: while existing solutions may be inexpensive, they have a rising economic cost. Any public or condominium infrastructure used to supply heat would continue to deteriorate unless additional investments are made.

11. In the long term, new heat networks for a few buildings supplied from gas-fired autonomous boilers were shown to have the lowest supply cost, in the range of AMD 50,000–70,000 depending on the demand level (reduced or normative). From the affordability analysis, however, it appears that less than 10 percent of households would be able to pay for the normative heat supply and that only around 30 percent of the population would be able to afford even the reduced supply solution.

12. Heating with individual wood stoves is always one of the cheapest solutions, but it is neither clean nor convenient. Individual electric heaters are expensive to operate, even at the reduced demand level. Individual heating with natural gas, however, in the long-term is comparable in cost to the autonomous gas boiler option.

Urban Heating Strategy

13. The "Outline of Urban Heating Strategy" uses a phased approach based on the results of the technical and affordability analysis and the necessary changes in the institutional framework. The strategy proposes a first phase (Survival, years 1–2) during which the framework for the market-based provision of heating services would be put in place and during which tests would be conducted to see if consumers would choose existing centralized heat supply under conditions that would permit full commercialization of centralized heating services; the market also would be scrutinized for the emergence of private providers of autonomous heating services. Phase 2 (Recovery, years 3–5) would be characterized by the coexistence of surviving centralized heating systems with new heating options. Phase 3 (Growth, years 6–25) finally would see the emergence of large-scale demand for affordable heating solutions—primarily decentralized heating systems, possibly provided also through investment in DH modernization. These systems mostly would be provided by the private sector and would entail major improvements in service quality and coverage.

14. The actions proposed under the UHS for the first two phases (see Table 1) are "soft," concentrating on the provision of information to consumers and

(potential) suppliers; the elimination of legal, regulatory, and other institutional barriers to commercial and competitive heating options; and on enabling low-cost investment and setting the stage for more substantive investment in the third phase. This phasing is necessary as the heat market in Armenia is largely dysfunctional, with most consumers fending for themselves and the municipal heat suppliers bankrupt, supplying no more than 10 percent of the population with a service that is deteriorating and unable to collect more than a small fraction of the cost of centrally supplied heat. The UHS must overcome what are considerable barriers, ranging on the consumer side from a lack of information, income, and creditworthy consumer institutions (condominiums) to, on the supplier side, a lack of information on technical options and an enabling legal and regulatory framework for the commercial provision of heating services.

15. If centralized heating is to be retained the existing system will have to be modified to ensure that affordable heat is provided, in adequate quantities and of appropriate quality, without the use of widespread subsidies. The provision of heat must be controlled by the consumer, it has to be flexible, and it has to be billed based on metered consumption. One way of achieving a low-cost approximation of flexible heating would be to restrict supply to only one or two room radiators in each apartment (instead of to three or four), delivering a temperature of about 17° Celsius (assuming reasonable insulation), and to disconnect the remaining vertical risers. This is suggested only as an interim strategy, to buy time while the framework is constructed for market-driven heat supply. In practice, the investments needed to extend the life of centralized heating systems would make these systems much less competitive than autonomous and individual options and would expose them to a greater degree of market risk.

Table 1. UHS Phases and Actions

Phases *UHS Key Aspects*	*Survival* *(Years 1 and 2)*	*Recovery* *(Years 3–5)*	*Growth* *(Years 6–25)*
Regulation/market stimulation	Improve legal base for condominiums and adopt appropriate regulatory rules for different heat market segments	Stimulate and support embryonic heat market actors	Market monitoring
Institutional	Restructure CH companies for full cost recovery and accountability Develop condominium assistance program and implement pilot projects, especially on demand side	Commercialization and privatization of CH companies All collective heat consumers organized in condominiums and cooperatives	- -
Social	Develop social support scheme	Social support scheme operational	Social support scheme is phased out over suitable period
Technical All heating systems		If systems prove viable, introduce individual control and cost-allocation devices	Individual control is commonplace
Remaining DH systems	Disconnect risers to reduce supply costs; reduce heated area; install meters	Development dependent on market demand and full commercialization of DH entities	Improvements of CH infrastructure based on market demand and commercial financing
Other	Implement several building-level pilot projects	Simple demand side management measures implemented in buildings	Comprehensive building insulation and improvements
Gas infrastructure	Coordinate with pilot projects	Upgrade as necessary to support heating investments	Introduction of solar energy solutions for HTW
Promotional	***Implement comprehensive public awareness campaign*** Promote improved wood stoves	Continue information campaigns	
Financial	Set up affordable financing schemes for condominium heat infrastructure and private heating service providers	Enable mainstream access to affordable financing by condominiums and private heating service providers	Phase out any sovereign guarantees associated with condominium and heat supply financing schemes

16. Decentralized heating (autonomous systems) and individual natural gas heating should be promoted in all areas and, under a sensible institutional framework, be allowed to compete with centralized heat supply. The high initial costs associated with these options may, however, render them unaffordable to the majority of the population until economic growth improves the general purchasing power.

17. Recognizing that many households may in the short and medium term be unable to participate in collective, condominium-based arrangements or afford clean individual heating options, the government may wish to consider supporting the commercialization of wood stoves that are designed specifically for use in multi-

apartment dwellings. The environmental implications of continued wood burning would first need to be carefully assessed.

18. The low-cost insulation of buildings also should be encouraged by the systematic elimination of informational, institutional, financing, and affordability barriers. Measures such as the installation or repair of windows and doors in staircases and the tightening of window frames can be inexpensive and through the savings made can quickly recover their costs; they also can be done by the residents themselves. To capture the full benefits of such measures it may however be necessary to first have in place properly functioning condominiums.

Institutional and regulatory framework

19. *Condominiums*. The UHS presupposes that heating in multi-apartment residential buildings in urban areas is best provided centrally, as a communal service. At a minimum, each building should have its own central supply. The provision of central heating and other communal services is much facilitated if the apartment dwellers are organized and able to act as a single entity in their commercial relations with a service provider. About 50 percent of multi-apartment buildings in Armenia are organized as condominiums, but the overwhelming majority of such condominiums exist only on paper: the few active ones are severely constrained in the services they can provide to their members by institutional constraints and a lack of access to financing.

20. Households in multi-apartment buildings need support to organize effectively, either as a condominium or some other form of community-based group, and need training to manage their buildings and to contract communal services. This support should include at the minimum the following:

- legal changes to make condominiums more functional;
- the establishment of advisory centers and community activism to encourage urban households to form condominiums and other forms of community organizations;
- access to financing for building improvements and possibly for investment in community infrastructure;
- the provision, through enhancement of the family benefit program, of income support to low-income and vulnerable households, to enable them to meet their condominium obligations;
- a sustained broad information campaign and public education program, drawing on experience gained in demonstration projects.

21. Properly prepared condominiums can be effective counterparts for heat and other communal service providers. The experience of countries such as Lithuania indicates that the establishment and strengthening of condominiums can be the centerpiece of a successful heating strategy. The condominium should be legally responsible for providing heating to all its members, either by operating its own boiler and internal distribution system or by contracting out this service. It also should be responsible for managing heat distribution inside the building, for billing members for communal services provided to the condominium and collecting payments, and for full and timely payment to the heat supply company.

22. *The energy regulatory framework*. The market-based, competitive provision of heating services proposed by the UHS would require that changes be made to the legal and regulatory framework of the sector. Centralized heating services (district heating) would continue to be regulated by the Energy Commission, and the commission would continue to be responsible for technical and economic licensing, providing also the methodology for the setting of heat tariffs and approving the tariffs proposed by suppliers. Billing should be based on metered consumption, using a two-part tariff. Decentralized (autonomous) heating services would be based entirely on commercial contracts between supplier and customer. Suppliers would have to receive a technical license from the Energy Commission to ensure that their equipment and supply systems meet safety and environmental standards. They may also be required to submit to the commission key performance data for evaluation and dissemination by consumer protection groups.

23. *Commercialization of municipal heating companies*. Under the UHS, all heating providers would be required to operate on commercial principals, maintaining market-based relations with consumers, suppliers, and labor in a competitive environment. The existing heat supply providers in particular would have to change dramatically to achieve commercial viability and to avoid being closed down.

24. *Financial mechanisms*. Households, condominiums, small entrepreneurs, and municipal service providers in Armenia have basically no access to financing: the financial sector is reluctant to provide financing for ventures with perceived high risk. The UHS proposes the establishment of lending schemes accessible to condominiums and to private entrepreneurs that want to operate small boilers and sell heat to condominiums. Alternatively, credit enhancement and risk sharing mechanisms could be introduced that would encourage financial institutions to extend credits from their existing funds. All technical and institutional models for supplying heating services would have to be tested, however, before many of these financing schemes could be advanced and mainstreamed.

25. *Social and environmental concerns*. To enable poor households to take part in collective heat supply, the government of Armenia should develop a targeted social support scheme to replace the indirect, across-the-board subsidies to district heating. The purpose of such a scheme would be to mitigate situations in which the potential for chronic nonpayment by families within a condominium would prevent the condominium from entering into economically efficient contracts for communal services.

26. Until the UHS is implemented—and even after implementation—a large number of families would still have to rely on individual heat sources. Poor families in particular would inevitably continue to use wood or dung, with their associated environmental problems and social costs. While Armenia's deforestation problem should decrease substantially with the implementation of the UHS, deforestation might not cease completely. In the short and medium terms the government therefore should consider subsidizing the development or the capital cost of more efficient wood stoves.

1

Introduction

1.1 This report presents the outline of an urban heating strategy (UHS) for Armenia. The document is an output of Urban Heating Strategy Development for the Republic of Armenia, a project that was financed by international donors and based on contract TSP/F-Cons./01-2001 between

"Termosupply programms" PIU' SI
Ministry of Finance and Economy, Armenia
1 Melik-Adamyan St.
375010 Yerevan
Armenia
and
COWI A/S
2, Parallelvej
DK-2800 Kgs. Lyngby
Denmark

RAMBOLL of Denmark was subconsultant on the project.

1.2 This report contains:

- Summary of findings from Phase 1 of the project (presented in the Phase 1 report, October 2001) and from the work on institutional issues in Phase 2 (most of it presented in the Second Progress Report, October 2001).
- Findings from the analysis of institutional and social issues as discussed during a workshop in Yerevan on November 5-6, 2001.
- Results of financial calculations using a 20-year horizon to compare several heating options.
- Proposed outline of UHS and plan for commercialization of the heating sector.

2

Background

General Background

2.1 The economic blockade of 1992–94 reduced Armenia's ability to import petroleum and natural gas products, resulting in the collapse of many of the country's centralized heating systems. Today only about 10 percent of the population (and some public buildings) are served by these systems, compared to 35 percent of the population before the crisis. Low payment collection rates furthermore mean that the existing heating systems are not properly maintained and are increasingly unable to maintain minimum temperatures in apartments.

2.2 Urban households that do not have centralized heating are turning in growing numbers to fuelwood for heating, which in poorly ventilated apartments has serious health consequences. The use of fuelwood also causes environmental damage, with deforestation contributing to the silting of hydro reservoirs and to an increasing number of landslides.

2.3 The Republic of Armenia needs a new approach to meet the heating needs of its population. The Energy Regulatory Commission must adopt a strategy for development of a commercial heating sector based on analysis of the different heat supply options, and specifically of the affordability and environmental sustainability of these options. The legal and institutional arrangements also are important. At the consumer level, it is envisaged that homeowner associations (condominiums) will play an important role.

2.4 The security of fuel supply additionally is crucial for the functioning of any heating system. Major parts of Armenia's extensive gas distribution system have not been used for years, and their rehabilitation is only slowly getting under way.

2.5 This report summarizes the technical and economic aspects of the different urban heating supply options that have been identified as feasible for four selected cities: Yerevan, Charentsavan, Gyumri, and Jermuk. It also examines the institutional, legal, and regulatory framework for these systems, taking into account the key criteria of basic heating needs, fuel supply, and affordability. The conclusions of this study form the basis of an urban heating strategy (UHS) for Armenia. The UHS will provide the strategic framework for the short- and medium-term development of the Armenian urban heating sector.

Findings from Financial Analysis of Short-Term Options

2.6 The first phase of the project analyzed the different heat supply options that were thought to be feasible in the short and medium term (three to five years). The analysis was based on a minimum investment strategy that assumed that all existing plant and equipment would be kept in operation without any rehabilitation or reinvestment.

2.7 The different zones and heating options are defined in Box 2. (It should be noted that not all zones are present in all cities.)

Box 2. The Different Heating Options Defined

CHP (Zone 1): Areas supplied with heat from combined heat and power (CHP) plants (applies only to Yerevan)

Large HOBs (Zone 2): Areas supplied with heat from large heat-only boilers (HOBs)

Small HOBs (Zone 3): Areas supplied with heat from small HOBs

Reconnection to CH (Zone 4): Reconnection of areas that have been disconnected from centralized heating (CH)

No reconnection to CH (Zone 5): Areas that have been disconnected from CH and which cannot be reconnected due to the deterioration of infrastructure

'*Block*': A small building-level boiler providing heat for an autonomous supply scheme to between one and four buildings. *Block 1* is based on an HOB and *Block 2* on a small CHP plant

Individual: Individual supply of heat from electricity, natural gas (NG), solid fuels (normally wood), liquefied petroleum gas (LPG), or kerosene. To facilitate comparisons with CH, the individual natural gas solution uses the assumption that three or four gas stoves would be used per apartment. In practice, as few as one or two stoves per apartment would be used, making the individual natural gas option more competitive than suggested here.

2.8 The main findings were:

1) In the short and medium term, the continuation of CH is shown to be a least-cost strategy for all four cities (see Tables 2–5 in Chapter 3). In many networks, and especially in Gyumri, the operation and maintenance costs nonetheless are too high, indicating that there is scope for rationalization.
2) Of the individual heating solutions, solid fuel (wood) stoves and individual natural gas appear to be the cheapest solutions. Electricity, LPG, and kerosene are the most expensive heating sources. Given the high cost of electricity, the widespread use of electrical heating reported in the household survey can probably be explained by the inconvenience and nuisance of using wood and the fact that individual use of gas is not generally an option. Electricity furthermore is a flexible heat source that supplies heat where it is needed, in the quantities needed, and for the duration needed.
3) A comparison of individual and autonomous systems with CH suggests that in some cases the reconnection of interrupted CH (Zone 4) could lower the overall cost of heat supply. Where only half or less of an apartment is heated—a common situation at present—reconnection would be much less competitive.
4) The actual payment recovery for CH (between AMD 3,000 and AMD 25,000 per household per year) would not be enough to sustain any of the options analyzed—not even the minimal option of wood stoves

heating 25 percent of the apartment space to a low temperature in a shortened heating season.

5) The results of the household survey (see Section 2.3) suggest that the willingness to pay (WTP) for CH at an improved level is in the range of AMD 9,000 to AMD 12,000 per household per month during the heating season. At this level of payment the only affordable option is that of wood stoves heating less than 50 percent of the living space—the heating option, in fact, that already is used by many poor and very poor. This reinforces the view that CH must be provided in a manner that is adaptable to people's needs and affordability. The WTP analysis was based, however, on a promise of full heating of all rooms, and it should not be assumed that people would be willing to pay the amount quoted here for 50 percent heating or less.

6) The sensitivity analyses show that a flexible CH or autonomous supply could compare in price with the lowest-cost alternative of reduced-area wood stove heating. Given the inconvenience and the adverse health and environmental effects of wood burning in apartments, there therefore is a strong case for promoting CH as the better option, even to the poorest.

7) Even in the 25 percent heated case electrical heaters were found to be more expensive than CH, autonomous systems, or wood stoves. The fact that electrical heaters are used by many very poor families indicates that there would be a strong willingness to change to a system that is cheaper but which offers the same convenience and flexibility, such as CH or autonomous systems with individually regulated radiators.

Main Findings from the Household Survey

2.9 A qualitative and quantitative household survey was carried out in the four cities by international and Armenian consultants (ERM 2001). The main findings of the survey are as follows:

1) People prefer CH to all other solutions due to its cleanliness and convenience.
2) There is strong antipathy toward collective solutions such as condominium-based heat supply contracts.
3) The shortage of people able to take a leadership role is a major barrier to collective, decentralized solutions.
4) Most people would prefer to have CH supplied by the state for its perceived low cost and convenience.
5) People would be prepared to participate in resolving the heating problem, but would prefer to do so by contributing their labor rather than by making a financial contribution or taking personal responsibility for the solution, as would be the case in a condominium scheme.
6) The energy consumed for space heating accounts on average for 45 percent of an urban household's annual energy consumption. Heating accounts for about 5 percent of total household spending, but the poor

spend almost twice as much (6 percent) of their household budget on heating as do the non-poor (3 percent). Non-poor households spend about AMD 16,500–27,500 (US$30–50) a year on heating and poor households about AMD 13,750–22,000 (US$25–40).

7) Poor households also suffer non-monetary costs. These include the health costs associated with not having enough heat and the resulting productivity losses, and the health costs associated with burning dirty fuels in an inadequately ventilated environment. The heavy use of fuelwood additionally has environmental costs associated with deforestation and the opportunity costs of time spent collecting heating material, especially wood.

8) Few households pay for their district heating. According to the consumer surveys, household bills for DH average AMD 35,000–42,900 a year. The payment of bills, however, recovers only AMD 3,000–26,000 per household per year.

9) Eighty percent of households indicate a willingness to pay (WTP) more than AMD 24,000 AMD per year for a well-functioning collective heating system. This is consistent with the estimates of current expenditure in point 6 above, but is significantly more than most households pay for CH services (point 8).

10) Only about 50 percent of respondents indicate a WTP of the amount equal to current CH tariffs, even for an improved CH service. This suggests that the current typical fixed yearly charges for CH services are too high.

11) The highest level of cost recovery that could be achieved under the improved heating scenario, which maximizes the number of people who would be willing to pay against the total revenue that could be generated by the CH tariffs, is approximately AMD 36,000 per household per year.

12) It is unrealistic to expect that the average resident in any of the four cities would be able to pay the full cost of heating an entire apartment for all of the winter. It is essential therefore that DH be supplied in a flexible manner, perhaps offering the capability for individual regulation.

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Findings on Institutional Issues

2.10 The findings below are in part those arrived at during a Workshop on Institutional Issues of the UHS held on November 6, 2001 in Yerevan (see also Annex E).

The Role of Condominiums

2.11 Armenia already has many condominiums (602 in early 2001, representing 4,000 buildings and 182,000 apartments), but fewer than 50 percent are active and even fewer are involved in heat supply as an interface between the DH companies and individual consumers.[1]

2.12 Households in multi-apartment buildings tend to be skeptical about the likely effectiveness of condominiums (ERM 2001). The most commonly cited reasons are the following:

- lack of ability to pay for collective action,
- refusal to pay, because of the poor quality of service,
- the high number of vacant apartments (according to the survey, approximately 25 percent of households are absent from their apartments),
- psychological issues affecting participation (many people are out of work and poor, and the resultant feelings of disempowerment and indifference diminish their interest in collective action).

2.13 Other barriers for using condominiums in the UHS are:

- condominiums often consist of so many buildings that it can be a problem to achieve a proper democratic spirit,
- there is no financial support for condominiums, and no access to loans,
- it is virtually impossible to force nonpaying members to pay up,
- the condominiums are not linked to the sort of social support schemes that could help the poorest participate in activities that incur costs.

2.14 The experience of other countries, such as Lithuania, nonetheless indicates that the establishment and strengthening of condominiums can be the centerpiece of a successful heating strategy. The formation of operational and active condominiums in the cities to be affected by the UHS is probably a precondition for the provision of any form of communal heat service.

2.15 The following responsibilities and roles therefore are envisaged:

- The condominium should be legally responsible for contracting the heat supplier for deliveries to the entire building. The contract should describe the terms and conditions of delivery, tariffs, and so on and so forth. It should be a precondition that there be a meter at the inlet to the house, and that it be possible to cut the connection if payment does not take place in accordance with the contract.
- The condominium should be responsible for managing the distribution of heat inside the building and should be responsible for maintenance of heating installations inside the building. This would require that access to all apartments be permitted in the event of problems occurring with the heat installations.

[1] Some contracts do exist, however. ERM (2001) reports one case in the Davitashen district in Yerevan in which the DH company has made a contract with the condominium.

- The condominium should be responsible for billing apartments according to their individual consumption of heat.
- The condominium should be responsible for the collection of payment and for making payment to the heat supply company. Should the supplier be unpaid, supply to the whole building should be cut.

Required Changes in the Set-Up for Condominiums

2.16 The law on condominiums is in the process of being amended, and these amendments should include the following changes to enable condominiums to act efficiently within the envisaged heat supply strategy.

Collection fee

2.17 Current practice is that the heat supply company employs a resident to collect the payment from each customer, paying a fee for this work that generally amounts to 5 percent of the collected payment. This practice dates to the Soviet era. In most cases the collector is not the manager or chairman of the condominium.

2.18 While the outsourcing of the billing and collection of utility payments is practiced around the world and frequently has been recommended by the World Bank, in Armenia's case it contributes to the dysfunctionality of the collection system. A system that operates a single contract between the heat provider and the building as a whole, thus making the condominium itself responsible for the payment, would make payment collection much cheaper and easier, and this should be reflected in lower tariffs. The condominium management should be responsible for collection of payments from its members, and the cost of collection should be part of the condominium fee. This is common practice in many countries.

Size and staff of condominium

2.19 Some large condominiums in Armenia have been reasonably successful, and the indications are that this is because their chairmen may be motivated by the size of the fee they collect. For the UHS, however, it is suggested that a condominium be limited in size to facilitate one-point metering and fee collection and to enable the possibility that nonpayment be penalized through the interruption of supply. As a condominium can also be too small and its proper functioning thus constrained, it is important to find an appropriate compromise. During discussions of this issue it was suggested that a condominium be large enough to surround a common external space but no larger.

Property of condominium

2.20 The transfer of common property from the municipalities to condominiums has not yet begun. The municipalities frequently establish and rent out garages in condominium yards and yet often require that the condominium keep the remaining areas clean. Transferred t the condominium, these common areas could become a source of income that could finance other common projects.

The Energy Regulatory Framework

Heat tariffs

2.21 The existing provisions on tariff setting do not enable the billing of a fixed component and a variable amount that is charged according to actual consumption. This should be changed. Billing for a fixed component would ensure that all connected consumers contribute to system costs, including those that do not use heat to supplement the ambient heat from internal pipes and neighboring apartments. This is a key issue for the Energy Commission to address.

Contracting with the condominium

2.22 The existing legal framework recognizes the condominium as a legal entity and thus allows for contracting with the condominium, but there are no examples of this happening. In cases in which service contracts have been made with condominiums the contracts do not introduce the condominium as the legal purchaser (customer) of heating services: the condominium merely acts as a billing and collection agent for the service.

2.23 The outline of the UHS encourages heat suppliers to contract with condominiums as legal entities and the consultants have drawn up model contracts for this purpose. These are included here as Annex C (draft model contract for heat supply to a condominium) and Annex D (model licensed management contract for a boiler house).

Cutting supply to buildings

2.24 To facilitate the cutting of heat supply to buildings in the event of nonpayment, it is suggested that the condominium main charter clearly stress the common responsibility to pay utility bills and to specify that nonpayment will result in sanctions for all condominium members. To accommodate this, it is essential that model contracts for heat supply be prepared for all centralized heating and small autonomous systems.

Access to apartments

2.25 In accordance with the Armenian Constitution, access to private property is permitted only with the owner's consent or through the decision of a court. It is proposed that an accelerated legal procedure be implemented to oblige the court to approve or reject within two days of submission any application for access. In urgent cases, such as in the event of a leaking pipe, forcible access to an apartment should be permitted in the presence of members of the condominium, the housing management body, or the local authority.

2.26 Given the great number of uninhabited apartments it is proposed also that the "Energy Law" or the Civil Code be amended to require residents to inform the condominium or housing management of any prolonged absence that may be due to a move, for example. If the period of absence includes the heating season or part of it, the resident should be required to either cut off the heat supply or pay for the energy consumed. The resident should in any case nominate a proxy to provide access to the apartment should this become necessary.

3

Feasibility Analysis of Heating Options

Extension of Phase 1 Analysis

3.1 In Phase 1, the financial analysis focused on the short-term, five-year horizon, considering only the minimum investments necessary to keep systems running. This provided information about the options operating at present that is particularly useful given the limited possibilities of obtaining financing for any major investments.

To make longer-term strategic choices it was necessary to carry out similar analyses with a longer planning horizon and under the assumption that financing can be obtained for major improvements. This allowed a determination of the long-run costs of different heat supply options.

Methodology Used in Analysis of Heating Options

3.2 The main difference from the Phase 1 report is that major investments to ensure that plant and equipment would be functional in 20 years have been included in the analysis of CH supply. The new analysis additionally uses a cashflow methodology, wherein all future cashflows are discounted by a factor of 10 percent a year. (The Phase 1 analysis used a levelized annual cost approach.) The basic assumptions for the analysis are presented in Annex H.

3.3 Because it is impossible at this stage to prioritize one investment over another, the assumed investments relating to each single supply area are all assumed to be made simultaneously, as 10 years of consecutive investments of one-tenth of the total investment need.

3.4 The Armenian UHS relies on natural gas as the main heating fuel. For it to be able to supply the various types of heating systems, the natural gas transmission and distribution system requires investments in rehabilitation and in the establishment of new facilities. These investments have not been included in the calculations in Section 3.3, but they are taken into account in the affordability-adjusted scenarios on an area-by-area basis.

Results of Analysis

3.5 The results of the 20-year horizon analysis are presented for scenarios of normative and reduced heat demand.

3.6 The scenario of normative heat demand uses the Armenian (Soviet) SNIP norms for heat consumption in each type of standard building, including the consumption of 50 liters per person per day of hot tap water (HTW). This takes into account also that people bleed water from their radiators for HTW purposes.

3.7 The scenario of reduced heat demand replicates the way that heat is consumed in households that are individually heated using electricity, wood, or other solid fuels. This style of heating is characterized by the heating of a small part of the living area and the maintenance elsewhere of a temperature that is much lower than the normative comfort temperature of 20° Celsius. In this scenario the normative space heating demand is reduced by 50 percent and the HTW demand is eliminated, resulting in a total reduction of around 60 percent of the normative heat demand.

3.8 Tables 2–5 compares the results using a 20-year horizon with normative and reduced heat demand to the results using a five-year horizon, as calculated in the Phase I report. The short-term and long-term

3.9 comparisons of options should not be directly compared since the two calculation methods are dissimilar and since small changes have been made in the area delimitations. These changes do not, however, not change the general picture. The options with the lowest costs are presented in boldface.

Table 2. Comparative Cost of Heat in Yerevan (U.S. dollars per Gigajoule and per square meter of total dwelling area[2])

Yerevan	*20-YEAR HORIZON*				*5-YEAR HORIZON*	
Heat Price	*Normative heat demand*		*Reduced heat demand*		*Normative heat demand*	
	US$/GJ	US$/$m^2$/ year	US$/GJ	US$/$m^2$/ year	US$/GJ	US$/$m^2$/ year
Zone 1=CHP	8.75	3.54	17.02	2.93	8.69	3.51
Zone 2=large HOB	7.21	3.02	12.61	2.29	5.22	2.19
Zone 3=small HOB	9.26	3.80	17.50	3.08	**5.03**	**2.07**
Zone 4= Reconnection to CH	7.07	2.86	12.52	2.17	7.33	2.97
Block 1 – HOB	**5.32**	**2.15**	**8.79**	**1.54**	6.00	2.42
Block 2 – CHP	10.23	4.14	23.67	4.14	12.70	5.13
Individual electricity	13.98	5.65	15.74	2.75	14.44	5.83
Individual NG	6.94	2.80	11.62	2.03	8.16	3.30
Individual solid fuels	7.58	3.06	10.50	1.84	7.82	3.16
Individual LPG	15.52	6.27	17.15	3.00	16.00	6.46
Individual kerosene	16.63	6.72	17.94	3.13	17.02	6.87

[2] This is different from the concept of “useful area” used for tariff setting. An apartment of 50–60 m^2 will have less than 40 m^2 of “useful area.”

