PN ACE-154 99583

BURNS AND ROE ENTERPRISES, INC.

TECHNICAL REPORT for Delivery Order No. 11:

Tbilisi District Heating System Improvement Program

GEORGIA

June 30, 1998

Prepared by:	**Burns and Roe Enterprised, Inc. and the Georgian Company ArCi Consulting**
Submitted to:	**U S. Agency for International Development**
Contract No :	**CCN-0002-Q-00-93-00154-00 Energy Efficiency and Market Reform Project Delivery Order No 11**

S \DOUG\DO11\DO11RPRT COV

DELIVERY ORDER NO 11
TBILISI DISTRICT HEATING SYSTEM IMPROVEMENT PROGRAM

TABLE OF CONTENTS

PART I - OVERVIEW

1 0 EXECUTIVE SUMMARY

1 1 Introduction
1 2 Principal Findings
1 3 Recommendations

2 0 BACKGROUND

2 1 Objectives of Delivery Order
2 2 Scope of Work

3 0 DISCUSSION

3 1 Introduction
3 2 Defining the Problem
3 3 Some Possible Solutions
3 4 Sources of Financing

4 0 CONCLUSIONS and RECOMMENDATIONS

PART II – TECHNICAL REPORTS

A Study of Tbilisi Heating System Rehabilitation Possibilities
Attachment Program for Establishing Demonstrative Zone of Public Services in Tbilisi

B Tbilisi Combined Heat-Power Plant Rehabilitation Alternatives
Technical-Economic Optimization of Operational Regimes

APPENDICES

DO11Tabl doc

B

APPENDICES

Appendix A

USAID Delivery Order No 11 Statement of Work

Appendix B

References – Lists of Studies, etc

Appendix C

Trip Reports

Appendix D

Photographs

Appendix E

1 Subtask 1 – District Heating Thermal Station No 9 Rehabilitation (Co-generation opportunities)

2 Subtask 5 – Heat Supply System Rehabilitation for the Oncology Center (cancer) Hospital (co-generation opportunities)

3 Reference to Technical Report Previously Submitted March 1996 – Phase II, Selected Design Solutions and cost estimates March, 1996

4 Miscellaneous Information about Potential District Heating Projects

C

OVERVIEW

d

1 0 EXECUTIVE SUMMARY

1 1 Introduction

The work described in this report was conducted by Burns and Roe Enterprises, Inc (BREI) through it's contract with the U S Agency for International Development (USAID) The work was completed under the framework of USAID's Energy Efficiency and Market Reform Project for the Newly Independent States It was implemented under Delivery Order #11 for Georgia entitled, "Tbilisi District Heating System (DHS) Improvement Program " This work has included the development of specific projects that will lead to returning portions of the existing DHS back into operation In addition, USAID provided funds to implement some of the most urgently needed heating system rehabilitation work, which has been successfully implemented at four hospitals and two schools

Georgia is dependent on imported natural gas and petroleum fuels for generation of electricity and production of heat for domestic and commercial consumers Non-payment for energy by consumers, and lack of hard currency for the government to pay for imported energy resulted in large debts and eventual curtailment or stopping of gas and oil supplies Lack of gas, oil and electricity has in turn resulted in shutting down the enterprises producing the export commodities, which could have provided hard currency to pay for imported fuel or energy

The fuel crisis resulted in complete shutdown in 1993 of 46 district-heating system thermal stations for the past five winters, which formerly supplied heat and hot water to the city of Tbilisi The one small Combined Heat and Power (CHP) station in the center of Tbilisi has only operated intermittently over the past six years, mostly for supplying heat to government buildings In addition, more than 40 hospitals and orphanages have not had natural gas for hot water heating boilers, or diesel oil for emergency generators

The population has resorted to substituting electrical resistance heaters for warmth, for hot water heating and for cooking The electrical distribution systems were not designed for these loads and system protection measures such as fuses, breakers and load-shedding controls have been bypassed Power supply is still not reliable, with frequent outages, and varying voltage and frequency, causing damage to equipment

Up to the present time the main fuels now being used by the population for winter heating are kerosene, propane and wood Many large consumers of heat such as government buildings, universities, banks and private commercial enterprises have installed their own hot water heating boilers burning diesel oil, and disconnected their buildings from the district heating networks They can be switched back to natural gas supply when available

1 2 Principal Findings

- Forty-six district heating thermal stations representing about 2927 MWt (thermal) have been shut down since 1993 without any capital preservation of boilers and/or lay-up of 3268 km of distribution piping It is doubtful that any of these stations can be economically rehabilitated
- There are more than 5000 apartment buildings with more than 300,000 flats housing about 1,000,000 people which were previously supplied with district heating hot water
- Before 1993, 20% of electricity supply was for domestic household use Currently more than 70% of electricity is used for heating, hot water supply and cooking, which is inefficient
- It is estimated that more than 300 MWe of electrical load has been added since cut off of heating by the DHS
- Included in section II of this report are several design proposals and cost estimates and economic analyses for rehabilitation and/or re-powering of some district heating thermal stations and hospitals heating systems and geothermal hot water supply
- A summary of costs for DHS rehabilitation work are as follows

Description	Unit Cost	Estimated Total Cost, $
Restore hot water supply to apartments	$700-$900 per apartment	$3 5-4 5 million
Restoration of hot water network	$600/meter	$2,000 million
Reconstruct a typical CHP	$140-$250/kw	$420-750 million

- Included as an attachment to the technical report in section II of this report, is a proposal for a Pilot Demonstration Zone for metering of electricity, natural gas and geothermal hot water and installation of apartment gas heaters This project will cost about $200,000 Detailed designs and specifications were also prepared
- There have been several success stories about supplying heat to needy consumers USAID funds ($300,00) were used to repair boilers in two maternity hospitals, a mental hospital, and the Tbilisi Burn Hospital Also, a solar hot water system was installed at the burn hospital that will provide about 40% of their annual hot water consumption In addition, gas fired hot water boilers were installed at two schools

There are local contractors who can perform DHS rehabilitation work on a firm fixed price basis All work for the above DHS rehabilitation work were performed by local Georgian contractors All contractors were selected through a competitive bidding process, in accordance with USAID requirements

1 3 Recommendations

Over the past three years there has been review of previous studies and reports, detailed assessments of forty- seven thermal stations, twenty- three hospitals and orphanages, numerous schools, and surveys of the population In addition, several rehabilitation and re-powering proposals have been developed for alternative cogeneration Combined Heat and Power (CHP) Plants Following are a few recommendations that hopefully will help to alleviate the continuing energy crisis in Georgia, and especially in the city of Tbilisi

- It appears that the only realistic hope for restoring heat and hot water to the population of Tbilisi for domestic use is an eclectic mix of individual projects Some examples are a few district heating stations reconstruction or re-powering as cogeneration, some decentralized gas fired building heating boilers, development and utilization of existing geothermal resources for hot water, installation of through-the-wall gas fired heaters in individual apartments and solar hot water supply systems
- Most important is rehabilitation and restoration of metered natural gas supplies to individual apartment flats for cooking, heating and hot water heaters
- In parallel, it is necessary to upgrade and restore electricity metering and payment collection When tenants realize that natural gas is less than half the price of electricity and kerosene, there is an incentive to install relatively inexpensive gas heaters in their flats There is also the resulting environmental and health benefits
- Millions of dollars in loans are being considered for building more megawatts of fossil fired electric generating capacity However the already overloaded and depreciated distribution system cannot handle additional resistance heat loads Funding should be provided for continued rehabilitation of the natural gas and electrical distribution and metering systems to consumers
- The highest priority should be given to implementing targeted pilot projects coupled with the reforms for legal and accounting systems for payments for energy and continued privatization of the energy enterprises resulting in a workable free market economy

2 0 BACKGROUND

Twelve newly independent states (NIS) emerged from the collapse of the former Soviet Union in 1991 USAID has addressed and managed assistance to these countries through the Bureau for Europe and the New Independent States (USAID/ENI) Funding activities in the energy, energy related and environmental sectors have supported technical assistance, training, pre-loan assessments, feasibility studies and limited capital assistance in support of energy related equipment and cooperative activities with local institutions

USAID has provided support to the country of Georgia through its Mission in Yerevan, Armenia and through its resident contractor Burns and Roe and subcontractor ArCi Consulting Ltd in Tbilisi This support has been directed towards development of Georgia's institutional and regulatory reforms needed to attract private sector participation and investment, implementing conservation and energy efficiency programs in the industrial and residential sectors and developing indigenous energy resources such as geothermal, coal and solar

Numerous feasibility studies and proposals have been prepared over the past five years in support of funding decisions by the World Bank and the European Bank for Reconstruction and Development (EBRD) This report is the culmination of three years of work funded by USAID, which began with Delivery Order No 8 in 1995 to find solutions for the heating crisis, which has occurred, since then in the city of Tbilisi

2 1 Objectives of Delivery Order

The purpose of this delivery order was to address the critical emergency needs of the energy sector by expanding use of domestic energy resources and improving the efficiency of energy consumption An additional objective was to further evaluate the condition of the Tbilisi district heating systems and work with local authorities to provide immediate, near and long term proposals for providing heat to all economically viable consumers, as well as to the most vulnerable consumers such as hospitals, orphanages and schools Designs and specifications were generated to conduct a pilot metering, billing and collection project in a representative Demonstration Zone of Tbilisi

2 2 Scope of Work

Additional data collection and condition assessments were carried out by review of all available reports and studies to date and re-visiting of district heating thermal stations, Tbilisi TES, hospitals, schools and government buildings, as well as interviews with residents and technical specialists The Scope of Work required for developing the immediate, short and long term rehabilitation and development of district heating follows

- Identify alternative forms of heating, including cost of equipment, efficiencies, fuel and maintenance costs and economic comparison to other forms of heating
- Evaluate the potential future need for construction of new capacity
- Develop budgetary capital, operating and maintenance cost estimates for proposed rehabilitation plans
- Identify potential financing sources for system upgrade projects
- Include a Pilot Demonstration Zone installation and replication of metering, billing, collection and control systems to support the privatization and future commercialization of utility supply companies
- Provide limited procurement of critically needed spare parts and materials to renovate and operate boilers and piping
- Procurement of materials for the pilot metering project should have priority
- Consult and coordinate with the government of Georgia, the Municipality of Tbilisi, international financial institutions and other western consultants and donor organizations

3 0 DISCUSSION

3 1 Introduction

This report is a continuation and conclusion of work started in November 1994 under USAID Delivery Order No 8 – Georgia, to address the Critical Energy Needs (Emergency Program) after break-up of the Soviet Union in 1991 The objectives were to provide emergency assistance to Georgia's most vulnerable groups such as hospitals schools and orphanages and to accomplish a preliminary assessment and database for the district heating systems in Tbilisi A report, "Study of Tbilisi Heat Supply Systems, Rehabilitation and Development Opportunities" was prepared by ArCi Consulting for Burns and Roe in April-May, 1995 Burns and Roe completed a Report for Delivery Order 11 entitled " District Heating System Optimization and Hospital Heating System Rehabilitation for the City of Tbilisi" was completed in February 1996 This report summarized the results of the ArCi Study, and outlining a number of potential projects for rehabilitation or development

The objectives of USAID Delivery Order No 11 – Tbilisi District Heating System Improvement Program, as a continuation in February 1996, was to assess the current status of the Tbilisi district heating systems The tasks were to identify alternatives for providing heat for the population, evaluate potential future need for construction of new capacity, develop rehabilitation proposals and identify potential financing sources for system upgrade projects An additional requirement was to install and conduct a Demonstration Zone Pilot metering, billing, collection and control system to support the privatization and commercialization of district heating and utility service companies

This section of this report, Part I, presents an overview of the previous several years of studies, assessments and findings Part II of this report and appendices contains the detailed technical reports and reference information

3 2 Defining the Problem

Before 1960 heat was supplied to buildings and facilities in Tbilisi from about 1000 separate low capacity boiler houses The only central heating system was the Thermal Electric Station (TES) which originally heated eleven multi-flat dwelling houses

Development of the city's present centralized district heat supply systems based on medium and high capacity thermal stations began in 1960 At the same time, individual boilers were eliminated Development of the centralized heating systems was facilitated by the simultaneous construction of a natural gas distribution system throughout Georgia that supplied natural gas imported from outside Georgia

At the present time the Tbilisi Central Heat and Power (CHP) system is made up of 46 district heating thermal stations and the small Thermal Electric Station (TES), which represents a capacity of 3,600 GCal/Hr (2927 MWt) heat and about 18 MWe power As of 1993, the district heating systems were already in poor condition due to poor maintenance, and would have required large investment to rehabilitate Since 1993, most of the thermal stations have been shut down due to lack of natural gas and mazut, and all equipment has sustained additional damage due to lack of proper lay-up and preservation

- There are 110 hot water boilers varying in size from 0 8 GCal/Hr to 150 GCal/Hr for a total heat output of 7,327 GCal/Hr Ages vary from 9-30 years (1968-1989) These boilers are low efficiency designs, and most are beyond repair
- There are 111 steam boilers varying in size from 1-100 tonnes/Hr for heating mazut and water and for supplying steam to industrial consumers for a total steam production of 3042 tonnes/Hr Most of these boilers have deteriorated beyond repair
- There are more than 550 pumps for boiler feed, hot water distribution, water treatment and mazut, 286 heat exchangers and 79 deaerators, most of which have deteriorated beyond repair
- Most of the electrical equipment is more then 25 to 30 years old, obsolete and deteriorated beyond repair Much has been vandalized and removed
- There is about 3268 Km (2043 miles) of piping installed in the city of Tbilisi district heating systems Most of this pipe is either direct buried with bitumen-perlite insulation and polyethylene water proof wrap or laid in ferro-concrete trenches with mineral wool insulation and fiberglass-asphalt roofing material wrap Because the piping has been lying idle for several years without circulation or heat, damage due to internal and external corrosion and deterioration of insulation is estimated to be extensive
- About 1970 Km (1231 mi) balance of piping within the thermal stations for transporting cold and hot water, steam, natural gas and mazut is badly corroded and missing insulation Most valves are inoperable, frozen in position from corrosion and most of the piping is deteriorated
- Natural gas distribution piping throughout most of Tbilisi to thermal stations, businesses and apartments has been out of service since supply cut off during 1993-1994 Much corrosion and damage has occurred, and piping has been disconnected where hot water heaters, stoves and some boilers have been removed Distribution piping has been rehabilitated in some districts of Tbilisi, but piping within buildings need to be checked and leak tested
- Much of the single pipe hot water distribution piping and radiators in apartment buildings have corroded beyond repair and some have been removed

There are more than 300,000 families in about 5000 apartment buildings, many that are high rise, which were supplied with hot water from the district heating systems These families have since substituted electric heaters, kerosene heaters and wood stoves for heat and hot water Since the natural gas supply to Georgia was curtailed or completely cut off during 1993-1994, more than 70% of electricity supply for domestic household use is

being now used for heating, hot water and cooking Previously, only about 20% of electricity was used for domestic consumption, mostly for lighting

Results from assessments and cost estimates in technical reports in Section II indicate that it would require about $700 to $900 per apartment to rehabilitate the hot water heating system The cost to replace hot water network distribution piping would average about $600 per meter from thermal stations The cost to reconstruct a typical thermal station would be about $140 to $250 per kW The CHP tariff to cover heat production would have to be at least $0 06 per kWh equivalent The present tariff for electricity is about $0 033 per kWh, and there is very low collection of consumer payments As long as the tariff for electricity is lower than the cost of district heating, no one will pay

Before 1993 the cost of heat and hot water was less than one percent of a families annual income At the present cost of fuel, and rehabilitation of hot water district heating systems, in order to supply the same amount of heat and hot water a family would have to spend four to five times their present annual salary

It will be very difficult to overcome the present inertia of consumer attitudes and energy use patterns set over the past five years The population out of desperation for heat has purchased thousands of electric, kerosene, propane, wood and coal heaters and stoves Citizens will be hard pressed to again be asked to spend limited or non-existent income for new gas heaters, gas meters or electricity meters in the near future When tenants realize that natural gas is less than half the price of electricity and kerosene, there will be the incentive to install relatively inexpensive natural gas heaters in their flats, and replace electric hot water heaters with natural gas heaters

The conclusions are that as long as most of the population is insolvent, and electricity is not properly metered and paid for, there is little incentive for the population to pay for the energy they consume It will be very difficult to economically justify rehabilitation of district heating supply to most of the domestic population of Tbilisi

3 3 Some Possible Solutions

The most realistic solutions for restoring heat and hot water to the population is a combination of projects This includes reconstruction and/or re-powering of some district heating stations and installation of decentralized natural gas fired hot water boilers for some large buildings or groups of buildings Most important is rehabilitation of natural gas distribution piping and restoration of metered natural gas supplies to individual apartment flats for cooking, hot water heating and possibly some space heating In parallel, it is necessary to upgrade and restore electric metering and payment collection

There are several thermal stations that were evaluated for reconstruction as combined cycle Combined Heat and Power (CHP) plants that would have had good thermal hosts as well as being able to supply electricity to the grid in order to maximize fuel utilization

efficiency These hosts were government buildings, banks, schools and hospitals However, since completing the proposals, the potential thermal hosts procured and installed their own hot water boilers and disconnected their buildings from the network Since these hosts can burn natural gas to produce their own heat, they are not likely to pay more for hot water from a district heating system
Several of the proposals are included in Part II and in the Appendix E, and could be reconsidered in the future when economic and legislative reforms are stabilized and privatization of the energy sector will allow market forces to regulate the actual prices of energy In order to justify financing of any of the proposals, there must be the cash flow from revenues from tariff collections for electricity, natural gas and heat to pay for the fuel and service the loans for the projects

At the present time the most important potential rehabilitation projects are those for hospitals, schools and orphanages where the cost of energy is partially subsidized by the government The projects completed in the past two years with USAID and World Bank funding are examples of small investments of seed money to demonstrate the importance of energy conservation and developing entrepreneurial and management experience in a business environment Several other projects are listed in appendix E

The immediate to short term solution for supplying district heating to some of the population in at least four districts of Tbilisi is to spend about one million dollars per year for the next few years for maintenance and repair works at the Tbilisi Thermal Electric Station (TES) The major constraints to this solution are the poor condition of the hot water distribution piping en-route to buildings and the poor condition of the single pipe systems within the buildings, as well as lack of solvency of consumers

A longer-term solution is to replace the existing TES with a new high efficiency gas turbine combined cycle Combined Heat and Power (CHP) plant to tie into the existing hot water and electric distribution systems The existing electric transmission substation could handle up to 80 MWe Alternative conceptual designs have been evaluated for proposals as part of USAID Delivery Order 31 – Georgia, Least Cost Development plan

The Tbilisi Combined Heat and Power (CHP) plant Thermal Electric Station (TES) is a significant power generation and distribution site for the city because it serves as a primary substation with 18 feeders to the city grid The feeders supply power to high priority consumers such as the Parliament building, Ministers Cabinet, opera house, national stadium, hospitals, schools, banks, etc The present CHP capacity is 18 MWe, and the transmission substation provides 45 MWe to the city grid The total capacity of the 6 kV City lines and 35 kV grid lines is 80 MWe in case that the TES is reconstructed with increased capacity in the future

The three existing steam turbines can supply up to 70 MWt of heat (hot water) to four districts of Tbilisi, Didube, Chugureti, Mtatsminda and Krtsanisi The existing supply network is comprised of heating and hot water supply systems The network is divided into two zones of supply and return piping The upper zone supplying Mtatsminda and

Krtsanisi districts is about 13 km, and the lower zone supplying Didube and Chugureti districts is about 26 km Pipe sizes are 100, 125, 150, 200, 300, 400 and 500 mm diameters The heating and hot water supply systems are closed type with intermediate heat exchangers

Two hot water peaker boilers are in poor condition and should be removed They were designed to supply heat efficiently during very low temperature weather conditions The boilers seldom operated at more than 50-60% design load with poor efficiency at typical weather conditions in Georgia In addition, heating of water in a boiler is less efficient than using extraction steam from a power turbine to heat the water Also, the number of potential solvent heat consumers has been reduced because they installed their own hot water heating boilers, and disconnected themselves from the network

The piping supply networks are presently in poor condition and much has been out of service since 1993 At that time heat and water losses were as high as 25% due to deteriorated insulation and corrosion It is certain that further depreciation and damage to the piping systems has occurred due to both internal and external corrosion It will be necessary to inspect and repair individual sections of network piping before restoring supply of hot water to consumers This work can be done in steps to meet the heat load of potential solvent groups of consumers

In order for any of these proposals to be viable projects, there must first be an aggressive program to complete rehabilitation of the electricity and natural gas distribution systems in selected districts Then the electric wiring and natural gas piping must be rehabilitated and meters must be installed in selected groups of buildings where a majority of residents are solvent and willing to pay for utility services Some groups of buildings or large buildings with many apartments should be considered for rehabilitating hot water piping with meters and installation of hot water boilers

A pilot demonstration project was developed for the Digomi district of Tbilisi to install electric and natural meters and supply metered geothermal hot water to the central communal bathhouse There are 18 buildings in this district which vary from 5 to 14 floors, with from 60 to 130 flats per building totaling 1283 flats housing about 6000 people The reasons for selecting the Digomi district are the following

- Power distribution is typical for Tbilisi
- Gas supply system has been rehabilitated
- Representative cross-section of Tbilisi population
- District with typical mix of 18 buildings
- USAID funded a gas fired hot water boiler installation at the kindergarten
- Available geothermal hot water supply which can be expanded
- District heating thermal station No 5 in district next to buildings is attractive investment opportunity for privatizing and rehabilitating

The design is for about 334 electric meters to be installed in locked boxes in entrance areas for metering one, three, fifteen or thirty families per meter Because of the physical difficulties to change wiring in many buildings, the new Civil Code requires formation of Residents Associations for administering and accounting communal payments for groups of flats Existing meters will remain in apartments for consumers to monitor their consumption and to settle any disputes about their payments

Separate meters are installed for elevators and some common entrance and hallway lighting All of the electric meters will have switches to cut off service to non-paying consumers This will discipline consumers and change their attitudes and consumption patterns from not caring about how much electricity they are using to giving attention to saving electricity and money As a result it will be possible to guarantee electric power supply to paying consumers

The plans are to install 483 gas meters in flats that do not have meters The communal bathhouse needs to be repaired and geothermal hot water will be supplied and metered The design includes gas heaters to be installed in 45 single-family flats, 3 in the police station and 2 in the communal bathhouse

The detailed design proposal is described in Part II of this report Design and tender documents were prepared by ArCi Consulting, Ltd in Tbilisi for rehabilitation of electric wiring and natural gas piping to each apartment and installation of electric and gas meters Contractors were screened and selected and bids were received and evaluated by Burns and Roe and contracts were ready to be signed to start construction The USAID Mission in Tbilisi canceled the project because of concerns about legal issues related to Homeowners Associations and common areas specified in the new Civil Code The Mission was also concerned that there would not be any follow up monitoring of results

The results from this project will provide much valuable information for implementing metering programs in other districts such as

- Equipment and labor costs for metering in different types of buildings
- The effect of less expensive gas supplies on electricity consumption
- If payments for electricity and gas will improve

The Demonstration Zone pilot metering project is of special importance to the government of Georgia and the Municipality because it may be the first known project of its kind and size in the CIS that integrates gas and hot water metering as well as electric metering in the same project This project is an important example which lays the framework for the present ongoing reforms being developed for the accounting and management systems needed for the monitoring, billing and collection of tariffs for energy The project will also promote the development of energy management capabilities and organizational discipline needed for privatization in the energy sector

There is a significant amount of 62-64 C geothermal hot water at 2300 to 2500 m depths below the city of Tbilisi that can be utilized for heating of hot water for consumption USAID funds were used for repair and testing of an existing production well 5-T that presently supplies about 1900 cu M per day of water to about 3000 apartments in the Saburtalo District Also, well No 7-T was repaired for monitoring water level of resource during flow tests ArCi Consulting, Ltd in Tbilisi previously prepared a preliminary design proposal for increasing the capacity and re-injecting the water to prevent exhausting of the deposit This well could supply hot water to about 40,000 or more consumers The estimated cost for the re-injection system would be about $2,800,000

There are about eight other existing geothermal hot water wells in Tbilisi that were drilled about 15 years ago that could be put into service to supply hot water to several hundred thousand people It is estimated that about 65 MWt of geothermal hot water supply could offset about 50,000 tonnes of oil equivalent per year, which would reduce greenhouse gas emissions as part of Georgia's obligation according to the Global Climate Change Treaty Inspections and assessments would have to be made and designs prepared for supply and metering of hot water to consumers

A project was completed using USAID funds to install a solar hot water system at the Tbilisi Burn Hospital to supply as much as 40% of the annual hot water needs for cleaning, bathing and laundry needs There are many other examples of hospitals, orphanages, and possibly apartment buildings where solar hot water systems could be installed to reduce dependence on electrical consumption and expensive imported fossil fuels There would also be the environmental benefits achieved from these projects

3 4 Sources of Financing

The possibilities for locating multinational financing for district heating projects in Georgia at this time are not very optimistic The government has been slow in support of reforms for privatization of the energy sector, for implementing the necessary legal and accounting control systems necessary for private enterprises to grow and flourish There is also the uncertainty about the future of taxation and the kinds of taxes imposed for production of heat and power

There has yet to be any potential enterprises identified which would be willing to form a company or joint venture willing to invest private equity capital in any of the defunct district heating thermal plants for rehabilitation, re-construction or re-powering The Tbilisi Thermal Electric Station (TES) Combined Heat and Power (CHP) plant is supposed to be in the process of privatization as a Joint Stock Company, but in reality is still a government owned facility Another quasi private company Geothermia, Ltd has been chartered by the government and been given long term leases on some geothermal wells to operate as a geothermal utility service company to supply hot water to consumers and collect revenues However, these organizations do not have the private capital to invest in significant equity for obtaining loans, and are still dependent on the government even for operating expenses Added to this is the general economic crisis in the whole

country and the low solvency of the population at large to pay for hot water heat even if it was available

The World Bank has a present program called "Municipal Development Plan " that is funding tasks for developing institutional reforms, promoting competition, rehabilitation projects and maintenance projects

The European Bank for Reconstruction and Development opened a new office in Tbilisi this year (1998) and is interested in finding district-heating projects to provide loans It is understood that these loans are private and will require local equity investment as well as foreign partner investments

Another potential source of funding for some of the smaller projects is through the United Nations Development Program, office in Tbilisi The government must request funding for projects that show improvements in energy efficiency and/or reduce emissions of greenhouse gases The Global Environmental Fund could finance medium size projects up to one million dollars

The U S Trade Development Agency should be investigated as a possible source of financing for projects that will promote American goods and services

The German bank KfW will fund proposals and studies for German companies for the purpose of developing work and trade for German companies

There are many donor organizations that may be able to provide funding for smaller projects such as the hospitals and orphanages for humanitarian reasons

4 0 CONCLUSIONS and RECOMMENDATIONS

Almost all of the district-heating thermal stations have been shut down for the past four years without any technical preservation of boilers and equipment and hot water distribution piping Most of these plants have deteriorated to the point where it is not economical to even consider rehabilitation or rebuilding them It is not likely that any large-scale rehabilitation of district heating can be accomplished any time in the near future, if ever It may be possible to economically rebuild two or three of the stations with gas turbine or gas engine combined cycle heat and power plants as proposed in later parts of this report, provided that thermal hosts can be contracted and power can be supplied to the grid

Some of the factors that are disadvantages against major rehabilitation or reinstating of large centralized hot water district heating in Tbilisi are

- Relatively mild climate and short winters
- Complex terrain requires expensive technical solutions
- Reconstruction of thermal stations and electrical systems, distribution piping, consumer buildings internal piping, metering and control systems will require large investments
- Pay-back periods for thermal heat only stations would be very long, more than 15 years, compared to less than 5 years for combined heat and power stations
- The cost of thermal energy production for rehabilitated heat-only thermal stations could be as high as $0 085 to $0 095 per kWh equivalent compared to present electric tariff of $0 033 per kWh
- Most of population presently use electric, kerosene and wood to heat flats to 15-18 C (59-64 F) at best in winter (based on personal experiences) and could not afford to pay for district heat under present economic conditions and annual salaries
- Rehabilitation and reinstating of natural gas supplies and metering will probably be a more economical solution for heat for the domestic population, either from decentralized hot water boilers in multi-flat buildings or individual gas furnaces in some flats
- The refugee problem is still putting a drain on the Georgian economy

It has been said that the site property of many of the thermal stations is more valuable for commercial development of shopping malls, modern housing complexes and new business enterprises If fact, there is significant free enterprise growth that is occurring in the private sector For example, companies such as British Petroleum, Enron, British Airways, and dealerships for Mercedes Benz and BMW, McDonalds Restaurants, etc are opening offices or facilities in Tbilisi And yet the supply of electricity during the 1997-1998 winter in much of the city was only about two hours in morning and about four hours in the evening Also, the power is not stable, with voltage spikes and frequency

swings that damage equipment Almost every business has a generator to operate when the power is out These developments in the private sector should be a message to the Government of Georgia, that the reforms everyone talks about and work on need to be expedited to see more rapid privatization in the energy sector Entrepreneurial business development in the energy sector should be encouraged with the necessary legislation, tax benefits and positive legal status for contracts and recourse

Some recommendations which have already been repeated many times by many others for priority action

- Implement the Digomi pilot demonstration metering project described in Part II
- Find funding for rehabilitation of Tbilisi TES district heating supply and metering
- Continue rehabilitation projects for hospitals and orphanages
- Continue rehabilitation of natural gas distribution and metering
- Continue rehabilitation of electrical distribution and metering
- Emphasize the importance of legislative and accounting reforms being worked on by USAID and other organizations leading to privatization of the energy sector to support a free market economy

Development, Investment & Engineering
Ar&Ci Consulting

Delivery Order 11
Tbilisi District Heating System Improvement Program

STUDY OF TBILISI HEATING SYSTEM REHABILITATION POSSIBILITIES

Technical Report

Prepared under Contract No 5826-055 with Burns & Roe Enterprises, Inc

Tbilisi, 1998

16

CONTENTS

1. Introduction 1

1.1. Initial Situation 1
1.2. Identification of the Problem and Work Methodology 1

2 **Tbilisi Heat Supply** 3

2 1 **Historical Data** 3
2 2 **Centralized Heating System of Tbilisi** 3
2 2 1 Heat Generation 3
2 2.2 Thermal Energy Supply 4
2 2.3 Distribution and Utilization of Thermal Energy 5
2.2 4 Results of stopping the central heat supply system operation 7

3. Conclusions and Recommendations on Rehabilitation of Centralized District Heating System 9

3.1 Rehabilitation of centralized system for heat supply of population 9
3 2 Possibilities of Rehabilitation of Centralized Heat Supply Systems for Heating of the Existing Buildings and Institutions 11

4 **Autonomous Heating Systems** 21

4 1 **Rehabilitation of Existing Autonomous Heat Supply Systems** 21
4 2 Creation of New Autonomous Heating Systems 21

5 **Use of Renewable Energy Sources** 25

5 1 **Geothermal Energy** 25
5 2 **Solar Energy** 27

6. Conclusions and Recommendations on Heating Supply to Population 29

6.1. Main Principles of Upgrade of Heat Supply Systems Inside Buildings 29
6.2 Possibilities of Heat Supply System Modernization Located in Buildings 29
6.3. Cost of Thermal Energy and its Price 38
6.4. Nominal Heat Consumption by Households in Tbilisi 40
6.5 Solvency of Households in Tbilisi 42
6.6 Individual Heating Systems for Population 46

Attachment - Program for Establishing Demonstrative Zone of Public Services in Tbilisi

1. Introduction

1 1. Initial Situation

Today Georgia is in a state of deep economic crisis The Power sector is the most critical branch of the National Industry On one hand, it is one of the reasons for the economic crisis in Georgia, and, on the other hand, due to the economic crisis it suffers serious problems itself

All Though Georgia has its own resources of fossil fuel, during the soviet period sufficient attention was not directed toward their exploration and extraction

Since 1992, when Georgia become an independent country, it had to cover almost all kinds of demands for fuel for the power system by means of purchasing and importing gas and fuel oil, paying world market costs However, the rise of purchase costs was not followed by adequate income from increased consumption prices In the current situation most a consumers are not financially capable to cover the costs of consumed power, gas and thermal energy, and there appeared an inscreasing gap between costs of actually consumed power and costs covered by consumers Accumulated debts grew because of the low solvency of power generation enterprises They could not pay foreign fuel suppliers and thus they reduced power generation or even stopped functioning

Simultaneous ceasing of all Tbilisi (and almost all of Georgia) district heating systems' operation in 1993 immediately impacted the power supply system The situation has become worse after stopping natural gas supply to households in 1994 as a result, the demand for electric power for cooking, and particularly for providing heating to apartments and offices, was greatly increased

Currently, the increased demand can not be completely met by means of Georgian power generating enterprises, and it results in to administrative ways for of power consumption limitation

In the existing situation rehabilitation of the thermal energy supply will largely reduce electric power consumption, This is an issue of great importance for the purpose of improvement of whole power sector

Difficulties experienced by the power sector of Georgia impacts all the rest of national industries, as availability of power is one of the vital sources for rehabilitation of the production system for adequately raising the welfare level in Georgia

1.2 Identification of the Problem and Work Methodology

The goal of the report is to summarize results of investigations on possibilities of rehabilitation of centralized thermal energy supply (district heating systems) in Tbilisi, and on seeking alternate suggestions connected with heating supply which

were investigated during 1995 to 1998 for scope of work in USAID 'Delivery order #11 ' This final report is an expansion on, and conclusion of the work which was performed in USAID 'Delivery order # 8'

- To present an overview of the facilities of district heating systems
- To visit Ministries, Departments and Technical Institutes
- To look for and become familiar with all reports, studies and assessments performed by third parties
- To prepare a database on current conditions of district thermal stations
- To select demonstrative projects among district heating systems and to develop proposals of their rehabilitation
- To select demonstrative projects for existing autonomous heating systems and to develop proposals for their rehabilitation
- To select demonstrative projects and to prepare recommendations on creating new autonomous heating systems
- To work out proposals for utilization of renewable sources of energy
- To prepare a pilot project for creating system of proper metering, payment collection and power consumption control systems
- To estimate necessary capital investments needed for implementing all the developed out proposals and projects, and preparation technical specifications of necessary equipment and materials
- To monitor the transportation, delivery and installation of the necessary equipment and material during the implementation process of the above mentioned projects

2 Tbilisi Heat Supply

2 1 Historical Data

Until 1961 Tbilisi consumers were supplied with heat generated by autonomous boilers, the total number of which equaled 1000 units At that time the only source of centralized heating supply was Tbilisi Thermal Power Station built in 1938, which is still operating

In the middle of 1950 an order was given regarding priority development of centralized heating systems for the city, which gradually replaced the autonomous boilers

Construction of the first district heating stations (DHS) started in 1958 In 1961, with the start up of the first DHS a new era of monopoly development of centralized heating systems started, lasting until 1989, when the last DHS # 48 commissioning took place

By 1989 the structure of Tbilisi heat supply system was as follows

80% centralized heat supply from DHS,
6% centralized heat supply from the Tbilisi Thermal Power Station,
5% centralized heat supply from industrial thermal stations,
9% autonomous boiler facilities

Consumers of the centralized heating system were residents of about 6000 blocks of flats and about 1000 public and administrative buildings The centralized heating system supplied heat to 83% and hot water to 75% of the city population

1993 was the last year when the district heating stations operated As natural gas supply stopped, operation of DHS became impossible and the situation is still the same

2 2 Centralized Heating System of Tbilisi

2 2 1 Heat Generation

Until 1993 heat generation for the centralized district heating system was carried out by 47 district thermal stations the total thermal capacity of which was 4295 MWt Thermal capacity of separate DHS-s varied from 3 48 MWt to 204 5 MWt Total number of boiler facilities located at DHS-s equaled 326 units Due to various boiler damages and lack of stand-by equipment, actual capacity of DHS was about 2930 MW

Average efficiency of small boilers was 65-75%, while that of larger boilers varied within 80-85%

The boilers were equipped with gas burners or combined burners which operated using natural gas or mazut fuel Low capacity steam boilers were used for mazut heating Steam also was used for water deaeration If there were no steam boilers, then deaeration was done by means of vacuum pumps Hardness of water used to compensate losses in the heating piping network was reduced by means of regeneration with Sodium Chloride

Regulation of boiler facility regimes was performed manually There were no instruments for controlling fuel composition The negative impact of DHS on the environment was significant due to the noise, Sulfur and Nitrogen Oxide emissions and Soot While using mazut fuel M-100 (with sulfur composition above 4%) all of the sulfur was emitted into the atmosphere, as no filters were installed

During all of the operating period only minimum maintenance was carried out

After the operation was terminated no conservation measures were taken to preserve boilers and equipment At present the majority of boiler facilities are in such a poor condition that there is no use in rehabilitation Electric equipment is almost completely removed

Numerous attempts to classify DHS according to their technical condition, carried out by both Georgian specialists and foreign consultants, gave completely contradictory results This probably means that their technical condition varies significantly and can be characterized as unsatisfactory (with exception of DHS #48)

2 2 2 Thermal Energy Supply

Thermal energy hot water supply in the Tbilisi centralized district heating system was performed by means of pipelines of 1166 km length Most of the pipes are laid in concrete ducts located on 0,7-1,0 m depth under the city streets At the same time controlling and locking fittings are located in accessible concrete chambers Water leaks (discharge) possibilities were not foreseen in concrete ducts structure and according to Georgian specialists water leaks during the operation of pipelines are collected in ducts Hydraulic tests are necessary to assess condition of piping network

Newer pipelines were laid underground without arrangement of concrete ducts In such cases bitumen-pearlite thermal insulation of pipes was used For the assessment of such pipelines condition, excavation works and internal electronic pig and/or TV inspections should be carried out

Part of the pipes laid on the surface are accessible for inspection Their thermal insulation is in very poor condition but the pipes themselves have no signs of significant damages

