CURRENT STATE OF HEAT SUPPLY IN RESIDENTIAL SECTOR OF THE REPUBLIC OF ARMENIA

(as of April 2008)
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# Table of Content

1. **Introduction** ........................................................................................................................................................................ 6

2. **Background and Current Situation of Urban Heat Supply in Armenia** ........................................................................................................................................ 6
   2.1. Background of Centralized Heat Supply .......................................................................................... 6
   2.2. Current Situation of Utilization of Heat Supply Facilities in Yerevan ............................................ 9

3. **Armenian Housing Stock and Public Sector Overview** .............................................................................................................................. 11
   3.1. Housing Stock ....................................................................................................................................................................... 11
   3.2. Public Buildings ................................................................................................................................................................. 12
   3.3. Heat Demand of Heating and Hot Water Supply of Residential and Public Buildings .......... 13

4. **Legislative Regulatory and Institutional Field of Heat Supply** .............................................................................................................. 14

5. **Assistance of International Organisations and Programs to the Rehabilitation and Development of the Sector** .......................................................................................................................... 22
   5.1. United States Agency for International Development (USAID) .............................................. 22
   5.2. Armenia Renewable Resources and Energy Efficiency Fund (R2E2) .................................... 24
   5.3. UNDP/GEF: Armenia - Improving the Energy Efficiency of Municipal Heating and Hot Water Supply Project ........................................................................................................... 25
   5.4. Armenian Social Investment Fund (ASIF) ................................................................................................. 25
   5.5. Advanced Experience Trainings on Heat Supply Technologies and Management .................. 26

   6.3. Techno-Economic Features of Regional/District Heat Supply Systems ............................... 31
   6.4. Heat Supply Schemes of Residential Areas of RoA ............................................................... 35
   6.5. Analysis of Technical Parameters of the DH Systems ........................................................... 38

7. **The Impact of Natural Gas Import Prices on Tariffs of Energy Services** ................................................................................................................................. 44
   7.1 Experience of Central and Eastern European Countries in the Field of Natural Gas Consumers Classification and Tariffing .................................................................................................. 45
   7.2 Energy carriers’ tariff changes in the framework of perspective increase of natural gas purchase prices .................................................................................................................................................. 46
   7.3 The Impact of Tariff Preferences, Given to Centralized Heat Supply, on other Consumers of Natural Gas ............................................................................................................................................ 49

8. **Energy Efficiency Increase of Gas Equipment** ................................................................................................................................. 51
   8.1 Trend analysis for use, import and realization of gas equipment ...................................................... Error! Bookmark not defined.
   8.2. Existing juridical-normative framework for domestic gas equipment realization and use ........................................................................................................................................................................ Error! Bookmark not defined.

9. **Environmental Impact of Different Heat Supply Systems and Technologies** ................................................................................................................................. 59
   9.1. Assessment of greenhouse gas emissions reduction and energy saving potential from the rehabilitation of centralized energy supply in proposed project sites ................................................................................................................................. 59
9.2 Kyoto Protocol Clean Development Mechanism (CDM) Application Possibilities Assessment
........................................................................................................................................................63
10. ANALYSIS OF HEAT SUPPLY REHABILITATION PILOT PROJECTS............... 63

10.1. Non-Operating Heat Supply Projects Implemented in Residential Buildings.........63
10.2. Functioning and Ongoing Energy Supply Projects for Residential Buildings ........69
10.3. Energy Supply Projects for Public Buildings .................................................................86
10.4. District Heating (DH) Rehabilitation Projects with Application of CHP Technologies .....88
10.5. Monitoring the Energy Efficiency and Environmental Impact of Operating Systems ....96
DEFINITIONS

Separate generation: technologically independent production of electrical and heat energy, correspondingly in condensing power plant and boiler house.

Individual heat supply system: system for apartment heating and hot water supply, or only heating.

Reference values: technical or economic values, which are entered into computer model for technical and economic indexes calculation of heat supply restoration options.

Baseline: the level of green house gas emissions, which will exist in the business as usual scenario in case not implementing the given project.

Centralized heat supply system: a system, which supplies multi-apartment and/or public buildings heating or heating and hot water service through common heat network and from one or a few heat sources.

Cogeneration: simultaneous generation in one process of electrical and thermal energy based on a useful heat demand (external).

Cogeneration ratio: Part of total design heat load covered by cogeneration units.

CHP unit: a unit that can operate in cogeneration mode.

Cogenerator (with gas engine): CHP unit equipped with gas engines.

Connected heat load: overall design heat load of the buildings connected to the heat supply system.

Liner density of heat load: the connected heat load per a meter of external heat supply network, kW/m or MW/km.

Surface density of heat load: overall heat load per 1ha or 1km² of residential district area, kW/ha or MW/km².

Waste heat: gas engine ventilation, lubrication and boosting systems and engines exhausting gas heat.

“Condensing” generation: electrical energy generation without waste heat utilization or partial utilization (particularly, when flue gas temperature is more than 120°C).
1. INTRODUCTION

UNDP/GEF energy efficiency project elaborated and presented to the government of the Republic of Armenia a report on improvements implemented in the field and situation analysis during the period after the acceptance of N°1384 decree on “Republic of Armenia residential areas energy supply improvements” dated 9th of September, 2002. The mentioned report summarizes development assessments and analysis of the future of the sector and includes the commentary of the following issues:

- Juridical initiatives for local self-governing bodies and the role of condominiums in heat supply rehabilitation procedure for heat supply sector improvements,
- Assistance of international organizations and projects towards the development of the sector and pilot projects exploitation experience and lessons learned,
- Analysis of heat supply schemes elaboration procedure for Armenia residential areas,
- Training,
- Environmental issues of the field, as well as
- As a result of the envisaged increase of natural gas import prices internal market heat carriers’ tariffs expected changes analysis and suggestions for price formation policy review.

The current analysis will enable to demonstrate more realistic approaches towards Project’s future work planning, as well as will favor organizing the cooperation among other projects being implemented in the framework of international assistance and Armenia Renewable Energy Resources and Energy Efficiency Fund.

2. BACKGROUND AND CURRENT SITUATION OF URBAN HEAT SUPPLY IN ARMENIA

2.1. Background of Centralized Heat Supply

Ensuring the required comfortable conditions in residential, public and industrial buildings depends on the reliable work of the heat supply systems. In its importance the heating system is no second to other engineering structures: electricity, gas and water supply systems without which life in a modern town and other settlements would be unthinkable.

Prior to the economic and energy crisis Armenia stood out for rather high indicators of centralised heating: 35% of the housing in the country and 90% of residential and public buildings were provided with centralised heating. Heat supply of the residential sector was carried out from both major heat sources (TPS) and district boiler plants (DBPs) (35%), and medium and small capacity heat sources (65%).

The development of the heat supply systems of the residential buildings in the settlements of Armenia can conventionally be divided into 2 phases.

Late 1950s are considered to be the beginning of Phase 1 when construction of residential buildings and gasification of the settlements started to be implemented intensively.

The heat supply of the residential area was implemented by up to 6 Gcal/h capacity district boiler houses where cast iron water boilers and steam boilers of various capacities were installed. The boiler equipment were placed in separately built houses and provided the centralised heating of the connected residential and public buildings and hot water supply of a part of these.
Phase 2 of the development of the heat supply systems started in early 1970s and ended in late 1980s. This phase is characterised by the formation of large centralised heat supply systems on the basis of Yerevan, Hrazdan and Vanadzor thermal power plants (TPPs) and 100-200 Gcal/h DBPs. Medium capacity boiler houses equipped with steel water boilers and steam boilers were constructed for the heat supply of relatively smaller housing estates and districts.

During the said years 8 DBPs with 1260 Gcal/h total design capacity were built and commissioned in Yerevan (without the DBP No.12 – the top boiler house of Yerevan TPP); a number of districts in the neighbourhood of Yerevan, Hrazdan and Vanadzor TPPs were connected to the heat supply system.

The DBPs were reconstructed into heat substations (HS); the implementation of this heat supply scheme made it possible to connect the existing heat distribution networks with their customers to new, larger heat supply systems, minimizing the capital investments to that end.

In late 1980s the heat supply systems in 55 settlements of Armenia having apartment blocks presented a combination of large (based on TPPs and DBPs) and district (based on medium and small capacity boiler houses) systems.

The development of large central heating systems in those years was justified by the high productivity of the powerful heat sources and high environmental indicators. Operation of these systems later revealed a number of obvious disadvantages: low reliability, difficulties in detecting leaks in the external thermal network of great length, heat losses exceeding the norms, lack of locks regulating the water consumption in the networks, the lack of heat meters, etc.

The specifications of the centralised heat supply systems of 54 settlements of the Republic of Armenia (Yerevan excepted) having apartment buildings as of 1990 (operated by Communjermoenergo CJSC) are given in Table 2.1.

Table 2.1. Characteristics of the centralised heat supply systems of RoA settlements

<table>
<thead>
<tr>
<th>NN</th>
<th>Specifications</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Number of boiler houses, including:</td>
<td>280</td>
</tr>
<tr>
<td></td>
<td>Large (10.0 Gcal/h and more)</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Medium (3.0 - 10.0 Gcal/h and more)</td>
<td>117</td>
</tr>
<tr>
<td></td>
<td>Small (up to 3.0 Gcal/h)</td>
<td>122</td>
</tr>
<tr>
<td>2.</td>
<td>Total installed heat capacity, Gcal/h</td>
<td>2,130</td>
</tr>
<tr>
<td>3.</td>
<td>Number of connected buildings, including:</td>
<td>7,601</td>
</tr>
<tr>
<td></td>
<td>Residential buildings</td>
<td>4,844</td>
</tr>
<tr>
<td></td>
<td>Schools, kindergartens</td>
<td>598</td>
</tr>
<tr>
<td></td>
<td>Health facilities</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>Other buildings</td>
<td>2,067</td>
</tr>
</tbody>
</table>

Tables 2.2 and Table 2.3 below provide the summary specifications of the heat supply systems of Yerevan.

Since 1992, under the acute energy crisis caused by the stoppage or restriction of natural gas supply imported into the RoA, decommissioning of Metsamor Nuclear Power Plant and very limited power generation by the TPPs, the amount of heat generated for the heat supply of residential and public buildings also decreased sharply in the country. After 1996 when gas supply and 24-hour power supply were practically restored in the country, the volumes of
centralised heat supply services continued to diminish due to the liberalisation of the prices on energy carriers and the deterioration of the socio-economic situation of the population.

Table 2.2. Characteristics of DBPs and Yerevan TPP

<table>
<thead>
<tr>
<th>NN</th>
<th>Heat source</th>
<th>Year of commissioning</th>
<th>Installed capacity, Gcal/h</th>
<th>Number of connected buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>1.</td>
<td>DBP - 1</td>
<td>1977</td>
<td>90</td>
<td>310</td>
</tr>
<tr>
<td>2.</td>
<td>DBP - 2</td>
<td>1979</td>
<td>150</td>
<td>320</td>
</tr>
<tr>
<td>3.</td>
<td>DBP - 3</td>
<td>1986</td>
<td>200</td>
<td>190</td>
</tr>
<tr>
<td>4.</td>
<td>DBP - 4</td>
<td>1972</td>
<td>120</td>
<td>303</td>
</tr>
<tr>
<td>5.</td>
<td>DBP - 5</td>
<td>1984</td>
<td>150</td>
<td>350</td>
</tr>
<tr>
<td>6.</td>
<td>DBP – 7a</td>
<td>1990</td>
<td>200</td>
<td>539</td>
</tr>
<tr>
<td>7.</td>
<td>DBP - 8</td>
<td>1981</td>
<td>200</td>
<td>417</td>
</tr>
<tr>
<td>8.</td>
<td>DBP - 11</td>
<td>1977</td>
<td>150</td>
<td>308</td>
</tr>
<tr>
<td>9.</td>
<td>Yerevan TPP</td>
<td>1963</td>
<td>787</td>
<td>630</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>2,047</strong></td>
</tr>
</tbody>
</table>

Table 2.3. Characteristics of the boiler houses in Yerevan

<table>
<thead>
<tr>
<th>NN</th>
<th>Heat source</th>
<th>Year of commissioning</th>
<th>Installed capacity, Gcal/h</th>
<th>Number of connected buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>1.</td>
<td>1 Khachatryan</td>
<td>1976</td>
<td>60</td>
<td>79</td>
</tr>
<tr>
<td>2.</td>
<td>Araratian</td>
<td>1983</td>
<td>22</td>
<td>49</td>
</tr>
<tr>
<td>3.</td>
<td>Aeration</td>
<td>1972</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>4.</td>
<td>Conservatoire</td>
<td>1975</td>
<td>24</td>
<td>69</td>
</tr>
<tr>
<td>5.</td>
<td>67 Orbeli</td>
<td>1980</td>
<td>38</td>
<td>72</td>
</tr>
<tr>
<td>6.</td>
<td>70 Avetisyan</td>
<td>1979</td>
<td>16</td>
<td>27</td>
</tr>
<tr>
<td>7.</td>
<td>Small capacity boiler houses</td>
<td>1976</td>
<td>629</td>
<td>1,411</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>806</strong></td>
</tr>
</tbody>
</table>

In view of the unmanageable situation in the residential heat supply sector and aiming to promote the development of the sector, on September 5 2002 the RoA Government passed the well-known Decision No. 1384-N “On Reforms of the RoA Municipal Heat Supply Systems” which approved the “Strategy on Heat Supply of the RoA Settlements”. However, the said Decision failed to assist with bringing about positive change in the municipal heat supply sector as no practical projects were later proposed by the Government.

Later on, the lack of own resources of the operators of the municipal heat supply sector, the insufficient level of collection of heat supply payments, deterioration of the structures, facilities and equipment of the systems, as well as the illegal consumption of hot water from the heating systems by the population resulted in continued decrease in the number of houses receiving centralised heating. In 2004 the system ultimately stopped functioning. Since the same year the functioning of the “Heat Enterprise” CJSC operating the heat system of Yerevan and the “Gyumrijermo” company of Gyumri was terminated. Prior to this, the same
fate had befallen the “Communjermoenergo” company operating the heat sector of the marzes of the country. 

Data on the number of fed from Yerevan heat supply system, by the year, are summarized in Table 2.4 (according to the data of “Heat Enterprise” CJSC)

Table 2.4. Number of buildings in Yerevan from the centralised heat supply system, by the year

<table>
<thead>
<tr>
<th>NN</th>
<th>Heating season</th>
<th>Number of residential houses supplied with centralised heating</th>
<th>Number of other houses supplied with centralised heating</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1990 – 1991</td>
<td>4,310</td>
<td>980</td>
<td>Suppliers: of “Heat Enterprise” CJSC; Yerevan TPP</td>
</tr>
<tr>
<td>2.</td>
<td>2001 – 2002</td>
<td>960</td>
<td>128</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>2002 – 2003</td>
<td>611</td>
<td>56</td>
<td></td>
</tr>
</tbody>
</table>

As a result, at present the apartment owners use space and hot water heaters of various types and manufacture (see subsection 8.1 for details).

It is obvious that this randomly spreading method for heat supply of residential buildings cannot meet the requirements (household, health, sanitation, environmental, etc.) of the population, and a priority issue has occurred to implement centralised heat supply systems which would be able to meet the demand of the population on thermal energy, ensuring appropriate quality, reliability and affordability.

To resolve the issue of heat supply to newly built residential buildings, small capacity heat supply systems are being constructed and operated which basically supply 1-2 houses. The current development process of Yerevan heating sector was typical of the 1950s when it was implemented randomly, without a strategy for the sector and a master plan for heat supply.

Presently about 10-12 centralised heating systems are operational in Yerevan, supplying the newly built houses.

Since 2002 the re-commissioning of the centralised heating systems of the existing residential houses started in the towns of Armenia (mainly in Yerevan) through private investments. Most of these activities were carried out through WB loans (see Annex 1).

Some work was done in the country to re-commission the centralised heating of schools, hospitals and policlinics. Centralised heating systems of 85 schools were constructed and commissioned in Yerevan through the funds made available by various donor organizations. Centralised heating systems of some 140 schools were re-commissioned in other towns and settlements of the country. The centralised heating systems of the basic part of hospitals and other health facilities in Yerevan and other settlements were re-commissioned through various financial sources. The heating systems of the greater part of administrative buildings were also commissioned. The heat supply issues of higher educational institutions and hotels have basically been addressed.

2.2. Current Situation of Utilization of Heat Supply Facilities in Yerevan

Presently there are 338 separate heat supply facilities and some 48 basement boiler houses on the balance sheet of Yerevan Municipality. The status of basement boiler houses needs to be clarified because the process of their areas privatisation is not regulated although pursuant to the existing construction norms of the RoA (CNRA) operation of gas-fired boilers in the basements of residential buildings is prohibited. 6 other auxiliary facilities which formerly supported the heat supply process are also on the balance sheet of Yerevan Municipality.
Meanwhile the 2005-2020 Master Plan of Yerevan envisages rehabilitating DH systems in the residential areas of Ajapniak, Davtashen, South-Western (Harav-Arevmtyan), Avan and Nor Nork districts of Yerevan, as well as heat supply from Yerevan TPP and small capacity heat sources in other parts of the city.

Implementation of DH will enable to ensure:
- consumers safety;
- preservation of housing;
- efficient fuel use;
- reduction of adverse effects on the environment; and
- urban development norms.

In order to implement heat supply projects, pursuant to Decision 785-N of the Government of Armenia dated May 13 2004, by the decisions of Yerevan Mayor 58 small heat supply facilities were leased out to this day.

Due to multiple deflections from the timetable of activities by the lessees, 18 out of 58 of the above-mentioned decisions were cancelled by the decisions of Yerevan Mayor.

The statement on the lessees of the small heat supply facilities leased out by the decisions of Yerevan Mayor is provided in Annex 2.

The activities of the lessees under the 36 effective contracts (see Annex 2) include the following:

- heating is carried out by 4 lessees: “South Therm” CJSC (43 Khanjian street boiler house, 7 houses; “Yerfrez” CJSC (70 Avetisyan street boiler house, 2 houses); 51/3 Arabkir condominium (51/9 Arabkir boiler house. 2 houses); and A. Martoian (22 Kotchar boiler house, 4 houses);
- formerly heating was being carried out by 4 lessees (“EcoEngineering” CJSC (92 Jrashat boiler house); “ArmRusGasProm” CJSC (5/6 Avan boiler house); “ArmRusGasProm” CJSC (“Medic -2” boiler house) and R. Khatchatryan (5 Rubinyantz street boiler house), however later on heating was stopped for different reasons (see subsection 10.1 for details);
- assemblage of boiler houses were completed by two lessees - “Jermosem” CJSC, 16 Komitas Ave. boiler house, and “OSAR Building” CJSC (3 A.Khatchatryan str. boiler house) however no contracts were concluded with the residents, and so far no heating is provided;
- considerable work has been carried out by one lessee, “Suren and Sevak” CJSC (1/2 Leningradyan str. boiler house) in order to provide heating (a significant part of the equipment of the boiler house has been installed);
- no work is being done by 22 lessees, or the course of activities is unsatisfactory (there is a considerable deflection from the timetable); and
- the contracts of the remaining 3 lessees were signed in 2007, and the work is going on according to the timetable.

A number of factors account for this course of activities carried out by small capacity boiler houses:

- Fails on behalf of lessees/wrong organisation of work/incorrect assessment of the amount of work (due to the poor condition of the boiler houses and the centralised heating systems buildings/facilities);
• Increased investment risk especially due to gasification of residential houses in which case a notable part of the residents address the issue of heating through individual heating;
• Lack of professional experience of the major part of lessees;
• The institute of management of apartment blocks is still weak and not fully established; it lacks the experience and skills to pass collective decisions, therefore cannot organise the reconstruction/rehabilitation of internal networks in particular;
• The lending scheme for the rehabilitation of heat supply systems is not fully operational due to the imperfection of the mechanisms for lending the unfavourable lending terms;
• Other factors, like lack of skills to work with the residents, etc.

Pursuant to RoA Government Protocol Decisions No. 30 dated August 3 2006 and No. 31 dated August 31 heat supply system assets located in the Administrative Territories of the Municipalities of Avan and Davtashen respectively were transferred to them on gratis use right.

In Avan community the centralised heat supply of 3 residential houses in D. Varuzhan district was rehabilitated by "ArmRusCoGeneration", and currently actions are taken to expand it and to organise heat supply through combined heat and power plants (CHP).

In Davtashen community no essential work has been carried out by the lessee, “MEP Invest” CJSC, to rehabilitate heat supply (old equipment of five centralised Heating Systems were disassembled, and the design/blueprint of the heat supply system of around 30 apartment blocks fed from the CHS of Davitashen 1st and 4th districts). In this situation the Municipality might make a recommendation to the RoA Government to cancel the decision on free utilisation of the assets.

3. ARMENIAN HOUSING STOCK AND PUBLIC SECTOR OVERVIEW

The materials of this section were compiled based on the data of the RoA National Statistical Service ("Housing Resources and Public Utility of the Republic of Armenia, 2006", Statistical Handbook, 2007).

3.1. Housing Stock

The total area of RoA housing as of January 1 2007 was 76173,3 thous. sq. m., including 43395,5 thous. sq. m. (57.0%) in urban communities and 32777,8 thous. sq. m. communities (43.0%). Around 51,5 % of apartment blocks falls to 1-2-storey housing. The overwhelming majority of apartment blocks in the country, over 74 % (in Yerevan, 50%) has external stone walls. The rest have sheet walls, are monolithic or have walls of different structures. The structural solutions of the external walls affect essentially the heat demand of the heating of the building.

The total are of housing of Yerevan comprised 20806,1 thous. sq. m. or 27.3% of the total area of housing of the country and 48% of that of urban communities. The main indicators of the RoA housing, without the data on non-privitised dormitories, are provided in Table 3.1.
Table 3.1. Main Indicators of RoA Housing*

<table>
<thead>
<tr>
<th>Settlement, region</th>
<th>Apartment blocks</th>
<th>Residential private/detached houses</th>
<th>Total area provided to 1 resident, sq. m./man</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of houses</td>
<td>Number of apartments</td>
<td>Total area, thous. sq. m.</td>
</tr>
<tr>
<td>Yerevan</td>
<td>4,709</td>
<td>210,183</td>
<td>13,979.5</td>
</tr>
<tr>
<td>Marzes</td>
<td>17,069</td>
<td>206,962</td>
<td>12,574.5</td>
</tr>
<tr>
<td>Total RoA</td>
<td>21,778</td>
<td>417,145</td>
<td>26,554.0</td>
</tr>
</tbody>
</table>

*Total area of non-privatised dormitories constitutes 302 thous. sq. m., including 116.6 thous. sq. m. in Yerevan, or 38.6% of total.

Distribution of the total housing area of Armenia by the urban and rural communities is provided in Table 3.2.

Data in Table 3.2 indicate that the larger part of the apartment blocks are in settlements under marz administration.

Table 3.2. Distribution of Housing by the Community

<table>
<thead>
<tr>
<th>Settlement, region</th>
<th>Total area</th>
<th>Urban communities</th>
<th>Rural communities</th>
<th>% of urban</th>
<th>% of rural</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>thous. sq. m.</td>
<td>thous. sq. m.</td>
<td>thous. sq. m.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yerevan</td>
<td>20,806.1</td>
<td>20,806.1</td>
<td>-</td>
<td>100.0</td>
<td>-</td>
</tr>
<tr>
<td>Marzes</td>
<td>55,367.2</td>
<td>22,589.4</td>
<td>32,777.8</td>
<td>40.8</td>
<td>59.2</td>
</tr>
<tr>
<td>Total RoA</td>
<td>76,173.3</td>
<td>43,395.5</td>
<td>32,777.8</td>
<td>57.0</td>
<td>43.0</td>
</tr>
</tbody>
</table>

Table 3.3 presents the distribution of apartment blocks by the storey (absolute and relative indicators). These data also cover the indicators of dormitories.

Table 3.3. Quantitative distribution of apartment blocks by the storey

<table>
<thead>
<tr>
<th>Settlement, region</th>
<th>Number of houses</th>
<th>Number of houses by the storey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of houses</td>
<td>1</td>
</tr>
<tr>
<td>Yerevan</td>
<td>4,709</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>100.0%</td>
<td>0.5</td>
</tr>
<tr>
<td>Marzes</td>
<td>17,069</td>
<td>5,902</td>
</tr>
<tr>
<td></td>
<td>100.0%</td>
<td>34.6</td>
</tr>
<tr>
<td>Total RoA</td>
<td>21,778</td>
<td>5,928</td>
</tr>
<tr>
<td></td>
<td>100.0%</td>
<td>27.2</td>
</tr>
</tbody>
</table>

In quantitative terms the distribution of housing by the storey varies greatly between the capital city and the marzes. Apartment blocks are predominant in Yerevan: the share of buildings with 5 and more storeys constitutes about 78%. Low apartment blocks are more common in the marzes, with the share of buildings with 1-2 storey reaching 65%.

3.2. Public Buildings
Public buildings include the buildings of institutions and facilities of general education, health, culture and other sectors. Quantitative indicators and data on the total are of these, where available, are given in Table 3.4.

### Table 3.4. Quantitative indicators of public buildings

<table>
<thead>
<tr>
<th>Public institutions</th>
<th>Quantity</th>
<th>Total in RoA</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In Yerevan</td>
<td>In marzes</td>
<td>Quantity</td>
</tr>
<tr>
<td>Preschools</td>
<td>172</td>
<td>451</td>
<td>623</td>
</tr>
<tr>
<td>- including kindergartens</td>
<td>52</td>
<td>258</td>
<td>310</td>
</tr>
<tr>
<td>General educational institutions</td>
<td>263</td>
<td>1204</td>
<td>1467</td>
</tr>
<tr>
<td>- including: secondary schools</td>
<td>211</td>
<td>984</td>
<td>1195</td>
</tr>
<tr>
<td>- including: colleges</td>
<td>17</td>
<td>25</td>
<td>42</td>
</tr>
<tr>
<td>Music, arts and fine arts schools</td>
<td>40</td>
<td>173</td>
<td>213</td>
</tr>
<tr>
<td>Vocational schools</td>
<td>10</td>
<td>18</td>
<td>28</td>
</tr>
<tr>
<td>Vocational educational institutions</td>
<td>27</td>
<td>56</td>
<td>83</td>
</tr>
<tr>
<td>Higher educational institutions</td>
<td>19</td>
<td>4</td>
<td>23</td>
</tr>
<tr>
<td>Health facilities</td>
<td></td>
<td></td>
<td>460</td>
</tr>
<tr>
<td>- including: hospitals</td>
<td></td>
<td></td>
<td>140</td>
</tr>
<tr>
<td>Cultural institutions</td>
<td>18</td>
<td>8</td>
<td>26</td>
</tr>
</tbody>
</table>

### 3.3. Heat Demand of Heating and Hot Water Supply of Residential and Public Buildings

Rough estimates of heat demand of heating and hot water supply of the residential and public sector buildings are based on the size of the total area of the buildings, average climate conditions, number of population and the realistic daily norm of hot water consumption/use. The latter was stated at 70 l per person, based on the analysis of the comparative seasonal indicators of consumption of natural gas and electric power by the population and the statistics on tentative and pilot projects.

Table 3.5 below presents the annual heat demand of the heating and hot water supply of the residential and public buildings in Yerevan, in the marzes and in the country.

Thus, the annual heat demand of the heating and hot water supply of the housing and public buildings of the Republic of Armenia as of January 1 2008 comprises around 10.27 million Gcal/a, with the share of Yerevan making 28%.
### Table 3.5. Annual heat demand of residential and public buildings

<table>
<thead>
<tr>
<th>Consumer groups</th>
<th>Load type</th>
<th>Annual heat demand, thous. Gcal/a</th>
<th>Total RoA heat demand</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yerevan</td>
<td>Marzes</td>
</tr>
<tr>
<td>Apartment blocks</td>
<td>Heating</td>
<td>1239,0</td>
<td>1351,0</td>
</tr>
<tr>
<td></td>
<td>Hot water</td>
<td>602,0</td>
<td>587,0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1841,0</td>
<td>1938,0</td>
</tr>
<tr>
<td>Private houses</td>
<td>Heating</td>
<td>339,1</td>
<td>3830,1</td>
</tr>
<tr>
<td></td>
<td>Hot water</td>
<td>289,0</td>
<td>1273,0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>628,1</td>
<td>5103,2</td>
</tr>
<tr>
<td>Public buildings</td>
<td>Heating</td>
<td>399,7</td>
<td>359,9</td>
</tr>
<tr>
<td>Total heat demand</td>
<td></td>
<td>2868,8</td>
<td>7401,1</td>
</tr>
</tbody>
</table>

### 4. LEGISLATIVE REGULATORY AND INSTITUTIONAL ORGANIZATION FRAMEWORK OF HEAT SUPPLY SECTOR

#### 4.1. State participation in heat supply development activities

The provision of centralized heat-supply in settlements is a critical issue both for the state and the public, and is related to the safety of population, protection of environment, efficient use of imported energy resources and preservation of housing stock.

Giving importance to the role of the state in the sector’s development, it is necessary to review those legal acts, which were adopted to provide the sector’s development, so it is up-to-date.

Yet in 2001 RoA Strategy for Heat-Supply Rehabilitation in the Residential Areas was elaborated, which was adopted by RoA # 1384-N resolution, dated 05.09.2002 and was edited by RoA Government # 77-N decree, dated 15.01.2004. The strategy aimed to make the RoA residential areas heat-supply sector viable and provide the population with qualified and affordable heat-supply, at the same time regulate the environmental issues and assist the poverty reduction. The document defined that the heat-supply sector development was by phases, however as it turned out later the schedules were unrealistic. As a matter of fact, this strategy did not favor heat-supply sector improvement at all, because the RoA government did not implement working projects later on.

After RoA residential areas heat-supply sector strategy input, a number of legislative-normative acts have been adopted, which are directed towards the sector’s general development, as well as regulation of the heat-supply organizational procedure, including the heat-supply facilities lending, CHP, as well as gas supply and gas use procedures.

Despite the fact that the mentioned legislative-normative documents, as well as the institutional system itself are directed towards meeting the main objectives of the sector’s development, however it has to be noted, that current legislative field imperfection is mostly an obstacle to the sector’s development, as it does not correspond to the sector’s combined principle and, for making it more perfect, it is necessary to transfer the corresponding functions to state authorized body. The necessity of creating an authorized body by state is also conditioned by the need of one joint legislative act (law) creation, which provides the sector’s regulation. Taking into account the problem’s necessity, the working group created in the framework of the project has elaborated “Implementation of legislative reforms for
Main legislative-normative acts for the sector’s general development are as follows:

- The Law of the RA on “Energy” (adopted on 07.03.2001);
- The Law of the RA on “Energy Saving and Renewable Energy” (adopted on 09.11.2004)\(^1\);

The following decrees have been adopted on CHP:

- RoA Public Services Regulation Committee # 206-N decree on “Approving cogeneration based on a useful heat demand tariff calculation methodology” (adopted on 04.05.2007),
- RoA Public Services Regulation Committee # 168-L decree on “Approving cogeneration based on a useful heat demand tariff defining principles” (adopted on 11.04.2007),
- RoA Public Services Regulation Committee # 279-N decree on “Defining power and heat energy separated production efficiency base (primary) parameters” (adopted on 11.04.2007),
- RoA Public Services Regulation Committee # 280-N decree on “Defining power energy tariff maximum value supplied from facilities of cogeneration based on a useful heat demand” (adopted on 22.06.2007).

The following legislative-normative acts have been adopted on gas supply and gas use:

- RoA Public Services Regulation Committee # 95-N decree on “Rules on gas supply and use” (adopted on 08.07.2005),
- RoA Government # 1458-N decree on “Safety requirements for gas equipment used for domestic purposes” approval of technical regulations (adopted on 07.09.2006),

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\(^{1}\) The Law of the RA on “Energy Saving and Renewable Energy” governs the principles of the state policy on energy saving and the renewable energy development and the mechanisms of implementation thereof. To take the measures in the sector of heat-supply as per the law, it is necessary to provide an appropriate legal regulation environment, promoting introduction of energy saving technologies and construction norms.

\(^{2}\) The Government Order (Protocol) #24 on “Strategy for the Development of the Energy Sector within the Context of the Development of the Republic of Armenia”, adopted by RoA Government on 29.06.2005 is noted, that at present the Republic’s heat-supply system’s exceeding part is collapsed and the investments to be done for heat-supply rehabilitation are mainly to be directed and promoting energy saving and energy efficiency technologies import.
According to RoA Government #2024-N decree dated 05.12.2002 multi-apartment buildings gas supply systems rehabilitation (reconstruction) works are being regulated up to RoA Government # 1384-N decree approval on heat supply implementation in the buildings. As well as modifications and amendments to # 2024-N decree were done by # 1170-N decree. The exercising 2024-N decree says, that in apartments the gas for heating purposes should be used in such buildings, which correspond to building norms and safety requirements. Detailed information on gas supply and gas use decrees application is brought in Section 8.2.