Table 3. Comparative Cost of Heat in Charentsavan (U.S. dollars per Gigajoule and per square meter of total dwelling area)

Charentsavan	*20-YEAR HORIZON*				*5-YEAR HORIZON*	
Heat Price	*Normative heat demand*		*Reduced heat demand*		*Normative heat demand*	
	US$/GJ	US$/m²/ year	US$/GJ	US$/m²/ year	US$/GJ	US$/m²/ year
Zone 1=CHP	-	-	-	-		
Zone 2=large HOB	-	-	-	-		
Zone 3=small HOB	7.13	3.73	12.74	2.93	**4.83**	**2.53**
Zone 4= Reconnection to CH	9.74	4.81	18.68	4.02	6.01	2.95
Block 1 – HOB	**5.11**	**2.54**	**8.24**	**1.79**	5.75	2.86
Block 2 – CHP	9.60	4.78	21.97	4.78	11.90	5.91
Individual electricity	13.76	6.85	15.21	3.31	14.15	7.03
Individual NG	6.36	3.17	10.22	2.22	7.39	3.67
Individual solid fuels	7.22	3.59	9.63	2.09	7.42	3.69
Individual LPG	15.32	7.63	16.66	3.63	15.72	7.81
Individual kerosene	16.48	8.21	17.55	3.82	16.80	8.34

Table 4. Comparative Cost of Heat in Gyumri (U.S. dollars per Gigajoule and per square meter of total dwelling area)

Gyumri	*20-YEAR HORIZON*				*5-YEAR HORIZON*	
Heat Price	*Normative heat demand*		*Reduced heat demand*		*Normative heat demand*	
	US$/GJ	US$/m²/ year	US$/GJ	US$/m²/ year	US$/GJ	US$/m²/ year
Zone 1=CHP	-	-	-	-		
Zone 2=large HOB	5.40	3.88	7.77	2.50	**5.35**	3.85
Zone 3=small HOB	-	-	-	-		
Zone 4= Reconnection to CH	7.49	4.84	12.49	3.64	6.16	4.43
Block 1 – HOB	**4.78**	**3.28**	**7.41**	**2.26**	**5.35**	**3.67**
Block 2 – CHP	8.65	5.93	19.45	5.93	10.63	7.28
Individual electricity	13.45	9.22	14.48	4.41	13.74	9.41
Individual NG	5.55	3.80	8.26	2.52	6.29	4.31
Individual solid fuels	6.71	4.60	8.41	2.56	6.85	4.70
Individual LPG	15.03	10.30	15.98	4.87	15.33	10.50
Individual kerosene	16.25	11.14	17.00	5.18	16.48	11.30

Table 5. Comparative Cost of Heat in Jermuk (U.S. dollars per Gigajoule and per square meter of total dwelling area)

Jermuk	*20-YEAR HORIZON*				*5-YEAR HORIZON*	
Heat Price	*Normative heat demand*		*Reduced heat demand*		*Normative heat demand*	
	US$/GJ	US$/m²/year	US$/GJ	US$/m²/year	US$/GJ	US$/m²/year
Zone 1=CHP	-	-	-	-		
Zone 2=large HOB	6.44	3.82	11.23	2.91	**5.10**	**3.02**
Zone 3=small HOB	9.74	5.54	18.89	4.66	5.76	3.28
Zone 4= Reconnection to CH	**4.56**	3.01	**6.86**	2.00	6.71	4.42
Block 1 – HOB	4.76	**2.81**	7.44	**1.91**	5.30	3.13
Block 2 – CHP	8.55	5.04	19.61	5.04	10.49	6.19
Individual electricity	13.59	8.02	14.82	3.81	13.91	8.21
Individual NG	5.90	3.48	9.17	2.36	6.76	3.99
Individual solid fuels	6.93	4.09	8.97	2.31	7.10	4.19
Individual LPG	15.16	8.94	16.30	4.19	15.50	9.14
Individual kerosene	16.35	9.64	17.26	4.44	16.62	9.80

3.10 The following conclusions can be drawn:

- The effect of the reduced demand is that prices per Gigajoule for all heating options almost double, whereas prices per square meter of apartment are reduced by 20–40 percent.
- The least-cost solution in the long term is an autonomous system with a small heat-only boilerhouse supplying a small number of buildings (called Block 1 in the tables). This is the case both for normative and reduced demand. However, an individual natural gas option with a reduced number of gas stoves per apartment would in many cases be cheaper and would probably (even though it does not give the same level of comfort as district heating) in many areas be a competitive solution, provided the safety aspects can be satisfactorily addressed.
- In the reduced case, Block 1 is financially more or less comparable with solid fuel (wood) stoves, but the heat-only boiler should be preferred for its higher convenience and for the avoidance of wood cutting. [3]
- In the short term, CH is least-cost in many areas due to the fact that it utilizes equipment and plant that is already written off.
- Small CHP (Block 2) is not feasible at present, but it may become more financially attractive after 2008, when the Medzamor nuclear power plant is scheduled for decommissioning and there will be a need for alternative electricity generation.

3.11 In some cities the reconnection of CH (Zone 4) appears to be the cheapest option, but this is misleading. While a small investment may appear

[3] The calculations assume a standard wood stove purchased at low price and with poor efficiency. The result would be slightly different if the calculations were based on a more expensive, more efficient wood stove.

sufficient to bring significant benefits, that investment can only be made on the back of much larger investments in plant rehabilitation. The investment to reconnect CH cannot be made on its own.

3.12 The conclusion to which these calculations point appear to point is that all CH systems should be abolished and autonomous systems promoted instead. However, it would be neither financially beneficial nor in practice possible to reorganize all existing CH into autonomous systems at the same time as promoting such systems in zones where DH is no longer operational (Zones 4 and 5). The heating cost in each zone as presented in the tables furthermore is an average value that disguises the underlying variations in financial viability between more and less densely populated areas in the same zone.

3.13 As a more realistic basis for a heating strategy, the following recommendations therefore are made:

- In the short term, CH in Zones 1–3 should be maintained to the extent that it is possible to supply affordable heat to customers. This should be proved by a business plan.
- In the longer term, CH supply should only be maintained in the most financially viable supply areas. In all others it should be discontinued (see Section 4 for more details).
- CH in Zone 4 should not be resumed in the short term, except in the rare cases where a viable reconnection can be made for little cost. Autonomous systems should be promoted in the place of CH (see Section 4).
- Autonomous systems should be promoted in Zone 5 and in the parts of Zones 1–3 that will be disconnected from CH.
- If a new medium-size CHP plant were to be built in Yerevan, it could provide the cheapest source of heat for areas adjacent to the plant. This would only be the case should there prove to be a real need for the extra power, however, such that the heat produced could be priced as a waste product.

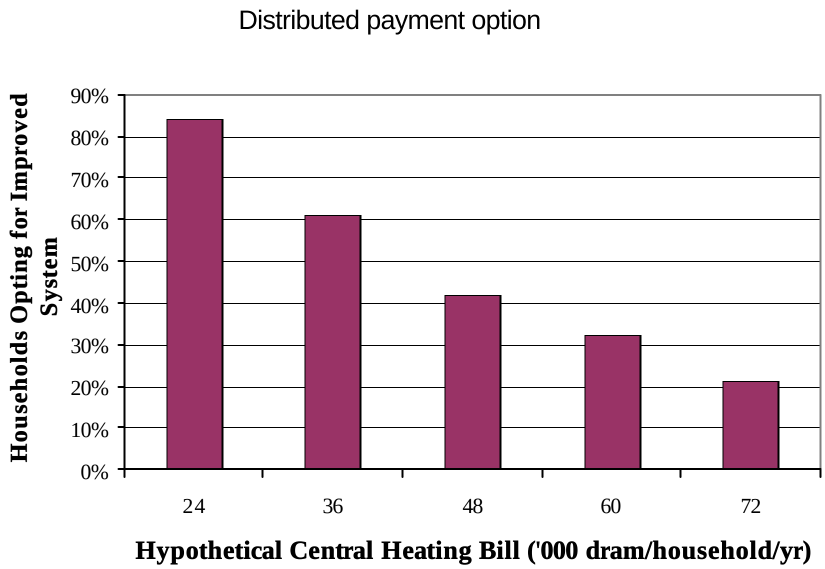
3.14 It is worth noting that these results only are valid under the assumption that the relative prices of the different fuels will remain as they are today. In reality, both gas and electricity are priced at less than international levels and therefore are likely to increase in price. The significance of future price increases for these fuels is uncertain, because wood is likely also to become more expensive as forest resources are depleted and wood cutting restrictions enforced.

3.15 For more details on the different heating options see Annex F and Annex G.

Affordability-Adjusted Scenarios

3.16 The overall conclusions of the financial analysis in the above section can be compared to the willingness to pay (WTP) as based on the household survey results (see ERM 2001). The results in Tables 2–5 can be converted to annual payments by multiplying by the average apartment size (60 square meters for Yerevan and 58 square meters for the other cities). For the four cities this produces a heat bill of around AMD 90,000 per year assuming normative heat demand and around AMD 60,000 per year assuming reduced heat demand.

Figure 1. Willingness To Pay for Centralized Heating



Source: ERM (2001).

3.17 The survey results were as follows: 80 percent of households responded that they would be willing to pay AMD 24,000 (US$50) annually for an improved supply of centralized heating, 60 percent would pay AMD 36,000 (US$70), and 40 percent AMD 48,000 (US$100) (see Figure 1). This suggests that probably less than 10 percent of people would be willing to pay for the normative heat supply and only around 30 percent for even the reduced supply solution.

3.18 The implications of this finding are significant:

- It would be difficult for CH suppliers to find buildings with enough customers to buy even the most reduced supply option.
- It would be difficult to motivate condominiums to engage in heat supply.
- In the short term, the "cheap" existing supply options, applying a minimum investment strategy and selling a reduced supply option, would have the best chance of attracting customers. The DH infrastructure would continue to deteriorate if this option were taken, however.
- Electricity and wood stoves, which have low investment costs and offer the capability of reducing supply to whatever level is affordable, will continue to play a major role in heat supply, at least in the short and medium term. The use in apartment buildings of wood as a fuel should be discouraged, however, not only for reasons of fire safety and

indoor air pollution but also because of the impact on deforestation. Under "normal" circumstances wood would not be used in apartment buildings; under the circumstances described in this report fuelwood accounts for 24–48 percent of Armenia's annual allowable cut of wood.[4]

3.19 Given these findings, the following guidelines are recommended:

1) The urban heating strategy should consist of a first phase during which it is tested whether the CH options can be made financially viable (**survival**), followed by a period during which the surviving CH systems coexist with new heating options (**recovery**), and a period of larger investment to produce massive improvements and new construction (**growth**) to reach the majority of the urban population.
2) If CH is to be continued, modifications will have to be made in the way it is supplied to consumers to ensure the delivery of **affordable** quantities and quality of heat without the need for subsidies.
3) **Decentralized heating** (autonomous systems) and **individual natural gas** should be promoted in all areas where a sustainable CH option does not exist. Such systems will not, however, be affordable to the majority of the population until such time as economic development has improved general purchasing power.
4) The government should consider supporting the commercialization of **improved wood stoves** for those families that are unable to avail themselves of the solutions suggested in this strategy.

3.20 A number of affordability-adjusted scenarios have been prepared to assess the feasibility of this approach (see also Annex A). These scenarios assume a drastic reduction of heating demand during the survival period, to bring the demand into line with that which is identified by the household survey as affordable. Investment in existing heat supply networks also is kept at an absolute minimum. In the recovery period the demand starts to increase, and during the growth period demand returns to the norm and the necessary investments in and rehabilitation of existing CH are made.

3.21 The demand for heating can be reduced by decreasing the comfort temperature, heating only a fraction of the apartment, and disconnecting on average one-third of buildings (those with the lowest WTP). The principle is demonstrated in Table 6, taking Yerevan as an example.

[4] The range depends on how much of the solid wood is earmarked for other purposes, such as construction. In addition to apartment buildings, detached houses in urban and rural areas also consume a significant amount of wood for heating purposes.

Table 6. Affordable Heat Demand in Yerevan

	Heating days	*Degree-days*	*Indoor temp. (°C)*	*Area heated*	*Heat demand*	*Connection*	***Supply rate***
Normative	139	2,241	17	100%	100%	n/a	**100%**
Present situation	90	1,683	17	100%	75%	100%	**75%**
Years 1–2 (Survival)	90	1,323	13	67%	40%	67%	**27%**
Years 3–5 (Recovery)	90	1,683	17	75%	56%	75%	**42%**
Years 6–25 (Growth)	around 110	1,962	17	88%	77%	90%	**69%**

3.22 Tables 7–10 indicate the average cost of supplying a standard apartment during a heating season for each heating option (including CH from each of the existing boiler houses) during the three phases proposed for the heating strategy. It should be noted that the number of degree-days[5] is different from city to city, with Gyumri being the coldest and Yerevan the warmest city. This accounts in part for the difference in heating costs between the cities. The main assumptions are listed in Annex A. The results for Yerevan are presented graphically in Figures 2–4.

Table 7. Affordable Heat Supply Options in Yerevan (AMD/apartment/year)

	Years 1–2 (Survival)	***Years 3–5 (Recovery)***	***Years 6–25 (Growth)***
Subzone 1.1 (Shengavit)	47,415	50,760	104,066
Subzone 1.2 (Erebuni)	46,563	**50,632**	99,219
Subzone 2.1 (Davidashen, BH 3)	**36,324**	53,021	95,689
Subzone 2.2 (New Nork – part 1, BH 4)	43,048	59,357	93,368
Subzone 2.3 (New Nork – part 2, BH 5)	48,702	66,796	103,936
Subzone 2.4 (Malatya-Sharhumian, BH 7)	44,537	62,659	104,448
Subzone 2.5 (Avan, BH 11)	42,636	59,618	96,797
Subzone 3.1 (Arabkir – Total)	38,844	54,796	94,733
Subzone 3.2 (Qanaqer-Zeytun - D20 N 8/1)	44,013	60,784	102,447
Block heating (HOB)	70,783	78,684	81,471
Individual electricity	88,780	131,503	154,200
Individual natural gas	69,788	80,029	83,760
Individual solid fuel	43,533	64,197	**73,311**
Individual LPG	96,923	144,790	169,628
Individual kerosene	102,165	153,270	177,791

Note: BH – Boiler house

[5] Degree-days is a way to calculate the annual heating requirement in a specific location by both taking into account the difference between ambient temperature and the temperature required inside a house for a sufficient level of comfort and the number of days heating is needed.

Table 8. Affordable Heat Supply Options in Charentsavan (AMD/apartment/year)

	Years 1–2 (Survival)	*Years 3–5 (Recovery)*	*Years 6–25 (Growth)*
Subzone 3.1 (BH 2)	60,039	76,094	147,083
Subzone 3.2 (BH 4)	55,500	69,837	125,949
Subzone 3.3 (BH 5)	48,899	62,926	119,596
Block heating (HOB)	80,541	89,083	95,501
Individual electricity	107,141	153,050	193,416
Individual natural gas	75,187	86,278	94,725
Individual solid fuel	44,658	63,215	78,549
Individual LPG	117,668	169,135	213,936
Individual kerosene	124,898	179,949	226,346

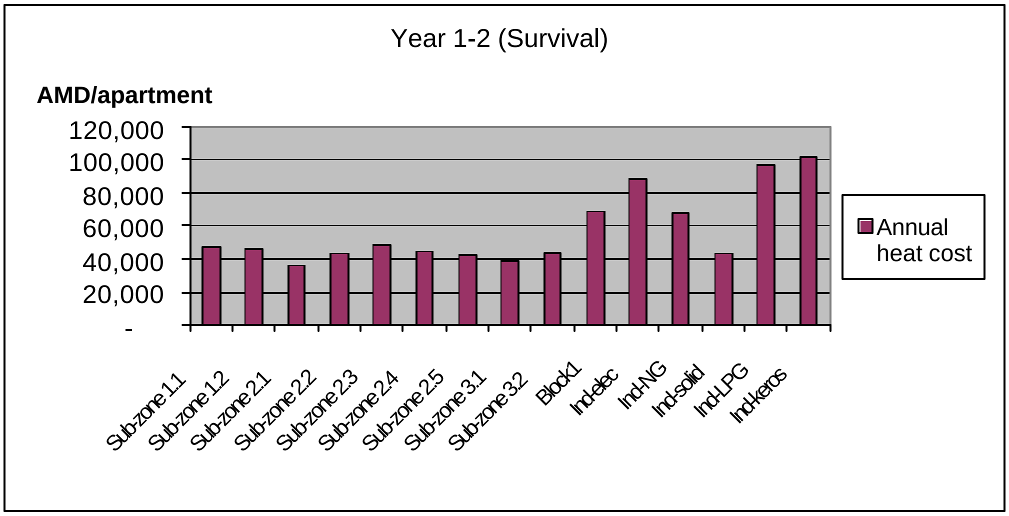
Table 9. Affordable Heat Supply Options in Gyumri (AMD/apartment/year)

	Years 1–2 (Survival)	*Years 3–5 (Recovery)*	*Years 6–25 (Growth)*
Subzone 2.1 (ANI boiler)	91,588	103,626	144,827
Block heating (HOB)	100,855	111,761	116,337
Individual electricity	145,711	203,087	234,759
Individual natural gas	85,256	99,408	105,535
Individual solid fuel	60,985	84,395	96,049
Individual LPG	161,247	225,671	260,648
Individual kerosene	172,653	241,901	277,534

Table 10. Affordable Heat Supply Options in Jermuk (AMD/apartment/year)

	Years 1–2 (Survival)	*Years 3–5 (Recovery)*	*Years 6–25 (Growth)*
Subzone 2.1 (BH 3)	65,032	79,509	126,574
Subzone 3.1 (BH 1)	56,809	77,831	187,431
Block heating (HOB)	82,809	93,792	99,526
Individual electricity	119,764	177,483	214,645
Individual natural gas	77,471	91,714	99,307
Individual solid fuel	50,001	73,557	87,535
Individual LPG	131,931	196,741	237,923
Individual kerosene	140,527	210,200	252,630

Figure 2. Annual Heating Costs for Standard Apartment during Survival Phase, Yerevan



Note: Zones 1–3 signify centralized heating options, where Zone 1 is based on CHP, Zone 2 on large HOBs, and Zone 3 on small HOBs

Figure 3. Annual Heating Costs for Standard Apartment during Recovery Phase, Yerevan

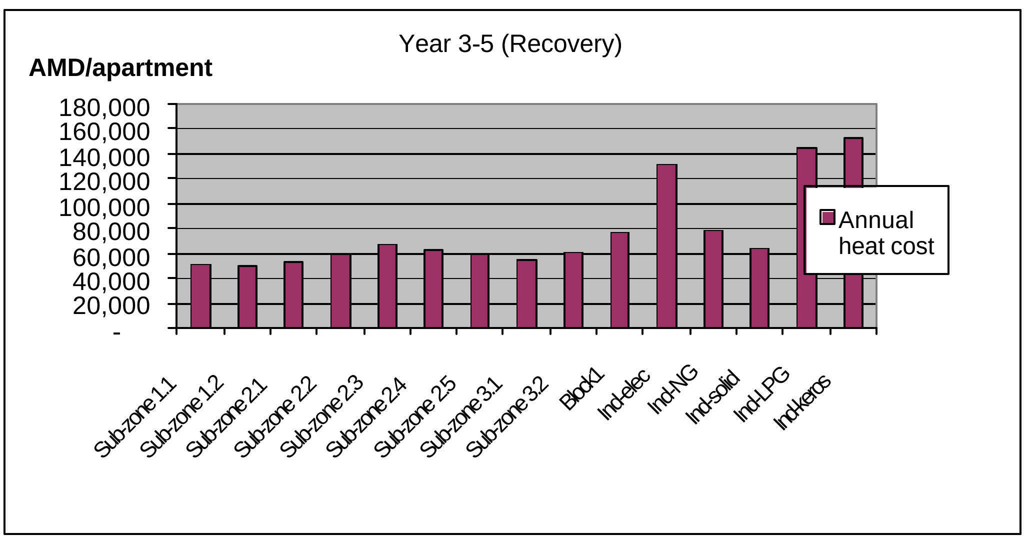
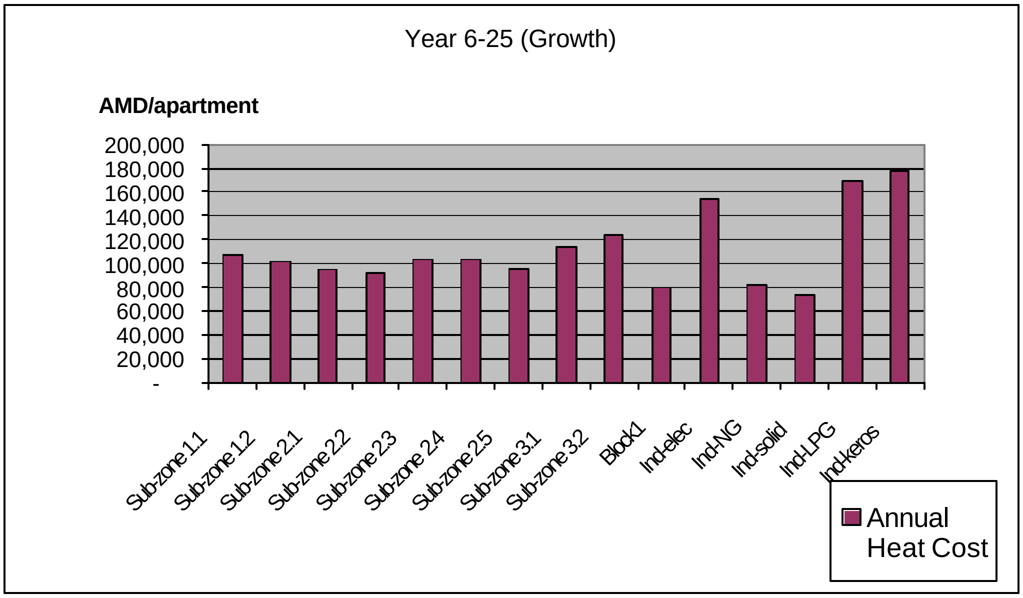


Figure 4. Annual Heating Costs for Standard Apartment in Growth Phase, Yerevan



3.23 The comparison of affordable heating options leads to the following conclusions:

General

- During survival, most of the CH solutions are among the least-cost options even though they sometimes are more expensive than the average affordability level.
- Individual natural gas and block heating are not affordable for most of the population during the survival and recovery periods (to five years), but they become the cheapest solutions in the growth period over the longer term.
- Heating with individual wood stoves is always one of the cheapest solutions, but it cannot compete for cleanliness and convenience. The continued use of wood in apartment buildings is unsustainable for the country's forest resources and should be strongly discouraged. Where there is no alternative to wood, the use of efficient woodstoves should be promoted.
- In Yerevan, Charentsavan, and Jermuk it should be possible to devise affordable heating options that would allow the CH systems to survive for the three to five years necessary to attract financing for CH system rehabilitation or for the construction of new systems based on individual NG/block heating. In the longer term, when new investments would need to be made, CH systems would be more expensive than individual NG and block heating.
- In Gyumri, development of a survival strategy for the ANI boiler house may be possible only if significant reductions are first made to bring

operation and maintenance costs to a level approaching that of other CH systems in Armenia. This could probably be achieved through a merger of the two organizations responsible for heat production and distribution.

3.24 It should be noted that the above conclusions do not take into account the likelihood of higher gas prices (see also Section 3.5).

Block boilers

3.25 The use of block boilers raises a number of environmental and urban planning questions. In the long term, block boilers may be the most cost-effective collective heating solution, and consequently a large number of gas-fired boilers—in some areas as many as one per two or three apartment buildings—are likely to be constructed. This would not have a significant impact on air quality as natural gas is a clean fuel. However, the large number of boiler houses, which most likely would be placed next to existing apartment buildings,[6] would have a certain visual impact and would pose some challenges for urban planners.

Natural Gas Development Plan

3.26 In parallel with the preparation of the urban heating strategy, the Project Implementation Unit of the Ministry of Finance and Economy commissioned a natural gas supply study for the four cities in the UHS. The study was to investigate in greater detail the investments needed to expand gas supply as described in the UHS scenarios and to examine the implications for gas supply costs. The key results of the study are as follows:[7]

- The price of imported gas is likely to increase to between 150 percent and 180 percent of the present level by year 2020. This would entail an increase in end-user prices of between 33 percent and 60 percent.
- The necessary investments in the rehabilitation of high- and medium-pressure pipelines correspond to an average cost of US$19 per connected household, ranging from US$15 per household in Yerevan to US$35 per household in Charentsavan. Amortized over 10 or 15 years this corresponds to an extra supply cost of around US$1–3 per household per year.
- The necessary investments in the rehabilitation of low-pressure pipelines would result in a cost of US$12–28 per connected household, depending on the supply option selected. Amortized over 10 or 15 years this corresponds to an extra supply cost of around US$2–3 per household per year.

3.27 **Significance of gas price increase.** The calculations for the UHS were carried out using the current gas price, so an increase in the gas price would affect the cost level of all gas-based alternatives (CH, block heating, and individual NG). The increasing gas price differential needs to be added to the balance costs of gas-based

[6] In some instances existing CH boiler houses or central substations might be converted to block boiler houses.

[7] The full results are published in the report "Identification of Priority Investments in Gas Sector in Compliance with Urban Heating Strategy of the Republic of Armenia.", (Yerevan Project, 2002)

heating options presented in this report. The effect would be slight during the first five years, producing only a 5–10 percent increase on the calculated balance cost, but after this period the competitiveness of gas-based alternatives in relation to wood stoves would be significantly affected if wood fuel prices were to remain stable. As forest resources are being depleted it is conceivable however that the price of fuelwood also would increase.

3.28 **Significance of investments in the rehabilitation of gas transmission and distribution infrastructure.** The costs of rehabilitation of the natural gas networks (high- and medium-pressure as well as low-pressure pipelines) are included in the affordability-adjusted scenarios on an area-by-area basis.

3.29 On balance, it is concluded that the results of the gas study do not significantly alter the conclusions expressed in Section 3.4.

Impact on Carbon Dioxide Emissions

3.30 Implementation of the proposed heat strategy would lead to a reduction of carbon dioxide (CO_2) emissions. The baseline assumption is that the consumption of heat will continue on the 2002 level for the next 25 years. The strategy scenario assumes that heat consumption will follow the survival scenario in 2003 and 2004, the recovery scenario in 2005–07, and the growth scenario from 2008 onward. The result would be the following CO_2 savings:

Year	*2003*	*2004*	*2005*	*2006*	*2007*	*2008-27*
Savings in tones* CO_2	63,203	50,535	37,868	31,495	25,122	18,749

* tones refers to metric ton

3.31 The accumulated savings are:

Year 2012: 301,967 tonnes CO_2
Year 2022: 489,457 tonnes CO_2
Year 2027: 583,201 tonnes CO_2

4

Outline of Urban Heating Strategy for Armenia

Introduction

4.1 The proposed heat strategy is to operate in three phases:

- In the short term (0–2 years) the strategy is focused on **survival**. The objective during this phase is to keep the key CH infrastructure operational while the CH suppliers are reorganized and the foundations put in place for an efficient heat market. As the purchasing power of the general population is low the willingness to pay for heat will be correspondingly low. Any centralized option will have to provide a quality and quantity of heat that is both affordable and competitive with individual and flexible options such as electricity and solid fuel stoves.
- In the medium term (3–5 years) the emphasis is on **recovery**: the development and implementation of sustainable heating options and the creation of a base, for the longer term, for a cost-efficient and sustainable heat supply structure. This period gives CH companies the opportunity to show the balanced budget and sound financial performance that would make them eligible for financing from national and international financing institutions. For new autonomous systems (block heating) this period is one in which, through pilot projects, to demonstrate institutional and technical sustainability and to create the basis for future expansion as and when general affordability allows.
- In the medium to long term (6–25 years) there will be possibilities for **growth**. Investment will be attracted to the most cost-efficient of the existing CH systems and to a broad variety of block heating schemes. Alongside this development, and provided the safety problems of gas have been satisfactorily resolved, gas distribution companies will promote and implement individual gas solutions.

Heat Strategy Elements

4.2 The main elements of the heat strategy are presented in the Table 11 and described in more detail in the following sections.

Table 11. UHS Phases and Actions

	Survival (Years 1 and 2)	*Recovery (Years 3–5)*	*Growth (Years 6–25)*
Regulation / market stimulation	Develop regulatory base for condominiums and heat market	Stimulate and support embryonic heat market actors	Market monitoring
Institutional	Restructure CH companies; achieve full cost recovery Develop condominium assistance program and implement pilot projects	Commercialization/privatization of CH companies All collective heat consumers organized in condominiums and cooperatives	- -
Social	Develop social support scheme	Social support scheme operational	Social support scheme is phased out over suitable period
Technical (district heating systems)	Disconnect risers to heat smaller areas of apartments; install meters	Individual control introduced Simple demand side management measures implemented in buildings	Individual control is commonplace Improvements of CH infrastructure Introduction of solar energy solutions for HTW and more comprehensive building improvements
Promotional	Implement comprehensive public awareness campaign Promote improved wood stoves	Continue information campaigns	-
Financial	Set up condo-lending scheme and boiler lending schemes	Start operation of condo and boiler lending schemes	IFI* lending

*IFI = international financial institutions

Regulation and market stimulation

4.3 **Modification of the condominium main charter.** The main charter of future condominiums should clearly address the possibility that the condominium undertake an administrative and intermediary role with regard to the heat suppliers.

4.4 **Transfer of ownership.** The transfer to the condominiums of the ownership of yards and other common areas will open up the possibility of condominiums organizing themselves around the tasks of managing these areas, and potentially will create the opportunity to raise money; for example, through renting out garages. It furthermore will raise the possibility of condominiums taking on the responsibility of organizing the heat supply.

4.5 **Empty apartments.** The large number of abandoned apartments is a major obstacle to the promotion of efficient heat supply in Armenia. The owners of abandoned apartments have an obligation to pay for heat and other services delivered to these apartments, but payment is seldom received. The following steps should be taken:

- It should be made possible for a condominium to take legal measures to collect unpaid dues from apartment owners.
- Legislation should permit rapid access to empty apartments for the purposes of disconnecting radiators.

4.6 **Creation of a decentralized heating market.** The government will take steps to facilitate the creation of a decentralized heating market. This market should in principle encompass all multistory apartment buildings not connected to CH. The following support will be needed:

- Support to condominiums (including financial and technical support and standard contracts).
- The streamlining of regulatory functions, primarily those regarding safety and the environment, and the institution of clear rules with minimal red tape (the one-stop-shop concept).
- Tax and import duty privileges for decentralized suppliers, or more direct financial support.

4.7 **The need for regulation.** In terms of the regulatory regime, a distinction should be made between CH systems and autonomous systems. The former have the nature of a monopoly and will need to submit to the regulatory supervision of the Energy Regulatory Commission (ERC) for technical licensing (environment and safety) and tariff approval. For autonomous systems the rule should be that they need only a technical license from the ERC: tariff issues should be left to the determination of the buyer and seller.