Lengths of pipelines from different District Thermal Stations to consumers vary from 4,3 km to 58 km Thermal networks of District Thermal Stations often have

connections with each other Each thermal energy supply network has many loops and cross connections From one point of view, such type of connections were increasing the reliability of the heat supply system, but from the other, caused excessive inactivity in parts of the system

The majority of thermal networks are not equipped with a secondary loop, therefore hot water is directly supplied from District Thermal Station to heating devices of consumers

Newer networks are equipped with thermal substations with facilities to separate the primary and secondary loop piping
The relief of Tbilisi has different elevations which causes additional problems for arrangement of thermal energy supply networks Difference between elevations was got over by arrangement of pump stations In case of damage to pumps, excessive pressure resulted in emergency situations in the lower points of thermal energy supply networks

The heating network was designed to provide a 150^{0}C water in supply piping But the low quality of locking fittings could not resist the increased pressure at such temperature and the actual temperature of supplied water was about 90^{0}C

Piping diameter was selected with large spare capacity (from 100 to 700 mm), because it was necessary to transfer significant volumes of low temperature water and to compensate for leakage

Main sources of leakage were elastic compensators for thermal expansion of piping and from locking fittings Total water losses in all thermal networks of the city were exceeding 2900 t/hour Consequently, if thermal energy losses during generation were about 18% An additional 20% of thermal energy losses were occurring due to poor thermal insulation and leakages

Design lifetime of thermal energy networks was 25 years According to operating repair schedules, about 45 km of piping had to be renovated each year, but no more than 10 km were actually repaired

According to the assessment of Georgian specialists, about 300 km of thermal networks needed complete replacement by 1993 Such assessment must be considered as underestimated By a factor of at least 2

Thus, considering that expenditures needed for thermal network rehabilitation does not differ from those needed for construction of new ones we must admit that approximately half of the thermal networks actually do not exist at present

2 2 3 Distribution and Utilization of Thermal Energy

District heating systems in Georgia, as well as in other countries of the former Soviet Union, have been constantly improved According to the government instructions,

such an improvement was intended to reduce the amount of metal used in the systems and the amount of work needed for installation

During the 1960-ies two-pipe heating systems were completely substituted by simple one-pipe systems Regulating pipe fittings were no longer used in most of the heating systems

In order to reduce the number of heating devices (radiators or convectors) in district heating systems, the government approved increased temperature standards for heat carrier, though in reality such a high temperature had never been achieved

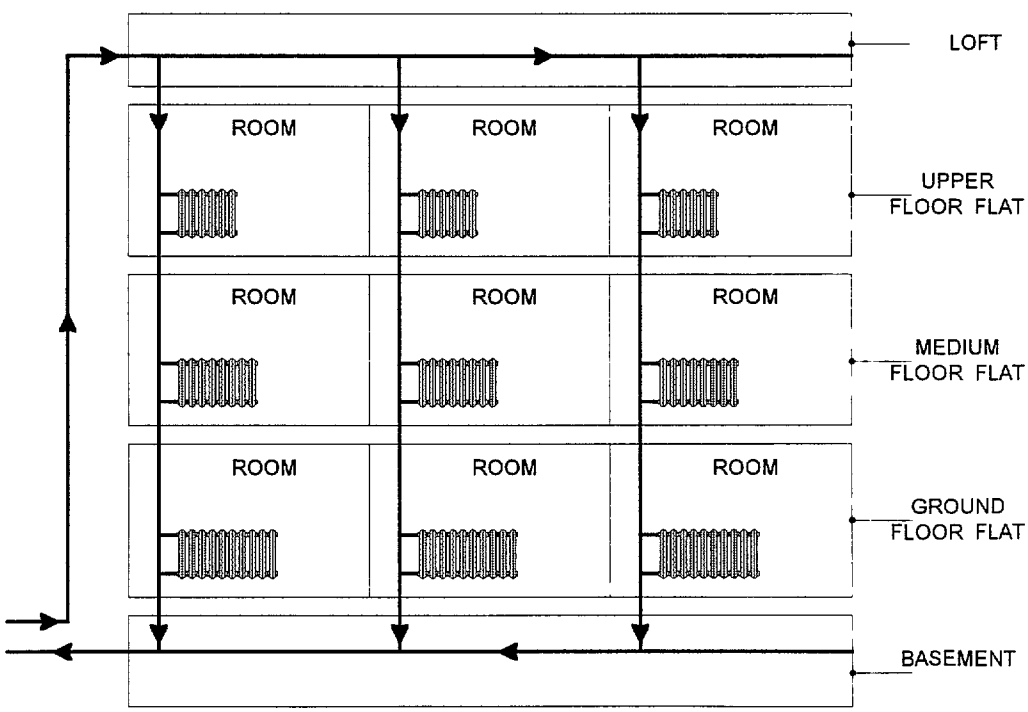
As a result of such improvement the heating systems became so simple, that no special qualification was were for their installation, no adjustment was needed during start-up and the only operational problems were leakage

Thus, if we consider that the purpose of the heating system improvements carried out during the last decades was to reduce its cost to the minimum, then the purpose has certainly been achieved

In most cases district heating system piping in existing buildings is a vertical, one pipe system with serially connected heating equipment The heat carrier (hot water) runs through the pipes in the downward direction, from the upper floors to the ground floor Consequently the heating temperature falls and in order to provide homogenous heating the surface area of heating devices is larger at the lower floors Thermal capacity of heating equipment can not be locally regulated as regulating valves are not provided

Figure 1 2 - 1

Principal scheme of single-pipe heating system of building



The above described system does not provide the possibility of consumption metering in apartments separately and does not allow to switch off insolvent consumers

About 870,000 citizens of Tbilisi (83% of the whole population) were consumers of central district heating system by 1993 70% of total thermal energy, produced by all district thermal stations, was used for population needs Specific heat consumption rate for heating of residential buildings was about 90 kWh/m^2 /year

About 1,000 administrative and public buildings were also served by district thermal stations Specific heat consumption rate for them was about 75 kWh/m^2/year

Before 1990 prices on heat power were stable - 3 87 Rubles/MWh (#) for population and public institutes and 13 97 Rubles/MWh (#) for industrial enterprises

Heating costs for a middle-level family, occupying about 50m^2 of heating area, were about 25 Rubles per year This amount was equal to about 0 3-0 5% of the average annual income of one family In such conditions all consumers actually paid bills for their heating supply

2 2 4 Results of stopping the central heat supply system operation

Due to the stopping of the natural gas supply to Georgia, operation of the central heat supply system was ceased and its consumers were left without heating since 1993-1994 Consequently, electric power consumption for heating purposes was increased Electric power consumption by population has reached especially high levels

Table 2 2 4

Electric power consumption in Tbilisi (MWh)

Year	1992	1996
Total consumption	1,642,000 00	1,996,000 00
Consumption by population	473,000 00	910,000 00

It is clean that any measures with regard to restoration of heating systems will be helpful for reducing load on the whole power system, which itself is in a deep crisis

In the process of developing recommendations on rehabilitation of Tbilisi central heating system or implementing any other measures to provide thermal energy to various groups of consumers, it should be taken into account that the situation in Georgia differs from any other countries of the former Soviet Union

Ceasing operation of the centralized district heating system resulted in a considerably lower welfare level of the main part of population of Tbilisi But, due to the soft climate of Georgia, such decrease turned out not to be so catastrophic Heating season in Tbilisi is lasting from November 15 until April 15 The coldest month is January, when the average temperature is about $+1^0C$ For most countries of the former Soviet Union and Eastern Europe the task of maintaining centralized heat supply system has no alternatives, as heating in such countries is as vital as water or power supply

To maintain central the heat supply system, governments of Russia, Ukraine and Byelorussia had to make a decision about partial funding of population heating costs from state and local budgets In Baltic States, where actual revenue level of population is considerably higher than in Georgia the population is able to cover the cost of centralized heat supply almost completely With regard to Georgia, incomes of the state, local or family budgets are not expected to increase in the nearest future up to the level, sufficient to cover centralized heating supply costs Consequently, new solutions of heating system rehabilitation must be found

3 Conclusions and Recommendations on Rehabilitation of Centralized District Heating System

3.1 Rehabilitation of centralized system for heat supply of population

One of the main characteristics taken into consideration during evaluation of the design of a creation of district heating system is the value of specific heat load for a given district

Assessment of the economic efficiency of centralized heat supply in Western Europe has shown, that the value of specific heat load ≥ 30 MW/km^2 can be considered as favorable This parameter is close to the analogous ones being used in the former USSR

The situatation, existing in Tbilisi before 1990 was favourable for development of centralized heat supply systems 47 district heating stations with total actual thermal capacity of 4245 MWt were under the control of the city enterprise "Tbomeurneoba", responsible for centralized heat supply to the city These thermal stations were providing heat to about 83% of the population and a major part of public buildings and offices Total amount of thermal energy used by the consumers was 1869 MWt from this 1273 MWt was used for residential buildings, 545 MW for public buildings and offices, 19 MWt - for industrial enterprises

Considerable difference between the actual capacity of thermal stations and consumed capacity resulted from the heat losses Experts of "Tbomeurneoba" considered, that average losses during the thermal energy generation is 18%, and losses during heat transmission through heating piping is 19%

The city system of centralized heat supply provided a territory of 56 km^2 area, which results in an average specific heat load (considering total consumption for heating and hot water supply purposes) – of 33 4 MWt/km^2

Considering only the consumption for heating, the spesific heat load was 25,6 MW/km^2

According to information from "Tbomeurneoba", until 1990 about 98% of consumers were regularly paying for heating and hot water

' Until the 1990 price for heat supply was stable for the population it was 10 kop/m^2 ($) per month, which amounted to 50 kop/m^2 per year (with 5 month heating period), and 4,2 kop/m^2 per month in case of calculation of monthly expenses from annual amount

The tariff for hot water until July of 1993 was 60 kop/person per month, assuming a consumption rate of 130 l/day per person at 55 C^0 hot water temperature

For an average household the annual expenses on centralized heating and hot water supply until 1990 amounted to less than 1% of annual family income

Analyzing today the situation, which existed in the past, it is necessary to take into consideration the influence of the fact of consumers' solvency on the actual value of specific heat load

Comparison of results of analysis of household average solvency in Tbilisi (see Chapter 6 5) with possible value of tariff on thermal energy supply after rehabilitation of centralized heating system (see Chapter 6 3) shows obvious disparity Financial capabilities of average statistic household to cover expenses for heat supply are limited by $100 US per year, while necessary expenses may amount to $455 US per year

This disparity is confirmed by the assessment performed by the State Department of Statistics, which considers that according to the situation in July of 1997, incomes of 65% of population are lower then subsistence minimum level

It is clear that present condition of consumers' solvency abruptly decreases actual volume of specific heat consumption It is natural that with improving general economic situation in Georgia solvency of population will correspondingly increase, although in the nearest future it is hard to believe that the favorable conditions for economically efficient operation of centralized heat supply systems will be created soon

There may exist an opinion that reasonable way out of this situation will be found by means of decentralization of heat supply systems Indeed, within the city there are compact sections with high specific index of heat load But, unfortunately, the fact of insolvency appears even on the lowest level - i e on the level of multi-flat block It is difficult to expect that in a democratic society there exist methods allowing removal of insolvent consumers from residential buildings and let solvent consumers settle in these vacant flats In the most prestigeous districts of the city such processes have already begun in a natural way, but this process covers only a small part of city territory Investments for modernization of existing heat supply system in multi-flat residential buildings, which will allow disconnect insolvent consumers from the common heat supply system amounts to $700-900 US for a medium size flat (50 m^2 of living space) At the same time, it must be taken into account that it is necessary to carry out such modernization in all flats, but only part of the consumers will be solvent in the building Also, it must be taken into account that in those multi-flat residential buildings where the concentration of solvent consumers has been already performed in a natural way, measures for modernization of heat supply system can be avoided In this case more simple modernization option (see Fig 6 2-5) can be used, but implementation of heat consumption metering in flats is absolutely essential

Arguments given in this chapter mostly belong to the problem of heat supply to the population, but from this its importance is not decreasing, i e the population is the major consumer of heat **So the probability of resolving the problem of heat supply for the Tbilisi population by means of rehabilitation of centralized heat supply**

system is doubtful if rehabilitation of these systems will be carried out according to Western Standards

The basis for such a conclusion are

- high investment costs and correspondingly high price for thermal energy (hot water)
- low solvency of consumers
- low cost of natural gas becoming available to population

3 2 Possibilities of Rehabilitation of Centralized Heat Supply Systems for Heating of the Existing Buildings and Institutions

As it has already been mentioned in the previous section, the solution of the city heating problem by means of rehabilitating the centralized heat supply system is connected with serious problems **One of the main obstacles is the necessity of costly modernization of the existing heating systems serving residential buildings as a result of which it will become possible to separate insolvent consumers from the common network and carry out actual consumption recording for each flat separately**

It is not necessary to carry out such modernization in buildings of institutions and organizations if such a building is occupied by one consumer In this case it will be enough to install one calorimeter at the place where the pipe enters the building It is also not necessary to install individual regulating equipment on heating facilities as institution employees use it to make an economy of heat consumption much less frequently than in their own flats The central regulation method (from the boiler room) of heat supply of public buildings is effective enough and permits to change the heating intensity according to weather conditions, also during night and holidays

During recent years many attempts of Georgian as well as foreign specialists to classify the existing thermal stations in Tbilisi according to their technical feasibility have provided absolutely controversial results This most probably indicates the lack of reliable information about the condition of thermal networks, while the main differences of technical condition of thermo-generating equipment are minimal and their general condition (with rare exceptions, e g Thermal Station N 48) can be described as unsatisfactory

The only actual advantage of some thermal stations is a comparatively good location Data on centralized heat supply system in Tbilisi are attached Analysis of these data establish at a priority of thermal power stations according to the following characteristic features

- more than 30% of the thermal station heat loads are due to non-residential buildings,
- the districts served by the thermal stations are is characterized by high rated heat load (MW/km^2),

- a great number of non-residential buildings are served by the thermal station which improves the chances of finding solvent consumers

Thermal stations meeting the above requirements are as follows

Tbilisi Thermal Electric Station, TS N 6, TS N 8, TS N 10, TS N 19, TS N 25, TS N30, TS N 36, TS N 47

At present, out of 47 thermal stations, only Tbilisi Thermal Electric Station is operating Its operation is determined by the necessity to generate power, but demand for heating energy is gradually increasing During the heating period of 1996-1997 Tbilisi Thermal Electric Station supplied heating for 42 non-residential buildings of total heat demand 16 7 MWt Tariff for thermal energy was 35 Lari/GKal (23 2 US $ per MWh) Tbilisi Thermal Electric Station management hopes to receive from the Ministry of Fuel and Energy exclusive conditions for natural gas supply for 1997-98 winter season (at price $61 5 US per 1000 m^3) and relatively high tariffs for electricity supplied to the national grid ($46 US per MWh) According to calculations of Georgian scientists this will allow Tbilisi Thermal Electric Station to reduce tariffs on thermal energy supply down to $17 US per MWh and acquire new consumers

It is evident that such low tariffs reflect only short term expenses on generation and heat supply Tariffs determined in this way do not sufficiently cover expenses needed for rehabilitation and construction of new thermo-generating units and thermal networks

Thermal energy prime cost calculated by the company "Lahmeyer International" ("Study of Heat Supply in Georgia Based upon Tbilisi Example) in case of a complete renewal of centralized heat supply in the area served by Thermal Station N 8, taking into consideration maximum long term expenses, turned out to be much higher than the current electricity tariffs and amounts about $85-95 US per MWh

Obviously it is only be possible to establish an acceptable tariff on heating (close to electricity tariff) only by means of an abrupt reduction of investments This is possible only in case of a minimum distance between consumers and the thermal station, which means that only minimum expenses will be needed for the piping system rehabilitation Thus, the most probable reason for rehabilitation of any thermal station is the initiative on the part of a solvent consumer occupying a non-residential building (or a group of buildings) located near this thermal station

For example, such consumers may be

- for Thermal Station N 10 - the Republican Hospital (1200 beds) and State Medical Institute,
- for Thermal Station N 19 - The State University,
- for Thermal Station N 30 - Municipal Hospital N 1,
- for Thermal Station N 25 - a large medical complex etc

Examlple of such a scenario is well demonstrated by the events which took place in relation with the heating problem of the Parliament building in Tbilisi At present, heating of the Parliament building is provided by the Tbilisi Thermal Electric Station, although the consumer is constantly complaining about low quality of services. This is caused by a considerable distance between the consumer and the heat supply source (2300 m) and damaged piping

The best option was found as a result of study of alternatives evaluted by Georgian specialists It included rehabilitation of Thermal Station N 9 located 200 m away The rehabilitation program includes dismantling of a part of the equipment inside the thermal station building and installation of two new boilers, with 2 9 MWt capacity each, and also replacement of piping Rehabilitation works began in September 1997 Investments were estimated as $400, 000 US According to the estimates provided by the Georgian specialists generated energy cost would be $34 5 US per MW/h, if fuel oil will be used for fuel

Further development of the rehabilitation program of Thermal Station N 9 by means of installing additional boilers will be able to provide heat supply to other non-residential buildings, such as the State Office, Ministry of Foreign Affairs, Ministry of Communications, Youth Palace, Supreme Court, First Classic Gymnasium etc Maximum distance from Thermal Station N 9 is 400 m

In order to transfer heat from TS N 9 to new consumers, it is possible to use the existing heating piping in case of partial replacement

In order to use fuel at maximum efficiency, instead of using additional boilers TS N 9, the thermal station can be equipped with units generating both electricity and heat Supply of generated energy to the city grid (through power substation "Sololaki" and "Mtatsminda") is possible from the place where TS N9 building is located While selecting the type of units with co-generation, two options were taken into consideration gas turbine with a heat recovery boiler or gas engine with a heat recovery boiler

Option 1 - Thermal Electric Station with a Gas Turbine

The combined scheme of a co-generation thermal electric station involves utilization of thermal energy of exhaust gases coming from the turbine by means of a water-tube boiler Keeping in mind that the gas turbine must operate all the year round, its electric efficiency should be such as to provide heat generation according to the demand during summer (demand for hot water supply only)

Considering that demand for capacity needed for hot water supply is 3 6 MW_{therm} , the facility may consist of a gas turbine of 1 5 MW_{el} with a corresponding heat recovery boiler In order to cover heat load during winter, the heat recovery boiler must be equipped with a re-heating system, which permits to increase the heat capacity up to 10-12 MW_{therm} In this case, two new boilers of 5 8 MWt installed at TS N 9 for heating of the Parliament building can operate at peak or stand-by regimes

Weak points of this option are as follows

- low electric efficiency of gas turbines of 2 MW_{el} is 25-26%,
- necessity of additional investments for the installation of a gas pipeline and compressor station in order to increase natural gas pressure to 12 bar

Option II - Thermal Electric Station with a Gas Engine

Start up of a thermal electric station with a gas engine is much simpler from the technical point of view as compared to gas turbine thermal electric stations Gas engines of 2 MW_{el} are especially simple in operation In case of TS N9 two gas engines of 1 6 MW_{el} capacity can be used Heat generation capacity in this case is 4 MW_{therm} and can provide basic heating for hot water supply

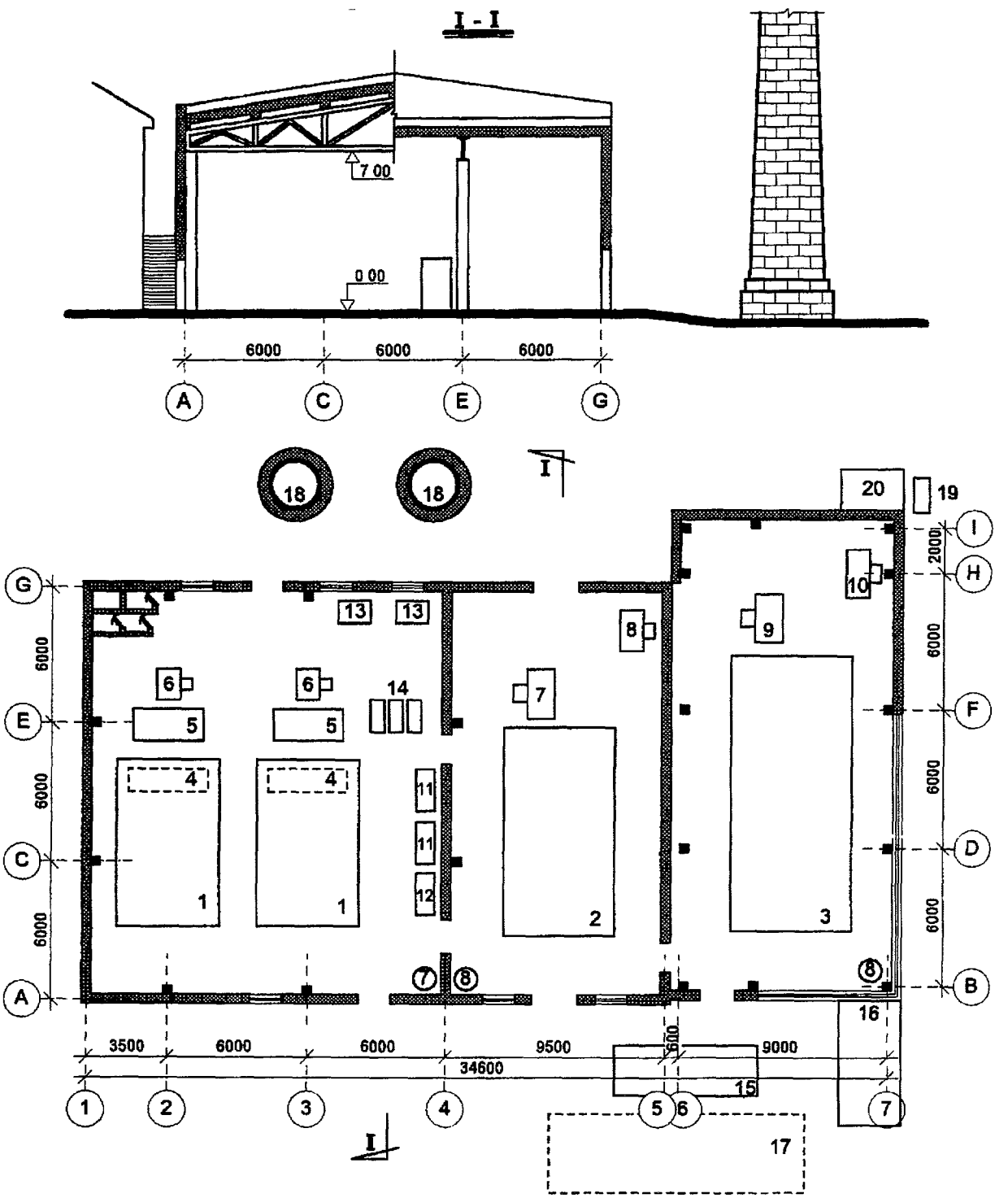
In winter heat loads can be covered in the same way as for the gas turbine option

An additional advantage of gas engines is high electric efficiency up to 48%

Taking into consideration that the same amount of investment - $6 0 million US - is needed for both of these options, the advantages of a thermal electric station with two gas engines are evident

Figure 3 2-1

Layout of Equipment in TS-9 before Rehabilitation

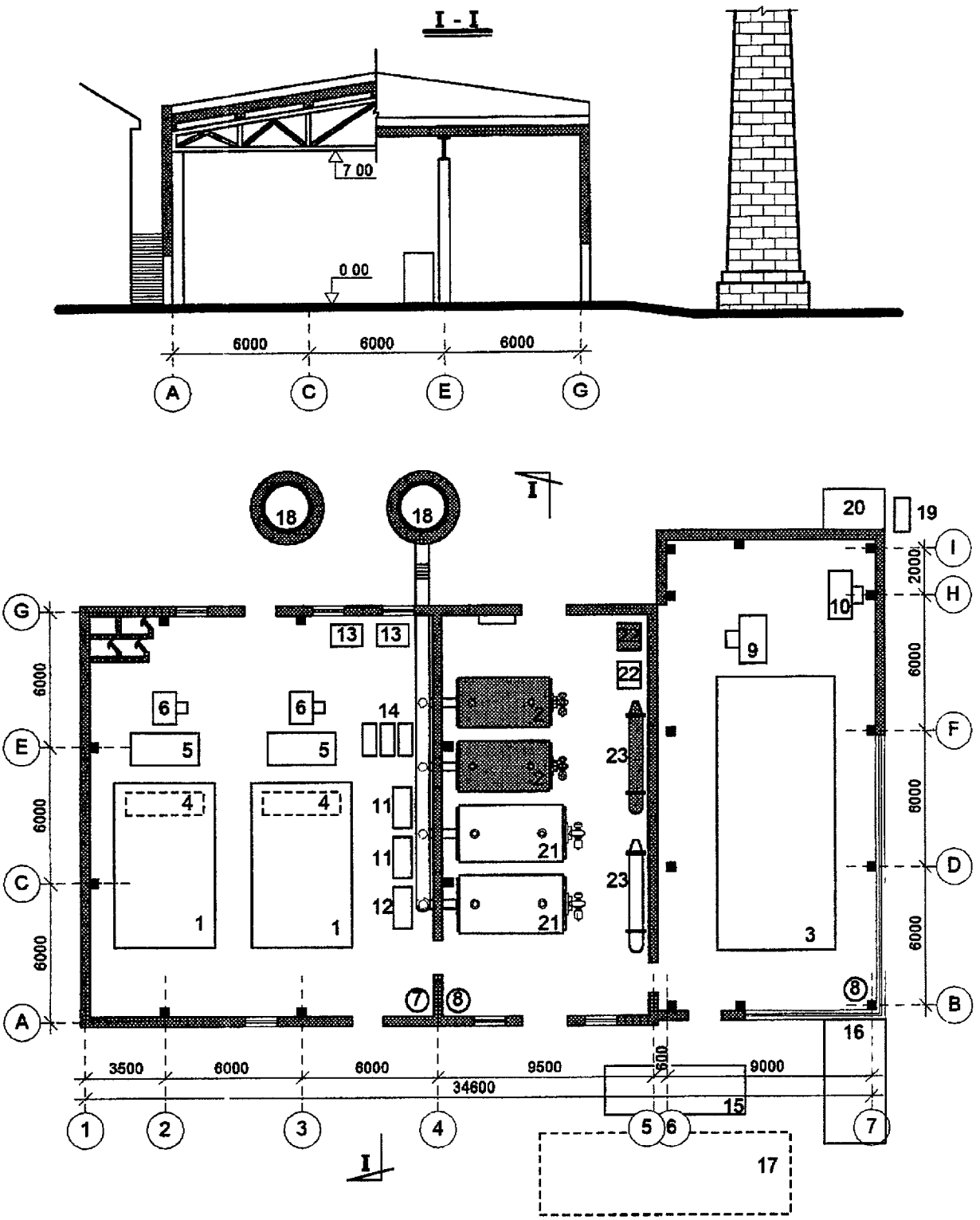


Legend

1 Steam boiler DKBP 10/13
2 Hot-water boiler KBГM-20
3 Hot-water boiler KBГM-30
4 Fan D-10
5 Economizer
6 Smoke exhauster DH-10
7 Smoke exhauster DH-17
8 Forced-draft fan BDH-12 5
9 Smoke exhauster DH-17
10 Forced-draft fan BDH-15
11 Circulation pump D200-95
12 Circulation pump TsN-1000
13 Circulation pump D200-95
14 Feeding pump KM 45/55
15 Water treatment equipment
a) Deaerator V=25m3
b) Cationite filter D=600
c) Brine tank
16 Mazout facilities
a) Mazout pump 3B-4/25
b) Mazout heater PM-6/25
a) Mazout filters
17 Underground tank for mazout
18 Stacks D=2 0m H=25 0m
19 Brine pump K20/30
20 Brine tank

Figure 3 2-2

Proposal on partial replacement of equipment in TS-9 for heating supply to the Parliament building

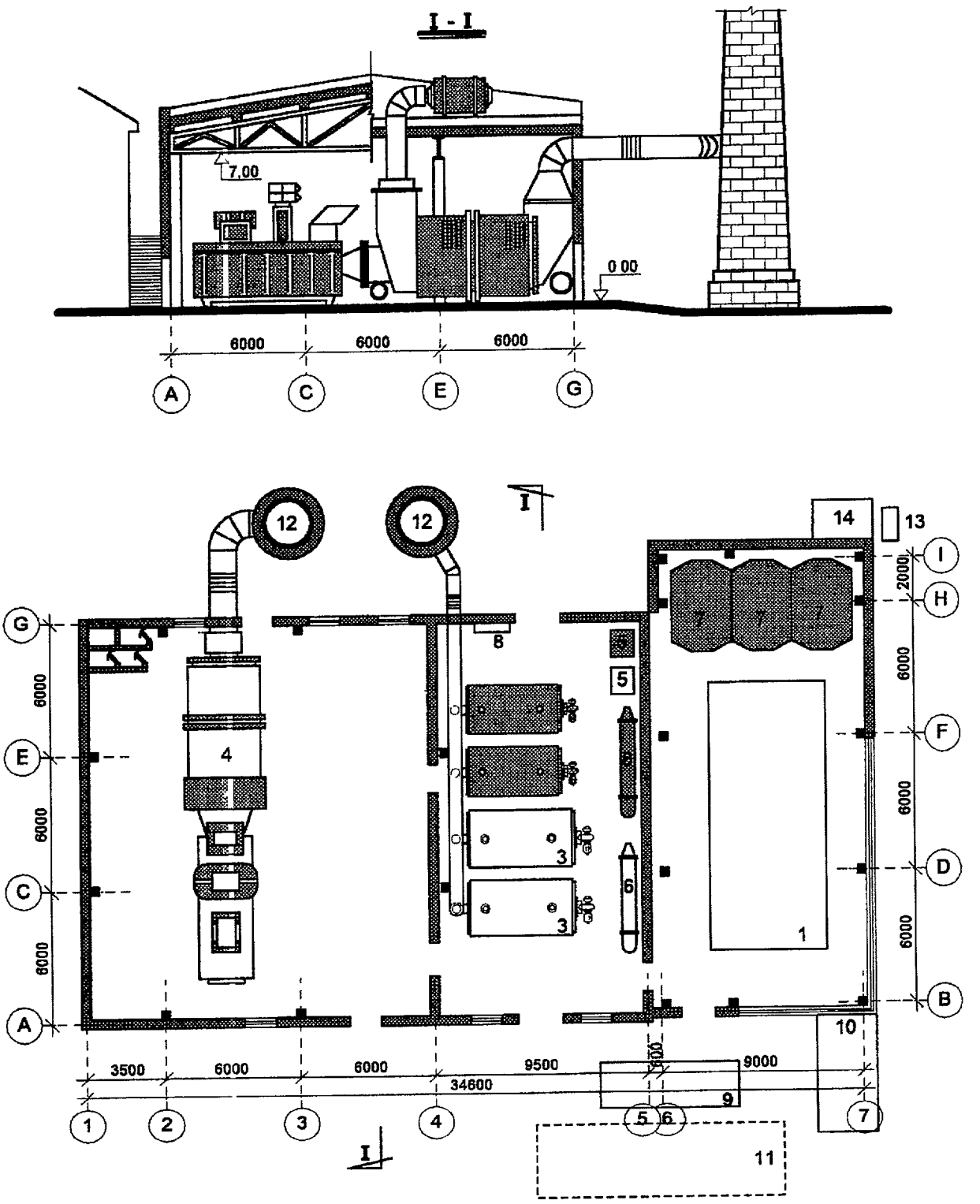


Legend (new equipment)

2 New hot-water boilers of 2 9 MW power
21 Proposed hot-water boilers of 5-6 MW power
22 New circulation pumps
23 New heat exchangers

Figure 3 2-3

Proposal on Installation of Gas Turbine in TS-9

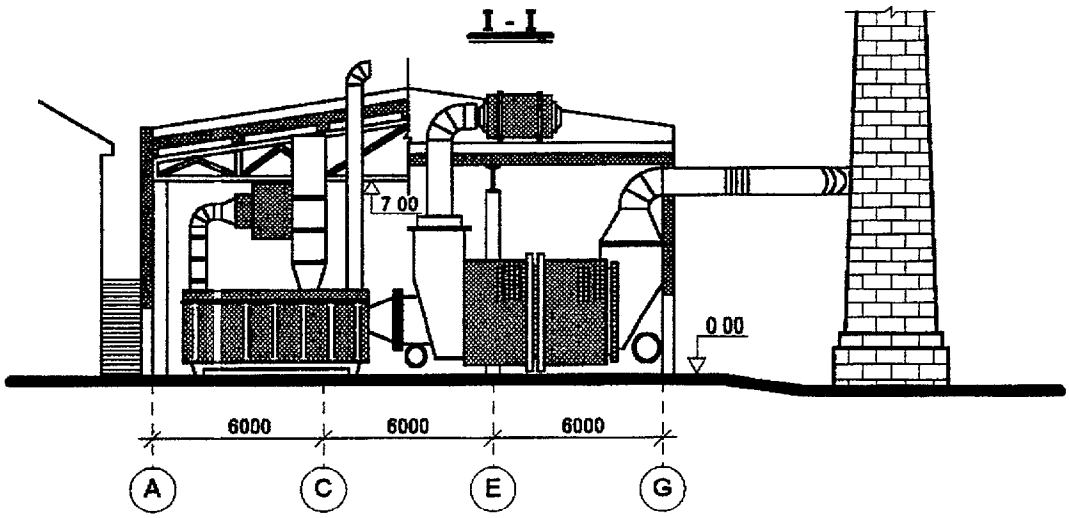


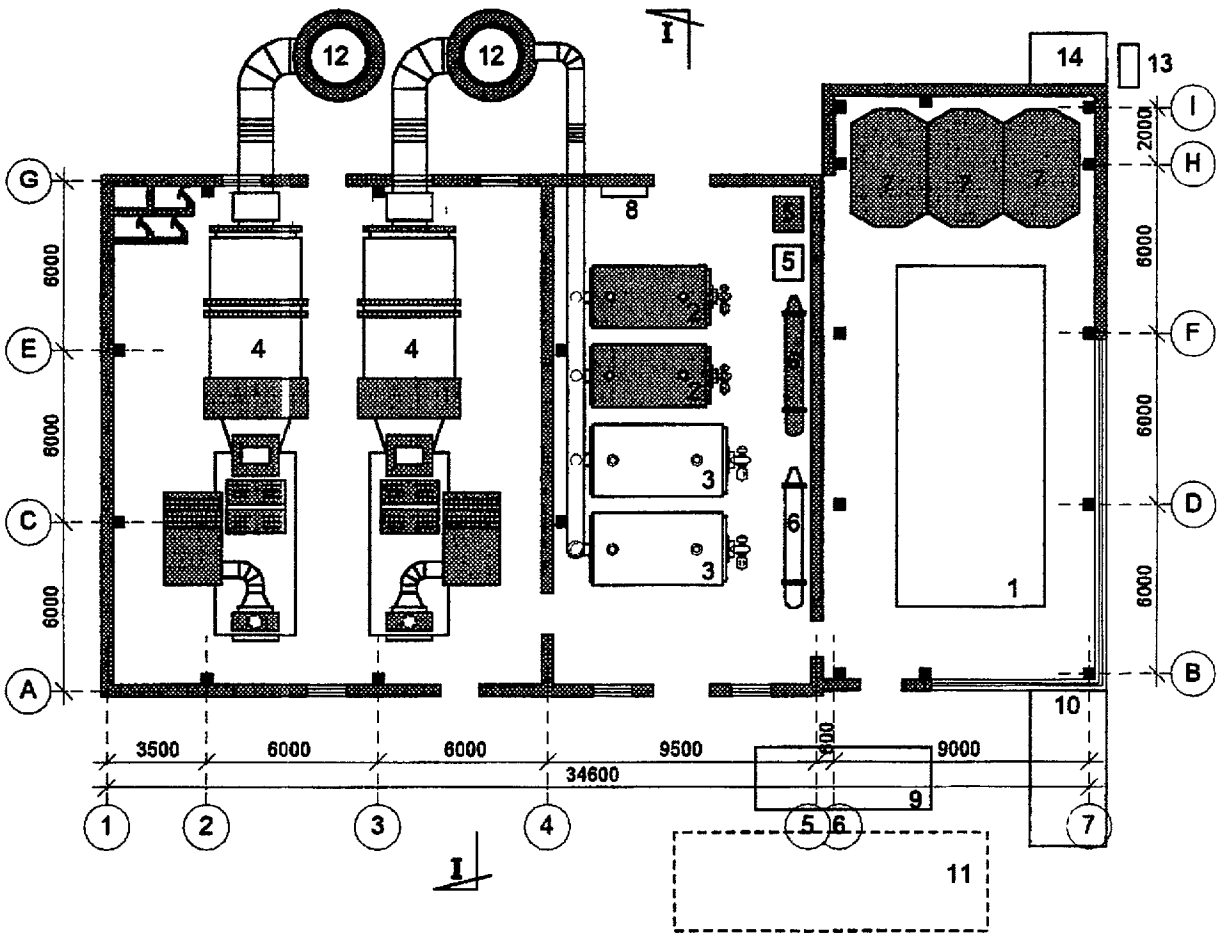
Legend (new equipment)

2-3 Hot water boilers for relieving peak thermal loads
4 Gas turbine of 1 5 MW electric power and HRSB of 12 MW power with reheating system

Figure 3 2-4

Proposal on Installation of Gas Engines in TS-9





Legend (new equipment)

2-3 Hot-water boilers for relieving peak thermal loads
4 Gas engines of 1 6 MW electric power (each) with HRSB's of 4 MW thermal power (each)