At present, by the initiative of RoA Ministry of Urban Development a number of interstate construction norms (ICN) are input. According to the agreement reached with RoA Ministry of Urban Development, the Alliance to Save Energy initiated “Thermal Protection of Buildings” ICN setting up procedure, and UNDP/GEF Heat-supply project implemented “Heat Networks” MCH 4.02-02-2004 and “Thermal Insulation of Equipment and Pipelines” MCH 4.02-03-2004 ICN setting up, which is presented to Ministry of Urban Development of RA for organizing the approval procedures.

The following decrees have been adopted on boiler houses lending:

1. RoA Government # 1112-N decree on “Hand in inventory to Yerevan municipality” (adopted on 21.08.2003),
2. RoA Government # 785-N decree on “Heat-supply facilities lending and RoA Government # 1112-N, dated 21.08.2003 decree changes” (adopted on 13.05.2004),
3. Yerevan municipality decrees on lending to physical and legal entities the heat-supply facilities (boiler houses, heat substations), which are under the municipality jurisdiction, for multi-apartment buildings and other facilities heat and hot water supply provision.

It is worth mentioning that heat-supply facilities lending procedure is implemented on contractual basis and it is specifically mentioned, that the given boiler house (or heat substation) should be used for heat-supply purposes. Given heat-supply inventory completion act is attached to the contract, as well as rehabilitation works implementation schedule, which control implementation is commissioned to “Institutional Buildings Maintenance and Operation (IBMO)” SCJSC. In case of contract’s some conditions violation, a possibility of contract’s early abrogation is envisaged. Such conditions include the rehabilitation works implementation schedule, in case of multiple breaches of the latter, the “IBMO” SCJSC develops a report, and by the corresponding Yerevan municipality decision the contract is repudiated, which serves as a base, that in case of necessity, specific actions envisaged by court order regarding lending certificate are undertaken for its abrogation.

4.2 Normative acts’ elaboration for CHP tariff formation and for heat-supply systems rehabilitation through the use of heat substations

In USSR CHP or heat-based district heating was widely used in medium and large size cities centralized heat-supply systems and annually provided up to 35 mln. t.c.f. economy by country’s scale. In comparison to “heat-based district heating”, which is certainly based on centralized heat-supply, the modern CHP or “cogeneration” has wider application scope and, in practice, is based upon desired heat demand.

Regardless of CHP technological cycle, the produced energies price formation issue is problematic, especially in the context of the technology’s high capital cost, which balanced solution can substantially impact CHP development perspectives.

In the context of CHP, it is very difficult, if not possible, to diversify the invested, as well as exploitation and preservation, fuel, overhead and other costs among the produced energies. In comparison to other enterprises, where the various product types production costs distribution issue is not raising specific problems, the CHP possesses a number of peculiarities, which makes it difficult to give solutions. The main ones are the following two:
• in the absence of one type of energy production the other’s is impossible or not feasible;
• one type of energy production amounts or parameters of an energy plant influence the other product type efficiency indicators.

In the Soviet period the heat-based district heating stations were implementing the fuel costs distribution by “physical” method, which as a result of combined production was attributing the received fuel total economy to electricity, putting the thermal energy production into unfavorable conditions from economy standpoint. The Russian Federation rejected that method application in 1995, when it was obvious that thermal energy purchase from thermoelectric power station was inexpedient. This method continues to be applied in the Republic of Armenia, may be because of inertial thinking and that heat-supply centralized systems are not being operated, for the purpose that norm was adopted. Corresponding RoA Government # 509-N, dated 2006 and RoA Public Services Regulatory Committee (PSRC) decrees adopted are those first steps, which reject the expenses differentiation “physical” method contradicting the current market conditions: in favor of economy method.

Different principles of price formation for thermal and power energies are applied in connection with market situation and heat-supply sector state policy on national and European level of countries assisting the cogeneration development. Particularly, in Germany the thermal energy sale price is fixed and the electricity tariff is determined by remainder principle. In the context of electrical and thermal energy freed markets, temporary subsidizing mechanism of one or other type of energy is common. European Parliament and European Council 2004/8/EC directive by somehow encouraging the combined production development, notes the main tariffing principles of useful heat demand based on combined production services, which are essentially connected with electrical and thermal energies regulating or freed markets situations. Each European Union member country is authorized to elaborate such price formation policy, which encourages combined production development, considering its own country market situation and priorities.

RoA Government 509-N decree, dated 2006, which content main principle items and justifications are elaborated by UNDP/GEF Project relate to Avan and Davidashen primary projects. However, at the same time it creates a precedent for heat-supply rehabilitation based on cogeneration energy stations, as separate production solutions can not resist the non-centralized heating systems competitiveness spreading rapidly in the apartment sector.

Taking as a base RoA Government and RoA PSRC decrees, as well as European Parliament and European Council 2004/8/EC directive approaches and principles, the Project has elaborated and presented to RoA PSRC for discussions and approval two normative documents proposals, which determine combined production thermal and electrical energies price formation principles and tariffs calculation methodology. After corresponding procedural discussions RoA PSRC approved this normative documents by # 168-L and # 206-N decrees, in 2007.

Combined production electrical and thermal energies tariffs formation principles, according to # 168-L decree, fix cogeneration based on useful heat demand efficiency indicators, electricity calculation method based on combined production, the additional timeframe given for heat-supply rehabilitation, as well as define heating and hot water supply services tariff rates formation principles.

# 206-N decree on tariffs calculation methodology approval defines combined production electrical and thermal energies tariff rates constant and variable components calculation methods, natural gas tariff changes, AMD inflation and AMD/dollar exchange rate tariff components clarification formulas, heating and hot water supply internal (apartment level) networks rehabilitation investments return conditions and etc.
In addition to the adopted decrees, RoA PSRC # 279-N and 280-N decrees, dated June 22, 2007, define combined technologies fuel efficiency assessment initial (baseline) parameters and electricity adjoining tariff value produced in combined way and supplied. These normative documents development together with European Union legislative field harmonization with RoA legislative field is an envisaged measure for first semester of 2007 National project.

4.3 Institutional schemes and needs used in heat-supply systems

Heat-supply system rehabilitation investor organization, apartments’ owners, condominium (other managing body of a building) and among the community the citizen-legal relations can be implemented and regulated according to the following institutional schemes:

- **Option 1.** Thermal energy supplier specialized organization (legal entity) - intermediate organization (condominium) – consumer (multi-apartment building owners).
- **Option 2.** Thermal energy supplier company (legal entity) – consumer (multi-apartment building owners).

For internal (apartment level) heating system exploitation, maintenance, fees payment calculation and levying mechanisms input it is necessary to make right choice of the institutional system and establish the relations on equal legal basis, considering the corresponding mechanisms application. Such choice will enable to create mutually beneficial cooperation, by specifically defining the participant subject role in the field of citizen-legal relations. State and community budget use and getting assistance regarding legal mechanisms’ setting is also important.

**Option 1** - in case of choosing this, two type bilateral contracts are being signed. In the first contract legal relation parties are boiler house exploiting company (major investor and CJSC created by community) and condominium, where the condominium takes on itself the fee collection for the consumed energy according to the tariff, as well as provides the internal network maintenance and preservation which is considered to be heat-supply total shared property. The condominium company informs the internal network about the current losses, as well as on the jeopardy threatening to the building’s total shared property as a result of heat-supply. The second contract is signed between heat-supply company and each proprietor, where the company is obliged to supply some amount of thermal energy, and the proprietor is obliged to consume it and pay for that through intermediate organization (condominium). In the end, in the contract the condominium is considered both as an authorized representative by the building residents, and as supplier middleman.

**Option 2** – in case of choosing this, bilateral contract is being signed. One party implements thermal energy supply, and the other one consumes the supplied thermal energy and pays for that. The heat-supply is implemented by the system, which the company is exploiting (investor and CJSC created by community) and apartments proprietors signed contract, and the fee collection is realized by the company’s representative (worker). According to the contract, the thermal energy fees can be collected in different ways: according to heat equipment actual capacity, heated space or thermal energy meter statement. In case of the latter, the installed heat regulators on the radiators by the means of valves can carry out heat consumption individual regulation, providing in the apartments convenience of any desired level and, at the same time, saving energy resources and individual means.

To provide the heat-supply, concrete requirements have to be defined according to which the authorized state and (or) local self-governing bodies should promote heat-supply rehabilitation and implementation, including:
• Based upon the items of “Local self-governing” law there is a need to clarify the local self-governing bodies role in the heat-supply rehabilitation and implementation activities;
• Based upon the items of “Condominiums” and “Multi-apartment building management” laws there is a need to clarify the condominiums role for the same issues.

Joint proposal customer for residential area heat-supply systems should be the community, which has also to assist the investors on new systems creation and exploitation. At present, by their financial and human resource potential the communities are more consolidated facilities, than the condominiums (and in most of the cases substitute the latter), that’s why they should conduct active standpoint what regards to the communities’ communal maintenance sub-facilities planning and rehabilitation works, which corresponds to residential areas defined plan/area.

Under the current conditions, the condominiums’ possibilities do not allow to consider the heat-supply systems rehabilitation works as medium and major systems rehabilitation initiator, that’s why the systems rehabilitation tactics should not be based upon condominiums, however, that should not exclude their incorporation in internal systems rehabilitation, as well as the apartment owners organizational works. From the strategic and economic efficiency stance, the major specialized companies will be more viable, and the condominiums can be considered as a partner or a costumer by regulating the private operator and individual proprietors’ relations: from the consumers’ interests protection standpoint.

4.4 Legal field analysis of heat-supply sector regulation and the need of required legislative improvements implementation for heat-supply rehabilitation

In the sector of public heat-supply, the legislative field imperfection is immediately related with the complex regulation need of that sector’s economic, social, technological and legal mechanisms.

The existing legal acts regulate the activity licensing, price formation, and a number of issues regarding the supplier-consumer relationship, without completely considering the sector’s technical, technological peculiarities, high potential of energy saving, legal relations particularities, and high risk of investment, as well as the great social and environmental significance.

Taking into account the mentioned above, it appeared necessary to analyze the legislative system of thermal energy regulation, as well as review the legal relations, which are under regulation, through legislative improvements in the field of thermal energy regulation.

According to the 6th article of the Law of the RoA on “Energy Saving and Renewable Energy”, the main directions of the state management policy elaboration and implementation conducted by the state in the field of energy saving are as follows:

• Energy saving and renewable energy field state (national, purposeful) programs development, approval and implementation;
• The organizational and coordination works implemented by state programs in the direction of energy carriers efficient use;
• Energy saving requirements inclusion into the state programs targeted on economy development of the Republic of Armenia:
• Energy saving and energy efficiency standardization documents development and input;
• Energy expertise implementation system creation regarding the existing and to be constructed objects’ proposals in the direction of energy resources efficient use;
- Energy saving and renewable energy development proposals and projects financial assistance and etc.

The mentioned above items of the law have to be considered as a baseline, for residential areas heat-supply strategy implementation mechanisms creation and proposed solutions approval, however, it should be noted, that the steps carried out in meeting this direction are not sufficient.

According to the Law of the RoA on “Energy” in the energy sector the state policy principles and their implementation mechanisms are being regulated. In the 4th “Main concepts” article of the law the “energy” concept is defined as “electrical energy (power) and thermal energy” and equally regulate both electrical and thermal energy fields. The law defines the licensing, tariffs and services payments determination order, as well as consumers’ energy supply provision guarantees in the energy sector.

According to this law, state regulation two mutually exclusive principles exist: “strict” regulation, when the producing thermal station capacity exceeds 5.8MW and unregulated, when it is less than 5.8MW. The first principle is shown for all the capacities in the initial draft of RoA law on “Energy” and is connected with the fact that previously the heat-supply provision was mainly carried out from state major boiler houses or thermal electrical stations. The second principle was input as a result of the law changes taken place on 25.12.2003, when the input of heat-supply systems on the base of small capacity boiler houses was initiated. As a result, in accordance with the 2nd item of 23rd article of the Law: “For exclusively own needs provision the electrical and thermal energy production activities are not licensed”. Thermal energy production, transfer and distribution activities are also not licensed (are not licensed and tariffs are not defined), if the installed capacity of these systems does not exceed 5.8MW. At the same time, it is worth mentioning, that energy carriers’ construction, that provide those activities, stays in the licensing field.

This item possesses a number of uncertainties:

i. The 1st item of the same article notes, that in spite of the capacity, the construction activities are licensed in thermal energy supply sector. This license status is incomprehensible. If in the license there are going to be mentioned any area, buildings, objects, are they? If yes, then it means, that other people cannot obtain license for that same area, and that the given company gets exclusive right, without price regulation (as production license is not being provided) and the consumers are subject to be monopolized, which can be restricted only by indirect competitiveness of other sources of thermal energy. If not, then the sense of construction license provided by regulating body is not explicable, as well as the issues to be solved by that license.

ii. “System installed capacity” phrase generates different opinions. If a company in someplace builds a few boiler houses, then, a question rises, whether system’s installed capacity is the summation of built boiler houses capacity or each boiler house capacity is considered separately. As well another issue arises, how to deal with small capacity cogeneration facilities (the electrical part without exceptions is subject to regulation), and what to understand by saying distribution or transfer network installed capacity.

iii. In addition, the relationships of major (5.8 MW and more) regulation and small non-regulation companies, which exist on the same area are incomprehensible. For example, whether on the area of regulation company non-regulated suppliers can exist.

All these problems generate some contradictions among suppliers and consumers interests, which resolution mechanisms are not visible.

According to the 48th article of the Law “…Consumers, sub-consumers and suppliers relationships are regulated according to the rules of supply and use”, which, by the “g” item
of 17\textsuperscript{th} article of the same Law, are defined by RoA PSRC. It should be noted, that according to the existing “Thermal energy supply and use temporary rules” (adopted on 29.05.2001, by #23\textsuperscript{rd} decree of RoA Energy Regulation Committee) the supplier should be a “licensed person”.

It should be considered, that heat-supply systems, as well as electrical energy and gas systems safety provision mechanisms are not defined in “On energy” Law, however “j” item of the 5\textsuperscript{th} article defines the energy sector safety provision as a state policy principle. Although the Law does not authorize some body to develop safety technical norms for heat-supply sector. At the same time, it should be mentioned, that in RoA yet are not developed and adopted water heating boilers and gas individual heating systems safety technical regulations, which should have defined realistic means for built and to be built systems technical safety provision (rehabilitation).

According to RoA Government #2024-N decree, in the apartments the gas for heating purposes should be used only in those buildings, which construction norms and safety requirements are in contingency. As a result, not always the solutions existing currently in multi-apartment buildings can be considered as endorsed by the required norms.

In the baselines of Strategy for the Development of the Energy Sector (#24 decree (protocol), dated 29.06.2005) as primary issues are mentioned:

- Ensure reliable energy-supply by low prices, including the heat-supply as well: so as to satisfy the basic/vital needs of all the consumers, at the same time, encourage the energy saving.
- Ensure environmental viable energy supply, including the heat-supply as well: based upon sustainable development principles and in harmony with RoA international environmental obligations,
- Develop research projects directed towards goals and priority issues implementation, which are pointed out by the strategy.

At the same time, the decree mentions, that energy safety and independence provision is one of the main requirements presented to energy policy, as well as to heat-supply sustainable development policy.

However, it is worth mentioning, that the yet collapsed situation of Armenian energy system in comparison to the other fields of energy sector, is not paid the needed attention by state.

For the implementation of RoA Government #1384-N, dated 05.09.2002 and #1112-N, dated 21.08.2003 decrees substantial work was carried out in Yerevan for multi-apartment buildings heating and hot water supply provision, so to lend the heat-supply objects to legal and physical entities. At present, 36 such small boiler houses have already been lent. Here the approach has to be as follows: in the future, when switching from larger sources of heat-supply to centralized heat-supply those do not have to become barriers but make the organic continuation of it.

There are also heat-supply internal building system reconstruction juridical issues. The heat-supply internal building system reconstruction issue includes the technical study and assessment of the current situation, in addition the inventory works, as well thermal energy distribution schemes (vertical, horizontal) use possibilities. There is a need to clarify, who is responsible for internal building system research implementation, which will incorporate estimation of financial investments of different heating schemes.

According to RoA Government decree # 346 “On residential and public buildings technical situation research and certification”, dated 30.10.1996 and RoA Government decree # 1625-N “On mandatory norms determination of multi-apartment building general share-hold property protection”, dated 10.09.2002, technical assessment and inventory of the building, as compound part of certification process, should have proceeded that inventory lending to condominiums. However, as for 2006 the buildings technical research and certification procedure can mainly be considered a failure.
Analyzing RoA current legislation, which relates to thermal energy production, supply and consumption, identifying the legislative gaps and based upon international experience, there is a need to realize corresponding changes and amendments in the legal acts and develop RoA Law on “Heat-supply” (complete and more detailed alternative of conceptual document on heat-supply rehabilitation legislative improvements implementation is presented in Annex 6), which will favor the joint and interdependent use of RoA existing laws in the heat-supply sector, firm coordination, as well as will clarify the relationships between all incorporated legal entities and state, and will ensure the sector’s control mechanisms. In this sense, the law will ensure the basis of heat-supply juridical, economic and organizational relations, necessary for the sector’s regulation, as well as state management and local self-governing bodies’ jurisdictions: thermal energy market participants’ rights and obligations frameworks regarding the sector’s planning, supervising, regulation and control issues.

Residential and public buildings, communal service objects heating and hot water supply, as well as industrial enterprises, small and medium objects non technological heat-supply (water) will be considered as regulation field for that sector.

5. ASSISTANCE OF INTERNATIONAL ORGANISATIONS AND PROGRAMS TO THE REHABILITATION AND DEVELOPMENT OF THE SECTOR

Over the recent years several international organizations participated in the reforms of the heat supply sector, which include legal reforms, establishment and empowerment of ESCOs, implementation of pilot projects in the heat supply, energy efficiency and energy saving sector, promotion of renewable energy resources and public awareness raising. Heat supply schemes for various settlements of Armenia were developed and analysis of the feasibility indicators of various heat supply systems were performed by a number of donor-funded projects.

This Chapter provides a brief introduction to the key efforts and activities of the heat supply sector donors over the recent years. Detailed information on the heat supply projects implemented by donor organizations is provided in Section 10.3.

5.1. United States Agency for International Development (USAID)

The assistance at the establishment of an efficient and reliable energy system, which is crucial for sustainable economic growth, environmental protection and social well-being and which will meet the needs of the newly formed market economy is one of the main objectives of the United States Agency for International Development (USAID). To this end, the USAID-implemented past and present energy projects have the following targets: 1) enhancement and development of the private sector participation; 2) raising economic and environmental efficiency; and 3) diversification of energy sources.

USAID has implemented and continues to implement a number of projects related to the heat supply sector which are presented below.

This program was implemented over 2001-2007. The goal was to promote implementation of actions aimed at development of energy saving and renewable energy resources in Armenia. The program supported the introduction of knowledge and experience of energy efficient technologies in Armenia, the establishment of a services market in the area of energy efficiency and renewable energy, and development of energy service companies (ESCOs). A number of heat supply and energy efficiency demonstration projects were implemented under the program.

5.1.2. Commercialization of Energy Efficiency Program (CEEP) Implemented by Advanced Engineering Associates International, Inc. (AEAI)\(^4\)

This program has been implemented since May 2007 and seeks to address the problems that hinder faster development of demand for energy efficiency services and products. It also seeks to expand the use of energy efficiency to increase private sector lending for energy efficiency projects (EEPs). Other objectives of the program include development of heat supply sector service and equipment providers, domestic production of heating equipment to reduce reliance on more expensive, imported products, thereby increasing the local capacity.

The program develops socially-oriented pilot projects aiming at implementation of energy efficiency measures at institutions wholly or partially covered by public financing, including hospitals, kindergartens, special schools and other similar health facilities and educational institutions.

The program also works with local consumer organizations to provide extensive outreach and education to consumers about the economic advantages and disadvantages of energy efficiency services and equipment, as well as health, safety and environmental issues.

5.1.3. Municipal Network for Energy Efficiency: Alliance to Save Energy

In 2001-2007 Alliance to Save Energy implemented the Municipal Network for Energy Efficiency (MUNEE) Program under USAID funding. The objective of the program was to share the positive/best experience in energy saving within the entire region through a relatively cheaper method. The program worked the following four key areas:


ii. *Residential energy efficiency and heating* under which small rotary funds were created in several Armenian towns to help condominiums implement energy efficiency measures in residential houses;

iii. *Education and awareness raising* which includes counseling on development of residential energy efficiency and heating projects, as well as organizing training courses, workshops and seminars on issues of energy efficiency and heating for municipality representatives and condominiums, and energy education seminars for high school students; and

iv. *Strengthening the municipal network for energy efficiency in Armenia and cooperation with towns* which includes enhancement of links with local self-government (LSG) and municipalities, organizing discussions and exchange of best practices on energy efficiency issues of several Armenian towns, as well as

\(^3\) http://www.aeai.am/Erep/Armenian/index.html
\(^4\) http://www.aeai.am/Armenian/index.html
organizing training on energy efficiency and urban energy planning and study tours to other countries.

5.1.4. Housing Sector Heat Supply Program

The program was launched in July 2005 and aimed at assisting the implementation of the strategy on heat supply on RoA settlements adopted in 2002, as well as identify efficient and economically viable solutions for heat supply of Armenia’s various settlements. The program also sought to address institutional issues to promote transparency and effectiveness of provision of services, improve the level of fees collection and establishment of a sustainable commercial energy market.

The major goals of the Program were not reached because of the Program termination in 2006. Among the most essential outcomes of the program are the heat supply schemes for the towns of Sevan and Spitak designed under the program; currently UNDP/GEF Program is dealing with the implementation of these schemes.

5.2. Armenia Renewable Resources and Energy Efficiency Fund (R2E2)

Armenia Renewable Resources and Energy Efficiency Fund started its operation since November 2005. It implements credit and grant projects targeted at the development of renewable energy and energy efficiency sectors in Armenia.

The efficient cooperation between the RoA Government and the WB result in the implementation of the WB Financed Urban Heating Loan Project, Renewable Energy Loan Project; Renewable Energy Grant Project supported by Global Environmental Facility (GEF) trust fund; and Gas and Heating Grant Project supported by Global Partnership for Output Based Aide (GPOBA) trust fund.

The Fund’s Urban Heating Project activities include:

i. Development of enabling environment for effective and safe provision of heating services;

ii. Providing loans to beneficiaries with apartment heating purpose in multi-apartment buildings;

iii. Providing capital grants to around 9,000 to low income (socially vulnerable) families; and

iv. Rehabilitation of heating systems of around 100 schools.

The Fund’s Gas and Heating Project envisages to provide heating grants to 8,000 more socially vulnerable households to enable them to gain access to improved gas and heating services and for provision of heaters. Under the Fund’s Renewable Energy Project lending is provided for small hydropower plants and wind power plants; activities will also be carried out to create a favourable environment for investments, and to identify and develop wind, solar, biogas, bio-ethanol, hydrogen and other resources of renewable energy.

http://www.r2e2.am/armversion/index.php
5.3. UNDP/GEF: Armenia - Improving the Energy Efficiency of Municipal Heating and Hot Water Supply Project

The project implementation started in 1999. It is implemented in two phases:


In this phase the barriers to rehabilitation and improving the energy efficiency in municipal heat supply were identified, and recommendations were made to remove these. The project also aimed to select the most appropriate/relevant strategy option for heat supply development, in order to later elaborate a larger scale project.

**Phase 2 (2005 - present) – “Armenia – Improving the Energy Efficiency of Municipal Heating and Hot Water Supply” Project**

The objective of the project is to reduce greenhouse gas (GHG) emissions resulting from current heat and hot water supply practices in Armenian cities by laying the foundation for the sustainable development of heat and hot water supply services in these cities while taking into account global environmental impacts. Within this framework the project aims to:

I. enhance the role of condominiums in collectively passing decisions on organising heat and hot water supply services at the building level;

II. support the restructuring and capacity building of the existing companies through improving their service quality and operational efficiency;

III. support the new decentralised service providers to commercially run, market and diversify their businesses, in order to promote the use of alternative environmentally clean and energy efficient technologies and to structure financing for the required investments in areas that do not sustain the centralized district heating services; and

IV. promote the dissemination of the results, experiences and lessons learnt, assessing the GHG emission reduction volumes, as well as develop norms for supporting sustainable use of forest resources and implementation of the objective of the Climate Change Convention.

The proposed capacity building and other technical assistance activities will complement, and will be implemented in close co-operation with, the activities of the other donors including the World Bank/IDA funded Urban Heating Project and USAID funded activities in the field of energy, heat supply in particular.

Additional opportunities for co-operation will also be explored with other donors, in the areas of promotion of local self-government bodies, urban development, promotion of small and medium enterprise (SME), advancement of application of energy saving and renewable energy.

5.4. Armenian Social Investment Fund (ASIF)

The Armenian Social Investment Fund (ASIF) was created in 1996, to assist with the rehabilitation of basic infrastructure and support the subsistence of the most needful groups. The recent major projects of ASIF are ASIF II, launched on November 1 2000, and ASIF III,
launched on December 20 2006. About 70-75% of the funding for these projects is provided by the WB, 5-20% by the RoA Government, 5-7% by the communities, and the rest by other donors and sponsors.

The objectives of ASIF II and ASIF III are as follows:

i. raise the living standards of the poor and vulnerable groups through rehabilitation of community infrastructure and improving the quality of and access to services; and

ii. promote complementary institutional capacity building at the community and municipal level so as to improve the quality and sustainability of municipal investments and service delivery, financial management, increase accountability, and enhance greater stakeholder participation at the local level.

These projects finance projects on renovation, reconstruction and construction of kindergartens, schools, orphanages, health centres and other public buildings; rehabilitation and construction of heat supply systems of the said buildings; renovation, reconstruction and construction of drinking water supply, irrigation and sewage systems, environmental improvement, and other similar projects.

5.5. Advanced Experience Trainings on Heat Supply Technologies and Management

A number of trainings/seminars, presentations of advanced technologies, discussions and meetings on heat supply sector management and institutional issues were organized and conducted in the framework of UNDP/GEF Heat Project. The main events implemented by the Project include:

- On March 22, 2006 Caterpillar Company presented its production, particularly the electrical and cogeneration units. Representatives of Caterpillar and “Zeppelin Armenia” and other stakeholder companies participated in that event held in the hall of RA Ministry of Nature Protection.

- On October 18, 2006 presentation and operational training of “fusio-therm” pipes was conducted in the hall of Golden Tulip (Yerevan) hotel, which was organized by UNDP/GEF Project, German “Aquatherm” company and “AH Building Technologies” LLC.

- A study tour to Denmark was organized in 4-8 December 2006, and assisted by “Ramboll” consultancy company. The objective of the visit was to familiarize with the Danish experience of centralized heat supply systems, modern technologies and equipment being exploited in those systems, study the adopted corresponding laws and sub-legislative acts in Denmark, the existing tariff policy and the steps undertaken towards emission reduction, so as to use (introduce) these in RA.

- A training on “The Use of Heat Regulating Devices in the Heat Supply Systems” taking place in the Project office on December 20, 2006 was organized by “Danfoss” company, UNDP/GEF Project and “Yerevannakhagits” CJSC. The updated “DANFOSS C.O.3.5” computer program elaborated by “Danfoss” company was presented. In addition, the program application on specific examples was demonstrated. The participants were provided with this computer program.

- A presentation of Software for Heat Supply Small Systems Calculation developed by the Project, as well as financing mechanisms of heat supply rehabilitation projects was also introduced during the meeting held in “Armenia Marriott” hotel on March 22, 2007. About 35 officials including governmental authorities, condominiums, scientific
and design institutions, supplier and energy service companies (ESCOs) participated in this meeting.

- A seminar on “Energy efficiency technologies with application in residential sector” was organized by the Project and “Heat Automatic Machinery Moscow Plant” in Golden Tulip (Yerevan) hotel on 10 January, 2008. Heating and cooling energy efficient technologies based on heat pumps were presented and discussed in the framework of the seminar. Also, site visit to energy supply center at #6 Hyusisajin ave. was organized for seminar participants.

- A study tour for Armenian specialists on Gas Appliances Energy Efficiency and Labeling to Plzen, Check Republic was organized within the “Capacity Building for Cost-Effective Development and Implementation of Domestic Gas Appliances Energy Efficiency Labeling Program in RA” task during 16-22 February, 2008. The visit was organized by the Project, and “TODERO” Non-Governmental Association as a hosting party. The objective of the visit was to familiarize the Armenian specialists with Check experience in the field of energy efficiency standards and pricing procedures of gas devices, and their testing/certification procedures and capacities.

UNDP/GEF Project has also participated in two thematic exhibitions on heat technologies organized in Armenia during the recent years:
1. initiated and assisted by the Government of RA and USAID in 15-16 March, 2006;

The main objective of the exhibitions was the information provision to the public on existing technologies and creation of contacts among all participants of heat sector market such as: companies providing heat services, condominiums, banks, credit organizations and donors. Around 33 various organizations presented their production and provided services to the stakeholders at the exhibitions.

6. TECHNO-ECONOMIC FEATURES OF HEAT SUPPLY SYSTEMS

This Section deals with the techno-economic features of rehabilitation of heat supply systems, from individual (apartment-level) to high level of concentration, and their economic affordability for the population is assessed.


Detailed information on the specifications of the appliances used in individual apartments, the market situation and delivery companies are provided in Subsection 8.1. The various appliances used for heat supply of individual apartments can generally be grouped into the following three types of systems:
- “open” combustion chamber gas heater for heating and gas flow water-heater for hot water supply;
- “closed” combustion chamber gas heater for heating and gas flow water-heater for hot water supply; and,
- apartment double-pressure boiler for heating and hot water supply.
All of these systems are in the most unfavorable zone of the current natural gas tariffs, i.e. among the consumers using under 10 thous. Nm$^3$ with 59 AMD/Nm$^3$ and 84 AMD/Nm$^3$ when subsidized and not subsidized respectively.

The prices on heat supply services of individual systems are determined for an average apartment with 60 sq.m. total area, 79 W/sq.m heating specific characteristics and 3.7 man/apartment habitation density. Both the subsidised and non-subsidized options of natural gas tariffs are considered. The exchange rate of the Armenian dram is taken at the official figure of the RoA Central Bank for 2007, 357 AMD/USD. The calculations are made for 12% value of the internal norm of profitability of investments. The service terms of gas appliances are accepted based on the data of delivery companies or expert estimations.

The results of calculations of the prices on the heat supply services of individual systems (VAT included) are for both gas tariffs are given in Table 6.1.

### Table 6.1. Prices on services of individual systems, AMD/kWh

<table>
<thead>
<tr>
<th>Composition/Structure of individual system</th>
<th>Heat power prices in the case of gas tariffs being subsidized, AMD/Nm$^3$</th>
<th>Including the fuel component, %</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Open” chamber heater and gas water-heater</td>
<td>12.50 15.71</td>
<td>60.0 67.9</td>
<td>357 AMD/USD</td>
</tr>
<tr>
<td>“Closed” chamber heater and gas water-heater</td>
<td>13.80 16.96</td>
<td>54.3 62.9</td>
<td></td>
</tr>
<tr>
<td>Apartment double-pressure boiler</td>
<td>18.90 21.88</td>
<td>36.1 44.3</td>
<td></td>
</tr>
</tbody>
</table>

The table data show the true picture of relatively cheaper and more affordable solutions. Particularly after lifting the subsidies on natural gas, the prices on the services of even the most affordable of these systems actually reach the price of nighttime electric power, and those of the individual double-pressure boilers reach the prices of average end use tariffs on 0.4 kW tension electric power.

It should be noted that, given the natural gas import prices, the individual systems with a higher fuel component in the heat power price, i.e. heaters, will be affected most.

The influence of natural gas import prices on the operation and maintenance costs and service prices of individual apartment heat supply systems is shown in Subsection 7.2.

### 6.2. Techno-Economic Features of Small-Scale Centralized Heat Supply Systems

During 2002-2007 no essential changes occurred in the small capacity DH systems sector which serves the residential buildings in Yerevan.

The Project has studied the small capacity DH systems to identify the barriers to their development which influence the tariff most and account for its increase. The calculations were made by the software developed by the Project’s experts.

#### Approaches used
- The calculations were made pursuant to the construction norms and rules of the RoA;
The boiler houses’ own needs were accepted at 1.5% of the installed capacity; a 10% reserve of the installed capacity was envisaged; Estimates of the capital costs required for the heat source and the external heat networks were made roughly. Estimates of the capital costs of the heat source (engineering infrastructures included) are based on the value of construction of a boiler house equipped with 1 MW capacity heat-only boilers; Estimates of the external heat networks were based on the network sections pipes material characteristics; and The calculations were based on the market prices, under the current (subsidised) gas tariffs and 1USD=357AMD exchange rate.

The basis for calculations was a residential area comprised of 4 buildings in the Physics Institute district of Yerevan Ajapnyak community. For systems of 6 and 10 buildings the characteristics of the system for 4 buildings were multiplied by the coefficients of 1.5 and 2.5 respectively.