Commercialization of centralized heating

4.8 For more details on this issue please refer also to Annex B.

4.9 A guiding principle of the UHS is that the existing CH supply must be commercialized or must be closed down. The commercialization of CH will require the establishment in a competitive environment of market-based relations with consumers, suppliers, and labor, and must include the following aspects:

- full cost recovery
- no direct subsidies given to or by the CH companies
- no social obligations to be held by CH companies

- the market must be opened to private operators, both regulated and unregulated
- CH operators working in a competitive environment must be allowed to make a profit on heat supply

4.10 The DH companies should by May 2003 have been converted to municipal holding companies owning the physical assets, the debt burden, and accounts receivable but with no operational responsibility. A plan for the management or lease of smaller parts of the system also should have been made by that time. The parts that cannot be taken over by management/lease contractors will continue to be held by municipal operation companies. In the meantime the municipal companies must supply to a reduced consumer base (where marginal costs are lowest and affordability adequate) in accordance with the rules set out below:

- New contracts are to be signed with all future customers. These contracts must specify the performance of the supplier (the quantity and quality of heat supply), the requirements to be made of the customer (for example, the maintenance of internal piping and timely payment), and sanctions due upon noncompliance.
- All contracts must be drawn up with legal entities in a way that makes it feasible to cut supply upon nonpayment, including, for example, the interruption of supply to all households of a condominium.
- Partial prepayment must be required prior to beginning supply to buildings.
- All supply must be metered and heat charged on the basis of Gigajoules used (meters must be paid for by customers under a subsidy scheme).
- A fixed tariff should cover at least 25 percent of total costs, with a variable tariff reflecting the marginal cost of supply.
- The heat delivered must be variable, to enable people to buy only what they need. (If valves are not installed, agreements could be made according to the temperature of heat supplied, the length of the supply season, or the number of radiator strings supplied.)

4.11 Compulsory metering would eliminate HTW tapping as a financial problem for CH companies: no measures otherwise have been taken to address this problem. In the longer term, CH providers should consider providing HTW using the closed system concept, which necessitates less water treatment and incurs less corrosion in the main pipes.

Support to condominiums

4.12 The following recommendations are made to support the establishment and operation of condominiums in relation to heat supply:

- Condominiums should be permitted under law to contract with a heat supplier for deliveries to the entire building.
- The condominium should be made responsible for managing the distribution of heat inside the building and should be responsible for maintaining heating installations inside the building. In the case of an

autonomous heat system, the condominium should be responsible also for the pipes from the building to the boiler and for the boiler house (but not necessarily the boiler itself).[8]

- The condominium should be allowed to collect payment for utility services from the individual apartments.
- The condominium should be allowed to contract with external service providers for maintenance services on behalf of all inhabitants.
- Support schemes should be launched that provide technical assistance and financial support or micro credits.
- The operation of condominiums should be facilitated through the provision of tools for their work, including specifically the provision of guidelines in relation to heat supply.
- Training should be provided for condominium managers and information made available on the potential functioning of a condominium in relation to the provision of heating services.

Social support mechanisms

4.13 It is recommended also that a heat sector subsidy program be introduced for poorer households, to mitigate the problems faced by suppliers of collective heat when individual households are unable to pay their bills. The criteria for eligibility may be lifted directly from the existing Family Benefit Program.

4.14 The heat bills for families eligible for the general family benefit program and that receive centralized heat should be paid directly to the heat supplier. It is recommended also that only the fixed part of the tariff be refunded: A precondition for this is that it must be possible to regulate the heat in the apartment, so that the family can cut off the supply should it find itself unable to afford the variable part of the bill.

4.15 In the long term it is recommended that to be eligible for a heat subsidy a household should belong to a condominium. This condition would be expected to promote the establishment of more condominiums.

4.16 A preliminary estimate of the maximum need for subsidy support indicates that it would correspond to 0.6 percent of the present budget for the Family Benefit Program in the first years after implementation of the UHS.

Technical interventions

4.17 During year 1 (centralized heating):

1) Select buildings for supply that promise full cost recovery, based on business plan
2) Offer two collective alternatives:

- Full option, for say AMD 75,000
- Reduced option, for say AMD 45,000 (corresponding to operating a single string only through each apartment). Central heating points also could be eliminated to reduce losses

[8] Autonomous heat systems use small heat-only boilers (HOBs). The boiler can be owned by the heat service provider and the pipes and the boiler house by the condominium.

3) If not sufficient, “mothball” DH systems for one year

4.18 During year 1 (block boilers):

1) Prepare pilot projects for block boilers

4.19 During year 2 (centralized heating):

1) Install meters (energy or flow) in all buildings that will be supplied with heat
2) All heat to be sold through collective heat supply agreements
3) Heat savings may be made through:
– elimination of entire strings
– installing balancing valves on strings to adjust the flow of heat

4.20 During year 2 (block boilers):

1) Implement pilot projects for block boilers

4.21 Years 3–5 (centralized heating and block boilers):

1) Condominium lending scheme introduced to include support for the installation of individual controls (bypasses, radiator valves, heat allocators)
2) Minor improvements to existing DH systems
3) Heat supply contracts signed with condominiums/cooperatives on the principle of collective responsibility
4) Private operators establish new block heating schemes
5) Simple building improvements

4.22 Years 6–25 (all systems):

1) Condominium lending scheme to produce modern flexible and individual heat control, including, for example, two-string systems, thermostatic valves, heat allocators, and individual metering
2) Major improvements to those remaining large DH systems that can provide heat on a commercial basis
3) Introduction of solar HTW heaters

Promotion and campaigns

– Implement comprehensive public awareness campaign to disseminate information about the merits of the technical options, the supporting framework, and the financial implications
– Promote improved wood stoves

Financial support schemes

4.23 The introduction is recommended of a revolving heating fund to finance the following:

4.24 The early introduction of meters on all collectively heated buildings

4.25 A condominium lending scheme using micro credits to enable condominiums to invest in individual metering and control

4.26 A boiler lending scheme aimed at private operators that wish to supply heating services to multi-family buildings

4.27 In the long run their local banks and international financial institutions are expected to offer other financial options. The emergence of such financing will depend, however, on the heating sector first becoming financially viable.

List of References

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Annex A

Affordability-Adjusted Heating Scenarios

Yerevan

Investments and Operation and Maintenance

Period	**Present situation**			**Years 1 and 2 (Survival)**			**Years 3–5 (Recovery)**			**Years 6–25 (Growth)**			
	First year investment	*Operation*	*Maintenance*	*Investment*	*Operation*	*Maintenance*	*Investment*	*Operation*	*Maintenance*	*First year investment*	*Operation*	*Maintenance*	*Preconditions and comments to cost calculation*
	US$	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$*	*US$/year*	*US$/year*	
Zone 1 (currently supplied by CHP)													
Subzone 1.1 (Shengavit)													
Boiler station(s)			92200			81,000			85,300	700,000	55,000	52,260	
Transmission system										1,305,730			
Substation(s)										150,000			
Distribution system										753,500			
Internal installations										148,500			
Total	0	0	92,200	0	0	81,000	0	0	85,300	3,057,730	55,000	52,260	3,057.73

Period	***Present situation***			***Years 1 and 2 (Survival)***			***Years 3–5 (Recovery)***			***Years 6–25 (Growth)***			*Preconditions and comments to cost calculation*
	First year investment US$	*Operation US$/year*	*Maintenance US$/year*	*Investment US$/year*	*Operation US$/year*	*Maintenance US$/year*	*Investment US$/year*	*Operation US$/year*	*Maintenance US$/year*	*First year investment US$*	*Operation US$/year*	*Maintenance US$/year*	
Subzone 1.2 (Erebuni) Boiler station(s)			40700			35,200			37,500	300,000	36,215	22,730	
Transmission system										505,268			
Substation(s)										84,182			
Distribution system										301,400			
Internal installations										59,400			
Total	0	0	40,700	0	0	35,200	0	0	37,500	1,250,250	36,215	22,730	1,250.25
Zone 2 (supplied by large HOB)													
Subzone 2.1 (Davidashen, BH3)													
Boiler station(s)			143000	40,000	24,105	60,000	60,000	24,105	60,000	2,600,000	116,504	146,648	
Transmission system				48,800		14,640	73,200		14,640	2,200,000			
Substation(s)				36,000		18,000	54,000		18,000	457,440			
Distribution system				72,000	46,218	9,600	108,000	46,218	9,600	1,794,000			
Internal installations				32,000		8,000	48,000		8,000	1,552,000			
Total	0	0	143,000	0	0	115,200	343,200	0	127,800	8,603,440	116,504	146,648	
Subzone 2.2 (New Nork - 1, BH4)													
Boiler station(s)			169,450	32,000	16,528	40,000	48,000	16,528	40,000	2,608,000	123,465	140,273	

Period	***Present situation***			***Years 1 and 2 (Survival)***			***Years 3–5 (Recovery)***			***Years 6–25 (Growth)***			
	First year investment	*Operation*	*Maintenance*	*Investment*	*Operation*	*Maintenance*	*Investment*	*Operation*	*Maintenance*	*First year investment*	*Operation*	*Maintenance*	*Preconditions and comments to cost calculation*
	US$	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$*	*US$/year*	*US$/year*	
Transmission system				74,400		22,320	111,600		22,320	4,180,000			
Substation(s)				31,200		15,600	46,800		15,600	440,000			
Distribution system				91,800	56,730	12,240	137,700	56,730	12,240	2,268,000			
Internal installations				42,800		10,700	64,200		10,700	577,800			
Total	0	0	169,450	0	0	142,500	408,300	0	168,200	10,073,800	123,465	140,273	
Subzone 2.3 (New Nork - part 2, BH5)													
Boiler station(s)			24,300	40,000	21,402	60,000	60,000	21,402	60,000	1,800,260	63,118	89,387	
Transmission system				33,600		10,080	50,400		10,080	2,000,000			
Substation(s)				26,400		13,200	39,600		13,200	187,040			
Distribution system				52,200	25,119	6,960	78,300	25,119	6,960	1,308,780			
Internal installations				23,000		5,756	34,500		5,756	1,115,500			
Total	0	0	138,900	0	0	110,200	262,800	0	123,100	6,411,580	63,118	89,387	
Subzone 2.4 (Malatya-harhumian, BH7)													
Boiler station(s)			190,810	32,000	40,576	60,000	48,000	40,576	60,000	3,530,600	128,873	190,537	
Transmission system				86,400		25,920	129,600		25,920	3,600,000			
Substation(s)				72,000		36,000	108,000		36,000	627,200			

Period	**Present situation**			**Years 1 and 2 (Survival)**			**Years 3–5 (Recovery)**			**Years 6–25 (Growth)**			
	First year investment	*Operation*	*Maintenance*	*Investment*	*Operation*	*Maintenance*	*Investment*	*Operation*	*Maintenance*	*First year investment*	*Operation*	*Maintenance*	*Preconditions and comments to cost calculation*
	US$	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$*	*US$/year*	*US$/year*	
Distribution system				116,580	75,132	15,540	174,870	75,132	15,540	2,967,720			
Internal installations				47,800		11,950	71,700		11,950	2,318,300			
Total	0	0	190,810	0	0	150,200	532,170	0	175,200	13,043,820	128,873	190,537	
Subzone 2.5 (Avan, BH11)													
Boiler station(s)			134,820	32,000	20,771	40,000	48,000	20,771	40,000	2,056,000	99,782	133,118	
Transmission system				69,600		20,880	104,400		20,880	3,350,000			
Substation(s)				40,800		20,400	61,200		20,400	400,000			
Distribution system				74,400	58,285	9,920	111,600	58,285	9,920	1,856,250			
Internal installations				40,000		10,000	60,000		10,000	545,400			
Total	0	0	134,820	0	0	116,100	385,200	0	125,200	8,207,650	99,782	133,118	
Zone 3 (supplied by small HOB) Subzone 3.1 (Arabkir - total)													
Boiler station(s)			9630	4,800	2,254	1,200	7,200	2,254	1,200	344,600	30,424	10,336	
Transmission system													
Substation(s)													
Distribution system				6,548	1,735	880	9,822	1,735	880	220,500			
Internal installations				3,600		600	5,400		600	32,400			

Period	**Present situation**			**Years 1 and 2 (Survival)**			**Years 3–5 (Recovery)**			**Years 6–25 (Growth)**			*Preconditions and comments to cost calculation*
	First year investment	*Operation*	*Maintenance*	*Investment*	*Operation*	*Maintenance*	*Investment*	*Operation*	*Maintenance*	*First year investment*	*Operation*	*Maintenance*	
	US$	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$*	*US$/year*	*US$/year*	
Total	0	0	9,630	0	3,989	2,680	22,422	3,989	2,680	597,500	30,424	10,336	
Subzone 3.2. (Qanaqer-Zeytun - total)													
Boiler station(s)			8100	4,800	2,255	1,200	7,200	2,255	1,200	316,800	30,383	10,012	
Transmission system													
Substation(s)													
Distribution system				5,220	2,320	700	7,830	2,320	700	214,500			
Internal installations				4,200		700	6,300		700	37,800			
Total	0	0	8,100	0	4,575	2,600	21,330	4,575	2,600	569,100	30,383	10,012	

Charentsavan

Investments and Operations and Maintenance

Period	***Present situation***			***Years 1 and 2 (Survival)***			***Years 3–5 (Recovery)***			***Years 6–25 (Growth)***			
	First year investment *US$*	*Operation* *US$/year*	*Maintenance* *US$/year*	*Investment* *US$/year*	*Operation* *US$/year*	*Maintenance* *US$/year*	*Investment* *US$/year*	*Operation* *US$/year*	*Maintenance* *US$/year*	*First year investment* *US$*	*Operation* *US$/year*	*Maintenance* *US$/year*	*Preconditions and comments to cost calculation*
Zone 3 (supplied by small HOB):													
Sub-zone 3.1.A (BH-2):													
Boiler station(s)			7,320		6,722	200	4,400	6,722	200	232,070	10,675	7,060	
Transmission system						300			300				
Sub-station(s)													
Distribution system							6,625			121,159			
Internal installations						100	800		100	74,800		100	
Total	0	0	7,320		6,722	600	11,825	6,722	600	428,029	10,675	7,160	
Sub-zone 3.2.A (BH-4):													
Boiler station(s)			8,390		7,100	200	5,400	7,100	200	271,860	13,600	8,908	
Transmission system Sub-station(s)						300			300				
Distribution system							5,250			166,500			
Internal installations						100	1,200		100	110,400			
Total	0	0	8,390		7,100	600	11,850	7,100	600	548,760	13,600	8,908	
Sub-zone 3.3.B (BH-5):													

Period	***Present situation***			***Years 1 and 2 (Survival)***			***Years 3–5 (Recovery)***			***Years 6–25 (Growth)***			
	First year investment	*Operation*	*Maintenance*	*Investment*	*Operation*	*Maintenance*	*Investment*	*Operation*	*Maintenance*	*First year investment*	*Operation*	*Maintenance*	*Preconditions and comments to cost calculation*
	US$	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$*	*US$/year*	*US$/year*	
Boiler station(s)			4,490		3,800	200	5,400	3,800	200	271,820	13,655	8,909	
Transmission system						200			200				
Sub-station(s)													
Distribution system							4,100			150,000			
Internal installations						100	1,200		100	98,840			
Total	0	0	4,490		3,800	500	10,700	3,800	500	520,660	13,655	8,909	
ub-zone 3.4.B (Atkins):													
Boiler station(s)			258			862			862			862	
Transmission system													
Sub-station(s)													
Distribution system													
Internal installations													
Total	0	0	258	0	0	862	0	0	862	0	0	862	
Subzone 3.5.B (Ar BH - Ar-Ar)													
Boiler station(s)			2,646			2,646			2,646			2,646	
Transmission system													
Substation(s)													
Distribution system													
Internal													

Period	**Present situation**			**Years 1 and 2 (Survival)**			**Years 3–5 (Recovery)**			**Years 6–25 (Growth)**			
	First year investment	*Operation*	*Maintenance*	*Investment*	*Operation*	*Maintenance*	*Investment*	*Operation*	*Maintenance*	*First year investment*	*Operation*	*Maintenance*	*Preconditions and comments to cost calculation*
	US$	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$*	*US$/year*	*US$/year*	
installations													
Total	0	0	2,646	0	0	2,646	0	0	2,646	0	0	2,646	
Boiler station(s)			258			862						862	
Transmission system													
Substation(s)													
Distribution system													
Internal installations													
Total	0	0	258	0	0	862	0	0	0	0	0	862	
Subzone 4.7 (Ar BH - Ar-Ar)													
Boiler station(s)			628			2,646						2,646	
Transmission system													
Substation(s)													
Distribution system													
Internal installations													
Total	0	0	628	0	0	2,646	0	0	0	0	0	2,646	
Total, excluding detached houses													
Zone 6 (detached houses)													

Gyumri

Investments and Operations and Maintenance

Period	***Present situation***			***Years 1 and 2 (Survival)***			***Years 3–5 (Recovery)***			***Years 6–25 (Growth)***			
	First year investment	*Operation*	*Maintenance*	*Investment*	*Operation*	*Maintenance*	*Investment*	*Operation*	*Maintenance*	*First year investment*	*Operation*	*Maintenance*	*Preconditions and comments to cost calculation*
	US$	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$*	*US$/year*	*US$/year*	
Zone 2 (supplied by large HOB)													
Subzone 2.1 (ANI)													
Boiler station(s)		400,000		0	331,000	23,000		331,000	90,000		331,000	100,000	Staff reduced from 221 to 110
Transmission system			23,000	0								20,000	
Substation(s) (12)				0								18,000	
Distribution system				0								16,000	
Internal installations				0						7,100,000		12,400	
Total	0	400,000	23,000	0	331,000	23,000	0	331,000	90,000	7,100,000	331,000	166,400	
Zone 4 (disconnected; possible to reconnect)													
Subzone 5.2 (Sheram)													
Boiler station(s)													

Jermuk

Investments and Operation and Maintenance

Period	***Present situation***			***Years 1 and 2 (Survival)***			***Years 3–5 (Recovery)***			***Years 6–25 (Growth)***			
	First year investment	*Operation*	*Maintenance*	*Investment*	*Operation*	*Maintenance*	*Investment*	*Operation*	*Maintenance*	*First year investment*	*Operation*	*Maintenance*	*Preconditions and comments to cost calculation*
	US$	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$*	*US$/year*	*US$/year*	
Zone 2 (supplied by large HOB)													
Subzone 2.1 (BH-3)													
Boiler station(s)			29,900		24,192	1,000	5,500	24,192	1,000	543,720	39,765	22,684	
Transmission system						1,000			1,000				
Substation(s)						200			200				
Distribution system							15,000			557,670			
Internal installations						500	3,200		500	321,600			
Total	0	0	29,900		24,192	2,700	23,700	24,192	2,700	1,422,990	39,765	22,684	
Zone 3 (supplied by small HOB)													
Subzone 3.1.A (BH-1)													
Boiler station(s)			9,000		7,650	500	9,700	7,650	500	271,860	22,224	9,590	
Transmission system													
Substation(s)													
Distribution system						500	6,000		500	256,724			
Internal installations						200	1,700		200	116,700			

Period	***Present situation***			***Years 1 and 2 (Survival)***			***Years 3–5 (Recovery)***			***Years 6–25 (Growth)***			
	First year investment	*Operation*	*Maintenance*	*Investment*	*Operation*	*Maintenance*	*Investment*	*Operation*	*Maintenance*	*First year investment*	*Operation*	*Maintenance*	*Preconditions and comments to cost calculation*
	US$	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$/year*	*US$*	*US$/year*	*US$/year*	
Total	0	0	9,000		7,650	1,200	17,400	7,650	1,200	645,284	22,224	9,590	
Zone 4 (disconnected; possibility for reconnection)													
Subzone 4.1 (BH-3)													
Boiler station(s)													
Transmission system													
Substation(s)													
Distribution system													
Internal installations													
Total	0	0	0	0	0	0	0	0	0	0	0	0	

Annex B

Commercialization of District Heating in Armenia

AB.1 The commercialization of district heating can be defined as the process by which the sector develops the incentive and ability to conduct its business activities according to commercial principles, with the objective of earning a profit. In a commercial business environment, decisions are driven by economics and competition, and in the absence of competition, by regulation.

AB.2 In a competitive environment, business decisions are driven by a need to optimize all resources, such as investments, human resources, fixed assets, and inventory. The development of employees who are accountable for their own performance and of independent managers who act based on facts and economic analysis, of financial independence, and of a focus on delivering the best service to all customers are all important to the successful commercialization of this sector. The institution of legal and regulatory requirements that obligate the utilities to serve their customers, that provide system stability and reliability, that ensure the safety of employees and customers, and that operate in an environmentally sound manner also are essential.

AB.3 The key elements for the commercialization of district heating may be grouped as follows:

- business planning
- organizational development
- human resource management and development
- financial management and control
- public relations
- legislative and regulatory relations

AB.4 The state has a central role in defining heating strategy and in creating an appropriate legal and regulatory framework for the market, but it is obvious that private sector participation is essential to the commercialization of the district heating and the creation of a decentralized heating market. The experience of the reform of the power sector is informative in this regard.[9] The following are the results expected from private sector participation:

- rapid commercialization of currently operational DH facilities
- creation of a decentralized local heating market
- further development of the DH market through the development of cogeneration and combined-cycle heat and power projects

Commercialization of Currently Operational District Heating Facilities

AB.5 There are many different approaches to engaging the private sector, offering varying degrees of private sector risk, ownership, and control. The main options, listed with an increasing degree of private sector risk and control, are: (a) management contract, whereby a private firm assumes responsibility for operating the company for a fee (possibly related to profitability) but assumes no operating or investment risk; (b) operating lease, whereby the private firm assumes responsibility for operating the company, pays a fee to the government, and assumes the operating but not the investment risk (investments generally remain the responsibility of the government); (c) full concession, whereby the private firm assumes the responsibility and risk for operations and capital investment, but the assets are owned by the government (the operator may pay a concession fee); and (d) divestiture, whereby the private firm buys the assets and assumes full operating and investment responsibility and risk.

AB.6 Private sector participation in the commercialization of operational DH facilities can be arranged through the privatization of the assets or through management contracting. The privatization of assets is the preferred option. The two options are discussed in more detail below.

Privatization of the DH system

AB.7 As a general principle, the greater the degree of transfer of risk and control to the private sector, the greater the efficiency gains, provided that a sound legal and regulatory framework and tariff regime are in place. The government should not retain any ownership or direct control over the privatized companies. The public interest, in terms of prevention of the abuse of monopoly power and the charging of appropriate tariffs, should be protected by the Energy Commission on behalf of the government.

[9] Restructuring measures, including regulatory and tariff reforms, the introduction of contractual relationships, and investment in sector-internal metering, have resulted in significant commercialization of the power sector, but it is believed that full commercialization will be achieved only through the involvement of the private sector. The conventional "strategic investor" concept may need to be reconsidered, however, due in part to lack of interest among strategic investors and the relative lack of success of the strategy thus far—the result, perhaps, of a lack of local knowledge. Distribution companies in Armenia and Azerbaijan recently have been privatized to investors that have no international reputation and little financial strength but that have extensive regional experience and an appreciation of local peculiarities. Although it is premature to draw conclusions, preliminary results are encouraging.

AB.8 Transferring full risk and control could be achieved by either the sale of 100 percent of the shares or by a full concession, if properly designed. In Armenia, the private management of state- and municipality-owned district heating will likely be the preferred option for private sector involvement, given the following realities:

- the poor technical and financial condition of the system
- high losses and low collection of revenues
- the absence of system metering and consumer metering
- the technical peculiarities of the system, which preclude the possibility for individual disconnection of the consumer
- the huge investments necessary to solve these problems

Management contract

AB.9 Management service contracts for the Yerevan District Heating Company (YDHC) could be structured along the lines of a performance contract, in much the same way as the management contracts are structured for the provision for other utilities of demand-side management services and operating and maintenance services. The distinguishing feature of performance contracts is that remunerations are tied to operating and efficiency improvements and are designed on the basis of sharing revenues. It is recommended that the terms of the management contract for the DH system in Armenia include the full range of system management services. The private management company (PMC) should design and install efficiency improvements and equipment, manage the entire system within the selected control area, and handle all billing and collection. The improvements made under the management contract should involve both capital improvements (for example, new boilers, pipelines, pumps, and meters) and non-capital-intensive operating and management improvements (billing and collection, financial management, and operation and maintenance practices).

AB.10 The performance-based management contract contemplated instructing the PMC, relying on its own employees, to take over the existing system or part of that system and finance upgrades to improve efficiency and improve billing and collection practices. The PMC would be permitted to recoup a reasonable return on investment and income through a performance fee that would be tied to the revenues collected over and above the baseline revenues of the existing system operated by YDHC. The division of the revenues between YDHC and the PMC would be based on a specified amount of guaranteed additional revenues, the amount and requirements of the capital investment, and the PMC's success in meeting its performance goals.

AB.11 All contract types for performance management services (guaranteed fixed payment, guaranteed percentage of additional revenue, and shared additional revenue) should be considered for use, taking into account the condition of the system or part thereof and the level of interest from the private sector. The different contract types are outlined as follows:

AB.12 *Guaranteed fixed payment* performance contracts simply require the system owner to pay the contractor a fixed payment, usually monthly, out of the additional revenue accrued as a result of improved operational efficiency. The system owner retains any excess additional revenue. The PMC would be required to guarantee that the additional revenue would exceed or equal the fixed payment, averaged over a period of time. Should the additional revenue fall below the guaranteed amount, the PMC would issue a check to YDHC or provide a credit for the difference, to be deducted from the next payment. YDHC would pay only the actual amount saved.

AB.13 *Guaranteed percentage of additional revenue* performance contracts usually require the contractor to handle the payment of the system costs. The contractor guarantees that the improvements provided will save the owner a certain percentage of the baseline system costs. The guaranteed percentage of additional revenue may be a fixed percentage for the length of the contract or it may increase over time. Where the percentage varies over the course of the contract, it may be set lower at the start of the contract to enable the contractor to quickly recoup its investment in efficiency improvements, subsequently increasing as the contract matures. The contractor keeps additional revenue above the guaranteed amount to cover its costs. Regardless of actual costs, YDHC should pay the PMC an agreed percentage of the baseline system costs. The advantages to YDHC are that additional revenue is guaranteed and that the PMC has an incentive to make the system as efficient as possible. The disadvantage to YDHC is that, should actual additional revenue be much more than the guaranteed amount, it would save only the specified percentage.

AB.14 *Shared additional revenue (the "fit the pricing" approach)*. Under this approach YDHC and the contractor would split any additional revenue that accrues from the improved operation of YDHC. The calculation is made by subtracting the additional revenue collected after the improvements from a baseline estimate, and then adjusting this total to reflect current heat prices. The division of the calculated revenue between the contractor and the owner may be constant or variable over the duration of the contract. A variable split usually will commit in the beginning a larger percentage to the contractor to enable capital costs recovery, with the bias shifting to the system owner in later years. Under a shared additional revenue contract, YDHC would pay its own system costs and would pay the PMC the agreed percentage of the additional revenue on a monthly basis. The advantages of such a contract are that both the owner and the contractor benefit where additional revenue is high; the PMC has an incentive to make the system as efficient as possible; the contractor is responsible for servicing and maintaining the equipment and has overall system responsibility; and the owner does not bear financial risk should the equipment fail to perform as expected.

AB.15 The initial term of the management contract should at least match the term of debt repayment of the capital improvements financed by the private company.

AB.16 Prequalified private companies would be invited to bid for each part of the heating system based on a "simple gross" basis (in which bids are submitted above a certain amount net of current earnings, assuming existing operation and maintenance and fuel costs). YDHC would cooperate in the preparation of an audit report, which should include the baseline of heat consumption and revenue collection for a typical 12-month period. The baseline figure would be used to calculate additional revenue.

AB.17 The PMCs would at their own cost perform a preliminary assessment of the characteristics of the DH system and of the revenue collection and payment system within the service zone of the YDHC.

AB.18 A management contract usually includes a purchase option of the serviced system upon completion of the term of the contract. Such a clause should be included in the privatization law.

Creation of a Decentralized and Local Heating Market

AB.19 The creation of a decentralized and local heating market is essential for the commercialization of the sector. It is estimated that the share of decentralized and local heating in the overall heating market ultimately will be around 60 percent. Such systems are not attractive for major investors due to their limited capacity, seasonal nature, and the small scale of the business but could be attractive for local small and medium-size engineering and energy service companies. To create an environment able to encourage the development of this market the regulatory role of the state must first be resolved (see Section 4.2.1) and venture capital or project financing funds made available with acceptable terms and interest rates.

AB.20 Once these obstacles have been cleared it is the small local companies that will have the best chance of succeeding in this business. Being close to the consumer they can be flexible in providing an affordable service of the required quality; they also are in the best position to provide related services, such as hot water, laundry, and real estate management, making the business a year-round concern.

Development of the District Heating Market through the Development of Cogeneration and Combined-Cycle Heat and Power Projects

AB.21 The development of cogeneration projects potentially could become the main way of further developing the DH market in Armenia. The development of such projects as Independent Power producers (IPPs) in particular could be made possible by the increasing demand for new power generation capacity and the need to replace by 2008 the Medzamor nuclear power plant. The advantage of cogeneration projects and their attractiveness for private investors stems from the fact that the main product of such plants is electricity, with heat produced only as a secondary or waste product. This has two major implications: (a) the tariffs for heat generated at cogeneration plants is lower than that of heat generated at DH boiler houses, and (b) the risks associated with DH are of secondary importance in the investment decision-making process, since DH is not the primary business of the investor.

AB.22 There is already some experience in place following a recent attempt in Armenia to develop cogeneration projects. The Vanadzor chemical plant has been reopened, for example, along with a thermal power plant to provide heat and power for the chemical installation and potentially heat for Vanadzor's district heating system. A European investor also is interested in developing a gas turbine combined heat and power project at Yerevan thermal power plant. The plant is already connected to Yerevan's DH system, although not on a commercial basis: both parties in the arrangement are state-owned enterprises and the power plant is not paid fully for the heat it supplies to the city.