Table 3 2 - 1

Data on centralized heat supply system in Tbilisi

Thermal station		Population			Public buildings and offices		Industrial enterprises	Thermal network	District		
No	Actual capacity, MW	Area Thous m^2	Thous persons	Total load, MW	Area Thous m^2	Total load, MW	Load, MW	Length, km	Area m^2	Total, MW	Total specific demand, MW/km^2
1	2	3	4	5	6	7	8	9	10	11	12
TS-1	81 20	267 50	20 00	26 33	232 50	24 01	4 06	34 53	1 00	54 40	54 40
TS-2	11 60	51 80	2 50	4 99	47 50	4 52		4 35	0 25	9 51	38 05
TS-3	52 20	462 40	34 40	45 36	70 00	6 73		38 13	1 82	52 08	28 62
TS-4	11 60	192 20	10 80	19 02	90 00	9 05		10 25	0 60	28 07	46 79
TS-5	17 40	217 00	22 50	23 66	75 00	6 61		14 50	0 35	30 28	86 50
TS-6	116 0	499 60	37 80	49 30	412 50	41 30	7 77	51 10	2 25	98 37	43 72
TS-7	17 40	156 40	13 30	17 28	17 50	1 62		12 18	0 85	18 91	22 24
TS-8	81 20	399 30	18 80	35 50	252 20	25 52		48 10	1 15	61 02	53 06
TS-9	34 80	102 50	9 10	11 48	77 50	7 66		39 73	0 80	19 14	23 93
TS-10	40 60	213 20	14 20	20 65	200 00	19 26		24 28	0 72	39 90	55 42
TS-12	81 20	500 50	34 00	47 79	105 00	11 60	4 99	41 90	2 65	64 38	24 29
TS-13	46 40	265 00	16 00	24 94	125 00	10 90		28 50	0 85	35 84	42 17
TS-14	104 40	267 80	16 50	25 40	157 50	16 59		35 70	1 00	41 99	41 99
TS-16	40 60	6 50	0 60	0 70	52 50	8 82	19 37	11 00	1 76	28 88	16 41
TS-17	133 40	1322 00	78 00	121 80	100 00	11 37	4 87	55 68	3 00	138 04	46 01
TS-18	104 40	612 20	33 40	55 45	168 80	15 54	3 02	44 72	1 70	74 01	43 53
TS-19	87 00	320 20	17 90	29 58	425 00	39 79		36 00	1 15	69 37	60 32
TS-20	81 20	605 80	35 80	55 91	92 50	10 79		45 70	2 10	66 70	31 76
TS-21	116 00	476 80	24 40	42 57	152 50	15 43	0 81	33 30	1 50	58 81	39 21
TS-22	69 60	198 70	11 20	19 49	150 00	16 47	17 52	38 23	6 80	53 48	7 86
TS-23	121 80	184 50	11 10	18 44	80 00	7 19	2 32	11 68	2 00	27 96	13 98
TS-24	58 00	108 80	24 20	30 74	145 00	14 50		26 60	2 00	45 24	22 62
TS-25	174 00	393 70	22 30	35 96	562 50	54 52		58 04	2 30	90 48	39 34
TS-26	11 60	55 80	4 00	5 80	45 00	4 18		5 40	0 30	9 98	33 25
TS 27	11 60	29 40	2 00	3 02	42 50	4 06		8 24	0 20	7 08	35 38
TS-28	92 80	472 50	32 70	45 47	177 50	16 47		52 40	1 50	61 94	41 30
TS-29	4 64	53 60	3 10	5 34	25 00	2 32		8 29	0 40	7 66	19 14
TS-30	18 56	118 30	9 20	12 64	112 50	12 06	0 58	9 50	1 00	25 29	25 29
TS 31	34 80	154 50	10 60	15 89	87 50	7 89		17 25	0 90	23 78	26 42

1	2	3	4	5	6	7	8	9	10	11	12
TS-32	58 00	212 30	15 70	21 11	32 50	3 02		20 35	0 90	24 13	26 81
TS-33	11 60	18 50	1 90	2 20	75 00	7 19		4 00	0 36	9 40	26 10
TS-34	8 12	54 10	3 20	5 34	15 00	1 29		3 25	0 20	6 62	33 12
TS-35	11 60	2 40	0 25	0 34	15 00	2 90	4 52	5 36	0 18	7 76	43 11
TS-36	81 20	204 60	14 60	20 18	275 00	25 52	1 51	42 00	2 06	47 21	22 92
TS-37	6 96			0 00	10 50	1 39		5 72	0 04	1 39	34 80
TS-39	5 80	18 90	0 40	1 51	40 00	4 29		4 30	0 05	5 80	116 00
TS-40	13 92	23 60	2 20	2 67	47 50	5 45	2 09	11 23	0 52	10 21	19 63
TS-41	23 20	204 00	17 90	21 46	67 50	6 61		18 71	0 50	28 07	56 14
TS-42	3 48			0 00	8 80	0 82		0 06	0 02	0 82	54 91
TS-43	174 00	879 60	50 30	80 50	95 00	11 48		30 00	2 00	91 99	45 99
TS-44	139 20	739 40	39 90	66 82	93 80	10 67	4 18	23 29	1 30	81 66	62 82
TS-45	139 20	535 70	36 30	51 16	67 50	7 66		29 55	1 30	58 81	45 24
TS-46	139 20	932 10	59 80	87 70	87 50	10 09		45 00	2 18	97 79	44 86
TS-47	92 80	183 30	18 50	21 34	125 00	11 02		27 00	0 60	32 36	53 94
TS-48	162 40	370 00	37 80	40 25	92 50	9 05		50 68	1 38	49 30	35 72
Total	2927	13287	869	1273	5429	545	78	1166	56	1896	34

4 Autonomous Heating Systems

4 1 Rehabilitation of Existing Autonomous Heat Supply Systems

As the central heat supply to Tbilisi was given priority, the number of autonomous heat supply systems was reduced to minimum by 1990's

Usually the autonomous boiler houses that provided heating to hospitals were considered as auxiliary heat supply sources for an emergency situation at the central system In most cases, health institutions (hospitals) were simultaneously consumers of the central heating system Also, autonomous boiler houses were preserved in some schools and residential houses located in the suburbs of Tbilisi In 1990 the total number of houses with autonomous heating systems was about 200, while the total thermal capacity of these systems equaled approximately 300 MWt

In 1993 the majority of these autonomous heating systems were not operating When the central heating system stopped supplying heat in 1993, more and more efforts were made for their rehabilitation, especially for those heating health institutions Rehabilitation works were mainly funded by international foundations within humanitarian and technical assistance programs Usually such rehabilitation includes replacement of depreciated boilers and electrical equipment Boilers used before 1997 were equipped with burners operating on diesel fuel By the end of 1997 preference was given to boilers using natural gas, which considerably reduced operational costs of heat supply due to the low cost of natural gas as compared to diesel fuel Average cost of rehabilitating an existing heat supply system of a hospital is $ 50000 - 60000

At present about 50 autonomous heating systems are already rehabilitated and operating in Tbilisi

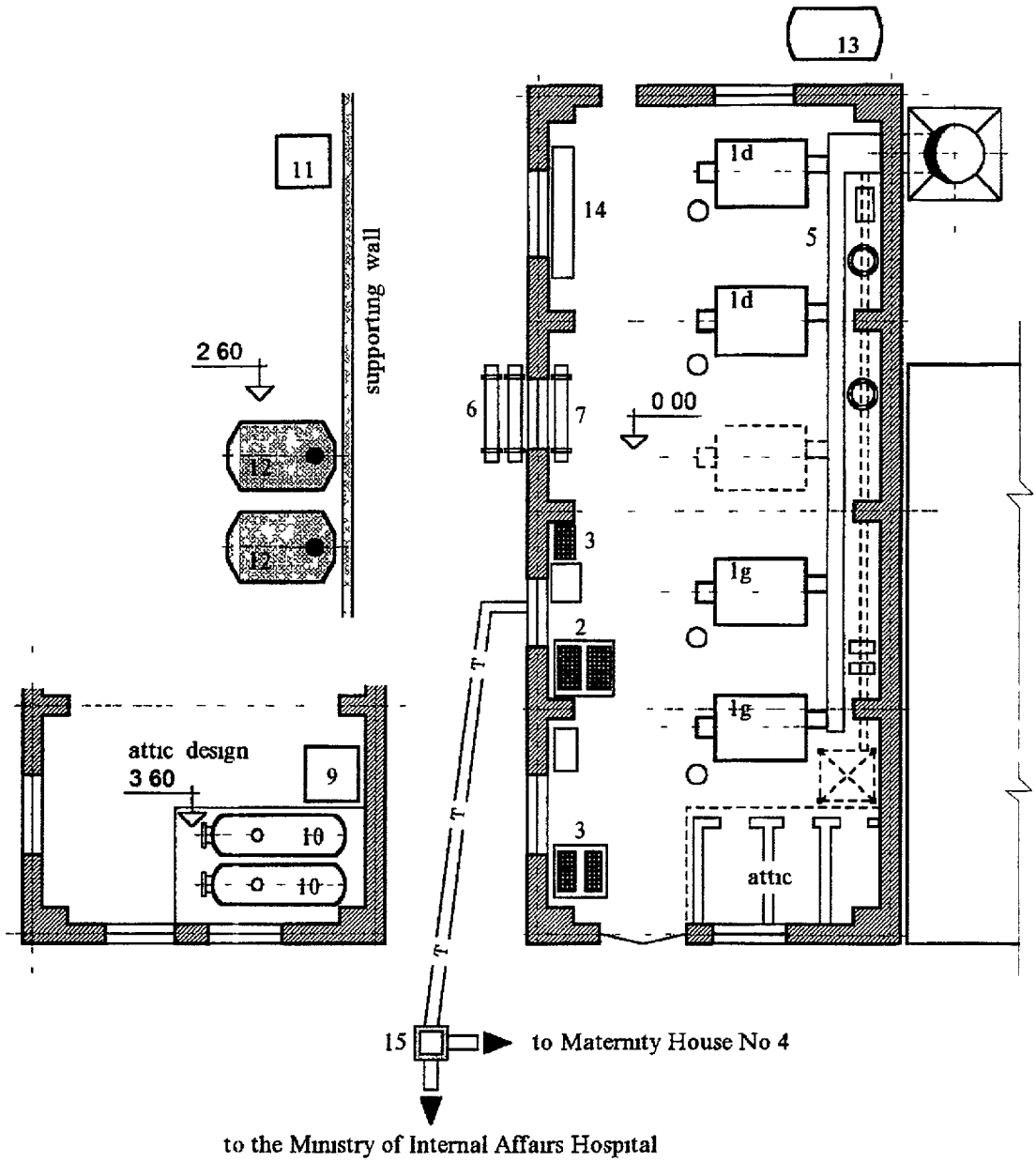
4 2 Creation of New Autonomous Heating Systems

Ever since operation of the central heating system stopped, there have been numerous attempts to create new autonomous heating systems for public and administrative buildings At present, there are about 100 buildings in Tbilisi which have autonomous low capacity boilers This number includes 48 schools where installation of autonomous heating systems was funded by the World Bank, within the "Municipal Service Development Program" in Georgia The capacity of water heating boilers installed in these schools is 200-300 kWt each and they have burners for #2 diesel fuel oil As a rule, such boilers were installed in basements, which, according to the current safety standards of Georgia, excludes the possibility of using natural gas as a fuel In future this serious oversight can be eliminated by installing boilers within assembled containers in a free space next to the building to be heated or on its flat roof Natural gas fuel will permit reducing operational costs for heating, as prices for natural gas three times are lower than those for liquid fuel

Figure 4 1-1

Example of rehabilitation autonomous heating system

Equipment Arrangement Design in the Boiler Facilities of Maternity House No 4



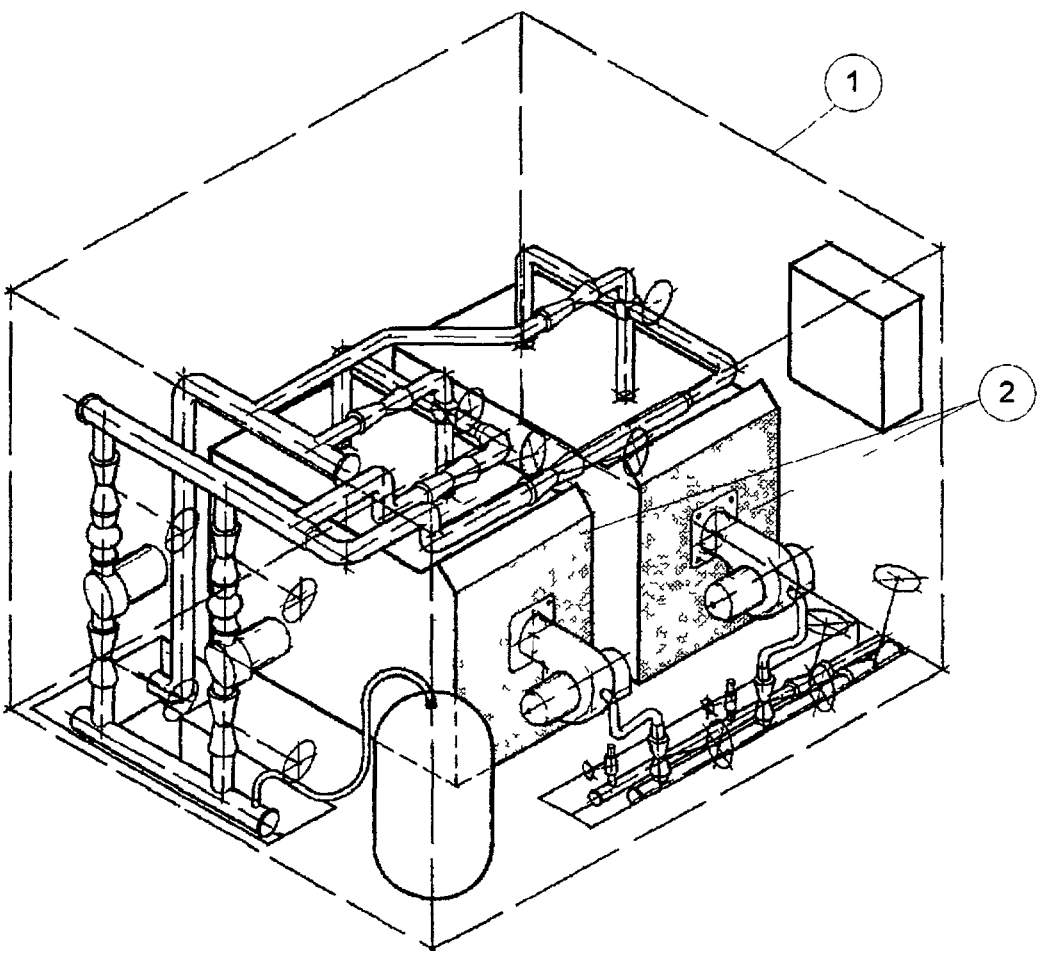
Legends

1d - boiler E 1/9 diesel-fired
lg - boiler E 1/9 gas fired
2 - pump KM80-50
3 - pump K20/30
4 - pump KM8 16
5 pumpK8/18
6 - steam heat exchanger (removed)
7 - steam heat exchanger (new)
8 water softener
9 -condensation tank
10 -water heat exchanger
1 1 -saline solution tank
12 -diesel fuel tank
13 -water supply tank
14 -gas distributing unit
15 -heat path

Average cost of equipping schools with autonomous heating systems varies within $3000- 4000, depending on the need to rehabilitate the existing heat distribution piping inside the building

Figure 4 2-1

Proposal on Installation of Boiler Equipment in Assembled Container

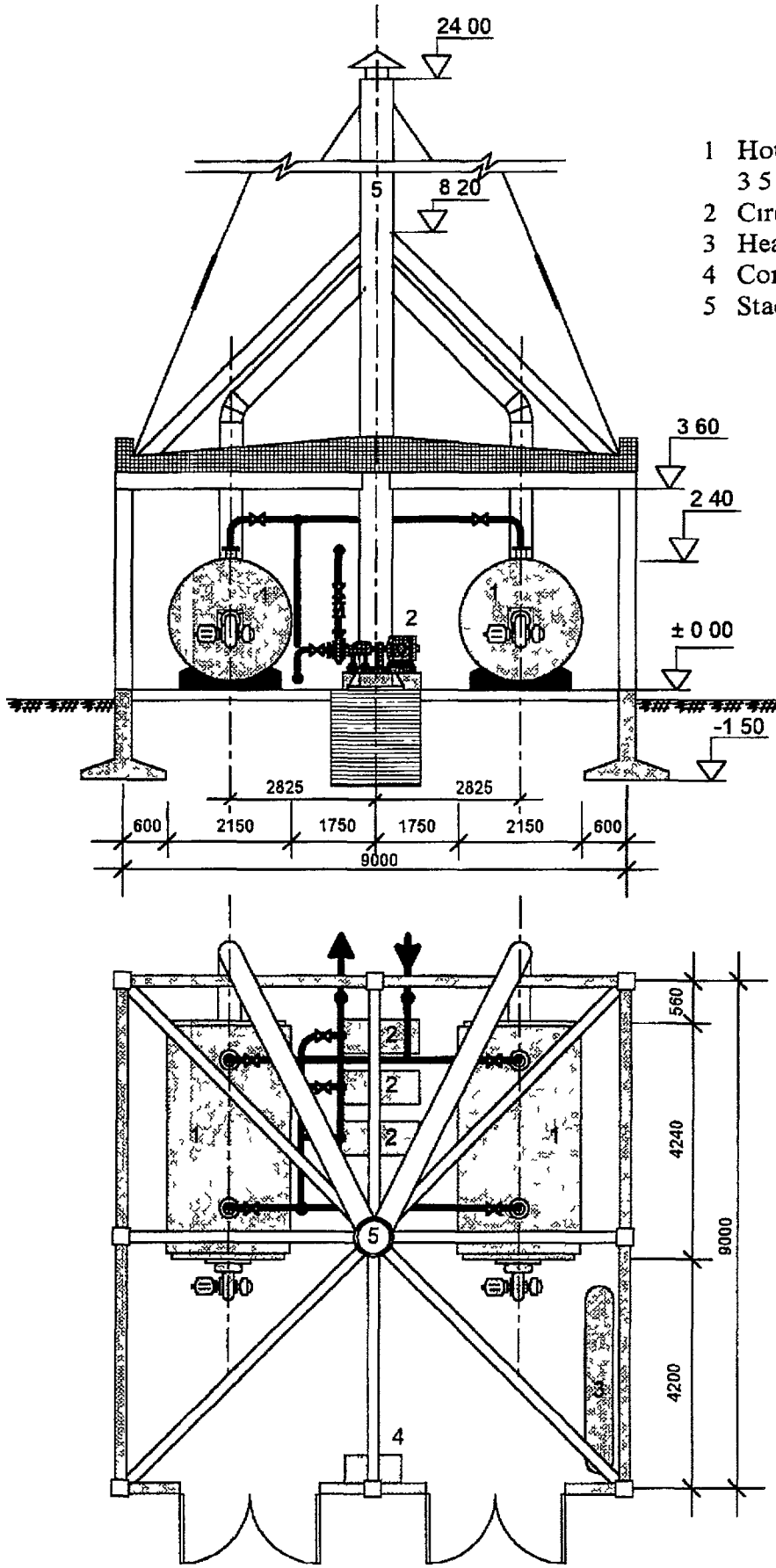


Legend

1 Assembled metal container with dimensions L=3100mm, W=2600mm, H=2000mm
2 Hot-water boilers of 100-300 KW thermal power

Figure 4 2-2

Proposal on Installation of Boiler Equipment inside the Assembling building



Legend

1 Hot-water boilers of 3 5 MW thermal power
2 Circulating pump
3 Heat-exchanger
4 Control board
5 Stack H=24m

5 Use of Renewable Energy Sources

5 1 Geothermal Energy

In Tbilisi there is a historical tradition of use of thermal water for sanitary (bathing and medical) purposes Up to the present time there exists in Tbilisi an old district known by its hot sulfur baths of healing qualities Reserves of geothermal water were also observed in other districts of Tbilisi Geothermal water deposit "Lisi" can be considered as the most important one, taking into account its water resources and actual possibilities of geothermal water utilization Hot water from the most productive well N5 is supplied to consumers of "Saburtalo" district Flow rate of the well N5 is 1900 m^3 per day of water with 62-64^{0}C temperature, which is supplied by gravity flow through existing piping of 2 km length to the "Saburtalo" district territory located much lower than well heap On the district territory the geothermal piping is connected with distributing piping of District Thermal Stations N 1 and N 32, through which hot water is supplied directly to 3000 apartments This geothermal water supply system is not equipped with any metering devices This does not allow metering of actual water consumption and complicates collection of payment for consumed hot water

Price of 1m^3 hot water for population is about 0,25 Lari ($0,19 US) Thermal insulation of piping does not exist Because of this, temperature of supplied water during the winter period is 35-40^{0}C By its chemical and bacteriologic qualities geothermal water is close to the potable water standards but has unpleasant odour of hydrogen sulfide (H_2S)

The possibilities of operating well N5 by gravity flow through hydrosyphon effect are studied at present In case of significant increase of well flow rate, The number of consumers can be increased, but at the same time the whole system must be equipped with metering devices and 2000 m^3 volume accumulating tanks must be installed According to the preliminary assessment cost of these measures is about $650-700 thousand US

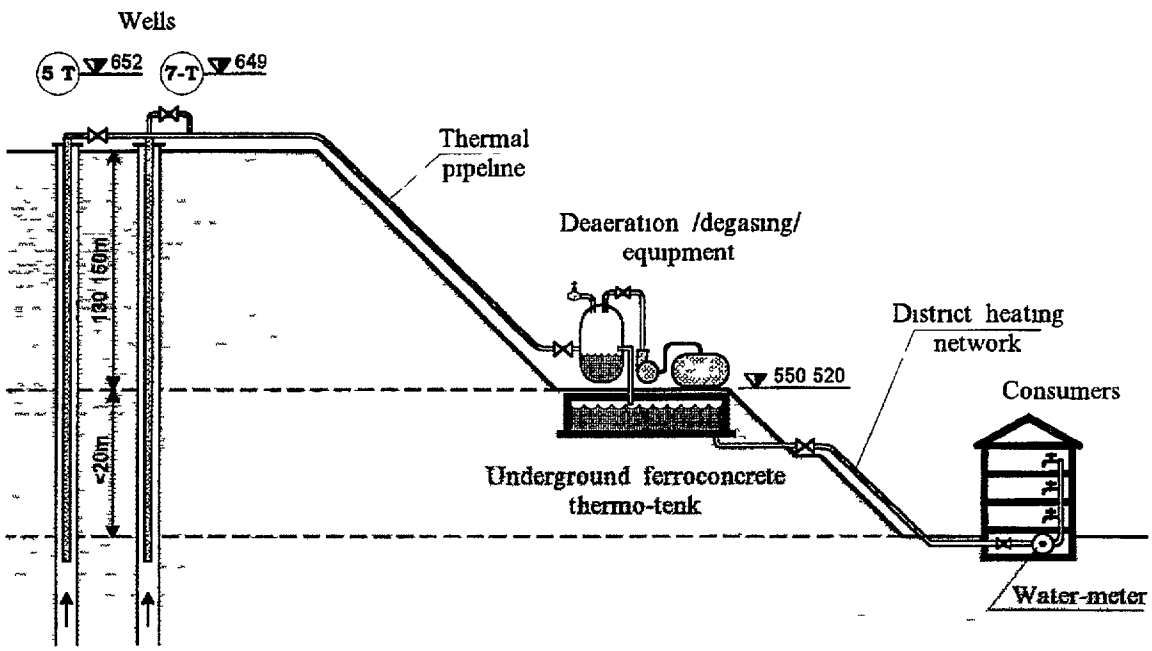
Activation of productive well flow rate can cause acceleration of exhaustion of water resources of the deposit In such case a re-injection system must be created This system will provide flow of thermal water through heat exchangers and re-injection of cooled water back into the deposit through another well According to the preliminary assessment, the possible expenses on creation of a re-injection system equals $2,5- 2,8 million US It is obvious that such modernization of the geothermal water supply system will increase cost of 1m^3 of hot water up to $1,2-1,3 USer month

Temperature of geothermal water extracted from 2300-2500 m depth will allow its efficient utilization only for hot water supply Use of geothermal water for heating will be expedient in case of possibility to extract 90^{0}C temperature water According to the opinion of Georgian specialists it is possible that at the 4000 m depth there is water with such temperature, but to prove this an observation well must be drilled

Thus, we can conclude that utilization of existing geothermal wells for the hot water supply in Tbilisi is an important possibility for saving of fossil fuel and also reduction of emissions to the atmosphere

Figure 5 1-1

Schematic Drawing of Geothermal Hot Water Supply System with Activisation of Productive Wells' Flow by Hydrosyphon



5 2 Solar Energy

During the Soviet period the interest in development of Solar Energy systems in Georgia was limited by availability of cheaper fossil fuel and electric power Solar energy utilization was overviewed as a scientific subject, but not as a practical source of energy It should be mentioned that current low tariffs on power does not encourage active the interest directed to this renewable source of energy

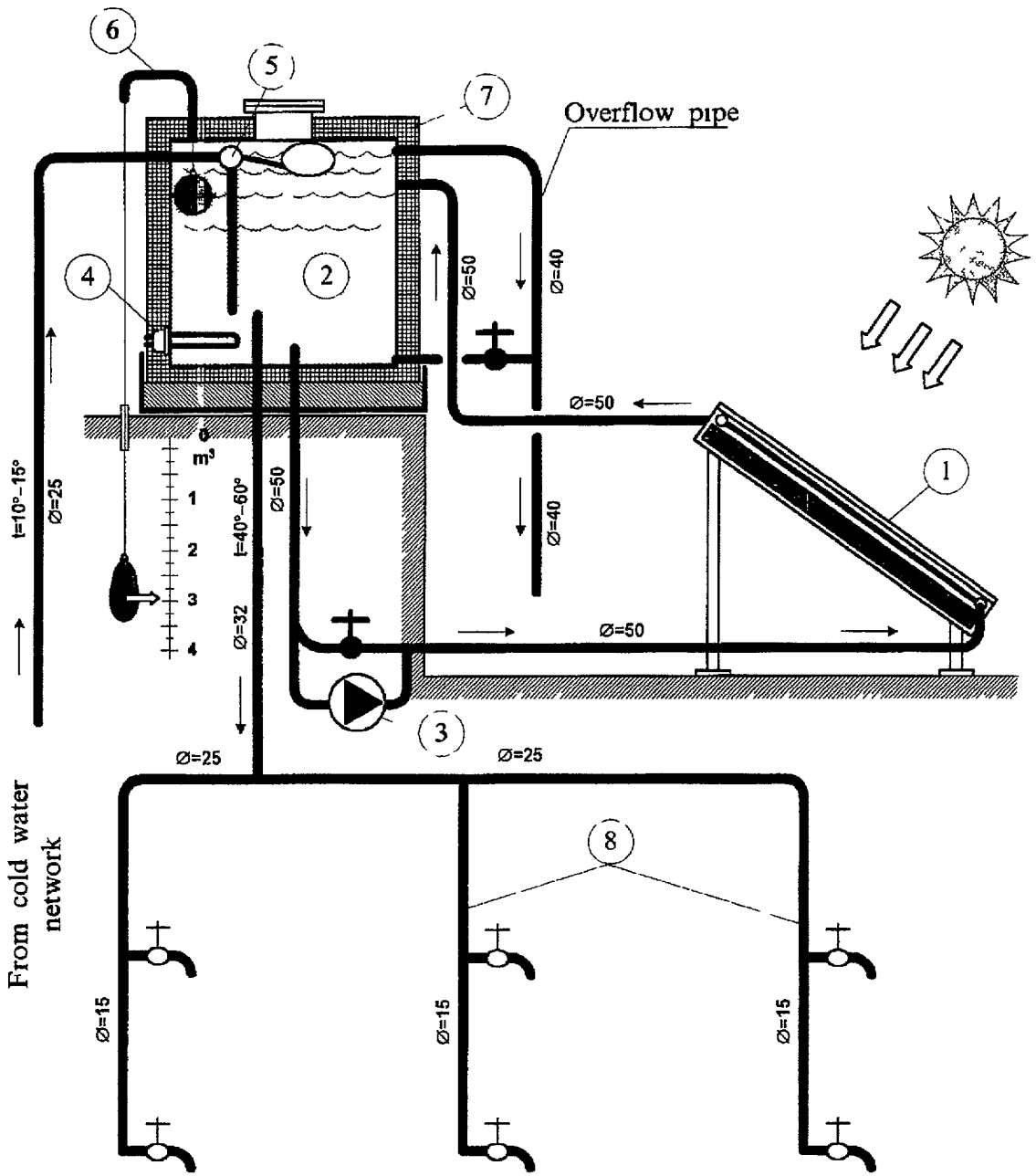
Actynometric investigations, which have been provided in Georgia since 1928, indicates, that the activity of solar radiation in Georgia is not sufficient for economical and efficient utilization for heating of apartments without use of additional power sources However, the existing experience shows that even the simplest solar energy systems of collector type are able to almost totally satisfy demands for hot water during 8-9 months per year Water heating systems of that type, installed on the flat roofs of two hospitals (part of a large medical complex in Dighomi region) have been functioning for the recent 15 years

At the beginning of 1998 a new water heating solar system, with flat thermoisolated collectors of 48 m^2 area, and a accumulator tank of 4 0 m^2 volume, was installed on the roof of the Burn Center The project was funded by USAID through a program of technical assistance to the power sector of Georgia To cover the lack of solar radiation during days of cloudy weather, the accumulator tank is supplied with electric heaters of 18 KW capacity This system allows it to generate annually 6700-7000 KWh thermal energy, and is capable of saving (taking into consideration current electricity tariff costs, which is 0 045 Lari per KWh) about $2500 US per year Installation costs of a solar energy system of this kind equals to $20000 US (expenses on repair works of roof hydroisolation and hot water supply pipe system rehabilitation are not included), or approximately $420 US per m^2 area of solar energy collectors In this system solar energy collectors (without selective cover) of local production were used with 75% efficiency of conversion of solar radiation into thermal energy

Thus, it may be assumed that the raise of costs of energy in Georgia (particularly - for electric power costs) will cause the development of opportunities for economically effective solar energy systems

Figure 5 2-1

Schematic Drawing of Solar Energy Collector System for Hot Water Supply to Burns Center



LEGEND

1 Solar heat collectors 48m²
2 Hot water tank V=3m³
3 Water pump
4 Electric heater
5 Floating lock
6 Air pipe
7 Thermal insulation
8 Consumers

6. Conclusions and Recommendations on Heating Supply to Population

6.1. Main Principles of Upgrade of Heat Supply Systems Inside Buildings

Besides its main function - efficient heating of consumers, inner heat supply system shall provide the possibility to control heat consumption intensity and measure actual thermal power consumption by each consumer The control system for heat consumption intensity shall be such as to provide the possibility to cut off insolvent consumers from the common heating system of the building

To dispel possible doubts in the necessity of establishing metering system for real heat consumption, the analogy can be made with the situation in the power supply sector One of the main reasons for the deep crisis in the power sector is the absence of a reliable system for metering power actually consumed by each consumer Obviously it is necessary to avoid similar situations in the heating supply sector

6.2 Possibilities of Heat Supply System Modernization in Buildings

Metering of actual heat consumption

The main condition of a successful implementation of any program regarding the district heating system efficiency improvement is creation of a mechanism for billing and payment collection according to the actual consumption

The technical basis for such a mechanism is installation of heat meters at the heat supply systems

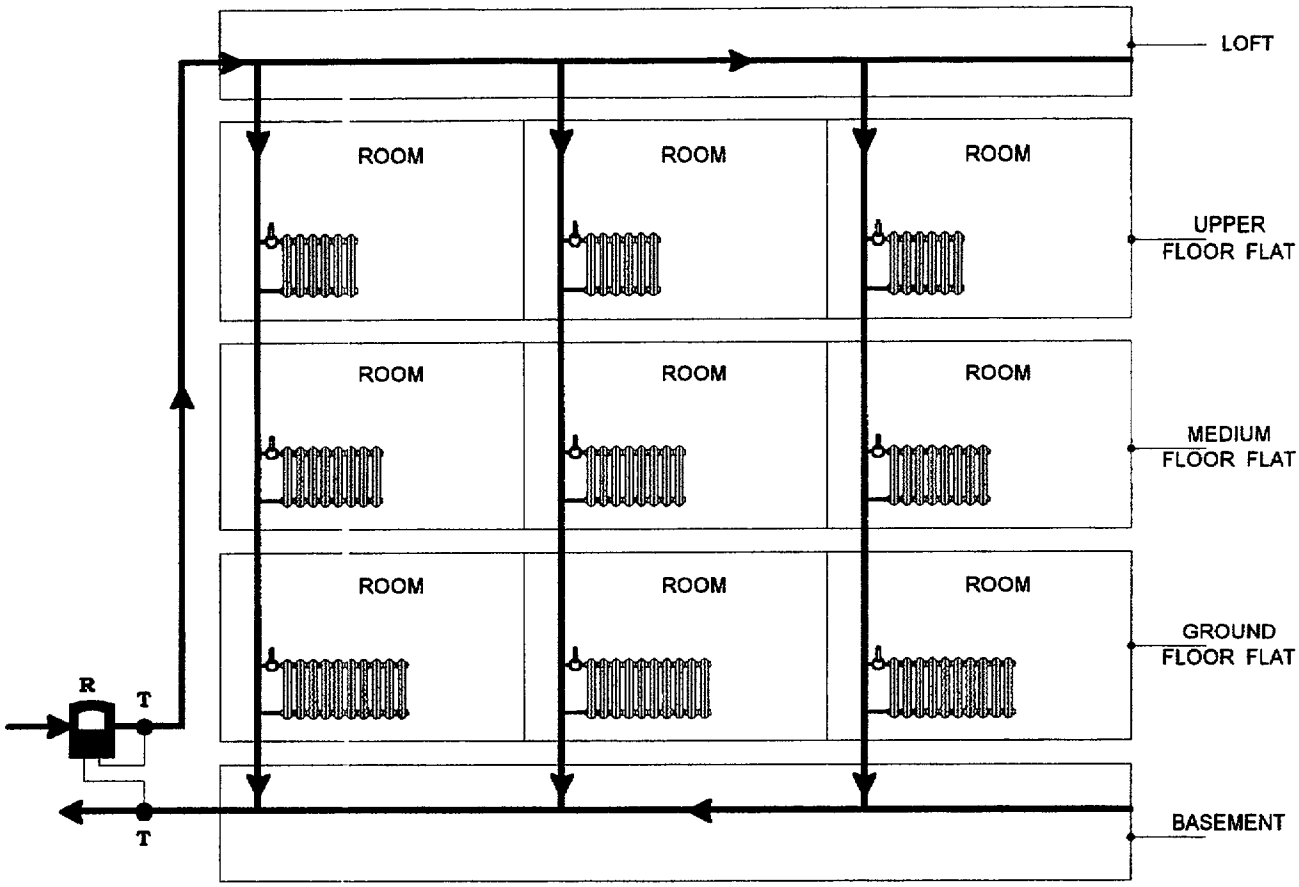
From the psychological point of view it is important to conduct metering at the lowest consumption level, but the existing branching of pipes in the blocks of flats does not permit to carry out metering for each flat separately

The most available method to organize heat consumption metering in buildings connected to centralized (district) or decentralized (group) heat supply sources is installation of heat meters at the place where the heating pipeline enters the building Expenses for installation of a such meter are within the range of 1000 USD (200 kW) - 1500 USD (400 kW) per one unit of equipment

If the heat supply system refurbishment is limited only to the installation of common heat meters, then the payment can be apportioned between the apartment owners (families) only according to the area of each flat Such an apportionment does not differ from the former practice of heat supply billing and payment and preserves all its shortcomings It can be stated that the knowledge of heat consumption volume registered by a common meter installed at the place where the heating pipeline enters a block of flats will hardly stimulate the inhabitants to improve thermal insulation of their flats and save heat

Figure 6 2-1

Upgrading of existing heating systems with heat consumption meters



K - Meter with a temperature controler,
T - Temperature sensitive element,
🌡 - Distribution meter of evaporative type

If we reject the method of establishing payments according to the flat area and install distributing meters of evaporative type on each radiator, thus providing the possibility to determine exactly how the total heat supply is distributed between flats A distributing meter of evaporative type is a meter in which special liquid is used which evaporates depending upon the temperature of radiator The expenses of meter installation on one radiator are equal to $12-15 US But usage of distributing meters will create certain injustice, E g the owners of apartments that are located at the end face of the building will have to pay not only for heating, but also for the unfavorable location of their flats This shortcoming can be overcome only by means of installing electronic heat meters on all radiators that are capable to determine the temperature inside the apartment, but this would be an extremely costly way for the system refurbishment

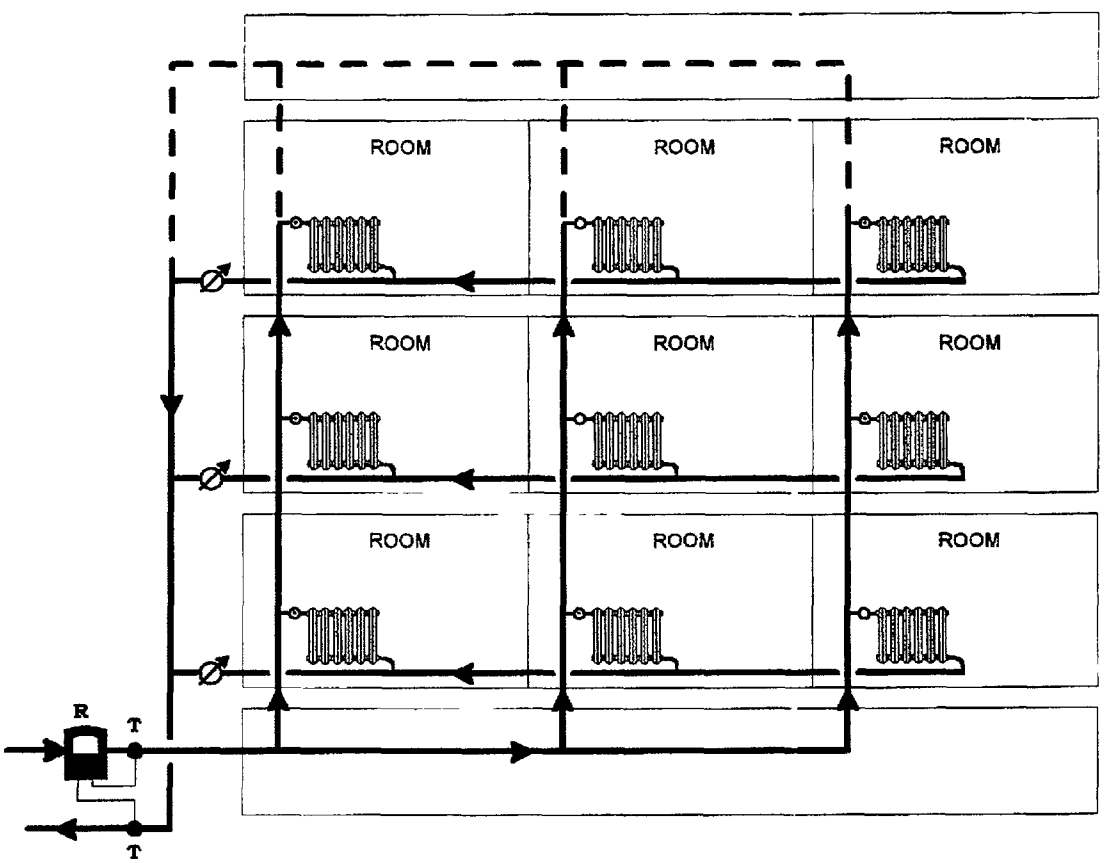
All these methods of refurbishing heat supply systems to buildings have a common weak point connected with the attempts of the population to tamper with the equipment installed in their flats, especially if it influences the family budget