The study was done:
- for 4, 6 and 10 standard buildings with the following connection rates: 100%, 80% and 60% s;
- for horizontal and vertical schemes of internal heat networks;
- in view of the status of the project implementing agency - private investor or condominium; and
- for different terms of financing - different structure of capital and loan interest rates.

**Tariff analysis**

Analysis of capital costs indicates that other conditions being equal, the internal networks constitute the greater part of capital costs, some 60–70% of total investments for vertical and horizontal internal networks respectively.

Investments for rehabilitation of internal heat network outside and inside the apartments were calculated based on the following specific costs: USD 10.3/sq.m. in the case of vertical and $USD 13.85/sq.m for horizontal instalment (cast iron heating appliances, without measuring equipment). In this case, the average value of the vertical internal heat network makes some $USD 600/apartment, and that of the horizontal network, some USD 900/apartment (VAT included).

Although in the case of the horizontal system the tariff of heat power is considerably higher, it has a number of operational advantages, particularly; the possibility of disconnecting the users from the system without entry into the apartment in case of non-payment and in case of defects occurring in the apartments.

Calculations indicate that the installed load increase leads to a decrease in the tariffs, as the consumption growth rates exceed the annual costs growth rates. For the capital costs it is accounted for by the fact that the investments in the internal heat network increase proportionally while the investments in the heat source and external heat networks increase at a lower rate.

In the case of less than 4 connected average standard buildings the tariffs for district heating are rather high and uncompetitive as compared to various individual heat supply systems. Meanwhile, the increase in the number of connected buildings from 4 to 10 leads to reduced heating tariffs.
The assessment of the connection rate impact revealed that decreased connection rate leads to an increased tariff. This is explained by the fact that the investments in the heat source are calculated according to the connection rate, while the external heat networks and the common part of the internal heat networks, regardless of its type, are calculated for 100% connection rate. As a result, the decrease in capital investments and in consumption occurs disproportionately which leads to the heating tariff increase.

At low connection rate (60%) the tariff increase rates for the vertical networks are higher than those for the horizontal system, as the weight of the commonly used part of the in-building heat networks is larger in the case of vertical networks.

The major share of annual costs are comprised of the gas expenses (some 70% of operation and maintenance costs) and loan payments, for example, for 10 buildings and the horizontal networks, with 100% connection rate, capital structure of 70/30%, 10% loan interest rate and 10 year term of loan pay off, loan payments constitute about 55% of the annual costs.

Obviously the size of the tariff is very sensitive towards the interest rate. Thus, for example, for 4 buildings, with 60% connection rate and 14% loan interest rate the heat tariff becomes unaffordable and uncompetitive, even against electricity.

In the case of implementing heat supply projects by investors and without owner participation, under 12% IRR (70/30% capital structure, 10 year term of loan pay off), and 60% connection rate the tariffs are given in Table 6.2.

<table>
<thead>
<tr>
<th>Loan interest rate</th>
<th>14%</th>
<th>12%</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>For 4 buildings (60%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tariff (AMD/kWh) (Horizontal/Vertical)</td>
<td>20.6 / 19.7</td>
<td>20 / 19.2</td>
<td>19.4 / 18.6</td>
</tr>
<tr>
<td>For 10 buildings (60%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tariff (AMD/kWh) (Horizontal/Vertical)</td>
<td>18.6/ 17.4</td>
<td>18 / 16.9</td>
<td>17.4 / 16.4</td>
</tr>
</tbody>
</table>

Comparison of tariffs specified in Table 6.2 with the tariffs of individual heating options shows that these are considerably higher than the prices of individual heating with gas heaters (some 12.5 AMD/kWh), however these are lower than or almost the same as the heat price produced by apartment boilers (approx. 19.8AMD/kWh).

However, considering a number of apparent advantages of district heating (safety, housing stock preservation, comfort, good hygiene and sanitation), it can be competitive with gas heaters even in the case of higher tariffs. Meanwhile, taking into account the solvency of the population, it should at the same time be lower than the tariffs formed for apartment boilers (19.8AMD/kWh, considering the value of the boiler and the 10-year term of service, as well as the value of the in-building network and ½ of gas supply costs).

In the case of 60% connection rate, for example, for 4 buildings, even with 10% interest rate, the heat tariffs (19.4 and 18.6 for horizontal and vertical networks respectively), almost equal to the tariffs formed for apartment boilers and are close to the average weighed tariff of electric power (21.7AMD/kWh), i.e. use of district heating becomes inexpedient. Under these conditions the role of explanatory activities among the population become extremely important.
For small capacity DH systems study a software was developed by the experts of UNDP/GEF Project, which enables to determine the economic indicators for DH rehabilitation based on the investment financing terms, consumers connection rate and other factors. The software was presented to representatives of potential investors, condominiums, agencies delivering services and goods in heat supply sector and experts at the conference in March 2007.

**General conclusions**
Based on the above, to promote heat supply systems rehabilitation activities it is expedient to consider:

- application of favourable tariffs on gas used for DH;
- lending at the lowest possible rate; and
- providing grants for reconstruction of DH internal networks.

### 6.3. Techno-Economic Features of Regional/District Heat Supply Systems

District heating systems are characterized by the presence of more than one DHS in the areas under development. Solutions of this kind were applied for Yerevan and marz town systems. The economic estimations for system rehabilitation are considered for various heat sources and concentration degrees.

#### 6.3.1. DH Systems Indicators Based on Boiler Houses

The sizes of investments required for systems rehabilitation under Yerevan climate conditions and at various connected summary heat loads for HTW and heating and three different values of linear density of external heat networks loads) are given in Table 6.3. The same Table also provides the tariffs on services of these systems for various IRR values and two options of installment of heating and HTW internal systems.

**Table 6.3. Prices on Heat Supply Services of the Systems**

<table>
<thead>
<tr>
<th>No.</th>
<th>Connected load kWh (th.)</th>
<th>Metric density, kW/m</th>
<th>Internal networks</th>
<th>Heat power tariffs without VAT at ....% of IRR, AMD/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>1st</td>
<td>7,740</td>
<td>6.52</td>
<td>vertical</td>
<td>13.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>horizontal</td>
<td>14.52</td>
</tr>
<tr>
<td>2nd</td>
<td>11,290</td>
<td>5.03</td>
<td>vertical</td>
<td>14.17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>horizontal</td>
<td>15.02</td>
</tr>
<tr>
<td>3rd</td>
<td>6,065</td>
<td>3.60</td>
<td>vertical</td>
<td>14.71</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>horizontal</td>
<td>15.60</td>
</tr>
</tbody>
</table>

The table data indicate that in the considered range of IRR the tariffs on heat power of systems with horizontal internal networks are 0.9-1.3 AMD/kWh higher than those on the systems with vertical internal networks.

Under the current unsubsidised tariffs for natural gas (127.7 USD/thous. Nm³, without VAT), the tariffs of heat generated with individual apartment-level gas-fired facilities vary between 16.0-17.0 kWh, including VAT (see Section 7 for details). If the table data are compared to this indicator, it will be observed that only the first system of the highest density of the load under certain financing conditions and vertical installation of the internal networks will be competitive with individual systems. The prices of the services in the other two systems are higher than the prices of the individual systems.
Merger and consolidation of district systems are technically expedient by the double-pressure scheme. In this case the specific investments in rehabilitation of main networks and DHS, as well as the operation costs on compensation of heat losses and energy carrier circulation in circle 1 and circle 2 grow significantly. Specifically, for example, merger of several DHS (summary connected load = 27.5 MW; linear density of load = 5.15 kW/m) cause a raise of tariffs on heat supply services to the level of tariffs of the third system with the worst indicators provided in Table 6.3. These are obviously uncompetitive with the indicators of individual systems, unless the more comfortable conditions and safety provided by the DH systems and other factors are considered.

In order to get a more general snapshot of the optimal degree of centralisation of heat supply systems, we shall consider the impact of two of several factors affecting this degree. These are: the linear density of the heat load of external networks, \( q_L \), W/m, and the share of HTW load, \( \rho_{HW} \). The ranges of changes of these indicators are taken at 3-7 kW/m and 0.025 – 0.20 respectively. The latter is the ratio of the HTW average daily load to the heating calculated load.

The option of rehabilitation of heating for apartment blocks areas is considered. Estimation of investments based on the system capacity is rough, by the specific indicators.

Under Yerevan climate conditions, in the case of HTW average load \( \rho_{HW} = 0.10 \) share, the influence of the heat load density and connected summary (heating and HWS) capacity on the tariffs on DH services provided by DHS is graphically presented in Figure 6.1.

![Figure 6.1. Impact of connected load and density on heat power tariffs.](image)

It can be seen from the figure that the optimal size of heat load under which minimum tariffs on heat power are ensured (all price indicators are given without VAT) depends on the density of load of networks. The higher the value of density, the more the optimal value is moves towards the area of large capacities: in the 3-5 MW range of connected capacities lowest tariffs on heat power are ensured.
The links of the impacts of hot water supply load on the prices of heat supply, for the 5 and 10 MW values of connected summary load and $q_k = 4 - 7 \text{kW/m}$ value of heat load density of networks are graphically illustrated in Fig. 6.2 and Fig. 6.3.

**Fig. 6.2. Heat power tariffs in a 5 MW connected capacity system**

**Fig. 6.3. Heat power tariffs in a 10 MW connected capacity system.**

In Fig. 6.2 and 6.3 $T_{th} = 14$ AMD/kWh ordinate shows the approximate level of the competitive tariff on heat power against heat supply systems with gas-using individual systems, i.e. $T_{th} < 14$ AMD/kWh range centralised systems are advantageous as compared to individual ones. The abscissa of the intersection points of curves and $T_{th} = 14$ line specify the share limit of HTW supply load at higher values of which the centralised systems are
economically expedient. It can be observed that in a 10 MW maximum capacity system at a high value of heat load density, 7kW/m, the share of hot water supply load must exceed about 8%, so the system be economically preferable to the individual one.

### 6.3.2. Restoration of DH Systems through CHP Technology

During calculations of systems with cogeneration energy source pursuant to the methodology established by the RoA PSRC, first the level of competitive tariff on delivered heat power is estimated, and afterwards, according to the residual principle, the tariff on electric power is established. The competitive tariff on heat power is considered within the same limits, 12-14 AMD/kWh (without VAT).

In this case, the tariff on the co-generated electric power received through the residual principle, i.e. co-generated based on a useful heat demand, must be compared to the one-part tariff of the TPP ‘closing’ the annual balance of the energy sector. Currently Harzdan TPP is the one the calculated one-part tariff on the electric power delivered by which constitutes 20.261 AMD/kWh, without VAT and 24.313 AMD/kWh, VAT included (according to the RoA PSRC methodology and in the case of non-subsidised tariff on natural gas). This, the condition of economic attractiveness of a system with cogeneration energy source is expressed by the following in equation:

\[ C_{EI} < 20.261 \text{ AMD/kWh (el.).} \]

The \( C_{EI} \) tariff on the electric power delivered from an energy source depends on the structure of invested capital, profitability of investments, financing terms, etc., in addition to the technical parameters and economic indicators. Within the framework of this study only the impact of profitability of the project is taken into account. In this case, as well as in the option of the boiler houses, the tariff levels of services are explored at various values of IRR.

For the systems specified in Table 6.3 several options of the composition of key equipment for cogeneration energy sources equipped with gas engines are considered which ensure various levels of the cogeneration coefficient.

If under the conditions of Armenia the IRR= 12% be considered as unacceptable, the tariffs on electric power delivered from the systems with compositions specified in Table 6.4 will be lower than the one-part tariff on the electric energy delivered from the TPP ‘closing’ the annual balance of the energy sector of Armenia. The differences in the two price indicators, i.e.

\[ \Delta C_{EI} = 20.261 - C_{EI} \text{, AMD/kWh (el.)} \]

without VAT, indicate the evaluation of the economic efficiency of one or another system and are summarised in Table 6.4.

### Table 6.4. Difference in the one-part tariff of the ’closing’ TPP and the tariff of electric power delivered from cogenerators

<table>
<thead>
<tr>
<th>Connected load of system, kW(th.)</th>
<th>Composition of key equipment</th>
<th>Cogeneration coefficient</th>
<th>Difference in prices on delivered electric power, AMD/kWh, without VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>HP, 12 AMD/kWh</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>vertical</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>vertical</td>
</tr>
</tbody>
</table>
Analysis of data of Table 6.4 allows to make the following key conclusions:

- The optimal value of calculated heat load share covered by cogenerators (cogeneration coefficient) is within the range of 0.25 – 0.30;
- in the case of applied pricing principles for cogenerated electric and heat powers the electric power delivered from cogeneration systems is competitive with electric power delivered from the TPP closing the balance of the energy sector at IRR 12% value of investments;
- all the considered options are exceptions which foresee tariffs lower than 14 AMD/kWh for heat power sale and in-building and in-apartment horizontal installment systems. For these options the investments IRR value limits practically vary within 12% acceptable under RoA conditions, and therefore involve some risk especially in low density heat load systems;
- high density heat load system 1 (see Table 6.3), depending on the internal networks installment mode, is economically profitable within the range of up to 14-17% IRR values; and
- low density heat load system 3 is economically profitable within the range of lower IRR values, 13.0-15.0%.

Thus, given the present tariffs on natural gas, cogeneration district systems are economically expedient within a broad range of investment profitability norm.

Consolidation of cogeneration systems through merger of in-district systems and use of double pressure systems up to 25-30 MW(th.) level of connected capacity, does not essentially improve heat supply economic indicators.

Considering the complications of larger systems operation related to hydraulic and heat regulation, detection and elimination of leaks, installment of main networks in the dense city construction, etc., it can be concluded that the construction of the remaining DSs is inexpedient.

6.4. Heat Supply Schemes of Residential Areas of RoA

Pursuant to the RoA Government Decision No. 509-N on Pilot Projects of Heat Supply System Rehabilitation with Implementation of Heat and Power Cogeneration Units, dated 13 April 2006 the relevant RoA agencies are obliged to develop the economically substantiated/feasible heat supply schemes for RoA settlements with the assistance of Armenia Renewable Resources and Energy Efficiency Fund (R2E2 Fund) and involvement of international assistance programs.
In order to implement the said RoA Government Decision, the Project has in its 2007-2008 Action Plan envisaged the development of the heat supply systems for several towns which have heat supply rehabilitation potential.

In accordance with the CIS Intergovernmental Construction Norms (MCH 4.02-02-2004, 'Heat Networks', Article 5.1), the long-term development solutions for urban areas heat supply, as well as separate district heat supply systems shall be designed within heat supply schemes.

In the Republic of Armenia neither normative documents for establishment of the format for urban areas heat supply schemes, requirements for the schemes, nor development and approval documents exist. The only document specifying the composition of municipal heat supply schemes and the procedure for development and approval, is Instruction CH 531-80, 29/12/1980 endorsed by the USSR GosStroy (State/National Construction) still in the Soviet era. In this connection, the Project has basically applied the provisions of the aforementioned Intergovernmental Construction Norms and the Instruction during the development of municipal heat supply schemes.

The following municipal heat supply schemes were developed under the 2007 Action Plan:

- town of Kajaran, including the option of a joint scheme with Zangezur Copper and Molybdenum Plant;
- Shengavit community of Yerevan, including the prospective option of feeding from Yerevan TPP to be rehabilitated in the steam-and-gas power (-generating) unit;
- Erebuni community of Yerevan, including the prospective option of feeding from Yerevan TPP to be rehabilitated in the steam-and-gas power (-generating) unit; and
- South-Western (Harav-Arevntyan) residential area of Yerevan.

The 2008 Action Plan envisages the development of heat supply schemes for micro-regions 1, 2, 3 and 4 of Nor-Nork residential area, as well as the development of options for heat supply rehabilitation of the public buildings of Chambarak community, Guegharkunik marz, through use of animal waste biogas units (either currently under way).

The heat supply scheme for the towns of Sevan and Spitak were developed by USAID/Residential Heating Project during 2006. Based on the scheme for Sevan and as requested by the foreign investor, the Project has also prepared the feasibility study for heat supply rehabilitation of a micro-region of Sevan covering 46 residential buildings through implementation of cogeneration technology which is presently at the exploration phase by the potential investor.

The key conclusions of heat supply systems developed by the Project are presented below.

**Kajaran city heat supply scheme**

Within the framework of this project were considered 4 options of the city’s residential and public buildings’ heat supply rehabilitation program, including with the use of the ordinary and cogeneration technologies, with the sub-options of the city’s and the mining complex’s separate and joint systems. The most expedient option for the city’s and Zangezur copper and molybdenum mining complex’s joint power supply is the cogeneration power source. It makes possible to maintain available prices of heating and hot water both for the population and the mining complex, to raise the reliability of power supply of the mining complex and to
cut the annual consumption of natural gas for about 6.5 million Nm$^3$ and decrease the greenhouse gas ejection annually by 12 thousand tons.

The heat supply scheme was presented to Kajaran city’s and Zangezur mining complex’s managements for discussion and presentation of investment suggestions.

**Yerevan city Shengavit community heat supply scheme**

Within the framework of this project was considered the Yerevan TEC community “triangle” district’s residential and public buildings heat supply rehabilitation option. Even in case of compensating the whole load of the investments for the system rehabilitation by heat energy the prices of heat supply services remain lower as compared with the same level of individual services by natural gas heating and prices for hot water device services. That solution makes possible to reach the decrease of natural gas consumption by 4.2 mln. Nm$^3$ and the annual decrease of the greenhouse gas ejection will equal up to 8.0 thous. tons.

In the result of the analysis of the technical economic indicators of other districts of the community are given expedient solutions of heat supply rehabilitation that can provide relatively affordable prices for heating and hot water supplies. These solution have become basis for the zoning of the other districts of the community.

The heat supply scheme was suggested to the Yerevan municipality and the concerned ministries for discussions and the development of joint investment suggestions.

**Yerevan city Erebuni community heat supply scheme**

In the course of developing the Erebuni community heat supply scheme, as basis was taken the fact that in accordance with the strategy of developing the energy sector, it is stipulated to start the construction of the steam-gas 2$^{nd}$ power unit in the Yerevan TEC. In the result of drafting the territory of the community in a better position in respect of the TEC, it becomes more attractive from the point of view of heat supply with combined technology. In this option the annual savings of fuel as compared with the individual systems is about 3.7 mln. Nm$^3$, the annual decrease of the greenhouse gas ejection will equal up to 7.0 thous. tons.

The construction of the second power generating unit is stipulated in 2011-2016 time period. In current situation from 4 district systems of the community only one, the system #4 has around 10 MWh of the building heat load and could be furnished with a cogeneration power source. For the other districts as a short time solution must be implemented individual systems.

The heat supply scheme has been presented to the Yerevan municipality and the relevant ministries of the RA for discussing and presenting jointly worked out investment suggestions.

**Yerevan city South-East residential area heat supply scheme**

Yerevan South-East residential area is one of the biggest ones in the city. The gross load of the heating and HT load of the residential and public buildings is 150 MWh, the annual gross heat demand is 286 GWh, the average density of the heat load (850 kWh) is favorable from the point of view of a centralized heat supply rehabilitation. From previously operating 19 systems of the heating and HTW supply of residential area buildings the rehabilitation of at least 9 with gas-pump cogeneration technologies which is economically expedient. In case of installation of these systems the annual economy of fuel as compared with individual systems
can reach up to 15-16 mln. Nm$^3$, the carbon dioxide ejections will decrease down to 30-32 thous. t:

In the rest of the residential area districts, which have relatively low density of the gross load or the low values of HTW share, the scheme stipulates the rehabilitation of the district systems on the bases of boiler-houses or the implementation of individual solutions.

The scheme gives assessment as well to the economic efficiency of the cogeneration systems in conditions of the inevitable raise of the natural gas importation prices. It is shown that in such conditions the cogeneration systems can involve other districts as well, the rehabilitation of the heat supply of which in conditions of the current prices for the natural gas is disputable.

The South-East residential area heat supply scheme has been presented to the Yerevan municipality and relevant ministries of the RA for discussing and presenting jointly worked out investment suggestions.

Taking as basis the part of the worked out heat supply schemes were suggested system rehabilitation drafts based on the technical economic calculations or the preliminary technical economic calculations, the data on the power and ecologic indicators of which are presented in part 9 of this report.

6.5. Analysis of Technical Parameters of the DH Systems

The USAID/GEF program’s international consultants, taking into account the technical economic unfavorable indicators for the rehabilitation of the DH systems on the basis of the boiling houses, have repeatedly suggested to consider the limitation of the system’s installed capacity. This approach is conditioned by the fact that in case of the availability of regulating and measuring devices installed at the consumers’ sites it is possible to have certain decrease of heat load from considerations of power conservation. However it is difficult to give a quantitative assessment to that phenomenon. It is more realistic to consider the limitation of the capacity in the beginning stage of the DH system rehabilitation as a temporary solution and later to bring it to consistency with the installed capacity of the standard level systems in parallel with the improvement of the overall social economic situation.

The goal of this approach which is contradicting the currently accepted construction approaches is to decrease as much as possible the required investment volumes for the rehabilitation of the system and to lower the heat energy tariffs in the beginning stage of the DH systems’ rehabilitation.

The international consultants are suggesting as well to consider the question of the optimization of the heat supply and heating systems temperatures and other technical parameters. In this section are presented the results of the analysis of changes in the system capacity and parameters.

6.5.1. The economic expediency of limiting the heating systems’ installed capacity

The limiting of the DH system’s installed capacity will bring to the undersupply of the heat, which depends on the size of the capacity decrease and the specific character of the heating curve peculiar to the given residential area. In particular in conditions of Yerevan in case of the relative standard capacity of the heating system ($\rho_o \leq 1$) the change of the annual relative heat demand for heating ($q_o$) is expressed in Table 6.5 below.
Table 6.5. The connection between the heating system’s capacity and the annual heat demand in Yerevan conditions

<table>
<thead>
<tr>
<th>The level of limitation of the system capacity, %</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>The relative capacity of the system, $\rho_o$</td>
<td>1,0</td>
<td>0,9</td>
<td>0,8</td>
<td>0,7</td>
<td>0,6</td>
</tr>
<tr>
<td>The annual relative heat demand for heating, $q_o$</td>
<td>1,000</td>
<td>0,99</td>
<td>0,975</td>
<td>0,96</td>
<td>0,925</td>
</tr>
<tr>
<td>The level of the undersupply of heat, %</td>
<td>0</td>
<td>1,0</td>
<td>2,5</td>
<td>4,0</td>
<td>7,5</td>
</tr>
</tbody>
</table>

Thus a certain limitation of the heating system capacity will bring to a considerable less undersupply of the heat power. The source of compensation for the under supplied heat of the DH system can become another system of centralized power supply: electric power or natural gas.

In case of limiting the installed capacity of the heating system the investment needed in all links of the system will decrease: in the source, in the external nets and in the inside building heating systems: In case of capacity limitation of any degree the changes in the volumes of investments in different links of the system are assessed by different methods. The methods for calculating the investments for any concrete system are provided in Attachment 3.

From data in Table A.3.3 of the Attachment 3 we conclude that the limitation of the heating systems’ installed capacity and as a result of that the decrease of the investments required in all links of the heat supply system are to certain extent decreasing the investments required for the rehabilitation.

We suggest to consider two options of the Centralized heat supply system: with heating and HWT services and only with heating services.

**Option1. The heating power tariffs in conditions of limited heating systems capacity**

We assume that the DH system’s installed capacity limitation concerns only the heating systems, that is the HTW supply is provided in standard volumes. As it has been already mentioned, the undersupplied by the centralized system heating power is compensated by electric power of gas supply systems with the retail tariffs of the final consumption. These tariffs are:

- the 0.4 kV voltage electric power average tariff including the VAT: 21.7 AMD/kWh,
- the unsubsidized tariff of natural gas for monthly up to 10 thous. Nm³ consumption: 84 AMD/Nm³.

The calculations for the system with 7.8 MWh (including for the heating: 6.2 MWh) standard gross load presented in Attachment 3 were made for the case of 12% internal rate of return on investments. The compensation of the undersupplied heat power through the electric power and natural gas systems and the increase of capacity in the result of that and the additional investments are not taken into account.

The final consumption tariffs for the DH system heating thermal power, calculated by that principle, without the VAT are presented in Figure 6.4 and Table 6.6.
Figure 6.4. The impact of limiting the central heating systems’ installed capacity on the heat power tariffs

Figure 6.4 graphs show that the decrease of the central heating system’s installed capacity results in certain decrease of the tariffs for heating services. In particular in the vertical DH system with pewter pipes that decrease makes approximately 0.27 AMD/kWh in case of each 10% decrease of the heating system’s installed capacity. The same result with relatively expensive aluminum pipes with horizontal installation systems makes 0.43 AMD/kWh.

In conditions of such tariffs for heating thermal power in the course of the heating season, the compensation for the central heating and undersupplied power costs on the level of an average residential apartment is presented in Table 6.6.

Table 6.6. Heating fees on the level of average residential apartment, in thous. AMD without VAT (option 1, heating and HWT)

<table>
<thead>
<tr>
<th>Name of the indicator</th>
<th>The relative capacity of the system</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.0</td>
<td>0.9</td>
</tr>
<tr>
<td><strong>Installation of the inside apartment system: vertical, battery: pewter</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat tariff, AMD/kWh</td>
<td>14,34</td>
<td>14,09</td>
</tr>
<tr>
<td>Central heating service fee, thous. AMD</td>
<td>114,99</td>
<td>111,92</td>
</tr>
<tr>
<td>The additional fee for heating: - for electric power</td>
<td>-</td>
<td>1,45</td>
</tr>
<tr>
<td>- for natural gas</td>
<td>-</td>
<td>0,49</td>
</tr>
<tr>
<td>The full fee for heating: - for electric power</td>
<td>114,99</td>
<td>113,37</td>
</tr>
<tr>
<td>- for natural gas</td>
<td>114,99</td>
<td>112,41</td>
</tr>
<tr>
<td>The annual saving of payments for heat: - for electric power</td>
<td>-</td>
<td>1,68</td>
</tr>
<tr>
<td>- for natural gas</td>
<td>-</td>
<td>2,64</td>
</tr>
<tr>
<td><strong>Installation of the inside apartment system: horizontal, battery: pewter</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat tariff, AMD/kWh</td>
<td>15,35</td>
<td>15,11</td>
</tr>
<tr>
<td>Central heating service fee, thous. AMD</td>
<td>123,08</td>
<td>120,00</td>
</tr>
<tr>
<td>The full fee for heating: - for electric power</td>
<td>123,08</td>
<td>121,45</td>
</tr>
</tbody>
</table>
We can make certain conclusions on the savings in one apartment annual heating fees as well from Figure 6.5, which concerns a vertical installation system with pewter batteries. In it the 114.99 thous. AMD horizontal line shows the annual heating fee size in conditions of \( \rho_s = 1 \) capacity (or in condition of zero decrease in capacity). The difference of that horizontal line and the other curves shows the annual savings by the resident-customer depending on the type of the alternative source of energy.

![Figure 6.5](image-url)

**Figure 6.5. The annual fees for central and additional heating thermal power in conditions of limiting the installed capacity.**

In case of compensating the undersupply of the heat by electric power of natural gas with the purpose of providing the standard thermal comfort the size of the resident-customer’s annual savings is at maximum reaching correspondingly to 5,4% and 10,4%. With the installation of relatively more expensive aluminum heating horizontal batteries, the savings are more visible in the systems, up to 8,9 and 13,1% correspondingly with electric energy and natural gas.
Option 2. The heating power tariffs in conditions of limited heating systems capacity

In this option we consider only the heating load (the calculated standard is 6,2 MWh) supporting system: The hydraulic calculation of the external thermal grids is done on the basis of new loads so as the push developed by network pumps remain approximately on the same level as in the previous option. In the result are reduced both the construction investments, and the thermal losses of the grids.

Only in case of limiting the installed capacity that is supposed to meet the heating load the thermal power tariffs, central heating and undersupplied power compensation on the level of an average apartment in the course of the heating season, are presented in Table 6.7.

Table 6.7. Heating fees on the level of average residential apartment, in thous. AMD without VAT (option 2, only heating and HWT)

<table>
<thead>
<tr>
<th>Name of the indicator</th>
<th>The relative capacity of the system</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,0</td>
<td>0,9</td>
</tr>
<tr>
<td><strong>Installation of the inside apartment system: vertical, battery: pewter</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat tariff, AMD/kWh</td>
<td>13,39</td>
<td>13,12</td>
</tr>
<tr>
<td>Central heating service fee, thous. AMD</td>
<td>107,27</td>
<td>104,05</td>
</tr>
<tr>
<td>The full fee for heating:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- for electric power</td>
<td>107,27</td>
<td>105,49</td>
</tr>
<tr>
<td>- for natural gas</td>
<td>107,27</td>
<td>104,54</td>
</tr>
<tr>
<td>The annual savings in payments for heat:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- for electric power</td>
<td>-</td>
<td>1,78</td>
</tr>
<tr>
<td>- for natural gas</td>
<td>-</td>
<td>2,74</td>
</tr>
<tr>
<td><strong>Installation of the inside apartment system: horizontal, battery: pewter</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat tariff, AMD/kWh</td>
<td>14,74</td>
<td>14,48</td>
</tr>
<tr>
<td>Central heating service fee, thous. AMD</td>
<td>118,04</td>
<td>114,83</td>
</tr>
<tr>
<td>The full fee for heating:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- for electric power</td>
<td>118,04</td>
<td>116,27</td>
</tr>
<tr>
<td>- for natural gas</td>
<td>118,04</td>
<td>115,32</td>
</tr>
<tr>
<td>The annual savings in payments for heat:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- for electric power</td>
<td>-</td>
<td>1,76</td>
</tr>
<tr>
<td>- for natural gas</td>
<td>-</td>
<td>2,72</td>
</tr>
<tr>
<td><strong>Installation of the inside apartment system: horizontal, battery: aluminum</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat tariff, AMD/kWh</td>
<td>17,64</td>
<td>17,13</td>
</tr>
<tr>
<td>The central heating service fee, thous. AMD</td>
<td>141,30</td>
<td>135,82</td>
</tr>
<tr>
<td>The full fee for heating:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- for electric power</td>
<td>141,30</td>
<td>137,27</td>
</tr>
<tr>
<td>- for natural gas</td>
<td>141,30</td>
<td>136,31</td>
</tr>
<tr>
<td>The annual savings in payments for heat:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- for electric power</td>
<td>-</td>
<td>4,03</td>
</tr>
<tr>
<td>- for natural gas</td>
<td>-</td>
<td>4,99</td>
</tr>
</tbody>
</table>

In order to make the differences of the heating thermal power tariffs in 1st (Table 6.6) and 2nd (Table 6.7) options more evident their corresponding levels in case of different degrees of decreasing the heating systems installed capacity are presented in Figure 6.6.
Figure 6.6. The thermal power tariffs in cases of different decreases of the heating systems’ installed capacity

The analysis of the graphs in Fig. 6.6. makes possible to conclude that in the systems that need relatively low investments, in case of only heating, the tariffs of central heating are lower than the heating and HWT service system heat power tariffs. The picture is changed in connection with the inside building heating systems relatively big investments (horizontal installation, aluminum batteries) in which the addition of the HWT services is decreasing the energy power tariffs due to relatively low investments for the HWT inside building systems from one side and from the other side the increase of the general power demand for around 60%.

In respect of the size of the annual savings by resident-customers through compensating the heating undersupply with electric power or natural gas, then it is approximately on the same level, and at maximum reaches correspondingly to 5.5% and 10.5%. In the more expensive Aluminum heating batteries with horizontal installation these volumes also are not essentially different from the indicators of option 1, up to 10.0 and 14.5% correspondingly in case of using electric power and natural gas.

6.5.2. The expediency of passing to low temperature schedule

In water heat supply single-circuit systems the calculated temperatures of the supplied and backflow water are correspondingly taken as 95 and 70°C. In conditions of current prices of equipment, fuel and labor the optimization of the DH system’s temperatures and other parameters is an important technical economic task, which in accordance with the requirements of the CIS Intergovernmental construction standards, is solved for each concrete system on the basis of separate technical economic calculations.

Taking into account the technical characteristics of the equipments available in the Armenian market, were made comparative calculations for power system of 7.8 MWh considered in the previous subdivision, correspondingly for 95/70°C and 80/60°C temperature schedules. Same options were considered for the heating and HWT inside building systems, with the same
technical and economic indicators. The main results of the calculations are presented in Table 6.8. The economic indicators are given without the VAT.