The Role of the State in Commercializing the Heating Sector

AB.23 There are four primary components to the role played by the state in the commercialization of the heating sector. These are as follows:

- to develop the privatization strategy
- to create a legislative base able to encourage commercial enterprise
- to fulfill a regulatory function
- to develop a strategy of subsidies for needy consumers

AB.24 *The privatization strategy* should be developed along the lines described in Section 1 and should be adapted specifically for each DH scheme in Yerevan and other cities to which it is applied.

AB.25 *Legislative base*. The legislation must be changed to:

- emphasize the obligation of consumers to pay their bills
- enable access to apartments to permit technical examinations and so that nonpaying consumers might be disconnected
- clarify the role of condominiums and protect consumer rights
- clarify the state regulatory function
- define tax and administrative privileges to support the development of a decentralized and local heating market

AB.26 Perhaps the most important legislation is that which will define the role of condominiums and protect consumer rights. The recommended strategy places the condominium in the role of retailer, purchasing heat from the supplier that it then would distribute among the members of the condominium in return for payment from each individual household. However, only 55 percent of apartment buildings in Yerevan are organized into condominiums, and nationwide this figure is only 40 percent. The established condominiums furthermore are neither financially nor organizationally viable, and in their current state would be unable to perform the function envisaged for them.

AB.27 Condominiums nonetheless may be the only organizations able to protect the rights of the consumer to a product and service of the appropriate quality; they furthermore provide the best hope for an intermediary that can support the supplier in its dealings with the consumer. It is essential therefore that condominium be developed in this role of mediator or local regulatory authority.

AB.28 It will be necessary to evaluate the viability of each condominium individually, and the proposed legislation in this area thus should allow maximum flexibility for the applied solution. The heat supplier should have the final say in deciding the role of the condominium (as single buyer, agent, guarantor, or local regulator), as each condominium within a district is likely to have a different level of credibility and capability.

AB.29 The *state regulatory function* in the heating sector should be limited to the following:

- establishment of required safety standards
- establishment of environmental standards
- licensing and tariff regulation for CH and DH

AB.30 The requirements for safety and environmental standards should be established at a minimum acceptable level to suppress their impact on the cost of heat, which must above all be affordable. For example, under current safety standards it is prohibited to install boilers in basements, requiring therefore that a separate boiler house be maintained. This requirement has a high burden of cost and potentially could limit the development of a decentralized heating market. There are dozens of inoperational boiler houses in building basements and the question of their relocation is important. It is recommended that the safety standards be reexamined to take into account other safety measures, such as ventilation and fire and smoke alarm and protection, that could mitigate the risk of fire or explosion.

AB.31 Licensing and tariff regulation functions should be differentiated for DH and for other market players in decentralized local heating. All companies and entities in the heating sector (DH as well as decentralized and local heating) should be required to hold a technical license ensuring that safety and environmental requirements are met.

AB.32 In the case of DH, the state should provide the full range of regulatory functions, including business licensing and tariff regulation. The Energy Regulatory Commission (ERC) should be involved also in the privatization process, specifically in the establishment of the criteria for the submission and evaluation of proposals and business plans. In the case of management contracting, ERC also should be involved in establishing performance criteria and in evaluating performance.

AB.33 It is recommended that, for decentralized and local heating systems, business license requirements and tariff regulations be waived. The purpose of this proposed privilege is to make the business more attractive for local engineering and energy service companies. Should such companies wish to extend their business to a larger territory or consumer base they of course should be permitted to do so, in which case they would be required to apply for a license in the normal manner, submitting a business plan and tariff calculations for ERC review and approval. In such cases the heat tariff also would be regulated.

Annex C

Model Contract for Heat Supply to Condominium

AC.1 AGENT CONTRACT

Republic of Armenia, city of _________ _________ 200_

The company ______________________, hereafter the Principal, represented by ______________________, and the Condominium ____________________________, hereafter the Agent, represented by ____________________________, hereafter the parties, signed this agreement according to the following terms.

1. Definitions

HEATING ENERGY – energy in the form of hot water, which belongs to the principal and is sold to residents by the agent (hereafter the consumer).

Gcal – Giga calories, the metering unit of heating energy, equal to 4.187 x 10.9 Joules.

FORCE MAJEURE – accidents and events, the fault of which does not depend on people (disasters, military action, and other accidents envisioned by law), resulting in the insufficient implementation of obligations, in case of which the parties are declared free of their obligations.

RULES OF HEATING SUPPLY USE – as confirmed by the Energy Regulatory Commission of the Republic of Armenia.

2. Subject of the Contract

According to this contract, the Agent, on behalf of the Principal, is obliged to implement the following actions:

- Signing of heating energy supply contracts with the residents
- Collection of payments
- Activities envisioned by this contract

3. Heating Energy Tariff

AC.2 No changes of tariff are permissible during the term of the contract

AC.3 At the time of signing this supply contract, the contracted price is defined as___________ dram / Gcal (including VAT)

AC.4 In the event of a change in the heating supply tariff as directed by the Energy Regulatory Commission of Armenia (hereafter the Commission) during the term of this contract, the new energy heating tariff will come into force according to the terms defined by the Commission.

AC.5 The sale of heating energy to residents at a price higher than that defined by this contract is forbidden.

4. Quantity of Heating Energy (the Rule of Decision and Changes to Contracted Quantity)

AC.6. The metering unit of heating energy is the Gcal, as determined through heat metering.

AC.7 Changes in the supply of heat to that which is defined in this contract are permissible only in the following cases:

AC.7.1 When the consumer requires a quantitative change.
AC.7.2 In case of danger to life or health.
AC.7.3 In case of pollution of network water or major leaks causing supply constraints..
4.2.4 In case of failure by the consumer to meet payment obligations.

AC.8 Limitation and quantitative change of heating energy may occur if so determined through Legislation.

AC.9 Changes in the supply according to clause 4.2, can be also implemented by the Agent, as long as information has been given before implementation.

AC.10 According to this contract, ________ Gcal heating energy must be supplied.

5. Payment of Agent (the Rule of Payment)

AC.11 For implementation of obligations envisioned by this contract the Agent has the right to a payment corresponding to 10 percent of sold heating energy.

AC.12 The payment of the Agent will take place at the moment of factual consumer payment.

AC.13 The Agent has right to additional payment if the Agent guarantees in a written form, in presence of Principal the proper implementation of payment of some consumers. The amount of additional payment is _____ percent.

AC.14 The sums collected by the Agent are submitted to the Principal latest on the day envisioned by this contract.

AC.15 The payment of the sums collected by the Agent to the Principal forms an act, which is an indivisible part of this contract.

6. Responsibilities of the Parties

AC.16 The Principal is responsible for the following:

- To provide the Agent with quantitative and qualitative heating supply as described in this contract,
- To restart heating supply after a stop within a period of __________ hours (max 24) following written information from the Agent about the occurrence of supply stop,
- To implement the payment of the Agent the sums envisioned by this contract (the contract can envision the right to immediately discontinue payment under certain circumstances).
- To inform immediately about circumstances that require urgent measures such as restriction of or stopping heating supply
- To submit to the Agent calculations that documents the amount to be paid.

AC.17 The Agent is responsible for the following:

- To accept the supplied heating energy from the Principal according to the rules envisioned by this contract.
- To sign heating supply contract with consumers according to the legislation of the Republic of Armenia.
- To collect the payments of heating energy supply, within a period of 5 days from due date.
- To inform the Principal about the any stops in the heating supply and accidents occurred.
- To protect the metering equipments installed on the territory of the consumer.
- To facilitate the entry of the principal's legal representatives into the house for reading the meters and checking their technical condition.
- To participate during the reading of the meter.
- To inform the Principal in a written form about foreseen irregularities in consumers payments.
- To implement the precautionary measures envisioned in the Rules of Heating Supply and Use vis-à-vis the consumers.
- To inform about the timetable of repairs; during the implementation of which the heating energy can be reduced or stopped.
- To inform the Principal within 24 hours in case the heating supply does not meet the set quality standards.

7. Accepting of Heating Energy

AC.18 Heating energy must be supplied at the agreed delivery point

AC.19 In case the heat meters are non-operational for ______ days, the quantity of heat energy is defined to be equal to the average consumption of the following 3 days. In case metering is missing for more days the quantity is defined according to the rules of the Commission.

8. Additional Responsibilities of the parties

AC.20 The Principal is responsible for qualitative supply of heating energy, unless the reason for sub-standard quality is one of those mentioned in clause 4.2, and in other cases envisioned by the Rules of Heating Supply Use and legislation of the Republic of Armenia. In this case the Principal must compensate any damages suffered by the Agent as a consequence of the sub-standard heating supply, and should compensate any penalty to the consumers by the agent.

AC.21 The Agent is responsible to pay 1 percent penalty of non-paid sums for every after-term payment that should be submitted to the principal not later than the deadline envisioned by this contract.

AC.22 The parties are free of responsibilities, if the failure to meet their responsibilities was connected with force majeure.

9. The date of effectiveness of contract and deadline of activities.

AC.23 This contract is effective as from the date of the signing and ratification by both parties.

AC.24 The deadline of contract's activity _______________ (month and year).

10. Other terms

AC.25 This contract is regulated according to the Legislation of the Republic of Armenia.

AC.26 If the Agent interferes with the activity of meter readings, the Principal has right to create a One Party Act, according to the rules envisioned by Rules of Heating Supply Use.

AC.27 Disputes in the framework of this contract are solved by mutual negotiations, if necessary with the intervention of a commission, or according to the rules of court.

AC.28 Violation of heating supply qualities is determined by a Two Party Act. In case of non-appearance of one party, the other party can create a One Party Act, according to the Rules of Heating Supply Use.

AC.29 The annexes regarding heating energy, the act connected with collected sums, fixation of quantity and quality, attached to this contract are indivisible parts of the contract.

AC.30 Any change of this contract should be implemented in written form and be ratified like this contract.

AC.31 After _______ days following the signature of this contract, the agent is responsible for starting the signing of heating supply contracts with consumers. Before ______________ days following the commencement of heating supply, the agent must report to the principal regarding the contracts, which have been signed by him, after which clause 4.5 of this contract is amended to reflect the new amount of contracted heat.

AC.32 This contract is signed in 2 original copies in Armenian language, both copies has equal legal power. Each party has one copy.

LEGAL ADDRESSES OF PARTIES, RATIFIED
TERMS OF PAYMENT AND SIGNATURES.

PRINCIPAL AGENT

ACT REGARDING
HEATING ENERGY SUPPLY

Done on date ____ ____ ____

Heat metering data ____
Quantity of supplied energy _____________________________________
Value of supplied energy by currency (dram) _________________

Name, surname and signatures of act’s authors.

Annex D

Model Licensed Management Contract for Boiler House

LICENSED MANAGEMENT

AD.1 CONTRACT FOR BOILER HOUSE

Republic of Armenia, city of ___________ "___"___________200-

The company ______________________, hereafter the Owner, represented by ______________________, and the company ______________________________, hereafter the Manager, represented by ____________________________, hereafter the parties, signed this agreement according to the following terms.

1. Definitions

Gcal – Giga calories, the metering unit of heating energy, equal to 4.187 x 10.9 Joules.

FORCE MAJEURE – accidents and events, the fault of which does not depend on people (disasters, military action, and other accidents envisioned by law), resulting in the insufficient implementation of obligations, in case of which the parties are declared free of their obligations.

RULES OF HEATING SUPPLY AND USE - confirmed by Energy Regulatory Commission of RA.

BOILER HOUSE AND ATTACHED ESTATE COMPLEX - till the pipes leading to the own area of consumer, valves, metering equipments and other equipments, including HOB and CHP.

2. Subject of the Contract

AD.2 By this Contract the Owner engages the Manager to operate and manage the ___________ heat supply boiler house (hereinafter boiler house) and is obliged to pay to the Manager according to provision of Article 5, and the manager is obliged to manage (operate) the boiler house according to the rules envisioned by this contract.

AD.3 This contract is the based on acknowledgment of the Owner that external management provides the best business plan for the boiler house.

AD.4 Handing over the boiler house to the Manager does not mean the transmission of the ownership rights. The manager does not have any right to give the boiler house over for exploitation ex gratia and for hypothecation (including donation).

AD.5 The Owner must hand over all data concerning the boiler house to the Manager.

AD.6 The contract regarding the boiler house is signed by The Manager on behalf of himself. He is obliged to present himself in public as a Licensed Manager. In written deals and other documents the Manager on behalf of himself should use the "L.M." notation. During the implementation of activities, which do not require written formulations, the Manager is obliged to inform the other party about the management arrangement.

AD.7 This contract should be ratified by a notary and the management right licensed through state registration.

AD.8 The Owner guarantees that nobody has property right on the boiler house (if such rights do exist, then this should be mentioned in the contract as well as the nature of this and the legal owner).

AD.9 The Manager must implement the obligations stated in this contract by himself. However, the Manager may implement his contractual obligations with the help of other persons, if there is a written allowance given by the Owner or, if such assistance is based on the interests of the Owner and the Manager has no possibilities to inform the Owner about this arrangement. The manager has full responsibility for the activities of his elected Agent.

AD.10 For the protection of his own rights on the boiler house, the Manager during the terms of this contract has the right to demand the neutralization of any kind of violation of law according to the rules defined by the articles 274, 275, 277 and 278 of Civil Code of the Republic of Armenia.

AD.11While operating the boiler house, the Manager is obliged to carry out his activities according to the decrees of "Energy Law"(RHSU) and Energy Regulatory Commission. The Manager is obliged to sell the produced energy according to the tariff ratified by the Energy Regulatory Commission, which is equal to ____ Gcal/AMD. In case of a change of tariff, the tariff enters into force according to the rules defined by the RHSU.

3. The effectiveness and terms of activity

AD.12 This contract is effective after the moment of its notary ratification and the state registration of licensed management right.

AD.13 The termination date of the contract is __________.

4. The commission of the boiler house to the Manager

AD.14 After this contract has been made effective, the boiler house is handed over to the Manager within a period of _____ days. A transmission statement must be drawn up and ratified by both sides.

AD.15 In the transmission statement it is obligatory to mention the boiler house and the attached estate complex.

AD.16 The transmission statement is an inseparable part of this contract.

5. The separation of the boiler house from the Manager's other properties

AD.17 The Manager shall express the financial status of the boiler house in a separate balance sheet. The Manager shall carry out separate calculations for all matters related to the boiler house.

AD.18 The Manager has no right to use the territory of the boiler house for other activities. The Manager must separate the boiler house and its property complex from his other properties.

6. Payment of Manager

AD.19 The payment of the Manager is defined as ___ percent of the income of operation of the boiler house, or as monthly payments in the amount of _________. The manager will be given a gratuity depending on the results of boiler house management.

AD.20 The terms of the payment are________________

AD.21 The manager is paid by the following order_________________.

7. Reports and controls of the manager

AD.22 The manager must submit reports to the Owner on implemented activities for every month before the fifth day of the following month.

AD.23 The report should include the data for the implementation of tasks (including any new signed contracts, the level of fee collection, accidents and repair works in the attached estate complex).

AD.24 If the Owner does not agree with data included in the report, he must send written objection to the Manager within three days after receiving the report, requiring the Manager to amend the report or implement additional activities.

AD.25 The Owner with the help of his representatives will control the activities of Manager. The Owner has no right to hamper the activities of Manager. The Owner representatives have the right to ask for clarification of data in reports and to act according to the provisions of para. 4 of Clause 2.2 and 9.2.

8. Repair of the boiler house and the attached estate complex

AD.26 The manager is ready to repair the boiler house before the heating season, so that it will be ready to produce heat from the beginning of heating season.

AD.27 The boiler house will be repaired by means of collected fees (the Contract can envisage the repair on account of the Manager based on future fee collections and credit sources provided by state authorities).

9. The obligations of the parties

AD.28 The Owner is obliged:

- to hand over the boiler house and the attached estate complex to the manager, according to the provision of the Contract,
- not to sign contracts with other persons, which passes on property rights related to the boiler house to such persons, during the effectiveness of this Contract
- to pay to the Manager according to the provision of this Contract,
- not to release confidential commercial information of the Manager
- not to hamper the activity of the Manager, by the activities which are not envisaged by the legislation of the Republic of Armenia,
- not to breach any legislation or regulation relating to the heat sector,
- to implement the repair activities according to provisions of Rules of Heat Supply and Use and this Contract,
- to transfer the collected amount (payments for heating) to the Owner on 17th day of the financial year.

10. Responsibilities of the parties

AD.29 The parties are responsible by law for the obligations envisaged by this Contract.

AD.30 In case that damages are sustained to the boiler house during the period of this Contract, the Manager must inform the Owner about such damages.

AD.31 The manager is responsible for the fulfillment of the obligations regarding the management of the boiler house with his personal assets (sequestration). If the assets of the Manager are not adequate, then the responsibility goes to the Owner..

AD.32 If a mortgage is taken in the boiler house in order to pay for responsibilities of the Manager or the Owner, the lender may take over the operation of the boiler house to ensure the timely payments of what is due to him. In this case the lender must sign an agreement with the Owner countersigned by the Manager.

AD.33 The parties are free of responsibilities, if the failure to meet their responsibilities was connected with force majeure.

11. Other conditions

AD.34 The relations, which are not envisioned by this contract are regulated by the existing Legislation of the Republic of Armenia.

AD.35 Any disputes arising out of this Contract will be settled between the parties by mutual negotiations, or referred to adjudication/arbitration.

AD.36 Any change or addition to this contract should be implemented in written form and be ratified like this contract.

AD.37 This contract is signed in 2 original copies in Armenian language, both copies has equal legal power. Each party has one copy

LEGAL ADDRESSES OF PARTIES, RATIFIED

TERMS OF PAYMENT AND SIGNATURES.

Annex E

Institutional Issues (Notes from Workshop)

AE.1 This annex is a note from the second day of a workshop on institutional issues, held in Yerevan on November 6, 2002. The day was structured as a series of group discussions around different issues presented by the Ministry of Finance and Economy. This section will roughly cover the main items discussed and seeks to present the consensus view that was reached at the workshop.

AE.2 In the summary below the consultant has added some clarifications and additional information to assist understanding of the issues discussed.

How to Individually Control Centralized Heat Supply?

AE.3 The need for individual (or building wide) control of the heat supply is clear from the evidence presented in the Phase 1 report and the household survey. Since affordability is low, consumers must be given the option to regulate the heat supply according to the amount of money they can afford to spend on heating.

AE.4 The technical options by which to enable individual control of heating include the following:

- Disconnect parts of the internal radiator network so that a number of rooms in each apartment can remain unheated.
- Regulate the heat flowing into the building to give room temperatures that are lower than the normative temperature. This should be achieved via gradual regulation of the heat flow, not by the expediency of switching the heat on and off.
- A combination of the first two options.
- Introduce individual valves for each radiator and, where necessary, install bypasses so that heat can flow on to other consumers even should a neighboring apartment turn the heat flow down or off. It would be preferable in this case to install heat allocators on the radiators to make it possible to differentiate heat bills according to individual consumption and thereby to provide an incentive for energy saving.

AE.5 Table E.1 illustrates the cost of installing individual control in one entrance of a nine-story building supplying 36 families.

Table E.1 The Cost of Enabling Individual Control of Heat within a 36 Apartment Condominium

Unit	*Number*	*Unit price (US$)*	*Cost (US$)*
Flow meter	1	200	200
Energy meter	1	1,000	1,000
Radiator valves	108	18	1,944
Heat allocators	108	21	2,268
Balancing valves	20	80	1,600
Differential pressure control	1	500	500
Total			**US$7,512**
Total per family			**US$208**

AE.6 In new buildings it is possible to install risers in the common entrance areas with individual metering for each apartment, and to connect all radiators in one apartment using horizontal distribution pipes. This is an expensive solution, however, since modern individual heat meters cost close to US$1,000 apiece.

AE.7 The advantage of the first three options listed above is that they are comparatively cheap. The disadvantage is that to the changes must be effected centrally, and that the "one-size-fits-all" solution that they represent will neither meet individual needs nor enable the condominium to benefit from any opportunities that might arise to cut supply drastically should any residents close down rooms or abandon their apartment altogether. These solutions furthermore fail to address the problems of serious distortions of the heat balance in a building—some apartments typically will get more heat than others, and occasionally even more than they need—and may even worsen these problems.

AE.8 The fourth solution also can create some balancing problems, and often will need to be accompanied by other measures at the network level and the use of balancing valves on individual risers.

AE.9 Any energy savings made through enabling consumer control would convert into financial savings for the heat supplier, and ultimately for the consumer—provided that the savings are not parlayed into higher temperatures for other network consumers who do not pay per unit of heat, and provided that they are not manifested as higher network losses. For autonomous systems this is not a problem, but for larger centralized systems the conversion to consumer-controlled distribution would mean a gradual change of system operation from a fixed-flow, variable-temperature system to a variable-flow system. As this process takes place it will be necessary to consider the hydraulic parameters of the network and to gradually implement system changes, particularly the installation of variable speed pumps.

AE.10 For all four options it is a pre-condition that they be followed up by group metering at the building or condominium level, and that the tariff structure, through the use of a two-tier tariff, provide incentives for savings and demand reductions.[10]

What Role Can Condominiums Play?

AE.11 Condominiums can play a pivotal role for the gradual transfer from a centralized, supply-based heating concept to a decentralized, demand-based one. A golden principle of sound operation is to have one point (the point of delivery) at which the supplier can deliver a controllable, measurable amount of energy, with the option of cutting supply at the same point in case of non-payment. For electricity it is technically feasible for the point of delivery to be inside the individual apartments, but for heat supply to existing apartments the logical delivery point is a building (or condominium) meter from which heat will be shared by many consumers.[11] In this case there is a need for a legal entity with the authority to organize the sharing of the common bill and to impose the payment discipline needed to keep supply coming to the common delivery point.

AE.12 Condominiums can play an important role as an intermediary between a heat supplier (DH company or autonomous system) when a contract of heat supply is to be drawn up that specifies an agreed service level and an agreed unit price. They also can also play a role in dealing with empty apartments and with people who choose to be without collective supply. If such matters were left to individual contracts, the households that opt out of the collective would be able to free-ride on the heat purchased by their neighbors, which, for example, would help to maintain the value of the apartment through preventing dampness and the growth of mold. In the case of a contract with a condominium, those households unwilling to participate in the scheme (provided that they are in a small minority, as defined in the condominium charter) could be forced to pay for connection to the heat supply and could be charged a fixed monthly fee for the "free" heat they receive from neighboring apartments and risers. Provided that effective means can be found of forcing absent owners to pay due fees, this would greatly enhance the financial feasibility and lower the financial risk of collective supply solutions.

AE.13 In the longer run it is envisaged that a number of private building management companies could be contracted to take care of both maintenance and billing and collection.

AE.14 It can be concluded that the formation of operational and active condominiums in the cities to be affected by the UHS is probably a precondition for the survival of collective heat supply. Even though some potential (private) heat suppliers have plans to offer supply from small autonomous boiler houses, contracting directly to

[10] For a comprehensive comparison of heat metering options see JP Building Engineers and the Center for Energy Efficiency in Buildings (2002).

[11] For new buildings or existing buildings that are being upgraded with new heat supply systems, it is often possible to supply heat through risers in the stairwells, with horizontal distribution pipes to individual apartments and meters and shut-off valves in the staircase.

individual customers, this is unlikely to be feasible outside the more affluent neighborhoods of Yerevan and would therefore apply only to a small percentage of the total heat market.

Legal Obstacles to Contracting with Condominiums

AE.15 There are no major legal obstacles for basing collective heat supply on contracts with condominiums instead of individuals. For cases in which condominiums are to act as agents rather than as end users, it nonetheless is recommended that a standard contract be developed.

AE.16 There is a danger that any attempt to share with the heat producer the risk of nonpayment would result in high risk premiums or would significantly limit the number of potential operators, leading to a situation in which autonomous schemes would be few in number and would cover only a small fraction of the total heating market. In mitigation of this risk, the supplier, in the event that that a low level of collection is registered, has the legal right to cut off the heating supply, irrespective of the type and form of contractual relations.

AE.17 (For a model contract for heat supply to condominiums, see Annex C).

Regulatory Issues: Protection of Consumer Rights

AE.18 In terms of regulatory regime, a distinction should be made between centralized heating (CH) systems and autonomous systems. Larger systems (to the extent that these will continue to exist) will have the nature of monopolies and will, as is the case today, need to submit to the regulatory supervision of the Energy Regulatory Commission (ERC) for technical licensing (environment and safety) and tariff approval. For autonomous systems, the rule should be that they need only acquire technical licensing from the ERC: issues regarding tariffs should be left to the determination of the buyer and seller of heat.

AE.19 This presupposes that there will be an open market populated with many heat suppliers and that it will be easy for consumers to switch from one supplier to another. In order to do so, however, the consumer (for example, a condominium) would need to own the distribution heat pipes and the boiler house (although not the boiler itself). Should the condominium own the boiler as well as the distribution system, the operator would work to a management contract and no particular regulatory framework would be needed.

Commercialization of Centralized Heat Supply

AE.20 The existing heat supply companies will need to be commercialized if they are to survive without government subsidies, which in their traditional universal form will be eliminated. Commercialization will require that the company carry out its activities according to commercial principles, and possibly with a degree of privatization, such as the use of management contracts.

AE.21 The commercialization should as a minimum include a streamlined organizational structure, efficient operation (rationalization) based on contractual obligations, full cost recovery through the enforcement of payment, and no undertaking of “social” obligations.

AE.22 One important issue is that of consumer debt, which stands at more than US$10 million and is in most part effectively unrecoverable. This issue is likely to obstruct early full privatization. Another question that must be answered is whether centralized supply should be continued at all. The option exists to gradually let CH disintegrate into hundreds of smaller systems that can be taken over by private entrepreneurs. In some parts of the network this may be the least-cost solution, but in others it would also mean a loss of economy of scale. Detailed system analysis is needed to determine which option is to be preferred, with heat density being the most important parameter.

Annex F

Recommissioning of Boiler House No. 2 in Central Yerevan

Introduction and Overview

AF.1 Boiler House no. 2 in Central Yerevan is a typical large-scale boiler house with a total capacity before it was shut down of 174 MW (3 x 58 MW). After shutdown, one of the boilers was removed; the station and the transmission and distribution system have now been out of service for a number of years and are in very poor condition.

AF.2 The boiler house used to supply approximately 245 buildings in Zone 5, comprising 10,568 apartments and a total heated area of 595,838 square meters. The total annual heat demand for the district is currently 56,558 MWh and the demand for hot tap water 9,723 MWh. Energy savings due to metering and demand side management are expected to reach 30 percent over a 10-year period.

AF.3 The feasibility study for the recommissioning of the heating district formerly supplied from Boiler House no. 2 comprises six different scenarios in three series, all based on the use of natural gas. These are as follows:

AF.4 *Series 0*. Heating season 90 days, no hot tap water (HTW) supply, rehabilitation of existing facilities:

AF.5 Rehabilitation of the existing boiler house, transmission network, district substations, distribution network, and internal building installations.

Series 1. *Heating season 90 days, no HTW supply:*

1) Construction of a new boiler house. Rehabilitation of the existing transmission network, district substations, distribution network, and internal building installations.
2) Construction of a combined heat and power plant with a 25 MW combined-cycle plant. Rehabilitation of the existing transmission network, district substations, distribution network, and internal building installations.

Series 2. *Heating season 139 days, normal HTW supply:*

3) Construction of a new boiler house. Rehabilitation of the existing transmission network, district substations, distribution network, and internal building installations.
4) Construction of a combined heat and power plant with a 20 MW combined-cycle plant. Rehabilitation of the existing transmission network, district substations, distribution network, and internal building installations.
5) Construction of a combined heat and power plant with an 8 MW gas turbine plant. Rehabilitation of the existing transmission network, district substations, distribution network, and internal building installations.

AF.6 The calculations found scenario 0 to produce the lowest heating costs, both expressed in terms of the value of the total costs and as the balanced heat price (see Table F.5). The introduction of demand side management is calculated to deliver savings of approximately 7 percent to the average consumer.

AF.7 The calculations show that investment would not be viable in a CHP plant of this scale in this location. The heating season in Yerevan is just 90–139 days, and scenario 2 envisages shutting down the heating plants outside this season, with the result that the operating period would be too short for a CHP plant. A CHP plant could operate at full capacity (power mode) all year round, but this would require a different design and additional investment in cooling facilities. However, this strategy depends heavily on the electricity sales price, and with the assumed ratio between the fuel price and the electricity price would not be feasible.

Development of Scenarios

AF.8 *Scenario 0* comprises the rehabilitation of the boiler house, transmission network, district substations, distribution network, and internal building installations. Heat consumption will be measured using a separate heat meter for each building. The hot tap water supply will not be reestablished, but it is acknowledged that unauthorized tapping will take place.

AF.9 The boiler configuration is one rehabilitated 58 MW boiler and one new 20 MW boiler, producing spare capacity of approximately 28 percent.

AF.10 *Scenario 1* envisages the construction of a new 62 MW boiler house and the rehabilitation of the existing transmission network, district substations, distribution network and internal building installations. Heat consumption will be measured using a heat meter for each building. The hot tap water supply will not be reestablished, but it is acknowledged that unauthorized tapping will take place.

AF.11 The boiler configuration is two new boilers of 60 MW and 20 MW, producing spare capacity of approximately 30 percent.

AF.12 *Scenario 2* envisages the construction of a new 62 MW combined heat and power (CHP) plant with a 25 MW combined-cycle power and heat generator and rehabilitation of the existing transmission network, district substations, distribution network, and internal building installations. Heat consumption will be measured using a heat meter for each building. The hot tap water supply will not be reestablished, but it is acknowledged that unauthorized tapping will take place.