We also must expect some dishonest actions on the part of representatives of corresponding institutions who will from time to time read distributing meters and determine amount of heat consumed during the heating season A serious drawback of the above methods is the impossibility to stop supply of heat to insolvent consumers, separating them from the whole system In order to provide such a possibility, it is necessary to reject the one pipe systems and substitute them with two pipe systems

Some problems may arise during the installation of two horizontal pipes in apartments inside the existing buildings, while half inch diameter pipe can be easily installed along the room perimeter, including under the balcony door thresholds

Figure 6 2 - 2

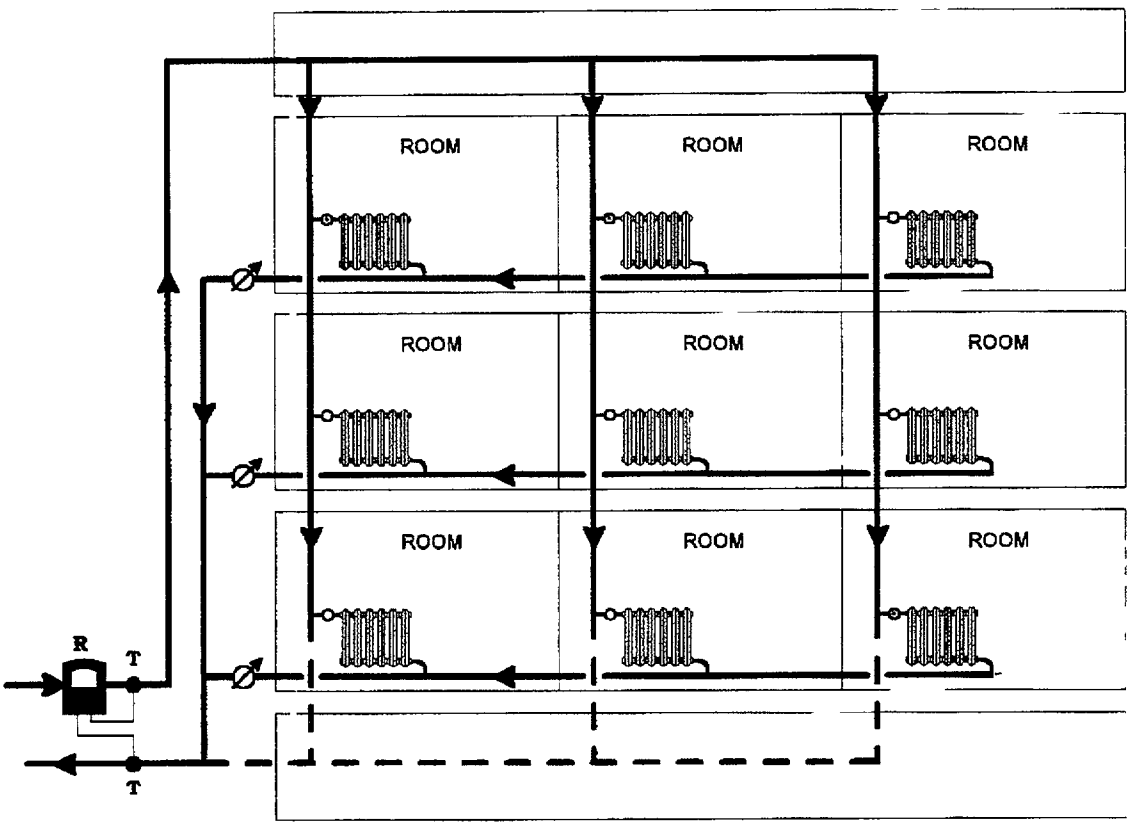
Installation of additional horizontal thermal piping in existing heating systems
(supply of heat carrier from lower point)



R - Meter with a temperature controller,
T - Temperature sensitive element,
O - Heat exchanger valve,
Ø - Hot water meter,
--- - Sections of piping to be removed

Figure 6 2-3

Installation of additional horizontal thermal piping in existing heating systems (supply of heat carrier from upper point)



R - Meter with a temperature controller,
T - Temperature sensitive element,
⊙ - Heat exchanger valve,
Ø - Hot water meter,
--- - Sections of piping to be removed

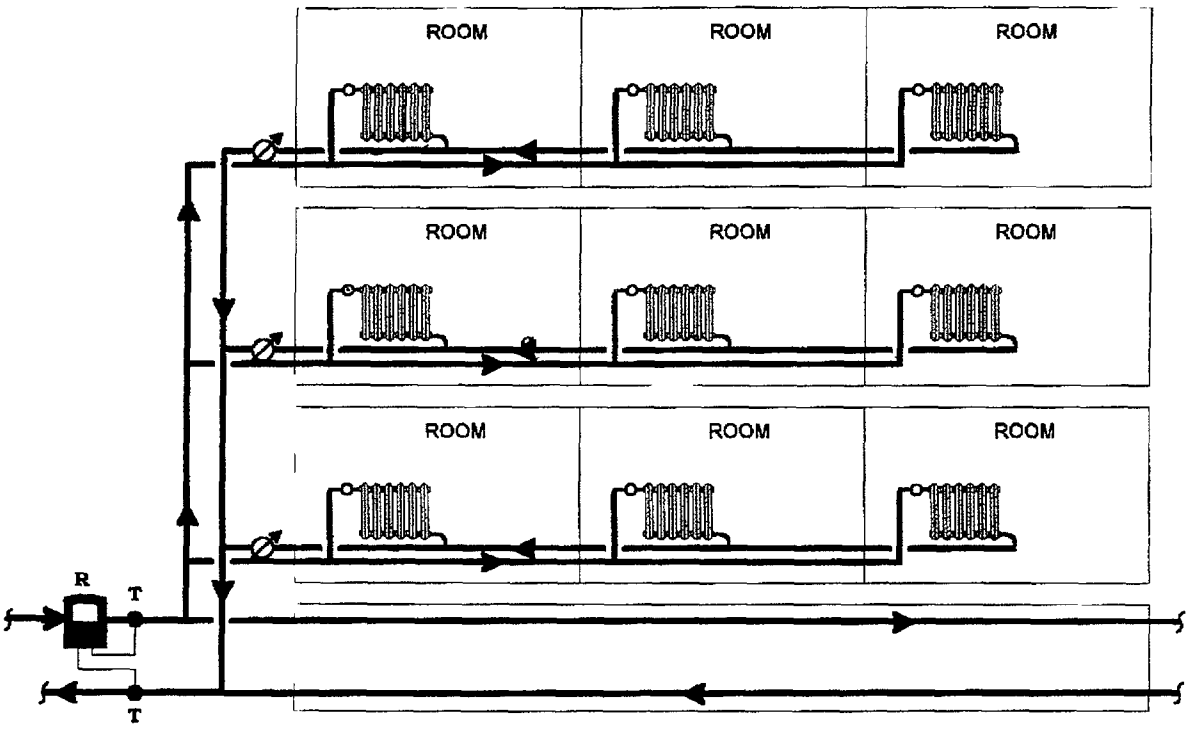
It is very difficult to determine the average cost of such a reconstruction as these expenses depend upon the area of apartment and its arrangement For standard three room apartment of 50 m^2 heating area (residential area) the reconstruction cost (without replacement of radiators) will equal 700-900 US $

It must be noted that in the process of reconstruction of heat supply systems serving the existing buildings it will be necessary to carry out refurbishment in all flats, of both solvent and insolvent consumers This would significantly increase the expenses per one solvent consumer

While designing the heat supply to new buildings (under construction) its recommended to reject the former practice of installing vertical pipes

Figure 6 2 - 4

Horizontal two-pipe heating system for new buildings



R - Meter with a temperature controller,
T - Temperature sensitive element,
⊙ - Heat exchanger valve,
Ø - Hot water meter,

Though water meters in the flats shown on the schemes can not serve as commercial metering devices of heat consumption, in case of two pipe heating systems, the readings can be used to establish how total heat registered by meters installed at the place where the pipe enters the building is further distributed between the flats

Two pipe heat supply systems permit not only to stop heat supply to insolvent consumers by means of a simple valve, but also to regulate heat supply to the whole flat

System for Control of Heat Consumption Intensity

Possibility of heat supply intensity regulation is extremely important, because heat consumption inside the building continually changes according to the weather conditions and customers' requirements

Efficient system of heat supply intensity regulation includes two elements

- Centralized control by means of heat generator (in boiler house or thermal station),
- Individual (radiator) means of regulation

Centralized control provides the preliminary rough adjustment of heat carrier's temperature, depending on weather conditions and individual means of regulation, to allow to execute more precise correction of heat consumption, depending on actual heat losses in the apartments, as well as on actual heat inputs (solar heat, heat from the lighting sources and other equipment, heat generation from the human body etc)

Individual means of regulation allows the consumer to regulate the temperature inside the apartment depending on his own requirements (or financial capability) irrespective of other consumers or centralized regulation

Individual devices for heat consumption regulation

Individual regulators and heat consumption metering devices in the heating systems should be utilized together If the consumer does not receive the information about the actual amount of consumed heat with the help of regulating devices, then he looses control of heat saving and his own financial expenses From the other side, individual metering of heat consumption is effective only when the consumer has the possibility to regulate heat consumption according to his own demand

Expenses for installing individual means of regulation on the heating devices are mostly determined by the design of the heating system For vertical single-pipe systems these expenses will be considerably higher than in case of double-pipe systems

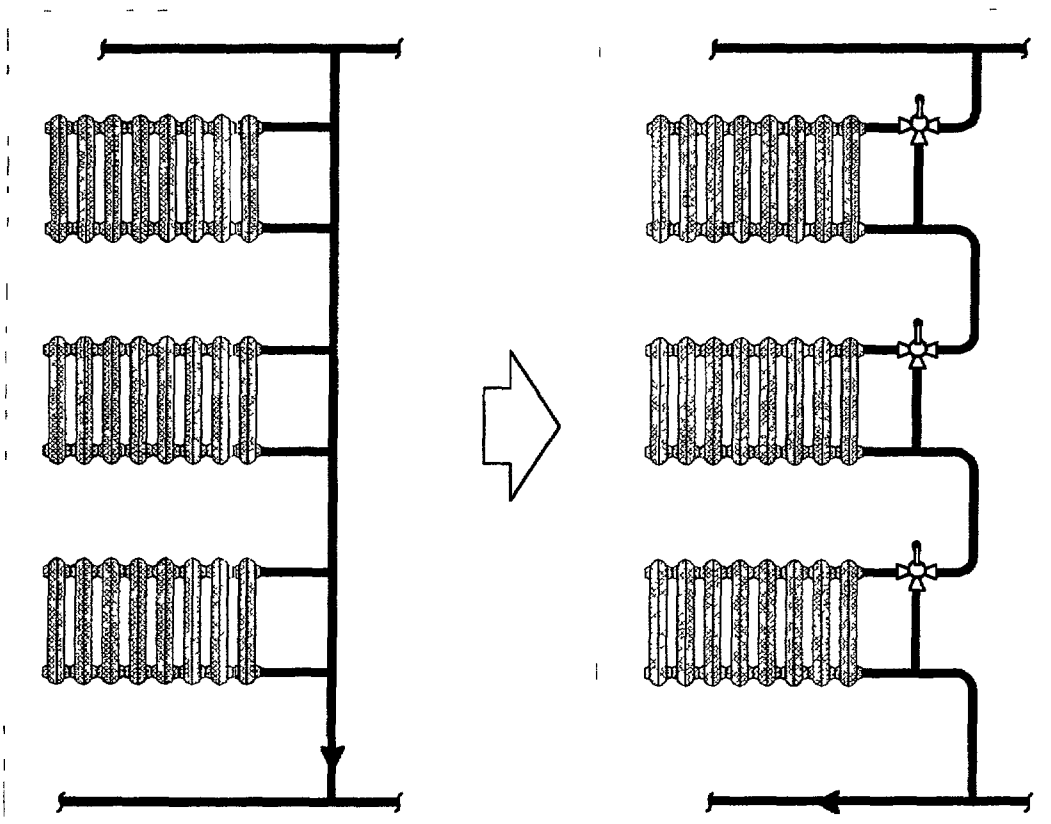
In case of the double-pipe system, simple control valves can be used In case of vertical single-pipe systems it is necessary to use more expensive three-way valves and in addition the heating piping shall be provided with a by-pass section Expenses for such modification will amount to $40-50 US per radiator, under the condition that the radiators will not be replaced

In case of manual regulation the consumer will often have to adjust the temperature, depending on the variation of heat loss and heat supply in the apartment Regulation quality and energy efficiency in this case depends only on the consumer

Figure 6 2 - 5

Upgrading of existing heating systems with individual devices
for heat consumption regulation

Vertical one pipe system



- Three-way valve,

- Distribution meter of evaporative type

The most efficient regulation of temperature in the building is achieved by means of automatic thermostatic valves Thermostatic valves consist of two parts valve and regulator The regulator contains the thermostat, which has a metal pin When heated this pin expands and locks the valve, corresponding to the flow of heat carried through the heat exchanger is changed Expenses on the installation of automatic thermostatic

valve and arrangement of bypass section for each radiator may amount to $60-65 US, on the condition that the radiators will not be replaced

Essential obstacles for the installation of automatic thermostatic valves (besides their high price) is their high hydraulic resistance, which can cause deregulation of existing heating systems

Besides, it must be considered that implementation of thermostatic valves is justified in those heating systems which have spare capacity for heat generation

In order to determine possible investment costs required for optimal measures for upgrade of consumers' heating systems, it's reasonable to make references to the study performed by the company LAHMEYER INTERNATIONAL

Table 6 2 - 1 Investment expenses for for customers

	Heated area[1]	Number of flats[2]	Sets of connected fittings[3]		Heat istribution meters[4]		Heat meters[5]		Total expenses
	(m^2)	Items	Items	Thous DM	Items	Thous DM	Items	Thous DM	Thous DM
Dwelling houses	212 000	4 240	19 080	1 526,40	19 080	381,60	0	0,00	1 908,00
Public houses and offices	136 000		5 440	435,20	2 720	54,40			489,60
Total number of buildings	190					54,50	190	304,00	304,00
Installation expenses				514,92				9,50	578,92
Sub-total									3 280,52
10 % added for contingency									328,05
Total for District 8									3 608,57

[1] Distribution of heated area for dwelling houses and public buildings and offices was performed according to the actual situation for the whole district (supply region)
[2] Number of flats was determined based on average living area per flat - 50 m^2
[3] It is assumed that each flat has on average 4,5 heating radiators, and for offices - one radiator per 25 m^2 of heated area
[4] 50% of public buildings and offices are used by one consumer, so for this part of buildings installation of heat distribution meters has not been foreseen
[5] For each building one heat meter is foreseen

Separate prices, in DM ($1=1.62 DM August, 1997)

Set of connected fittings		Heat distribution meter		Heat meter	
Materials	80,00	Materials	20,00	Materials	1 600,00
Installation	21,00	Installation	2,50	Installation	50,00
Total	101,00	Total	22,50	Total	1 650,00

Source LAHMEYER INTERNATIONAL Survey of Heat Supply System in Georgia Based on Tbilisi Example By request of Kreditanstalt für Wiederaufbau August of 1997, page 38 of the Attachment

Determination of investment costs was performed by the company LI for Vake district in Tbilisi

Analysis of given data allows us to calculate specific investment cost per 1 m^2 of heated area

- for whole district - 6,38 US $/ m^2
- for residential buildings - 8,70 US $/ m^2

So, investment costs for upgrade of the heating system per one flat with living space of 50 m^2 amount to about $435 US

These expenses include

- Part of expenses for installation of one common heat meter on the entrance of heating pipeline in the building
- Expenses for installation of automatic thermostatic valves on each radiator in flat (4-5 items)
- Arrangement of piping bypass section for each radiator in flat (4-5 items)
- Installation of distribution meters of evaporator type for each radiator in flat (4-5 items)

If manual three-way valves will be used instead of automatic thermostatic valves, then investment costs per flat will be reduced to 320-340 US $

6 3 Cost of Thermal Energy and its Price

The purpose of this chapter is to determine the possible range of thermal energy prime cost values, including total expenses for its centralized or decentralized generation, supply and consumption by consumers

To achieve the above purpose we considerably relied on the results of the "Survey of Heat Supply System in Georgia Based on Tbilisi Example" worked out by "Lahmeyer International" at the request of "Kreditastalt fur Wiederaufbau" (The final version of this report is dated as of August 1997)

In this substantial report the company "Lahmeyer International" studies alternative options of centralized (district) and decentralized (grouped) heat supply to two Tbilisi districts

Summary results of prime cost calculation for heat supply (production - supply - consumption of heat energy) to Vake residential district (the district is served by Thermal Station N8) and Digomi residential district (the district is served by Thermal Station N48) are given in the Tables below

Table 6 3 - 1 Dynamic Prime Cost (Production Cost) for Supplying District No 8 in DM per kWh (Percentage Rate 10%)

N	Description of the Option	Price of Electricity Supplied to the Grid (in tetries per kWh)			
	1 62 DM = $1 August, 1997	Basic 3 0	4 0	5 0	6 0
1	Central supply from the site of the former thermal station by means of two boilers, 15 MWt_{therm} each	142 95	146 40	149 86	153 31
2	Central supply by means of constructing a new thermal electric station at the former boiler room site gas turbine of 3 3 MWt_{el} connected to a heat recovery-boiler with an additional heating capacity of 15 Mwt_{therm}, also two reserve boilers of 15 MWt_{therm} capacity	177 98	170 03	162 09	154 14
3	Central supply by means of constructing a new thermal electric station at the former boiler room site gas turbine of 3 9 MWt_{el} connected to a heat-recovery boiler with an additional heating capacity of 30 MWt_{therm}, also two reserve boilers of 15 MWt_{therm} capacity	183 18	172 76	162 35	151 93
4	Central supply by means of constructing a new thermal electric station at the former boiler room site gas engine facility of 3 x 1 6 MWt_{el} with two peak boilers of 12 MWt_{therm} capacity each	181 46	166 87	152 29	137 7
5	Decentralized heat supply by means of installing 17 new boiler stations with 30 container modules of 1 MWt_{therm} capacity each for supplying different areas	152 37	155 76	159 16	162 56

In the main (basic) option (price of electricity supplied to the common grid - 3 tetries per kWh) rated cost for District No 8 varies from 143 DM per MW-hour to 183 DM per MW-hour It can be seen that in case of centralized heat generation by two boilers of 15 MWt_{therm} capacity each, installed in the existing building, lower prime cost is expected (143 DM per MW-hour) than that of decentralized heat supply by means of 17 small boilers (152 DM per MW-hour) The estimated prime cost (production cost) includes refurbishment of a considerable part of the existing distribution network and all works to be carried out in the buildings

Table 6 3 -2 Dynamic Prime Cost (Production Cost) for Supplying District No 48 in DM per kWh (Percentage Rate 10%)

N	Option Description	Price of Electricity Supplied to the Grid (in tetries per kWh)			
	1,62 DM = $1 August, 1997	Basic 3 0	4 0	5 0	6 0
1	Central supply from the site of the former thermal station by means of two restored hot water boilers	85 36	87 41	89 47	91 53
2	Central supply by means of a thermal electric station, also restoration of one reserve/peak boiler gas turbine of 6 4 MWt_{el} connected to a heat recovery-boiler of 38 MWt_{therm}	125 47	113 81	102 15	90 49
3	Central supply by means of a thermal electric station, also restoration of one reserve/peak boiler gas engine facilities of 7 2 Mwt_{el}, also two peak boiler of 15 MWt_{therm}	127 19	114 81	102 43	90 06
4	Decentralized heat supply from the existing substations at the former boiler room site 8 permanent boiler stations of total capacity 38 MWt_{therm}	96 53	98 93	101 33	103 73
5	Decentralized heat supply from the site of existing substations at the former boiler room 8 mobile heating boiler stations, total number of modules 19 with 2 MWt_{therm} capacity each	90 70	93 10	95 50	97 89

In the main (basic) option (price of electricity supplied to the common grid 3 tetries per kV/h) rated cost for District No 48 varies between 85 DM per MW-hour and 127 DM per MW-hour It can be seen that the prime cost is the lowest in case of centralized heat production in the existing boiler rooms The next option is decentralized heat supply from 8 substations As needed investment is lower for mobile facilities than for the permanently installed ones, the prime cost of Option 5 (91 DM per MW-hour) is lower as compared to the prime cost of Option 4 (97 DM per MW-hour)

Prime cost of heat generated at District Station No 48 is lower by 60 DM per MW-hour than that for District Station No 8 An important reason for the lower cost is the

existence of a distribution network that can be partially used in future As a result, in the prime cost for District No 48 capital expenditure for the distribution system equals 14 DM per MW-hour as compared to 46 DM per MW-hour for District No 8 As for heat generating facilities in ThS No 48, the feasibility of their rehabilitation is better here than in ThS No 8 area Rated capital expenditure for heat generation in ThS No 48 is lower by 20 DM per MW-hour

In our opinion a set of measures provided for during the prime cost estimation of heat supply from ThS No 8, is the most characteristic for the general situation in Tbilisi Though, as expected, prime cost of heat supply to this area turned out to be very high

It must be noted here that **heat supply restoration in Georgia is a measure which will directly reduce electric power consumption Though if consumers are offered heating for a price higher than the electricity price, electricity consumption will not drop** Proceeding from this judgment it is reasonable to review the prime cost of heat supply only for ThS No 48, which however is also high enough

Thus, taking into account the inevitable rise of electricity prices, the average value of central or individual (grouped) heat supply in favorable conditions can be about 90 DM per MWh (55 4 US $ per MWh)

Bearing in the mind current VAT rates (20%) in Georgia, the heating energy tariff will amount to not less than 60 US$ per MWh

As it has already been mentioned, such a tarrif can be efficient only if the existing electricity tariff (34 8 US $ per Mwh) will correspondingly increase almost two times

6 4. Nominal Heat Consumption by Households in Tbilisi

While estimating the minimum demand of heat supply to appartments which still have central heating, it is considered that in the nearest future it will be impossible to increase saving of thermal energy by means of improvement of thermal insulation of houses

Considering the climate conditions in Tbilisi (maximum range from -8^{0}C air temperature outside, +18^{0}C temperature inside buildings), the rate used in assessing average amount of heat needed for heating appartments was 70 W/m^2 (not including heat needed for hot water supply) Lower rate was taken for buildings built after 1985 - 66 W/m^2 In our opinion these rates do not correspond to the present condition of buildings

Inspection of buildings and inquiry of Georgian specialists proves that the following factors should be considered when estimating thermal insulation properties of buildings

- Worsening of thermal insulation properties caused by the fact that the construction standards were not followed during the construction,

- Worsening of thermal insulation properties caused by the fact that the corresponding maintenance was not carried out,
- Expansion of the heated area of appartments by means of their reconstruction - building additional logias and balconies, the outer walls of which do not conform with the thermal insulation requirements

The most cautious estimates show that the influence of the above factors on thermal insulation properties of buildings may result in the increase of average amount of heat needed for heating to 80-85 W/m^2

Our opinion is that one can not expect that the average heat consumption will fall below 70 W/m^2 (not including hot water supply) as a result of carrying out measures for heat regulation in appartments and arranging mechanism of payment collection for consumed heat supply

According to the former USSR standards, the heating season duration in Tbilisi (from November 15 till April 15 of the next year) was calculated based upon the expected low temperature hours

Table 6 4 - 1 Standards on Number of Heating Hours

Temperature Range	-14 9 -10 0	-9 9 -5	-4 9 0	+0 1 +5 0	+5 1 +8 0	Total
Number of Heating Hours	10	73	552	1 649	1 364	3 648

Considering the nominal demand of thermal energy and heating season duration it is possible to calculate average annual heat consumpiton by a particular consumer

Table 6 4 - 2 Heat Consumtion Data

Heat Consumption	80 W/m^2 of residential area
Heating Season	November 15 till April 15
Number of Full Load Hours	1897 (3648 x 0 52)*)
Annual Heat Consumption	151 8 kWh per m^2

*) Here we used coefficient 0 52 to calculate number of Full Load Hours from total number of heating hours per year

Concequently in order to heat one flat with 50 m^2 residential area (heated area) average annual heat consumption needed for heating equals 7 59 MWh

It is possible to calculate monthly and annual needs for heating of 50 m^2 appartments using the former thermal energy tarrifs for a case of centralised district heating system rehabilitation

Table 6 4 - 3 Annual and Monthly Expenditure for an Average Statistical Household

Annual Expenditure	60 US$ x 7 59 Mwh = 455 4 US$
Monthly Expenditure	455 4 US$ 12 = 37 95 US$

6 5 Solvency of Households in Tbilisi

Official statistical information about family income in Tbilisi permits us to determine the level of expenses which the population is ready to spend for its requirements, including heat supply

It must be noted that the available official information regarding the social condition of the population is often inconsistent and sometimes controversial

The given analysis is based upon published information, obtained by means of inquiry carried out by the State Statistical Department, The Conjuncture Research Center, Research Institute of Social Opinion and Oxford Research International from 1995 to 1997

All the inquiry results proves, that the population income grows but is still at a very low level A substantial part of family income consists of random income, including funds obtained from selling personal property

According to the Conjuncture Research Center data, during the period from June 1995 untill June 1996, actual average income growth of Tbilisi population equaled 200% i e that an average income of a family of 3 7 members (average number of family members in Tbilisi) equaled 232 US $ The share of non-monetary income is about 7% of the above number

Table 6 5 -1 Average Monetary and Non-monetary income in Tbilisi in 1995-96

	Average Income (US $)		Median Income (US $)	
	1996	**1995**	**1996**	**1995**
One household	232 40	75 10	118 20	30 90
Per capita	70 00	26 10	39 60	10 60
Self estimate of the amount needed per capita	569 92	136 00	400 00	75 00

Source Conjuncture Research Center

Though it must be noted that in 1996 the average median family income was only 118 US$, which means that income distribution is extremely uneven between different population groups

In Tbilisi about 10% of rather well-off families has about 43 1% of total income while 10% of the poorest families have only 9% of total income

Table 6 5 - 2 Income Distribution in 1995-96

Decilar group	1	2	3	4	5	6	7	8	9	10
Share in total income %	0 9	1 8	2 8	3 9	5 3	7 1	8 8	11 5	14 8	43 1

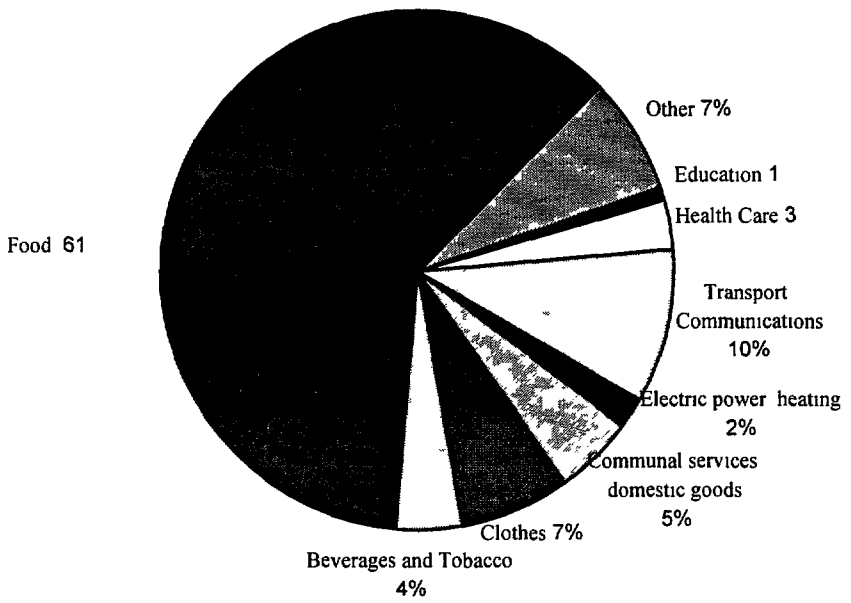
According to the State Statistical Department Gin's Index - statistical measure of inequality from 0 (equal distribution) to 10 (absolute inequality) - dropped from 0 58 to 0 53 It must be noted, that in 1993 Gin's Index was 0 35, while in 1994 - 0 52 In the previous years the inequality was less conspicious and mainly caused by non-monetary privileges, such as availability of products and services It is clear, that the situation considerably worsened with the devastation of the state Such an uneven income distribution will hinder economic and political development and we hope that in 1995 it reached the peak

In March 1997 the subsistence level estimated by the State Statistical Department on the basis of the 2500 calorie product basket equaled 106 7 laries ($83 US) The same index for a four person family was 187 2 laries ($145 US)

According to the research carried out by the State Statistical Department, in the first quarter of 1997 the income of 57% of Tbilisi population was below the subsistence level In 1995 the this index equaled 70%

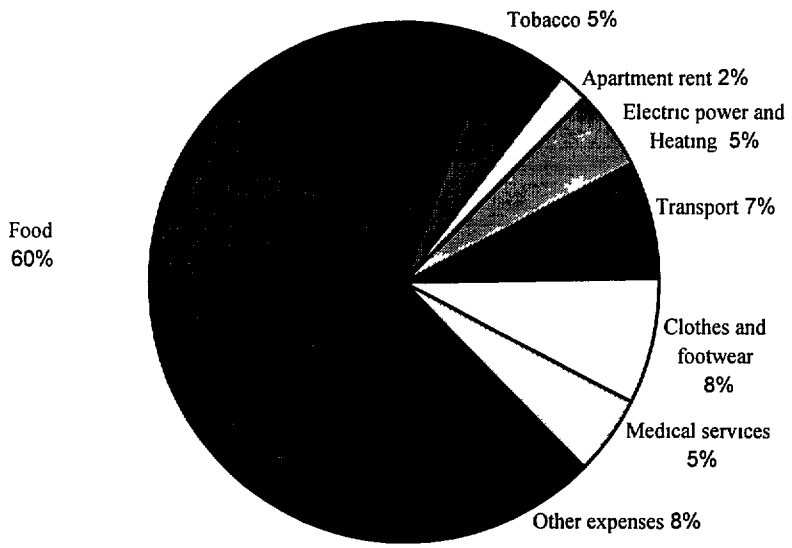
For our analysis data regarding the expense distribution of the population is the most important

Figure 6 5 - 1 Average Household Expenses of the Population Summer 1996



Source The State Department of Statistics DomesticExpenses Survey

Figure 6 5 - 2 Median Household Expense Categories EDI (Tbilisi State University Survey)



Source EDI, TbilisiState University

If we take into consideration that due to the extremely low average level of the population's income, people have to spend their money at once to cover their immediate needs, then it can be assumed that the average income of the population equals average expenses This assumption enables us to estimate expenses of an average Tbilisi family for electricity supply and heating in 1996 as $4 65 - $5 9 US per month (2% of average income - total $232 4 US, 5% of medial income - total $118 2 US) i e $55 8 - 70 8 US per year

If we assume that half of total expenses for heating and electricity is spent by households on heating during four coldest months of the year, then average monthly expenses on heating will amount to $7 0 - 8 75 US $

In order to check the obtained data, we carried out an inquiry in November 1997 As a result it was established that an average statistical family of four members lives in an apartment of 50 m^2 **The most widespread methods of heating apartments are electric heaters, kerosene heaters and wood stoves The total capacity of electric heaters used to heat one average flat (50 m^2) is 2-5 kW The upper limit is determined by the capacity of the existing electric wiring of 1 5 - 2 5 mm^2 cross-section** During winter the population is supplied with electricity only during 5-8 hours instead of 24 hours This time is not enough to heat the whole apartment by means of electric heaters

Thermal capacity of kerosene heaters equals 1 5 - 2 5 kW As a rule such a heater can additionally heat only part of the flat - 20 - 25 m^2 Average consumption of kerosene

is 1 5-2 5 liters per day If the cost of one liter kerosene is about 0 3 laries, monthly expenditure is $13 5 - 22 5 US

The majority of the population does not pay for consumed electricity During the inquiry it became impossible to establish the share of the population that does not pay for consumed electricity as people refused to answer this question Usually the temperature in heated rooms is no higher than 18^{0}C but extremely low incomes do not permit to increase heating expenses Thus the research results show that average heating expenses of Tbilisi families exceed the official statistical indices three times but still remain extremely low and amount no more than 100 US$ per year

This conclusion allows us to state that solvency of households in Georgia during short-term period will not be high enough to cover family expenses on heating by means of traditional district heating system

6 6 Individual Heating Systems for Population

In June 1993 the supply of natural gas to Georgia was extremely reduced The limited emergency reserves of mazut kept in the reservoirs of thermal stations were withdrew and distributed to the Bread Plants Starting from winter 1993-1994 the main part of Tbilisi population (about 80%) was left without heating

In the above mentioned situation the population started to use, first of all, electric heaters, which were available in each family as people often used to switch them on even when the central district heating systems were functioning The capacity of the existed electric heaters was not sufficient and people started to extend the number of the heaters for their residences Thus the power supply lines were overloaded and the population began to provide additional electric lines to their apartments As usual the additional electric lines were switched primarily to the switch-gears of living house blocks, bypassing the meters, which are installed in each apartment, as the above mentioned meters are designed for lower power supply, of about 5-17 A However, the main reason for bypassing the meters was the tendency of the population to avoid payment for consumed electricity

In 1994 the gas supply to the population was cut completely, and there appeared new demand on the electric power for cooking

The city electric system, which functioned in the limited conditions was overloaded and could not overcome the further extension of consumed electricity Day by day the existing transformers were damaged, switching gears and cables very destroyed It should be taken into consideration that these events took place in parallel with reduction of power generation in Georgia Since 1994, in winter , when the deficiency of electric power is maximal, the supply of the power to Tbilisi is limited to 6-8 hours a day

The population began to use wood and kerosene heaters for heating their flats Because of low income, heating of only small spaces were possible Living rooms were used as kitchens

Most of the living houses are not equipped with special piping for exhaust of stoves The pollution was directed out through the windows

Since 1996-1997 supply of the city with wood and kerosene has been improved and better control of wood cutting was organized, as in previous years the population used to cut wood around the city and, sometimes, even in the parks inside the city

Nowadays the majority of people prefer to use kerosene heaters Supply of kerosene is much better 1 liter of kerosene costs about $0,27-0 35 US The thermal capacity of existing kerosene heaters varies from 1,0 kW to 4,5 kW The most popular are the South-Korean heaters of about 2,5 kW, the price of which is $80-90 US Such kerosene heaters are able to heat a living room of about 25 sq m consuming average 3 liters per day (for day-time only) The efficiency of the South-Korean kerosene heaters is maximal but, because exhaust gases from burning are collecting in the heated rooms, it's need to be refreshed periodically

Perspective of Utilization of Individual Heating Devices

The main changes in problem of heating are related with restoration of the natural gas supply to Georgia Since 1996 consequent rehabilitation of existing gas supply system has been provided in Tbilisi, but the process is developing very slowly Only 25 000 households are getting natural gas for recent two years, that is 7,5 - 8,0 % of the city population The gas system rehabilitation is provided by the municipal enterprise "TBILGASI" The funding of the works is included in the municipal budget of Tbilisi Two ways of paying for consumed gas is offered to the population

- rated - 3,5 $US per month per each family member
- actual - according to the gas meter, about 0 13 $US per cub m

The cost of installation per each meter is about $90-100 US

In November-December 1997 the population of Dighomi (one of Tbilisi districts) was interviewed, as the natural gas supply has been restored there since 1996 Out of 366 interviewed households 37 prefer the installation of meters and pay according to its indications, 227 prefer to pay rated payment for gas, 102 deny the gas supply at all The results indicate the low solvency of population in Georgia

Those who prefer the installation of meters (10% of population) belong to comparably well-supported households They can pay for installation of meters and thus get the possibility to consume or save gas according to their demands The natural gas expenses for average size family paying according to meter amounts about $4-5 US per month

The households who cannot pay for installation of meters would have to pay extended cost of gas, as rated The rated cost of natural gas for average family is 14 $US per month

Remaining part of households (38% of the interviewed population) is not able to pay monthly gas payment at all

The interview results showed that all the households who get natural gas, do use it for cooking and for heating as well It should be noted that heating by gas allows to save money not only to households that pay according to meter readings, but also to households that pay rated amount **When one pays according to the gas meter indications, he/she saves money on heating of flat, because heating by gas is much cheaper than heating by means of kerosene heaters Gas is 2-2 5 times cheaper than amount of kerosene with the same thermal capacity (with account of prices for December 1997) If one pays the rated payment for natural gas, monthly expenses for gas are 3-3,5 times more, than in previous case But in this case consumer can burn unlimited amount of gas**

Heating rooms by means of gas stoves, as in case of kerosene heaters, cause pollution of air inside flats Though the pollution is less harmful for health, heating of flats with use of gas stoves is unacceptable from hygienic point of view and the efficiency of heating is lower due to inconvenient location of kitchen inside the flat (from heating point of view)