Table 6.8. The main technical economic indicators for the systems operating with 95/70°C and 80/60°C temperature schedules

<table>
<thead>
<tr>
<th>Name of the indicator</th>
<th>Unit of measure</th>
<th>Vert. + pewter 95/70°C</th>
<th>Hor. + pewter 95/70°C</th>
<th>Hor. + Aluminum 95/70°C</th>
<th>80/60°C 95/70°C</th>
<th>80/60°C 95/70°C</th>
<th>80/60°C Hor. + Aluminum</th>
</tr>
</thead>
<tbody>
<tr>
<td>The external network investments</td>
<td>mln. AMD</td>
<td>66,82</td>
<td>69,20</td>
<td>66,82</td>
<td>69,20</td>
<td>66,82</td>
<td>69,20</td>
</tr>
<tr>
<td>Investments in inside building systems</td>
<td>%</td>
<td>13,9</td>
<td>13,9</td>
<td>11,6</td>
<td>11,6</td>
<td>8,8</td>
<td>8,5</td>
</tr>
<tr>
<td>The general system investments</td>
<td>mln. AMD</td>
<td>306,80</td>
<td>322,34</td>
<td>402,90</td>
<td>418,43</td>
<td>582,82</td>
<td>640,15</td>
</tr>
<tr>
<td>The temperature losses in the external networks</td>
<td>%</td>
<td>100,0</td>
<td>100,0</td>
<td>100,0</td>
<td>100,0</td>
<td>100,0</td>
<td>100,0</td>
</tr>
<tr>
<td>The operation power of network pumps</td>
<td>%</td>
<td>100,0</td>
<td>129,5</td>
<td>100,0</td>
<td>129,5</td>
<td>100,0</td>
<td>129,5</td>
</tr>
<tr>
<td>The thermal power tariff</td>
<td>AMD/kWh</td>
<td>14,34</td>
<td>14,89</td>
<td>15,35</td>
<td>15,91</td>
<td>17,25</td>
<td>18,25</td>
</tr>
<tr>
<td>The tariff of hot water</td>
<td>AMD/m³</td>
<td>726,5</td>
<td>755,0</td>
<td>778,2</td>
<td>806,0</td>
<td>874,5</td>
<td>925,4</td>
</tr>
<tr>
<td>The heating fee of an average apartment</td>
<td>thou. AMD/year</td>
<td>114,8</td>
<td>119,3</td>
<td>122,9</td>
<td>127,4</td>
<td>138,1</td>
<td>146,1</td>
</tr>
<tr>
<td>The operation power of network pumps</td>
<td>%</td>
<td>100,0</td>
<td>103,9</td>
<td>100,0</td>
<td>103,7</td>
<td>100,0</td>
<td>105,8</td>
</tr>
</tbody>
</table>

The analysis of the data summarized in Table 6.8. shows that passing to lower temperature modes does not increase the HWT attractiveness neither from the point of view or the preliminary volumes, nor the tariffs for heating and HWT services. The main reason for thermal losses in the external networks is the much lower part of the reduction from system investments and especially in conditions of considerable growth of the system heat pumping costs.

Thus passing from the traditional 95/70°C temperature schedule to 80/60°C in current conditions is unacceptable as because of the preliminary volumes, as because of the prices for the heat supply services.

The analysis of the both temperature schedules that speaks in favor of 95/70°C schedule, does not all speak about the optimality of the latter but gives only a comparative assessment.

The problem of the heat supply schedule optimization is a complex problem, which must be solved with the consideration of all parameters and technical indicators of the system.

7. THE IMPACT OF NATURAL GAS IMPORT PRICES ON TARIFFS OF ENERGY SERVICES

At present, the natural gas existing tariffs’ system of RA internal market encourages comparatively major consumers with the monthly consumption exceeding 10.000 m³. These types of consumers include electrical energy producers, industrial companies and some heat supply systems. According to the consumption amount, the two level consumers classification system does not have sufficient flexibility and does not consider state policy domination from the standpoint of promoting different sectors’ development. Particularly the level of small scale centralization heat supply is at harm, which frequently appear in the high tariff zone of natural gas.
In the perspective of natural gas import prices inevitable and significant increase, such serious modifications of energy services tariffs are anticipated, which completely do not promote the increase of energy efficiency and the independence level of the RA energy sector.

Other countries experience in the framework of natural gas consumers classification and tariffs formation issues are analyzed in the given section, as well as energy services tariffs are estimated in the context of natural gas import prices increase.

### 7.1 Experience of Central and Eastern European Countries in the Field of Natural Gas Consumers Classification and Tariffing

The analysis was implemented considering the political and economic prehistory of the countries, which stand near to Armenia from the standpoint of disclosure of heat supply encouragement mechanisms.

The consumption groups classification principles vary in different countries and are summerized in the Table 7.1 below:

**Table 7.1. Natural gas consumption groups classification principles in a number of Eastern and Central European countires**

<table>
<thead>
<tr>
<th>Country</th>
<th>Consumer groups’ classification, according to annual amount*)</th>
<th>Tariff rates, TMIN, %**)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estonia</td>
<td>+ 5-zone consumption sector</td>
<td>1 rate, 53 %</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>+ 8-zone</td>
<td>1 rate, 62 %</td>
</tr>
<tr>
<td>Hungary</td>
<td>+ hourly</td>
<td>2 rate, 72 %</td>
</tr>
<tr>
<td>Serbia</td>
<td>+ daily</td>
<td>3 rate</td>
</tr>
<tr>
<td>Croatia</td>
<td>+ 2-zone</td>
<td>2 rate</td>
</tr>
<tr>
<td>Latvia</td>
<td>+ 8-zone</td>
<td></td>
</tr>
<tr>
<td>Romania</td>
<td>+ 4-zone</td>
<td>1 rate</td>
</tr>
<tr>
<td>Moldova</td>
<td>+</td>
<td>1 rate</td>
</tr>
</tbody>
</table>

*) number of zones depending on the natural gas annual consumption,  
**) minimum tariff relative value in comparison to the maximum is brought in the column as well (usually, the one designed for the population).

Only *Estonia* is similar to Armenia with the exception of the fact that consumption is determined on annual basis instead of monthly. Furthermore, the classification is done for 5-zone annual consumption, while in Armenia it is 2-zone annual consumption. In Estonia the annual retail sale tariff is the minimum for consumers exceeding 10,000 m³ and makes the 53% of the set maximum tariff for the consumers, who annually consume till 200 m³. In Armenia the annual set tariff for consumers exceeding 10,000 m³ makes the 65% of the maximum.

More flexible and varied classification and tariffing system has *Serbia*, and a system, which encourages centralized heat supply development exists in *Hungary* and *Moldova*.

In *Hungary* under centralized heat supply classification fall those systems, which have 100 m³/h designed maximum consumption per hour, that means, approximately 950 kW installed or 800 kW connected capacity. It is envisaged to have 2 tariff levels for different cases: 1) to be fed from distribution network and 2) to be fed from high pressure network. In comparison to the average capacity consumers maximum tariff, then for those systems the natural gas sale tariffs make correspondingly 82.7, 81.9 and 71.9%:

In *Moldova* preferential tariffs are defined both from the boiler houses, as well as from cogeneration heat sources implemented for centralized heat supply systems. In the first case, the natural gas tariff makes 75% of the maximum retail tariff, and in case of cogeneration 65%.

In the rest of the countries brought in the table centralized heat supply direct and immediate preferential conditions are not defined. Centralized heat supply systems development
encouragement is provided depending on the growth of consumption amounts by the use of the reduced tariffs systems.

7.2 Energy carriers’ tariff changes in the framework of perspective increase of natural gas purchase prices

The Armenian existing natural gas one-part tariff system’s 2-zone tariff changes depending on the expected increased of the natural gas purchase prices are presented in Table 7.2 (calculated according to PSRC RA tariff methodology). Under the conditions of natural gas purchase prices growth and calculated by the PSRC existing methodology final 0.4 kW tension electricity consumption and Hrazdan TPP supplied electricity tariff energy rate will grow reaching levels shown in Table 7.3. The calculations were made for Armenia’s energy system production and consumption structure in 2007.

Table 7.2. Natural gas purchase prices impact on tariff levels

<table>
<thead>
<tr>
<th>Consumption groups</th>
<th>Natural gas purchase prices on RA border, USD/1000 Nm³ (VAT excluded)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>110, subsidized</td>
</tr>
<tr>
<td>Monthly till 10,000 Nm³ consumers, AMD/1000 Nm³, (VAT included)</td>
<td>59000</td>
</tr>
<tr>
<td>Consumers exceeding monthly 10,000 Nm³, AMD/1000Nm³, (VAT included)</td>
<td>101,25</td>
</tr>
</tbody>
</table>

Table 7.3. Natural gas purchase prices impact on electricity tariffs

<table>
<thead>
<tr>
<th>Electricity purchase (supply) level</th>
<th>Natural gas purchase prices on RA border, USD/1000 Nm³ (VAT excluded)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>110</td>
</tr>
<tr>
<td>0.4 kW tension energy final consumption average tariff, AMD/kWh, (VAT included)</td>
<td>23,27</td>
</tr>
<tr>
<td>Hrazdan TPP supplied electricity tariff energy rate, AMD/kWh, (VAT included)</td>
<td>18,65</td>
</tr>
</tbody>
</table>

In case of natural gas expected prices perspective dynamics showed in Table 7.2 and the existing tariff system levels, only fuel components’ levels of different type of heat supply systems supplied heat energy prices are shown in Table 7.4.

Table 7.4. Fuel constituents of heat energy final consumption prices, AMD/kWh, VAT included

<table>
<thead>
<tr>
<th>Heat supply system type</th>
<th>System’s total coefficient of efficiency, %</th>
<th>Natural gas purchase prices on RA borders, USD/1000 Nm³, (Vat excluded*)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>110</td>
</tr>
<tr>
<td>Individual (furnace + water heater) gas expense &lt; 10000 Nm³/month</td>
<td>82,0</td>
<td>11,01</td>
</tr>
<tr>
<td>Individual (water heating boiler) gas expense &lt; 10000 Nm³/month</td>
<td>93,0</td>
<td>9,71</td>
</tr>
<tr>
<td>Small systems: natural gas expense till 10000 Nm³/month</td>
<td>87,0</td>
<td>10,38</td>
</tr>
<tr>
<td>Medium and big systems: natural gas expense &gt; 10000 Nm³/month</td>
<td>84,0</td>
<td>7,00</td>
</tr>
</tbody>
</table>

* The estimations are calculated on the basis of 357 Armenian dram/USD exchange rate.
So as to assess natural gas purchase prices impact on heat energy final consumption prices, it is necessary to consider also the conditional invariable expenses (exploitation and conservation, investment) impacting heat energy price formation and other expenses, which are immediately impacted by natural gas prices. Those assessments for different type of five systems are given in Table 7.5. For exploitation expenses of each system, the influence of gas prices increase is only considered on behalf of buyable electricity and water. By the way it was accepted, that electricity share-part in water tariff made 25%. The rest of exploitation and conservation expenses were accepted as invariable/stable.

Table 7.5. Heat energy final consumption prices structure in the framework of natural gas perspective prices growth*

<table>
<thead>
<tr>
<th>Natural gas purchase price on country border</th>
<th>USD/1000 m³</th>
<th>110</th>
<th>150</th>
<th>190</th>
<th>230</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual system (closed combustion furnace + water heater), gas expense till 10000 m³/month</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total efficiency %</td>
<td>82</td>
<td>82</td>
<td>82</td>
<td>82</td>
<td>82</td>
</tr>
<tr>
<td>Fuel cost VAT included AMD/kWh</td>
<td>11.01</td>
<td>13.70</td>
<td>16.39</td>
<td>19.08</td>
<td></td>
</tr>
<tr>
<td>Water cost AMD/kWh</td>
<td>1.205</td>
<td>1.225</td>
<td>1.243</td>
<td>1.261</td>
<td></td>
</tr>
<tr>
<td>Electricity cost AMD/kWh</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Non fuel variable expenses AMD/kWh</td>
<td>1.205</td>
<td>1.225</td>
<td>1.243</td>
<td>1.261</td>
<td></td>
</tr>
<tr>
<td>Invariable expenses AMD/kWh</td>
<td>4.744</td>
<td>4.744</td>
<td>4.744</td>
<td>4.744</td>
<td></td>
</tr>
<tr>
<td>Fuel constituent %</td>
<td>64.9</td>
<td>69.7</td>
<td>73.2</td>
<td>76.1</td>
<td></td>
</tr>
<tr>
<td>Non fuel variable part %</td>
<td>7.1</td>
<td>6.2</td>
<td>5.6</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>Invariable part %</td>
<td>28.0</td>
<td>24.1</td>
<td>21.2</td>
<td>18.9</td>
<td></td>
</tr>
<tr>
<td>Heat energy price with VAT included AMD/kWh</td>
<td>16.96</td>
<td>19.67</td>
<td>22.38</td>
<td>25.08</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Individual system (open combustion furnace + water heater), gas expense till 10000 Nm³/month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total efficiency %</td>
</tr>
<tr>
<td>Fuel cost with VAT included AMD/kWh</td>
</tr>
<tr>
<td>Water cost AMD/kWh</td>
</tr>
<tr>
<td>Electricity cost AMD/kWh</td>
</tr>
<tr>
<td>Non fuel variable expenses AMD/kWh</td>
</tr>
<tr>
<td>Invariable expenses AMD/kWh</td>
</tr>
<tr>
<td>Fuel constituent %</td>
</tr>
<tr>
<td>Non fuel variable part %</td>
</tr>
<tr>
<td>Invariable part %</td>
</tr>
<tr>
<td>Heat energy price with VAT included AMD/kWh</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Individual system (apartment water heating boiler), gas expense till 10000 Nm³/month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total efficiency %</td>
</tr>
<tr>
<td>Fuel cost with VAT included AMD/kWh</td>
</tr>
<tr>
<td>Water cost AMD/kWh</td>
</tr>
<tr>
<td>Electricity cost AMD/kWh</td>
</tr>
<tr>
<td>Non fuel variable expenses AMD/kWh</td>
</tr>
<tr>
<td>Invariable expenses AMD/kWh</td>
</tr>
<tr>
<td>Fuel constituent %</td>
</tr>
<tr>
<td>Non fuel variable part %</td>
</tr>
<tr>
<td>Invariable part %</td>
</tr>
<tr>
<td>Heat energy price with VAT included AMD/kWh</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Small scale centralized system, installed capacity 300kW, gas expense till 10000 Nm³/month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total efficiency %</td>
</tr>
<tr>
<td>Fuel cost with VAT included AMD/kWh</td>
</tr>
</tbody>
</table>
### Table: Average capacity of centralized system, installed capacity 4700kW, gas expenses exceeding 10000 Nm³/month

<table>
<thead>
<tr>
<th></th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total efficiency</td>
<td>86.0</td>
<td>86.0</td>
<td>86.0</td>
<td>86.0</td>
</tr>
<tr>
<td>Fuel cost with VAT included</td>
<td>6.84</td>
<td>9.02</td>
<td>11.21</td>
<td>13.39</td>
</tr>
<tr>
<td>Water cost</td>
<td>1.256</td>
<td>1.276</td>
<td>1.296</td>
<td>1.314</td>
</tr>
<tr>
<td>Electricity cost</td>
<td>0.482</td>
<td>0.513</td>
<td>0.544</td>
<td>0.576</td>
</tr>
<tr>
<td>Non fuel variable expenses</td>
<td>1.738</td>
<td>1.790</td>
<td>1.840</td>
<td>1.890</td>
</tr>
<tr>
<td>Invariable expenses + income tax</td>
<td>8.610</td>
<td>8.610</td>
<td>8.610</td>
<td>8.610</td>
</tr>
<tr>
<td>Fuel constituent</td>
<td>39.8</td>
<td>46.5</td>
<td>51.8</td>
<td>56.1</td>
</tr>
<tr>
<td>Non fuel variable part</td>
<td>10.1</td>
<td>9.2</td>
<td>8.5</td>
<td>7.9</td>
</tr>
<tr>
<td>Invariable part</td>
<td>50.1</td>
<td>44.3</td>
<td>39.8</td>
<td>36.0</td>
</tr>
<tr>
<td>Heat energy price with VAT included</td>
<td>17.19</td>
<td>19.42</td>
<td>21.66</td>
<td>23.89</td>
</tr>
<tr>
<td>0.4 kW electricity tariff</td>
<td>23.27</td>
<td>24.78</td>
<td>26.28</td>
<td>27.79</td>
</tr>
<tr>
<td>System “closing” TPP tariff energy rate</td>
<td>18.65</td>
<td>24.46</td>
<td>30.27</td>
<td>36.08</td>
</tr>
</tbody>
</table>

* The estimations are calculated on the basis of 357 Armenian dram/USD exchange rate.

---

**Figure 7.1. Individual systems heat energy and electricity tariffs change depending on gas purchase prices**

The way gas prices impact on individual systems heat energy tariffs is obviously better reflected in the diagrams of the Picture 7.1 above. In comparison, in the picture is also given low tension electricity averaged retail tariff change.
All estimations were made for investments profitability internal norm’s IRR?? 12% value. Centralized systems invariable expenses also considered the income tax. For individual systems were also considered investments on chimneys lying installation??. In all systems, in exception from, naturally, furnace heat alternatives were envisaged inter-apartment networks lying investments: including investments on regulation and tracking technical means.

The tables’ data analysis enables to conclude the following:

1. In the framework of natural gas present tariffs, heat energy lowest prices are provided by combustion “open-fired furnaces + gas water heaters” option. The prices for combustion close-fired and gas water heater system and medium capacity centralized heat supply system services are approximately equal;
2. Taking the option of individual heat supply with apartment boiler, the heat energy prices are high in comparison to other individual systems, app. 5-6 AMD/kWh;
3. The small scale centralized systems, which are under high value of natural gas present functioning tariff, are competitive even in comparison to electricity;
4. “Furnace + water heater” system is more sensitive to natural gas purchase prices growth: natural gas 1000 Nm$^3$ each 40 dollar rise brings to heat energy kWh price increase by 2,71 AMD, in case, when centralized heat supply system makes in total 2,23 AMD.

7.3 The Impact of Tariff Preferences, Given to Centralized Heat Supply, on other Consumers of Natural Gas

Those systems are more sensitive to natural gas tariffs increase, which heat energy price fuel constituent is high. The mentioned above relates to comparatively simple systems, and the ones rehabilitated not through capital solutions, so as to those small scale systems, which by the means of grants, state budget or Armenia renewable energy resources and energy efficiency fund crediting at present are input in the Republic’s facilities of social significance. These small scale systems sometimes face one more issue. This is about the problem rising from marginal level of natural gas tariffs two-level scale, when because of climatic or other conditions, the system consumption can be 10,000 Nm$^3$ and even less, and more in the same heating season, and as a result of these essentially different tariff levels.

At present, for preserving the existing tariff system, as well as in case of some preferences provision to centralized heat supply systems (starting from “one multi-apartment or public building + one heat source” systems), despite of capacity and monthly gas consumption, the tariffs of other consumers of natural gas should increase, so as not to impact the supplier’s economic indexes. Let’s assess other consumers’ tariffs impact sizes, in case of various paces of centralized heat supply development.

Taking small scale consumers’ share-part as 30% in natural gas 2006 consumption structure, the final consumption conditional averaged non subsidized tariff can be decided, that makes:

$$T_M = 0.3 \cdot 84 + 0.7 \cdot 0.15326 \cdot 357 = 63.5 \text{ AMD/Nm}^3$$

So, in the context of subsidy absence the preferential tariff makes 0,15326*357/63,5=86% of the conditional average, and the small scale consumers: 84/63,5=132%. In case of preferential tariff defining to any consumer group, the supplier’s invariable incomings are provided by the corresponding increase of all other consumers’ tariff, estimating so that the averaged tariff stays unvaried. The more will be the number of consumers using preferential tariff and high natural gas consumption volumes; then more substantial is the tariff increase of the rest of consumers.

Centralized heat supply systems rehabilitation is a fundamental procedure and requires substantial time. Supposingly, while creating preferential tariff conditions for these systems the rehabilitation indexes can in the first 5-7 years period make from 40 to 200 MW, according to installed heat capacity (so as app. 140-700 multi-apartment building), then the
gas tariff increase for the rest consumer groups will be reflected in the diagrams shown in Pic. 7.2.

![Diagram of gas tariffs](image)

**Figure 7.2 Centralized heat supply systems preferences impact on natural gas tariff of other consumer groups**

Pic. 7.2 diagrams show that centralized heat supply rehabilitation even with “the most aggressive” paces (200MW and natural gas annual consumption app. 4%) and in case of preferential tariff 80% level in comparison to the averaged, other consumers’ tariffs growth will make in total 0.84% or in the context of present averaged tariff 0.53 AMD for each Nm³. Other consumers’ new averaged 64.03 AMD/Nm³ tariff, which makes the consumption annual amounts 96% in the context of natural gas consumption invariable structure, will bring to the following two levels of the existing two degrees:

- for consumers till 10 000 Nm³/month: 84,81 AMD/Nm³,
- for consumers exceeding 10 000 Nm³/month: 55,12 AMD/Nm³,

In other words, at present in comparison to the existing tariffs it will increase correspondingly by 0.81 and 0.41 AMD for each Nm³. Natural gas tariff for centralized heat supply systems in this context will make 0.8x63.5=50.8 AMD/Nm³ or the highest tariff 50.8/84.81=60%.

So it can be concluded, that such levels preferences provision to centralized heat supply systems is having unnoticeable impact on natural gas tariffs supplied to other consumer groups and cannot have essential influence on the services or products supplement prices provided to those groups.

**General conclusions**

a) Suggest PSRC of RA and “ArmRusgasprom” CJSC jointly discuss the issue of natural gas consumers classification system input;

b) The centralized heat supply systems, which provide one or a number of multi-apartment residential buildings heating or heating and hot water supply from one heat source, are necessary to be classified as separate consumer group of natural gas, without capacity or consumed natural gas amounts limitation or gradation;

c) Natural gas tariff sold to centralized heat supply systems to be defined by the maximum tariff 60-65% level of retail sale: during the whole period or some part of centralized heat supply system service;

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Taking into account natural gas purchase prices inevitable and sharp increase and connected with it the non desirable worsening of energy carriers present existing tariff system, it is necessary to review electricity retail sale tariffs formation principles, considering heat-electrical stations participation level in the electricity production structure on seasonal basis. It is necessary also to incorporate electricity retail tariffs annual time zones;

e) In case of natural gas import price approximate 170 USD/1000 m³ value the heat energy prices for heat supply systems production with the apartment boiler may reach low tension electricity average tariff. In this context, so as to meet heat demand, it is logical to make a transfer from natural gas to electricity. That additional amount of the electricity will be totally produced in Hrazdan TPP, which “closes” the annual balance. By the way, for covering 1kWh additional heat demand app. 1,16kWh should be supplied from that station, because of transfer and distribution losses. So, if the sale tariffs defining principles stay invariable for “Armenian electrical networks” CJSC, then the company’s harms for each additional kWh (used for purposes of heating and hot water supply) will make 1,16 x 30,27- 26,28 = 8,83 AMD (in case of gas purchase price 190 USD/1000Nm³). This index presents the difference of Hrazdan TPP energy rate and retail tariff, considering the transfer and distribution losses;

f) In the context of energy carriers tariffs similar deformation the transfer to electrical heating and hot water supply will bring to electricity production in TPPs and, as a result, the growth of natural gas import amounts, which contradicts to the policy of energy efficiency and energy savings and the principles of more efficient systems input into heat supply sector (RA government project, which was adopted by the decree dated April 28, 2008) and deteriorates the environmental situation in the Republic of Armenia.

8. ENERGY EFFICIENCY INCREASE OF GAS EQUIPMENT

The collapse of centralized heat supply systems and the lack of realistic state policy directed towards this sector’s rehabilitation, resulted in the mass expansion of heat supply individual solutions. The latter was greatly favored by heat and hot water individual gas appliances penetration in the Armenian market, as well as by skillfully organized advertisement of this appliances.

The usage of gas appliances for heat supply has to be considered as modern and obligatory solution, which by its energy and environmental parameters and, particularly, for safety reasons, concedes collective solutions.

The existing market tendencies cannot be disregarded, the analysis of these will enable to objectively assess the individual solutions’ evident and hidden advantages and defects/faults.

Under the existing conditions and aside from gas appliances exploitation safety reasons, the energy efficiency issue is of great importance.

The labeling of energy efficiency indicators of domestic gas appliances is classified in the range of the most efficient mechanisms of state policy in the energy efficiency sector, as well as it has a high popularity in various countries worldwide. It favors the increase of energy

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8 According to RF “OAO Gasprom” company’s decision starting from January 1st, 2009 the natural gas import price to the Republic of Armenia will make 165 USD/1000 Nm³, so as substantially near to the given parameter. As a result, the problem connected with energy carriers’ price formation principles is up-to-date and has an urgent need of review by RA PSRC.
efficiency technologies and products variety demand in the market: influencing the preferences of the consumers by means of awareness raising increase among them. The labels, which are on products, which have undergone an expertise defined by a corresponding procedure, inform the consumer of device’s energy performance, which favors the better justified consumer’s choice on product or service.

USA, Australia, Canada and number of other countries have great achievements in the sphere of gas consuming devices energy efficiency standards elaboration and use. EU also takes certain steps to determine the minimum value of gas consuming energy efficiency devices. In EU countries existing gas devices energy efficiency labeling is the component part of their conformity assessment system. Directive 92/42 of EU is the legal-normative basis of labeling process which determines the demands the energy efficiency of water heating boilers operating with gas and fluid fuels (EC Directive 92/42 on “Efficiency Requirements for New Hot-Water Boilers Fired with Liquid or Gaseous Fuels”). The requirements for gas efficiency minimum indicators of gas devices are presented in number of other EN standards.

UNDP/GEF Project expert group implemented initial studies, which show that in the field of natural gas consumption, for domestic needs exists great potential for energy saving. International experience analysis of the energy saving policy in this sector allows to state, that indirect impact on the consumers preferences, obtained by means of gas appliances energy efficiency labeling system implemented in energy carriers “domestic” consumption sector, is one of the most functional and efficient measure of energy savings policy.

8.1 Trend analysis for use, import and realization of gas appliances

Present structure of domestic gas appliances formed starting from 1998 in the Armenian market, parallel with resident-consumers gas supply restoration procedure, which got widely spread after 2002, when, multi-apartment buildings gasification was at its might.

Started from 2005 county’s gas appliances market occurred some positive turns which caused by improvement of living standards, as well as operating of legal regulation regarding gas appliances installation, operation and maintenance requirements. Particular the number of sold gas stoves (convectors) with improved technical characteristics as well as gas boilers has been significantly increased. Together with it, gas appliances realization annual amount substantially increased. For comparison purposes, it can be mentioned that if during 1998-2004 app. 130 thousand units of domestic gas appliances serving different purposes got realized, then only in 2007 that number made 105 thousand. The sales amount and number of different types of devices used for domestic purposes by 20.12.2007 are shown in Table 8.1.

<table>
<thead>
<tr>
<th>Product name</th>
<th>Import amount, unit</th>
<th>Total gas appliances at present, unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1998-2004 2005 2006 2007 total</td>
<td></td>
</tr>
<tr>
<td>Gas cookers</td>
<td>21995 26344 28443 31003 107785</td>
<td>506753</td>
</tr>
<tr>
<td>B type gas stoves</td>
<td>40924 54566 43173 22732 161395</td>
<td>161395</td>
</tr>
<tr>
<td>C type gas stoves</td>
<td>14899 28339 19849 23818 86906</td>
<td>86906</td>
</tr>
<tr>
<td>Gas boilers</td>
<td>18504 8242 10302 12362 49410</td>
<td>49728</td>
</tr>
<tr>
<td>Gas water heaters</td>
<td>38200 25900 18500 16650 99250</td>
<td>239790</td>
</tr>
</tbody>
</table>
Instantaneous water heaters’ sales amount reduces starting from 2005. The mentioned tendency can be explained by the preferences modifications connected with the population's living standards increase: households find more reasonable to install two-circuit gas boilers for solving two problems, heating and hot water supply simultaneously.

The amount of heating gas appliances realization in 2005 was the most, when 91000 units were sold, which is explained by the gasification rates of multi-apartment buildings during that period of time (more than 90 thousand households). Analysis of the presented data shows, that starting from 2005 and on, together with comparatively low efficient B type gas stoves (convectors) realization amount decrease, two-circuit heating boilers sale amount increased, which are more reliable from energy efficiency and safety side. C type convectors realization amount in 2006 decreased in comparison with the previous year by app. 43% (population's gasification lower rates in comparison with 2005), however during the next year it increased by app. 20%.

Domestic gas stoves realization amount maximum parameters were also registered during 2005. During 2006-2007 the realization amount reduced by app. 30% annually, and the main reasons of the latter are:

- apartments gasification intensity decrease,
- modifications of population's preferences of appliances used for heating purposes (gradually a transfer takes place towards gas boilers providing higher level of heat convenience).

Some qualitative changes have occurred in the domestic gas stoves furnaces realization structure. By 2007 B and C type furnaces realization amounts were merely equal, making app. 23000 units. It is expected, that during 2008-2012 gas furnaces market structure will not sufficiently change, and the realization amounts will slightly decrease making 35000-40000 by 2008, and for the next 3-4 years 20000-25000 units.

Domestic gas boilers realization amounts annual constant tendency of app. 20% growth is noticeable, which is mainly connected with the substantial enlargement of gas devices supply in the market and household's living standards growth. By 2007, the households consuming app. 17% natural gas for heating purposes use gas boilers, it is assumed, that by the end of the studied presumption period (2012) this index will make 25-30%.

Though starting from 2005 the households preferences are gradually directed towards more energy efficient and safe heating gas devices, however, at present B type open combustion gas convectors amount in the households occupies dominant share-part: app. 161000 units (app. 54% of the heating domestic gas appliances).

Parallel with the increase of number of gasified households, the resident-consumers used gas heating appliances amounts' accumulative growth is shown in Pic. 8.1. As it shows, starting from 2005 and on, simultaneously with households’ gasification rates, the share part of consumers using individual gas heating devices grow.
Study implemented by the Project in collaboration with «Gasotherm» identified the importers (manufacturers) of domestic gas appliances, which are currently available in the market, as well as found out sales organization systems, including their human resources managing concepts. A standard questionnaire for domestic gas appliances market assessment was developed for that purpose. List of companies participated in the survey is as follows:

1. «Megatherm» LLC
2. «Ar&Ar Engineering» LLC
3. «Evroprofile» CJSC
4. «Thermoros-Ar» LLC
5. «Thermosis» LLC
6. «Airfel Trade» LLC
7. «Ayb Bem Gym Engineering» LLC
8. «Armen Tumanyan» Private Entrepreneur
9. «Mava Therm: CJSC
10. «Menua» LLC
11. «Czeshki dom Karma» LLC
12. «Evrotherm» CJSC
13. «Davaran» company
14. «A.H. Building Technologies» LLC
15. «Tavi» LLC
16. «Nor tun» shops network

The following conclusions were made based upon the analysis of the completed questionnaires.

1. Domestic gas appliances currently in the market is completely imported from abroad. Only «Evrotherm» CJSC and «Ar&Ar Engineering» LLCs are exceptions,
whose procure the separate blocks and components from their partners, i.e. producers of domestic gas boilers and assemble the gas boilers, then sell them with “Eurotherm” or “Ar & Ar Engineering” trademarks.

2. Mostly all the companies, which participated in the survey are a partner (official representative, distributor) of some international industrial group in the field of gas domestic appliances and present in Armenia the brands of devices manufactured by those companies.

3. 93% of companies manage their trade activities from retail trade specialized shops, 80% carry out the wholesale trade to the retailers and 70% fulfil the wholesale trade to the end users (governmental, public and commercial organizations).

4. All survey participants are involved widely in advertising activities. So as, for example, 80% of the companies prefer television based advertising, 50% radio advertising, 30% prioritize magazines and newspapers, other 30% order street polls. 79% of the participants use Internet, as marketing policy tool.

5. More than 70% of the domestic gas appliances suppliers (manufacturers) organize trainings/seminars for their staff. Sales staff of the companies mainly possess higher education, of 30-35 middle age group.

6. According to the representatives of companies participated in the survey the 50% of consumers purchase gas appliances for the first time, 21% buy new gas appliances so as to get rid from the old appliances.

7. While obtaining domestic gas appliances, the households are headed by the following parameters:
   - Price 80%,
   - Trade name (brand) 57%,
   - Technical characteristics, including energy efficiency 80%,
   - Manufacturing country 70%,
   - Post-service production 65%.

Approximately 300 households have been questioned, so as to identify the consumers’ preferences for trade names existing in the today’s market. In order to increase the objectiveness level of the obtained results the survey was carried out in Yerevan, Gyumri, Alaverdi, Yegegnadzor cities and in Nor Armavir village of Armavir marz.

According to Pic. 8.2 as of February 1st, 2008 Persian made open combustion (B type) gas furnaces “Nicola” and “Ghaynar-Khazar” trade names are the most popular among resident-consumers. “Mora”, “Karma”, “Eskabe” gas convectors with close combustion substantially concede with their use volume to the open combustion gas furnaces having lower energy efficiency parameters.