AF.13 The configuration of the heat sources is one combined-cycle CHP of 25 MW and two new boilers of 40 MW and 25 MW, producing spare capacity of approximately 30 percent. One of the boilers is reserved for the CHP plant.

AF.14 *Scenario 3* calls for the construction of a new 58 MW boiler house and rehabilitation of the transmission network, district substations, distribution network, and internal building installations. Hot tap water supply will be reestablished by local heat exchangers at the building level. Heat consumption will be measured using a heat meter for each building; consumption of hot tap water also will be metered.

AF.15 The boiler configuration is two new boilers of 55 MW and 20 MW, with spare capacity of approximately 30 percent.

AF.16 *Scenario 4* envisages the construction of a new 58 MW CHP station with a 20 MW combined-cycle power and heat generator and rehabilitation of the existing transmission network, district substations, distribution network, and internal building installations. Heat consumption will be measured using a heat meter for each building; consumption of hot tap water also will be metered.

AF.17 The configuration of the heat sources is one combined-cycle CHP of 20 MW and two new boilers of 40 MW and 20 MW, producing spare capacity of approximately 39 percent. One of the boilers is reserved for the CHP plant.

AF.18 *Scenario 5* calls for the construction of a new 58 MW CHP station with an 8 MW gas turbine power and heat generator and rehabilitation of the existing transmission network, district substations, distribution network, and internal building installations. Heat consumption will be measured using a heat meter for each building; consumption of hot tap water also will be metered.

AF.19 The configuration of the heat sources is one gas turbine CHP of 8 MW and three new boilers of 8 MW, 20 MW, and 40 MW. Spare capacity will be approximately 31 percent. One of the boilers is reserved for the CHP plant.

Heat Demand

Current heat demand

AF.20 The heat demand of the district served by Boiler House no. 2 was analyzed during Phase 1 of the UHS survey. The total heated area is 595,838 m², with energy demand averaging 2.35 W/m²/°C.

AF.21 The heat demand was calculated for two situations, as follows:

1) Supply of heat present only during the heating season; no official supply of hot tap water (HTW). Unauthorized tapping from the radiator system is

acknowledged and allowed at 50 liters of water per person per day. The length of the heating season is 90 days and the selected comfort level 17°C, corresponding to 1,683 degree-days.

Heat demand	56,558 MWh
HTW demand	9,723 MWh
Distribution losses	5,743 MWh (8 percent)
Total annual heat demand	72,024 MWh
Peak load capacity	61.1 MW

2) Supply of heat during the whole year. Hot tap water is supplied, corresponding to 27 percent of the heat demand. The length of the heating season is 139 days and the selected comfort level 17°C, corresponding to 2,241 degree-days.

Heat demand	75,310 MWh
HTW demand	16,567 MWh
Distribution losses	22,969 MWh (20 percent)
Total annual heat demand	114,846 MWh
Peak load capacity	57.4 MW

Demand for greater heating comfort

AF.22 The request for heating comfort is governed by the amount that consumers can afford to spend and the cost of the service provided by the heat supplier. The current situation can be characterized as a short heating season, underheating of apartments, deteriorating heating installations, and low comfort. As Armenia's economic situation improves, consumer affordability will increase and their demand for better service and a higher degree of comfort also should increase. The logical result will be higher heat consumption.

Demand side management

AF.23 Changing energy prices, rising demand for greater comfort levels, an increased ability and willingness on the part of consumers to pay for energy, more efficient ways of organizing heat supply, and, most important, the introduction of individual metering of heat consumption will increase awareness of the advantages of demand side management and ultimately this should produce significant energy savings.

AF.24 The potential energy savings that could be realized through metering and demand side management is 40–50 percent. This assumes energy savings due to metering and demand side management of 30 percent over a 10-year period, leaving room for improvement of the general level of comfort.

Hot tap water

AF.25 Hot tap water (HTW) usage is expected to remain constant at an average of 50 liters per person per day, producing an aggregate figure of 210 MWh per year for the four buildings served by Boiler House 2.

AF.26 In the scenarios calling for the reestablishment of HTW supply, however, HTW usage is assumed to fall slightly due to the fact that consumers will be required to pay for it. It is estimated to average out at 18 percent of the combined heat and HTW consumption.

Future heat demand

AF.27 In the scenarios that discount the reestablishment of HTW supply, the total requirement for capacity is estimated at 62 MW. In those that call for HTW supply to be reestablished, the requirement is estimated at 58 MW.

CHP Plants

AF.28 A combined-cycle CHP plant typically comprises a gas turbine, an exhaust boiler, a steam turbine, power generators, and heat exchangers for heat production.

AF.29 The gas turbine CHP plant comprises mainly a gas turbine, a power generator, and heat exchangers for heat production.

AF.30 As a single stage electricity tariff is foreseen, no heat accumulator is included in any of the six scenarios.

Table F.1 Characteristics of Different Heat Generating Systems

		20 MW CC	*25 MW CC*	*8 MW GT*
Efficiency	Power	45%	45%	30%
	Heat	45%	45%	58%
	Loss	10%	10%	12%
Capacity	Power	20 MW	25 MW	4.1 MW
	Heat	20 MW	25 MW	8 MW

Feasibility Study

Methodology

AF.31 This section presents the costs of each scenario, including investments, operation and maintenance costs, and fuel costs for each year. The net present value (NPV) of all costs and income (excluding income made from heat sales during the planning, or exploitation, period) is calculated. The scenario that produces the lowest NPV may be regarded as the most feasible.

Planning period	20 years
Technical lifetime of all investments	20 years
Investments made during year	0
First year of operation	1
Net interest rate (after inflation)	10 percent
Price level	September 2001

AF.32 The calculation does not consider inflation as all calculations are made at the same (fixed) price level and all expenses are expected to follow the same general inflation.

AF.33 The NPV is calculated for the year before any scheduled investments are made.

AF.34 The balanced heat price—the average heat price over the planning period, which balances the accounts of the heat production entity—also has been calculated. The calculated figure includes interest on loans and other needs for financing, but does not include profit.

AF.35 Finally, the average annual costs of heating and HTW for a single apartment have been calculated to enable assessment of the consequences to the individual consumer.

Investments and Operation and Maintenance Costs

Table F.2 Investments Required under Six Different Scenarios

	Unit	*Scenario 0*	*Scenario 1*	*Scenario 2*	*Scenario 3*	*Scenario 4*	*Scenario 5*
Rehabilitation of boiler house	US$	400,000					
Construction of boiler house	$US\$/MW_{(heat)}$	50,000	50,000	50,000	50,000	50,000	50,000
Construction of CHP plant	$US\$/MW_{(power)}$			565,500		565,500	565,500
Rehabilitation of network	US$	2,782,800	2,782,800	2,782,800	2,782,800	2,782,800	2,782,800
Rehabilitation of internal building installations	US$	1,146,600	1,146,600	1,146,600	1,146,600	1,146,600	1,146,600
Reestablishment of HTW supply	US$				499,800	499,800	499,800

Investments

AF.36 For the purposes of this comparison, all investments are taken to be made during the same year. The plants will be put into operation the following year. Maintenance costs are assessed under the condition that the lifetime of the investment is 20 years; at the end of this period the scrap value of the investment is taken to be zero.

Operation and maintenance costs

AF.37 Annual operation and maintenance costs are assessed at 1.5 percent of the investment in new plants and 3 percent of the investment in the rehabilitation of existing plants.

Distribution losses

AF.38 The distribution losses after rehabilitation of the distribution network are assessed at 20 percent of the gross heat turnover at the network, assuming that the heat supply is maintained 365 days per year. The heating season currently is 90 days, so the distribution losses are taken to be 25 percent of the gross heat turnover at the network. This corresponds to 8 percent of gross heat turnover during the 90-day heating season.

Fuel Prices

Table F.3 Fuel Prices

Fuel	*Price including taxes US$/MWh*	*Price excluding taxes US$/MWh*
Natural gas (Large consumers using more than 10,000 cubic meters per year)	8.496	7.080

Electricity Sale Prices

AF.39 The sale prices for electricity produced by independent producers and sold to the public grid are not available. For the purposes of this study it is assumed that electricity is sold to the public grid at an average price of 30 percent of the official electricity sales price to consumers. It is assumed also that there is a single-stage tariff for the electricity sale price.

Table F.4 Electricity Sale Prices

	Price including taxes US$/MWh	*Price excluding taxes US$/MWh*
Electricity sale price to consumers	45.450	37.875
Electricity sale price to the public grid	15.550	12.575

Consequences for Consumers

AF.40 The average annual cost of heating and of HTW is calculated for a typical three-room apartment with a total floor area of 77.2 square meters, inhabited by four persons with the following demand for heat and HTW:

Heat	7.70 MWh/year
HTW	0.94 MWh/year

Results

AF.41 The costs of heat and HTW have been calculated for the situation before and after the expected savings due to demand side management. The results are tabulated in Table F.5.

Table F.5 The Cost of Heat Supply under Six Different Scenarios

Costs of Heat Supply Before Demand Side Management

		Scenario 0	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
		Rehab. Of 62 MW Boiler Station - Heat Supply in Heating Season	New 62 MW Boiler Station - Heat Supply in Heating Season	25 MW CC - Heat Supply in Heating Season	New 60 MW boiler House - Heat Supply all the year	20 MW CC - Heat Supply all the year	8 MW GT - Heat Supply all the year
Configuration		58 MW existing boiler, 20 MW new boiler	60 MW and 20 MW new boilers	25 MW CC, 25 MW and 40 MW new boilers	55 MW and 20 MW new boilers	20 MW CC, 20 MW and 40 MW new boilers	8 MW GT, 8 MW, 20 MW and 40 MW new boilers
NPV of total costs over 20-year period	USD	11.335.265	13.919.431	26.035.143	17.276.249	25.589.323	20.977.406
Balanced heat and HTW price	USD/MWh	22	28	52	25	37	30
Cost of Heat and HTW for a 77.2 m² 3-room flat with 4 persons	USD/year	203	249	466	246	364	299

Costs of Heat Supply After Demand Side Management

		Scenario 0	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
		Rehab. Of 62 MW Boiler Station - Heat Supply in Heating Season	New 62 MW Boiler Station - Heat Supply in Heating Season	25 MW CC - Heat Supply in Heating Season	New 60 MW boiler House - Heat Supply all the year	20 MW CC - Heat Supply all the year	8 MW GT - Heat Supply all the year
Configuration		58 MW existing boiler, 20 MW new boiler	60 MW and 20 MW new boilers	25 MW CC, 25 MW and 40 MW new boilers	55 MW and 20 MW new boilers	20 MW CC, 20 MW and 40 MW new boilers	8 MW GT, 8 MW, 20 MW and 40 MW new boilers
NPV of total costs over 20-year period	USD	10.637.051	13.221.217	25.336.928	16.207.083	24.473.367	19.927.118
Balanced heat and HTW price	USD/MWh	24	30	58	27	40	33
Cost of Heat and HTW for a 77.2 m² 3-room flat with 4 persons	USD/year	189	235	451	232	350	285
Cost savings due to demand side management	%	7%	5%	3%	6%	4%	5%

AF.42 The calculations found scenario 0 to produce the lowest heating costs, both expressed in terms of the value of the total costs and as the balanced heat price (see Table F.5). The introduction of demand side management is calculated to deliver savings of approximately 7 percent to the average consumer.

AF.43 The calculations show that investment would not be viable in a CHP plant of this scale in this location. The heating season in Yerevan is just 90–139 days, and scenario 2 envisages shutting down the heating plants outside this season, with the result that the operating period would be too short for a CHP plant. A CHP plant could operate at full capacity (power mode) all year round, but this would require a different design and additional investment in cooling facilities. However, this strategy depends heavily on the electricity sales price, and with the assumed ratio between the fuel price and the electricity price would not be feasible.

Annex G

Feasibility of Gas Supply to a Small-Scale District Heating System

Introduction and Overview

AG.1 This feasibility study for the supply of gas to a small-scale heating district takes as its study sample the district supplied by the Vratsakan no. 4/7 boiler house. Vratsakan 4/7 supplies four identical buildings, totaling 224 apartments. The nearest gas distribution line is approximately 190 meters distant. The boiler house was commissioned in 1986 and was in operation until the 1991–92 heating season. The boilers, heat distribution system, and building installation are in reasonable condition but require substantial rehabilitation.

AG.2 The annual heat demand from the district is 1,714 MWh and the demand for hot tap water is 210 MWh. Energy savings due to metering and demand side management are expected to reach 30 percent over a 10-year period.

AG.3 The feasibility study examines three different scenarios, all using natural gas, as follows:

- gas supply to the existing boiler house
- gas supply to block boiler houses at the building level
- individual gas heaters at the apartment level

AG.4 The calculations found the first of these options, which requires the rehabilitation of the existing boiler house and heating systems, to return the lowest heating costs, expressed both as the present value of total costs and as the balanced heat price.

AG.5 The introduction of demand side management would be expected to result in savings to the average consumer of approximately 8 percent over a 20-year period.

Selection of Site

AG.6 Four sites were suggested for the study. All are located in Yerevan and comprise a small boiler house supplying a number of residential buildings. The main characteristics of each site are outlined below.

AG.7 *Site 1: Vratsakan No. 4/7.* The boiler house supplies four identical buildings, and a total of 224 apartments. The nearest gas distribution line is approximately 190 meters from the boiler station. The boiler station was commissioned in 1986 and operated up to the 1991–92 heating season. The boilers, heat distribution system, and building installation are in reasonable condition but nonetheless require substantial rehabilitation.

AG.8 *Site 2: S. David No. 2.* The S. David boiler house supplies five buildings, totaling approximately 200 apartments. The nearest gas distribution line is approximately 150 meters away. The boiler house has been out of operation for a number of years and is in very poor condition: for it to be put back into service the boilers and all other equipment would first have to be replaced. The heat distribution system and building installation similarly are in poor condition.

AG.9 *Site 3: Zeytun No. 6/3*. This boiler house supplies 17 buildings, for a total of approximately 700 apartments. The nearest gas distribution line is approximately 670 meters away. Although the boiler house has been out of operation for a number of years the boilers have had few hours of operation and are in good condition. The boiler station, heat distribution system, and building installation would require only limited rehabilitation

AG.10 *Site 4: Sayat Nova No. 14.* The Sayat Nova boiler house supplies three buildings, totaling approximately 200 apartments. The nearest gas distribution line is approximately 300 meters away. The boiler house has been out of operation for a number of years and the boilers and associated equipment are in very poor condition and must be replaced. The heat distribution system and building installation also are in poor condition.

Selection of site

AG.11 The boiler house at Vratsakan was selected as the one that is most representative of a small Armenian boiler house. The boilers are not new, nor are they completely run down. While some rehabilitation work would be required, most of the necessary equipment is present and can be restored.

AG.12 The total annual heat demand for the district is 1,714 MWh, and the demand for hot tap water is 210 MWh. Energy savings due to metering and demand side management are expected to reach 30 percent over a 10-year period.

Development of Scenarios

AG.13 The feasibility study examined three different scenario, all based on the use of natural gas. These are outlined as follows:

AG.14 *Gas supply to the existing boiler house.* This scenario envisages the recommissioning of the existing boiler station; rehabilitation of the heat distribution system and of the internal heating system in the buildings served, including pipes and radiators; and the establishment of an HTW supply based on a local heat exchanger at the building level. A new recirculation pipe for HTW would be established in the basement. Metering of heat consumption would be based on a heat meter for each building and heat allocators. The HTW consumption would be measured in each apartment. A gas distribution pipe would be established from the nearest gas offtake point to the boiler house.

AG.15 *Gas supply to block boiler houses.* The second scenario calls for the construction of a new block boiler house next to each building; the connection of each new boiler house with the existing internal heating system in the corresponding building; the rehabilitation of the internal heating system in the buildings, including pipes and radiators; and the establishment of an HTW supply from the block boiler house. A new recirculation pipe for HTW would be established in the basement. Heat consumption would be measured using a heat meter for each building and heat allocators; HTW consumption would be measured in each apartment. A gas distribution pipe would be established from the nearest gas offtake point to each of the block boiler houses.

AG.16 *Individual gas heaters.* The third scenario calls for the establishment of individual gas heaters in each apartment. The existing boiler house, heat distribution system, and internal heating system would be decommissioned. Armenian regulations do not permit the use of gas-fired HTW heaters, so HTW production would be based on the use of electrical heaters. Gas and electricity consumption would be metered for each apartment. Internal gas pipes and a gas distribution pipe would be established from the offtake point nearest to each building.

Heat Demand

Current heat demand

AG.17 The four buildings are identical nine-story blocks of flats of concrete panel construction. The energy demand of this type of building was analyzed during Phase 1 of the UHS and identified as 2.60 W/m²/°C. The total area to be heated of the four buildings is 16,320 m². The length of the heating season is 90 days and the selected comfort level is 17°C, corresponding to 1,683 degree-days. The total annual heat demand for the district therefore is 1,714 MWh, or 105 kWh/m².

Demand for greater heating comfort

AG.18 The demand for heating comfort is governed by the ability and willingness to pay of consumers and the cost of the service provided by the heat supplier. Given the high cost of service and the relative impoverishment of consumers, the current situation in Armenia is a short heating season, underheating of apartments, deteriorating heating installations, and an overall low level of comfort. As the country develops economically, consumers will become better able to pay for heating and will demand better service from suppliers and a higher degree of comfort. The result will be higher heat consumption.

Demand side management

AG.19 Changing energy prices, rising consumer demand for greater comfort levels, and increased ability and willingness on the part of consumers to pay for energy, more efficient ways of organizing heat supply, and, most important, the introduction of individual metering of heat consumption will increase awareness of the advantages of demand side management and ultimately should produce significant energy savings. (See Appendix G.2 for a detailed description of demand side management measures.)

AG.20 Metering and demand side management potentially could deliver energy savings of 40–50 percent. This calculation assumes energy savings of 30 percent over a 10-year period, leaving room also for an improvement of the general level of comfort.

Hot tap water

AG.21 The demand for hot tap water is assumed to remain at an average of 50 liters per person per day, for an aggregate of 210 MWh/year for the four buildings.

Future heat demand

AG.22 The future heat demand is tabulated in Table G.1. The capacity requirement for the Vratsakan No. 4/7 boiler house is 2.7 MW.

Table G.1 Future Heat Demand

Year	0	1	2	3	4	5	6	7	8
Net heat demand before demand side management (MWh/year)	1714	1714	1714	1714	1714	1714	1714	1714	1714
Savings due to demand side management (MWh/year)	0	0	34	68	102	136	171	205	239
Net heat demand (MWh/year)	1714	1714	1680	1646	1612	1578	1543	1509	1475
HTW demand (MWh/year)	210	210	210	210	210	210	210	210	210

Year	9	10	11	12	13	14	15	16 - 20
Net heat demand before demand side management (MWh/year)	1714	1714	1714	1714	1714	1714	1714	1714
Savings due to demand side management (MWh/year)	273	307	342	342	342	342	342	342
Net heat demand (MWh/year)	1441	1407	1372	1372	1372	1372	1372	1372
HTW demand (MWh/year)	210	210	210	210	210	210	210	210

Feasibility Study

Methodology

AG.23 The costs of each scenario, including investments, operation and maintenance costs, and fuel costs were calculated for each year, and the present value (PV) of all costs during the planning (or exploitation) period calculated. The PV of all costs for each scenario were compared and the scenario showing the lowest PV thus identified as the most feasible. The key assumptions for the calculations were as follows:

Planning period	20 years
Investments are made in year	0
First year of operation	1
Net interest rate (after inflation)	10 percent
Price level	September 2001

AG.24 The calculation does not consider inflation, as all calculations were made assuming the same (fixed) price level and all expenses were assumed to follow inflation. The PV was calculated for the year before the investments are made.

AG.25 The balanced heat price—the average heat price over the planning period, which balances the accounts of the heat production entity—also was calculated. The balanced heat price includes interests on loans and other needs for financing, but does not include projected profit.

AG.26 In order to assess the consequences for the individual consumer, the average annual costs of heating and HTW for one apartment were calculated.

Investments and Operation and Maintenance Costs

AG.27 All investments are assumed to be made during the same year, and the plants put into operation the following year. Assessment of maintenance costs assumes the lifetime of the investment to be 20 years, after which time the scrap value of the investment is taken to be zero. A summary of investments and costs for the different scenarios is shown in Table G.2 (see also Appendix G.1 for a more detailed breakdown of figures).

Table G.2 Investments and O&M Costs

Scenario	*Investments (US$)*	*Operation and maintenance costs (US$)*
Gas supply to the existing boiler house	40,720	10,990
Gas supply to block boiler houses	254,720	13,290
Individual gas heaters	109,410	6,306

Fuel and Electricity Prices

Table G.3 Fuel and Electricity Prices

Fuel	*Price, including taxes (US$/MWh)*	*Price, excluding taxes (US$/MWh)*
Natural gas - Large consumers (> 10,000 m3/year) - Individual consumers	 8.496 9.960	 7.080 8.300
Electricity	45,450	37.875

Consequences for Consumers

AG.28 The annual costs of heating and HTW were calculated for a typical three-room apartment, with a floor area of 77.2 square meters and inhabited by four persons. The heat and HTW demand for the household were established to be as follows:

Heat	7.70 MWh/year
HTW	0.94 MWh/year

Results

AG.29 The calculations found the scenario calling for the rehabilitation of the existing boiler house and heating systems to give the lowest heating costs, expressed both in terms of the present value of total costs and as the balanced heat price (see Table G.4).

AG.30 The introduction of demand side management was calculated to deliver savings of approximately 8 percent to the average consumer.

Table G.4 The Cost of Heat Supply under Three Different Scenarios

Costs of Heat Supply Before Demand Side Management

		Rehabilitation of Boiler Station	HOB at Building Level	Individual Gas Heaters
PV of total costs over 20-year period	USD	286.775	478.013	358.420
Balanced heat and HTW price	USD/MWh	20	33	24
Cost of Heat and HTW for a 77.2 m² 3-room flat with 4 persons	USD/year	177	295	221

Costs of Heat Supply After Demand Side Management

		Rehabilitation of Boiler Station	HOB at Building Level	Individual Gas Heaters
PV of total costs over 20-year period	USD	262.831	457.066	340.379
Balanced heat and HTW price	USD/MWh	21	36	27
Cost of Heat and HTW for a 77.2 m² 3-room flat with 4 persons	USD/year	162	282	210
Cost savings due to demand side management	%	8%	4%	5%

Appendix G.1

Investments

Scenario 1: Gas supply to the existing boiler house

Gas system

	Investment (US$)	*Operation and maintenance costs (US$/year)*
Pipe line 159 mm, length 70 m 108 mm, length 120 m	2,880	
Total	2,880	330

Heating system

	Investment (US$)	*Operation and maintenance costs(US$/year)*
Rehabilitation of boiler house, incl. gas meter and safety and control devices	5,600	
Heat distribution system	420	
Internal heating system	2,560	
Internal HTW system, incl. heat exchanger	3,260	
Meters and heat allocators	26,000	
Total	37,840	10,660

Boiler house efficiency	85 percent
Distribution network efficiency	88 percent

Scenario 2: Gas supply to individual block boiler houses

Gas system

	Investment (US$)	*Operation and maintenance costs (US$/year)*
Pipe line 159 mm, length 100 m 108 mm, length 200 m	4,500	
Gas reduction station	4,000	
Meters and safety and control devices	-	
Total	8,500	670

Heating system

	Investment (US$)	*Operation and maintenance costs (US$/year)*
Construction of four individual block boiler houses, incl. gas meters, safety and control devices, and connection to building	214,400	
Internal heating system	2,560	
Internal HTW system, incl. heat exchanger	3,260	
Meters and heat allocators	26,000	
Total	246,220	12,620

Boiler house efficiency 90 percent
Distribution network efficiency 95 percent

Scenario 3: Individual gas heaters

Gas system

	Investment (US$)	*Operation and maintenance costs (US$)*
Pipe line, medium and low pressure 159 mm, length 200 m 108 mm, length 30 m	4,000	
Gas reduction station	1,000	
Gas distribution pipes to meters; meters: and safety and control devices	3,000	
Total	8,000	680

Heating system

	Investment (US$)	*Operation and maintenance costs (US$)*
Gas radiators, ventilation and exhaust pipes, and control equipment	53,760	
Internal pipe system in apartments	2,850	
Electricity supply		
Electrical HTW heater	44,800	
Total	101,410	5,626

Gas heater efficiency 80 percent
Water heater efficiency 95 percent

Appendix G.2

Demand Side Management

Changing energy prices, rising demand for greater comfort levels, an increased ability and willingness on the part of consumers to pay for energy, more efficient ways of organizing heat supply, and, most important, the introduction of individual metering of heat consumption will increase awareness of the advantages of demand side management and ultimately this should produce significant energy savings.

Key demand side measures include the following:

- installation of meters at the building level
- installation of thermostatic valves and heat allocators
- proofing of windows and closing of entrances and staircases
- heat insulation of building walls

Typical savings are presented in the following table. All figures are expected average values. The expected payback time is presumed to be 2,500 degree-days.

Investments	*Unit*	*Investment (US$)*	*Typical energy saving (%)*	*Simple payback time (years)*
Installation of meters at the building level	Per block of apartments	900–1,200	5–15	1.7–2.3
Installation of thermostatic valves and heat allocators	Per apartment	200–300	17–23	1–2
Proofing of windows and closing of entrances and staircases	Per apartment	400–600	8–10	1–2
Heat insulation of building walls	Per apartment	600	17–23	3–4

Investment in energy saving measures would result in the energy savings detailed in the table. Actual cost savings would depend on how the investment is financed. If the investment were to be financed over a period equal to the payback period, the cost of heating would remain unchanged until the investment is paid back. At end of the payback period the cost would be reduced as described in the table.

All of the above measures—the installation of meters at the building level, installation of thermostatic valves and heat allocators, and the proofing of windows and closing of entrances and staircases—are considered to be feasible.

The potential for energy savings due to metering and demand side management is 40–50 percent. As there is likely to be an increase in the demand for comfort arising concurrent with the economic development of the country, an energy savings of 30 percent over a 10-year period is considered realistic.

Annex H

Spreadsheet Models: Methodology and Assumptions

Introduction

AH.1 This annex presents the methodology and assumptions used to perform the feasibility analysis of the heating options in the main report.

General Methodology

AH.2 For the first two to five years all existing heating systems will be maintained on a minimum level with no or few investments and the lowest possible operation and maintenance costs. This level will be maintained until the situation has stabilized and the future of the plant has been decided. After the first five-year period it is the objective to establish modern production, transmission, and distribution facilities to ensure reliable operations during the next 20 years, or alternatively to convert to decentralized or individual solutions.

AH.3 The costs of collective heat are reduced by simple technical means (such as the disconnection of radiator strings) such that they might be kept within the willingness to pay (WTP) of consumers and within the cost of competing individual heating systems, primarily electrical or solid fuel stoves.

AH.4 In general, the district heating systems in Zones 4 and 5 (formerly supplied by collective heating systems but now using individual heating) will not be reconnected or recommissioned. The consumers in these zones are in general assumed to continue with individual heating options or to shift to decentralized small boiler systems.

Scope

AH.5 The zones and subzones, including boiler plants, transmission systems, central heating points, distribution systems, and building installations, were assessed individually. The assessment comprised the following:

- Heat demand. The heat demand was calculated as described in Appendix H.3.
  The heat price was calculated for two cases: (a) without energy savings due to demand side management; and (b) including energy savings due to demand side management.

- Investment strategy. See Appendixes H.8–H.11.
- O&M costs. The costs of operation and maintenance were individually calculated, applying the cost basis described in Appendix H.5 Operation and Maintenance Costs
- Fuel Prices. See Appendix H.6 Fuel Prices.
- The current price of natural gas was used for the whole assessment period.

Timing

AH.6 The general timing of the recovery of the district heating systems is described in Table H.1.

Table H.1 Recovery of the District Heating Systems

Year	*Year number*	*Period*
2002	0	Present year (year of comparing all investments)
2003	1	Start of planning period Start of reconstruction First year of survival period
2004	2	Last year of survival period
2005	3	First year of recovery period
-	-	-
2007	5	Last year of recovery period
2008	6	First year of growth period First year with comprehensive investments
2017	15	Last year with comprehensive investments
-	-	-
2027	25	Last year of growth period End of planning period

AH.7 The planning period is 25 years, starting from 2003 (year 1). It is further divided into three periods, as follows:

- survival period (2003 and 2004 or years 1 and 2)
- recovery period (2005–07 or years 3–5)
- growth period (2008–27, or years 6–25)

Survival Period (Years 1 and 2)

AH.8 The cost of heat should not exceed the WTP and the costs of competing fuels.

AH.9 The strategy of the district heating company (DHC) is to survive, to rationalize organization and manning, to keep existing consumers, and to keep existing facilities in operation.

Investments

AH.10 Investments should be kept to a minimum. Necessary investments are spread equally over the two years and have been calculated individually on a local price basis. Given the lack of funds in the country, the extent and quality of the renovation may not be optimal. The physical condition of the plants may continue deteriorating and some DH systems or districts may be lost during this period.

AH.11 Generally, investments must be paid back during the year in which they are defrayed.

AH.12 The first investment is made in 2003 (year 1). All costs are discounted to 2002 (year 0) and compared in that year.

Calculation of Heating Costs

AH.13 The heating costs comprise the capital costs of investment, operation and maintenance costs, and fuel costs. The heat price should be kept at a minimum.

AH.14 No state subsidies of the heat price are expected, but state credits or donor credits on commercial or soft conditions are a possibility. No credits from private commercial sources are considered possible.