Measures for Rehabilitation of Heating Systems in Apartments

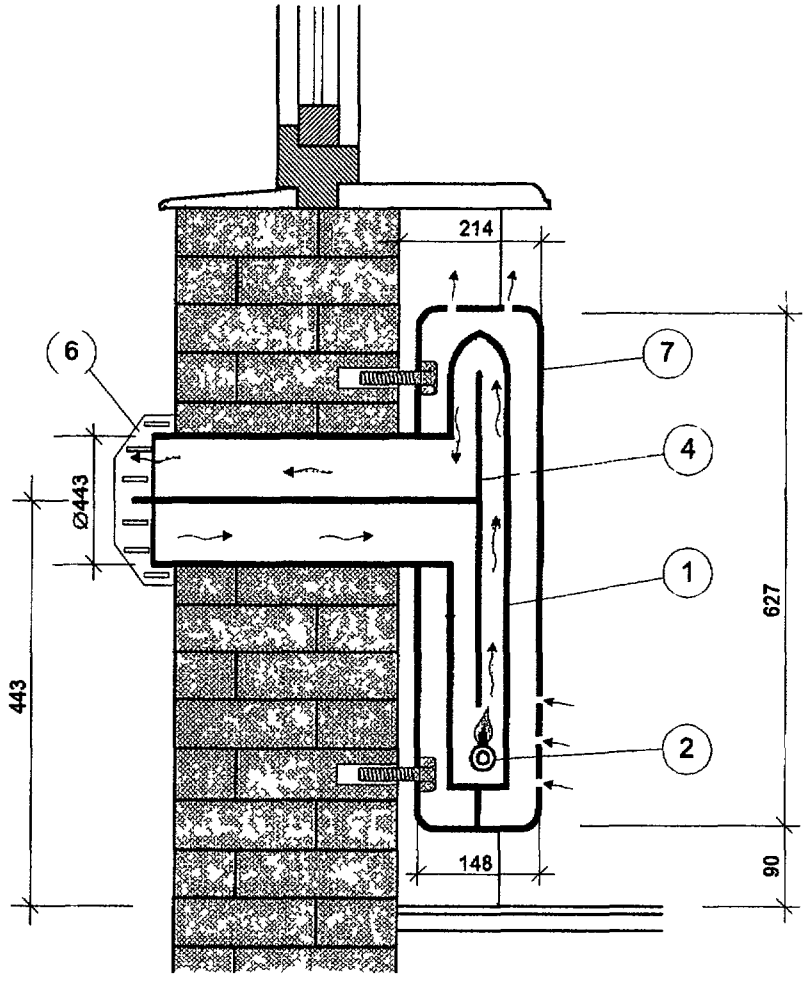
Restoration of natural gas supply to the population opens new possibilities of using autonomous heating devices

Autonomous heating systems are specially designed to provide the possibility of reducing gas consumption They are installed directly inside the space to be heated and have direct connection with the atmosphere

Those heating devices that use gas for fuel and not require vertical exhaust duct must be specially noted

Figure 6 6 -1

Design scheme of individual gas heater



In the lower part this kind of heater has metal carcass-heater (1) equipped with a pipe injector burner (2), which is supplied with air required for combustion directly from the outside, through a special opening in the wall (3) Hot gases from the burner go through the carcass-heater upwards, then over the partition (4) located in the casing, then down and after emitting the heat through the walls of the carcass-heater, arre exhausted outside through an opening (5) Air required for combustion gets into the heater and then the combustion products are blown out into the atmosphere through the same grid, closed with anti-wind flap (6), due to which wind has almost no influence on the gas burning process The top of the device is covered with a metal protective housing (7) so that there is space left between the cover and the carcass-heater, passing through which the air is heated by contacting the hot surfaces Some gas heater models are equipped with fans which intensify heat transfer

Generally heat transfer of the devices is regulated automatically by means of simple bi-metal or manual position regulators

Efficiency of gas heaters with exhaust ducts for exhausting out combustion products is about 80% If capacity equals 2-5 kW, natural gas consumption is 0 11 - 0 13 m^3hour/kW At current gas tariffs - 0 17 lari/m^3 (≈ 0 13 US$/$m^3$) - the thermal energy price will be 1 9 - 2 2 tetri/kW h (1 5 - 1 7 US$/kWh), i e twice lower than in case of using thermal energy from kerosene stoves

Installation of Heating Devices in the Existing Flats

It is convenient to install autonomous gas heaters simultaneously with the rehabilitation of Tbilisi gas supply systems

The gas supply system actually includes all residential districts of Tbilisi (except two new residential districts Gldani and Didi Digomi) Gas has not been supplied to the population during the last four years due to a dramatic reduction of natural gas import to Georgia Since the end of 1996 natural gas import to Georgia has become more or less stable, which allowed to renew gas supply to some residential districts

By the beginning of 1998 gas supply systems that provide gas to 25 000 households in Tbilisi have been rehabilitated and are currently operating

In blocks of flats gas is usually used only for kitchen cooking stoves However results of interviews revealed that kitchen gas stoves are often used as heaters

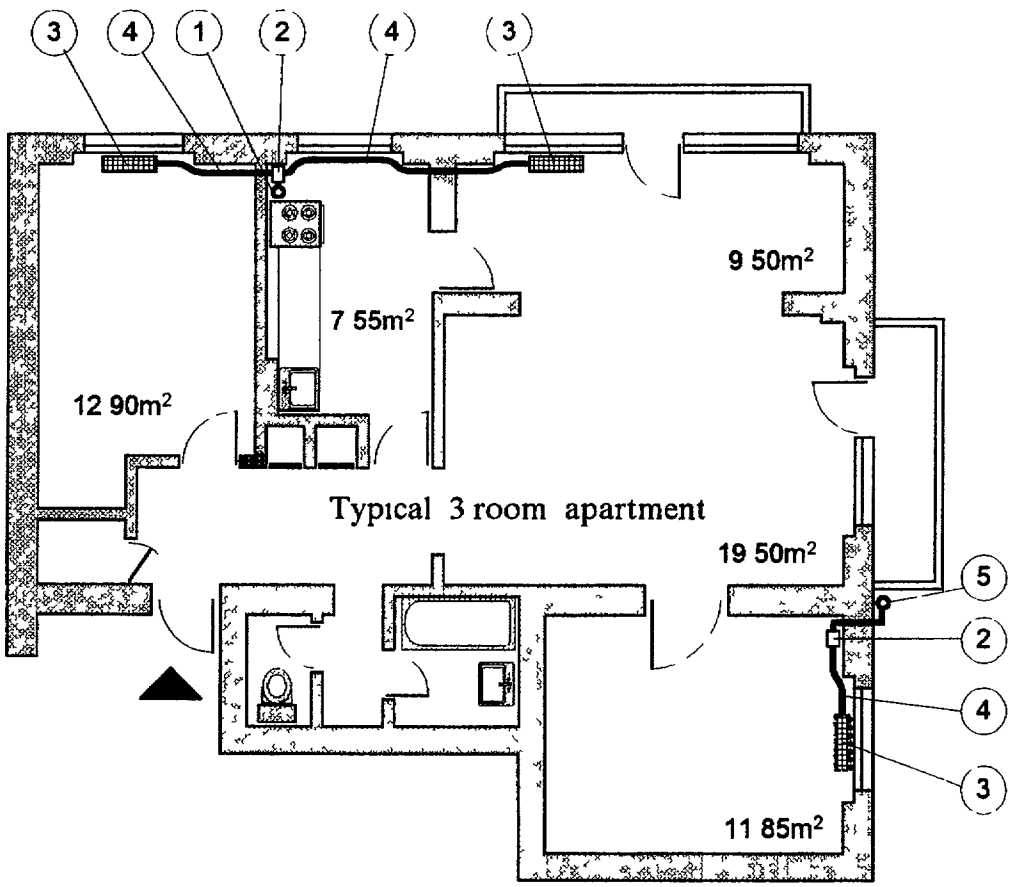
Gas is supplied to the flats by means of vertical gas piping, which ordinarily passes in the kitchens

The gas supply system rehabilitation, which is now being carried out by the Tbilisi municipality, includes installation of gas meters The whole process is slowed down due to the fact that apartment owners have to pay for the installation of meters (90-

100 US $) Under these conditions only 10-12% of apartment owners agree to install gas meters

It is recommended to install gas heaters only in the flats that are already equipped with gas meters The gas meters which are being installed in the flats can measure gas consumption up to 6 m^3/h If we take into consideration that the maximum gas consumption by cooking stoves equals 1 2-1 4 m^3/h, it is evident that one gas meter can measure additional gas consumption required for gas heaters

Figure 6 6-2



1 Existing vertical gas piping, 2 Gas meter, 3 Gas heater,
4 New horizontal gas piping, 5 New vertical gas piping

The Figure 6 3-1 shows the scheme of gas heaters installation in a typical 3 room apartment The dimensions of 2-5 kW capacity heaters permit their installation under the window seals, instead of the existing water radiators

Gas will be provided to the heaters using the traditional method - steel gas pipes of small diameter

For convenience of installation it is recommended to use copper pipes with thin walls (which are widely used in Georgia in oxygen systems of hospitals) and also plastic pipes For those systems where there is little distance between the existing vertical gas pipes and heating devises, it is possible to use elastic hoses which are currently used for providing gas from propane tanks to cooking stoves

For those systems where there is considerable distance between the existing vertical gas pipes and heating devises, it may be necessary to install new external vertical pipes In this case it is necessary to consider the necessity of installing an additional gas meter in the apartment The cost of a gas heating system of 2-5 kW capacity (including installation costs) equals 250-350 US $

Installation of 10000 heating devises can reduce the consumption of electricity during the winter period by amount for generation of which a 25 000 - 35 000 kW capacity power station is needed Construction of such a power station would cost 25-35 million US $ While the amount necessary for purchase and installation of 10000 heaters is ten times lower Low cost of natural gas (1 3 US $/m^3) as compared to the current electricity tariffs (0 35 US $/kW h) and kerosene prices (0 30 US $/liter) allow to reduce money spent by the population on heating about 1 5 -2 times

Wide usage of autonomous gas heaters will significantly help to solve the problem of heating the population

ATTACHMENT

Program for Establishing Demonstrative Zone of Public Services in Tbilisi

Development, Investment & Engineering
Ar&Ci Consulting

Delivery Order 11.
Tbilisi District Heating System Improvement Program

Task 9
Program for Establishing Demonstrative Zone of Public Services in Tbilisi

Technical Report

Draft

Prepared under Contract No 5826-055 with Burns & Roe Enterprises, Inc.

Tbilisi, 1998

71

CONTENTS

1 General 1

1 1 Introduction 1

1 2 Initial Situation - Background 1

1 3 Identification of the Problem and Methodology 2

1 4 Selection of the Region for Investigation 3

2. Recommendations on Creation of the Demonstration Zone 5

2 1 Upgrade of existing power supply systems in blocks of flats 5

2 1 1 Option I Individual Metering of Consumed Power 6

2 1 2 Option II Collective metering of power consumption 16

2 1 3 Option III Collective power consumption metering for large groups of consumers 18

2 2 Modernization of Existing Gas Distribution Systems in Block of Flats 21

2 3 Activities on Rehabilitation of Hot Water Supply to Population 23

2 3 1 Perspective Activities for Rehabilitation of Hot Water Supply to Population 27

2 4 Measures for Rehabilitation of Heating Systems in Apartments 29

2 4 1 Installation of Heating Devices in the Existing Flats 30

2 4 2 Installation of Gas Heaters in Apartments within the Demonstration Zone 32

2 5 Summary Estimated Budget for Demonstration Zone Project Implementation 33

72

1. General

1 1 Introduction

Power Sector crisis in Georgia is partly caused by low level of payment collection for consumed electricity This problem is especially tough in connection with payment for power supply to population

By the end of 1997 the power consumption has sharply increased due to use of electric heaters for heating of apartments The real paid consumption equals to 20% of actual power consumption

Taking into consideration that current tariffs on electric power do not cover the power generation costs, the negative impact of low level of payment for consumed power on the whole power sector of Georgia becomes obvious Thus, even millions of dollars of loans invested into Georgian Power Section for recent years can not improve the critical situation much

It's obvious that in the existing situation, the efforts should be concentrated on improving the power distribution system as well, taking into consideration its structural reforms and technical modernization

Gas supply system rehabilitation is one of the important activities that significantly facilitate overcome of the power crisis In the process of rehabilitation of gas supply to population it is very important to create reliable system for metering of actual consumption, which will allow to avoid complications in interrelationships with consumers Wide utilisation of natural gas by various consumers will significantly reduce the consumption of the deficient electric power

In favourable conditions, the usage of renewable power (solar, wind, geothermal power etc) sources can be effective as well

1 2 Initial Situation - Background

The existing system of communal services provided to Tbilisi population is typical for whole Georgia

Electric power distribution on whole territory of Tbilisi is provided by the Municipal Enterprise "Telasi" The monopolization of Tbilisi power system by "Telasi" creates obstacles for implementation of efficient system of gradual power distribution and payment collection for consumed power "Telasi" controls the reading of existing meters and collects money in cash by means of payment collectors Power distribution systems are not equiped with reliable means to control work of payment collectors Thus, illegal agreement with consumers may take place while reading meters or record keeping by collectors Confidential interviewing of population showed the evidence of corruption in the power distribution system Curently the Government is discussing privatization of "Telasi", but terms are not announced yet

Natural gas distribution is provided by Joint Stock Company "Tbilgazi" Rehabilitation of the system has been started since the long idle period At present gas supply has already been restored approximately to 25 000 households, that is 8%-9% of Tbilisi population

Existing gas distribution system is not equipped with metering devices in apartments This fault is partly being improved in the rehabilitation process, but, as the metering device installation costs are to be covered by population, only 10-12% households are able and agree to pay for installation of gas meters in their apartments The rest of the households pay rated monthly payments for consumed gas No problems has been raised in the relationship between the households with meters and "Tbilgazi" As to those who pay rated payments, to the opinion of "Tbilgazi", in winter period consumers are using more gas compared with rated amount Thus, this difference is not measured and is not paid Interviewing of the population didn't reveal any illegal relationships between "Tbilgazi" and the consumers Privatization of the Joint Stock Company "Tbilgazi" is planned to be made in Spring 1998

Centralized Heat Supply to Tbilisi was provided by thhe Municipal Enterprise "Tbomeurneoba" Recent years centralized district heating system was not operating and probably will not work at least for nearest future It should be taken into consideration that in most districts the heating system couldn't be rehabilitated and it's necessary to find some other operational functions for those boiler houses and thermal stations The issue of "Tbomeurneoba" privatization is not considered yet

Centralized fresh water supply of Tbilisi is provided by the Municipal Enterprise "Tbiltskhalkanali" Water supply costs are covered by population according to standard rates Established water consumption rate per consumer is very high, as it includes existing losses of whole water supply system of Tbilisi The issue of "Tbiltskhalkanali" privatization has not been raised yet

1 3 Identification of the Problem and Methodology

The aim of the present study is to figure out necessary measures for improving the relationships between consumers and communal services

Initial analysis of the problem confirms tight interrelations between different components of the task, e g

Equipping of the power distribution systems by metering devices for the reliable accounting of actual power consumption will be definitely opposed by problems of low solvency of consumers It will be a mistake to make consumers with low solvency to use the most expensive and deficient power source for their needs Thus, in order to save population from poverty and provide minimum level of comfort it is necessary to supply population with additional comparably cheaper fuel - natural gas However, in this case the following may happen gas supply may provoke population to use gas stoves in kitchens for apartment heating purposes, which cannot be accepted from hygienic point of view To overlook this problem accessible, secure heating facilities should be suggested to population

Listing of task components' interrelationship examples may be continued, but the arguments given above are enough to understand the necessity of complex solution of the problem Thus, program of the study contains the following technical components

- Selection of measures for modernization of existing power distribution system in a block of flats, providing reliable metering of actual power consumption and advantageous conditions of power supply to consumers, who cover completely payments for power consumed by them
- Selection of measures for modernization of existing gas distribution systems in a block of flats, providing reliable metering of actual gas consumption and payment collection
- Selection of measures for existing heat distribution system modernization in a block of flats, providing reliable metering of actual heat consumption and payment collection
- Selection of measures for existing water (both cold and hot water) supply system modernization in a block of flats, providing reliable metering of actual water consumption and payment collection

Institutional component of the program includes working out recommendations for creating lower level self-managing entities like an associations of apartment owners in a block of flats This kind of self-managing units are included in the new Civil Code of Georgia

Implementation of the whole complex of measures in accordance with the recommendations of the above mentioned study would allow to clarify the following important questions

- What capital costs are necessary for complex modernization of technical infrastructure of different kind blocks of flats?
- How does the natural gas supply impact power consumption by households?
- How well will be improved the payment system for consumed power and gas?
- How will the better communal services impact apartment market prices, etc

Analysis of obtained results will help to determine optimal forms and sources of financial support necessary for implementation of wide-scale programs of this type in Georgia

1 4 Selection of the Region for Investigation

On the basis of comparing different regions of Tbilisi, Dighomi district, block 2 was selected as the territory for complex study The selected territory is called "Demonstrative Zone" in the present report

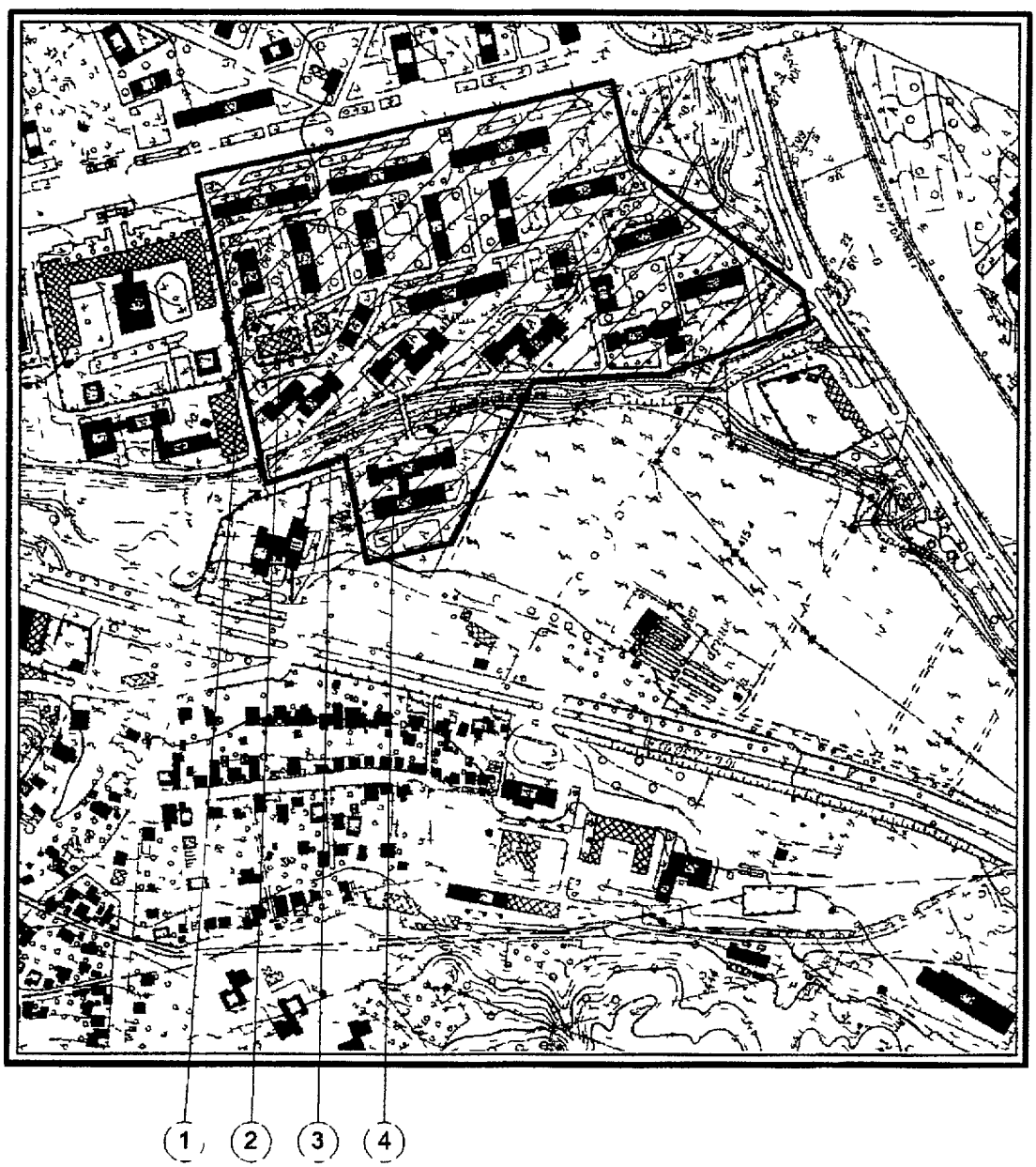
The selected territory is characterized by the following features

- Power distribution grid of this territory is typical to Tbilisi system in total
- Gas supply system is already rehabilitated on the territory
- Solvency level of the population living on the territory corresponds to medium level of Tbilisi population in whole
- 18 block of flats (from 5 to 14 storied buildings, from 60 to 130 flats in each building) are located in this territory The buildings are constructed according to design typical for Tbilisi in whole

- The territory includes a school building with autonomous heating system using liquid fuel
- The kindergarten building located on the territory is funded by USAID technical assistance program to install an autonomous heating system using natural gas as a fuel
- On the same territory there is the district heating station #5, which is not operating now and can be used under new function
- There is a possibility to supply geothermal waters from the existing well, which is not practically used

Figure 1 4 -I

Plan of the Demonstrative Zone Territory



Legend 1 Kindergarten, 2 District Thermal Station #5, 3 Limits of residential area with 6000 residents, 4 Secondary School

2 Recommendations on Creation of the Demonstration Zone

2 1 Upgrade of existing power supply systems in blocks of flats

To provide separate electric power supply for especially large and top priority consumers modernization of municipal power supply system has been actively carried out in Tbilisi during last 3-4 years Funding of works to arrange separate power supply for municipal entities (hospitals, schools, administrative buildings, water supply facilities, municipal electric transport, etc) is provided from municipal budget Works on separate energy supply of commercial enterprises are financed by the enterprises themselves

This modernization of power supply systems allows to provide favorable conditions of electricity supply for municipal top priority sites and also control power supply to commercial enterprises directly from switchyards in accordance with payment for consumed electricity In case of large consumers of power such modernization is profitable, but it can not be used to provide separate power supply to small-size consumers, such as households

In the framework of the Municipal power supply system the whole II block of Digomi district (Demonstration Zone area), which comprises 18 blocks of flats (about 1550 flats), is considered as one consumer Any attempt to provide separate power supply for small groups of residential buildings of this block by means of dedicated line results in carrying out expensive electro-technical measures beyond this block

It is much more efficient to provide favorable power supply to the selected group of buildings and upgrade existing power distribution systems in all residential buildings in such a way that individual flats or groups of flats can be switched off for payment default

It should be noted, that power distribution systems of several residential buildings in Tbilisi had been upgraded in 1997 as an experiment carried out on behalf of "Telasi" As a result of modernization, meters had been taken out of flats and installed into locked cabinets on the ground floor of each entrance of residential buildings Each meter was provided with switch to cut power supply off, and open single-phase (two wires for each flat - "+" and "-") wiring was laid from cabinets to flats We think that such upgrade has a number of shortcomings Namely,

- consumers can not control indications of their meters
- open wiring allows connections to electric power meter of another flat
- there are no meters measuring power consumed by elevator and entrance lighting

Besides, favorable regime of power supply of the upgraded residential buildings had not been provided when experiment was carried out Such favorable regime is extremely important for population to trust and support experiment

Nevertheless, the fact that such experiment was carried out should be considered as a positive event It shows that the problem of regulation of power supply to population is important and this is acknowledged by municipality

Within the framework of Demonstration Zone project we recommend to test three options of upgrading existing power distribution systems in residential buildings

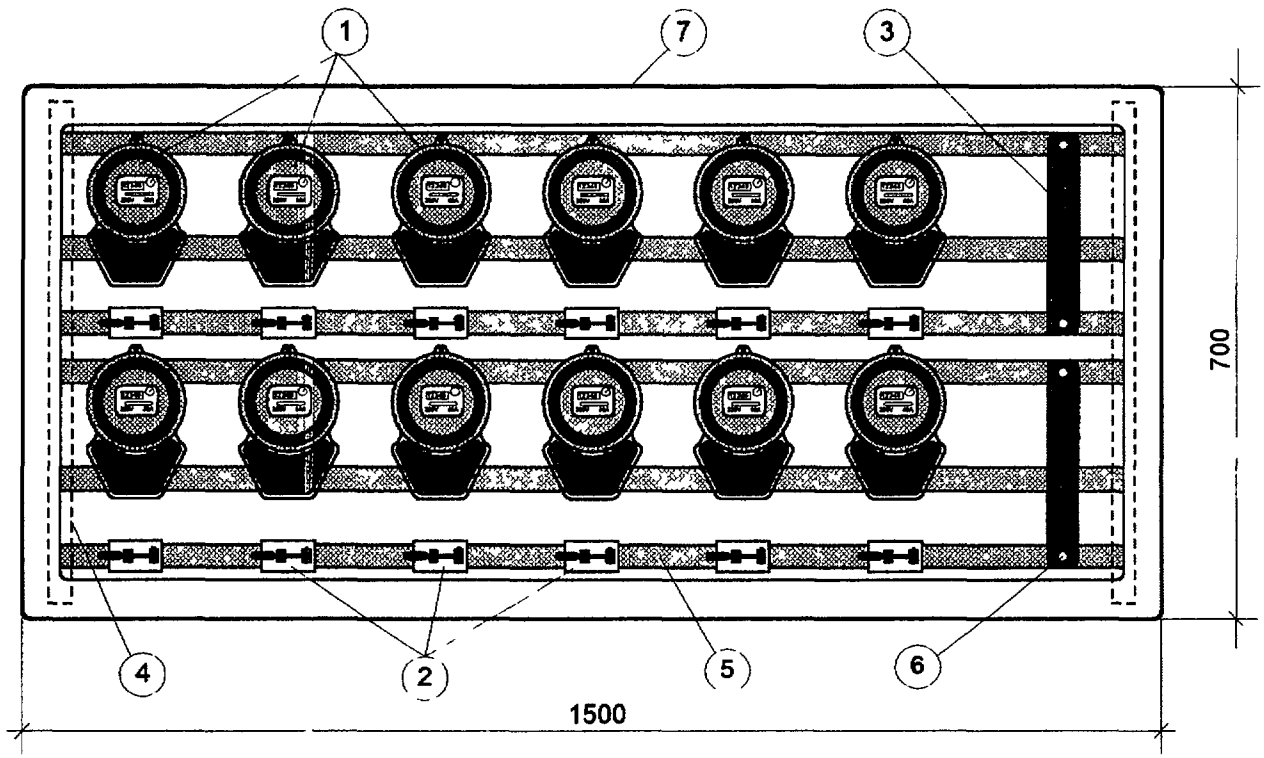
2 1 1 Option I Individual Metering of Consumed Power.

This option of power distribution system modification allows to perform reliable metering of electric energy consumed by each family In case of non-payment each flat can be individually switched off

Single-phase meters for controling of power consumption are installed in lockable metal cabinets of two types at each floor of residential building

Figure 2 1 1 -1

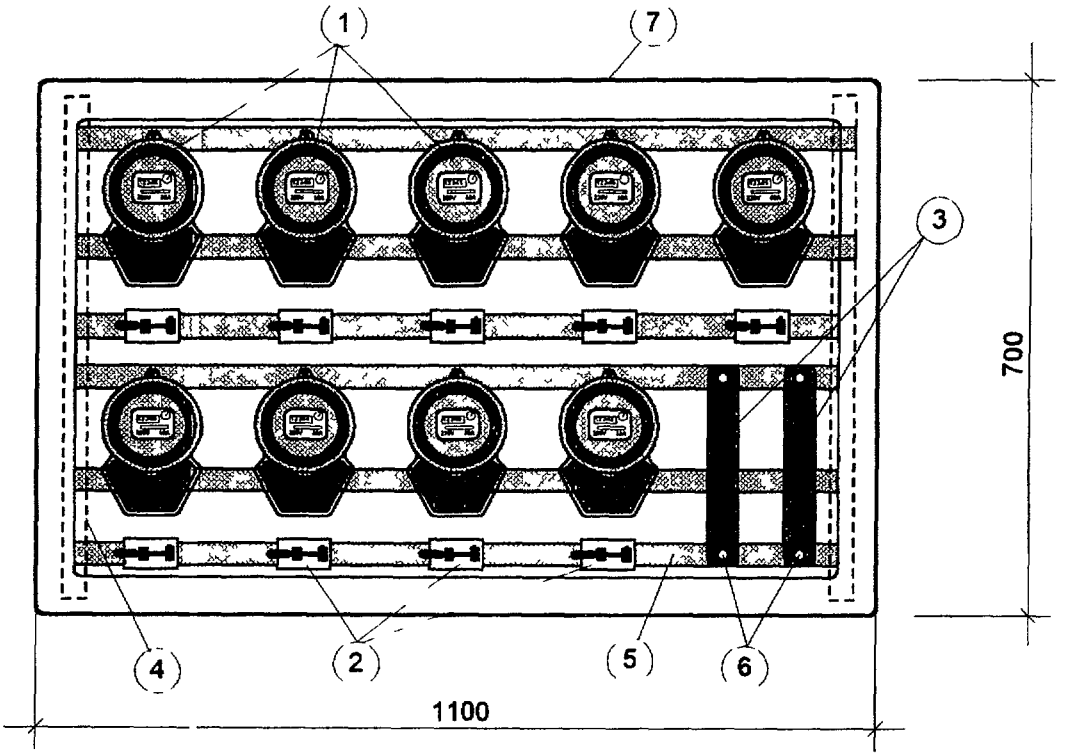
Cabinet for meters type C-12 (single-phase)



1 - Single-phase meter 40A (12pcs), 2 - Single-phase switch 40A (12pcs), 3-7 Components of cabinet

Figure 2 1 1 -2

Cabinet for meters type C-9 (single-phase)



1 Single-phase meter 40A (9 pcs), 2 Single-phase switch 40A (9 pcs),
3-7 Components of cabinet,

Supply of power to these cabinets will be provided by means of single-phase insulated cables of 25-32 mm^2 cross-section, enclosed into metal pipes Size of cross-section for power supply cable is determined with account power consumption simultaneity factor K_{ps}=0 5

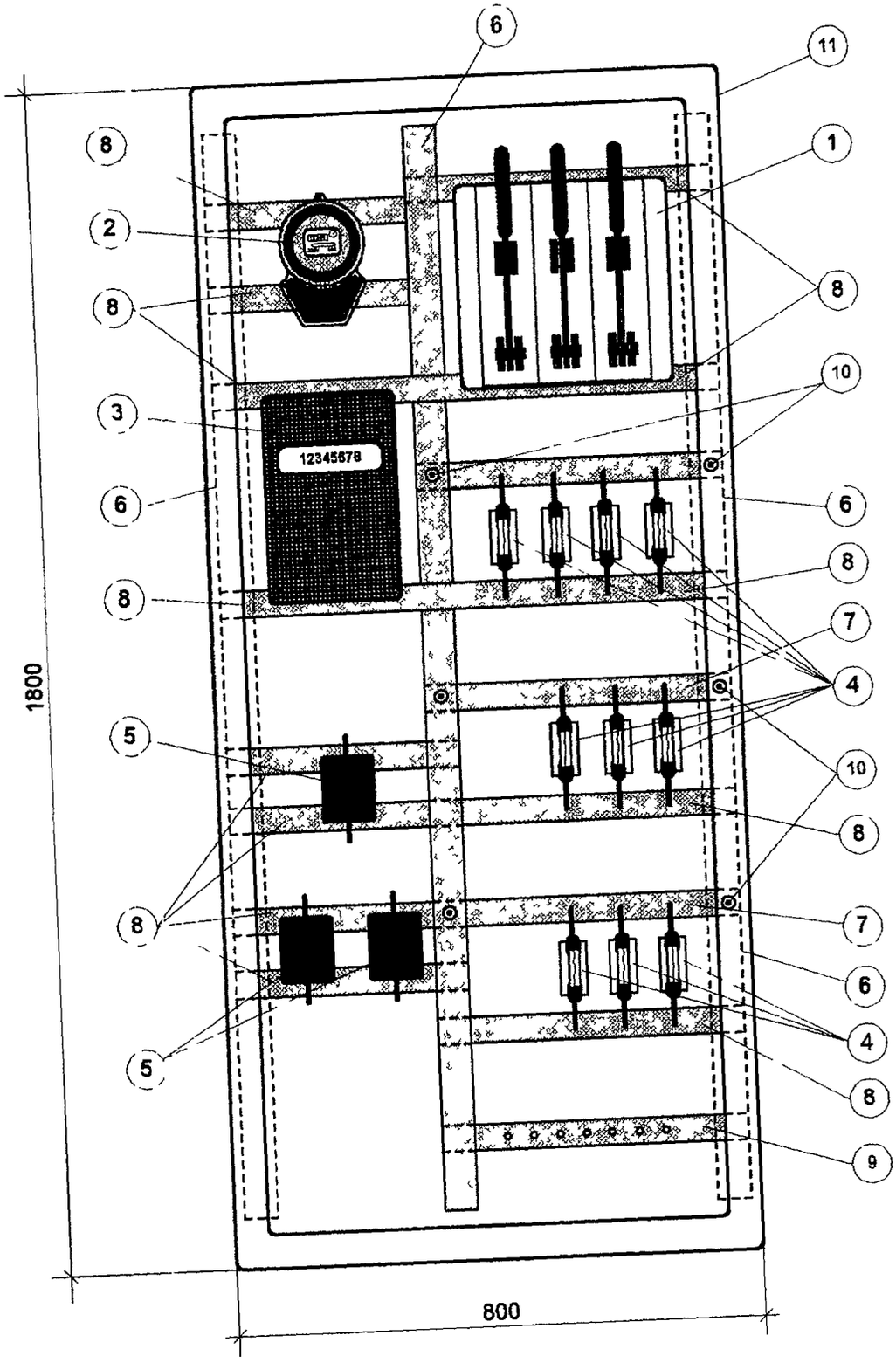
Wiring from cabinets to flats will be provided by means of single-phase insulated wires of 4 0 mm^2 cross-section Cross-section of cables limits power load of each flat by value up to 7KW

Existing meters will not be dismounted and consumers will be able easily control power consumption In case of disagreement of control meter readings with indications of meters installed inside the flat, indications of control meters should be considered as basic one for calculation of amounts to be paid (Prior to installation into cabinets all control meters should be tested to verify accuracy of indication)

Power distribution cabinets shall be installed on the ground floor or each entrance of residential building These cabinets shall be equipped with three-phase meters to determine amount of power consumed by elevator (if present) and also with single-phase meters for entrance lighting

Figure 2 1 1 -3

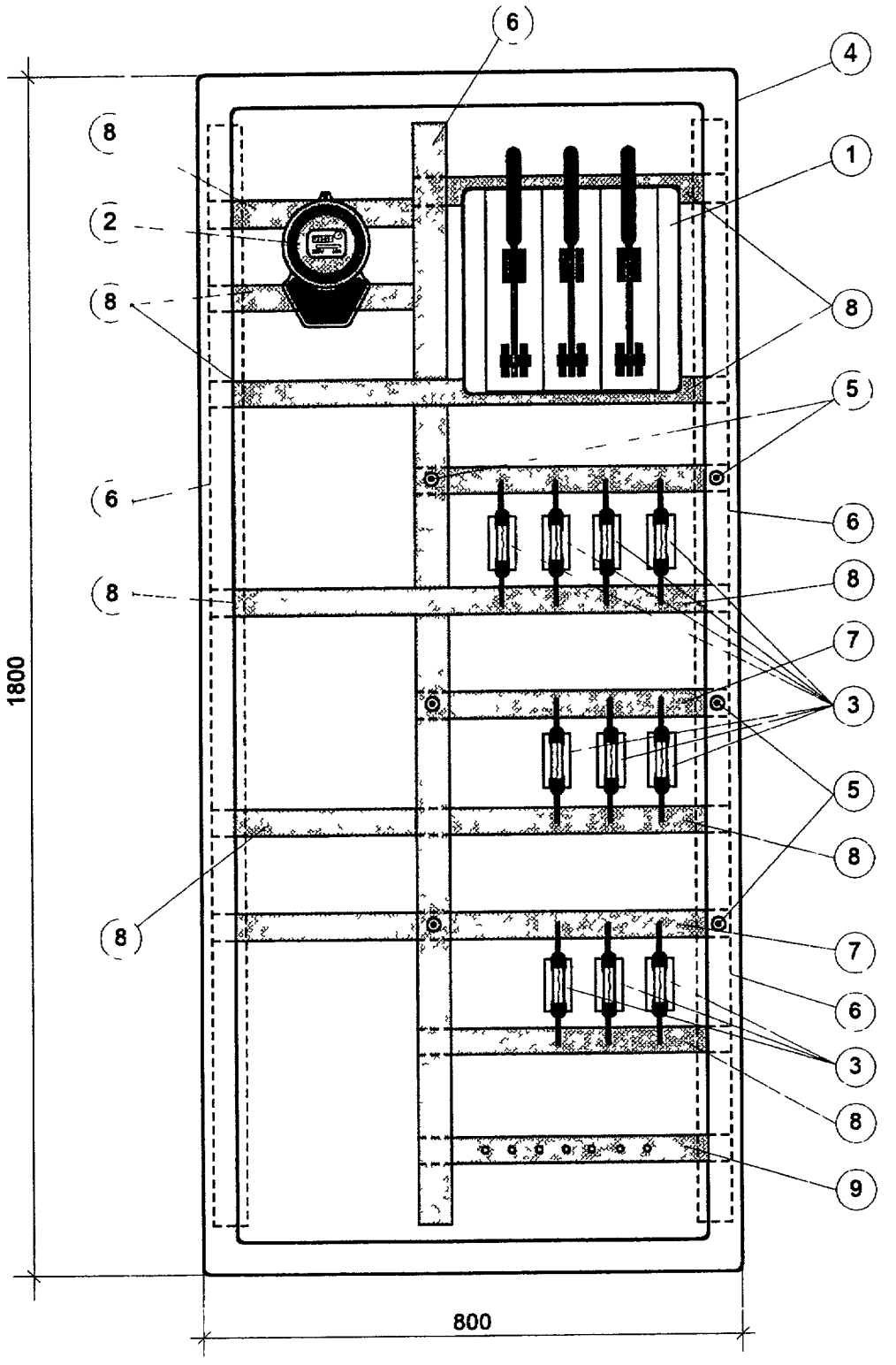
Building entrance distribution cabinet type DC-EL (for buildings with elevators)