RA market two-circuit gas boilers realization amounts analysis as of 01.02.2008 by trade names are of interest (Pic. 8.3). Italian “Baxi”, as well as “Ariston”, “Ferroli” and “Beretta” gas boilers enjoy the highest trustworthiness among the households. Korean “Squirrel” gas boilers occupy the second place by their sales. “Evrotherm” CJSC is proceeding among local producers (assemblers), which assemble domestic gas boilers with the same trade name. More or less significant sales are assured by “Ariston”, “Ferroli”, “Beretta”, “Mercury”, “Bosch”, “Viessman”, “Fondital” trademarks.
Pic. 8.2 Used for heating gas convectors’ share parts realized in RA market, according to trade names as of 01.02.2008

Pic. 8.3 Domestic gas boilers share parts realized in RA market, used for heating according to trade names as of 01.02.2008

In the framework of the survey households’ gas appliances classification was carried out as well, according to their energy efficiency parameters:
35% of the domestic gas boilers belong to the 1st class (up to 90% efficiency rate), 63% to the 2nd (90-94% efficiency rate) and 2% to the 3rd class (efficiency rate more than 94%).

App. 30% of the used domestic gas convectors belong to the 1st (up to 80%) energy efficiency class, 45% to the 2nd (80-85%), and 25% to the 3rd (higher than 85%) class.

Gas boilers and convectors market segmentation was done, each belonging to the mentioned energy efficiency class. The segmentation was done according to its retail prices, as a result it can be concluded that both mean and low price segment boilers possess high energy efficiency parameters. The said above can be considered as a factor favoring energy efficiency labeling mechanisms incorporation.

8.2. Existing legal and normative framework for domestic gas appliances realization and use

RA gas appliances market, gas devices installation, exploitation and realization were merely not in the normative regulation field till 2006.

Some common items on gas appliances exploitation safety were included in a range of decisions made by RA government and RA Public Services Regulatory Commission, particularly, RA government “On approval of multi-apartment buildings gas supply systems rehabilitation (reconstruction) and control temporary order” # 2024-N decision dated December 5, 2005, “On approval of RA residential buildings gas supply order” 129-N decision dated February 9, 2006; as well as some other decisions of RA Prime-minister and Public Services Regulatory Commission.

In the absence of the legal and normative documents described definite requirements to domestic gas appliances operation, the market of gas appliances formed as a result of an existing supply, consumers’ paying capacity and preferences. Lack of state policy influenced on the consumer's preferences at the market of gas appliances occurred a lot of relatively cheap simple construction gas convectors available on market, which are not corresponded with the basic operation safety and energy efficiency requirements. Moreover, some of the households use home made gas furnaces.

According to RA Government # 238-N decision dated February 2, 2006 the following types of gas fired appliances were included in the product types’ list, which are subject to obligatory conformity assessment:

- furnace/oven for heating, heating-cooking and food preparation by gaseous fuel: 7321 119, 7321 81,
- centralized heat supply boilers by gaseous fuel: 8403 10,
- non inertial gas water heaters: 8419 11 000.

According to the article 8 of RA law “on Standardization”; the requirements presented to the product types included in the conformity obligatory certification list should be defined by corresponding Technical Regulations.
Obligatory conformity assessment is done based upon laws and legislative acts and provides the production compliance to the technical regulations and standards’ requirements. As far as, the mandatory requirements set by the technical regulations and normative documents refer to production safety, human life, health and environment protection, then the main objective of the conformity obligatory assessment is the safety provision. The products list subject to the conformity obligatory assessment is set by technical regulations or in case of their absence by the RA government # 1149-N decree, dated 29 of July, 2004.

«Gas devices, used for domestic purposes, safety requirements Technical Regulation» # 1458-N decree dated September 7, 2006 by RA government set the requirements presented to gas domestic appliances. The mentioned normative document particularly defines requirements presented to gas devices safety, branding, packaging, installation, and other accompanying documents, as well as the procedures of conformity obligatory certification.

Technical requirements presented to all the mentioned below types of gas devices are included in the Technical Regulation:

- gas heating appliances (gas boilers) with water contour with the heat rate up to 70 Kwt,
- gas water heaters with the heat rate up to 100 Kwt,
- instantaneous gas water heaters,
- Cylindrical gas water heaters,
- Gas stoves,
- Housing gas cookers,
- Portable domestic gas cookers.

Requirements implementation, defined by Technical Regulations, is provided by the National standards mentioned below:

- GOST 11032 (8th section). Domestic cylindrical gas solid water heaters. General technical requirements.
- GOST 19910 (5th section). Domestic instantaneous gas water heaters. General technical requirements.
- GOST 20219 (5th section). Domestic gas water heaters with water contour. General technical requirements.
- GOST 20548 (6th section). Up to 100 Kwt heat capacity gas boilers with heat capacity up to 100 kwt.
- GOST R 51377. Domestic gas stoves. Safety requirements and testing methods.
- GOST 10798 (5th section). Housing gas cookers.
- GOST 30154 (5th section). Domestic portable gas cookers.
As it was already mentioned, gas devices mentioned types’ obligatory conformity assessment is done according to the procedures set by «On conformity evaluation» RA law.

9. ENVIRONMENTAL IMPACT OF DIFFERENT HEAT SUPPLY SYSTEMS AND TECHNOLOGIES

As, at present Armenia lacks an institute, which will collect statistical data about all operating centralized heat supply systems, this chapter presents greenhouse gas emissions and their reduction potential of proposals relating to the Project, operating, as well as elaborated with the Project specialists, though not yet implemented. Heat supply systems environmental impact assessments are given only on behalf of the greenhouse gas emissions.

9.1. Assessment of greenhouse gas emissions reduction and energy saving potential from the rehabilitation of centralized energy supply in proposed project sites

Heat supply systems environmental impact assessments are given only on behalf of the greenhouse gas emissions.

In the suggested proposals of centralized heat supply rehabilitation both combined, as well separate production technologies are used. Their technical and economic indexes were presented in detail in the 6th section.

Greenhouse gas emissions reduction assessment was implemented for equal conditions of energy results receipt, so as, when the heat energy amount received from individual heating devices and centralized heat supply system are equal.

Main technical parameters of Yerevan, Gyumri, Kajaran and Sevan cities heat supply rehabilitation proposals elaborated in the framework of the Project are summerized in Table 9.1.

Table 9.1 Main parameters of centralized heat supply rehabilitation proposals

<table>
<thead>
<tr>
<th>N</th>
<th>System title</th>
<th>Technology used</th>
<th>Installed capacity, MW</th>
<th>Primary energy consumption, MWh/year</th>
<th>Energy final consumption, MWh/year</th>
<th>Efficiency, %</th>
<th>Number of incorporated apartments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gyumri, Krimyan Hayrik str. (5/1, 5/4)</td>
<td>Water heating boilers</td>
<td>2.47</td>
<td>2530</td>
<td>2277</td>
<td>90</td>
<td>180</td>
</tr>
<tr>
<td>2</td>
<td>Spitak, “Kentron-1” district</td>
<td>Water heating boilers</td>
<td>2.0</td>
<td>2298.8</td>
<td>1988.5</td>
<td>88.5</td>
<td>185</td>
</tr>
<tr>
<td>3</td>
<td>Kajaran, municipal centralized heat supply system</td>
<td>Water heating boilers</td>
<td>18.5</td>
<td>49880</td>
<td>40882</td>
<td>82</td>
<td>2163</td>
</tr>
<tr>
<td>4</td>
<td>Sevan, cogeneration system of micro-regions district</td>
<td>Gas engines and peak boilers</td>
<td>13.6 (th.) 3.85 (el.)</td>
<td>82880</td>
<td>36373 (th.) 23060 (el.)</td>
<td>71.7</td>
<td>1784</td>
</tr>
<tr>
<td>5</td>
<td>Yerevan, Shengavit</td>
<td>Cogeneration from steam</td>
<td>43.174</td>
<td>194530</td>
<td>66811 (th.) 76050 (el.)</td>
<td>73.44</td>
<td>5200 (2800’ hot)</td>
</tr>
<tr>
<td>Community</td>
<td>Turbine Energy Block</td>
<td>Water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------------------------------------</td>
<td>-------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>6</strong></td>
<td>Cogeneration from steam turbine energy block</td>
<td>29.31 (th.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yerevan, Erebuni district, combined cycle gas turbine unit of Yerevan TPP</td>
<td>142653</td>
<td>48131 (th.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>58800 (el.)</td>
<td>74.96</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2650</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>7</strong></td>
<td>Gas engines and peak boilers</td>
<td>17.2 (th.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yerevan, Avan community, cogeneration system</td>
<td>334837</td>
<td>127754 (th.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>97541 (el.)</td>
<td>67.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>10172/8646</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>8</strong></td>
<td>Gas engines and peak boilers</td>
<td>16.0 (th.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yerevan, Davidashen community, cogeneration system</td>
<td>332261</td>
<td>118.033 (th.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>99.451 (el.)</td>
<td>65.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>8471/7200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: 1. In Avan and Davidashen centralized heat supply proposals the cogeneration systems in summer regime operate with the co-generators, which waste gas is not completely utilized, that reduces the energy station efficiency.
2. The final electricity consumption with cogeneration energy sources is estimated considering the energy losses in distribution networks.

In the basic options the greenhouse gas emissions assessment is made, considering the apartments’ distribution according to the consumed energy types (Table 9.2).
<table>
<thead>
<tr>
<th>City</th>
<th>Energy source</th>
<th>Number of apartments, unit</th>
<th>Heating Energy consumption for 1 apartment, MWh/year</th>
<th>In total, MWh/year</th>
<th>Hot water Number of apartments, unit</th>
<th>Energy consumption for 1 apartment, MWh/year</th>
<th>In total, MWh/year</th>
<th>Total consumption, MWh/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gyumri, Krimyan Hayrik str. (5/1, 5/4)</td>
<td>Natural gas</td>
<td>173</td>
<td>5.202</td>
<td>900</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>900</td>
</tr>
<tr>
<td></td>
<td>Electricity</td>
<td>7</td>
<td>1.357</td>
<td>9.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>9.5</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>180</td>
<td>4.97</td>
<td>894.1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>909.5</td>
</tr>
<tr>
<td>Spitak, “Kentron-1” district</td>
<td>Natural gas</td>
<td>178</td>
<td>5.202</td>
<td>926</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>926</td>
</tr>
<tr>
<td></td>
<td>Electricity</td>
<td>7</td>
<td>1.357</td>
<td>9.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>9.5</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>185</td>
<td>4.97</td>
<td>920.1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>935.5</td>
</tr>
<tr>
<td>Kajaran, municipal centralized heat supply system</td>
<td>Natural gas</td>
<td>1557</td>
<td>5.202</td>
<td>8099.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>8099.5</td>
</tr>
<tr>
<td></td>
<td>Electricity</td>
<td>102</td>
<td>1.357</td>
<td>138.4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>138.4</td>
</tr>
<tr>
<td></td>
<td>Wood</td>
<td>504</td>
<td>3.28</td>
<td>1653.1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1653.1</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2163</td>
<td>4.57</td>
<td>9891.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>9891.0</td>
</tr>
<tr>
<td>Sevan, cogeneration system of micro-regions district</td>
<td>Natural gas</td>
<td>1711</td>
<td>5.202</td>
<td>8900.6</td>
<td>1642</td>
<td>1.61</td>
<td>2643.62</td>
<td>11544.2</td>
</tr>
<tr>
<td></td>
<td>Electricity</td>
<td>48</td>
<td>1.357</td>
<td>65.1</td>
<td>142</td>
<td>0.96</td>
<td>136.32</td>
<td>201.5</td>
</tr>
<tr>
<td></td>
<td>Wood</td>
<td>25</td>
<td>3.28</td>
<td>82.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>82.0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1784</td>
<td>5.07</td>
<td>9047.8</td>
<td>1784</td>
<td>1.56</td>
<td>2779.94</td>
<td>11827.7</td>
</tr>
<tr>
<td>Yerevan, Shengavit community “Eranyakuni” district, combined cycle gas turbine unit of Yerevan TPP</td>
<td>Natural gas</td>
<td>1921</td>
<td>5.202</td>
<td>9993.0</td>
<td>391</td>
<td>1.61</td>
<td>629.51</td>
<td>10622.6</td>
</tr>
<tr>
<td></td>
<td>Electricity</td>
<td>3279</td>
<td>1.357</td>
<td>4449.6</td>
<td>2409</td>
<td>0.96</td>
<td>2312.64</td>
<td>6762.2</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>5200</td>
<td>2.78</td>
<td>14442.6</td>
<td>2800</td>
<td>1.05</td>
<td>2942.15</td>
<td>17384.8</td>
</tr>
<tr>
<td>Yerevan, Erebuni community, combined cycle gas turbine unit of Yerevan TPP</td>
<td>Natural gas</td>
<td>978</td>
<td>5.202</td>
<td>5087.6</td>
<td>939</td>
<td>1.61</td>
<td>1511.79</td>
<td>6599.3</td>
</tr>
<tr>
<td></td>
<td>Electricity</td>
<td>1672</td>
<td>1.357</td>
<td>2268.9</td>
<td>1711</td>
<td>0.96</td>
<td>1642.56</td>
<td>3911.5</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2650</td>
<td>2.78</td>
<td>7356.5</td>
<td>2650</td>
<td>1.19</td>
<td>3154.35</td>
<td>10510.8</td>
</tr>
<tr>
<td>Yerevan, Avan community, cogeneration system</td>
<td>Natural gas</td>
<td>1470</td>
<td>5.202</td>
<td>7646.9</td>
<td>173</td>
<td>1.61</td>
<td>278.53</td>
<td>7925.5</td>
</tr>
<tr>
<td></td>
<td>Electricity</td>
<td>7176</td>
<td>1.357</td>
<td>9737.8</td>
<td>8473</td>
<td>0.96</td>
<td>8134.08</td>
<td>17871.9</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>8646</td>
<td>2.01</td>
<td>17384.8</td>
<td>8646</td>
<td>0.97</td>
<td>8412.61</td>
<td>25797.4</td>
</tr>
<tr>
<td>Yerevan, Davidashen community, cogeneration system</td>
<td>Electricity</td>
<td>7200</td>
<td>1.357</td>
<td>9770.4</td>
<td>7200</td>
<td>0.96</td>
<td>6912</td>
<td>16682.4</td>
</tr>
</tbody>
</table>
As a result of centralized heat supply implementation the greenhouse gas emissions estimations are brought in Annex 4, Tables 4.1-4.8. For the basic and designed alternatives of water heating boilers in centralized heat supply systems, the energy consumption is considered only for heating, and in CHP systems for heating and hot water supply.

Greenhouse gas emissions reductions in centralized heat supply systems with CHP are decided, considering, the generated emissions in Hrazdan TPP (as energy station, which “closes” the annual balance of RA energy system) detruded from electricity production equivalent to the electricity produced by co-generators.

The estimations are made on the equal levels of heat energy final consumption in the basic and designed alternatives.

Economically affordable potential assessment of energy savings and greenhouse gas emissions reduction is made for all the heat supply alternatives discussed above (tables of Annex 4). Besides that, the parameters received as a result of installing heating and hot water supply individual devices in multi-apartment area, as well as heat supply systems rehabilitation and centralized heat supply existing primary proposals implementation in public and trade areas. The results are summarized in Table 9.3.

Table 9.3 Summery data on energy savings and greenhouse gas emissions reduction

<table>
<thead>
<tr>
<th>N</th>
<th>System title</th>
<th>Fuel savings, MWh/year</th>
<th>Greenhouse gas emissions reduction, t.CO2e/year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Parameters of implemented proposals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Heating and hot water individual devices in multi-apartment area</td>
<td>179190*)</td>
<td>77580*)</td>
</tr>
<tr>
<td>2.</td>
<td>Heat supply systems in public and trade areas</td>
<td>61667*)</td>
<td>13184*)</td>
</tr>
<tr>
<td>3.</td>
<td>Existing centralized heat supply in primary proposals</td>
<td>494</td>
<td>84</td>
</tr>
<tr>
<td>4.</td>
<td>Gyumri, Krimyan Hayrik str. (5/1, 5/4), centralized heat supply system</td>
<td>370.6</td>
<td>41.9</td>
</tr>
<tr>
<td>5.</td>
<td>Spitak, “Kentron-1” district, centralized heat supply system</td>
<td>240.8</td>
<td>18.1</td>
</tr>
<tr>
<td></td>
<td>Parameters of planned proposals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Yerevan city, Avan community centralized heat supply system based on CHP</td>
<td>170649</td>
<td>34207</td>
</tr>
<tr>
<td>7.</td>
<td>Yerevan city, Davidashen community centralized heat supply system, based on CHP</td>
<td>165822</td>
<td>33708</td>
</tr>
<tr>
<td>8.</td>
<td>Yerevan city, Erebuni community “Erebuni” centralized heat supply system based on combined cycle gas turbine-energy unit of Yerevan TPP</td>
<td>105007</td>
<td>21026</td>
</tr>
<tr>
<td>9.</td>
<td>Yerevan city, Shengavit community “Eranyuni” district centralized heat supply system based on combined cycle gas turbine unit of Yerevan TPP</td>
<td>186839</td>
<td>37538</td>
</tr>
<tr>
<td>10.</td>
<td>Sevan city, micro-regions centralized heat supply system based on CHP</td>
<td>45818</td>
<td>8971</td>
</tr>
<tr>
<td>11.</td>
<td>Kajaran city centralized heat supply system</td>
<td>5666</td>
<td>3345</td>
</tr>
<tr>
<td></td>
<td>T O T A L</td>
<td>921763.4</td>
<td>229703</td>
</tr>
</tbody>
</table>

*) The data presented according to December, 2006.
9.2 Kyoto Protocol Clean Development Mechanism (CDM) Application Possibilities Assessment

For implementation and co-financing purposes in the framework of Kyoto Protocol Clean Development Mechanism (CDM) UNDP/GEF Project carried out “Avan” and “Davidashen” projects greenhouse gas emissions reduction potential assessment.

The assessment was financed by UNDP regional office and carried out by “Factor Consulting and Management” international consultancy organization. In the context of special methodologies lack related to centralized heat supply and by the offer of an international consultant the combination of two methodologies was used for the proposals. The mentioned methodologies are as follow:

- AMS IIB (supply side production efficiency growth), which can be used from the standpoint of electricity CHP;
- AMS IIIB (fossil for fuel switch), which is theoretically usable as transfer from electrical heating devices to centralized heat supply.

In case of proposals implementation, carbon dioxide reduction amount will make for “Avan” proposal app. 34,2 \(10^3\) t/year, which will result in app. 342.000 euro/per annum additional income, and in case of “Davidashen” proposal will make 33,7 \(10^3\) t/per annum and 337.000 euro/per annum correspondingly.

It is envisaged to prepare the signing of Mutual Understanding Memorandum between United Nations Development Project and the Republic of Armenia, which aims to establish non exclusive framework for greenhouse gas emissions reduction activities elaboration and implementation assistance cooperation between the parties in the framework of CDM project being carried out in the Receiving country. The draft memorandum was sent to the RA Ministry of Nature Protection in October, 2007, as Kyoto Protocol authorized ministry. At present, the proposal is still in the phase of reaching agreement.

10. ANALYSIS OF HEAT SUPPLY REHABILITATION PILOT PROJECTS

The study of the progress of pilot programs makes it possible to assess objectively the causes of their success or failure, review the circumstances and factors that are hindering the heat supply rehabilitation and work out legal, economic, financial, technical and technological measures for overcoming them. In chapter we consider the heat supply rehabilitation of the residential and public buildings, as those that have been started in the past, as those that are in progress currently.

10.1. Non-Operating Heat Supply Projects Implemented in Residential Buildings

A number of centralized heat supply projects have stopped to operate a little while after the start due to different reasons. In this section we give the prehistory of those projects and are analysed the causes of their failure.
10.1.1. The heat supply system rehabilitation program of the boiling house “Medic 2”

The program’s purpose has been to provide Yerevan city Surenyan street 1, 2, 3, 4, 11a, 11b residential buildings heat supply through refurbishing the existing boiling house.

The boiling house “Medic 2” that is on the books of the Yerevan municipality by the decision of Yerevan Mayor of September 15, 2004 has been rented out to “ArmRusGasProm” CJSC (for 10 years).

For the accomplishment of the Program “ArmRusGasProm” CJSC has in 2004 reconstructed the operating boiling house and the external heat supply network. The boiling house has been refurbished by modern highly efficient boilers, new pumps, plate type water heaters and other equipment. Part of the underground external HWT system has been reconstructed into the onground system. In the internal heating system of the building at Surenyan 4 were made partial reconstruction works, in the basement of the building was placed a heat meter and on the heating batteries were placed allocators.

In the course of the accomplishment of the Program “ArmRusGasProm” CJSC refused to do the reconstruction work of the Surenyan 11a and 11b buildings’ systems, as long as their risers and joints, as well as the heating devices (panel type) were installed inside the walls and it was not possible to do any reconstruction work there and to install allocators on the heating devices. The heat supply system was put into exploitation since December 20, 2004.

The investment cost for the Surenyan 4 building heat supply rehabilitation and “Medic 2” boiling house refurbishment program has been 62,507.5 USD, from which 53,011.0 dollars are loan means and 9,496.5 USD (4,510,844 AMD) or the 15% of the investments will be on the account of ArmRusGasProm” CJSC. The Program’s investments per unit residential surface and per unit installed capacity have been correspondingly 9.7 USD/m² and 33.1 USD/kWh. The parameters of the residential buildings that are supplied from “Medic-2” are presented in Table 10.1.

Table 10.1. The characteristics of the residential buildings supplied by the boiling house “Medic-2”

<table>
<thead>
<tr>
<th>NN</th>
<th>The address of the building</th>
<th>Number of floors</th>
<th>Number of apartments</th>
<th>The total surface of apartments, m²</th>
<th>The calculated heating capacity, kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Surenyan street 1</td>
<td>9</td>
<td>54</td>
<td>3300</td>
<td>270</td>
</tr>
<tr>
<td>2</td>
<td>Surenyan street 2</td>
<td>9</td>
<td>54</td>
<td>3400</td>
<td>270</td>
</tr>
<tr>
<td>3</td>
<td>Surenyan street 3</td>
<td>9</td>
<td>56</td>
<td>3400</td>
<td>275</td>
</tr>
<tr>
<td>4</td>
<td>Surenyan street 4</td>
<td>9</td>
<td>54</td>
<td>3396</td>
<td>270</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>218</td>
<td>13496</td>
<td></td>
<td>1085</td>
</tr>
</tbody>
</table>

From 218 apartments of 4 buildings connected to the system only 152 were heated or 70% of total number of apartments. Those apartments that were not connected to the Centralized heating system were heated by electric power, gas heaters and individual gas boilers.

In the course of the exploitation of the system it has become clear that there is illegal use of hot water from the heating system and it is impossible to calculate that the additional consumption of heat power because of the multifunction of the water meters installed in the cellars of the buildings.

The residents were distrustful in respect of the heat power calculating system, as long as it is determined by calculations made on the level of the buildings heat meter data and on the basis of the data of allocators, which were not seen as trustworthy by them.
Besides the technical malfunctions were not corrected in the heating internal system as well as the internal surfaces of the risers, admission joints, pipes and heating batteries were not cleaned.

In the course of exploitation it became clear that the volume of heat power consumed by the residents was in average for 30-40% less than the calculated capacity which results in higher actual tariff of the heat power.

At the moment of starting the space heating the tariff is determined as 14 AMD/KWh, which was considered to be the affordable/preferable as compared with other options of heating.

The system has operated in 2003/04, 2004/05 and 2005/06 heating seasons. After 2005/06 heating season the total debt of the population for the consumed space heating has been 1875.0 thous. drams, which has been 23% of the collectable bills.

In the next heating season because the residents refused to pay the space heating bills and rejected to sign the heat supply contracts with the suggested tariffs the operating organization has stopped the exploitation of the system.

The main reasons for the Program’s failure:
- The exploitation of the system by the company in the previous years was done with inadequate professional level,
- Because of the underload of the system and the wrong technical solutions the overdue losses have brought to the substantial increase of the actual tariffs and financial losses by the operating company.
- “Complexity” of the heat power calculation system,
- Low level of collection of payments for heating,
- The gasification of the buildings, that made possible for many apartments to organize the space heating through gas heaters or individual boilers.

10.1.2. The heat supply rehabilitation program of Avan Sayat Nova district buildings 7, 8, 8/1, 8/2

The purpose of the Program has been to rehabilitate the heat supply of the Avan community Sayat-Nova district buildings 7, 8, 8/1, 8/2 through reconstructing the DH system in the adjacent to the buildings territory into a boiling house.

By the decision of the Yerevan Mayor of September 10 of 2004 number 1740-A the DH system number 5/6 of Avan community which is on the books of the Yerevan municipality with the purpose of rehabilitating the heat supply has rented out it to “ArmRusGasProm” CJSC (for 10 years).

“ArmRusGasProm” CJSC has accomplished a partial reconstruction of the internal heating system of buildings 7, 8/1, 8/2 of Sayat-Nova district and has installed horizontal internal heating system of building number 8 and as well a heat energy metering system. Three modern and highly efficient water heating boilers were installed in the DH system together with their auxiliary equipment (heat exchangers, pumps, extension pipes, a unit for chemical processing and etc.). The external heat systems were rehabilitated.

The investment cost of the district’s 4 buildings’ heat supply rehabilitation program has amounted to 122,568.5 USD, from which 66,148.5 USD were invested on the account of loan means and 56,420.0 USD or 46% of the total on the account of cofinancing by “ArmRusGasProm” CJSC. The weighted investments into the system’s rehabilitation have correspondingly amounted to 20.9
dollars/m² and 129.0 USD/kWh per 1 m² total surface and 1 kWh installed capacity. The parameters of the residential buildings that are supplied by the system Table 10.2.

Table 10.2. The characteristics of the residential buildings supplied by the boiling house number 5/6 of Avan

<table>
<thead>
<tr>
<th>#</th>
<th>The address of the building</th>
<th>Number of floors</th>
<th>Number of apartments</th>
<th>The total surface of apartments, m²</th>
<th>The calculated heating capacity, kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sayat-Nova district 7</td>
<td>9</td>
<td>54</td>
<td>2709</td>
<td>252</td>
</tr>
<tr>
<td>2</td>
<td>Sayat-Nova district 8</td>
<td>9</td>
<td>36</td>
<td>2133</td>
<td>198</td>
</tr>
<tr>
<td>3</td>
<td>Sayat-Nova district 8/1</td>
<td>9</td>
<td>36</td>
<td>2133</td>
<td>198</td>
</tr>
<tr>
<td>4</td>
<td>Sayat-Nova district 8/2</td>
<td>9</td>
<td>36</td>
<td>2133</td>
<td>198</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>162</td>
<td>9108</td>
<td>846</td>
</tr>
</tbody>
</table>

The heat supply system was put into exploitation on January 20, 2005.

The inside apartment horizontal system of building 8 of the district makes possible to calculate and regulate the amount of heat power that enters into each apartment. From 162 apartments of the only 123 were heated or 76% of total surface. Those apartments that have not been connected to the centralized heating system were heated by electric power, gas heaters and individual gas boilers.

For heating season the tariff has been determined as 14 AMD/kWh which was considered to be the affordable/preferable as compared with other options of heating.

The space heat calculation in the apartments of building number 7, 8/1 and 8/2 has been done by the meters installed on the heating batteries, in building 8 in accordance with individual heat meters. The heat meters installed on the heating batteries have not satisfied the customers, were commented as “complicated” in calculating principle. The customer is dissatisfied as well because of the underconsumption and other losses that are not taken into account in the tariffs.

The main reasons for undersupply were:

- in some buildings the heating systems contained certain pollution,
- the exploiters were not consistent in regulating the boiling house operation mode,
- the regulation of the heat power by the customers is conditioned by their solvency.

In the result of the impact of these factors the actual consumption as compared to the stipulated norm has amounted up to 26%.

In 2004/05 heating season the consumer heat power in total has amounted by March 15 to 3,839,201 AMD, the debts: 3,539,724 AMD. The payments have been 8%.

After 2006/07 heating season the total debt of the population has been 3,860 thous. AMD. The rate of efficiency of the system has been 65 %.

For 2007/08 heating season the operating organization has suggested heating tariff as 18 AMD/kWh, which has been rejected by the population (only 20% of residents have agreed to sign contracts) and the organization has stopped the exploitation of the system.

*The causes of the Program’s failure:*

- The exploitation of the system by the company in the previous years was done with inadequate professional level,
Because of the underload of the system and the wrong technical solutions the overdue losses have brought to the substantial increase of the actual tariffs and financial losses by the operating company,

- “Complexity” of the heat power calculation system,
- Low level of collection of payments for heating,
- The gasification of the buildings that made possible for many apartments to organize the space heating through gas heaters or individual boilers.

10.1.3. “Jrashat 92” heating system rehabilitation pilot program

By the sponsorship of the Government of Netherkands the Dutch “Ecofis” and local “Ar&Ar Engineering” companies have jointly accomplished in 2002 the boiling house Jrashat 92 and supplies by it 4 buildings’ heating system rehabilitation pilot program. With that purpose were created the “Eco Engineering” LLC and the §Jrashat¦ condominium, in which are involved the buildings 92 and 92/1 on Jrashat street, teh characteristics of which are presented in Table 10.3.

In the former boiling house were installed 3 modern boilers and auxiliary equipment with total capacity of 800 kWh, were reconstructed the external and internal heat networks (in apartments partially), were installed heat meters, in apartments: allocators and regulating valves.

Table 10.3. Characteristics of buildings supplied by Jrashat 92 boiling house

<table>
<thead>
<tr>
<th>#</th>
<th>The address of the building</th>
<th>Number of apartments</th>
<th>The total surface of apartments, m²</th>
<th>The calculated heating capacity, GCal/hour (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Jrashat 92</td>
<td>40</td>
<td>2866</td>
<td>0.157 (183)</td>
</tr>
<tr>
<td>2.</td>
<td>Jrashat 92/1</td>
<td>12</td>
<td>947</td>
<td>0.078 (91)</td>
</tr>
<tr>
<td>3.</td>
<td>Baghramyan 1/1</td>
<td>38</td>
<td>4175</td>
<td>0.198 (230)</td>
</tr>
<tr>
<td>4.</td>
<td>Antarayin 190</td>
<td>24</td>
<td>2683</td>
<td>0.153 (178)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>114</td>
<td>10671</td>
<td>0.587 (682)</td>
</tr>
</tbody>
</table>

The construction installation works of the system were finished in 2003 February. Heat was supplied to Jrashat 92 and 92/1 (for 1 month) buildings free of charge, without corresponding contractual arrangements.

The results of the next 2003/04 heating season are as follows:

- Two more buildings were connected to the system at Baghramyan 1/1 and Antarayin 190 and were supplied with heat for 1 to 3 moths,
- Were supplied with heat 100 apartments or about 87.7% of the total surface on “Heat supply company - condominium – residents” contractual relations.
- The tariff for space heating was determined as 13.5 AMD/kWh for the consumer (condominium) and 14.5 AMD/kWh for subscribers (residents),
- The amount of the consumed heat energy has actually made 203.6 MWh, or the 30% of the calculated heat demand, which is conditioned by the regulation of the heat power by the residents, the technical shortcomings of the internal heating system, as well as the shortened heating period,
- The payments fro heating were calculated by the condominium (with the help of the supplier)ª on the basis of the data of the meters and the allocators. The actual collection has been 98%.
In 2004/05 heating season taking into account the indicators of the previous season action consumption, the supplying company has refused to operate the boiling house because of the financial losses and has suggested accomplishing the heating with the following scheme.

On the basis of the Heat supply company - condominium – residents contract the condominium is taking obligation to pay the compensation of the operating fixed costs in the amount of 900 thous. AMD/month and variable costs for the consumed gas, electric power and water in accordance with the meters. The indicators of the heat power meters are not taken into account, the money to be paid is distributed in accordance with the data of the apartment allocators.

The condominium has failed to meet the contractual obligations and the gas supply has been terminated. The heating has been supplied only for 45 days, in the course of which the accumulated debts have amounted to 450 thous. AMD of fixed and 270 thous. AMD of variable costs (for the consumed gas).

Before the 2005/06 heating season in response to the application of the “Jrashat” condominium the experts of the USAID/GEF Program have studied and analyzed the results of the previous heating seasons with the purpose of reconstructing the system in the coming heating season. In this connection on October 14, 2005 the Department of Construction, Amelioration and Utilities of the Yerevan municipality in the result of the discussion with the participation of the Program’s specialists and stakeholders were pre-calculated the main approaches for the regulation of the “heat provider-consumer” relations.

The results of the accomplished actions:

1. By the preliminary calculations for 2005/06 season the heating tariff has been 17 AMD/kWh for the duration of 90 days heating and 300 MWh heat power consumption.
2. Taking into account the results of the previous heating seasons the residents have suggested for the 2005/06 heating season the following conditions:
   - To operate the boiling house by “Eco Engineering” LLC on contractual basis between the condominium and the residents,
   - The condominium and the residents must pay the debts accumulated for the previous heating season and must make advance payments for the given heating season gas.
Only 58% of the owners of apartments have agreed to buy heating services on these conditions.
3. In the result of the further discussions with the Ar&Ar Engineering LLC 67% of the owners of apartments have agreed to buy heating by the recalculated 14.6 AMD/kWh tariff. In such conditions the heating tariff grows up to 16 dram/kWh. The condition on prepayment made by the operator was fulfilled only partially and the sum that was collected by December 12 was about 1.2 mln. AMD, which was only 66% of the demanded money.