AH.15 The heating costs are expressed as the balanced heat price: the heat price that balances the accounts of the heating company over the two-year period of operation. All expenses over this period (2003–04, or years 1 and 2) are discounted to 2002 (year 0) and the present value (PV) calculated. The PV of all expenses is compared to the PV of the heat sales during the same period and the balanced heat price (see Appendix H.12).

Recovery Period (Years 3–5)

AH.16 The cost of heat during the recovery period may follow the gross domestic product (GDP) but should not exceed the WTP nor the costs of competing heating systems, which also are expected to follow the GDP.

AH.17 The strategy of the DHC is to recover, to increase service and liability levels, and to look for previously lost consumers and new consumers.

Investments

AH.18 Investments should be kept to a minimum. Necessary investments are spread equally over the three years and have been calculated individually on a local price basis. Small investments in production facilities or distribution networks are allowed, provided that they increase reliability or efficiency.

AH.19 Generally, investments must be paid back during the year in which they are defrayed.

AH.20 No state subsidies, state credits, or donor credits are available. Credits from private commercial sources are possible.

AH.21 Some lost DHCs may be recovered during this period as condominium-based or -owned entities.

AH.22 The first investment is made in 2006 (year 3). All costs are discounted to 2002 (year 0) and compared in that year. It is assumed that investments and operation and maintenance costs are the same each year.

Calculation of Heating Costs

AH.23 The heating costs comprise the capital costs of investment, operation and maintenance costs, and fuel costs.

AH.24 The heating costs are expressed as the balanced heat price: the heat price that balances the accounts of the heating company over the three-year period of operation. All expenses over the three-year period (2005–07, or years 3–5) are discounted to 2002 (year 0) and the present value (PV) calculated. The PV of all expenses is compared to the PV of heat sales during the same period, and the balanced heat price calculated (see Appendix H.12).

Growth Period (Years 6–25)

AH.25 The cost of heat during the growth period may follow the GDP, but should not exceed the WTP nor the cost of competing fuels, which also is expected to follow the GDP. After a period of investments in heat production or distribution facilities the heat price will stabilize. This will make room for the servicing of credits and will provide reserves for future investments.

AH.26 The strategy of the DHC is to convert to commercial operations, to maintain service and liability levels, to extend supplies, and to connect new consumers.

Investments

AH.27 The costs of investments have been calculated individually (see Appendix H.4). Investment and operation and maintenance are assumed to be at such a level that the plants may be kept in operation for 20 years. Investments in production facilities or distribution networks to increase reliability or efficiency will be necessary. It is expected that the DHC will be able to attract credits. Investment will be paid back over a longer period, making larger investments possible.

AH.28 The first investment is made in 2008 (year 6). Considering the lack of funds in Armenia, it is assumed that the investments are spread over the first 10 years (2008–17, or years 6–15) of the planning period and depreciated over 20 years (2008–27, or years 6–25). All costs are discounted to 2002 (year 0) and compared in that year. It is assumed that investment and operation and maintenance costs are the same each year.

Calculation of Heating Costs

AH.29 The heating costs comprise the capital costs of investment, operation and maintenance costs, and fuel costs.

AH.30 No state subsidies, state credits, or donor credits are available. Credits from private commercial sources are possible.

AH.31 The heating costs are expressed as the balanced heat price: the heat price that balances the accounts of the heating company over the 20-year period of operation. All expenses over the 20-year period (2008–27 or years 6–25) are discounted to 2002 (year 0) and the present value (PV) calculated. The PV of all expenses is compared to the PV of the heat sales during the same period, and the balanced heat price calculated (see Appendix H.12).

Appendix H.1

Zoning and Assessment of Existing Heating Supply Systems

Guidelines for Zoning of Urban Areas

For the purpose of building up scenarios for heat supply in the urban areas that are the target of the Urban Heat Strategy, the areas need to be divided into zones.

The zoning should take place using the following terminology:

- Zone 1 should designate areas that currently are supplied from a CHP plant.
- Zone 2 should designate areas that currently are supplied from large heat-only boiler (HOB) plants. Large plants are defined as those that serve more than 1,000 apartments.
- Zone 3 should designate areas that currently are supplied from small HOB plants.
- Zone 4 should designate areas that formerly were connected to combined heat and power (CHP) or HOB plants and that could be reconnected at relatively small cost (this is not relevant in **Kyrgyz Republic** so this zone will not appear in the calculations).
- Zone 5 should designate areas of multistory buildings that could be connected to an existing CHP or HOB plant only at a more than moderate cost.
- Zone 6 should designate areas of detached houses with a low density of heat demand and that are best suited for individual heat supply. To the extent that there are detached houses in the geographical areas that otherwise would fall under the definition of Zones 1, 2, or 3 these houses should be considered to belong to Zone 6.

Appendix H.2

Cost Assessment of Developed Heat Supply Options

Guidelines for Cost Assessment of Heat Options

CHP and HOB options

- Combined heat and power (CHP) options have been assessed for Zone 1 and the appropriate subzones of Zone 4.
- Heat-only boiler (HOB) options have been assessed for Zone 2, Zone 3, and the appropriate subzones of Zone 4.
- All remaining options are assessed independently from zoning.
- *General*
- For each city, a standard apartment has been determined, in terms of area (square meters), number of occupants, heat demand, and hot tap water (HTW) demand.
- The analysis will determine the balance cost for a standard apartment for each of the collective heating options in the relevant zones and subzones, and for each of the building-level and individual options in the standard houses. ("Balance cost" is the cost of investments in communal or individual solutions amortized over a 20-year period and expressed as a monthly cost that is added to any operating costs. For collective systems balance costs represent the heat tariff at which the heat supplier can balance its accounts over a 20-year period.)
- The assessment will not include any stranded costs (essentially, the payback of old debt) or any savings made in order to build new plant in the future.
- The assessments are carried out including and excluding HTW supply and including and excluding energy conservation efforts (demand side management).
- In the first instance the costs do not include the expense necessary to expand the natural gas network. This will be analyzed in a separate exercise.

Appendix H.3

Heat Demand

The actual heat demand in each zone and subzone is estimated by assessing and applying the following:

- the specific heat demand for a number of typical buildings
- the number of each of the typical buildings
- the number of apartments
- the total square meters of each building (not the number of “useful” square meters, as previously used)
- the number of inhabitants per apartment
- degree-days, length of heating season, and comfort level
- the heat demand for hot tap water (HTW)
- transmission and distribution efficiency
- production efficiency

1) Specific heat demand

The specific heat demand for space heating has been assessed for typical buildings in each city, with reference to the actual situation. It has been assessed directly by calculation of transmission and ventilation losses. The specific heat demand calculated this way shows reasonable conformity with the specific heat demand derived by the calculation of the heat balances for selected buildings.

Figure H.1 Specific Heat Demand: Apartment Buildings

Standard buildings: Jerevan, Charentsavan, Gyumri, Jermuk			
		3 cities	
Five-story block of apartments with stone walls		*Norm:*	
Average size of apartment	m²	58,4	
Average no. of people per apartment	-	3,9	
Volume/area factor	m^3/m^2	4,15	
Specific heat demand for space heating (block level)	$W/m^3/°C$	0,53	
Specific heat demand for space heating (apartment level)	W/m²/°C	2,20	
		9-story	*14-story*
Multistory block of apartments (9-14 stories) with concrete panel walls		*Norm:*	*Norm:*
Average size of apartment	m²	58,0	74,2
Average no. of people per apartment	-	3,8	4,0
Volume/area factor	m^3/m^2	4,26	4,05
Specific heat demand for space heating (block level)	$W/m^3/°C$	0,61	0,61
Specific heat demand for space heating (apartment level)	W/m²/°C	2,60	2,47
Individual small-size residential buildings		*Norm:*	
Average size of apartment	m²	58,0	
Average no. of people per apartment	-	3,9	
Volume/area factor	m^3/m^2	4,20	
Specific heat demand for space heating (block level)	$W/m^3/°C$	0,75	
Specific heat demand for space heating (apartment level)	W/m²/°C	3,15	
Specific buildings: Gyumri			
		Gyumri	
Four-story block of apartments			
Average size of apartment	m²	58,4	
Average no. of people per apartment	-	3,9	
Volume/area factor	m^3/m^2	4,15	
Specific heat demand for space heating (block level)	$W/m^3/°C$	0,65	
Specific heat demand for space heating (apartment level)	W/m²/°C	2,70	

Figure H.2 Specific Heat Demand: Detached Houses

Detached houses		**Yerevan**	**Gyumri**
Average size of house	m²	106,7	100
Average no. of people per apartment	No.	5,7	5,0
Specific heat demand for space heating	W/m²/°C	3,00	3,00

No detached houses in Jermuk and Charentsavan

2) Degree-days

The number of degree-days in each of the four cities has been calculated with reference to two different comfort levels: 20–17 °C and 16–13 °C. For each comfort level, the first figure expresses the targeted indoor temperature and the second figure the temperature that should be achieved by the external heating source. The difference, 3 °C, is supposed to be realized through the activity of the inhabitants and the use of electrical appliances.

Table H.2 Degree-Days, Yerevan

Yerevan		Case 1	Case 2
Average outdoor temp.	°C	0,88	-1,70
No. of heating days (case1)		139	
No. of heating days (case2)			90
Comfort level	°C	17	17
Degree-days (case 1)		2.241	
Degree-days (case 2)			1.683
Comfort level	°C	13	13
Degree-days (case 1)		1.685	
Degree-days (case 2)			1.323

Table H.3 Degree-Days, Gyumri

Gyumri		Case 1	Case 2
Average outdoor temp.	°C	-2,13	-5,98
No. of heating days (case1)		191	
No. of heating days (case2)			120
Comfort level	°C	17	17
Degree-days (case1)		3.654	
Degree-days (case2)			2.758
Comfort level	°C	13	13
Degree-days (case1)		2.890	
Degree-days (case2)			2.278

Table H.4 Degree-Days, Charentsavan

Charentsavan		Case 1	Case 2
Average outdoor temp.	°C	-0,88	-4,60
No. of heating days case 1	-	189	
No. of heating days case 2	-		100
Comfort level	°C	17	17
Degree days case 1	-	3.378	
Degree days case 2	-		2.160
Comfort level	°C	13	13
Degree days case 1	-	2.622	
Degree days case 2	-		1.760

Table H.5 Degree-Days, Jermuk

Jermuk		Case 1	Case 2
Average outdoor temp.	°C	-1,17	-4,65
No. of heating days case 1		217	
No. of heating days case 2			120
Comfort level	°C	17	17
Degree -days (case 1)		3.900	
Degree-days (case 2)			2.597
Comfort level	°C	13	13
Degree-days (case 1)		3.032	
Degree-days (case 2)			2.117

3) HTW demand

Officially there is no provision of hot tap water. However, there is a tradition for and general acceptance of the tapping of hot tap water from the radiator system. This illicit HTW tapping is assessed, based on data from the district heating companies, at 50 liters per person per day.

4) Demand side management

Changing energy prices, rising demand for greater comfort levels, an increased ability and willingness on the part of consumers to pay for energy, more efficient ways of organizing heat supply, and, most important, the introduction of individual metering of heat consumption will increase awareness of the advantages of demand side management and ultimately this should produce significant energy savings.

Key demand side measures include the following:

- installation of meters at the building level
- installation of thermostatic valves and heat allocators
- proofing of windows and closing of entrances and staircases
- heat insulation of building walls

Typical savings are presented in Table H.6. All figures are expected, average values; the expected payback time presumes 2,500 degree-days.

Table H.6 Savings Realizable through Demand Side Management

Investments	*Unit*	*Investment (US$)*	*Typical energy saving (%)*	*Simple payback time (years)*
Installation of meters at the building level	Per block of apartments	900–1,200	5–15	1.7–2.3
Installation of thermostatic valves and heat allocators	Per apartment	200–300	17–23	1–2
Proofing of windows and closing of entrances and staircases	Per apartment	400–600	8–10	1–2
Heat insulation of building walls	Per apartment	9,000–12,000	17–23	15–20

Investment in energy saving measures would result in the energy savings as described in the table. The actual cost savings would depend on how the investment is financed. If the investment is financed over a period equal to the payback period, the cost of heating will remain unchanged until the investment is paid back. After the end of that period, the cost will be reduced as described in the table.

The insulation of building walls pays itself off only after a period of up to 20 years, but the installation of meters at the building level, installation of thermostatic valves and heat allocators, and proofing of windows and closing of entrances and staircases may be feasible.

The potential for energy savings due to metering and demand side management is 40–50 percent. Demand for greater levels of comfort is expected as the country's economy develops, so the energy savings due to metering and demand side management are assumed to reach 30 percent. Demand side management measures are assumed to be implemented equally over a 10-year period.

The investment in demand side management is not included in the total investment

5) Production, transmission, and distribution efficiencies

The present efficiencies of production and transmission and distribution are assessed based on information from the district heating companies. Efficiencies are not assumed to exceed the figures presented in Table H.7.

Table H.7 Maximum Efficiency after Rehabilitation

	Transmission and distribution efficiency	*Production efficiency*
Large boiler houses	85%	90%
Small boiler houses	90%	90%
Block 1 (block heating: HOB on natural gas)	98%	90%
Ind-elec (individual electrical heating)	100%	100%
Ind-NG (individual natural-gas-fired heaters)	100%	82%
Ind-solid (individual solid fuel stoves)	100%	73%
Ind-LPG (individual liquefied petroleum gas)	100%	82%
Ind-keros (individual kerosene stoves)	100%	82%

Appendix H.4

Investments

1) Large Boiler Houses (>1 MW)

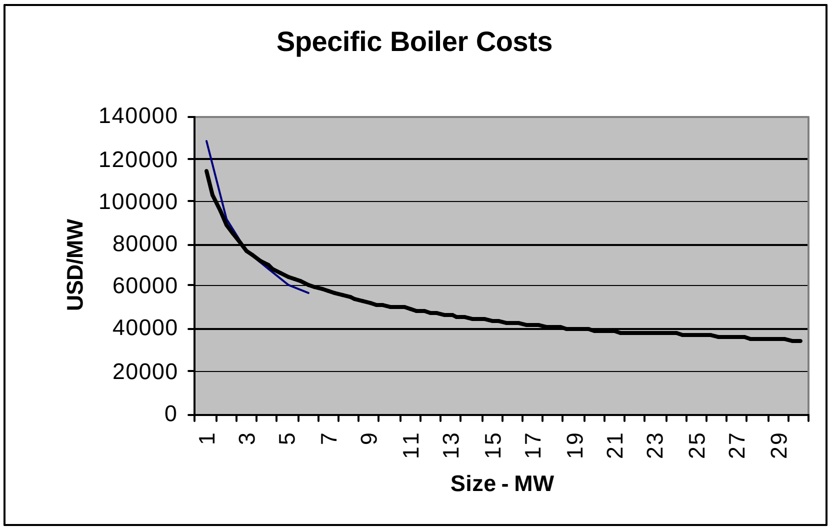
Figure H.3 tabulates the costs of building natural gas-fueled boiler houses of different capacities and compares graphically the decline in specific costs with increasing capacity. Plant components, including boilers, burners, water treatment plants, and pumps, are priced from international suppliers. Foundations, buildings, flue stacks, and connections to gas and district heating grids are supplied locally. The costs of land acquisition is not included. All stations are configured with two or more units, but there is no spare capacity. The cost of labor as a proportion of the overall cost of the boiler house is assessed at 20–25 percent.

For planning purposes, the specific cost of boiler houses larger than 20 MW is taken as 40,000 US$/MW.

Figure H.3 Costs of Boiler Houses

Size (MW)	*Cost of boiler house (US$)*	*Other costs[1] (US$)*	*Design, administration, and constr. (US$)*	*Total (US$)*	*Specific cost (US$/MW)*
0.6	73,200	24,000	14,580	111,780	186,300
0.8	80,000	26,000	15,900	121,900	152,375
1	83,700	28,000	16,755	128,455	128,455
2	123,400	35,700	23,865	182,965	91,483
3	158,400	43,400	30,270	232,070	77,357
4	186,200	50,200	35,460	271,860	67,965
5	202,700	57,900	39,090	299,690	59,938
6	233,500	65,500	44,850	343,850	57,308
8	282,000	81,000	54,450	417,450	52,181
10	308,400	96,300	60,705	465,405	46,541
12	361,200	111,700	70,935	543,835	45,320
16	431,700	142,400	86,115	660,215	41,263
20	537,400	173,200	106,590	817,190	40,860
25	634,300	211,600	126,885	972,785	38,911
30	784,100	250,000	155,115	1,189,215	39,641

1 Foundation, stack, building and connection to gas and heat network



2) Decentralized Boiler Houses

Table H.8 illustrates the cost breakdown for the installation of a small gas-fueled boiler house serving one typical building. Armenian legislation does not allow the installation inside buildings of gas-fueled boilers, but requires that such boilers must be installed in a separate building. The installation costs therefore include buildings, boilers, burners, flue stacks, water treatment plants, pumps, and connection to gas and district heating grids. All installations are configured with two or more units, but there is no spare capacity. The acquisition costs of land are not included.

The most common apartment buildings are of 4–15 stories and 24–60 apartments. Peak heat demand typically is 240–600 kW without the supply of HTW and 300–720 kW including HTW.

For planning purposes, the cost of construction of decentralized boiler installations in the range 200–800 MW is taken to be 128,700 US$/MW.

Table H.8 Construction Costs of Decentralized Boiler Houses

Item	*Cost (US$)*
Construction of new building	3,000
Supply and installation of boiler, water treatment plant, pumps, and other equipment	17,700
Connection to gas supply, including gas meter, regulators, and other equipment	1,850
Connection between boiler house and building	1,000
Heat meters	1,700
Connection for electricity, water, and sewage	500
Total cost	25,750

3) District heating pipelines

Tables H.9 through H.11 show the installation costs for a complete double-pipe system. Steel pipes, preinsulated pipes, and the fittings for preinsulated pipes are costed from international suppliers. Fittings for steel pipes and all other materials are supplied locally. The cost of acquisition of land is not included.

For planning purposes, the specific cost of 1.5US$/mm (diameter) per linear meter of double pipe is applied for the replacement of district heating pipes and for the construction of new pipes. For the rehabilitation of existing district heating pipes the specific cost of 1.0 US$/mm (diameter) per linear meter double pipe is applied.

Table H.9 Replacement of Existing Pipes in Concrete Duct

Nominal diameter	*Pipe*	*Other materials*	*Installation*	*Other expenses*	*Total*
(mm)	*(US$/m)*	*(US$/m)*	*(US$/m)*	*(US$/m)*	*(US$/m)*
100	45	52	24	24	145
150	70	81	38	38	226
200	100	115	54	54	323
250	120	138	65	65	387
300	140	161	75	75	452
400	190	219	102	102	613
600	280	322	151	151	903
800	380	437	204	204	1226

Table H.10 Installation of New Preinsulated Pipes

Nominal diameter	*Pipe*	*Other materials*	*Installation*	*Other expenses*	*Total*
(mm)	*(US$/m)*	*(US$/m)*	*(US$/m)*	*(US$/m)*	*(US$/m)*
100	70	21	23	23	137
150	110	33	36	36	215
200	155	47	50	50	302
250	190	57	62	62	371
300	225	68	73	73	439
400	325	98	106	106	634
600	435	131	141	141	848
800	560	168	182	182	1092

Table H.11 Rehabilitation of Existing Pipes in Concrete Duct

Nominal diameter	*Pipe*	*Other materials*	*Installation*	*Other expenses*	*Total*
(mm)	*(US$/m)*	*(US$/m)*	*(US$/m)*	*(US$/m)*	*(US$/m)*
100	-	57	23	16	95
150	-	88	35	25	147
200	-	125	50	35	210
250	-	140	60	42	252
300	-	175	70	49	294
400	-	238	95	67	399
600	-	350	140	98	588
800	-	475	190	133	798

4) Hot tap water systems

Standard prices are applied on all buildings, as follows:

- Heat exchanger, including control equipment: 1,000 US$/building
- Rehabilitation of HTW piping: 700 US$/building

Appendix H.5

Operation and Maintenance Costs

Operation costs

The calculation of operating costs is based on experience, and includes the following costs:

- salary for operating personnel
- consumption of electricity
- consumption of water
- consumption of chemicals
- other costs

1) Personnel

The number of personnel required for operation and maintenance after plant rehabilitation is expected to be 50 percent of the number required prior to rehabilitation. The number of administrative staff remains unchanged.

After rehabilitation the plants will use advanced automated equipment that requires qualified and trained staff for operation and maintenance. The average cost of staff is expected therefore to rise to US$250 per year per member of staff. This figure includes salary, social costs, administration, training and education, and other associated costs.

2) Maintenance costs

Maintenance costs are allocated as follows:

- Boiler house(s) — 2 percent of total asset value
- Transmission lines — 0.8 percent
- Substations — 3 percent
- Distribution lines — 0.8 percent
- Building installations — 1 percent

Appendix H.6

Fuel Prices

1) Natural gas

The natural gas price is based on the comparatively favorable border price of gas imported from Russia. The development of the strategy is based on the expected future international gas price. All other expenses are assumed to be unchanged (see Table H.12).

Table H.12 Current and Projected Prices of Natural Gas

Present Gas Price

	US$	%	
Border price	53,00	67,01%	Ref.: Armenian Gas Company
Operating expenses	8,64	10,92%	PIU, Thermosupply
Technical losses	3,03	3,83%	Border price:
Transportation	1,75	2,21%	Present import price
Distribution	1,28	1,62%	Consumer price 1:
Operating profit	1,24	1,57%	Large consumers > 10,000 m3/year
Total	65,91	83,33%	Consumer price 2:
VAT	13,18	16,67%	Small consumers < 10,000 m3/year
Consumer price 1	79,09	100,00%	
Border price	53,00	57,17%	
Operating expenses	19,98	21,55%	
Technical losses	3,03	3,27%	
Transportation	1,75	1,89%	
Distribution	1,28	1,38%	
Operating profit	1,24	1,34%	
Total	77,25	83,33%	
VAT	15,45	16,67%	
Consumer price 2	92,70	100,00%	

Future Gas Price

	US$	%	
Border price	83,00	72,12%	Ref.: Armenian Gas Company
Operating expenses	8,64	7,51%	PIU, Thermosupply
Technical losses	3,03	2,63%	Border price:
Transportation	1,75	1,52%	Gas price on international marked
Distribution	1,28	1,11%	Consumer price 1:
Operating profit	1,24	1,08%	Large consumers > 10,000 m3/year
Total	95,91	83,33%	Consumer price 2:
VAT	19,18	16,67%	Small consumers < 10,000 m3/year
Consumer price 1	115,09	100,00%	
Border price	83,00	64,49%	
Operating expenses	19,98	15,52%	
Technical losses	3,03	2,35%	
Transportation	1,75	1,36%	
Distribution	1,28	1,00%	
Operating profit	1,24	0,96%	
Total	107,25	83,33%	
VAT	21,45	16,67%	
Consumer price 2	128,70	100,00%	

2) Electricity

The electricity price is assumed to remain unchanged at 45.45 US$/MWh. The night tariff (effective between the hours 23:00 and 06:00) is not used.

3) Solid fuel

The price of solid fuel is assumed to remain unchanged at 14 US$/MWh.

4) Liquefied petroleum gas

The price of liquefied petroleum gas (LPG) is assumed to remain unchanged at 42.16 US$/MWh.

5) Kerosene

The price of kerosene is assumed to remain unchanged at 46.20 US$/MWh.

Appendix H.7

Yerevan Thermal Power Plant

1) General

The Yerevan thermal power plant (YTPP) is a combined heat and power (CHP) plant producing:

- 25-bar steam directly from the steam boilers
- 13-bar steam extracted from the steam turbine
- 1.2-bar steam extracted from the steam turbine

25-bar steam and 13-bar steam is sold to the industrial sector. 1.2-bar steam extracted from the steam turbine is used for the production of hot water for the district heating system

YTPP serves the district heating systems in Erebuni and Shengavit districts. Only one of the extraction turbines is necessary for the production of hot water for the present district heating system. Two turbines would be necessary if all disconnected parts were to be reconnected.

2) Efficiency

Based on the production data for 1999, the efficiency of YTPP is calculated at:

Annual average:	Eff_{total}	=	51%
	Eff_{power}	=	33%
	Eff_{heat}	=	101%
Heating season	Eff_{total}	=	53%
	Eff_{power}	=	33%
	Eff_{heat}	=	107%

It is assumed that the power production efficiency is 33 percent and that the advantage of combined heat and power production is fully assigned to the heat production side.

The efficiency is calculated using the following formula:

Efficiency: $(Q_{power} + Q_{heat}) / Eff_{total} = Q_{power} / Eff_{power} + Q_{heat} / Eff_{heat}$

or

$Eff_{heat} = Q_{heat} / ((Q_{power} + Q_{heat}) / Eff_{total} - Q_{power} / Eff_{power})$

where

Q_{power} = power production

Q_{heat} = heat and 13-bar steam production

Eff_{power} = efficiency of power production

Eff_{heat} = efficiency of heat and 13-bar steam production

Eff_{total} = total efficiency

3) Cost assignment

The “business as usual” strategy is based on the rehabilitation of one turbine, including auxiliary equipment. The “reconnection” strategy is based on the rehabilitation of two turbines, including auxiliary equipment. In both cases the turbines would be nearly fully exploited.

The costs are distributed on the power production side and the heat production side by comparing the marginal costs of construction of an extraction CHP unit to the costs of construction of a new condensing power unit of the same size.

The construction costs of the two units are approximately the same per MW (fuel). As the power output of an extraction CHP unit is less by approximately 20 percent of optimal extraction compared to a condensing power unit of the same size, 20 percent of the construction costs may be assigned to the heat production side.

Appendix H.8

Investment Strategy, Yerevan

1) Zone 1

Subzone 1.1 (Shengavit)

No investments in 2003–07. Reconstruction will take place in 2008. Reconstruction comprises:

- Combined heat and power plant
  Rehabilitation of one extraction turbine by replacing the fan of the high-pressure turbine with a new fan (already in stock); rehabilitation of one boiler; rehabilitation of heat exchangers; replacement of pumps; and replacement of auxiliary equipment.
  Capacity of the turbine is 60 MWt and capacity of the boiler 420 tons steam per hour.
  20 percent of the total costs is assigned to the heat production side. The costs assigned to heat production are distributed to subzone 1.1 (Shengavit) and subzone 1.2 (Erebuni) according to the requested heat capacity.
- Transmission system
  Rehabilitation of above-ground pipelines of diameter 600–1,000 mm; replacement of 50 percent of above-ground pipelines of diameter 500 mm; replacement of above-ground pipelines of diameter less than 500 mm.
- Substations
  Reconstruction of seven substations, to include addition of new plate heat exchangers, pumps, and auxiliary equipment.
- Construction of a complete new distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of meters at the apartment level.

Subzone 1.2 (Erebuni)

No investments in 2003–07. Reconstruction will take place in 2008. Reconstruction comprises:

- Combined heat and power plant
  Rehabilitation of one extraction turbine by replacing the fan of the high pressure turbine with a new fan (already in stock); rehabilitation of one boiler; rehabilitation of heat exchangers; replacement of pumps; and replacement of auxiliary equipment. 20 percent of total costs is assigned to

the heat production side. The costs assigned to heat production are distributed to subzone 1.1 (Shengavit) and subzone 1.2 (Erebuni) according to the requested heat capacity.

- Transmission system
  Rehabilitation of above-ground pipelines of diameter 600–1,000 mm; replacement of 50 percent of above-ground pipelines of diameter 500 mm; and replacement of above-ground pipelines of diameter less than 500 mm.
- Substations
  Reconstruction of four substations, to include the provision of new plate heat exchangers, pumps, and auxiliary equipment.
- Construction of a complete new distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

2) Zone 2

Subzone 2.1 (Davitashen, BH3)

Small investments to take place in 2003–07. Reconstruction will take place in 2008. Reconstruction comprises:

- Boiler house
  Construction of a new boiler house with a capacity of 60.8 MWt in 2015.
- Transmission system
  Replacement of the transmission system.
- Substations
  Replacement of substations.
- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 2.2 (New Nork 1, BH4)

Small investments to take place in 2003–07. Reconstruction will take place in 2008. Reconstruction comprises:

- Boilerhouse
  Construction of a new boiler house. The existing system is more than 20 years old and rehabilitation is deemed not feasible.
- Transmission system
  80 percent of the existing network will be replaced.

- Substations
  11 substations will be replaced.
- Distribution system
  80 percent of the existing network will be replaced.
- Installation of heat meters at the building level.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 2.3 (New Nork 2, BH5)

Small investments to take place in 2003–07. Reconstruction will take place in 2008. Reconstruction comprises:

- Boiler house
  The existing boiler house is 16 years old (2003). Construction of a complete new boiler house with a capacity of 41.4 MWt in 2011.
- Transmission system
  Replacement of the transmission system.
- Substations
  14 substations will be replaced
- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 2.4 (Malatya-Sharhumian, BH7)

Small investments to take place in 2003–07. Reconstruction will take place in 2008. Reconstruction comprises:

- Boiler house
  The existing boiler house is 12 years old (2003). Construction of a new boiler house with a capacity of 78.7 MWt in 2011.
- Transmission system
  Replacement of the transmission system.
- Substations
  28 substations will be replaced.
- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 2.5 (Avan, BH11)

Small investments to take place in 2003–07. Reconstruction will take place in 2008. Reconstruction comprises:

- Boiler house
  Construction of a complete new boiler house with a capacity of 51.4 MWt. The existing system is more than 30 years old and rehabilitation is deemed not feasible.
- Transmission system
  95 percent of the existing network will be replaced.
- Substations
  10 substations will be replaced.
- Distribution system
  67 percent of the existing network will be replaced.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

3) Zone 3

Subzone 3.1 (Arabkir)

Two boiler houses in operation (Azatutyun 11 and Khachaturyan 4).