1 Three-phase switch (I pc), 2 Single-phase meter 17A (I pc)
3 Three-phase meter 3x5A (1 pc), 4 Fuses with holders and insulation,
5 Current transformer 50/5A (3 pcs), 6-11 Components of cabinet,

Figure 2 1 1 -4

Building entrance distribution cabinet type DC-L (for builfings with elevators)

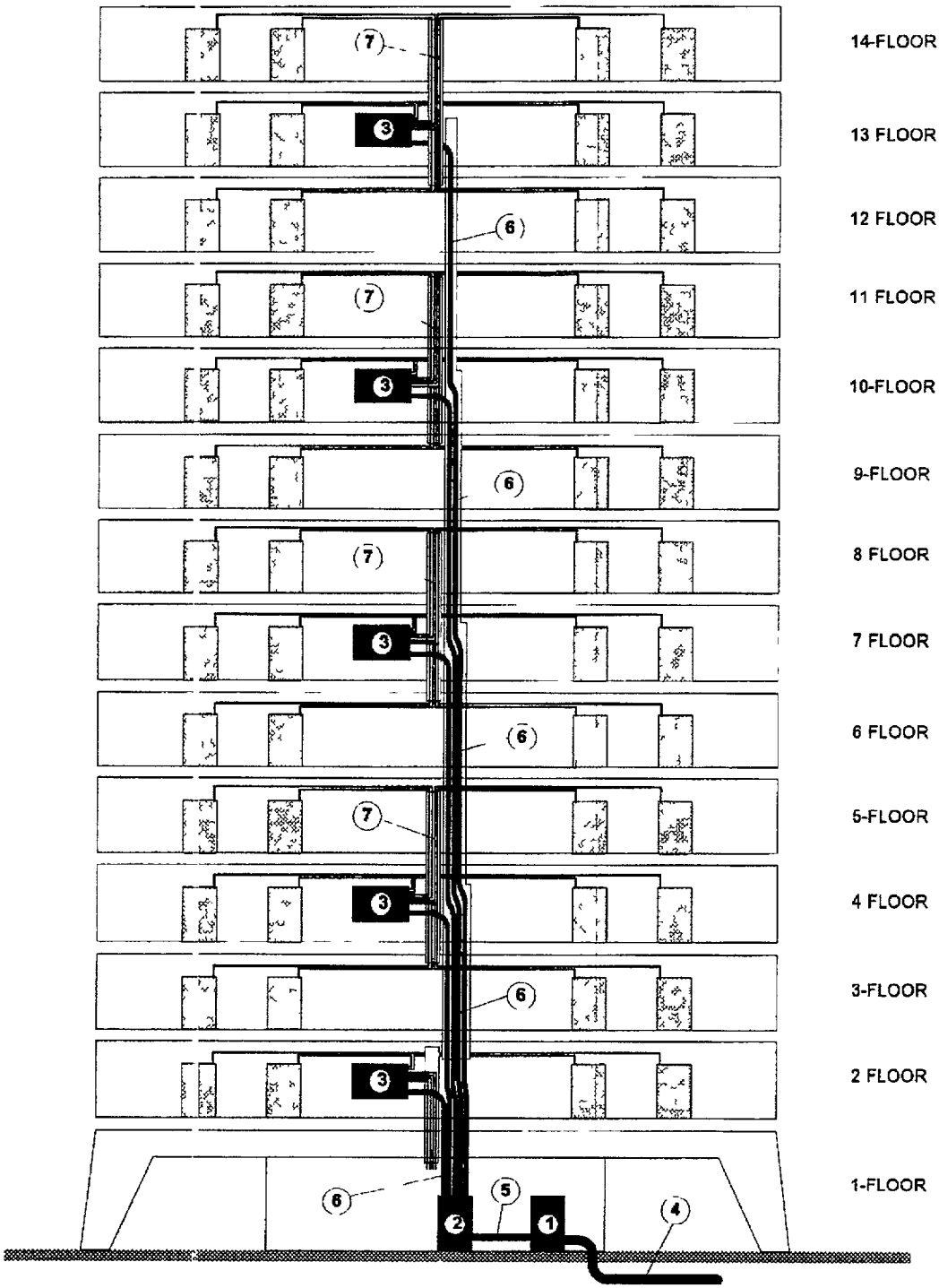


1 Three-phase switch (I pc), 2 Single-phase meter 17A (I pc)
3 Fuses with holders and insulation, 4-9 Components of cabinet,

General scheme of upgrading existing power distribution system for residential building providing individual power consumption metering looks as follows

Figure 2 1 1 - 5

Principal scheme for upgrade of power supply system in 14-store 83-flat residential building



1 Main power distribution cabinet of the building, 2 Entrance cabinet DC-EL
3 Power distribution cabinet C-12 (9) with meters 4 Main power cable
5 Cable supplying power to the building, 6 Cables supplying power to meter cabinets
7 Wiring supplying power to apartments

Figure 2 1 1 -6

14-store 83-flat residential building

Plan of the typical floor

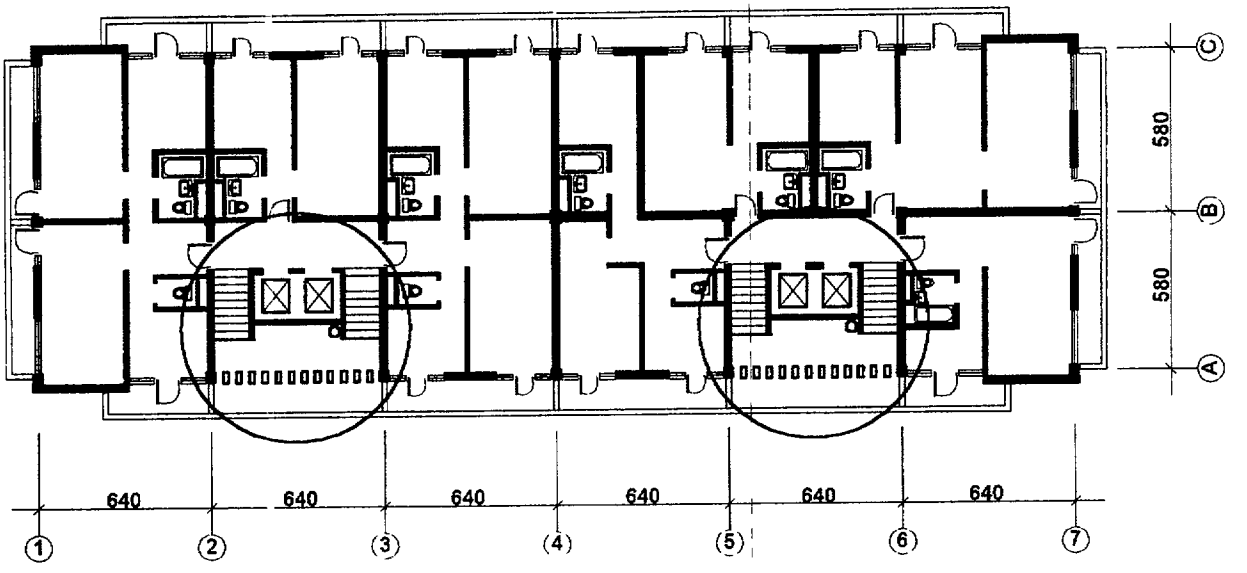


Figure 2 1 1 -7

Plan of the typical entrance

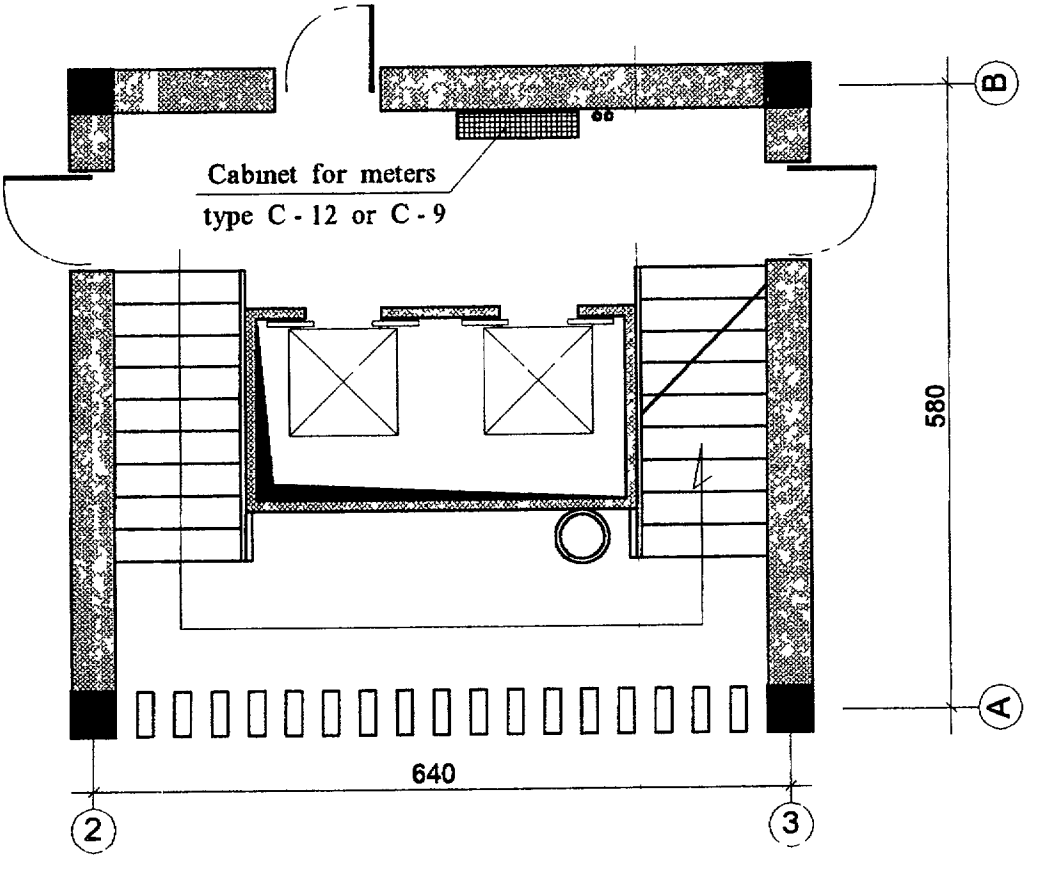
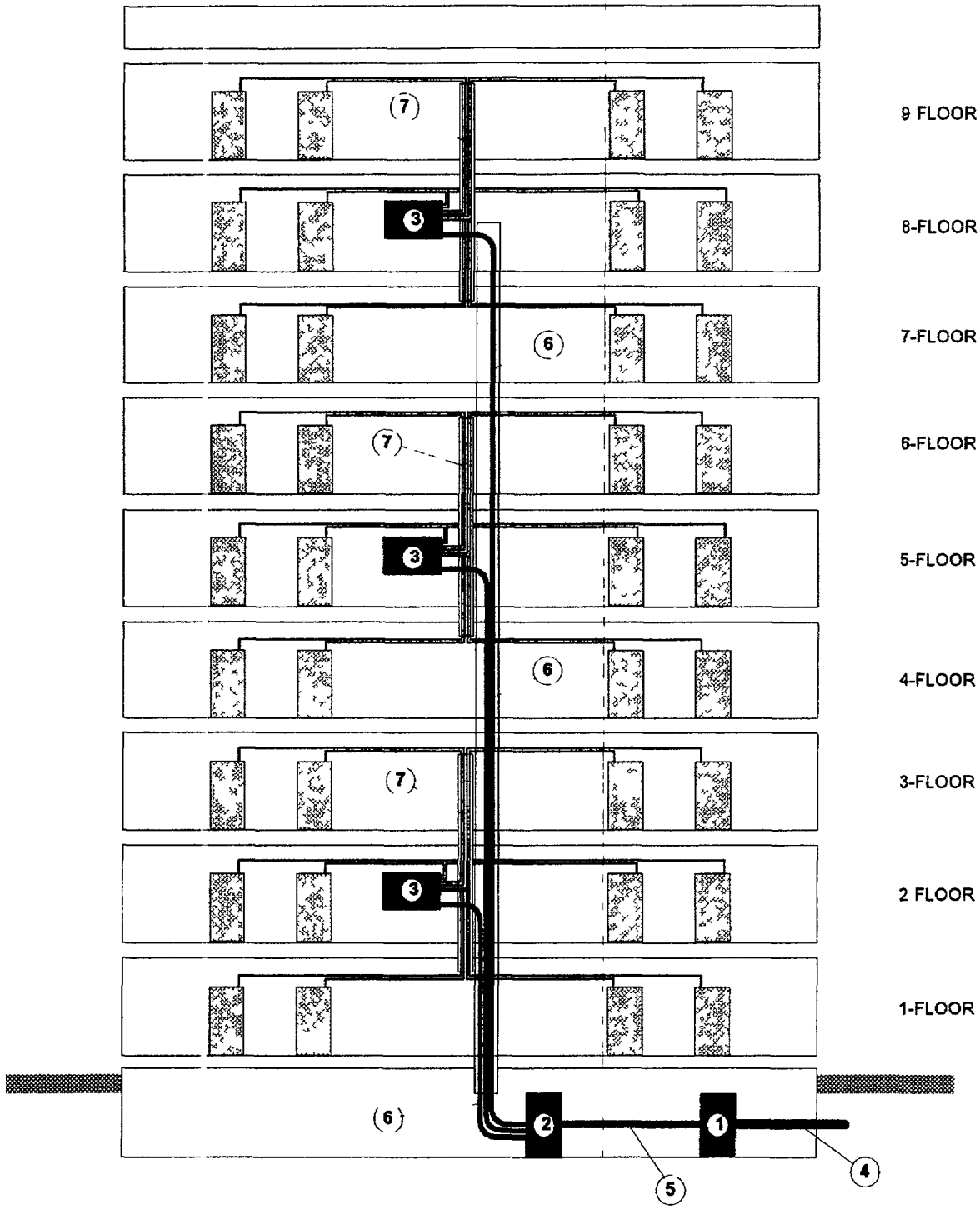


Figure 2 1 1 - 5

Principal scheme for upgrade of power supply system in of 9-store 96-flat residential building



1 Main power distribution cabinet oFthe building 2 Entrance cabinet DC-EL
3 Power distribution cabinet C-12 (9) with meters 4 Main power cable
5 Cable supplying power to the building 6 Cables supplying power to meter cabinets
7 Wiring supplying power to apartments

Figure 2 1 1 -9

9-store 3-block 96- flat residential building

Plan of the typical floor

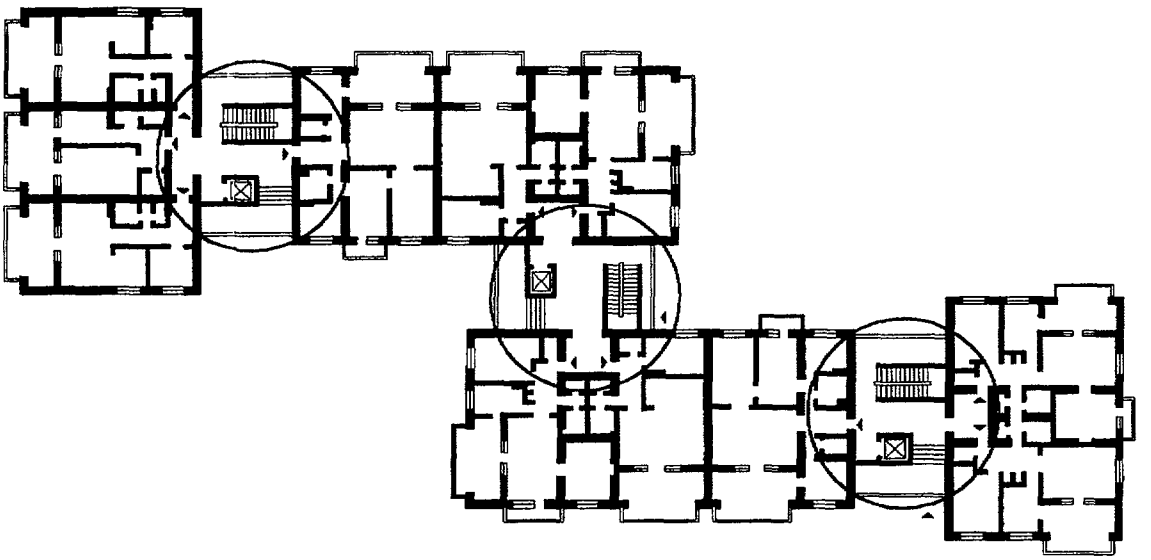
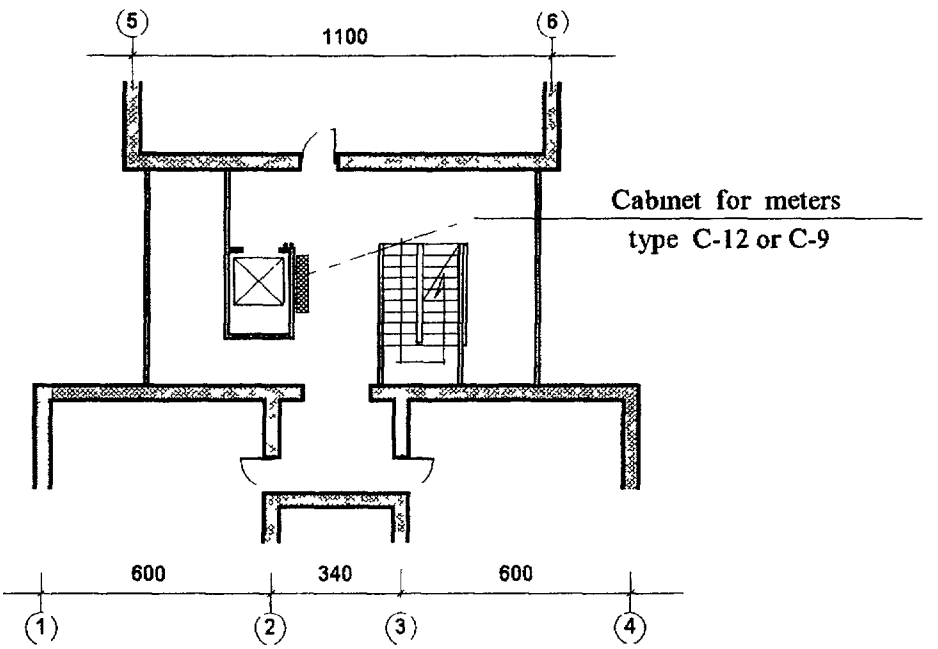


Figure 2 1 1 -10

Plan of the typical entrance



Estimated Cost of Power Supply System Modernization for an 14 Floor Residential Block of Flats (83 Flats)

N	Work Description	Total Cost (US $)	Including	
			Installation (US$)	Equipment and Materials (US$)
1	2	3	4	5
1	Dismounting of the main power cabinet of VRU-1-4300 type and installation of new one	700	50	650
2	Installation of two entrance power distribution cabinets of DC-EL type	1000	80	920
3	Installation of five floor cabinets of C-12 (single-phase) type	3800	750	3050
4	Installation of four floor cabinets of C-9 (single-phase) type	2460	440	2020
5	Making holes in interfloor partitions to install cable ducts (28 points)	80	80	-
6	Installation of AAShV (3x150 + 1x50) mm^2 type cables from the main power cabinet to two entrance power cabinets, L=40 m	560	80	480
7	Installation of KRPT (2x35) mm^2 type cables enclosed into metal ducts from entrance power distribution cabinet (I entrance) to floor distribution cabinets, L=150 m	3000	400	2600
8	Installation of KRPT (2x25) mm^2 type cables enclosed into metal ducts from entrance power distribution cabinet (II entrance) to floor distribution cabinets, L=140 m	2500	400	2100
9	Installation of vertical sections of KRPT (2x4) mm^2 type apartment cables into metal ducts, L=220 m	660	110	550
10	Installation of horizontal sections of KRPT (2x4) mm^2 type apartment cables and connection to apartment meters (83 points), L=780 m	2340	390	1950
11	Laying of APPV (2x2 5) mm^2 type vertical cables from entrance power cabinets and installation of switches with lighting fittings on each floor (28 points), L=300 m	600	100	500
12	Connection of elevator power supply cables to the control meters (2 points)	100	80	20
13	Connection of banquet hall power supply cables to the control meters	60	40	20
14	Connection of water supply pump power supply cables to the control meter	60	40	20
15	Filling of holes in interfloor partitions with cement-sand solution (28 points)	50	20	30
	Total estimated cost	17970	3600	14910

Estimated Budget for Modernisation of Power Supply System in 9 Floor 96 Flat Residential House

N	Work Scope	Total Cost (US$)	Including Installation (US $)	Including Equipment And Materials (US$)
1	2	3	4	5
1	Dismounting of existing and installation of new main power distribution cabinet, type VRU-1-4300	700	50	650
2	Installation of three entrance power distribution cabinets, type DC-EL	1500	120	1380
3	Installation of three floor cabinets, type C-12 (single-phase)	2280	450	1830
4	Installation of six floor cabinets, type C-9 (single-phase)	3690	660	3030
5	Making holes in interfloor partition for cable ducts installation (24 points)	70	70	-
6	Laying of AASHV (3x120 + 1x50) mm^2 type cables from main power cabinet to three entrance power cabinets L=80 m	1120	160	960
7	Laying of KRPT (2x35) mm^2 type cables in metal ducts from entrance cabinet (I entrance) to floor cabinets, L=90m	1800	240	1560
8	Laying of KRPT (2x35) mm^2 type cables in metal ducts from entrance cabinet (II entrance) to floor cabinets, L=90m	1800	240	1560
9	Laying of KRPT (2x35) mm^2 type cables in metal ducts from entrance cabinet (III entrance) to floor cabinets, L=90m	1800	240	1560
10	Laying of KRPT (2x4) mm^2 type cables in vertical metal ducts, L=240 m	720	120	600
11	Laying in open horizontal wires of KRPT (2x4) mm^2 type to apartments and switching to the existing apartment electric meters (96 points), L=810 m	2430	405	2025
12	Laying open vertical wiring of APPV (2x2 5) mm^2 type from entrance power distribution cabinets and installation of switches with lighting fitting (27 points) on each floor, L=270 m	540	90	450
13	Switching of elevator power supply cables to control electric meters (3 points)	150	120	30
14	Filling of interfloor partition holes with cement-sand solution (24 points)	50	30	20
	Estimated total cost	18650	2995	15655

2 1 2 Option II Collective metering of power consumption

This option of power distribution system upgrade provides metering of total actual power consumption for groups of 3-4 families (located in adjacent flats) In case of non-payment it will be possible to cut offpower supply to this group of consumers

Control three-phase meters will be installed in lockable metal cabinets on each floor of residential building Power supply to control meter cabinets will be provided by means of existing vertical three-phase cables

Wiring from cabinets to flats will be provided by means of single-phase insulated wires of 4 0 mm^2 cross-section Size of wire cross-section limits power load of each flat by value up to 7 0 K W rated load

Existing meters will not be dismounted and consumers will be able easily control power consumption In case of disagreement of control meter readings with indications of meters installed inside the flats indications of control meters shall be considered as basic ones for calculation of amounts to be paid (Prior to installation into cabinets all control meters shall be tested to verify accuracy ofindication)

Cabinets of control meters will be installed on each floor of residential building in accordance with the following scheme

Power distribution cabinets will be installed on the first floors of each entrance of residential buildings These cabinets shall be equipped with three-phase meters to measure power consumed by elevator (if present) and also with single-phase meters for entrance lighting (see Fig 2 1 2 -3)

Fig 2 1 2 -1

Cabinet for meters type C - C

1 -Single-phose meter 80A

2 -Single-phose switch 80A

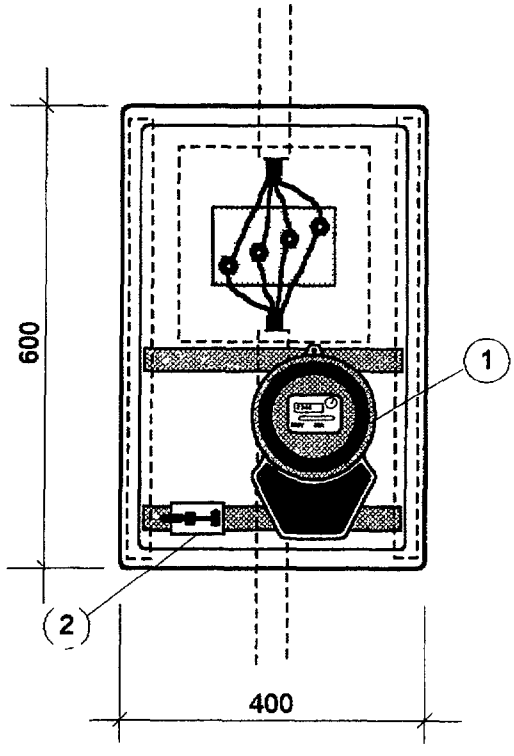
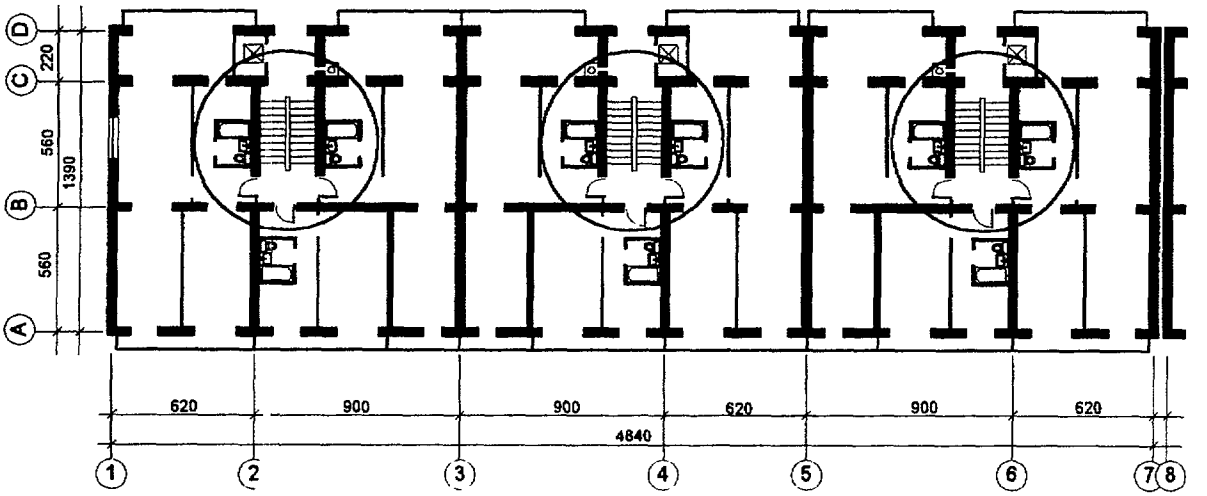


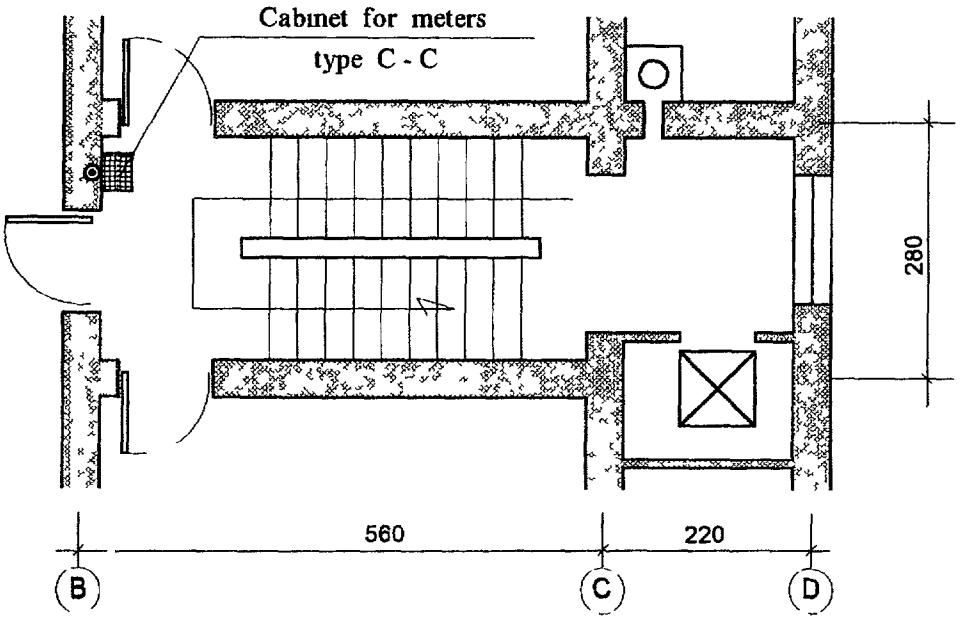
Figure 2 1 2 -2

8-floor 6-block 130- flat residential building

Plan of the typical floor



Plan of the typical entrance



Estimated Cost of Power Supply System Modernization for an 8 Floor Residential Block of Flats (130 Flats)

N	Work Description	Total Cost (US $)	Including	
			Installation (US $)	Equipment and Materials (US $)
I	II	III	IV	V
1	Dismounting of the existing electric distribution cabinet and mounting the new one of VRU-1-4300 type	700	50	650
2	Installation of six power distribution cabinets of DC-EL type in each entrance	3000	240	2760
3	Installation of 46 boxes of C-C type on each floor	5750	920	4830
4	Connection to the existing power meters installed in the flats (130 points) and to the switches of staircase lighting(48 points)	1040	900	140
5	Connection of elevator power supply cables to control meters (6 points)	300	240	60
	Total estimated cost	10790	2350	8440

2 1 3 Option III Collective power consumption metering for large groups of consumers

This option of power distribution system upgrade provides total actual power consumption metering for large groups of households group of 12-15 flats in 5-store residential buildings, group of 22-24 flats in 8-store residential buildings, group of 25-36 flats in 9-store residential buildings Correspondingly, in case of common non-payment it will possible to cut off power supply only to the whole group of consumers

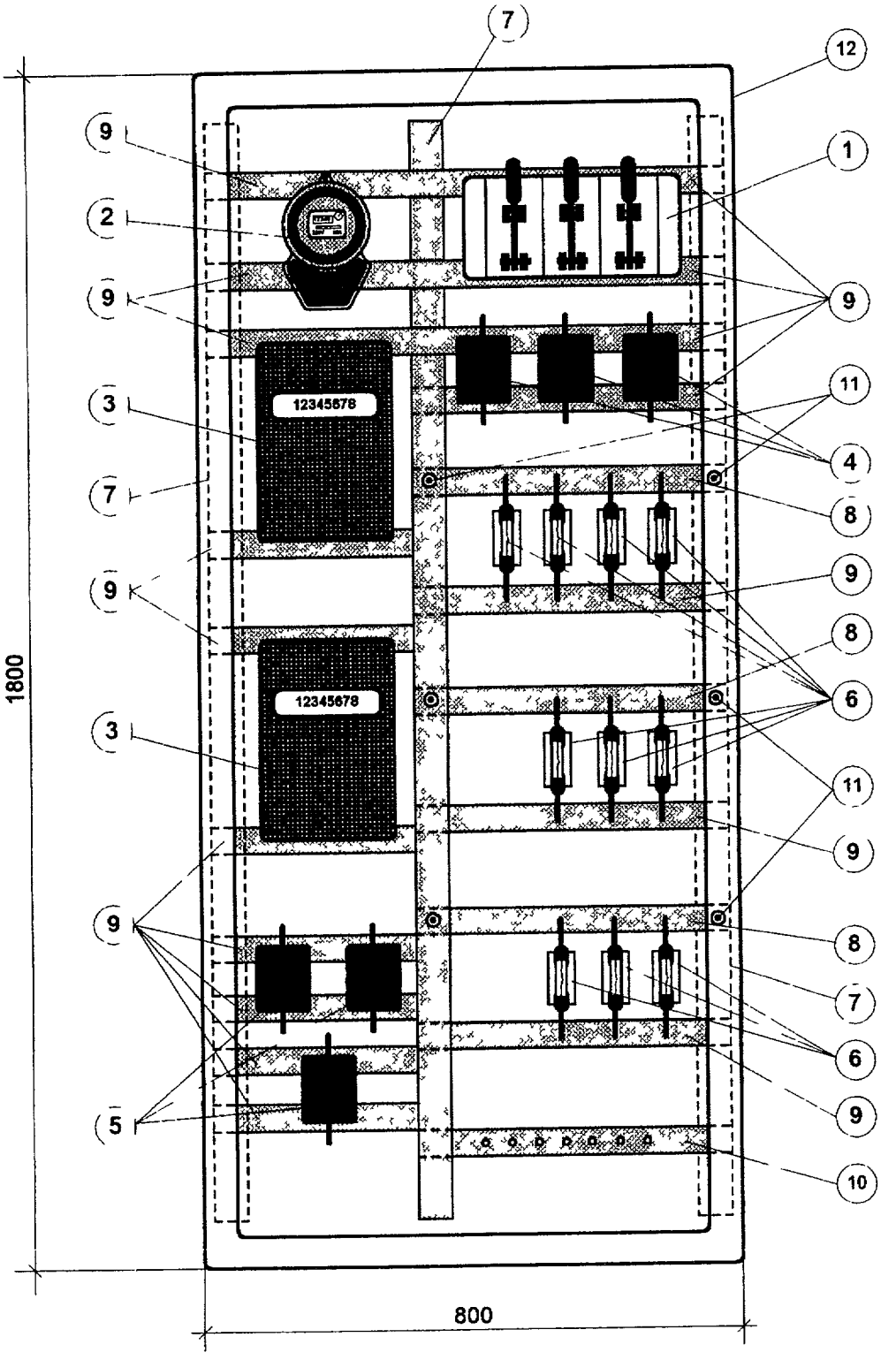
Within the framework of this option it will be necessary to install power distribution cabinets (such as DC-EL or DC-L) in each entrance of residential building and additionally three-phase control meter will be installed for total power consumption of all flats of this entrance

Reasonability of implementation of Option III may be doubtful, but experience of implementation of this kind of solutions in Armenia and several cities in Georgia - Rustavi, Gori, Batumi - proves its efficiency

Cabinet for control meters of DC-GEL type can be installed in accordance with the following scheme

Figure 2 1 3 -1

Building entrance distribution cabinet type DC-GEL (for buildings with elevators)

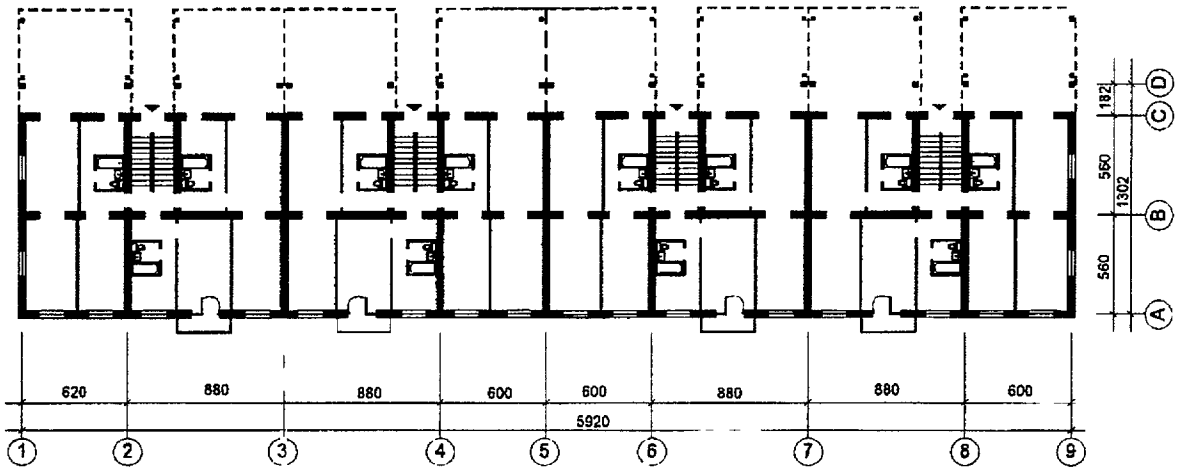


1 Three-phase switch (I pc), 2 Single-phase meter 17A (I pc)
3 Three-phase meter 3x5A (1 pc), 4 Current transformers 50/5A (3 pcs),
5 Current transformer 50/5A (3 pcs), 6-12 Fuses with holders and insulation