In the result, in 2005/06 heating season the work on the recommencement of the system operation were stopped.

The reasons for the Program’s failure:

1. The built system was expensive, that was never operated by its project parameters, which brings the increase in amortization (depreciation), which means raise in tariff.
2. In case of availability of the meters there has been not correct distribution of the heat power by apartments, which is connected as well with not operating of a certain number of allocators.

3. The exploitation of the system by the company in the previous years was done with inadequate professional level.

4. The inconsistency of the condominium that has shown inability to make collective decisions.

5. The lack of motivation in operating the boiling house by the leaser and operator §Ar&Ar¦ LLC.

6. Gasification of the buildings, that gave chance to accomplish the heating of certain apartments by gas heaters or inside apartment boilers.

10.2. Functioning and Ongoing Energy Supply Projects for Residential Buildings

In this part we present information about the heat supply rehabilitation projects that are currently in the process of accomplishment. Some parts of the projects exhibit an evident growth of trust of the residents in respect of the DH systems, in some other parts on the contrary there are trends of diminishing trust.

10.2.1. Heat Supply System for A. Avetisyan 70/1, 70/2 Buildings

The boiler house 70 which is on the books of the Yerevan municipality and is situated on Avetisyan street of the Arabkir community by the decree of the Yerevan mayor of 22.12.04 number 2423-A has been given for rent for 10 years to the “YERFREZ” OJSC with the purpose of the heat supply rehabilitation.

The works on the reconstruction of the boiler house, the construction and installation of the external and internal heating networks were started by the company in October 2003 and were finished in January 2004. Within the pilot project period of 2003-2004 the investment have made 51,712.6 USD, from which the 38,812.6 dollars were loan money and the 12,900 dollars were the cofinancing by the “YERFREZ” OJSC. In the course of the 2004/05. heating season the actual investment amounted to 28,450 US dollars, from which 5,521 dollars were loan means and the 22,929 dollars were the cofinancing by the “YERFREZ” OJSC.

The stable heat supply of the A. Avetisyan 70/1 and 70/2 buildings started from December 1, 2004 by the capacity of the available boiler house. The main characteristics of the system are stated in Table 10.4.

Table 10.4. Avetisyan 70 system’s main characteristics

<table>
<thead>
<tr>
<th>The installed capacity of the heat source, kW</th>
<th>The number of supplied buildings</th>
<th>Supplied apartments</th>
<th>Availability of measuring equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>Per one boiler house</td>
<td></td>
<td></td>
</tr>
<tr>
<td>590</td>
<td>290; 300</td>
<td>2</td>
<td>128</td>
</tr>
</tbody>
</table>

“Armenia - Improving the Energy Efficiency of Municipal Heating and Hot Water Supply” UNDP/GEF/00035799
It is necessary to mention that in 2003/04 heating season within the pilot program that was accomplished in the 70/2 building allocators were installed on the heating devices in the apartments, however in the 2004/05 season those meters have not worked. For heating in A.Avetisyan 70/1 and 70/2 buildings the vills were collected in accordance with the number of rooms: one room apartment – 15,000 AMD, two room apartments – 20,000 AMD, three room apartments - 25,000 AMD.

Within the 2007/08 heating season, which started on 15.11.07 and finished on 15.03.08, 128 apartments of two buildings were heated either for 89 or around 70%. The total surfaces of heated apartments made 5,816 m²: As compared with the previous year the heating volumes remain the same. The collectible money made 8 mln. AMD, which by the end of the heating season was actually collected by 100%.

“YERFREZ” OJSC planned the micro-gas-turbine (MGT) cogeneration system (electric and gas combined heat production) in A.Avetisyan St. buildings 70/1, 70/2. It is supposed to put into exploitation the A.Avetisyan 70 boiler house with around 167 kWh thermal capacity MGT, which on the basis of production of thermal energy will as well produce and provide to the city electric power network electric power. The MGT with the thermal energy production contour will be joined to the already in exploitation the boiler house countour accomplished by the previous program. The investment within the mentioned above program amounted to 245,593 USD, from which the $ 195,846 US are loan means and the 49,747 USD are “YERFREZ” OJSC cofinancing means.

Within the framework of the previous pilot program with 590 kW installed boiler and this program the stipulated around 167 kW cogeneration gross 757 kW (thermal) capacity is to provide the heat demand of the mentioned above buildings, as well as the HTW supply of these buildings. Currently the company is negotiating with the PSRC of the RA around the tariffs of electricity provided to the grid from the combined cycle power generations (CHP).

Within the 2008-2009 heating season it is stipulated to connect to the system one residential building on V.Hambartsumyan street. Concurrently the “YERFREZ” OJSC has signed a cooperation agreement with the UNDP Office (15.01.2008) on accomplishing the hot water generating pilot program through water heaters in Avetisyan 70/1 and 70/2 buildings.

The Key of Sucess Program
- the consistent work of the developer in respect of the realizaiton of the program.
- the relatively affordable price of the services,
- the operative organization of direct work with the residents.

10.2.2. Khanjyan 43 heat supply system

On the basis of the boiler house situated in the territory of the former HW system at the address of 43 Khanjyan str., the construction of the DH system was accomplished in 4 stages.

In 2002-2003 with the financing of the USAID “South Term” CJSC and Advanced Engineering Associates International (AEAI) companies have jointly accomplished the "Apartment heating Sayat Nova 33" pilot project, the purpose of which was the reconstruction of the 33 Sayat Nova str. building heating system through a private company: in conditions of commercialization of the supplier-consumer relations. The number of apartments was 100, the residential surface: 4.35 thous.m², number of floors: 7.
The following works were made within the pilot program:

- The reconstruction of the former centralized hot water supply system of the boiler house, where there were installed 500 kW capacity “Taurus” model Italian and 700 kW capacity “ATA” model locally manufactured 2 water heating boilers with all auxiliary equipment,
- The construction of the external heating network (with total length of 90m) and the reconstruction of the internal heating network,
- The installation of the heat power supersonic meters in the boiler house and at the points of system separation (3),
- Partial change of the batteries (around 30%),
- Installation of valves that are regulating the heat consumption,
- Installation of allocators on the heating batteries (260 units).

For the accomplishment of the Program were used 79.6 $10^3$ USD, from which 65 $10^3$ USD were the grant money provided by the USAID, and 14.6 $10^3$ USD the investment of the own means of the "South Term“ CJSC.

In the first heating season of 2003/04 only the 80 apartments of 100 at Sayat Nova 33 building were connected.

In 2003/04 heating season the heat supply system operation monitoring was accomplished by the NGO §National Association of Condominium Owners¦ through the thermal power supersonic meters installed in the boiler houses, the manometers, the gas meters and the service quality was monitored through the allocators installed in the apartment and thermometers, as well as through surveys made among the consumers.

In the result of the monitoring was revealed that:

1. In the course of the first dayse of operating the heating system because of numerous deficiencies a considerable number of apartments were heated insufficiently, the majority of these deficiencies were eliminated.
2. Within the period of heating the apartments have sustained the average normative standard level of temperature
3. Some disagreements and debatable issues were found in the mutual relations of the Heatsupplying organization and the “ArmRusgasard“ CJSC:
   - Because of the low level of heating bill collection in the course of the heating period, the bills for the used gas have been overdrafted, in the result of which there have been precautionary gas supply cuts (2 days);
   - Because of the absence of the gas pressure and the temperature mesureing device (corrector) there were certain difficulties in determining the amount of the actually consumed natural gas.
4. In the the course of the heating period the illegal hot water use from the system has been the 0.6% of the total consumption.
5. The efficiency of the boiler house operation has been evaluated as 90.5%.
6. The losses in the external heat networks were estimated to 6.6%, which is close to the normative value.
7. The thermal energy distribution by apartments was done unequally, which is connected with the internal deficiencies of the heating system. (air removing devides, valves of hydraulic balancing), blocking of rises and batteries.
8. The actual tarif of heating has been 15 AMD/kWh or 1700 AMD/m2 (for 90 day heating).
The program accomplished by the consumers has been evaluated by 9-10 units. In general the consumers are satisfied with the level of comfort, around 10% think that the tariffs are higher than the affordable level, around 15% of the apartments were not provided with normal temperature.

In this second phase of the Program by the cooperation between the Ministry of Economy and Finance of the RA “Heat Supply Program” PIO and “South Term” CJSC in 2004 was accomplished the reconstruction of the Sayat Nova 29 and 31 buildings heat supply and refurbishment of the operating boiler house program, with which it is stipulated to connect these two multi storey buildings (the total number of apartments 36, the surface 5320 m²) to the Khanjyan 43 boiler house.

The burner of one of the boilers and the circulation pumps were substituted, total 140 m long over ground thermal networks were built, the internal networks of the newly connected buildings were reconstructed, the supersonic heat meters were installed. The investment value of the phase was equal to 23,340 USD, from which 13,070 USD was the PIO loan means and the 10.270 USD on the account of the "South Term“ CJSC co-financing.

In the 2004/05 heating season 100 from the 136 apartments that were connected to the system have supplied with heat, which is around 74%.

The monitoring of the 2004/05 heating period was accomplished by the §Heat supply programs¦ PIO. The evaluation of the technical indicators was done in accordance with the meters installed in the boiler house for gas, thermal energy and water subsystem measurements, the evaluation of the quality of the heating service was done through surveys among the consumers.

In the result of the monitoring it has been discovered that in the course of the heating season the average rate of efficiency has been around 90%, the thermal losses in the external network have been 3%, the power losses stipulated with the flow losses have been 0,4%, etc.

The actual tariff of heat power has been 16.3 AMD/kWh. The level of the inside apartment comfort according to the residents has been in compliance with the normative.

In the third stage 2005, with USAID financing, the Advanced Engineering Associates company has accomplished one more program in the direction of the expansion of the same system, the purpose of which has been to join to the Khanjyan 43 boiler house 4 more many apartment buildings, at Khanjyan 43, 45, 47 and 47/1. The total number of apartments has been 53, the residential surface 5750 m², number of floors in average 3-5.

In this stage were built on ground thermal grids with total length of 358m, were reconstructed the internal heating horizontal networks of the buildings and was placed natural gas precise electronic meter. The Program was accomplished with the 38% participation of the residents, 12% participation of the “South Term” CJSC and USAID 50% (grant).

In 2005/06 heating season from 189 apartments of the 7 many apartment buildings connected to the Khanjyan 43 DH system, 129 apartments have received heating, that is to say around 68 % of the total.

The monitoring accomplished by NGO §National Association of Condominium Owners¦ since February 1 till March 15, 2006 has shown that:

1. in the course of the 110-day heating season the 0,9% of thermal power generated in the boiler house is connected with the illegal use of the hot water.
2. The efficiency coefficient of the boiler has been 88.3%. The losses in the external net: 6.46%. The total efficiency of the system: 82%.

3. Within the heating season in the apartments of 31% of owners the average temperature of air has been sustained up to 25°C, in 46% of apartments it has been 20°C, and in 23% of apartments: 16-18°C. In different rooms of the same apartment has been provided equal distribution of heat.

4. By the contract signed between the consumers and the heat supplying organization the tariff of the thermal energy has been determined as: heating battery section/hour: 1.33 dram. The average actual tariff has amounted to 11.3 dram/kWh, or by the recalculated residential surface: 1547 dram/m².

5. The level of the heat bill collection as of 20.04.06. has been 92.4%.

After the 2005/06 heating season a survey was made among the consumers in the result of which the heat supply quality was assessed by 8.9 points, including the 20% of questioned residents that have assessed the work of the system relatively low by 7 points, and the 30% has given the highest 10 points. After the heating season 11 apartments that were connected with the heating system were disconnected, from which 7 apartments because the residents were not in the city and 4 apartments because of the installation of double contour gas systems.

In the course of the next 2006/07 heating season from the 189 apartments that were connected with the system 115-day heating were received by 118 apartments or the 62%. The level of bill collection has been 98%. After that heating season another 38 apartments were disconnected form the system, from which 18 because the owners were out of the city and 20 apartments because of the installation of double contour gas systems.

“South Term” CJSC in order to preserve the attractiveness of the DH system has planned to provide the Sayat Nova 33 building with Centralized hot water supply, for the accomplishment of which with the anticipation of support they have applied to the USAID/GEF Program.

Taking into account that the objectives of the Program are to expand the use of ecologically clean and power efficient alternative technologies, on the basis of the results of the performed studies it is expedient to find a cofinancing option for the accomplishment of the Khanjyan 43 boiler house refurbishment with DH system with solar water heaters. With that purpose on June 19 of 2007 the USAID §South Term¦ CJSC and the Ministry of Ecology of the RA have signed a cooperation memorandum, with which they have defined the frameworks of the obligations of the participating parties in the course of the accomplishment of the project.

With this fourth phase it is stipulated to generate hot water with the gas boilers available in the boiler house and the solar heaters. The investment cost of the project has been 46.5 thous. USD, from which the 16.5 (35%) is the share of the “South Term” CJSC, and 30.0 (65%) is the Program’s participation (grant money). The Program has fully accomplished the obligations taken on December 15, 2007, however the system does not operate because of the prolongations of the construction of the external and inside building network of the Sayat Nova 33 building by the “South Term” CJSC.

Within the 2007/08 heating season from among 7 buildings that are connected to the heating system only 80 apartments have received heating or the 42% of the apartments: The level of bill collection has been 97%.

10.2.3. Kochar 22 heat supply system
2006 “Jerm MAS” LLC and USAID jointly undertook Kochar 20, Sundukyan 19, 21, 23 buildings central heating rehabilitation program accomplishment. The main characteristics of these many apartment buildings are given in Table 10.5.

Table 10.5. The characteristics of Kochar 22 buildings connected to the system

<table>
<thead>
<tr>
<th>The address of the building</th>
<th>Construction year</th>
<th>Number of floors</th>
<th>Apartments surface, m²</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total</td>
<td>Residential</td>
</tr>
<tr>
<td>Kochar 20</td>
<td>1968</td>
<td>5</td>
<td>40</td>
<td>2520</td>
</tr>
<tr>
<td>Sundukyan 19</td>
<td>1970</td>
<td>5</td>
<td>40</td>
<td>2520</td>
</tr>
<tr>
<td>Sundukyan 21</td>
<td>1970</td>
<td>5</td>
<td>40</td>
<td>2520</td>
</tr>
<tr>
<td>Sundukyan 23</td>
<td>1978</td>
<td>12</td>
<td>96</td>
<td>6050</td>
</tr>
</tbody>
</table>

The following works were done within the framework of the Program:
- The building of the boiler house at Kochar 22 was reconstructed, and there were installed 2 “Faquel” type water heating boilers with their auxiliary devices,
- An on ground external thermal supply network was built with a total length of 260m,
- An average pressure natural gas pipe has been built to feed the boiler house and a gas regulation point has been installed,
- The water supplying pipe and electric power supplying cables were built,
- The internal heating networks were built for all four buildings by horizontal installation, in three buildings entry nets were install thermal energy super sonic meters.

The Program’s investment cost has been 180 thous. dollars, from which 130 thous. dollars were invested by USAID as grant means and 50 thous. Dollars were invested by the §Jerm MAS¦ LLC.

Within the 2006/07 heating season (01.12.06-28.02.07) 105 apartments connected to the system were receiving heating.

By the contracts signed between the heat suppliers and consumers the collection bills were calculated in accordance with the number of heated apartments. The collection of the bills have been 90%, and the rest 10% were the bills of socially vulnerable families, that the §Jerm MAS¦ LLC has not collected for benevolence purposes.

Within the 2007/08 heating season, the duration of which has been 106 days, (01.12.07-15.03.08) the number of the heated apartments has decreased down to 102, or the 47% of the connected apartments. As compared to the previous season the decrease of the number of consumers was explained by the absence from the city of 3 apartment owners.

The contract between the consumers nad heat supplying companies were signed with the terms of the previous heating season. As of 01.04.08 the bill collection has been 93%. The rest 7% are the payments of the socially vulnerable families, that the §Jerm MAS¦ LLC has not collected for benevolence purposes.

10.2.4. The Central heat supply system of building at Yerevan Street 157a in Gyumry city

The Gyumry Yerevan street 157a building was built in 1968 and after the earthquake of 1988 was evaluated as building in emergency condition. By the efforts of the Urban Institute in 1998 it was reinforced, and in 2002 by the initiative of the Jinishyan Memorial foundation and the Ministry of
civil construction of the RA was initiated the program on the creation of management bodies, formation and support program of many apartment buildings.

Program implementation
The Jinishyan Memorial foundation has accomplished at the Yerevan street 157a building a series of works including the creation of the condominum, construction for the boiler house and reconstruction of the buildings’ heating systems, installation of measuring and regulating device necessary for providing normal operation of the DH system.

The Ministry of the RA in its turn has accomplished the work on the gasification of the boiler house, as well as provided support of the corresponding links of the Government of the RA and the coordination of the program jointly with the Foundation, as well as harmonization of the criteria.

Structure of the heating system
The heating system at Yerevan Street 157a consists of a boiler house placed in the roof and the building internal network with the horizontal distribution of heating. In the boiler house there are 2 75 KWh water heating boilers (Iranian production, type SB-70). The total surface of 48 apartments amounts to 2,78 thous. m², the residential surface is 1,59 thous. m².

The system has started to operate since 2004 January and supplied heating to all 48 apartments of the building. The exploitation has been accomplished by the condominium §Yerevan Street 157a\$.

It is necessary to indicate that building has specifically hire shares of socially vulnerable families (42%), which is even more highlighting the necessity of a relatively low price heat supply option. It is important as well, that the boiler house is being operated by the condominum, without the involvement of private means, which makes possible to subtract the profit share from the tariff and lessen the heat power tariff.

The horizontal installation of the heating system makes possible to install apartment thermal power meters, which are recording the amount of thermal power consumed by each of the apartments, however because of the lack of means there were not installed thermal regulating valves on the heating batteries, that has not made possible to regulate the consumption of thermal power.

In the course of 2004 the bills were collected on the ground of the operation data and the data collected from the individual thermal cost records, without implementing the corresponding coefficient. Because of that the cost of the thermal power of located in good conditions (in average) apartments has been considerably lower than of those located in worse conditions (apartments located in the sides of the building and in the 5th floor), which has given ground for the complaint of the apartment owners and their refusal from heating apartments.

In the course of 2005 because part of the individual thermal power meters were broken, as well as to provide equal conditions, the owners of apartments and the condominum have jointly decided to collect the heating bills basing on the actual operation costs and the total heated residential surface.

Because of the above mentioned shortcomings, as well as because of the migration of the residents in the 2006/07 heating season the number of heated 48 apartments has diminished to 32 (66.7% of the total), and the total heated surface has decreased from 2780 m² to 1830 m².

Tha monitoring done by the USAID/GEF Program in 2006/07 heating season in the system anbd in the result of hte survey it has been found that:
1. No heat supply agreement was signe between the condominium and the residents. The reasoning was that the heating was supplied by the condominium, all residents know well and trust each other and the chairman of the condominium.

2. For the consumers the actual bill for 120 days of heating has been 8.5 AMD/kWh, or by the recalculated residential surface: 1120 AMD/m².

3. In the course of the heating season 33% of owners’ apartments the average temperature of air was sustained up to 20°C and more, in 13% of apartments it has been 19°C, in 40% of apartments: 18°C and in 13% of apartments: 17°C. All owners have assessed the conditions of comfortability as good.

4. By the 10 point scale of assessment the 79% of consumers have assessed the heating of their apartments with 10 points, the 21%: with 9 points. While assessing they have taken into account the quality of the provided services, the maintenance, the relations with the heat supplier.

In the course of the 2006/07 heating season the bills for heating have been $1712,8 \times 10^3$ AMD, which has been collected completely.

The 2007/08 heating season the system operated since November 10 2007, till April 1, 2008, providing the normative 140 day heating. From among the 48 apartments the heating has been supplied in 30, that is to say in 62.5% of the total. In the course of the heating season the tariff of the thermal power has been 7.93 AMD/kWh, and the payments have amounted to $1970,0 \times 10^3$ AMDs, which has been collected completely.

10.2.5. Aparan city Baghramian street number 12, 14 and 46 residential buildings boiler houses exploitation and monitoring program

The central heating of the Aparan city 26 many apartment buildings, schools and buildings of other purposes till 1992 was done by 9.0 Gkal/h capacity 1 boiler house. In the course of 1992-2002 there was no central heating in the Aparan city.

By the initiative of the Aparan municipality and the support of the Government of the RA, taking into account the severe natural climatic conditions of the city it was decided to build in 2003 and put into exploitation heat supply systems, that would provide the city’s Baghramyan street 10 many apartment buildings’ central heating. For the accomplishment of the works the required financing was provided by the all Armenian foundation §Hayastan¦.

In 2003 were built and put into exploitation 5 systems, that provided the central heating for 6 many apartment buildings The main indicators of these systems are presented in table 10.6.

### Table 10.6. 2003 list of the systems put into exploitation

<table>
<thead>
<tr>
<th>The address of the system</th>
<th>The addresses of the supplied buildings</th>
<th>The number of apartments</th>
<th>Total surface, m²</th>
<th>The installed capacity of the boiler house, kW</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>total</td>
<td>heated</td>
<td></td>
</tr>
<tr>
<td>Baghramyan 6</td>
<td>Baghramyan 6</td>
<td>40</td>
<td>30</td>
<td>2650</td>
</tr>
<tr>
<td>Baghramyan 6</td>
<td>Baghramyan 8</td>
<td>16</td>
<td>7</td>
<td>1050</td>
</tr>
<tr>
<td>Baghramyan 10</td>
<td>Baghramyan 10</td>
<td>40</td>
<td>30</td>
<td>2650</td>
</tr>
<tr>
<td>Baghramyan 19</td>
<td>Baghramyan 19</td>
<td>50</td>
<td>48</td>
<td>3300</td>
</tr>
<tr>
<td>Baghramyan 23</td>
<td>Baghramyan 23</td>
<td>16</td>
<td>13</td>
<td>1050</td>
</tr>
<tr>
<td>Baghramyan 25</td>
<td>Baghramyan 25</td>
<td>40</td>
<td>32</td>
<td>2650</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>202</strong></td>
<td><strong>160</strong></td>
<td><strong>13350</strong></td>
</tr>
</tbody>
</table>
The exploitation of the operating systems is accomplished through condominiums. The boiler houses accomplish the obligations of the service operators to the building’s residents on public grounds. The payments for the central heating are calculated on the basis of the actual exploitation costs (for gas, electric power, water) and on the basis of data about the total residential surface of the apartments. Since 2003 were built as well the other 3 systems’ boiler houses, however because of the absence of means the system exploitation works have not been accomplished.

By the request of the Baghramyan street many apartment buildings number 12, 14, 46 the mayor of Aparan has decided to put into exploitation in 2007 as well the heating systems of the above mentioned buildings and provide the central heating of 95 apartments (Table 10.7).

Taking into account the limitations in resources faced by the municipality in accomplishing these works, the Aparan municipality applied in 2007 to USAID/GEF Program with request to support the accomplishment of these works.

Table 10.7. The characteristic of the systems to be put into exploitation in Aparan city

<table>
<thead>
<tr>
<th>NN</th>
<th>The address of the system</th>
<th>The number of supplied buildings</th>
<th>The number of supplied apartments</th>
<th>The installed capacity of the boiler house, kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Baghramyan 12</td>
<td>1</td>
<td>30</td>
<td>300</td>
</tr>
<tr>
<td>2.</td>
<td>Baghramyan 14</td>
<td>1</td>
<td>30</td>
<td>300</td>
</tr>
<tr>
<td>3.</td>
<td>Baghramyan 46</td>
<td>2</td>
<td>35</td>
<td>600 (2x30)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>4</td>
<td>95</td>
<td>1200</td>
</tr>
</tbody>
</table>

The Program’s experts have studied the technical conditions of the boiler houses and the heating internal systems of the buildings indicated in Table 10.7. In the result the municipality and the USAID/GEF Program have signed an agreement in November 2007 on cooperation, according to which the Program has taken obligation to support these 3 systems providing 3 gas meters. According to the agreement it is stipulated that as well in the heating season of 2007/08 there will be monitoring of the system.

*The works required for the system operation and raising the electric power efficiency of the system.*

The reconstruction of as the operating, as the three reconstructing systems the exploitation will be accomplished by condominiums (“Noy”, “Amar”, “Garin”):

*The financing and tariffs*

The financing of the works will be provided by the Aparan municipality. It is assumed to have as well the direct participation of the population in some of the assumed works. The heating tariffs will be determined for each system separately, basing on the actual exploitation costs and the total surface of the apartments to be supplied.

*Current situation*

Because of the prolongations by the municipality in putting the program into exploitation in 2007 were accomplished only Baghramyan number 14 building’s heating internal network partial reconstruction works. Gas meters were installed in the boiler houses of buildings number 12 and 14. In the middle of November 2007, because of the drastic decrease of the outside temperature, the municipality made decision to terminate the works on eliminating the deficiencies in the inside building systems and to restart them only after the 2007/08 heating season.

10.2.6. Arabkir 51/9 heat supply system
The boiler house at Arabkir 51/9 was operated in 1986-1991 by the “Jermayin Tntesuyun” CJSC of the Yerevan municipality. In 1992 because of the gas supply termination and energy crisis the boiler house did not operate.

In 2001 in the result of the construction of new gas supply network and certain reconstruction works the boiler house was again put into exploitation and one more building was connected to the system, namely Arabkir 51/3. The total number of apartments of the two many apartment buildings was 248, the total surface: 16,2 thous.m², the residential surface was 8,98 thous.m², the number of floors was 16, the structure was carcass-panel type.

By the decision of Yerevan municipality of December 28, 2004 number 2462-A, in accordance with the program for supplying, the Arabkir 51/9 boiler house was rented to the condominium §Arabkir 51/3¦. By the business program it is assumed to reconstruct and modernize the operating boiler house, installing there boilers with high efficiency, pumps, equipment for measuring heat power, reconstruct the external thermal network, etc. Till today the mentioned program of reconstruction has not been accomplished, however the system has operated with former installations.

There are 4 600 kWh capacity §Energia-3¦ water boilers made in Russian Federation installed in the boiler house and corresponding auxiliary equipment. The gas supply is provided through adjacent regulating station which is furnished with gas rotation meter. The external heat network with total length of 100m is underground.

In accordance with the application of the condominium §Arabkir 51/3¦ the USAID/GEF Program has organised in 2005/06 heating season and accomplished the study of that system (monitoring and survey of residents), the purpose of whish has been to analyse and assess the system’s exploitation, cost-recovery and efficiency indicators, as well as the quality of provided services.

The results of the heating system monitoring in 2005/06 heating season:

1. From 248 apartments connected to the system within 80-day heating season were heated 195 apartments or 79% percent of the total surface and 60m² surface of other purposes (from the point of view of heated surfaces it has been 86%),
2. In the course of the heating season the air temperature in the apartments of the owners was sustained about 20-22ûC.
3. No agreement was signed between the condominium and the residents. The residents in accordance with the list have given their consent to receive heating.
4. The tariff of the heating was defined at the general assembly of the apartment owners for 1 m² residential surface to be heated in the course of 90 days as 1750 AMD, or recalculated for a heating season with the duration of 80 days - 1555,6 AMD.
5. The bills calculated for the provided service amounted to 11724.2 103 AMD, from which as of 01.05.06 has been collected 11419.4 103 AMDs (97.4%).
6. The efficiency of the boilers have been 60.0%, and the losses in the external network have been 8.0%.
7. 10% of residents has assessed the supplied service as Excellent, the 25% as satisfactory.

The complaints concern the following circumstances:
- Within the heating period in around 10% of the apartments there have been accident prone connected with breakages in the batteries, and the 52% were noticed to have different internal technical deficiencies (leakages, pluggings), that have been eliminated by the apartment owners,
• In unfavourable conditions (the floor, the situation in the building) the temperature of the apartments has been for 1-2°C lower, because of the insufficient sections of the batteries, but not less normative than 18°C.

In the 2006/07 heating season as compared with the previous one there have been no essential changes. Heating services have reached 195 apartments in the course of 88 days. Some of the apartment owners because of the difficulties of paying the bills by the consent of the operator have switched off some sections of the heating batteries in their apartments.

The duration of the 2007/08 heating season was 97 days, the tariff of the 1 m² residential space heating has been 1750 AMD/m², and the collectible bills have been 11077.5 10³ AMDs. The level of bill collection as of 01.04.08 has been 95%.

10.2.7. Paruyr Sevak 106 heat supply system

In 2003 with the cooperation between the “Heat supply Program” PIO of the Ministry of Finance and Economy of the RA and the Yerevan Paruyr Sevak Street 106 building’s apartment owners was accomplished the heat supply pilot program of the building. The number of apartments in the three story carcass panel type building is 72, the residential surface is 3.25 thous.m², the number of entries is 4. Till the accomplishment of the pilot program the heating system of the building did not operate.

The program implementation works started on 10.10.03 and finished on 20.01.04. It was decided to choose for the boiler house the roof option.

The boiler house is installed with 2 water heating boilers of Italian Ferroli and Lamborghini companies with 300 and 290 KW capacities, with corresponding gas burners. There has been two contour installation of the heat providing system, and the linking joint is the 480 KWh capacity plate water heater. In the first (boiler-heater) and the second contours (water heater- consumer) the circulation of the hot water is performed by German Wilo company made pumps.

Within the framework of the Program were made the boiler house gas supply, heating internal network rehabilitation, regulation and measurement equipment installations (allocators, super sonic thermal power meter, water meter), as well as certain works in the direction of decreasing the thermal losses of the building.

58 apartment owners of the building participated in the Program. The investment money amounted to 51,645 USD, from which 45681 dollar were loan money (with 2 years of grace period, 10 year period with 5% interest rate), 5,964 USD were the co financing of the apartment owners.

The heating system has been exploited by the “Paruyr Sevak 106” condominium and in the 2003/04 heating season from 72 apartments 44 were heated or around 61%.

The results of system monitoring within the 2003/04 heating season.

Within the 2003/04 heating season the system monitoring was done by the Ministry of Finance and Economy of the RA ’Heat Supply Program’’ PIO. In the course of the monitoring the following was discovered:

1. The actual consumption of thermal power has been 99750 KWh, instead of the normative 83300 KWh,  
2. The efficiency of the boiler house operation has been 92.4%,  
3. The distribution of the thermal power was not allocated evenly, which is connected with a number of riser plugging,
4. There has been no registration of illegal water use by the consumers.
5. The actual tariff of the thermal power without the investments has been 7,0 AMD/KWh, with the investments: 17,15 AMD/KWh.

The payments for the thermal power consumed by the residents are calculated in accordance with the system’s exploitation actual costs, the cost of the thermal power meter installed in the boiler house and the results of the allocators installed on the batteries. For the 2003/04 heating season the level of the bill collection as of 15.04.04 has been 68.5%. After the end of the heating season the organized survey has given the following results:

*Advantage:*
- high level of residential comfort.

*Shortcomings:*
- the complaints with the metering equipment connected with the fact that in the apartments with small residential surface are sometimes allocated bigger than installed heating surfaces and for that given consumer it is not expedient to pay in accordance with the residential surface,
- Some consumers complain that actually the allocators that are distributing devices make it possible to define the payable bill for the consumed thermal power only through very sophisticated calculations and not immediately,
- the 75% of the consumers complains against the lack of the Centralized HWT.

Later till 2006/07 heating season, 6 more apartments have connected to the system and used the services. After that heating season the heating of 7 apartments that were connected to the system was disconnected because the 3 owners were absent from the city, and the 4 owners installed their own boilers. At the same time because of the breakage of the allocators power supply batteries installed on the heaters the general assembly of the consumers made a decision to calculate the payments for the consumed thermal power on the basis of the system exploitation actual costs, the indication of the thermal meter installed in the boiler house and the total surface.

In the course of the 2007/08 heating season that lasted for 140 days, 43 apartments used the service of the system. The actual tariff of the thermal power was 6.52 AMD/kWh, or 1m² by the total surface: 1050 AMD/m², the level of bill collection was 93%:

**10.2.8. Installation of individual heating devices in the apartments of Gyumry city Yerevan highway 109a and 155 buildings**

In the course of the recent years in Gyumry city with the financing and support of different international organizations were accomplished several pilot heating programs in many apartment buildings (gas boilers, ovens) a number of pilot programs. The programs have accomplished by the financing of the USAID by the Advanced Engineering Associates International (AEAI) the following works.
- The construction of the internal gas supply system,
- Installation of apartment ovens of type MORA,
- The heat insulation of the building (entrance doors, windows).