Small investments to take place in 2003–07. Reconstruction will take place in 2008. Reconstruction comprises:

- Boiler houses
  Construction of new boiler houses. Required capacity 6.9 MWt. The existing systems are more than 30 years old and rehabilitation is deemed not feasible.
- Transmission system
  No transmission systems.
- Substations
  No substations.
- Distribution system
  Construction of a complete new distribution system. The existing system is more than 30 years old and rehabilitation is deemed not feasible.
- Installation of heat meters at the building level.
- Reconstruction of internal installations
  Construction of new internal pipe systems.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 3.2 (Qanaqer-Zeytun)

Two small boiler houses in operation (Medik 2 and Do 8/1).

Small investments to take place in 2003–07. Reconstruction will take place in 2008. Reconstruction comprises:

- Boiler houses
  Construction of new boiler houses. Required capacity 5.9 MWt. The existing ones are more than 30 years old and rehabilitation is deemed not feasible.
- Transmission system
  No transmission systems.
- Substations
  No substations.
- Distribution system
  Construction of complete new distribution system. The existing system is more than 30 years and rehabilitation is deemed not feasible.
- Installation of heat meters at the building level.
- Reconstruction of internal installations. Construction of new internal pipe systems.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

4) Zone 4

The district heating systems in Zone 4 are disconnected and are not included in the strategy for recovery.

Subzone 4.1 (Shengavit)

If the decision is made to revive Shengavit, the necessary reconstruction will comprise:

- Combined heat and power plant
  Renovation of a second extraction turbine and of one boiler. 20 percent of total costs is assigned to the heat production side. The costs that are assigned to heat production will be distributed to subzone 4.1 (Shengavit) and subzone 4.2 (Erebuni) according to the requested heat capacity.
- Transmission system
  Rehabilitation of above-ground pipelines of diameter 600–1,000 mm; replacement of 50 percent of above-ground pipelines of diameter 500 mm; and replacement of above-ground pipelines of diameter less than 500 mm.
- Substations
  19 substations will be replaced.
- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.

- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.2 (Erebuni)

Necessary reconstruction if revival is decided comprises:

- Combined heat and power plant
  Renovation of a second extraction turbine and of one boiler. 20 percent of the total costs is assigned to the heat production side. The costs that are assigned to heat production will be distributed to subzone 4.1 (Shengavit) and subzone 4.2 (Erebuni) according to the requested heat capacity.
- Transmission system
  Rehabilitation of above-ground pipelines of diameter 600–1,000 mm; replacement of 50 percent of above-ground pipelines of diameter 500 mm; and replacement of above-ground pipelines of diameter less than 500 mm.
- Substations
  1 substation will be replaced.
- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.3 (Central, BH1)

Necessary reconstruction if revival is decided comprises:

- Boiler hose
  Construction of a new boiler house with two boilers. Required capacity 43.3 MWt. The existing system is more than 30 years old and rehabilitation is deemed not feasible.
- Transmission system
  Replacement of the transmission system.
- Substations
  All substations will be replaced
- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.4 (Central, BH2)

Necessary reconstruction if revival is decided comprises:

- Boiler house
  Construction of a new boiler house with two boilers. Required capacity 63.9 MWt. The existing system is more than 30 years old and rehabilitation is deemed not feasible.
- Transmission system
  Replacement of the transmission system.
- Substations
  All substations will be replaced.
- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.
- Internal installations
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.5 (Davitashen, BH3)

Necessary reconstruction if revival is decided comprises:

- Boiler house
  No new boiler house. Reconnection to BH3.
- Transmission system
  Replacement of the transmission system.
- Substations
  Replacement of 12 substations.
- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.
- Internal installations
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.6 (New Nork 1, BH4)

Necessary reconstruction if revival is decided comprises:

- Boiler house
  Reconnection to BH4. Installation of additional capacity of 15.6 MWt.
- Transmission system
  20 percent of the existing network will be replaced.

- Substations
  Three substations will be replaced.
- Distribution system
  20 percent of the existing network will be replaced.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.7 (New Nork, BH5 - part 2)

Necessary reconstruction if revival is decided comprises:

- Boiler house
  Reconnection to BH5. Installation of additional capacity of 40.7 MWt.
- Transmission system
  Replacement of the transmission system.
- Substations
  Replacement of 12 substations.
- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.8 (Malatya-Sharhumian, BH7)

Necessary reconstruction if revival is decided comprises:

- Boiler house
  Reconnection to BH7. Installation of additional capacity of 63.1 MWt.
- Transmission system
  Replacement of the transmission system.
- Substations
  Replacement of all substations.
- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.9 (Ajapnyak, BH8)

Necessary reconstruction if revival is decided comprises:

- Boiler house

Construction of a new boiler house with three boilers. Required capacity 138.8 Mwt. The existing boiler house is more than 30 years old and rehabilitation is deemed not feasible.

- Transmission system
  Replacement of the transmission system.
- Substations
  Replacement of all substations.
- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.10 (Avan, BH11)

Necessary reconstruction if revival is decided comprises:

- Boiler house
  Reconnection to BH11. Installation of additional capacity of 27.2 MWt.
- Transmission system
  5 percent of the existing network will be replaced.
- Substations
  Five substations will be replaced.
- Distribution system
  33 percent of the existing network will be replaced.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.11 (Nubarashen)

Necessary reconstruction if revival is decided comprises:

- Boiler house
  Construction of a new boiler house. Required capacity 1 MW. The existing boiler house is more than 30 years old and rehabilitation is deemed not feasible. Reconstruction will take place in 2003 and commissioning in 2004.
- Transmission system
  No transmission system.
- Substations
  No substations.
- Distribution system
  Replacement of the distribution system.

- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.12 (Qanaqer)

Necessary reconstruction if revival is decided comprises:

- Boiler house
  Construction of a new boiler house. Required capacity 78 MW. The existing boiler house is more than 30 years old and rehabilitation is deemed not feasible.
- Transmission system
  No transmission system.
- Substations
  No substations.
- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.13 (Arabkir)

Necessary reconstruction if revival is decided comprises:

- Boiler house
  Construction of a new boiler house. Required capacity 143.4 MW. The existing boiler house is more than 30 years old and rehabilitation is deemed not feasible.
- Transmission system
  No transmission system.
- Substations
  No substations.
- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.14 - Central

Necessary reconstruction if revival is decided comprises:

- Boiler house

Construction of a new boiler house. Required capacity 22 MWt. The existing boiler house is more than 30 years old and rehabilitation is deemed not feasible.

- Transmission system
  No transmission system.
- Substations
  No substations.
- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.15 (Malatya)

Necessary reconstruction if revival is decided comprises:

- Boiler house
  Construction of a new boiler house. Required capacity 23 MWt. The existing boiler house is more than 30 years old and rehabilitation is deemed not feasible.
- Transmission system
  No transmission system.
- Substations
  No substations.
- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.16 (Shengavit small boiler houses)

Disconnected. There are two options: recommission the small boiler houses or obtain supply from Yerevan thermal power plant (TPP).

Recommissioning of DH systems in Shengavit

Necessary reconstruction if revival is decided comprises:

- Boiler house
  Construction of five new boiler houses. Total required capacity 8.6 MWt. The existing small boiler systems, distribution systems, and internal installations are more than 30 years old.
- Transmission system
  No transmission system.

- Substations
  No substations.
- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Connection of DH systems in Shengavit to Yerevan TPP

Necessary reconstruction if revival is decided comprises:

- Connection of heating systems to Yerevan TPP (CHP)
  The existing small boiler systems, distribution systems, and internal installations are more than 30 years old. It will be necessary to renovate one back-up boiler at the existing Booster Boiler House no. 12.
- Boiler house
  No boiler houses.
- Transmission system
  Construction of 2.200 km transmission pipe line. Investment required is US$572,000.
- Substations
  Construction of five new substations.
- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.17 (Erebuni small boiler houses)

Disconnected. There are two options: recommission the small boiler houses or obtain supply from Yerevan thermal power plant (TPP).

Recommissioning of DH systems in Erebuni

Necessary reconstruction if revival is decided comprises:

- Recommissioning
- Boiler house
  Construction of 30 new boiler houses. Total required capacity 48.5 MWt. The existing small boiler systems, distribution systems, and internal installations are more than 30 years old.
- Transmission system
  No transmission system.
- Substations
  No substations.

- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Connection of DH systems in Erebuni to Yerevan TPP

Necessary reconstruction if revival is decided comprises:

- Connection of heating systems to Yerevan TPP (CHP)
  The existing small boiler systems, distribution systems, and internal installations are more than 30 years. No investments planned for further production capacity.
- Boiler house
  No boiler houses.
- Transmission system
  Construction of 14 km transmission pipeline. Reconstruction will take place in 2003 and commissioning in 2004.
- Substations
  Construction of five new substations.
- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

5) Zone 5

Disconnected: not possible to reconnect

6) Zone 6 (detached houses)

Appendix H.9

Investment Strategy, Gyumri

1) Zone 1

No district heating systems in Zone 1.

2) Zone 2

Subzone 2.1 (Gyumri, BH2, ANI)

No investments from 2003 to 2012. Reconstruction will take place in 2013. Reconstruction comprises:

- Boiler house
  The boiler house will be replaced in 2013. Two boilers with capacity 50MWt and 20MWt will be installed. Investment required: US$2,800,000.
- Transmission system
  Transmission system will be replaced in 2013. Investment required: US$3,321,000.
- Substations
  Investment required: US$600,000.
- Distribution system
  Investment required: US$2,900,000.
- Installation of heat meters at the building level
  Investment required: US$421,600.
- Reconstruction of internal installations
  Investment required: US$1,984,000.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.
  Investment required: US$2,118,480.

Total investment required: US$14,145,080. (Because of the late investment date, 2013, 50 percent of this amount should be invested within the planning horizon and 50 percent outside the planning horizon.)

3) Zone 3

No district heating systems in Zone 3.

4) Zone 4

District heating systems in Zone 4 are disconnected and are not included in the strategy for recovery.

Subzone 4.1 (Sheram 2)

Necessary reconstruction if revival is decided comprises:

- Boiler house
  Construction of a new boiler house with two new boilers, each with a capacity of 0.7 MWt. The existing system is more than 20 years old and rehabilitation is deemed not feasible. Reconstruction will take place in 2010 and commissioning in 2011. Investment required: US$100,000.
- Transmission system
  No transmission system.
- Substations
  No substations.
- Distribution system
  Replacement of the distribution system. Investment required: US$60,000.
- Installation of heat meters at the building level. Investment required: US$14,400.
- Reconstruction of internal installations. Investment required: US$26,400.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level. Investment required: US$43,080.
- Total investment required: US$243,880.

Subzone 4.2 (Old City)

Disconnected.

If it is decided to revive the system, reconstruction will comprise connection to heating systems served by BH2, ANI.

- Boiler house
  No new boiler houses. After reconnection of the Old City it is planned to install 70 MWt additional capacity (one 50 MWt boiler and one 20 MWt boiler) in 2013 in BH2, ANI. After connection of the Old City the total capacity of boiler house BH2, ANI will be 140 MWt. Investment required: US$2,800,000.
- Transmission system
  Construction of a new transmission system from the existing boiler house (BH2, ANI) to the Old City. 9,250 m of pipeline required, of diameter 220–400 mm. Investment required: US$4,144,000.
- Substations
  Construction of 25 new substations. Investment required: US$1,250,000.
- Distribution system
  Construction of 27,600 m network of 50–200 mm pipe. Investment required: US$4,140,000.
- Installation of heat meters at the building level. Investment required: US$469,200.
- Reconstruction of internal installations. Investment required: US$1,430,000.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level. Investment required: US$1,772,500.

Total investment required: US$13,205,700.

5) Zone 5

Disconnected: not possible to reconnect

6) Zone 6 (detached houses)

Individual heating options.

Appendix H.10

Investment Strategy, Jermuk

1) Zone 1

No district heating systems in Zone 1.

2) Zone 2

Subzone 2.1 (BH3)

Small investments to take place in 2003–07. Reconstruction will take place in 2008. Reconstruction comprises:

- Boiler house comprises four large steam boilers. The gross heat demand is approximately half of the capacity of one existing boiler. The existing boilers will be decommissioned and two small boiler houses constructed in the existing two substations.
- Boiler house
  Construction of two new boiler houses with a capacity of 4 MWt each. Investment required: US$543,720.
- Transmission system
  No transmission system after reconstruction.
- Substations
  No substations after reconstruction.
- Distribution system
  Construction of a new distribution system. Investment required: US$557,670 .
- Installation of heat meters at the building level. Investment required: US$54,400.
- Reconstruction of internal installations. Investment required: US$267,200.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level. Investment required: US$301,840.

3) Zone 3

Subzone 3.1 (BH1)

Small investments to take place in 2003–07. Reconstruction will take place in 2008. Reconstruction comprises:

- Boiler house
  Construction of a new boiler house with five boilers with a capacity of 1 MWt each. The existing system is more than 20 years old and rehabilitation is deemed not feasible. Investment required: US$271,860.

- Transmission system
  No transmission system.
- Substations
  No substations.
- Distribution system
  Construction of a new distribution system. Investment required: US$256,724.
- Installation of heat meters at the building level. Investment required: US$49,300.
- Reconstruction of internal installations. Investment required: US$67,400.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level. Investment required: US$76,050.

4) Zone 4

District heating systems in Zone 4 are disconnected and are not included in the strategy for recovery.

Subzone 4.1 (BH3)

Two buildings disconnected from the network of boiler house BH3. Necessary reconstruction if revival is decided comprises:

- Boiler house
  No new boiler house. Reconnection to the boiler houses replacing BH3.
- Transmission system
  No transmission system.
- Substations
  No substations.
- Distribution system
  Construction of a new distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

5) Zone 5

Disconnected: not possible to reconnect

6) Zone 6 (detached houses)

No detached houses.

Appendix H.11

Investment Strategy, Charentsavan

1) Zone 1

No district heating systems in Zone 1.

2) Zone 2

No district heating systems in Zone 2.

3) Zone 3

Subzone 3.1 (BH2)

Small investments to take place in 2003–07. Reconstruction will take place in 2008. Reconstruction comprises:

- Boiler house
  Construction of a new boiler house with three new boilers with a capacity of 1 MWt each. The existing boiler house is more than 30 years old.
- Transmission system
  No transmission system.
- Substations
  No substations.
- Distribution system
  50 percent of the previous network is currently in operation and will be renovated.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 3.2 (BH4)

Small investments to take place in 2003–07. Reconstruction will take place in 2008. Reconstruction comprises:

- Boiler house
  Construction of a new boiler house with four new boilers with a capacity of 1 MWt each. The boiler house is 14 years old.
- Transmission system
  No transmission system.
- Substations
  No substations.
- Distribution system

80 percent of the previous network is currently in operation and will be renovated.

- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 3.3 (BH5)

Small investments to take place in 2003–07. Reconstruction will take place in 2008. Reconstruction comprises:

- Boiler house
  Construction of a new boiler house with four new boilers with a capacity of 1 MWt each. The boiler house is 13 years old.
- Transmission system
  No transmission system.
- Substations
  No substations.
- Distribution system
  95 percent of the existing network is in operation and will be renovated.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

4) Zone 4

District heating systems in Zone 4 are disconnected and are not included in the strategy for recovery.

Subzone 4.1 (BH1)

Necessary reconstruction if revival is decided comprises:

- Boiler house
  Construction of a new boiler house with four new boilers with a capacity of 9 MWt each. The existing boiler house was constructed in 1967 and closed in 1999.
- Transmission system
  Replacement of the transmission system.
- Substations
  All five substations to be replaced, to include installation of plate heat exchangers, pumps, and auxiliary equipment.
- Distribution system
  Replacement of the distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.

- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.2 (BH2)

Part of the network is disconnected from the network of boiler house BH2.

Reconstruction, if revival is decided, comprises reconnection to the existing distribution system:

- Boiler house
  No new boiler house, but reconnection to BH2. Installation of additional capacity of 4 MWt in BH2.
- Transmission system
  No transmission system.
- Substations
  No substations.
- Distribution system
  50 percent of the network is out of operation and will be renovated.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.3 (BH3)

Necessary reconstruction if revival is decided comprises:

- Boiler house
  Construction of a new boiler house with four new boilers with a capacity of 1 MWt each. The boiler house is more than 30 years old.
- Transmission system
  No transmission system.
- Substations
  No substations.
- Distribution system
  Construction of a new distribution system.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.4 (BH4)

Part of the network is disconnected from the network of boiler house BH4.

Reconstruction, if revival is decided, comprises reconnection to the existing distribution system:

- Boiler house
  No new boiler house, but reconnection to BH4. Installation of additional capacity of 2 MWt in BH4.
- Transmission system
  No transmission system.
- Substations
  No substations.
- Distribution system
  20 percent of the network is out of operation and will be renovated.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.5 (BH5)

One building disconnected from the network of boiler house BH5.

- Boiler house
  No new boiler house; reconnection to BH5. No additional capacity needed.
- Transmission system
  No transmission system.
- Substations
  No substations.
- Distribution system
  5 percent of the network is out of operation and will be renovated.
- Installation of heat meters at the building level.
- Reconstruction of internal installations.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.6 (BH Atkins)

Necessary reconstruction if revival is decided comprises:

- Boiler house
  No renovation: recommissioning only.
- Transmission system
  No transmission system.
- Substations
  No substations.
- Distribution system
- Installation of heat meters at the building level.
- Internal installations

- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

Subzone 4.7 (BH Ar-Ar)

Necessary reconstruction if revival is decided comprises:

- Boiler house
  No renovation: recommissioning only.
- Transmission system
  No transmission system.
- Substations
  No substations.
- Distribution system
- Installation of heat meters at the building level.
- Internal installations
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.
- Reconstruction of HTW system, to include installation of HTW meters at the apartment level.

5) Zone 5

Disconnected: not possible to reconnect

6) Zone 6 (detached houses)

No detached houses.

Appendix H.12

Financial Analysis

The heating costs are expressed as the balanced heat price, which is the heat sales price that balances the accounts of the heating company over the actual period of operation. All expenses over the period are discounted to 2002 and the present value (PV) calculated for that year. The PV of all expenses is compared to the PV of the heat sales during the same period, and the balanced heat price calculated.

The balanced heat price for each of the three periods (survival, recovery, and growth) into which the planning period is divided is discounted to 2002 for purposes of comparison.

All expenses, investments, and operation and maintenance costs are the same each year, so the PV may be calculated by the use of PV coefficients. For example:

- The PV in year 0 of three equal-sized investments (A) made in each of years 3, 4, and 5 is: $PV_A = A \times F_{3\text{-}5}$
- The PV in year 0 of an investment (B) that is divided into 10 equal-sized portions and made in each of the years 6 to 15 is: $PV_B = B/10 \times F_{6\text{-}15}$

The coefficients are calculated by summarizing the annuity factors presented in Table H12.1.

Table H12.1 Present Value Coefficients

Annuities					
Purpose:	Calculation of the annual payment during a period of M years of an investment, S, made in N equal portions, S/N, over the first N years of the period.				
Total investment	S				
Split of investment over	N	years in equal portions, starting year 1			
Investment per year	S/N				
Present value coefficient over N years	F_N				
Present value of investment (PV)	S_{PV}	=	$S / N \times F_N$		
Annual annuity over M years	A_{M-N}	=	S_{PV} / F_M	=	$S / N \times F_N / F_M$
Interest rate 10%					

Present Value Coefficients			
$F_{1\text{-}2}$	=	1,7355	Present value of two investments, of 1 each made in years 1 and 2, in the year preceding the first year
$F_{3\text{-}5}$	=	2,0552	Present value of three investments, of 1 each made in years 3, 4, and 5, in the year preceding the first year
$F_{6\text{-}15}$	=	5,2863	Present value of a number of investments, of 1 each made in each of the years 6 to 15, in the year preceding the first year
$F_{6\text{-}25}$	=	7,0360	Present value of a number of investments, of 1 each made in each of the years 6 to 25, in the year preceding the first year
$F_{1\text{-}10}$	=	6,1446	Present value of a number of investments, of 1 each made in each of the years 1 to 10, in the year preceding the first year
$F_{1\text{-}20}$	=	8,5136	Present value of a number of investments, of 1 each made in each of the years 1 to 20, in the year preceding the first year

Demand side management

Energy savings due to metering and demand side management are expected to reach 30 percent over the 10-year period 2003–12 (years 1 to 10). The consequences of expected energy savings due to metering and demand side management again are calculated by the use of coefficients (see Table H.12.2). The coefficients are calculated by summarizing the annuity factors for energy consumption after energy savings (Table H.12.3).

Table H12.2 Present Value Coefficients for Energy Demand

Demand Side Management			
Present value coefficients of energy consumption before energy savings			
$PV_{1\text{-}2}$	=	1,7355	Present value of energy consumption in years 1 and 2, in the year preceding the first year
$PV_{3\text{-}5}$	=	2,0552	Present value of energy consumption in years 3, 4, and 5, in the year preceding the first year
$PV_{6\text{-}25}$	=	5,2863	Present value of energy consumption in each of the years 6 to 25, in the year preceding the first year
$PV_{1\text{-}20}$	=	8,5136	Present value of energy consumption in each of the years 1 to 20, in the year preceding the first year
Present value coefficients of energy consumption after energy savings			
$PVa_{1\text{-}2}$	=	1,6587	Present value of energy consumption in years 1 and 2, in the year preceding the first year
$PVa_{3\text{-}5}$	=	1,8125	Present value of energy consumption in years 3, 4, and 5, in the year preceding the first year
$PVa_{6\text{-}25}$	=	3,8550	Present value of energy consumption in each of the years 6 to 25, in the year preceding the first year
$PVa_{1\text{-}20}$	=	6,9318	Present value of energy consumption in each of the years 1 to 20, in the year preceding the first year

Table H12.3 Annuity Factors

Annuity factors				
Year	Present value of future consumption before energy savings	Energy savings compared to present consumption	Future energy consumption compared to present consumption	Present value of future consumption after energy savings
0	1,0000			
1	0,9091	3%	97%	0,8818
2	0,8264	6%	94%	0,7769
3	0,7513	9%	91%	0,6837
4	0,6830	12%	88%	0,6011
5	0,6209	15%	85%	0,5278
6	0,5645	18%	82%	0,4629
7	0,5132	21%	79%	0,4054
8	0,4665	24%	76%	0,3545
9	0,4241	27%	73%	0,3096
10	0,3855	30%	70%	0,2699
11	0,3505	30%	70%	0,2453
12	0,3186	30%	70%	0,2230
13	0,2897	30%	70%	0,2028
14	0,2633	30%	70%	0,1843
15	0,2394	30%	70%	0,1676
16	0,2176	30%	70%	0,1523
17	0,1978	30%	70%	0,1385
18	0,1799	30%	70%	0,1259
19	0,1635	30%	70%	0,1145
20	0,1486	30%	70%	0,1041
21	0,1351	30%	70%	0,0946
22	0,1228	30%	70%	0,0860
23	0,1117	30%	70%	0,0782
24	0,1015	30%	70%	0,0711
25	0,0923	30%	70%	0,0646

Economic parameters

Interest rate (discounting rate): 10 percent

Rate of exchange: US$1 = 550 AMD

All costs include 20 percent VAT

The calculated balanced heat price does not include profit to the district heating company of provisions for budget reserves.

Annex I

Heating Strategy for the Kyrgyz Republic: A Summary

AI.1 This annex summarizes the main results of the consultant report "Development of Heat Strategies for the Kyrgyz Republic,"[12] emphasizing those features of the strategy that are significantly different from those of the Armenian Urban Heating Strategy (UHS). The Kyrgyz heating strategy was developed for the three cities of Bishkek, Tokmok, and Osh, but the results are applicable to all cities of the Kyrgyz Republic that have centralized heating.

AI.2 The basic methodology is similar to the one used for the development of the Armenian UHS. The actual implementation of the methodology, including the scenarios used, was adapted to the local situation and the data available.

AI.3 The Kyrgyz Republic and Armenia have several basic conditions in common. They are poor, with an annual per capita GDP of around US$400, and they share an inherited Soviet-style energy infrastructure and housing stock. The deteriorating housing stock is now mostly privatized, but no organizations have emerged to take responsibility for common spaces. The fossil fuel needs of both countries are largely met by imports, but electricity production is mostly from indigenous sources: hydro in the case of the Kyrgyz Republic and nuclear in the case of Armenia.

Key Differences between Armenia and the Kyrgyz Republic

AI.4 The climate in the Kyrgyz Republic is somewhat colder than in Armenia, requiring more heat input to achieve the same comfort level.

AI.5 In Armenia, most centralized heating systems have not been functional for a number of years, and most households have had to find alternative ways of heating. In the Kyrgyz Republic, centralized heating has suffered frequent disruptions due to fuel shortages but in general is operational for at least part of the heating season.

AI.6 Armenia has made substantial progress in restructuring the energy sector, with a supportive regulatory framework and tariffs that are close to cost recovery. Collections have been a problem, though. For district heating the government has decided

[12] COWI A/S in collaboration with RAMBOLL. *Development of Heat Strategies for the Kyrgyz Republic.* Final consultant report. November 2002.

to terminate the general subsidization and instead to use targeted subsidies to ensure that low-income families have access to safe and affordable heating services. The Kyrgyz government has only recently started to restructure the energy sector. Tariffs have a long way to go to reach cost recovery levels (but collections are close to billings), and the government is willing to use earnings from electricity exports to continue the subsidization of heat.

AI.7 Natural gas is readily available in Armenia and the natural gas infrastructure extends to most municipalities, although in many cases connections to multi-residential apartment buildings still have to be reestablished. Gas is therefore the fuel on which most heating options are based. In the Kyrgyz Republic, however, natural gas is scarce, expensive, and networks exist in only a few locations. It is unlikely that natural gas will be available for individual heating solutions: the fuels most likely to be used are coal and electricity, as long as tariffs remain relatively low.

AI.8 A technical but important difference affecting the development of the two strategies is that the Armenian UHS is firmly grounded in a thorough heat demand analysis. The UHS for the Kyrgyz Republic was able to draw only on a 1999 Household Energy Study[13] that provide little detail on heat consumption and expenditures.

Background: The Heating Sector in the Kyrgyz Republic

AI.9 Fifteen percent of the population of the Kyrgyz Republic is provided with centralized heating, but only 8 percent of the poor have access to the service. Fifty percent of the urban population has access to centralized heating but only 2 percent of the rural population has the same access. Centralized heating is supplied to almost all multi-apartment buildings in the three cities of Bishkek, Osh, and Tokmok and many of them also receive hot tap water (HTW).

AI.10 Individual heating in single-family houses is characterized by the use of any available fuel—gas, electricity, coal, wood, or other flammable material—in often homemade boilers and stoves. These burners typically are inefficient and have a significant negative environmental impact. Coal, the cheapest fuel and one that is subsidized for the poorest, is also the dominant fuel, but electricity increasingly is used for heating and HTW preparation. The electricity tariff for residential consumers is low and electricity is widely used to substitute for gas or district heating when the supply of these main heating services fails. This can overload the electricity grid and causes high system losses.

AI.11 Most central heat and HTW is delivered to consumers unmetered; for example, only 80 of 2,200 substations installed as part of the Bishkek district heating project were equipped with building-level heat meters. Readings from heat meters in 18 buildings during the 2000–01 heating season showed an average consumption of 83 kWh per square meter per year. This indicates a low comfort level.

[13] London Economics, in cooperation with the National Statistics Committee of the Kyrgyz Republic. *Kyrgyz Republic Household Energy Study*. Final consultant report. July 2000.

AI.12 Consumption of HTW is high. The norm for consumption is 160 liters per person per day; readings from meters in 18 buildings in Bishkek over one month in winter 2000–01 showed a consumption of 474 liters per apartment per day. Other sources indicate consumption may be even higher. Typical consumption in Western Europe, in contrast, is 150 to 200 liters per family per day. The theft of HTW is widespread but is difficult to separate from water losses due to leakages.

AI.13 About 90 percent of centralized heating is supplied by the former Kyrgyzenergo (which has now been restructured), which operates two combined heat and power (CHP) plants to serve Bishkek and Osh. The remaining 10 percent is supplied by Bishkekteplokomunenergo (Bishkek only) and Kyrgyzzhilkomunsojuz, which operates a large number of small boiler plants nationwide.

AI.14 Residential heat pricing is based on a flat fee per square meter of heated space. The tariffs are set by the State Energy Agency at a level to recover all operating and maintenance costs, but this leaves little room for depreciation: heat tariffs reportedly realize only one-third of basic cost recovery. While heat supply costs vary significantly according to the heat source (CHP or heat-only boiler (HOB)) and the composition of fuels used (natural gas, heavy fuel oil or coal), residential heat tariffs are uniform for the whole country. The main heat supplier, the former Kyrgyzenergo, covers shortfalls in its financial return from heat supply by cross-subsidizing its district heating operations with revenues from electricity sales[14] and from the national budget.[15]

AI.15 Centralized heating is thus heavily subsidized and mainly supplied to the better-off population of urban areas. A rough estimate indicates that 1,500 million soms (more than US$30 million) per year is indirectly given as subsidies to the 15 percent of the population that receives centralized heating. This compares to 286 million soms (US$6 million) paid through the Unified Monthly Benefit (UMB) program in support of the poorest families and 94 million soms (US$2 million) paid in utility discounts to privileged groups such as Second World War veterans). Collection rates are reported to be relatively high, although many people have debts and pay late. Payments often are made directly to heat suppliers that have signed contracts with individual apartments. For example: in Bishkek, 74 percent of December 2001 billings had been collected by mid-January 2002; in Tokmok, 70 percent of billings for the 2000–01 heating season was collected; and in Osh, 92 percent of CHP billings for December 2001 was collected (data collected by telephone, February 2002).