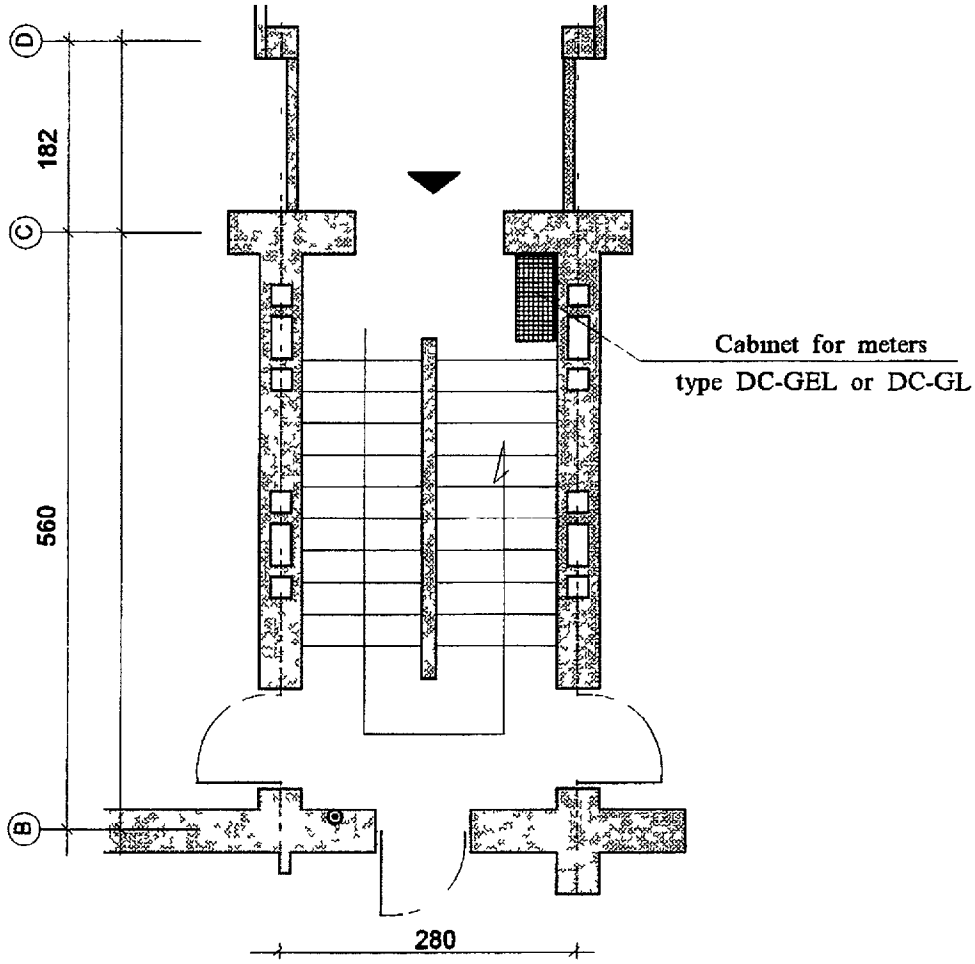
7-12 Components of cabinet,
Figure 2 1 3 -2

Installation of control meter cabinet of DC-GEL type
in 5-store 60 flat residential building

Plan of the typical floor



Plan of the first floor entrance



Estimated Cost of Power Supply System Modernization for an 15 Residential Blocks of Flats

N	Work Description	Total Cost (US $)	Including	
			Installation (US $)	Equipment and Materials (US $)
I	II	III	IV	V
1	Installation of 41 power distribution cabinets of DC-EL type in each entrance	22550	1640	20910
2	Installation of 16 power distribution cabinets of DC-GL type in each entrance	8000	640	7360
3	Connection of elevator power supply cables to control meters (41 points)	2050	1640	410
4	Connection of power cables that supply apartments to the control meters (57 points)	1710	1140	570
	Total estimated cost	34310	5060	29250

2 2 Modernization of Existing Gas Distribution Systems in Block of Flats

Since Summer of 1993 natural gas supply to Georgia was significantly reduced This caused cutting gas supply to population and deepening of power crisis Only in 1996 the volume of natural gas importing was increased slightly and this allowed to restore partly gas supply to population Since then rehabilitation of gas supply to Tbilisi districts funded by municipal budget was started Speed of gas supply rehabilitation process, performed by Joint Stock Company "Tbilgazi", is very much affected by limited financing, e g for whole 1997 year only about $ US 300 000 was allocated As a result, during last two years natural gas supply was provided only to 25 000 households, which is 8 0 - 9 0% of Tbilisi population Current speed of gas supply rehabilitation is unsatisfactory, taking into consideration the positive impact of gas supply on overcoming the power crisis in the country

Existing gas supply system is not equipped with metering devices This serious fault is partly recovered during the process of rehabilitation, but as the meter installation costs are to be covered by population, only 10-12 % of households are able to cover these costs and agree to install the meters in their flats

On the territory of Demonstrative Zone (six blocks of flats are selected), where the rehabilitated gas supply system is already operating for two years, the following picture of gas consumption has been formed

Table 2 2 -1

Conditions of gas consumption by households
in II quarter of Digomi district

Building No	Number of flats	Number of apartments using gas		Number of apartments not using gas
		with meters	without meters	
# 1	57	5	41	11
# 2	60	8	39	13
# 3	59	29	27	3
# 4	60	8	39	13
# 5	129	17	67	45
# 6	127	27	23	82
# 7	127	8	82	37
# 8	85	14	56	15
# 9	96	20	55	21
# 10	96	14	58	24
# 11	83	7	59	17
# 12	97	12	65	20
# 13	96	3	62	31
# 14	125	1	95	29
# 15	35	13	21	1
# 16	36	6	25	5
# 17	81	9	56	16
# 19	96	4	51	41
Total	1545	205	921	419

Statistical data given in the table allow to divide consumers into three categories

- 13 2% of consumers paying for consumed gas according to readings of meters with rate 0 17 GEL (~ 0 13 $US) per 1 m^3
- 60 0% of consumers paying for consumed gas according to established rate - 4 5 GEL (~ 3 5 $US) per person monthly
- 26 8% of potential consumers that temporarily are not using natural gas

First of all, these data demonstrate very low solvency of consumers Those households that pay according to readings of metering device, should be considered as wellfare families in Tbilisi They can afford themselves to cover gas metering device installation costs at once and thus, get possibility to save on cost consumed gas Interviewing of population revealed, that amounts to be paid according to monthly readings of gas meters approximately equal to 4-5 $US per month

Households, that were not able to pay for installation of metering device, are paying monthly rate for gas consumption, which equals to cost of 26 m^3 of gas per family member In this case approximate monthly expences for gas consumption equal to 14 $US per household

Households, that can not pay for gas consumption yet, are in the most emergent conditions This is caused by miserable income, which does not allow these families to afford to pay for gas metering device installation and for rated payment either

The situation is complicated by the fact that gas supplier the Joint Stock Company "Tbilgazi", as well as consumers, are upset with rated costs for gas consumption As representatives of "Tbilgazi" state, consumers in many cases consume much more gas (especially in winter periods) than the rated amount

In the framework of the ' Demonstrative Zone" project we are planing to install gas meters in 500 apartments Approximate cost per device equals to $US 100 (including cost of meter) Total expenses will be about $US 50 000

Implementation of planned activities will improve living conditions of about 8 000 consumers in Tbilisi

We expect that effectivity of measures on improvement of payment collection for consumed electric power (which are planned to be implemented on the territory of "Demonstration Zone") will increase if rehabilitation of gas supply system will be performed in parallel Availability of both power sources will allow population to reduce consumtion of defficient and expensive electricity, as they will satisfy their demands by means of comparably cheaper source of energy - natural gas

2 3 Activities on Rehabilitation of Hot Water Supply to Population

Centralized system of hot water supply, which is a part of Tbilisi centralized district heating system served 80 % of total Tbilisi population Cutting of gas supply to the city in 1994 has ceased functioning of whole centralized district heating system till today Before termination of operation, no proper conservation activities were provided for district heating system That's why its rehabilitation is unreal in the nearest future In addition there are some other arguments, that allow to suppose that main part of regional district heating systems could not be rehabilitated at all (see the attachment to the existing study)

Nowadays for water heating population is using the kerosene and gas stoves as well as electric water heaters About 20% of households have installed electric water-heater stationary devices Most of them use comparably cheaper flow-through electric water-heaters of 5-6 kW capacity Well-fare families prefer to use (more expensive) accumulative electric water-heaters, of 60-120 liters volume and of 1 8-2 5 kW capacity Population usually connects these electrical water-heaters to the power supply systems of their apartments in such a way that power lines are by-passing electric power meters It means, that consumed power is not accounted by existing meters

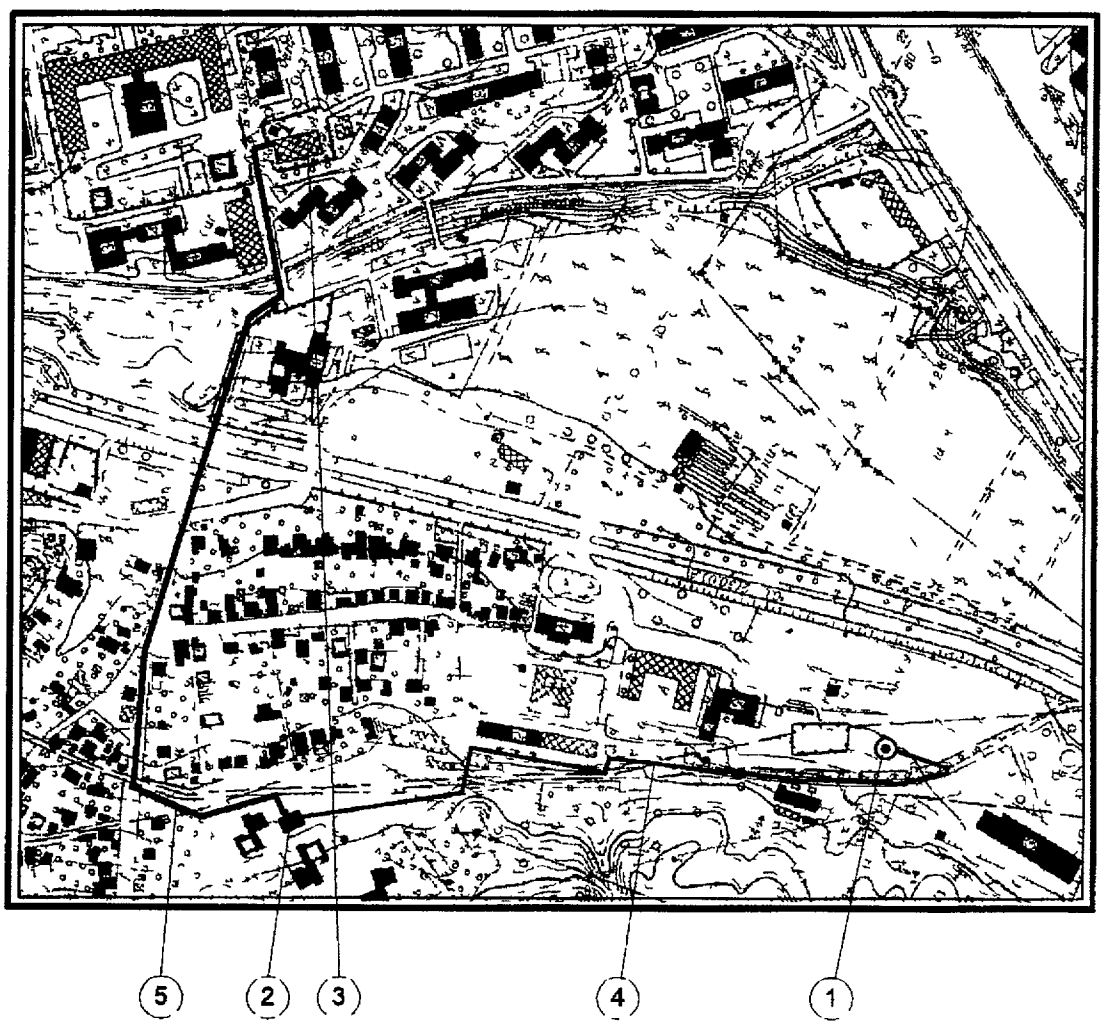
During the period of functioning of centralized hot water supply system, rated norm of hot water supply was rather high - 130 L water of 55^0C per each family member a day Currently, as the interviewing results showed, about 120-150 L water is consumed per family (containing 4 persons) daily Most part of hot water is used for bathing

On the territory of the demonstrative zone a simple bath is functioning, which is located in the building of the regional thermal station # 5 This bath is equipped with one shower in a displeasing room without any hygienic standards and, that's why, it is not popular among population

However, the above mentioned bath is a subject of our interest, as it is supplied with hot water from existing geothermal wells The practice of using hot water from geothermal sources for hygienic purposes (for bathing) has become tradition in Tbilisi There is a historical district in the city, popular with old, sulphur baths that have healing features Besides, there are some more prospected reserves of geothermal water resources in other districts of Tbilisi as well The most significant geothermal deposit in Tbilisi is located near Lisi lake, which supplies population living in Saburtalo district One of wells of Lisi deposit is located not far from the area of the Demonstrative Zone Well debit equals to 325 m^3 per day, temperature of water is 74° C Currently those geothermal waters are not utilized except one public building and the above mentioned bath A 100 mm diameter water pipe of 600 m length is provided from geothermal well and it is connected to # 5 by means of thermal water ducts of 250-400 mm diameter and 900 m length Thermal waters reach the Demonstrative Zone through these pipes

Figure 2 3 -I

Existing Geothermal Pipeline



1 Geothermal well, 2 Thermal sub-station building, 3 Thermal station building,
4 Geothermal pipeline of 600 m length and 100 mm diameter,
5 Geothermal pipeline of 900 m length and 250-400 mm diameter

Within the framework of the Demonstrative Zone Project we suggest to activate usage of geothermal water For this we are planing to renovate part of the thermal station #5 building In result, a new, well-equipped and comfortable bath with 100 person per day capacity will be arranged Functioning of public bath will reduce power consumption for water heating purposes In addition, utilizing of comparably cheaper geothermal waters will allow population to save family budgets Cost of $1m^3$ geothermal water in Saburtalo District equals to 0 5) GEL (~ 0 4$US), which is four times cheaper than cost of electric power needed for heating $1m^3$ cold water to 60° C temperature

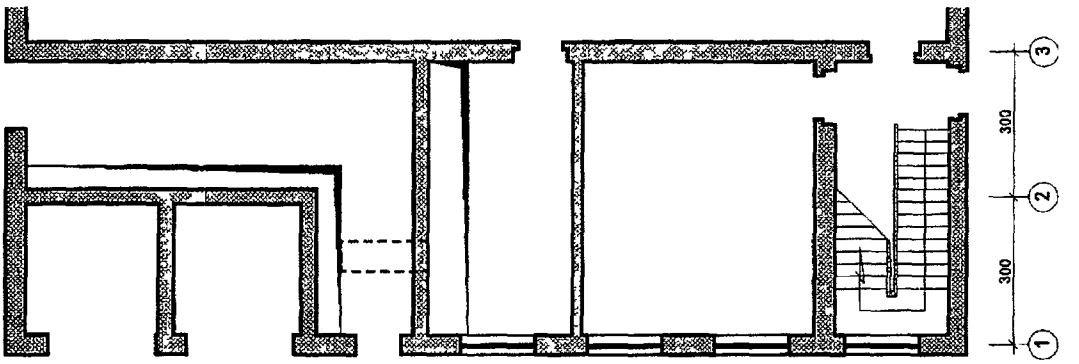
The fact of operating of misused thermal station will be a good example for revitalization of conserved property, such as the existing thermal station building and thermal objects of non-operating centralized district heating system

It should be noted that the "Tbilisi Centralized District Heating Optimization Program", which was worked out in 1988, was considering liquidation of # 5 thermal station

Figure 2 3 -2

Reconstruction Plan of Part of the Thermal Station #5 Building

Current Situation



Post-reconstruction View

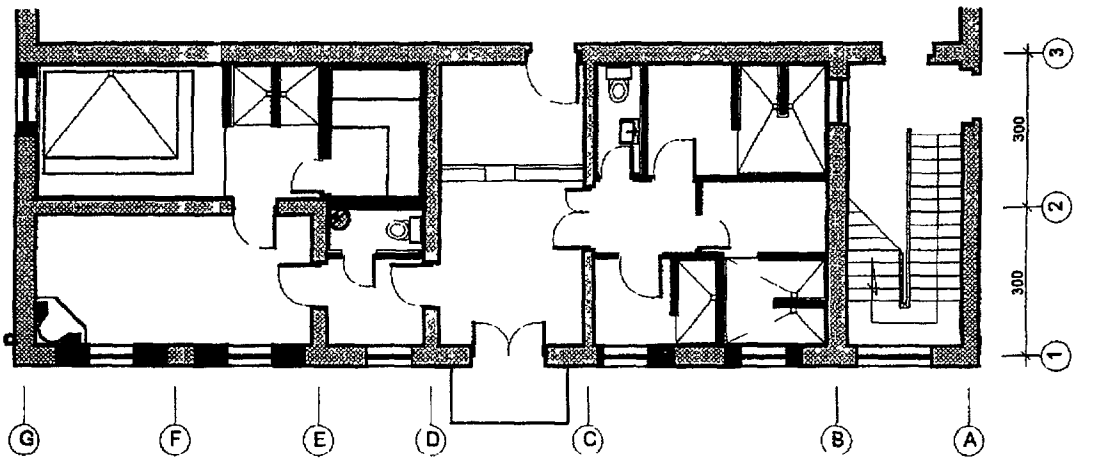
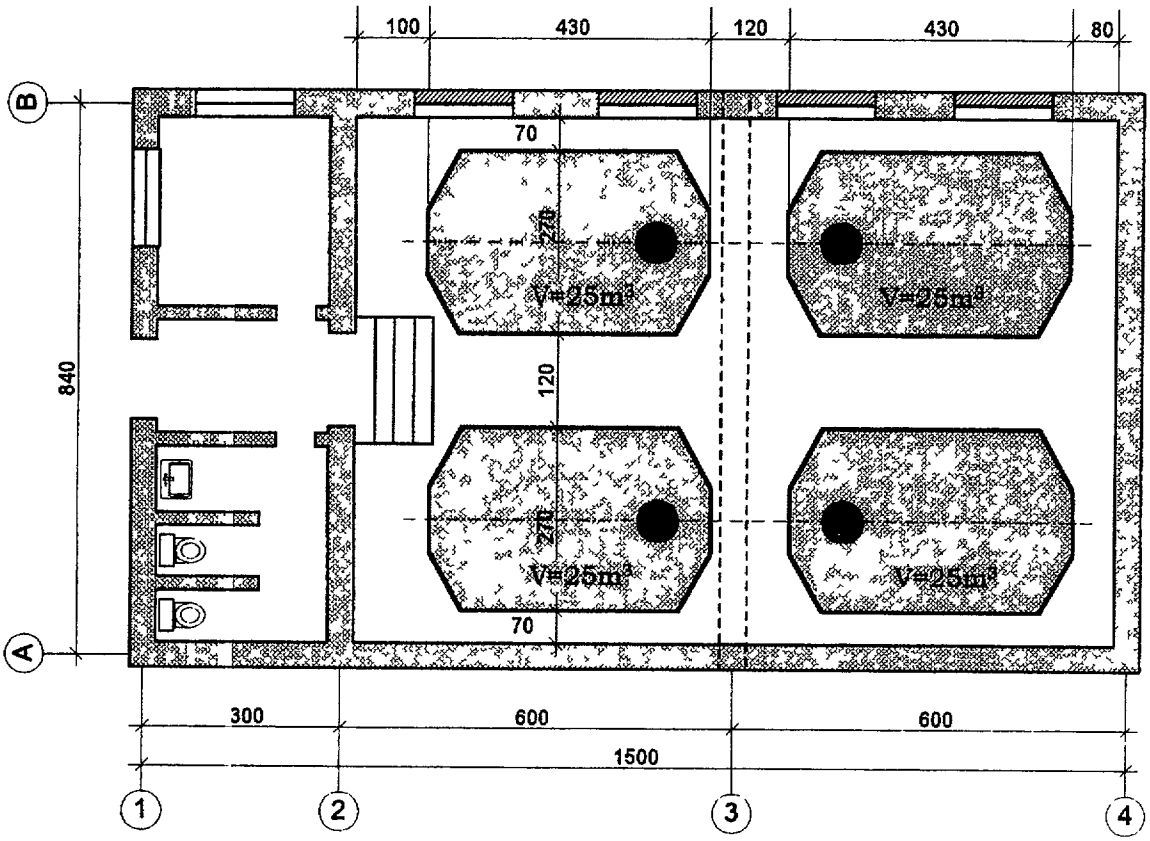


Figure 2 3 1 -1

Plan of Reconstruction of Existing Thermal Unit into the Accumulative Geothermal Station



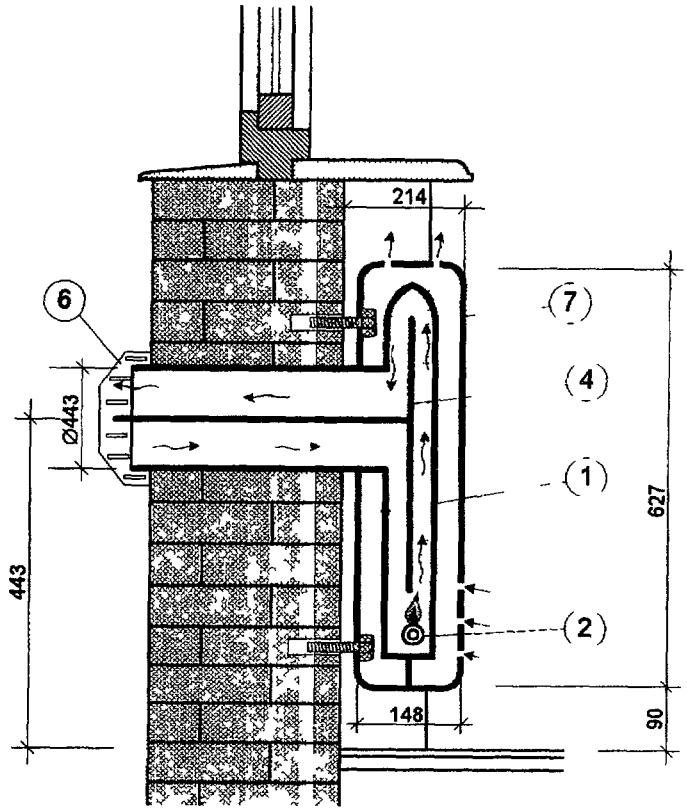
2.4. Measures for Rehabilitation of Heating Systems in Apartments

Restoration of natural gas supply to the population opens new possibilities of using autonomous heating devices

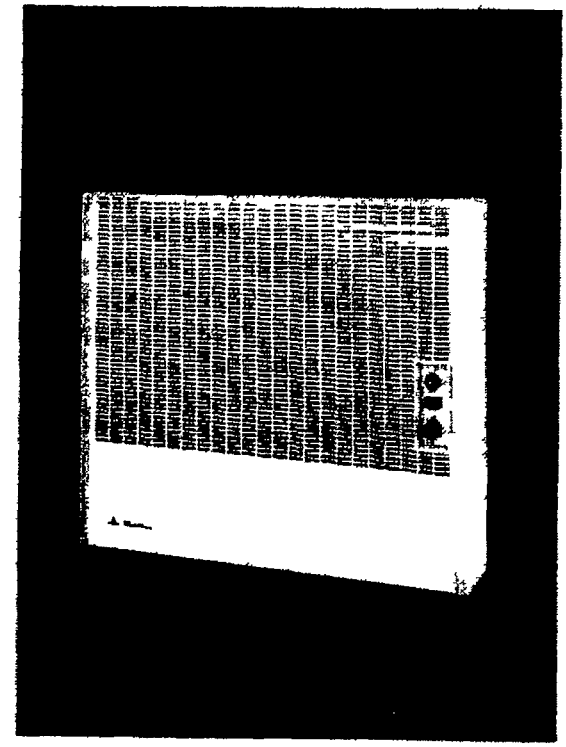
Autonomous heating systems are specially designed to provide the possibility of reducing gas consumption They are installed directly inside the space to be heated and have direct connection with the atmosphere

Those heating devices that use gas for fuel and not require vertical exhaust duct must be specially noted

Figure 2 4 -I



6101



In the lower part this kind of heater has metal carcass-heater (1) equipped with a pipe injector burner (2), which is supplied with air required for combustion directly from the outside, through a special opening in the wall (3) Hot gases from the burner go through the carcass-heater upwards, then over the partition (4) located in the casing, then down and after emitting the heat through the walls of the carcass-heater, arre exhausted outside through an opening (5) Air required for combustion gets into the heater and then the combustion products are blown out into the atmosphere through the same grid, closed with anti-wind flap (6), due to which wind has almost no influence on the gas burning process The top of the device is covered with a metal protective housing (7) so that there is space left between the cover and the carcass-heater, passing through which the air is heated by contacting the hot surfaces Some gas heater models are equipped with fans which intensify heat transfer

Generally heat transfer of the devices is regulated automatically by means of simple bi-metal or manual position regulators

Efficiency of gas heaters with exhaust ducts for exhausting out combustion products is about 80% If capacity equals 2-5 kW, natural gas consumption is 0 11 - 0 13 m^3hour/kW At current gas tariffs - 0 17 lari/m^3 (≈ 0 13 US$/$m^3$) - the thermal energy price will be 1 9 - 2 2 tetri/kW h (1 5 - 1 7 US$/kWh), i e twice lower than in case of using thermal energy from kerosene stoves

It is convenient to install autonomous gas heaters simultaneously with the rehabilitation of Tbilisi gas supply systems

The gas supply system actually includes all residential districts of Tbilisi (except two new residential districts Gldani and Didi Digomi) Gas has not been supplied to the population during the last four years due to a dramatic reduction of natural gas import to Georgia Since the end of 1996 natural gas import to Georgia has become more or less stable, which allowed to renew gas supply to some residential districts

By the beginning of 1998 gas supply systems that provide gas to 25 000 households in Tbilisi have been rehabilitated and are currently operating

2 4 1 Installation of Heating Devices in the Existing Flats

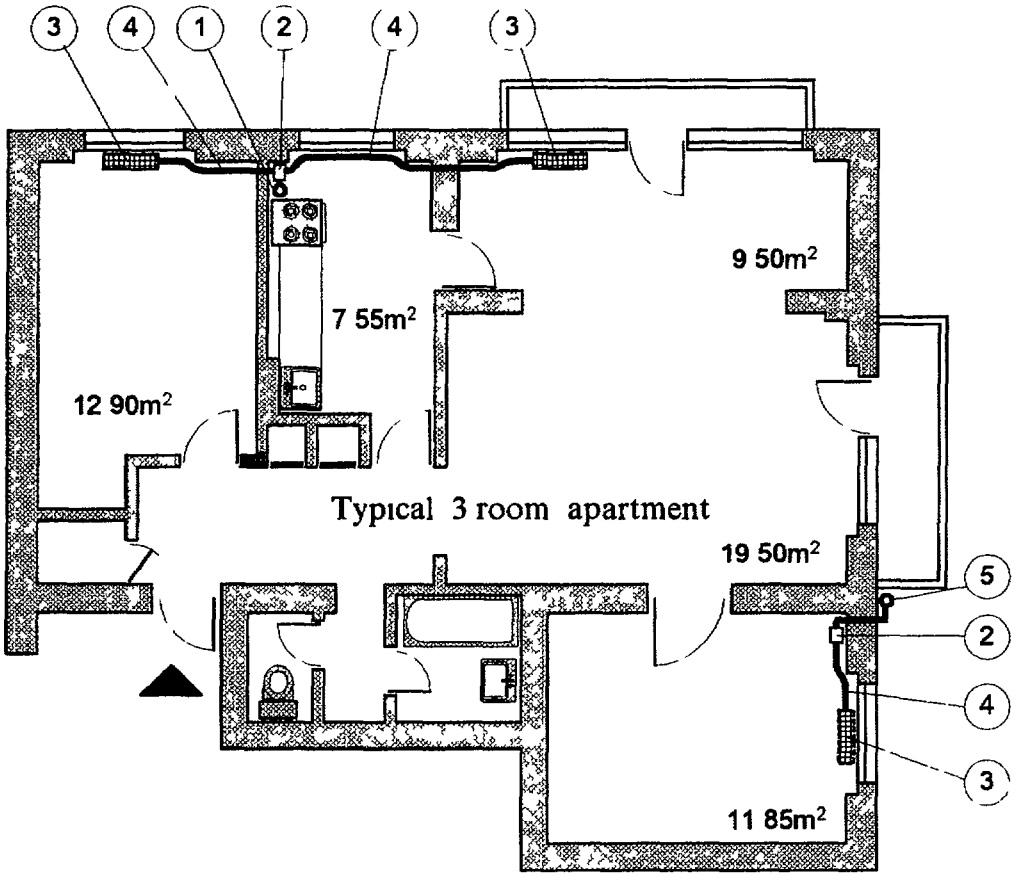
In blocks of flats gas is usually used only for kitchen cooking stoves However results of interviews revealed that kitchen gas stoves are often used as heaters

Gas is supplied to the flats by means of vertical gas piping, which ordinarily passes in the kitchens

The gas supply system rehabilitation, which is now being carried out by the Tbilisi municipality, includes installation of gas meters in the flats The whole process is slowed down due to the fact that apartment owners have to pay for the installation of meters (95-100 US $) Under these conditions only 10-12% of apartment owners agree to install gas meters

It is recommended to install gas heaters only in the flats that are already equipped with gas meters The gas meters which are being installed in the flats can measure gas consumption up to 6 m^3/h If we take into consideration that the maximum gas consumption by cooking stoves equals 1 2-1 4 m^3/h, it is evident that one gas meter can measure additional gas consumption required for gas heaters

Figure 2 4 1 -1



1 Existing vertical gas piping, 2 Gas meter 3 Gas heater 4 New horizontal gas piping, 5 New vertical gas piping

The drawing shows the scheme of gas heaters installed in a typical 3 room apartment The dimensions of 2-5 kW capacity heaters permit their installation under the window sills instead ofthe existing water radiators

Gas will be provided to the heaters using the traditional method - steel gas pipes of small diameter

For convenience of installation it is recommended to use copper pipes with thin walls (which are widely used in Georgia in oxygen systems of hospitals) and also plastic pipes For those systems where there is little distance between the existing vertical gas pipes and heating devises, it is possible to use elastic hoses which are currently used for providing gas from propane tanks to cooking stoves

For those systems where there is considerable distance between the existing vertical gas pipes and heating devises, it may be necessary to install new external vertical pipes In this case it is necessary to consider the necessity of installing an additional gas meter in the apartment The cost of a gas heating system of 2-5 kW capacity (including installation costs) equals 250-350 US $

Installation of 10000 heating devises can reduce the consumption of electricity during the winter period by amount for generation of which a 25 000 - 35 000 kW capacity power station is needed Construction of such a power station would cost 25-35 million US $ While the amount necessary for purchase and installation of 10000 heaters is ten times lower Low cost of natural gas (1 3 US $ /m^3) as compared to the current electricity tariffs (0 35 US $/kW h) and kerosene prices (0 30 US $ /liter) allow to reduce money spent by the population on heating about 1 5 -2 times

Wide usage of autonomous gas heaters will significantly help to solve the problem of heating the population

2 4 2 Installation of Gas Heaters in Apartments within the Demonstration Zone

In the framework of the Demonstration Zone project we are planing to install individual gas heaters with 3 0-4 2 kW capacity in about 50 apartments These heaters will be installed only in those apartments which are already equipped with gas meters and owners of which will cover installation costs which we estimate to be equal to $50 - $60 (not including cost of gas heater) Thus, at about $280 - $300 approximate cost of each gas heater the total expenses on this component of the project will amount $14 000 - $15,000 Implementation of this progral will allow us demonstrate effectiveness of one of the most affordable and efficient ways to resolve problem of heating of population

2 5 Summary Estimated Budget for Demonstration Zone Project Implementation

Demonstration Zone Components	Estimated Cost (US$)
1	2
1 Power supply	
1 1 Modernization of the power supply system of 14 floor 85 flat residential building (with individual metering of power consumption by each family)	17970
1 2 Modernization of the power supply system of 9 floor 96 flat residential building (with individual metering of power consumption by each family)	18650
1 3 Modernization of the power supply system of 8 floor 130 flat residential building (with summary metering of power consumption by group of 3 families)	10720
1 4 Modernization of the power supply system of the group of 15 residential buildings including 1240 flats (metering of total power consumption by groups of 15-30 families)	34380
Total	**81720**
2 Gas Supply	
2 1 Installation of 500 gas meters of 2 5m^3/hour nominal capacity in apartments	50 000
Total	**50 000**
3 Hot Water Supply	
3 1 Partial reconstruction of buildings of the non operating District Thermal Station #5 and arrangement of bathes with 100 persons per day capacity, operated on using of geothermal water	24 175
3 2 Reconstruction of the non operating Thermal Sub-station into the Geothermal Water Accumulating Station for storage of V=100m^3 geothermal water for supply to families	22 000(1)
Total	**46 175**
4 Heating	
4 1 Installation of 3 0-4 2 kW capacity gas heaters in 50 apartments	14 000
Total	**14 000**
Total estimated cost of project implementation	**169 895**

(1) item 3 2 is proposal for the future and is not included in the summary estimated cost

Burns and Roe Enterprises, Inc

Tbilisi Combined Heat-Power Plant

Rehabilitation, Technical-Economic Optimization of Operational Regimes

(Conceptual Proposal)

Tbilisi
1997

104

Prepared by

T Mıkıashvılı (GTU, B&R)

G Gurgenıdze (B&R)

O Vezırıshvılı (GTU, B&R)

M Margvelashvılı (B&R)

R Kandelakı (GTU, B&R)

J Hallberg (B&R)

D Kostıadı ("ARCI Consultıng")

V Lomtatıdze (Tbılısı CHPP)

O Kıguradze(GTU, Tbılısı CHPP)

D Labadze (Tbılısı CHPP)

D Khutsıshvılı (Tbılısı CHPP)

R Khaındrava (Tbılısı CHPP)

L Bakradze (Tbılısı CHPP)

CONTENT

1 Introduction

2 Project Importance

3 Heat Power Consumers Demand on Heat Power Generated by CHPP

4 Electric Power Consumers Demand on Electric Power Generated by CHPP

5 Tbilisi Combined Heat Power Plant - Power Generation Site

- 5 1 CHPP Flow Diagram and Power-Generating Units Condition of Power-Generating Units
- 5 2 Heat Supply System and Condition of Heating Mains
- 5 3 Fuel Economy

6 Optimum Operational Regimes for CHPP Steam Turbine Units

- 6 1 Seasonal Schedule of Heat Loads Guaranteed from Realization Point of View Temperature Diagram System Water Consumption Rate
- 6 2 CHPP Technical-Economic Parameters for Various Operational Regimes (with Existing Turbines)
- 6 3 Capital Costs Required for Rehabilitation of CHPP Units
- 6 4 Optimum Operational Regimes

7 Conclusions and Recommendations

8 Attachment

Abbreviations

CHPP - Combined Heat-Power Plant
STU - Steam Turbine Unit
STG - Steam Turbine Generator
ATU - Air Turbine Unit
CSAU - Combined Steam-Air Unit
VAT - Value Added Tax
HRB - Heat Recovery Boiler
PC - Pure Condensation

1 INTRODUCTION

Proposal "Tbilisi Combined Heat Power Plant Rehabilitation, Technical-Economical Optimization of Operational Regimes" is prepared by the company "Burns and Roe" within the USAID technical assistance program in Georgia, Georgian expert engineers and the consulting company "ARCI Consulting", based on the request of Tbilisi CHPP

Necessity of such works is determined by an energetic crisis, which recently takes place in Georgia The crisis is caused by several complex reasons After exclusion from unified energy system of the former Soviet Union Georgian power industry has faced very difficult problems Besides, the situation was also complicated by technological and physical depreciation of units in Georgian energy system, economic crisis typical for transition period, which results in an extremely low solvency level of population, and leakage of fuel resources Consequently, power plants working with organic fuel, turned out to be in an extremely poor condition This concerns also Tbilisi CHPP, as, due to the low solvency level of population, CHPP has lost the major source of its incomes provided through realization of the typical for such station high priority production - heat power Incomes, provided by sale of electric power are not sufficient to cover power plant operational-repair expenses As a result, Tbilisi CHPP has become unprofitable enterprise, and SAKENERGO has extremely limited its operation during a year This can be proved based on the power plant operation statistics for the recent 3 years

Due to inactivity of economic transformation process going on in Georgia, situation is not expected to be improved in the nearest future Therefore, essential changes shall be made in the concept of power-generating sites

New approach to Tbilisi Combined Heat Power Plants shall consider increase of production, which actually can be sold (even for export) - electric power, without any changes in heat power generation At the same time at the first stage, heat power generation can be reduced to the amount, required by solvent consumers only

Based on the above mentioned, we think, that <u>the main tasks of Tbilisi Combined Heat Power Plant Rehabilitation and Technical-Economical optimization of Operation Regimes are</u>

- to increase combined heat and power generation efficiency,
- to provide unit operation in basic regime (during a year),
- to provide CHPP operation both, in unified Georgian energy system and in autonomous grid,
- to minimize operational costs by arrangement of maximum possible automatic control of units

2 Project Importance

It is known, that for CHPPs heat load in Summer period (for hot water supply only) is 10-18% of the heat load in heating period Consequently, CHPP heat power generation efficiency in Summer period is reduced, and consequently plant annual efficiency is significantly reduced

The
problem of seasonal differences in heat power generation capacity is a basic problem, which can not be completely solved by traditional methods (partial outage of turbine units, or their operation in back-pressure or "PC" regimes)

The problem of heat capacity seasonal difference becomes more actual in electricity deficit conditions, when we face two mutually exclusive requirements, well-known to specialists first, it is necessary to generate maximum possible amount of electric power, and the second, cogeneration of heat and electric power shall be maintained

Therefore, we can say, that the problem of Tbilisi CHPP rehabilitation and technical-economical optimization of operation regimes is by no means actual and shall be solved immediately

3 Heat Power Consumers Demand on Heat Power Generated by CHPP

Tbilisi CHPP is the largest power generation site in Tbilisi It provides heat power for 474 consumers, 144 of which are administrative-public sites and 330 are of household needs

According to design data, CHPP designed heat capacity is 110 8 MW 55 5 MW - for administrative-public sites and 55 3 MW - for residential buildings

Designed heat loads for administrative-public sites are given in Table A1 (see Attachment, names of sites are "old", corresponding to 70-ees)

Due to the low solvency level, the largest part of consumers can not pay for consumed heat power Therefore, list of actual consumers, as well as their demand on heat power, is changed

Fig 1 represents the list of Tbilisi CHPP heat power actual solvent consumers, with indication of rated loads and amount of heat power consumed in 1996-97 heating season

<u>As we can see from Fig 1, actual demand of solvent consumers on heat power generated by CHPP currently is 12-16 MW</u>