The main data on the apartments and the installed ovens are given in Table 10.8.
Table 10.8. Characteristics of Yerevan Highway 155 building and installed ovens

<table>
<thead>
<tr>
<th>The address of the building</th>
<th>Number of floors</th>
<th>Type of apartments</th>
<th>The number of apartments / heated</th>
<th>Total surface, m²</th>
<th>Installed heaters’ type</th>
<th>Installed heaters’ type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gyumry city, Yerevan highway, 155</td>
<td>5</td>
<td>1 room</td>
<td>10/10</td>
<td>487</td>
<td>MORA-TOP VGH-6111</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 rooms</td>
<td>35/35</td>
<td>2205</td>
<td>MORA-TOP VGH-6121</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 rooms</td>
<td>15/15</td>
<td>1238</td>
<td>MORA-TOP VGH-6101</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>60/60</strong></td>
<td></td>
<td><strong>3930</strong></td>
<td><strong>375</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In the course of the 2006/07 heating season within the USAID/GEF Program were accomplished the Gyumry city Yerevan Highway 155 and 109a buildings’ individual heating and the monitoring of the efficiency of the devices. In the result of the studies and surveys done among the residents it was discovered that:

6. Within the period of heating the average temperature of air in the heated apartments has been 11-15°C.
7. The conditions of residential comfort were assessed by the residents mainly as average and bad.
8. The complaint is mainly concerning the following circumstances: situations of possible accidents connected with the deficiencies of the ovens, low quality of heating and uncomfortable conditions.
9. But for the bills of the consumed gas for the heating of the apartments was used as well additionally 3000-5000 AMDs.

Yerevan Highway 109a building was built in 2003 by the means of the Linsky foundation. For the purpose of heating were installed ARISTON type apartment boilers, the characteristics of which are described in Table 10.9.

Table 10.9. The characteristics of boilers of the Yerevan Highway building 109.

<table>
<thead>
<tr>
<th>The address of the building</th>
<th>Number of floors</th>
<th>Type of apartments</th>
<th>The number of apartments / heated</th>
<th>Total surface, m²</th>
<th>Installed heaters’ type</th>
<th>Capacity, kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gyumry city, Yerevan highway, 109a</td>
<td>4</td>
<td>1 room</td>
<td>10/10</td>
<td>500</td>
<td>ARISTON</td>
<td>9.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 rooms</td>
<td>8/8</td>
<td>520</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 rooms</td>
<td>8/8</td>
<td>640</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>26/26</strong></td>
<td></td>
<td><strong>1660</strong></td>
<td><strong>1660</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In the result of the studies and surveys done by the USAID/GEF Program it was discovered that:

1. within the heating season the average temperature of air in the apartments has been 11-15°C;
2. The conditions of residential comfort were assessed by the residents mainly as average.
3. The complaint are mainly concerning the following circumstances:
   • Deficiencies connected with the pluggings in the chimneys (around 20% of the apartments),
   • Low quality of heating and uncomfortable conditions (65%):
4. But for the payments for the used gas, because of the technical deficiencies of the ovens used for heating the apartments, the correction of the breakages or additional costs for electric power, around the 70% of the apartment owners have additionally paid 3000-5000 AMDs, and the other 30%: more than 5000 AMDs.

81
10.2.9. The implementation program for Spitak city “Center-1” district buildings Centralized heat supply system

In 2001-2003 by means of the Linsy foundation was built and put into exploitation the Spitak city “Center 1” district 23 many apartment building (276 apartments): In accordance with the construction plan the heat supply of the building must be done through Centralized system. For that purpose with the financial means allocated by the State budget of the RA was constructed a heating system (6 MWth capacity boiler house and around 650m long 4 pipe external thermal network. As of 2003 the main equipment is installed in the boiler house (6 boilers type §&Faqel¦, 1 MWth unit of capacity), the circulation and HWT pumps, water heaters and a gas regulation point.

The construction works of the heat supply system of the building were finished in 2003 November and have been made only the hydraulic tests of the boiler house and the external thermal networks. As long as the buildings heating and HWT internal network hydraulic tests were not done the system was not put into exploitation.

The boiler house in June 2006 by the Lori District Council has been passed by the rigth of ownership to the Spitak municipality (June 19, Ownership license No 06-006-3-1).

In February 2007 the Program has accomplished the preliminary studies of the technical conditions of the heat supply system and the technical characteristics of the connected buildings. In the result it was discovered that with not big investments it will possible to operate the system, raising the energy efficiency and providing the stable, trustworthy and affordable heat supply of 276 apartments. A corresponding interest was shown as well by the municipality.

The program of operating the system was discussed and approved by the Board of Trustees of Armenia’s renewable energy and energy saving foundation at the session of January 30, 2007.

In the result on March 22, 2007 the Spital municipality and the UNDP within the framework of the USAID/GEF Program signed an agreement of cooperation the purpose of which was to operate the Spitak “Center-1” district’s residential building’s DH system by 2007/08.

Starting from May 2007 with the participation of the Program and Spitak municipality representatives were accomplished surveys in order to find out among the owners of the mentioned above apartments wether they have desire to connect to the DH system. In the result of hte surveys and the further periodic awareness raising work done with the residents it became clear that around 67% apartments (185 households) had signed the preliminary agreement. The 40% of apartments that have expressed consent (111 households) are involved in the lists of the socially vulnerable families as of January 1, 2008.

For putting into exploitation the heat supply system the Program has accomplished and will still accomplish the following works:

- The substitution of the old boilers with modern energy efficient burners,
- The installation of gas meter,
- The substitution of the network and feeding pumps with more efficient ones,
- Installation of cold water reservoir, water meter, heat meter, air removers and extension vessels,
- Installation of hydraulic balancing valves at the entrances of the buildings,
- The elimination of deficiencies in the internal heating systems of the buildings and the disconnection of the apartments withdrawing from the Centralized heating system,
• The thermal inculation of the pipelines and equipment and etc.

For the selection of the contracting and equipment supplying organizations the USAID accomplished a number of tenders in July 2007, and the contracts were signed and the construction works began in September.

For the accomplishment of the works were selected contractor §Gagik Ghazaryan and Co. LLC, and equipment providing AH Building Technologies Ltd.

The financing was provided within the framework of USAID/GEF Program in the amount of 20,065 mln. AMD (in accordance with the prices suggested by the chosen companies), from which the 10 mln. AMD for the purchase of equipment, 4,818 mln. AMD for materials and 5,247 mln. AMD for works. The Spitak municipality had offered to commission the system exploitation to the “Apartment servicing Office number 2” community not commercial organization.

Creation of the foundation for supporting the energy savings.
Basing on the cooperation agreement signed between the Spitak municipality and the UNDP agreement within the framework of the USAID/GEF Program Clause 3 subpoint 2m by the undertaken obligations currently a fund is being created for supporting the heating systems and multi apartment buildings energy saving. The Fund will be comprised of the following means.
• The sums allocated for the Program of connecting to the reconstructed central heating system the socially vulnerable families, provided by the Renewable Energy and Energy Savings Fund of the Republic of Armenia.
• That part of the heating bill paid by the socially well to do families, which is compensated by that part of the Program’s budget for the rehabilitation of the Centralized heat supply small systems.

Tariffs
The heating tariff has been calculated for socially vulnerable and well to do families with differentiated approach. For the latters the calculates heating tariff does not include the amounts paid by the Fund for connecting to the heating system, which are in lump sum transferred to the account of the Energy Saving Fund.

The means provided by the Program for the socially well to do families as no interest loan are included into the tariff paid by the family in the tariff for heating. The money that is generated through these payments is transferred to the Energy saving support Fund.

The current situation
As of 2007 December 1 the works stipulated by the program are mainly finished with the exception of the installation of the heat meters, extention vessels and the thermal insulation of the pipes.

However for eliminating the deficiencies revealed in the course of the hydraulic testing of the boiler house and external thermal networks it is necessary to do additional works. In order to eliminate the shortcomings available in the boiler house already a number of additional works were made with the cost of 0,8 mln. dram which were not stipulated in the program of exploitation:

In the course of the hydraulic testings of the external thermal network in November 2007 it became clear that in a number of places there is a big leakage of water. However because of the decrease of the outdoor air temperature it was impossible to accomplish any reconstruction works and they were postponed till spring 2008.
It was impossible to predict these deficiencies of the system, as long as the heat supply system was built only 4 years ago and the positive results of the hydraulic testing are documented with corresponding documents.

10.2.10. Gyumri city Khrimyan Hayrik 3a, 5a, 4b and Raskatlyan 1 many apartment buildings DH system’s exploitation program.

Prehistory
In the course of 2001-2003 in the Gyumri city Tbilisyan 1 district on the account of the Linsky foundation and other financial means were reinforced (built) Khrimyan Hayrik 3a, 5a, 4b (80 apartments each) and in Raskatlyan 1 (40 apartments) buildings, the heat supply of which is stipulated by centralized method. Within that program with certain means allocated from the Budget of the RA (95.7 mln. AMD) the Shirak municipality built the boiler houses with the addresses Khrimyan Hayrik 5/1 and 6/1, each with 2 correspondingly 750 and 420 kWh capacity “Ecomax” boilers and auxiliary equipment and external thermal networks.

The construction installation works of these boiler houses were finished in 2003, the hydraulic tests of the boiler house equipment was done. However, the internal and external heating networks of the residential buildings were not tested and the boiler house was not connected with the gas supply system. And nothing has been done in respect of putting the systems into exploitation.

In 2007 the Program has done the preliminary study of the technical conditions and characteristics of the connected to this system buildings and it has been justified that with not big investments it is possible to put the system into exploitation, making it energy efficient and affordable for the consumers.

The question was discussed in Shirak Governor’s office (21.12.06) among the Governor’s office, Gyumry Municipality and Program’s representatives and in the result an agreement was settled between the Governor’s Office and the Municipality about the transfer of the ownership of the boiler house: By point 11 of Protocol number 36 of the First Session of the Armenia’s Renewable Energy and Energy Saving Foundation that took place in 2007 it was confirmed that the above mentioned buildings in Gyumry would be connected to the central heat supply system program.

On June 25 of 2007 the Gyumry Municipality and the UNDP signed a cooperation agreement within the framework of the USAID/GEF Program, the purpose of which is to put into exploitation by the beginning of 2007/08 heating season the Centralized heating systems of the Gyumry city mentioned residential buildings.

In June 2007 with the participation of the representatives of the Program and the Gyumry municipality were accomplished surveys in the mentioned above buildings so as to clarify the attitude of the apartment owners to the centralized heating system rehabilitation and heating conditions. In the result of the surveys and further periodically done with the residents awareness raising works around the 85% of the apartment owners (238 households) signed the preliminary agreement. From them around 27% (64 households) as of January 1, 2008 were involved in the lists of socially vulnerable families.

Program assumes to accomplish the following works:
- Installation of gas regulation point and meters,
- Installation of pumps, extension vessels, heat meters, pressure safety device and balancing valves, air removers and other auxiliary equipment.
• The connection of the boiler houses to the gas operating network.
• Thermal insulation of pipes and equipment.
• Substitution of the damaged batteries in the building's internal heating networks.
• Hydraulic testing of the boiler houses, distribution and internal (including the apartments) and elimination of the found deficiencies.
• Other works that are necessary for putting the systems into exploitation.

For the selection of the contractor and supplying companies the USAID has done a tender competition in July 2007, and the agreements were signed and the construction works started in September. For the accomplishment of the works through competition were selected the contractor EICG Ltd., and the equipment supplier AH Building Technologies Ltd.

The financing was provided by the USAID/GEF program: 31,12 mln. AMD (in accordance with the prices suggested by the selected organizations), from which: 15,7 mln. AMD was used for purchasing equipment, 8,65 mln. AMD: for materials and 6,77 mln. AMD for works.

The precalculated value of the exploitation program implementation is 29,979 mln. AMD. However, in the course of the testing and preparatory works there was need of additional costs. Those are connected with the elimination of the deficiencies of the external thermal networks in Khrimyan Hayrik 3a and Raskatlyan 1 buildings and cleaning the 350 heating batteries. The cost of this work increased the precalculated cost by 1,141 mln. AMD.

In accordance with the decision of the Gyumry municipality §Gyumry Center¦ condominium, which currently is servicing the mentioned above buildings must accomplish the exploitation of the heat supply systems at the address of Khrimyan Hayrik 5/1 and 4/1.

In accordance with subpoint 2 of point 3 of the Gyumry municipality and UNDP agreement within the framework of the USAID/GEF Program currently works are done for the creation of a Fund to support the energy saving works of the many apartment buildings. The purpose of the fund, the sources of its means and principles of management will be described in detail in clause 10.2.9 (with the example of Spitak project).

**Current situation**

The following works have been accomplished:

- Construction works,
- The technical expertise of the safety of the boiler houses done by the Service of Technical Safety of the RA with corresponding conclusions,
- Working out the technical certificates of safety of the boiler houses
- The technical expertise of the safety certificates of the boiler houses done by the Service of Technical Safety of the RA with corresponding conclusions,
- The training of the boiler houses staff and responsibilities and the provision of corresponding certificates
- The calibration of the gas equipment and connection of gas pipes supplying the boiler houses,
- The accomplishment of hydraulic tests.

In the Service of Technical Safety of the RA the works of registration and putting into exploitation of the boiler houses have not been accomplished. An obstacle to this is the fact that the Gyumry municipality has not yet undertaken steps for acquiring the certificates of ownership for the boiler houses.
Currently by the Shirak Governor’s Office, Gyumri municipality and the §Gyumri Kentron¦ condominium measures are being undertaken to register the ownership of the boiler houses and acquisition of ownership certificates for them.

Thus in the 2007/2008 heating season the systems were not put into exploitation because of the absence of the actual owner of the boiler houses and not registration by the Technical Safety Service of the RA because of the latter reason.

10.3. Energy Supply Projects for Public Buildings

This section presents information on public buildings (schools, kinder-gardens, hospitals, nursery homes and etc.) energy supply and energy efficiency increase projects, which were implemented by RA state institutions and donor organizations. General information on implemented and undergoing activities, as well as financial issues related to the mentioned main donor organizations and projects energy supply sector is presented in Section 5 of the given chapter.

10.3.1 Armenia Renewable Energy Resources and Energy Efficiency Fund

In the course of 2005-2007, Armenia Renewable Energy Resources and Energy Efficiency Fund on the account of the provided loan proceeds by the World Bank has rehabilitated heat supply systems in 97 schools in different RA marzes (in 2006 – 32 systems, and in 2007 – 52 systems), where the total installed capacity makes app. 34.15 MW. The installed capacity was calculated by average installed capacity (299-376 KW) for one school. Mainly “Mekusich” and “Ar&Ar” brands of local production, as well as “Alektherm” and Persian production water heating boilers were used.


In the framework of “Armenia Energy Efficiency, Demand-Side Management and Renewable Energy Program” and “Commercialization of Energy Efficiency Program”, carried out by Advanced Engineering Associates International, Inc. organization and by the financial assistance of USAID, a number of public buildings’ heat supply systems have been rehabilitated: schools, kinder-gardens, orphanages, hospitals, institutions and other similar facilities, as well as measures providing heat supply efficiency have been organized.

Projects implemented by Advanced Engineering Associates International, Inc. in the course of 2005-2007 include:

- Fuel substitution: switching from electricity to natural gas and containment,
- Only fuel substitution: switching from electricity to natural gas,
- Low efficiency gas boilers substitution with more efficient ones and containment,
- Only facility containment,
- Fuel substitution: switching from electricity to natural gas and containment, facility containment and solar energy use for hot water provision,
- Solar energy use for hot water supply.

According to the mentioned above, for some systems only energy efficiency (EE) measures were undertaken: so as to increase the already existing heat supply system energy efficiency. However, in the framework of this report only projects, which have implemented rehabilitation or construction of public buildings heat supply systems have to be specified.
In the framework of “Armenia Energy Efficiency, Demand-Side Management and Renewable Energy Program” during 2005-2006 approx. 16 heat supply rehabilitation projects have been implemented by 5.43MW total installed capacity, 3 of which are solar hot water supply systems having 0.07MW total installed capacity. In the framework of “Commercialization of Energy Efficiency Program”, which started in 2007 approx. 6 heat supply projects are underway having 1.94MW total installed capacity of the systems.

10.3.3 United States International Development Agency, Educational Sector Heat Supply Assistance Program

In the framework of USAID Educational Sector Heat Supply Assistance Program schools heat supply systems and lavatories have been constructed (reconstructed) in different marzes of RA. The selected schools have been proposed by RA Ministry of Urban Development, and their heat supply systems and lavatories construction (reconstruction) works have been carried out by EIICG, “SESKO” (“SHINENGSERVICE”) LLC and “Armgyuxshinnaxagits” subcontractor companies.

In the framework of Phase I of the project (2003-2005) 19 schools have been constructed (reconstructed), and during Phase II (2005-2007) 38 schools’ lavatories and heat supply systems: correspondingly 2.65MW and 8.62 MW total installed capacity.

10.3.4 Armenia Social Investment Fund

Armenia Social Investment Fund’s (ASIF) recent major projects were ASIF-2 (start in November, 2000) and ASIF-3 (start in December, 2006), which activities as well include kinder-gardens, schools, orphanages, health care centers and other public buildings heat supply systems rehabilitation and construction projects implementation.

In the framework of ASIF-2 and ASIF-3 in total 91 (57 of which by ASIF-2, and 34 by ASIF-3) heat supply systems rehabilitation and reconstruction projects in different marzes of RA projects were implemented and are underway at present. The total installed capacity of these systems makes app. 30.70 MW (this is an approximate calculation base on 10.3.1 section’s parameters).

10.3.5 Projects implemented by the funds of the Republic of Armenia State Budget

Yerevan city schools centralized heating systems rehabilitation and construction activities continue by RA state budget financing. Depending on schools’ administrative jurisdiction, the boiler houses rehabilitation (construction) activities are implemented either by Yerevan city municipality, or RA Ministry of Urban Development.

9 school heat supply systems were rehabilitated (constructed) by RA state budget financing in 2006, out of which 3 were implemented by Yerevan city municipality, and 6 by RA Ministry of Urban Development.

35 school heat supply systems were rehabilitated (constructed) in 2007, out of which 9 were implemented by Yerevan city municipality and 26 by RA Ministry of Urban Development. The given data vividly shows that in comparison to 2006, during the year of 2007 app. 4 times more schools heat supply systems were rehabilitated (constructed), which is conditioned by the growth of RA state budget corresponding purposeful provisions.
So, in the course of 2006-2007, the RA state budget financed rehabilitation (reconstruction) of 44 schools heat supply systems: with app. 14.80 MW installed total capacity (this is an approximate calculation based on 10.3.1 section’s parameters).

**10.3.6 Public Buildings Heat Supply Projects Overview**

In conclusion, in the course of the recent years RA state institutions and donor organizations have rehabilitated (constructed) 311 public buildings’ (schools, kinder-gardens, hospitals, nurseries and etc.) heat supply systems: having total installed capacity of 98.27 MW.

**Table 10.10 Rehabilitated (constructed) heat supply systems during recent years, envisaged for public buildings**

<table>
<thead>
<tr>
<th>#</th>
<th>Implementing organization/project</th>
<th>Number of rehabilitated/constructed heat supply systems</th>
<th>Total installed capacity MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Armenia Renewable Energy Resources and Energy Efficiency Fund</td>
<td>97</td>
<td>34.15</td>
</tr>
<tr>
<td>3.</td>
<td>United States International Development Agency, Educational Sector Heat Supply Assistance Program</td>
<td>57</td>
<td>11.27</td>
</tr>
<tr>
<td>4.</td>
<td>Armenia Social Investment Fund</td>
<td>91</td>
<td>30.70</td>
</tr>
<tr>
<td>5.</td>
<td>State Budget of the Republic of Armenia</td>
<td>44</td>
<td>14.80</td>
</tr>
<tr>
<td></td>
<td>Totally</td>
<td>311</td>
<td>98.27</td>
</tr>
</tbody>
</table>

At present, as a result of the use of heat supply actual operating systems in public buildings, the greenhouse gas emissions reduction assessment can not be specified, because heat energy production amount is absent.

**10.4. District Heating (DH) Rehabilitation Projects with Application of CHP Technologies**

In DH restoration projects with CHP technologies application it is envisaged to use cogeneration energy sources equipped with gas engines, and as for peak heat generators the use of modern highly efficient heat-only boilers is expected.

The given section presents the indexes of the only DH system being in operation and of three, which are under designing and construction phases.

**10.4.1. DH restoration project in the Avan residential area in Yerevan**

**Background**

According to Yerevan city 2005-2020 master plan it is envisaged to recover DH systems of Ajapnyak, Davidashen, Harav-Arevmtyan, Avan and Nor Nork residential areas.
UNDP/GEF energy efficiency project studied Yerevan Avan DH system restoration alternatives. The requirements presented were as follows: high efficient, reliable and measurable system with high-quality supply and possibility of demand side management.

DH systems viability is basically conditioned by the heat energy tariff. Taking into account the considered restoration options, the preferable ones are those, which provide competitive tariffs for heat energy considering population’s solvent demand. As a result, Avan DH restoration was suggested to be implemented using CHP units, as an alternative, which is economically found and affordable for population.

While making calculations for CHP price formation the following principles were used: heat energy tariff was determined based on the requirement to ensure its competitiveness as well as taking into account solvent demand of the population, and the electricity tariff was calculated by a remainder principle. This approach enables to provide heat energy affordable and competitive tariff and ensure the maximum involvement of residents into these services. The calculations made by UNDP/GEF Energy Efficiency Project were taken as a base, for RA government April 13, 2006 #506 decree development, which suggests RA Public Services Regulation Committee (PSRC), while providing a construction license to define, that the electricity tariff produced in cogeneration energy source should not exceed Hrazdan TPP electricity tariff.

UNDP/GEF Project together with “EvroSibEnergo engineering” investor company from the Russian Federation have developed 214 multi-apartment and 32 public buildings DH restoration investment project’s Feasibility study with the CHP units application in Avan district. Heat supply networks’ rehabilitation specific indexes presented by “Yerevannaxagits” CJSC were used while making the calculations. According to the Feasibility study it was envisaged installation of gas engines in heat sources, the capacity of which was selected corresponding to the hot water supply design load and formed 16 MW, complete replacement of main and distribution networks, internal heat networks recovery and reconstruction, installation of measurement and control modern equipment.

Avan DH system restoration project was estimated to make 21, 3 mln. USD with the payback period of 8 years. CHP technology use enabled heat energy affordability and competitive tariff provision.

Feasibility study of Avan DH restoration project was presented to Yerevan Municipality and RA PSRC by “EvroSibEnergo Engineering” CJSC and was approved by these bodies.

According to #30 protocol decision of RA Government dated August 3, 2006, Yerevan Municipality was ordered to hand over to permanent possession on gratis use right Avan DH system inventory to Avan municipality, in order to transfer it later to the jointly established company.

In order to implement Avan DH restoration project “ArmRuscogeneration” CJSC was created in 23.08.2006. According to #1454-A decision of Yerevan Municipality the heat supply inventory of the district was handed over to Avan municipality.

For rendering assistance at realization of the Avan DH system restoration project from the UNDP/GEF Project side “Memorandums of Understanding” dated December, 2006 and January, 2007 were signed between the UNDP and “ArmRuscogeneration” CJSC.

In the framework of the memos “ArmRuscogeneration” CJSC management met a lot of times with the Project experts to discuss the application of power and heat tariffs calculation methodology for combined production (cogeneration) based on useful heat demand, technical-economic calculations, tariff structure issues, as well as matters related with explanatory and awareness works to be carried out with the population.
In the framework of Kyoto Protocol Clean Development Mechanism (CDM) for the project implementation and co-financing, UNDP/GEF Project implemented “Avan” project green house gas emissions reduction potential assessment.

Yerevan city DH restoration pilot projects’ feasibility were presented to UNDP regional center, so as to provide additional technical assistance for CDM documents development. Together with “Factor” international consulting company, selected by UNDP, and the Project experts GHG emissions reduction potential was assessed. Suggestions regarding CDM AMS II.B and AMS III.B methodologies use expediency were presented for Avan and Davdishen investment projects implementation and proposal’s idea notification (PIN) was developed. According to the estimate, in case of Avan DH project implementation GHG emissions reduction will make app. 34000t/year (see Table 9.6), which will result in an additional source of income by app. 340.000 euro/year.

It is envisaged to prepare the signing of Mutual Understanding Memorandum between United Nations Development Project and the Republic of Armenia, which aims to establish non exclusive framework for GHG emissions reduction activities elaboration and implementation assistance cooperation between the both parties in the framework of CDM project realized in the Hosting country. The draft memorandum is still in the phase of reaching agreement with the stakeholder ministries.

**Progress of Work**

In 2007 “ArmRuscogeneration” CJSC has ordered heat and hot water supply internal networks design of Avan DH system restoration investment project commissioning complex (76 multi-apartment buildings) to “Yerevannaxagits” CJSC.

During 2007/08 heating season centralized heat supply of 3 multi-apartment buildings with 108 apartments in D. Varujan district, which is a part of a commissioning complex, was done. For that purpose #3/4 heat substation was reconstructed to boiler house, and HOBs at the capacities sufficient for supplying heat to the whole D. Varujan district (7 buildings) were installed. The external heat networks were rehabilitated according to “Hanardnaxagits” CJSC developed design.

In September, 2007 the Project experts and “ArmRuscogeneration” CJSC representatives made a survey among the residents of 8, 9, 10 buildings of D. Varujan district, according to developed questionnaire and awareness raising forms. According to the survey results, 50% of the surveyed apartment owners expressed their willingness to be connected to DH system.

Boiler house and external heat networks construction-assembling works were implemented during September-December months in 2007. Two HOBs each with the capacity of 1,1 MW were installed in the boiler house, and external heat network with 430m of length having four pipes was reconstructed and built, as well as heat supply pipes of inter-building network. The supplier pipes of inter-building network were assembled at the ground floors, and the supplier risers in the entrances, so two risers in each entrance.

In October, 2007 “ArmRuscogeneration” CJSC management applied to UNDP/GEF Project with a request of purchasing measurement equipment. The following equipment was purchased and handed over to “ArmRuscogeneration” CJSC through the Project means:

- Apartment heat meters – 55 pieces,
- Hot water apartment meters – 75 pieces,
- Hot water building level meters – 3 pieces.
Because of Christmas and New Year’s Eve holidays inter-apartment networks installation works were postponed till 13th of January, 2008 upon consumers’ request. By the way only 20 apartment owners expressed willingness to get connected to DH system. The works in the apartments were completed on 22nd of January and the system was put into operation. After January 22, seeing DH advantages 14 apartment owners as well expressed desire to get connected to central heat supply system. As a result, consumers’ total number made 34, or 31% of potential consumers. After heating season completion (end of March) six apartment owners as well expressed desire to get connected to DH system. In 34 apartments with individual heat supply designs and corresponding budgets horizontal distribution internal network assembly works with alumina radiators installation were implemented.

So as to measure consumed heat energy on the entrances of each apartment, apartment heat energy meters and hot water meters were installed.

UNDP/GEF Project has developed supply contract exemplary form to be signed by the residents. At present, “ArmRuscogeneration” CJSC works to connect remaining 4 buildings in D. Varujan district to the DH system. At the same time, “ArmRuscogeneration” and “EvroSibEnergo engineering” companies prepare Avan DH restoration investment project’s updated feasibility study. In this occasion, the Project experts provided consultancy to the specialists of those companies in connection with: gas engines capacity selection, their placement, sizing, costing, power and heat tariffs calculation methodology application and other issues. Following a great deal of discussions, the representatives of “ArmRuscogeneration” and “EvroSibEnergo engineering” companies agreed to consider UNDP/GEF Project experts’ comments and suggestions, which was fixed by a corresponding protocol. The discussion results were presented and approved by PSRC, which was also fixed by a corresponding protocol.

By the request of “ArmRuscogeneration” CJSC management the Project expert Mr. R. Tsovyan made a business trip to Moscow, so as to discuss the approaches of Avan investment project’s technical-economic justifications, as well as the application of CHP power and heat tariffs calculation methodology with the corresponding specialists of “EvroSibEnergo” and “EvroSibEnergo engineering” companies.

Conclusions on project’s progress

During 2007/08 heating season the implemented 3 multi-apartment buildings central heat supply rehabilitation investment project in D. Varujan district of Avan district can be considered as a pilot project in Avan district for identifying the actual amount of consumed heat energy, in case of using regulative and metering equipment and multipart tariffs for heating and HTW.

The successful implementation of the mentioned pilot project, as well as the residents’ satisfaction with qualified and affordable heat supply will encourage Avan DH restoration by increasing the number of consumers having desire to use DH services.

It is evident, that delay in project implementation and, as a result, consumers increasing distrust towards DH rehabilitation in the condition of gasification expansion resulted in passing to individual heat supply provision by a sufficient number of consumers and sharp decrease of people getting connected to central heat supply system correspondingly. Thus, if in June, 2006 during technical-economic substantiation the consumers’ connection rate was estimated to make 85%, then in September, 2007 3 multi-apartment buildings survey results done in D.Varujan district showed just 50%, and in December, 2007 it became only 18.5%.

However, in condition of gas prices increase power and heat energy tariffs calculation methodology for CHP production will enable having heat energy affordable tariff and in case of due arrangement
of explanatory and awareness raising works with consumers, the number of consumers desiring to be connected to DH system will increase considerably. In this case, it is very important that the system continues to operate in hot water supply summer regime.

Varujan DH system monitoring

The system monitoring was implemented during the months of February-March, 2008 by the experts of “ArmRusCogeneration” and the Project.

To analyze the monitoring results “ArmRusgaszard” and “Armenian electrical networks” companies provided information on gas and power consumption, as well as on payments for it.

Electronic thermometers were placed in 7 apartments out of total number connected to the system for temperature record (during 13-25 of February, 2008). For the same purpose, apartments’ normative heat demand for the month of February was calculated, taking as a basis, the Yerevan average outside temperature for that period provided by hydrometeorology service, which made -2,0°C. The calculations were made by the use of heat demand expanded figures, according to the norms defined for the apartments. The latter do not consider the dependence of separate apartments’ heat losses from frame filling sizes, geographical orientations (depending on the Earth sides) and possess averaged value for the whole building.

Apartments’ calculated heat demand and actual consumed heat energy amounts’ comparison shows, that heat energy consumption in February made 82% of the calculated. However, according to separate apartments’ consumption level in comparison to the calculated ones, it was described with severe disparity. The latter is shown in Table 10.14.

<table>
<thead>
<tr>
<th>Apartment number</th>
<th>Consumption compared to the calculated, %</th>
<th>Temperature level, °C</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1</td>
<td>2.9</td>
<td>6</td>
<td>uninhabited</td>
</tr>
<tr>
<td>3</td>
<td>8.8</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>29.4</td>
<td>70 - 75</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>26.5</td>
<td>80 - 90</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>20.6</td>
<td>100</td>
<td>18 - 19</td>
</tr>
<tr>
<td>4</td>
<td>11.8</td>
<td>100 - 140</td>
<td>18 - 25</td>
</tr>
</tbody>
</table>

Comparatively apartments’ low air temperature was recorded in the first and last floors of the buildings, higher temperatures (23 - 25°C) in one apartment of building # 8, where the actual consumption exceeded the calculated by 40%.

In the framework of the project implementation, in three buildings 70 apartments out of 108 (app. 65%) were gasified by 1st of January, 2008, where the gas consumption in January made 22654m³, or in average for one apartment 324m³. Judging by the consumed gas and electricity in the apartments, it may be concluded, that in 49 apartments gas-furnaces or apartment boilers were used for heating purposes and in 21 gas-stoves and electricity were used. The monitoring results made possible to assess also the following indexes:

- Mainly the apartments, which are not using gas-furnaces and boilers and are still not gasified, got connected to DH system: correspondingly 17 and 10 apartments. The remaining 7 apartments, which are now connected to the system, previously were heated by some kind of gas equipment.
• Until the DH system operation (January, 2008) the monthly natural gas consumption of 22 apartments (the rest 12 apartments were not gasified) connected to the system and gasified made 2369m³, or in average, for one apartment app. 108m³ gas. After the system’s operation, in February, the consumption made 413m³, in average app. 20m³/apartment. Gas average consumption is reduced by app. 5 times.

• Until system operation in 34 apartments electricity monthly (January) consumption made 24363 kWh or taking one apartment app. 717 kWh, after the operation, in February correspondingly 7861 kWh and 231 kWh/apartment, so as electricity consumption got reduced app. by three times.

• 34 apartments in February, 2008 consumed 66653 kWh heat energy, but in March 22342 kWh, or taking one apartment correspondingly 1960 and 657 kWh.

• The hot water actual consumption made app. 41 l. (person/per day), in comparison to normative 105 l/(person/per day) by residents favoring from hot water supply system.

• According to the averaged apartment favoring from heat supply services, total consumption of energy in January made 1620 kWh, in February 2360 kWh, so as by app. 46% more. In consideration of those months duration and outside air temperatures’ (in January -9,1°C, in February -2,0°C) differences, then that index will make app. 66%. Particularly, the payments for energy services have grown by similar proportions: 702 thousand Armenian drams (January) and 1010 thousand Armenian drams (February). Those indexes represent the inter-apartment better comfort in case of DH.