AI.16 The Kyrgyz Republic barters power and water from the Naryn hydropower plant in exchange for gas for centralized heating from Uzbekistan. At times when the bartered gas is received in insufficient quantities (for political, technical, or

[14] 332 million soms in 1998 (US$16 million at the 1998 exchange rate), 327 million soms in 1999(approximately US$8 million), and 594 million soms in 2000 (approximately US$10 million)

[15] In 1999, Kyrgyzzhilkomunsojuz was paid 253 million soms (approximately US$6 million)from the national budget to purchase fuel for centralized heating. In Bishkek the same year, Bishkekteplokomunenergo was subsidized by 31.6 million soms (approximately US$0.8 million.

financial reasons), the cash-poor CH supply companies are unable to purchase sufficient replacement fuel to ensure the stable and reliable supply of heat.

Background: Condominium Situation in the Kyrygz Republic

AI.17 The basic legislation is in place in the Kyrgyz Republic for the establishment and operation of condominiums, but unlike elsewhere in the former Soviet Union the establishment of condominiums here requires a lot of grassroots organization. Unit owners have to sign up, hold general meetings, and even provide copies of the title to register a condominium, and are unlikely to do so if they do not first fully understand the benefits that a condominium can bring. There are as a result relatively few condominiums. Support networks nonetheless have been established in several cities, providing, among other things, training for chairpersons.

AI.18 Condominiums have a major role to play in the provision of communal services, but there are major obstacles to achieving this. These include the following:

- Heating regulations are predicated on the heat supplier serving individual units. Condominiums are viewed as intermediaries, akin to the zhek, the Soviet-era municipal housing maintenance organizations, and not as collective consumers. This problem has been compounded by recent regulations on communal services that identify condominiums as communal service providers and that prohibit them from collecting payments from members for heating.
- Most of the buildings that have privatized apartments are still administered and maintained by zheks. Some zheks are partly privatized, but most are still municipally owned.
- The market value of apartments in some areas is very low, and the investment necessary to retrofit these apartments often exceeds their value. Payment for utilities often is the major expense related to housing.
- Migration to cities, especially to Bishkek, is a major problem. The supply of housing that has heating and other communal services is generally inadequate. There additionally are many unregistered inhabitants in Bishkek, which compounds the problem as the payment for some utilities is based on the number of registered persons in an apartment. In the smaller towns outside Bishkek, in contrast, many apartments are empty, creating problems related to payment for communal services.

Affordability of Heating

AI.19 According to the 1999 household energy study, poor urban households spend 1,893–2,226 soms (US$46–54[16]) annually on energy (the range is defined at the lower end by those that have electricity, piped gas, and district heating, and at the higher end by those that are connected only to electricity supply). Expenditures by non-poor households are in the range of 1,758–2,800 soms (US$42–68). The study does not break

[16] 1999 exchange rate: US$1 = 41 soms.

expenditures down into heating and non-heat-related costs, so for the purposes of this report it was assumed that 75 percent of energy expenditures goes to heating and HTW and the remaining 25 percent to gas and electricity for lighting, cooking, and running appliances. Further assuming that households can commit 15 percent[17] of their expenditures to energy without having to sacrifice other necessities, the resulting "average annual affordable expenditures" for heat and HTW of urban poor families and urban non-poor families in 1999 were calculated at approximately US$47 and US$127, respectively. Further assuming 2 percent annual income growth, it is estimated that in 2002 affordable heat and HTW expenditures were about US$50 USD annually for poor urban families and US$135 annually for non-poor urban families. The weighted average is US$87.

AI.20 Those affordable expenditures were compared to the actual payments for centralized heating in the three cities and to the payments based on full-cost-recovery tariffs. As shown in Table I.1, actual payments fall within the affordability range (at the upper end of the range in Bishkek and the lower end in Osh and Tokmok). The imposition of full-cost-recovery tariffs, however, would raise necessary expenditures far above affordability levels, particularly in Tokmok.

Table I.1 Affordable Payments for Current and Reduced Heat/HTW Consumption Levels

US$/year/apartment	*Bishkek*	*Osh*	*Tokmok*
Affordability	50–135	50–135	50–135
Present situation			
Actual payment	126	66	65
Full cost recovery	218	215	315
Indirect subsidy	92	149	250
Reduced consumption			
Actual payment	126	66	65
Full cost recovery	115	104	118
Indirect subsidy	-9	38	53

AI.21 Matching the cost of heat with affordable payments is a huge challenge. The most obvious response would be to reduce wastefulness through the introduction of metering and to reduce or completely discontinue HTW supply. For a scenario of reduced consumption it was assumed that space heating is reduced by one-third in all three cities, and that HTW supply is discontinued in Osh and Tokmok and consumption reduced to 20 percent of the existing level in Bishkek. On this basis, the situation for Bishkek would be much improved, with resulting full cost recovery within the affordable range (and in fact,

[17] Based on the 1999 household energy study, reflecting a proposal from Bishkek municipality. It is debatable whether a higher income share for energy could be considered affordable, since most families do not have large rent or other expenditures for housing.

at a lower expenditure than current payments). For a cogeneration plant (CHP), such as that in Osh, and for different HOB-based DH systems full cost recovery would require substantial price increases that only a small part of the population could afford, however.

Cost Comparison of Heat Supply Options

AI.22 A long-term (15-year) cost comparison of feasible supply options was made based on the assumption that anything but reduced heat consumption would not be affordable for the majority of Kyrgyz consumers for the foreseeable future, even should incomes increase.

AI.23 The reference for heating is a technical consumption of 157 kWh per square meter, which corresponds to the consumption needed to heat a typical Kyrgyz building to 20°C. The consumption for heating is expressed as a percentage of this reference consumption. For 2001, the consumption of energy for heating was 75 percent of this figure, corresponding to the fact that the supply temperature for centralized heating was below the comfort norm of 20°C. The reference for HTW consumption is 200 liters per apartment per day, which corresponds to normal consumption in Eastern and Western Europe. Actual consumption is expressed as a percentage of this, and currently is 235 percent. For Osh and Tokmok it was assumed that the centralized provision of HTW would be stopped completely and that households would heat water in kettles, consuming about 30 liters per day. From 2004, it is expected that income and consumption will grow at between 2 and 6 percent annually (see Table I.2).

Table I.2 Heat and HTW Consumption Scenarios in Bishkek

	Consumption level as a percentage of reference consumption		*HTW consumption*	*Heat consumption*
	HTW	*Heating*	*liters/ apartment/day*	*kWh/m²/y*
2001	235%	75%	470	118
2002	235%	75%	470	118
2003	50%	50%	100	79
2004	51–53%	51–53%	102–106	80–83
2015	63–101%	63–101%	127–201	100–158

AI.24 Based on these consumption scenarios, the costs of various centralized and noncentralized heating options were evaluated for the three cities over a 15-year period. This was done according to an iterative process, as the demand determines the costs and the costs determine the demand. The results are presented in Table I.3. The heat and HTW consumption and costs refer to a standard apartment of 48 m^2. It is assumed that all centralized heating is based on natural gas.

Table I.3 Long-Term Cost Comparison of Heating Options

	Present situation, 2001 (MWh/year/apartment for heat and HTW)	*Reduced consumption, 2004 (MWh/year/apartment)*	*Heating cost (US$/MWh)*	*Heating cost per apartment (US$/year)*
Bishkek: CHP-supplied area				
Present CHP system	27.6	-	7.9	218
Improved CHP system	-	8.3	13.9	115
Individual gas heating	-	8.3	24.4	203
Individual electric heating	-	8.3	32.2	267
Osh: CHP-supplied area				
Present CHP system	13.6	-	15.8	215
Improved HOB system	-	3.3	31.5	104
Individual gas heating	-	3.3	24.4	81
Individual electric heating	-	3.3	32.2	106
HOB-supplied areas in Bishkek, Osh, and Tokmok				
Present HOB	15.8	-	19.9	315
Rehabilitated HOB	-	3.7	31.9	118
Individual gas heating	-	3.7	24.4	90
Individual electric heating	-	3.7	32.2	119

AI.25 The results of the cost comparison depend to some extent on the supply options in place in the three municipalities. In Bishkek the CHP-based centralized heating option is least-cost, provided there is a continued need for electric power production from the plant. The DH system also has been recently improved with funding from multilateral and bilateral sources. The introduction of meters and no-cost/low-cost energy efficiency measures can dramatically reduce demand. Even though the cost-covering unit price would be much higher than the current level, the supply cost per apartment would be cut by almost 50 percent compared to the 2001 situation.[18] While centralized heating would remain much less expensive than any of the other options, however, a price of more than US$100 per year is too high for many of the urban poor. HTW would be produced at a marginal cost of about US$4/MWh in summer and winter. The low cost is partly explained by the fact that make-up water is preheated in condensers for the turbines.

[18] CHP officials in Bishkek point out that such a cost reduction might not be possible if the CHP plant has to be operated in an environment of high electricity demand.

AI.26 Outside the Bishkek CHP supply area block boilers and individual solutions comprise the long-term, least-cost solution. Block boilers can be either gas-fired (for one block) or coal-fired (for five to 10 blocks). Individual solutions (electricity and/or gas) would be cheaper for the consumer than centralized heating from Osh CHP at full cost recovery prices, and consumers may wish to disconnect from the centralized heating and use electricity. However, a massive conversion to electric heating is not possible because of the limited distribution capacity of the system. Analysis made elsewhere shows that the necessary investments in production and distribution capacity make this option expensive and, from a national perspective, unattractive. Similar circumstances face natural gas and the extension of the gas supply network. Finally, coal, wood, and other solid fuels are not a sustainable individual option for apartment buildings.

AI.27 Another aspect to consider is the recently formulated policy to use local fuel—coal—as much as possible. This policy makes sense in view of the difficult supply situation for gas and other fuels. For operational and environmental reasons, coal is best suited for large boilers. It has not been possible to obtain convincing estimates for the future costs of gas and coal and it is therefore difficult to compare gas- and coal-fired boilers connected to a district heating system to block boilers in an autonomous system. It is possible that the losses in the network would be compensated for by the lower fuel cost.

AI.28 The calculations indicate that it may be feasible for the Osh CHP area to continue to supply centralized heating using heat from the existing boilers. If this were to prove commercially viable, it may in the longer term be feasible to construct a new coal-based boiler and perhaps to use one of the existing boilers as a backup. This would depend on whether or not the centralized system could hold on to its customers under commercial (that is, non-subsidized) principles. If not, the obvious alternative is autonomous systems based on block boilers.

AI.29 The areas in Bishkek, Osh, and in Tokmok that are supplied with centralized heating from HOBs can be considered together. It should be noted, however, that they use different fuels and this will influence the actual production cost. The situation regarding HOBs is similar to the one explained above: commercialization would lead to reduced consumption and increased unit tariffs (with the same annual heat cost per family) rather than to simple full cost recovery based on today's consumption. As in the Osh CHP area, the alternatives are block boilers based on coal or gas, individual supply, or the continuation on commercial principles of central supply.

AI.30 Block boilers in autonomous systems would in the long term have advantages over centralized heating because of their lower losses from transmission. The major problem is that the necessary initial investments would in the short and medium term raise the unit cost of heat supplied, as a result of the removal of subsidies.

AI.31 The HOBs should be operated on commercial principles through the next heating season and beyond. Where technically feasible, it may be necessary to further reduce the supply temperature to make heating affordable for the average population. Wealthier families, should they choose to do so, can supplement with electric heaters and gas. As the use of meters becomes more widespread, the role of the supplier will become more market-oriented, guided by the imperative to supply a high-quality product to attract consumers.

AI.32 The application of commercial principles will also oblige heat suppliers to seek ways of reducing their costs. One way to achieve this is to optimize fuel consumption, using cheaper fuels and better boilers. The discontinuation of HTW supply and reduced demand additionally will lead to excess capacity, and it may be possible to interconnect networks and discontinue operation of the least efficient boilers. The use of any HOBs that are unable to reach financial viability would in practice have to be discontinued, with autonomous systems based on block boilers providing the alternative.

AI.33 Heating solutions based on solar energy (passive direct gain, active solar for domestic hot water, and active solar space heating) also were investigated. The Kyrgyz Republic has high insolation and solar energy may in the long term prove an option, but in the short-term solar solutions are impractical due to their high initial cost. Solar HTW could be cost-effective in the short term but HTW provision is not an immediate concern.

Heating Strategy

AI.34 The following four main principles for the heat strategy were defined early in the project by the Project Working Group that was appointed by the Government of the Kyrgyz Republic:

- full-cost-recovery tariffs for centralized heat supply
- payment according to consumption
- clear ownership and responsibilities
- social reform, targeting heat subsidies at the most needy households

AI.35 Based on the results of the least-cost comparisons and the affordability analysis the following guidelines for the heat strategy were suggested by the consultants:

- The existing CH should only be maintained to the extent that it can provide affordable heat. The only network that seems able to achieve this is Bishkek's large, interconnected network supplied from the CHP plant.
- Nonfeasible CH networks should be discontinued or minimized until feasible.
- Hot tap water should only be supplied if it can provide a financial surplus to the heating company.
- The use of autonomous systems (block boilers) should be promoted throughout the cities. The fuels used can be either gas (for one or two blocks) or local coal (for more than 10 blocks).

- Measures will need to be taken to make sustainable the increased use of electricity. Where no other supply options are feasible, for example, investment must be made in the power infrastructure.

AI.36 Based on these principles and guidelines, the heat strategy proposed for the Kyrgyz Republic outlines a phased approach similar to that of the Armenian strategy. The three phases described are as follows:

Years 1 and 2, Survival: CH to remain operational with minimum investments; initial steps (for example, metering and the lowering of demand) to be taken to deliver affordable CH.

Year 2-5, Recovery: Development and implementation of sustainable heating options.

Year 6-25, Growth: Investments to be made in CH rehabilitation and/or the large-scale dissemination of decentralized systems.

AI.37 The strategy has five main elements:

- commercialization of heat supply
- condominium assistance
- assistance to local entrepreneurs and manufacturers
- targeted support for poor households
- technical rehabilitation

a) Commercialization

AI.38 If they are to survive, district heating systems must be made commercial. They must otherwise be shut down. Because of network losses it is crucial to have a sufficient number of connections; if this is not the case then the system must be closed down.

AI.39 For the system to be considered commercial, (a) there can be no direct general subsidies; (b) there must be full cost recovery; and (c) private operators must be engage in supply.

AI.40 It will be necessary to establish holding companies to own the old debt and assets of the existing heating companies, and it will be necessary also to consider involving the private sector in operating and managing the most profitable networks. The involvement of the private sector should be sought through the use of a tender procedure (see also Annex B). The remaining networks should stay under the control of a municipal operating company. The commercialized heat companies should operate according to a firm set of rules. Key among these are:

- new supply contracts should be signed with legal entities (condominiums) rather than with individual households
- contracts must be based on minimum performance targets (such as a target supply temperature) and sanctions

- contracts with customers must explicitly allow for the interruption of supply in the event of nonpayment
- heat sales should be conditional on the partial prepayment of forward heating charges
- the metering of heat supply should be introduced over a period of three years
- a two-part tariff system should be introduced, to include a fixed tariff of at least 25 percent of total costs and a variable tariff
- heating quantities must be flexible to accommodate the differing abilities of customers to pay for heat

AI.41 The distribution of the joint costs of cogeneration between the heat and the power side additionally needs to be analyzed and agreed upon.

b) Condominium assistance

AI.42 The collective organization of consumers is necessary for heat supply because of the inflexibility of the current system design. This will have to be achieved in the face of a clear reluctance to establish collective solutions. Lessons from other countries suggest that such solutions can be made to work: with the proper support mechanisms (legal and others), condominiums offer a long-term solution to the problem of housing maintenance and communal services, as well as heating.

AI.43 The main barriers to the development of effective condominiums are unfamiliarity with collective decision-making, uncertainty over the responsibility for in-house installations, the substantial number of empty apartments outside Bishkek, and a lack of financing possibilities.

AI.44 To address these problems, we recommend that the legislation be amended to make the process of registration less onerous and to clarify ownership of and responsibility for common areas. Mechanisms to facilitate the creation and successful operation of condominiums include the following:

- financial support schemes
- support for poor families
- legal support (such as standard contracts and streamlined procedures)
- legislation to facilitate the seizure of apartments on payment default
- information campaigns
- training of condominiums
- implementation of pilot projects

c) Assistance to local entrepreneurs and manufacturers

AI.45 Local entrepreneurs will require support in preparing business plans and attracting financing for small boiler schemes. Notably this will require the provision of new lines of credit.

AI.46 In addition, the regulatory set-up should be simplified, including by the following expediencies:

- large CH systems need to be regulated by the State Energy Agency to avoid the development of monopolies
- smaller systems should need to have only technical licensing, such as safety and fire prevention licensing
- equipment should be technically certified to ensure quality
- heat prices in small systems should be agreed upon by suppliers and consumers

d) Targeted support for poor households

AI.47 When the substantial general subsidies for CH systems are terminated, part of the saving made should be used to fund a heat subsidy, targeted at and paid directly to the most needy families. It is proposed to use the scoring method of the Unified Monthly Benefit (UMB) program. The support should be large enough to cover at least the fixed part of the heat tariff. This would allow poor families to have at least minimum heating (namely that from other apartments and the internal distribution pipes), even should they chose to spend none of their money on heating.

AI.48 It is estimated that the financial support to the poorest families need only amount to around US$0.25 million annually, compared to the US$31 million that currently is used to cross-subsidize heat supply.

e) Technical measures

AI.49 The following technical measures are recommended for immediate implementation for each type of heat supply system existing in the three cities:

Bishkek CHP

- achieve financial separation of the steam and heat systems through the use of individual cost centers
- seek full cost recovery without cross-subsidies from electricity
- install meters (possibly double flow meters) in all buildings and bill according to consumption, using a two-part tariff system

Osh CHP

- discontinue power production
- continue heat production only to the extent that heat can be supplied at costs affordable to consumers
- seek immediate cost reductions by reducing supply; for example, through supplying buildings only via one radiator string per apartment, agreeing on a reduced supply temperature, and setting a shorter heating season
- discontinue HTW supply, with the possible exception of those buildings willing to pay for it

- disconnect those parts of the CH system that have excessively high heat consumption and disconnect buildings that default on payment
- investigate the possibility of conversion to local coal

All HOB-based heating systems

- where feasible, connect to existing CHP networks (Bishkek only);
- continue operation only to the extent that heat can be supplied at affordable cost
- seek immediate cost reductions by reducing supply; for example, through supplying buildings only via one radiator string per apartment, agreeing on a reduced supply temperature, and setting a shorter heating season
- close down HTW supply immediately
- disconnect those parts of the CH system that have excessively high heat consumption and disconnect buildings that default on payment
- investigate the possibility of conversion to local coal

AI.50 Demand-side energy saving measures also should be explored. Those measures related to the improved control of heating and that are most significant for the Kyrgyz Republic are as follows:

- At the building level: The renovation (or replacement) of substations to enable better control of the supply temperature to radiators in the building.
- At the apartment level: Installation of thermostatic valves on radiators to enable individual control of heating and to enable utilization of the solar gain through windows by reducing heating during sunny periods.

AI.51 These two measures are important also from an organizational point of view. By controlling the supply temperature the condominium can manage the common heat consumption of the entire building and can control payments to the heat supplier. The use of thermostatic valves, in combination with heat cost allocators on radiators, additionally can give apartment owners the means of controlling their own heating and thereby managing their heating bill to the condominium.

AI.52 Other simple heat management measures include the tightening of windows to decrease heat consumption. This can be done either by the householder or, more effectively, by a tradesman. In either case it can reduce drafts, save heat, and quickly pay back any investment made. Other building improvements, such as window replacement or wall and roof insulation, can achieve similar results, although often with longer pay back times.

Short-Term Targets of the Heating Strategy

AI.53 If the heating strategy is actively supported by all stakeholders and the short-term measures taken as outlined (see Table I.4), it should be possible to achieve the following situation within two to three years:

- Private or municipal suppliers provide heating services based on commercial principles.
- Residential heat consumers in multi-apartment buildings are organized as condominiums. The condominium is an association of its members (owners) that takes care of common property, specifically the structures and installations that are outside the apartments. If the building is owned by a single person or entity and rented out, the owner will be responsible for the common space, based on contracts with the tenants.
- The point of connection between heat supplier and customer is a meter (heat meter or flow meter). A contract regulates the relations between supplier and consumer based on metered quantities and some fixed price components.
- The customer is responsible for all installations after the meter, including installation cost, maintenance, and repair, as stipulated in the supply contract.
- The condominium will pay for heating (and other utilities) according to contracts and will be responsible (a) for distributing the costs between households, (b) for collection, and (c) for any debt that may accrue. Cost distribution typically will be based on meters for hot tap water and on heat cost allocators for heating.
- Members of the condominium are obliged to pay their share of expenses for heating as agreed in general meetings and in accordance with the law. The condominium can take legal action against members.
- Households that cannot afford to pay their share of the common expenses, for example, pensioners or the unemployed, should receive social support.
- No-cost and low-cost measures to improve insulation and to conserve energy are implemented on a wide scale.

Need for Donor Assistance

AI.54 Grant support for a range of measures in support of implementation of the heating strategy should be raised from donors. These measures should include the following:

- *Information campaign*. A campaign should be organized to raise awareness of the challenges and opportunities of the heating sector and to advocate the creation of condominiums.
- *Support to condominiums*. Support should include training and legal support; help in the implementation of pilot projects; design and seed capital for a lending scheme to enable condominiums to raise funds to finance low-cost building energy efficiency measures and, possibly, heating equipment; and support for the wide-scale introduction of meters.
- *Support to local entrepreneurs*. A lending scheme should be introduced to enable small private entrepreneurs to operate boiler plants and sell heat to condominiums.

– *Establishment of a social heat subsidy mechanism*. Support is needed in the design and implementation of a mechanism for heating subsidies targeted at the poorest families and in the implementation of pilot projects.

Table I.4 Heat Strategy Elements and Phases

	Short Term (Years 1 and 2)	*Medium Term (Years 3–5)*	*Long Term (Years 6–15)*

Institutional
Supply side
National level
	Establishment of a small task force, with participation from the main government agencies that will prepare recommendations (in relation to implementation of this strategy) for decisions to be made by government and municipalities and recommendations for business plans for private enterprises
	
	The government will make the decision regarding the termination of general subsidies for central heat supply
	Government issues decrees or regulations stating the following:
	
	Regarding tariffs
	– Heat supply companies will **determine the actual cost of heat production and distribution** (commercial prices) to consumers for different consumption levels per August 1, 2002, and will suggest new tariffs for the national tariff committee. The committee should approve heat tariffs before October 1 each year
	– Tariffs will be based on a **fixed payment per month** (fixed fee) **plus a variable payment** (consumption fee). (HTW only for Bishkek)
	  – **Without meters,** the fixed payment is per apartment per month of supply (separate heating and HTW). The variable payment is per square meter of apartment for heating and per person for HTW. Charge of a risk fee for consumers without meter
	  – **With meters,** the fixed payment is per apartment per month of supply, and the variable is per cubic meter (flowmeter) or per kWh (heat meter) for heating and HTW. Discounts available for consumers with meters
	– The **fixed payment should amount to about 25 percent** of the total
	– In the absence of a meter, tariffs should be charged according to an **estimate of the heat supplied,** based on the monthly supply temperature for heating and on the normative consumption of HTW. The tariffs should reflect full cost recovery of this consumption
	– From November 1, 2002 **tariffs for payment of HTW** per person per month should be **based on actual production and supply cost** for 160 liters per person per day
	– Consumers organized in a **condominium can demand that HTW supply is discontinued** if they wish and therefore need not pay the fixed fee for receiving HTW. The heat supplier has a right to enter apartments and check if illegal consumption is taking
		The government prepares national strategy and plans on the basis of experience gained through pilot activities and through city strategies. To include extension of the utilization of hydropower and solar energy
		
		The government issues decrees that:
		
		– Make mandatory meters for heating and HTW delivered by centralized systems
		
		The government will ensure that there is an **adequate legislative framework** for the establishment of (small) private enterprises in heat supply
			The government prepares legislative framework to promote and ensure energy efficiency in buildings and to utilize solar energy. This will include aspects of energy auditing and energy labeling

	place – Heat suppliers should apply separate tariffs for networks that are not interconnected. Each boiler house supplying a captive network must be a financially viable profit center or must be closed down **Regarding supply** – For payment according to a meter (flow or energy) for centralized heating, the heat suppliers will make **new contracts with consumers**. In multi-apartment buildings such contracts can only be made if a condominium is established or if all owners sign the contract – **Meters** for payment of central heat and HTW are **to be installed, maintained, and calibrated by the heat supplier** – Consumers in multi-apartment buildings **can demand to pay according to metered consumption** (contract) if they establish a condominium and pay for the meters in advance. Heat suppliers should install meters within one month from payment being made – **The heat supplier may install meters** (flowmeter on supply and return) in multi-apartment buildings and may add the cost of the meter to the fixed payment for connection, divided over an appropriate number of years. If the consumption is in excess of targeted consumption the heat supplier can discontinue HTW supply to all apartments. (If a condominium is established the householders can make a contract and avoid this) – The heat supplier has a **right to replace or renovate substations** in connection with network renovation projects, and has a right to collect the payment for this. Condominium will be owner. The State Energy Agency (SEA) should approve such projects. The government will intensify its efforts to **ensure long-term agreements are met** regarding gas supply and the export of electricity		
Institutional **Demand side** **National level**	The government **simplifies procedures for the establishment of condominiums** and removes the fee for establishment The State Energy Agency **establishes a public relations office** to initiate and coordinate and information activities The government/SEA issues **decrees or regulations stating** that: - **Consumers** (condominium, single homeowner, or public institution) **are responsible for all in-house installations (after meter)**. This includes the substation **- The condominium can with a simple majority decide that all owners install flowmeters** (a specific, approved version) **on all HTW taps**. Owners who do not wish to be supplied can demand disconnection. The condominium chairperson or other authorized person has the right to	The government/SEA issues **decrees or regulations stating that**: – From 2005, payment for heat to condominiums from common heating systems should be based on heat **cost allocators on radiators and, for HTW, meters on taps.** A regulation will specify the details Intensified **national program to empower the function of condominiums**, coordinated or integrated with public information program	The government takes the initiative to establish support of energy efficiency in buildings, with the focus on building improvements. Credit facilities are extended to condominiums, to include investments in solar energy The government/SEA issues decrees that make heat cost allocators for heating and flowmeters for HTW mandatory in multi-apartment buildings with common heating systems

	check for illegal consumption **PILOT ACTIVITIES** The government will establish or intensify a public **information program** related to heating and HTW supply, payment, and cost sharing in condominiums. The campaign will focus on institutional issues and on specific advice related to heating control, energy management, ventilation habits, and indoor climate and comfort. The program should be established with international support and should be implemented in collaboration with local public information programs	National program to support the development of **private maintenance and administration companies** to provide services to condominiums The government will initiate a program to promote the installation of substations, thermostatic valves, and heat cost allocators on radiators. This to be achieved with international financing and assistance, and with grants to condominiums	
Social **National level**	Government decision to: – Phase out non-targeted subsidies and subsidies to privileged groups over a short period of time – Introduce targeted support to homeowners who receive centralized heating and HTW. The support is calculated as a percentage of the fixed payment and the percentage is higher for homeowners in condominiums. The support is given on the same principles as the UMB and the limit for support is defined on the basis of the amount made available for support – Introduce a program, with support, to develop more efficient stoves that produce an improved indoor climate and that have less environmental impact **PILOT PROJECTS** Projects for **improved stoves and use of solar energy** for HTW		
Institutional **Supply side** **Local level**	The municipality takes the initiative to **establish a small task force** to suggest actions to be taken by the municipality, heat suppliers, and consumer organizations. The task force will closely cooperate with the national task force By August 1, 2002, **heat suppliers determine tariffs for full cost recovery** based on a forecast for the next year's consumption. Tariffs are approved by October 1. If the government postpones the termination of general subsidies until 2003 the subsidies will be used to reduce the tariffs. Consumers will be informed about the subsidy element of the tariffs Municipalities **increase their administrative capacity to register condominiums** and to support condominiums Heat suppliers **discontinue the supply of HTW** where it proves to be uncompetitive with calculated required tariffs. Consumers are advised in advance Suppliers adjust the supply temperature to make heating affordable for the average population	Establish organizational and financial support (favorable loans) to **private enterprises to establish block boilers**	

	PILOT PROJECTS Support to **private enterprises to install and operate block boilers** to supply heat and HTW to condominiums Project to investigate the use of night/day storage of electric heating in apartments using "heavy" radiators and timer-controlled HTW storage tanks		
Institutional **Demand side** **Local level**	Municipalities support the strengthening of existing independent organizational and legal **support to condominiums** Municipalities initiate **public information campaigns,** coordinated with a national information campaign, to explain new developments and to involve inhabitants in these developments. An important issue is how to manage energy consumption, including the disconnection of risers Heat suppliers make **contracts with condominiums** that wish to pay according to meter Heat suppliers **install meter**s on request by condominiums Homeowners for whom central supply of HTW will be disconnected establish **alternative individual supply** **PILOT PROJECTS** **Micro credit line** to support condominium investment in meters Pilot project with **meters for central supply, HTW flowmeters in apartments, and heat cost allocators**. Project extended to between six and 12 buildings, using the micro credit line involved. The experience gained is used to adjust the strategy	Extension of credit line with local and international financing Extensions of advisory functions to condominiums **Privatization of municipal maintenance companies (GEKs)** Establishment of targeted training programs for administration and maintenance companies **Credit** line to support condominium investment in substations (excluding Bishkek), meters, heat cost allocators, thermostatic valves, and window improvement	Credit line to condominiums continues