• Supplier-consumer financial relations are regulated according to the invoices developed by the heat supply company, where due to payment amounts are calculated based on the multiple-part tariff system.

Following can be concluded based upon the monitoring results

a) DH provides higher levels of comfort and the residents are ready to pay for heat supply quality improvement.

b) DH system has a need of detailed arrangement, as it does not provide the heating normative indexes of apartments having different order and orientation.

c) To obtain more reliable and representative data of apartments’ heating quality, it is necessary to equip all rooms of all apartments with corresponding inter-apartment air temperature measuring equipment, or just the rooms of representative apartments (1st, last and some other middle floor, with corner and middle or with other different orientations).

d) To obtain reliable data on the efficiency of heat supply services, it is necessary to implement longer lasting studies by equipping the system with additional measuring equipment.

10.4.2 DH restoration project of Davashashen community, Yerevan

Background

UNDP/GEF 00035799 Project studied Yerevan Davashashen DH system restoration alternatives. While making calculations the requirements presented to the DH restoration options and power and heat energy price formation principles were the same as the ones in Subsection 10.4.1 for Avan project.

In the outcome, it was proposed, that Davashashen DH system restoration to be implemented with the use of CHP units, which is justified decision and affordable option for the population.
UNDP/GEF Project has developed Davidashen DH restoration project’s feasibility study, where was also used the data presented by “Yerevannaxagits” CJSC on heat networks’ rehabilitation specific indexes.

In June, 2006 “SEP-invest” CJSC from the Russian Federation being the investor presented the feasibility study for Davidashen DH restoration investment project with CHP units application to Yerevan Municipality and RA PSRC, which was approved by them.

Taking into account the mentioned above, #34 protocol decision of RA Government dated August 31, 2006, defined that Yerevan Municipality had to hand over on gratis use right to Davidashen municipality the inventory of DH system, which is in the administrative borders of the district (in exception of #3 DHS), in order to transfer it later to the jointly established company. In regard to #3 DHS, according to RA Government decision, it is lent to new created joint company for the period of 25 years.

In order to implement Davidashen DH restoration project, “Davidashen Energakentron” CJSC was created in 11.09.2006. According to #1602-A decision of Yerevan Municipality, dated 10.10.2006 the heat supply inventory was handed over on gratis use right to Davidashen municipality, and #3 DHS was lent to “Davidashen Energokentron” CJSC for the period of 25 years.

The Project and “Davidashen Energokentron” CJSC signed “Memos of intentions” in 2006, in order to assist Davidashen district heat supply rehabilitation project implementation.

Current status

“Davidashen Energokentron” CJSC has implemented old equipment dismantling of five heat substations. Davidashen 1st and 4th districts’ app. 30 multi-apartment residential buildings heat supply system rehabilitation proposal, which are supplied from heat substations, is ready.

At present, the investor implements boiler house technical indexes and supply conditions clarification for contracts signing: “Davidashen Energakentron” CJSC management conducts negotiations for obtaining credit means. However, the work implementation current status does not nourish any hope that in 2008-2009 it would be possible to provide with even limited number of buildings.

Project assistance

“Davidashen Energakentron” CJSC management has met with PSRC and Project experts a lot of times to discuss the following issues: 1) application of the power and heat energy tariffs calculation methodology for CHP production based on a useful heat demand; 2) technical-economic calculations; 3) tariff structure and 4) explanatory and awareness raising works to be conducted within the population.

The same as in case of Avan project, in the framework of Kyoto Protocol Clean Development Mechanism (CDM) implementation; UNDP/GEF Project implemented “Davidashen” project green house gas emissions reduction potential assessment. In case of proposal implementation, GHG emission reduction amount will make app. 33,000t/year, which will result in an additional income of app. 330,000 euro/year.

Conclusions
Delay in project implementation (feasibility study was prepared yet in summer of 2006) and, as a result, consumers increasing distrust towards DH rehabilitation in the condition of gasification expansion, resulted in sharp decrease of people wanting to get connected to DH system, which in its turn may threaten Davidashen DH system restoration project..

10.4.3 Residential buildings heat supply system restoration in Sevan city micro regions district

Gegarkunik marz Sevan community heat supply scheme was developed by USAID “Residential sector heating project” in 2006. The scheme was studied by foreign investor “Heat Automatiques Moscow Plant” (HAMP) holding, who applied in 2007 to RA Prime Minister with a request of making investments for heat supply rehabilitation in Sevan city.

According to the instructions given by RA deputy prime minister, and as a result of discussions taken place under the heading of RA prime minister consultant Mr. G. Martirosyan, which were also attended by marz and city heads, the holding and Project representatives, it was decided to develop Sevan city micro regions, which comprise 46 multi-apartment buildings district, DH restoration pre-feasibility study.

Based on Sevan heat supply scheme, the Project developed pre-feasibility study and provided it to potential investor for study and final decision making. At the same time, joint working group was formed, which developed 3-party (Sevan municipality, HAMP holding and the Project) Cooperation Memo draft, which was presented to the investor for review. The working group obtained GE Jenbacher, Caterpillar, Deutz and other cogeneration technologies progressive companies production and maintenance services pricelists and together with Armenian market energy carriers’ price formation and tariff system data provided it to the investor.

Procedural normative documents’ package on joint ventures foundation in Armenia was also presented to the management of the holding company.

By the suggestion of HAMP holding company’s head in January, 2008 in Yerevan was organized a seminar devoted to heat supply progressive technologies, during which the descriptions of services and products, as well as realization and supply conditions of the holding company were presented.

According to the holding company, the Cooperation memo signing and working group future activities plans approval is envisaged to take place in May, 2008 during the visit of management to Yerevan.

Based on CHP technologies the Sevan micro regions DH restoration project’s main technical and environmental indexes are presented in the given report, in Section 9.1.

10.4.4 Cogeneration Energy Center Project of Yerevan State Medical University

Yerevan M. Heratsi State Medical University was the first in Armenia to implement energy center construction and operation based on the use of CHP technologies. In the yard of University’s main building is built energy center, where G3520C brand 2 gas engines manufactured by Caterpillar Company are installed, with their heat modules and utilization boilers. The installed electrical capacity is 4MW (el.), the heat capacity is 4.36 MW (th.). The electricity produced by energy center is supplied to distribution network and purchased by “Electric Networks of Armenia” CJSC, by the tariff set by RA PSRC. The average daily production during 2007/08 heating season made app. 80 MW (el.).
At present, the heat from energy center is only supplied to the three buildings of the University and the total estimated heat load makes app. 1.4 MW (th.). The supplied heat is used for meeting the University’s own needs and is not set. The University management plans to enlarge heat supply services provision framework by incorporating the district’s neighboring buildings, including also the ones under administrative possession, the heat supply of those will be realized by market principles. In regard to enlarging heat supply services the University rector applied to the Project with a request to develop the feasibility study.

At present, heat load calculations and feasibility study preparation works are being implemented by the Project experts,

So as to increase energy center work efficiency, the University management plans to implement buildings summer cooling as well, on the basis of CHP wastes heat by the use of the chillers.

10.5. Monitoring the Energy Efficiency and Environmental Impact of Operating Systems

In the framework of implemented measures by UNDP/GEF Project experts, the monitoring of boiler houses work for a few operating heating systems’ was done, so as to make improvements in heat supply sector. The selection was realized from individual, communal, educational institutions and health care organizations heating systems boiler houses, which are in the framework of Project interests.

a) By the order of UNDP/GEF Project “KMY Hayk Technology” CJSC and “Environmental Impact Monitoring Center” SNCO specialists implemented urban and inter-building air direct measurements during 2006/07 heat season in Yerevan and Gyumri cities, so as to estimate multi-apartment buildings’ residents gas-furnaces and apartment boilers exploitation impact.

According to the measurements results, the heaters immediate influence does not originate hazardous substances sanitary norms violation, of the air inside and outside the apartments.

Measurements detailed data, analysis results and suggestions are presented in the implementers’ report.

b) Boiler houses exploitation efficiency studies were realized using German production TESTO 335 analyzer, which enables to measure the following:

- Water heaters thermo-technical parameters and indexes: waste flue gas temperature, heat losses, boiler air surplus coefficient and etc.
- Contents of the substances impacting environment: carbon dioxide and nitric dioxide.

Electrochemical sensor is used in the mentioned device. It does not provide high accuracy and is not used for profound scientific studies, however meets the given study requirements.

The device is easily transported and used in various placements. Main technical descriptions and content of the mentioned device are as follows:

TESTO 335 gas analyzer (with 02 sensor) for measuring boiler house emissions,

- Carbon dioxide measurement module: 0 - 500 p.p.m. (the millionth part of the total),
- Nitric dioxide measurement module: 0 – 500 p.p.m.;
- Differential pressure (pressure differences) and flue gas speed measurement module;
- Sample module of 700mm length with NiCi-Ni thermocouple.
During 2006/07 and 2007/08 heating seasons app. 15 heaters working regimes parameters’ measuring was realized. Those included individual gas-furnaces, domestic (apartment) boilers, and small and medium capacity boilers: Yerevan, Edziadzin, Gavar cities boiler houses (2007 and 2008 implemented measures’ results and the list of boilers subjected to measurements are shown in Annex 4).

The list of facilities was formed in the beginning, then the Project specialists visited those facilities and made arrangements with the exploiters, and in case of necessity they were ordered to make preparations for measurements provision.

The preliminary results enable to conclude, that the applied manner of measurements does not provide reliable data, in case of individual gas-furnaces and apartment boilers. This is because the measuring device sensor is estimated for specific conditions, which are absent in the mentioned limited capacity devices. This is about the conditions relating to waste flue gas pipes diameter and length.

During heating sources monitoring of heat supply projects, results analysis of the implemented measurements enables to arrive at the following conclusions:

1. The measuring device enables to implement water heating boilers effective (express) testing, as well as main technical indexes exploitation estimation;
2. The measuring device is considered to be highly reliable means for boilers’ gas emissions concentrations recording, as well as based on the readings the fuel burning process can be regulated. According to those measurements, in the most boiler houses carbon dioxide and nitric dioxide contents vary from 0 – 10 p.p.m., which completely corresponds to modern heaters technical descriptions.
3. The parameters of coefficient of efficiency recorded by the measuring device consider only the most essential heat losses of gas using device: the losses related with waste flue gases, as well as it enables to estimate with a first roughness the installed boiler capacity and heat load equivalency.
4. To estimate boilers’ actual efficiency it is necessary to consider chemical incomplete burning losses, which can be estimated taking as a base carbon monoxide concentration parameters, which are recorded by the device, as well as external cooling losses, which are particularly substantial under the low heat load regime.
5. During some testing very low temperatures (see Annex 4, 50-80°C) of waste flue gas attest that the boiler operated with very low load. These regimes are inadmissible (if, of course, the boiler is not of condensing type), as those bear the risk of causing complete acid corrosion to boiler’s surface.

In the process of monitoring were also implemented some boilers burners’ simple regulation works evidently operating in inefficient regime (carbon monoxide explicitly high concentration): mainly connected with fuel/air relation regulation.

The app. calculated energy efficiency makes from 0,5% (school # 132 in Arabkir community, Yerevan) till app. 6.5% (“Gavar Orphanage” SNCO boiler house), which was estimated as a result of the Project specialists such type of regulation works.

The implemented studies included 18 boiler installations, which is not sufficient for making thorough analysis. It is necessary to expand the variety of researched gas using devices and the geography, as well as to use more accurate measuring devices.
Annex 6 (Chapter 4.4)

A Concept Paper (draft) on Implementation of Legislative Reforms for Rehabilitation of Heat Supply is developed by the Project.

The Goal

The goal of the Concept Paper is to present the legislative and institutional problems hindering the rehabilitation of heat-supply systems and to identify necessary state policy principles and mechanisms to solve those problems, which should ensure:

- Establishment (rehabilitation) and sustainable development of heat-supply systems with least negative impact in terms of energy efficiency and nature protection;
- Protection of multi-apartment buildings from the harmful influence of spontaneously growing heating-systems, which are incompliant with urban development, environmental and safety standards;
- Encouragement of the attraction of local and foreign, state and private investments into the sphere of heat-supply;
- Regulation of the monopolized services in the local market of thermal energy;
- Encouragement of the utilization of renewable energy resources and fuel for the purpose of arranging heat-supply;
- Prioritizing of the application of combined energy production installations, etc.

Introduction

The provision of centralized heat-supply in settlements is a critical state issue and is related to the safety of population, protection of environment, efficient use of imported energy resources and preservation of housing stock.

The practice of rehabilitating other spheres of RA public utilities (e.g. potable and irrigation water-supply) and other countries’ experience in providing similar services come to prove the need for active role of state regulation in those areas.

The rehabilitation of centralized heat-supply in the residential sector under the competitive conditions of partially introduced individual gas-heating systems can be made possible only in the event of the targeted state assistance, in view of the insufficient safety guarantees for individual gas-heated systems in the buildings and also the recent explosions in the buildings resulting in mortality cases, as well as in significant damage to the peoples’ life and property.

Not only the value of thermal energy should serve as the indicator of competativeness, but also other indicators of safety, energy efficiency, impact on the environment and others, and their the determination and performance control is once again a State issue.

Rehabilitation of centralized heat-supply is feasible through existing state-guaranteed low interest rate loans, grants, subsidies, assistance to the establishment of private business, creation of favourable conditions for activities and other tools, especially when private investments in this specific sphere are deemed high risk considering the limited paying capacity of consumers.
In the conditions of sustainable growth tendencies in the living standards of population, the consumption of thermal energy can constitute 1/3 of the primary energy carriers imported to the country and its usage efficiency is the issue of state safety.

**Situation Analysis of the Current Heat-Supply in the RoA Settlements**

Heat-supply systems of RoA multi-apartment buildings and buildings of other significance (administrative, education, health care, cultural etc) formed in 1980-s and heading towards centralization of heat-supply, at present are entirely terminated and not useful for further operation because of physical and moral deterioration.

Before 1990, in 55 settlements of Armenia, 9098 multi-apartment buildings (with 14.2 mln. sq.m. living floor space) and 3075 buildings of other significance were getting centralized heat-supply, including 4254 residential and 1008 buildings of other significance in Yerevan.

*Yerevan city was serviced* by Yerevan Thermal Power Station (TPS), 9 Regional Thermal Stations (RTS), “Kanaz” CJSC and the central boiler-houses of the Institute of Mathematical Machines with 229 central thermal units (CTU), that were in common operation cycle with the Regional Thermal Stations, as well as 231 district and group low-capacity boiler-houses with thermal network of 622,1 km total length, of which 97,9 km – trunk.

*Heat-supply of other cities in Armenia was provided by* Hrazdan State Regional Electric Power Station (SREPS), Vanadzor TPS, Gyumri RTS (Mayisyan boiler-house), 280 central, district and group boiler-houses, as well as central boiler-houses of industrial enterprises (Zangezur Copper Molybdenum Mining Complex, Charentsavan “Tzentrolit” Factory, Ararat Cement Factory etc), with thermal networks of 902 km total length.

The RA Government Resolution N1384-N, adopted on 05.09.2002, defined the Strategy for Heat-Supply Rehabilitation, which main principles include those requirements for the heat-supply system of RA settlements, that relate to the satisfaction of environmental, health-care, energy saving and energy efficiency requirements, provision of reliable, quality and affordable heat-supply, ensuring of legal and technical capacities for individual regulation of consumed quantities of thermal energy. The complete demolition of previously operating centralized systems is now an indisputable fact and the “survival” and “sustainability” stages as prescribed by that Resolution in compliance with their Schedule of Actions Implementation, in fact, did not ensure neither the survival, nor the sustainability of centralized systems.

During recent years, in relation to the intensive rehabilitation of gas-supply in the settlements of the country, a certain progress is traced in the heat-supply rehabilitation processes. In the capital and other cities of Armenia, 640 educational, cultural, administrative and health-care buildings had their heat-supply systems re-operated and constructed through the state budget, various foundations, grants and consumer resources.

Nevertheless, the rehabilitation rate of multi-apartment buildings’ heat-supply is still very low. In the result of pilot projects implemented by means of loans and grant resources in 2006 – 2007 in Yerevan, 6 boiler-houses have been put into operation, which ensured heat-supply for 20 multi-apartment buildings, another 6 boiler-houses were put into operation in Gyumri and Aparan cities, which ensured heat-supply for 6 multi-apartment buildings.
After a number of structural changes, the state ownership status of heat-supply systems of 340 separate objects in Yerevan city has been preserved. 38 small objects were given for rent by the City Municipal for the purpose of implementing heating rehabilitation projects, and the heat-supply property of Davtashen and Avan communities in Yerevan city has been granted for uncompensated use to Armenian-Russian companies aiming to rehabilitate the centralized heat-supply in the mentioned districts by applying combined production installations.

Based on the collected data, in other settlements of the Republic approximately 20% of the boiler-houses was preserved, and the majority (around 80%) has been alienated and used for other purposes.

In view of the above-mentioned, it is necessary to carry out radical reconstruction of the entire system and develop new management approaches, and the preserved buildings can serve as a prerequisite for attracting investments into the systems.

The approved Master Plans for a number of cities include rehabilitation and reconstruction, but the implementation of these issues requires development of specific projects, schemes, realistic approaches in terms of state financing and attraction of investments.

**Existing Problems in the Sphere of Legal Regulation of Thermal Energy Supply**

A perfect legal field in the public heat-supply area is directly linked to the need for complex regulation of its economic, social, technological and legal mechanisms. Existing legal acts regulate a number of issues on activity licensing, pricing, supplier-consumer relationships without fully considering the technical, technological characteristics of the sphere, high potential for energy saving, specifics of legal relationships, high investment risk and a big social and environmental significance.

Based on the above-mentioned, it is essential to analyze the legal system of thermal energy regulation and to review the regulated legal relationships in the sphere of thermal energy regulation through legislative reforms.


**RoA “Civil Code” (hereinafter the Code, adopted on 05.05.1998)**

The RoA Civil Code Article 224 and Article 6 of the Law “On Management of Multi-Apartment Buildings” determine the common property of the owners of the apartments and/or non-living spaces in multi-apartment or multi-unit buildings, which belong to those owners by right of common share ownership. Article 224 of the RoA Civil Code states, that “to the owners of apartments in a multi-apartment building belong, by right of common share ownership, the common premises of the building, the load-bearing construction of the building, inter-floor covers of the building (the ceiling, the floors), cellar, attic, technical stores, the roof, as well as the entrances.
servicing more than one building and envisaged for common full maintenance of multi-apartment buildings, staircases, stairs, elevators, elevator and other types of pits, the mechanical, electrical, technical and sanitary, and other equipment outside or within the apartment that serve more than one apartment”.

Article 224 of the RoA Civil Code has been amended under the Laws 07.05.2002 –AL-336 and 10.04.2005 AL-188. But it has to be noted, that in the Civil Code of RoA adopted on 05.05.1998, Provision 1 of Article 224 has been composed with the following content: “To the owners of apartments in a multi-apartment building belong, by right of common share ownership, the common premises of the building, the load-bearing construction of the building, the mechanical, electrical, technical and sanitary, and other equipment outside or within the apartment that serve more than one apartment.”

In the former interpretation of the RoA CC Article 224, the sentence “outside or within the apartment that serve more than one apartment” provided a much clearer legal status of the internal networks /thermal, water, electricity/ inside the buildings rather than the current composition of Article 224 as stipulated by the above-mentioned two laws. The new definition of RoA CC Article 224 in compliance with the amendment in 07.05.2002 /AL-336/ “…servicing more than one building and envisaged for common full maintenance of multi-apartment buildings” has created a pre-requisite for contradictory interpretations of the law by the objects of civil legal relationships. In particular, there is a misconception or a wrong impression, that the water supply, water removal and heating lines, pipes, equipment installed inside or going through the apartment which are designed for the joint full maintenance of the building are regarded as an exclusive property of the given apartment owner, and therefore he has the right to carry out actions over those (cut, break) without taking into consideration the opinion of other participants of common share ownership. Or the apartment owner decides, at his own will, to allow or not allow other participants of common share ownership and the authorised representatives of the building management body to carry out renovation of water-supply and heating lines, pipes and equipment. Problems arise when the apartment owners for various reasons hinder the implementation of renovation, re-equipment and modernization of water supply and heating lines, pipes and equipment considered to be common share ownership. Hence, there is a need for precision and maximum clear definition of the boundaries of multi-apartment buildings of common share ownership, as well as the scope of property rights over the property considered to be common share ownership of the apartment owners in the multi-apartments buildings. The difference between the present wording of the RoA CC Article 224 “envisaged for common full maintenance of multi-apartment buildings” and the former wording of 05.05.1998 - “outside or within the apartment, that serve more than one apartment” is more vividly expressed when e.g. analysing the legal status of heat-supply network as an integrated, common and indivisible object /property/. The internal network of heat-supply in multi-apartment building is one common system – an object of common share ownership right, therefore it should be owned, used and disposed with the agreement of its co-owners under the procedures prescribed by the RoA Civil Code and the RoA Law “On Management of Multi-Apartment Buildings”.

It has to be also mentioned, that the application of Article 217 of the CC, “Burdening Buildings and Structures With a Servitude” will allow to ensure rehabilitation activities of the heat-supply internal network. The above-mentioned article determines the legal grounds for burdening the buildings, structures and real estate with a servitude, that will allow, where necessary, in the event of rehabilitation of heat-supply network or installation of a new network, to install the pipe-lines (heat-supply riser) through the owner’s apartment who refuses from the heat-supply. Taking into consideration, that the apartments are supplied from common riser, in this case the riser will be
considered as a property of common share ownership, and the battery supplied from the riser – the ownership of the apartment-owner.

RoA Law “On Energy” (hereinafter the Law, adopted on 07.03.2001) establishes the principles of the government policy in the energy sector and the mechanisms for their implementation.

In Article 4 of the Law “Basic Definitions”, the concept “energy” is defined as “electric energy (capacity) and thermal energy” and is equally regulating both electric energy, as well as thermal energy sectors.

The Law defines the procedures for licensing, setting of tariffs and service fees, guarantees for ensuring electric energy supply to the consumers.

As per the Article 23 of the Law, Provision 2 “The generation of electrical and thermal energy exclusively for the internal needs of a consumer shall not be licensed”. The production, transport and distribution of thermal energy shall not be licensed (not licensed and no tariffs set), where the initially set capacities of those systems do not exceed 5.8 MW. In the meanwhile, it should be noted, that the construction of those energy installations shall comply with licensing requirements.

Article 48 of the Law states, that “the relationship between the consumers, the sub-consumers and the supplier are regulated by the Service Regulations and Usage Rules”, which in compliance with Article 17 of the same Law, sub-clause “e”, shall be defined by the Public Services Regulatory Commission of RA.

We should note, that as stated in the existing “Interim Rules for Thermal Energy Supply and Use” (adopted on 29.05.2001, Resolution N23 of the RA Energy Regulating Commission) the supplier must be a “Licensed person”.

It has to be considered that the mechanisms ensuring safety of the heat-supply systems, as well as the electric energy and gas systems are not determined in the Energy Law, although clause 8 in Article 5 defines ensuring of safety in the energy sector as the principle of state policy. Nevertheless, the Law does not authorise any authority to develop technical norms for the safety of energy supply sector. At the same time it should be noted, that until now there have not been devised any technical regulations for the safety of water-heating boilers (which are more hazardous elements of heat-supply systems) and gas-heated individual systems in Armenia, that would set the realistic means of ensuring (rehabilitating) technical safety of the constructed systems or those under construction.

The RA Laws “On Condominiums” (adopted on 07.05.2002) and “On Management of Multi-Apartment Buildings” (adopted on 07.05.2001) govern the management relations of property representing common share ownership of multi-apartment buildings and define the procedure of management of common share ownership of multi-apartment buildings, the owners of buildings, forms of management, competences of management bodies of building, the procedure of formation, activity and termination of activity thereof, as well as their mutual relations with state and local self-government bodies and organizations, define the legal status of condominium, the procedure of establishment, activity, reorganization and liquidation of condominium, as well as mutual relations of management bodies of building with state and local self-government bodies and organizations.

The RA Law “On Management of Multi-Apartment Buildings” (herein, MMAP AL) defines regulation of legal relations between the owners of multi-apartment buildings and organizations.
providing services, particularly, the binding nature of decisions made with the competence of the general meetings of owners of the building construction, etc.

In cases envisaged by the law, the decision made by the owners’ meeting of multi-apartment building (herein, MAB) within the scope of authorities of the meeting and with appropriate votes shall be binding for all the owners of the multi-apartment building constructions, including the owners not participated in the voting irrespective of the reasons or voted against the decision (paragraph 5, Article 11, MMAP AL).

The authorities of the meeting of the owners of multi-apartment building and the number of necessary votes shall be defined by the above-mentioned law. For example, the management of the issues re common ownership, not envisaged by the MMAP AL, which is necessary for ensuring the maintenance of building, can be adopted by votes of at least two third of votes (subparagraph “k”, paragraph 7, Article 11, MMAP AL and paragraph 9, Article 11, MMAP AL).

The law also defines the scope of competence of getting into MAB closed apartments. In case of emergency, particularly damages of water supply, water removal, heating, gas supply and other general networks of the building, as well as in other cases defined by the law, authorized persons can enter into temporarily closed apartments and those closed for an unknown period of time, if failure to immediately fix the damages may cause damage to life, health and property of others, and if prevention and fixing of the damages is impossible without getting into closed apartments (paragraph 5, Article 11, MMAP AL).

However, it should be taken into account that currently the property rights in consumer-supplier relations in the field of heat supply are more vulnerable; this particularly relates to the problems re regulation of registration of the right to heating networks in multi-apartment buildings. In this regard, it has become necessary to make amendments and supplements in view of defining and prescribing more substantially the rights to the property considered as common share ownership and the procedures of registration of property rights considered as common share ownership in regard to registration (for example, intra-building heating networks, as a unit of real estate) and adjustment of lines. The aforementioned adjustments may create sufficient legal grounds for ensuring the exercise of the common share ownership right by the owners of a multi-apartment building, boost that process and make implementation thereof simple and perceivable to the maximum, ensure the maintenance of the property considered as common share property and take general decisions thereon.

Making of the aforementioned amendments is interconnected with prescription of the ownership right to heat supply systems and the issue re clarification of property rights to the heating networks of the point of demarcation (heat supplier-consumer), which shall be prescribed by a legal normative act (by an appropriate law).

Article 37 of the RA Law “On Local Self-Governance” (adopted on 07.05.2002) defines the binding authorities of the head of community in the field of urban development and communal services. Article 10 of the aforementioned law sets down the functions of the head of community in regard to organization of the operation of intra-community communication lines, water-piping, sewerage, irrigation, heat networks and other constructions considered the community property. Article 49 of the law defines the list of the property that can become the community property for exercising the binding authorities. Heating systems are embedded in the Article as such a property. The law relates to the authorities defined in regard to heat-supply units that are considered as
community property. However, in view of the fact that urban power economy contains great risks and requires huge investment costs and operates within a wide range of changes, one of the tasks of energy planning is to determine the object assuming the risks and the extent to which it should be done; hence, it has become necessary to make appropriate amendments to the aforementioned law, as well as to adopt a new law governing the field, by defining the mechanisms of ensuring development, implementation and monitoring of the heating plan (heat supply perspective development schemes) by community. The main concern of the community heating plan is satisfying the demands of consumers with affordable tariff, which, at the same time, is promoting energy saving with prescription of the principle of causing minimum environmental damage. Community heating plans shall be consistent with the state strategy of fuel-power policy and national concerns in the energy sector.

Since the RA Law “On Energy” fails to govern tariffing of the heat energy produced in boiler houses not exceeding the installed capacity of 5.8 megawatt, in this case it is recommended to define procedures for business entities of coming to an agreement with self-government bodies (municipality) about the presented tariffs, thus ensuring guarantees for the consumer interest protection.

Establishment of “plan” zones in the community area, assuming priority development of any form of heat supply, is of great importance. Such zoning will enable to avoid competition of different heat supply systems in a certain zone of the community area, which significantly reduces the total efficiency of the heat supply system, for installation of extra capacities and duplication of engineering infrastructure systems in that case is excluded and a more predictable situation is created for investors.

The RA Law “On Energy Saving and Renewable Energy” (adopted on 09.11.2004) governs the principles of the state policy of energy saving and the renewable energy development and the mechanisms of implementation thereof. To take the measures in the sphere of heat supply as per the law, it is necessary to provide an appropriate legal regulation environment, promoting introduction of energy saving technologies and construction norms and, particularly defining that:

- the State encourages development of centralized heat supply (cool supply), the combined production of thermal and electric power on the economically grounded demand in the contexts of primary power saving, reduction of network losses and contraction of emissions of top-heat gas;
- the State initiates legal events, promoting reduction of legislative and sub-legislative obstacles in the area of combined production, simplification of regulations in appropriate administrative links and speeding up the procedures;
- the body regulating public services develops and puts into effect the system of the conditions for primary power resource pricing, service tariffing and purchase of power energy, that will promote the development of apartment-communal heat supply based on combined production;
- by involving appropriate scientific-research and planning institutions, the authorized government body appraises the economically affordable and justified potential of applying technologies for combined production in apartment-communal heat supply and other fields of economy in the Republic of Armenia and develops a national investment program.

The interim rules for thermal energy supply and use as approved by Resolution No.23 “On approval of interim rules for thermal energy supply and use” (adopted on 29.05.2001) govern mutual relations of water supply companies, consumers (subscribers) and sub-consumers (sub-subscribers)
and are binding upon them. The rules are equally applied to the legal relations in regard to sub-consumers.

As per the Law “On Approval of Interim Rules for Thermal Energy Supply and Usage”, the concept of water supply company is defined as a legal person holding a license of production, transmission and/or distribution of thermal energy. This Resolution, in fact, does not regulate those non-licensed activities that also related to that area (if not exceeding the installed capacity of 5.8 megawatt in thermal systems), as a result of which the activity of water supply companies operating with lower installed capacity and the relations with consumers become more risky.

The law “On approval of interim rules for thermal energy supply and use” defines that the supply of thermal energy by a heat-supply company to consumer (subscriber) is authorized in accordance with the RA legislation, when the following conditions are met: it should be in compliance with the defined procedure and technical conditions; on the basis of normative documents; combination of the heat-supply system with the heat consumption system, as well as availability of the contract of supply of thermal power with a thermal power supplying company.

As it is already mentioned, technical regulations defining the realistic means for ensuring technical safety (rehabilitation) of the constructed systems and those under construction are not yet developed and adopted in the RA, though paragraph “h” of Article 5 of the RA Law “On Energy” defines it as a principle of the state policy.

Conclusions

The fact of necessity to review and improve the current legal environment in the RA related to the field is also attributable to the necessity of settlement of the following problems in the process of establishment of the field:

- Establish a mechanism promoting involvement of the financial-banking system formed in the Republic in the reconstruction and rehabilitation process of heat supply systems;
- Create a favorable tax, credit, customs or warrant environment for involvement of the private capital;
- Create focused and effective subsidy mechanisms of heat supply services for the vulnerable layers of population;
- Promote the development and introduction of legal and economic relations regulatory environment derived from community rules and equivalent to market conditions;
- Define pricing principles especially in view of primary energy resource tariffing that promotes rehabilitation and sustainable development of heat supply with minimum impact in terms of energy efficiency and environmental issues;
- Establish and put into effect a complete package of technical safety normative documents (construction norms and rules, technical regulations, etc.) and ensure control over satisfying the requirements specified therein;
- Define the frameworks of authorities for state and local self-government bodies in regard to maintenance and rehabilitation of heat supply systems, planning, construction, operation and organization of new systems;
- Provide short-term and long-term planning for development of economically efficient and affordable and safe heat supply systems in the view of environmental issues;
- Define a binding registration norm of complex polytechnic (water, gas, energy-supply, water removal) provision of the heat supply system in the course of implementation of tasks of developing the general layout of settlements and polytechnic networks, etc.
Necessary steps

Analyzing the current legislation reproduction, supply and consumption of thermal energy, identifying legislative lapses and on the basis of the international experience, it has become necessary to make appropriate amendments and supplements to legal acts and to draft a new RA Law “On Thermal Energy”, which will promote unified and interconnected enforcement of the RA current laws in the field of thermal energy, prompt coordination thereof, as well as will explicate the mutual relations between all the business entities engaged in the field and the state and will ensure control mechanisms for the field. In this regard, the law will provide the basics of legal, economic and organizational relations for heat supply necessary for the regulation of the field, competences of state-government and local self-government bodies in the view of planning, management, regulation and control of the area and the frameworks of rights and duties of the participants in the thermal energy market.

The scope of the law will embed heating and hot water supply of dwelling and public buildings, units of public utility, as well as satisfying the non-technological thermal demand (water heating and hot water supply) of industrial enterprises, and small and medium-sized enterprises.