This number is supposed to increase in future With increase of solvency level of administrative-public sites, it will reach about its designed capacity - 55 MW But

first, heat power meters shall be installed at this power consumer sites Installation of such meters is not a difficult task

This procedure seems to be more difficult for household (residential) sites Installation of heat power meters individually for each consumer is extremely complicated, as existing systems of internal communications mostly do not allow to separate each consumer Therefore, heat power supply and metering for household consumers requires urgent complex solution Otherwise, even in case of population solvency level increase, Tbilisi CHPP can not be provided with the old number of such type consumers and new potential consumers

Dislocation of Tbilisi CHPP heat power solvent consumers is given on Fig 2

4 Electric Power Consumers Demand on Power Generated by CHPP

Total capacity of three generators installed at Tbilisi CHPP is 18 MW

CHPP is connected to energy system by means of two transformers ТРДНГ 25000/35 and two 35 kV transmission lines

CHPP provides 40-45 MW power as a regional sub-station by means of 18 feeder lines connected to the city grid Feeders connected to the city grid provide power supply for city top priority consumers (Parliament building, Minister's Cabinet, Opera House, National Stadium, hospitals, etc)

CHPP is significant power generating site, as it provides city power supply If necessary, it can provide individual power supply for separate consumers

In case of power generation increase in future, after necessary reconstruction, power can be transmitted by means of existing nets both by 6 kV city line, and by 35 kV lines belonging to the energy system These lines currently can provide 80 MW total power transmission

CHPP power transformers operate according to the technological process designed in 1939 This process involves the following main parts

1 - three turbine generators each of 5 3 MW capacity,

2 - 6 kV switchgear, built and installed in 1939 Distributing equipment is located on the third floor of the building The first floor houses reactors and feeder joints Oil switches and metering transformers are installed on the second floor and the third floor houses double, three-section collecting buses (2 working sections and 1 transfer section) and their commutation equipment

The mentioned distributing equipment is connected to CHPP turbine generators by means of three inlet lines and to 35/6 kV 25 MW power transformers by means of 2 inlet lines 5 feeders provide power supply for 6/0 4 kV service transformers, 8

feeders provide power supply for 6 kV voltage units (feed pumps, circulation pumps and network pumps), 18 feeders service city power supply grid and provide 40-45 MW power supply for city grid

3 - two ТРДНГ 25000/35 power transformers, which connect CHPP to the Georgian energy system by means of 35 kV transmission lines

5 Tbilisi CHPP - Power Generating Station

5 1 CHPP flow diagram and power generating units Condition of power generating units

Tbilisi CHPP is a central power generating station Installed electric power capacity of this plant is 18 MW, designed heat power generation is 110 MW, 70 MW of which are produced by steam turbine units (from process-regulated extraction) and the other 40 MW - by peak hot water boilers

The basic heat power generating units, installed at Tbilisi CHPP are

- four boilers - 2xБГ-50, 1xТМ-35, 1xБГ-35, to provide turbine steam supply,

- Condensing turbine generators with regulated steam extraction - 1xАП-6 and 2xАТ-6 Rated electric power generation of АП-6 turbine generator is 6 MW, heat power capacity - 25 MW This unit provides heat power only for enterprises According to the design, heat power is produced by means of steam extraction from turbine blading section Steam parameters are as follows pressure - 5 atmospheres, temperature - 230-244^{0}C, mass flow rate - 40 ton/h Rated electric power capacity of АТ-6 type turbine is 6 MW, heat power capacity - 22 MW Heat energy produced by this unit is intended for heating and hot water supply

- Heat power generating units (two basic boilers, two peak boilers, one peak water heater for water supply network) to provide hot water for heating and hot water supply systems

- Two ПТВМ-50 hot water boilers to increase plant heat power capacity in an extremely cold heating period

The basic technical parameters of Tbilisi CHPP power generating units are given in Table A2 (see Attachment)

CHPP simplified flow diagram (before upgrade-reconstruction) is shown on the Fig 4 Steam, produced in boilers (1) is delivered to turbine generators (2) through the common collector and, if required, to reduction-cooling devices (3) Turbines are provided with regulated steam extraction, from where, while operating in a heat supply regime, the main part of steam is delivered to basic network water heating boilers (6), peak boilers and peak water heating boiler through collectors (5 atm and 2 atm) Waste steam, amount of which is changed according to turbine operation

regimes, enters condensers (4) Condenser technical water circulation system is of running type, fed with water of the river Mtkvari Heat supply unit is connected to heat supply network by means of double pipe system Water, back from the heat supply network is delivered to boiler and water heating boiler (9) water main by means of system pump (5), and then goes to the "direct" line of heat supply network To compensate water losses in heat supply network, water is added partially from technical and partially from network water mains through chemical treatment facilities (10)

Condition of heat power generating units

According to assessment made by engineering staff of Tbilisi CHPP in 1996-1997 condition of units is as follows

Boiler No 1 (БГ-50) is in a satisfactory condition,

Boiler No 2 (БГ-50) - pipes of steam superheater shall be replaced, economizer needs overhaul,

Boiler No 3 (ТМ-35) is in operating state - furnace side water walls shall be repaired,

Boiler No 4 (БГ-35) is in operating state - air heater shall be cleaned,

Turbine generator No 1 (АП-6) is in a satisfactory condition,

Turbine generator No 2 (АТ-6) is in a satisfactory condition,

Turbine generator No 3 (АТ-6) - capital repair of this unit had been performed in 1992 and turbine generator have not been in operation after that Condensate pump shall be installed, operational capacity of ejectors shall be checked, turbine generator shall be dynamically balanced, control system shall be adjusted,

One basic (БО-200) and two peak (БП-115) boilers shall be replaced in heat supply system, network water heater (ПСВ-315-3-23) mainly is in a satisfactory condition, water pipe bundles shall be chemically treated (washed with perchloric acid)

Peak water heating boilers (2xПТВМ-50) shall be dismantled

Condition of electric power generating units

Turbine generator No 1 needs current repair

Turbine generator No 2 needs current repair

Turbine generator No 3 needs current repair

Power transformer No 1 ТРДНГ 25000/35 is in operating state, voltage regulation switch is out of order and needs overhaul,

Power transformer No 2 ТРДНГ 25000/35 is in operating state, voltage regulation switch is out of order and needs overhaul,

Due to normal operation and high quality preventive works carried out, 6 kV switchgear (which is built and installed in 1939) is ready for long-term operation after necessary repair Equipment of 18 feeder lines connected to the city grid is in an extremely poor condition and needs overhaul,

0 4 kV switchgear is in operating state, some devices need repair, equipment is old both, technologically and physically,

The following service transformers need preventive works

No 1 560 kVA
No 2 750 kVA
Stand-by 560 kVA
No 3 560 kVA
No 4 750 kVA

Batteries CK-10 are significantly depreciated and need current repair,

Cable lines going to the city grid and laid on the territory of CHPP are in an extremely bad condition (cable trench is destroyed, existing cables are interweaved and spread above the trench)

5 2 Heat supply network and condition of heating mains

Tbilisi CHPP heat supply system (Fig 5) serves four districts of Tbilisi - Didube, Chugureti, Mtatsminda and Krtsanisi According to dislocation, network is divided into two zones - upper and lower Upper zone heating mains serve Mtatsminda and Krtsanisi districts, lower zone heating mains serve Didube and Chugureti districts

Heat supply system is of double pipe type Length of the basic heating mains of the upper zone, including direct and back pipelines, is about 13 km, and of the lower zone - 26 km Conventional diameters of the main heat supply pipes are - 100, 125, 150, 200, 300, 400 and 500 mm Maximum operational pressure in pipelines is 85 m of water column

Heat supply system of Tbilisi CHPP comprises of heating and hot water supply systems According to heat supply system connection diagram and the way of heat carrier circulation, heating and hot water supply systems are of independent (closed) type - with intermediate heat exchanger Heating devices at heat power consumer sites are switched according to parallel schemes and in series Heating devices are mainly of radiator type

Tbilisi CHPP heat supply networks currently are in unsatisfactory technical condition According to data, provided by the plant engineering personnel, losses in heat supply network can reach 25% (both, heat and financial losses are included) *To determine reasons of increased losses, it is necessary to investigate individual sections of heat supply network These measures are necessary for planning long-term works on separation and repair of individual sections of heat supply network (to satisfy demands of existing and actual potential solvent consumers)*

Due to the leakage of funds, it is hardly possible to study in full actual condition of heat supply pipeline Therefore, the problem shall be solved step by step - according to consumer priority, separate sections of heat pipelines shall be repaired When economic condition of CHPP is improved, heating mains will be completely rehabilitated We think, this is the optimum solution of the problem

5 3 Fuel Economy

The basic fuel of CHPP is natural gas Stand-by fuel is mazout Basic diagram of Tbilisi CHPP natural gas supply is given on the Fig 6

6 Optimum Operational Regimes for CHPP Steam Turbine Units

6 1 Seasonal Schedule of Heat Loads Guaranteed from Realization Point of View Temperature Diagram System Water Consumption Rate

According to design data, rated heat power capacity of Tbilisi CHPP is 110 8 MW This capacity was provided by means of two water heating boilers and heat supply facility, which comprises of five surface type heat exchangers Network water heating in boilers is performed at the expense of steam heat power extraction from turbine units

The rated load was distributed between water heating boilers and heat supply units according to distribution coefficient - $\alpha_{CHPP} \cong 0\ 6$ Network water temperature in direct main (at the outlet of water heating boilers) was equal to 150^0C, and consequently, heat power consumers were provided with rated value of network water temperature

It shall be noted, that water heating boilers, installed at Tbilisi CHPP are designed to work in low (-10~-15^0C) external temperature conditions - their designed efficiency can be reached only in such conditions In Georgia the mentioned boilers can not produce more than 50-60% of designed capacity and efficiency Besides, physical condition of the boilers has become worse and also number of solvent heat power consumers has reduced Therefore, rehabilitation of these boilers can be considered as unreasonable

Thus, we think, that *water heating boilers shall be dismantled* and, correspondingly, plant technical-economic parameters shall be calculated without them The only

source of heat power in CHPP in such case is steam, provided by turbine unit heat extraction or basic boiler units through reduction-cooling device ($\alpha_{CHPP} \cong 1$)

Analysis given below, is performed without taking into account existence of water heating boilers Besides only heating season is considered, as well as the range of heat power capacities required for heating and hot water supply for actual solvent consumers As it was mentioned in paragraph 2 2, such range is 12-16 MW

Temperature diagram of the network water is given on Fig 7 The following input parameters are used

- estimated outside temperature -8~-10^{0}C (for Tbilisi),
- network water maximum temperature at inlet of consumer site is 95^{0}C, when outside temperature is -8~-10^{0}C - according to sanitary-hygienic norms,
- at the beginning and end of a heating season outside temperature is considered to be +8 5~+10^{0}C,
- network water maximum temperature at inlet of consumer site is 65-70^{0}C, when outside temperature is +8 5~+10^{0}C, according to sanitary-hygienic norms,
- temperature drop in heating devices is 25^0 - according to technical parameters of existing devices

Sections **ab** and **ac** of diagram corresponds to different values of network water flow rate (details will be given below)

Fig 8 represents heat load versus outside temperature for actual solvent consumers Essential difference between demand on heat power and provided heat power is caused by unsatisfactory condition of heating mains (where, according to data provided by plant personnel, financial and heat losses are up to 25%)

Fig 9 represents network water flow rate dependence on outside temperature Section ac shows possible reduction of network water flow rate (and consequently, reduction of power consumption for the own needs) in direct main operating in high temperature (~86^{0}C) regime - see Fig 7

Fig 10 represents seasonal schedule of heat loads (in heating period) for heat power solvent consumer

6 2 CHPP Technical-Economic Parameters for Various Operational Regimes (with Existing Turbines)

As it was mentioned in section 2, the proposal considers rehabilitation of Tbilisi CHPP trough adjustment-repair of existing units, to make the station ready to operate in the nearest heating season

Together with rehabilitation of the plant at this stage it is necessary to choose such regimes of exiting device operation, which can fully satisfy demand on power with minimum capital costs for plant, or, if possible, with maximum economic benefits This is currently the main optimization task for Tbilisi CHPP

Calculations have been done in two sub-stages

At the first sub-stage energetic parameters of turbine units in rated "TK", "K" and "TIIP" operational regimes were determined (calculations have been done using the program KUMIR-M, developed by the authors) Analyzing the results it was determined, that thermal efficiency of the units working in "TK" and "TIIP" operational regimes (partial vacuum) is actually the same in the required range of thermal capacities Besides, working in a partial vacuum regime it is necessary to perform remaking technical works This is quite difficult to do because of the necessary immediate works to be performed for maintaining the plant operability Consequently, for the second sub-stage we had chosen operational regime "TK" as proved many times operational regime

At the second sub-stage economic calculations were performed for various options using the following general conditions

- Average thermal capacity, required by actual solvent consumers in heating season - 14 MW (according to experience of the last year - see 6 1),
- Electric power tariff - 6 tetri/kWh including VAT,
- Natural gas calorific value - 7800 kcal/standard m^3,
- Price of natural gas - 0 075 lari/standard m^3 without VAT,
- Annual repair-operational costs - 1000 lari/year (according to the plant data)

Specific conditions for each option are given below

We can assume, that demand of solvent heat power consumers will not change and remain within 12-16 MW range

Based on the above mentioned, plane technical-economic parameters have been calculated for four options

Option I

- Plant operates during the heating season only (~3600 hours),
- Only one turbine unit is in operation - AT-6,
- Turbine unit operates in heat supply regimes according to electric power generation schedule ("TK" regime),

- Average gross thermal capacity of heat supply extraction is 14 MW (see heat load seasonal schedule - Fig 10),

- Average gross electric power capacity of the turbine units is 5 3 MW

Option II

- Plant operates during the heating season only (~3600 hours),

- Two turbine units are in operation - AT-6 and AП-6,

- AT-6 operates in heat supply regimes according to electric power generation schedule, AП-6 operates in condensation regimes ("K" regimes),

- Average gross thermal capacity of the unit AT-6 is 14 MW, electric power generation capacity - 5 3 MW,

- Average gross electric power capacity of the unit AП-6 is 5 3 MW

Option III

- Plant operates during the heating season only (~3600 hours),

- Three turbine units are in operation - 2xAT-6 and 1xAП-6,

- AT-6 operates in heat supply regimes according to electric power generation schedule, AП-6 operates in condensation regimes, AT-6 operates in condensation regimes,

- Average gross thermal capacity of the unit AT-6 is 14 MW, electric power generation capacity - 5 3 MW,

- Average gross electric power capacity of the unit AП-6 is 5 3 MW

Option IV

- Plant operates during a year (~7680 hours),

- Three turbine units are in operation - 2xAT-6 and 1xAП-6,

- During the heating season one AT-6 unit operates in heat supply regimes according to electric power generation schedule, and the rest of a year - in condensation regime, AП-6 and the other AT-6 operate in condensation regimes during a year,

- Average gross thermal capacity of the unit AT-6 in a heating season is 14MW electric power capacity - 5 3 MW For the rest of a year average gross electric power capacity of this unit is 5 3 MW,

- Average gross electric power capacity of the units AT-6 and AП-6 is 5 3 MW each

Results of calculations are given in detail in tables A3, A4, A5, A6 (see Attachment), and summary results are given in the Table No 1

As we can see from the Table No 1, plant operation after the urgent rehabilitation is economically efficient working only according to Options IV or, at least, III

It shall be noted, that the given conclusion is valid for fixed value of annual repair-operational costs - 1 million lari/year This value is determined by Tbilisi CHPP administrative-financial department and we have not included any corrections

6 3 Capital Costs for Rehabilitation of CHPP Units

General description of the condition of Tbilisi CHPP heat and electric power generating units was given in 5 1 Works required for rehabilitation of units were considered Scope of these works and necessary capital costs are given in the Table No 2 (estimations have been done with participation of plant engineering-technical personnel)

As it can be seen from the table, 25% of rehabilitation works (according to capital investments) shall be performed by local repair-operational personnel, the rest 65% - by contractor organizations Such distribution of repair works is initiated by CHPP administration with the purpose of maximum possible saving of investments

6 4 Optimum operational regimes

Tbilisi CHPP operation efficient regimes, while demand of solvent heat power consumers is restricted, are determined based on the above given analysis It is clear, that increase of the number of thermal power solvent consumers will cause increase of plant profitability up to its designed value This is the maximum, that can be reached before the plant reconstruction-upgrade Therefore, it is necessary to establish tariffs, which the former heat power consumers can pay Besides, competitive level shall be maintained with regard to other heat power generation sites, already existing or which are under construction by individual consumers This is possible in case, if the plant implements flexible tariff policy in combined heat-power generation conditions - combined heat-power generation allows the plant to change tariffs on heat power to maintain and attract consumers But boundary conditions shall be satisfied to prevent implementation of attractive tariffs at the expense of plant economic efficiency

Additional data are necessary to implement properly above mentioned policy Corresponding calculations have been done - Options V and VI, and conditions given in 6 2 were used in these calculations

Option V

- Plant operates during a year (~7680 hours),
- Three turbine units are in operation - 2xAT-6 and 1xAП-6,
- During a heating season (~3600 hours) two units AT-6 operate in heat supply regimes according to electric power generation schedule ("TK" regimes), and the rest of a year - in condensation regime, Unit AП-6 operates in condensation regimes ("K") during a year,
- Average total gross thermal capacity of two units AT-6 for heating season is 29 MW, electric power capacity - 10 6 MW For the rest of a year total average gross electric power capacity of these units is 10 6 MW,
- During a year average gross electric power capacity of the unit AП-6 is 5 3 MW

Option VI

- Plant operates during a year (~7680 hours),
- Three turbine units are in operation - 2xAT-6 and 1xAП-6,
- During the heating season (~3600 hours) all three units operate in heat supply regimes according to electric power generation schedule ("TK" regimes),
- Average total gross thermal capacity of all three units for heating season is 43 MW, electric power capacity - 16 MW

Results of calculations are given in Tables A7, A8 - see Attachment

Results if Options I-IV are presented on the Fig 11 as a diagram of CHPP income annual balance dependence on heat power tariff It shows revenue annual balances for different values of heat power tariffs when the plant operates in various regimes Besides, it gives us a possibility to come the right decision for proper implementation of heat power tariff policy

7 Conclusions and recommendations

- Individual air duct for CHPP natural gas supply shall be arranged Modern gas flow and calorific power meters shall be installed on the territory of CHPP

- Automatic and I&C devices installed on the units shall be repaired replaced with modern ones and completely equipped

- Precise list of actual heat power solvent consumers shall be drawn up, demand of potential heat power consumers shall be assessed for the nearest future, survey and separation works shall be performed at individual sections of heat supply network to satisfy existing and expected demand on heat power

- Urgently arrange heat power supply and metering for household consumers and enterprises Demonstration zone shall be created on purpose through preliminary selection of group of consumers, where the mentioned problem will be solved

- Heat supply mains need repair, heat and financial losses in network water pipelines shall be reduced to the minimum possible value Network water consumption and temperature meters, existing on the territory of CHPP, shall be rehabilitated

- CHPP is an important power generating plant supplying electric power for city needs If necessary, it is possible to exclude individual sites from the common system and provide their individual power supply

- It is necessary to rehabilitate immediately cable lines laid on the territory of CHPP and going to the city grid, and install them in special trenches

- It is desirable to dismantle water heating boilers installed in CHPP

- It is necessary to develop programs for calculation of the plant technical-economic parameters, both, for estimation of internal technological process efficiency, and to implement properly tariff policy

- Operation of Tbilisi CHPP is economically efficient when plant operates in regimes of Options VI, V IV, or at least III

- When the outside temperature is within the range 0 - 10^0C, it is preferable to maintain high (~86^0C) network water temperature in the direct main (instead of 70-76^0C) This can be done without any technical difficulties

- Works on upgrade-reconstruction of Tbilisi CHPP shall be continued to implement step by step highly efficient modern technologies

Table N 1 Summary Results of Calculation of CHPP Technical-Economic Parameters

Option	I	II	III	IV
Mode of operation / **Parameters**	One turbo-unit during heating season	Two turbo-units during heating season	Three turbo-units during heating season	Three turbo-units during the whole year
El power generation, MW * h/year	16 218	34344	52 470	114 098
El power tariff according to the agreement, tetri/(kW * h)	6	6	6	6
Revenues from el power realization thous lari/year	973	2 061	3 148	6 846
Thermal power generation, MW * h/year	38 880	38 880	38 880	38 880
Estimated tariff of thermal power, tetri/(kW * h)	3,8	3	2,6	2,2
Revenues from thermal power realization, thous lari/year	1 461	1 148	1 017	857
Amount required for the fuel purchase, thous lari/year	905,5	1529,96	2154,4	4 277,5
Repair-operation costs (according to the CHPP data), thous lari/year	1 000	1 000	1 000	1 000
Balance, thous lari/year	123	144	316	1 141

Table N 2 Work Scope for CHPP Facilities' Repair According To The Condition In 1996/97

N	Type of the facility	Work scope	Work Cost thous GEL	Contractor
1	2	3	4	5
1	Boiler N 1		18 4	State enterprise
2	Boiler N 3	Medium repair	17 2	State enterprise
3	Boiler N 4	Medium repair	12 0	State enterprise
4	Water supply system	Medium repair	10 0	State enterprise
5	Pumping system	Overhaul	13 9	State enterprise
6	Flushing of 2 boilers	Overhaul	7 5	Contractor
7	Power transformer N 1	Overhaul	20 0	Contractor
8	Power transformer N 2	Overhaul	15 0	Contractor
9	18 feeders 6 3 kV	Overhaul	30 0	El shop repair team
10	4 section of 0 4 kV	Current repair	6 0	El shop repair team
11	Station service transformers power cables circuit breakers	Replace	15 0	El shop repair team
12	6 3 kV buses	Medium repair	2 0	El shop repair team
13	Section inlet oil switches N 1 and N 2	Medium repair	2 5	El shop repair team
14	Section inlet oil switch	Medium repair	1 0	El shop repair team
15	Accumulating batteries	Current repair	2 5	El shop repair team
16	Charging units	Current repair	1 5	El shop repair team
17	Turbogenerator N 1	Current repair	7 0	State joint stock company repair team
18	Turbogenerator N 2	Current repair	7 0	State joint stock company repair team
19	Turbogenerator N 3	Current repair testing balance	7 0 2 0	State joint stock company repair team Contractor
20	Spare parts	purchase	120 0	Contractor
21	Main and auxiliary equipment	Emergency repair	50 0	Contractor
22	Thermal networks and drives	Emergency repair	40 0	Network shop
23	Heating main damaged pipes on the section of St Jorjadze	Emergency repair replace	150 0	Contractor
24	Total	-- -- -- - --	557 5	- -- -- - -- - -- -- - - -

Table - d1 **Estimated heat load (in 1970-1980) for administrative-public sites**

N	Site	Estimated heat load kW
1	*2*	*3*
1	Swimming pool, Tennis courts	29,1
2	Saksakhproject	235
3	Secondary school N70	174,5
4	Republic board of methodology	174,5
5	Personal service shop	744,3
6	Secondary school N46	116,3
7	Offset printing shop	407,05
8	Tuberculoses dispensary	272,1
9	Sakmedtechnic	46,5
10	Secondary school N46	174,5
11	•••	64
12	Secondary school N68	116,3
13	Secondary school N69	127,9
14	The Ministry of Foreign Affairs of Georgia	232,6
15	Air force headquarters	72,1
16	??? Radio center	23,3
17	Rustaveli state theater	755,95
18	Hotel "Tbilisi"	1221,2
19	Registration and enlistment office	69,8
20	Museum of Literature	44,2
21	Kindergarten N102	131,4
22	The Ministry of Culture	221
23	Rear services headquarters	1163
24	Opera and Ballet State Theater	593,1
25	Trade Union House	732,7
26	Academy of Art	703,6
27	"Zaria vostoka" editorial office	349
28	Saknakhshiri	1047
29	Aeroflot	93
30	Kino Palace	71
31	Mineral waters' shop	13,9
32	Officers Palace	687,3
33	Committee of State Security	1023,4
34	Palace of Communication	1163
35	Secondary school N1	232,6
36	The Ministry of Home Affairs	353,56
37	Music school N3	261
38	Music boarding school	299

Table - d1 (continuation)

1	2	3
39	Children Hospital (Abakeli St N 31)	1046,7
40	Supreme Court	651,3
41	Museum of Marksism and Leninism	645,5
42	Central Post Office	197,7
43	Hotel "Iveria"	2209,7
44	Kashueti Church	95,4
45	Picture Gallery	63,9
46	Hotel "Inturist"	1163
47	Government Palace	4019
48	Youth Palace	802,5
49	Metro station "Tavisuflebis Moedani"	171
50	I Chavchavadze Club	51
51	Department of Commandants' Office	18,6
52	Garage of the Ministry of Finance	226,8
53	Printing House	116,3
54	State Palace of Education	113,9
55	Cinema "Rustaveli"	581,5
56	Museum of Hystory	942,03
57	Pawn-shop	105,8
58	Tsekavshiri	1011,8
59	Sakmtavarenergo	2837,7
60	Polyclinic + bath-house	1116,5
61	National Public Library	465,2
62	Military Units	103,5
63	Museum of Art	93,04
64	Heating shop	23,3
65	Management Information Systems Institute-1	347,7
66	Management Information Systems Institute-2	144,2
67	Palace of Marriage	1135,1
68	Central Committee Garage	355
69	Zincography	11,6
70	Pasteboard Factory	23,3
71	Cinema "Kolkhida"	36,1
72	Secondary School N38	232,6
73	Music School (Kslelelektromsheni)	81,4
74	District Committee	139,6
75	Department of Heat Networks	34,9
76	Store houses of El Networks	23,3
77	El Networks	55,8
78	Choreography schools	380 3
79	Secondary School N37	243,1

80	Central Clinical Hospital	978,1
81	Rheumatic Polyclinic	95,4
82	Cardiology Institute	191,9

Table - d1 (continuation)

1	*2*	*3*
83	Chemistry Institute	273,3
84	Psychiatry Hospital	335
85	Printing shop	869,9
86	Store house of the shop	116,3
87	Department store	438,5
88	Secondary school N23	274,5
89	Kindergarten N3	22,1
90	Kalakproejct	290,8
91	"Tsiskari" publishing house	209,3
92	Metromsheni N5 tunnel team	63,9
93	Decorative shop	29
94	Marjanishvili Theater	280 2
95	Secondary school N25 + kindergarten tourist base	308,2
96	Technical typography	116,3
97	Polytechnic school	581,5
98	Polytechnic college	445,4
99	Maternity hospital N2	348,9
100	Hospital of emergency aid	232,6
101	Design office	48,8
102	Navigators' club	26,7
103	Stomatology polyclinic	169,8
104	Cycle track	26,7
105	Puppet-show	60,5
106	The Ministry of Justice	143
107	Youth Theater	868,8
108	R/W Secondary school N1	174,5
109	Machinery Building technical school	290,8
110	Main drug-store department	418,7
111	Chemistry Industry	68,6
112	Secondary school N28+Music school N2	93,04
113	Hostel of R/W technical school	209,3
114	City hospital N2	514
115	Engine-drivers school	68,6
116	R/W technical school	162,8
117	Cinema "October" ("Apolo")	46,5
118	Railwayman club	407,05
119	Cinema "Amirani"	48,8
120	Philharmonic (music center)	193,1
121	District committee	163,9
122	Secondary school N101	73,3
123	Institute of professional diseases	127,9
124	Library	87,2

125	Ocular polyclinic	188

Table - d1 (end)

1	*2*	*3*
126	Kindergarten	50
127	Center of Ferrous Metallurgy Residues	30,2
128	Gantiadi	104,67
129	Tbilisi artillery school	2093,4
130	Hydrometeorology services' Institute	697,8
131	"Kavgiprotransi"	639,7
132	Children Hospital N2	197,7
133	Institute of Parasitology	151,2
134	School of mentally disabled children	244 2
135	Market of 1 May district	58,2
136	R/W kindergarten N1	46,5
137	Kalinini Factory	228
138	Trolley-bus department day care kindergarten	72
139	Trolley-bus department kindergarten	72
140	Training institute of teachers	151 2
141	Secondary school N18	167,5
142	Kino studio	1825,9
143	Construction-installation department N8	16,28
144	Music Theater	325,6
	Total	**55 507,6**

474 sites - 110771 kW(thermal)
144 administrative and public sites - 55 507,6 kW (thermal)
330 dwelling sites - 55 263,4 kW (thermal)

Table - d2 ***Design technical parameters of Tbilisi CHPP power units***

Table -d2, a- ***Boiler units***

N	Unit	Type	Station N	Steam productivity, tones/h	Steam parameters Pressure bar	Temper ^0C	Rated heat product
1	2	3	4	5	6	7	8
1	Power boiler unit	••-50	1, 2	50	40	440	-
2	Power boiler unit	T•-35	3	35	43	450	-
3	Power boiler unit	••-35	4	35	43	450	-
4	Peak water heating boiler	••••-50	-	-	-	-	58,1

Table - d2 b- ***Turbo units***

Turbine type	••-6 (•-6-35/5)	••-6 (•-6-35)
Station number	1	2, 3
Rated el capacity, MW	6	6
Bleeding rated heat capacity, MW	25	22,5
Generated steam		
pressure bar	35	35
temperature, ^0C	435	435
consumption in heating mode, tone/h	55,8	42,3
consumption in condensation mode , tone/h	28,2	27,9
Waste steam pressure, bar	0,05	0,05
"Cooling" water		
temperature, ^0C	25	25
consumption, m^3/h	1850	1850
Steam during heat bleeding		
pressure, bar	-	1,2-2,5
temperature, ^0C	-	127-185
consumption, tone/h	-	35
Steam during industrial bleeding		
pressure, bar	5	-
temperature, ^0C	230	-
consumption, tone/h	40	-
Steam maximum consumption		
in high pressure cylinder, tone/h	-	25
in low pressure cylinder, tone/h	-	47,6

127

Table -2, g -***Heating unit***

		Main boiler	Peak boiler	Peak heater of network water
Type of heat exchanger		•O-200	••-115	•••-315-3-23
Heat capacity, MW		10	8,7	32,8
Number		2	2	1
Heating steam				
pressure,	bar	2 5	5	2 5-4
temperature,	^{0}C	175	220	127 - 144
consumption,	tonn/h	-	-	86 5-88,5
Network water				
consumption,	tonn/h	345	300	1130
heating,	^{0}C	25	25	25

128

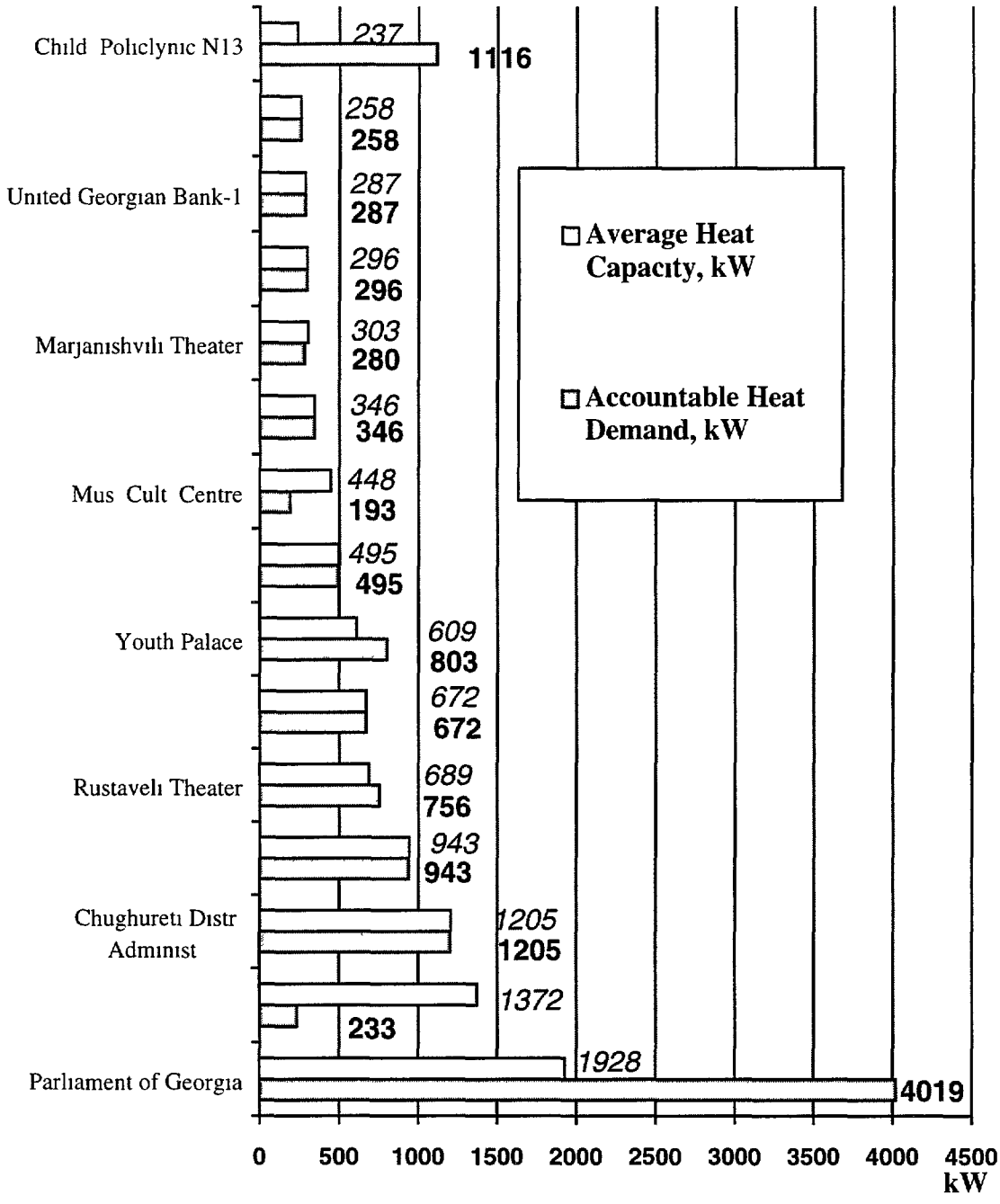


Fig 1 **Heat Demand of Solvent Consumers of Tbilisi CHPP in 1996-1997**

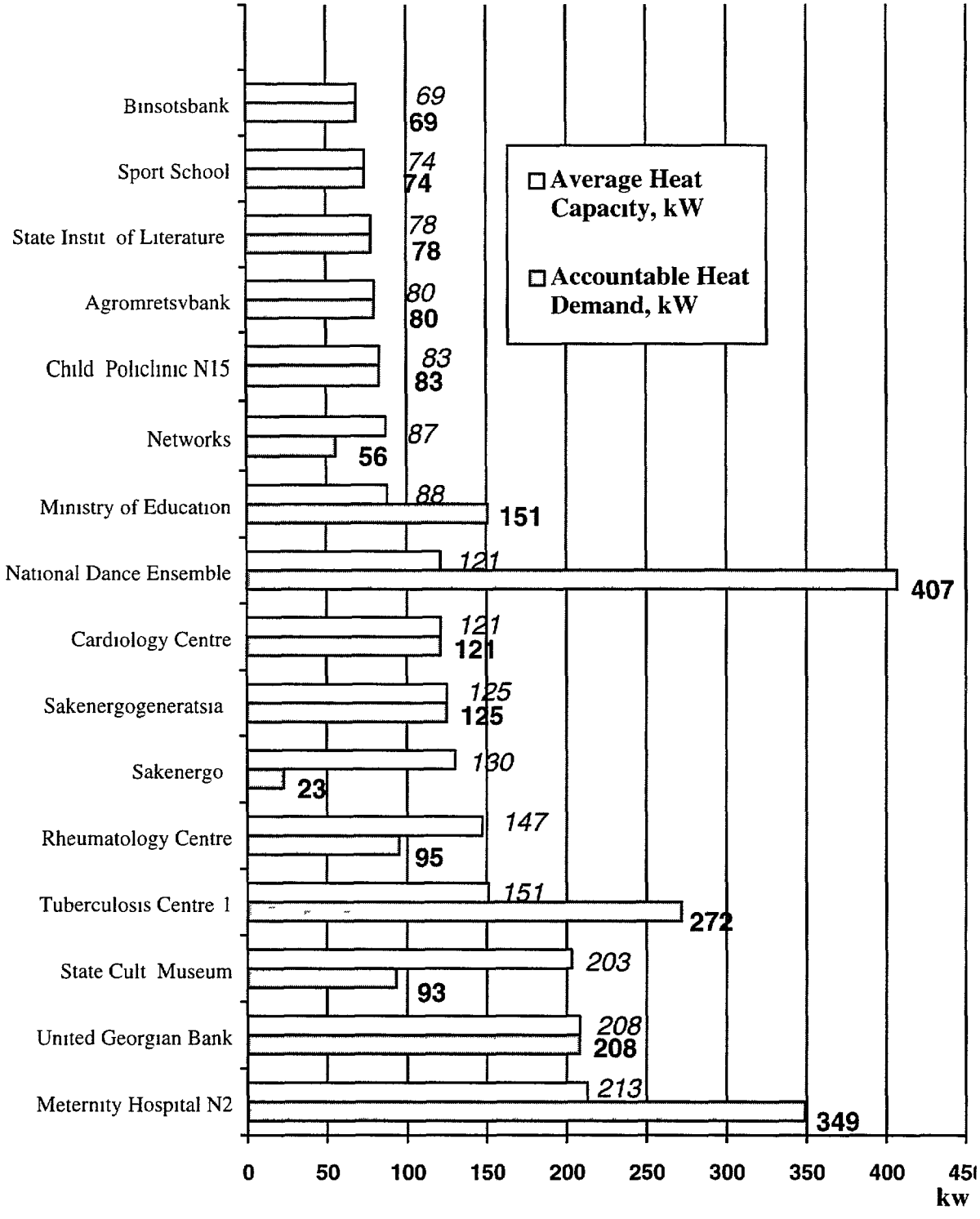


Fig 1 (continue) **Heat Demand of Solvent Consumers of Tbilisi CHPP in 1996-1997**

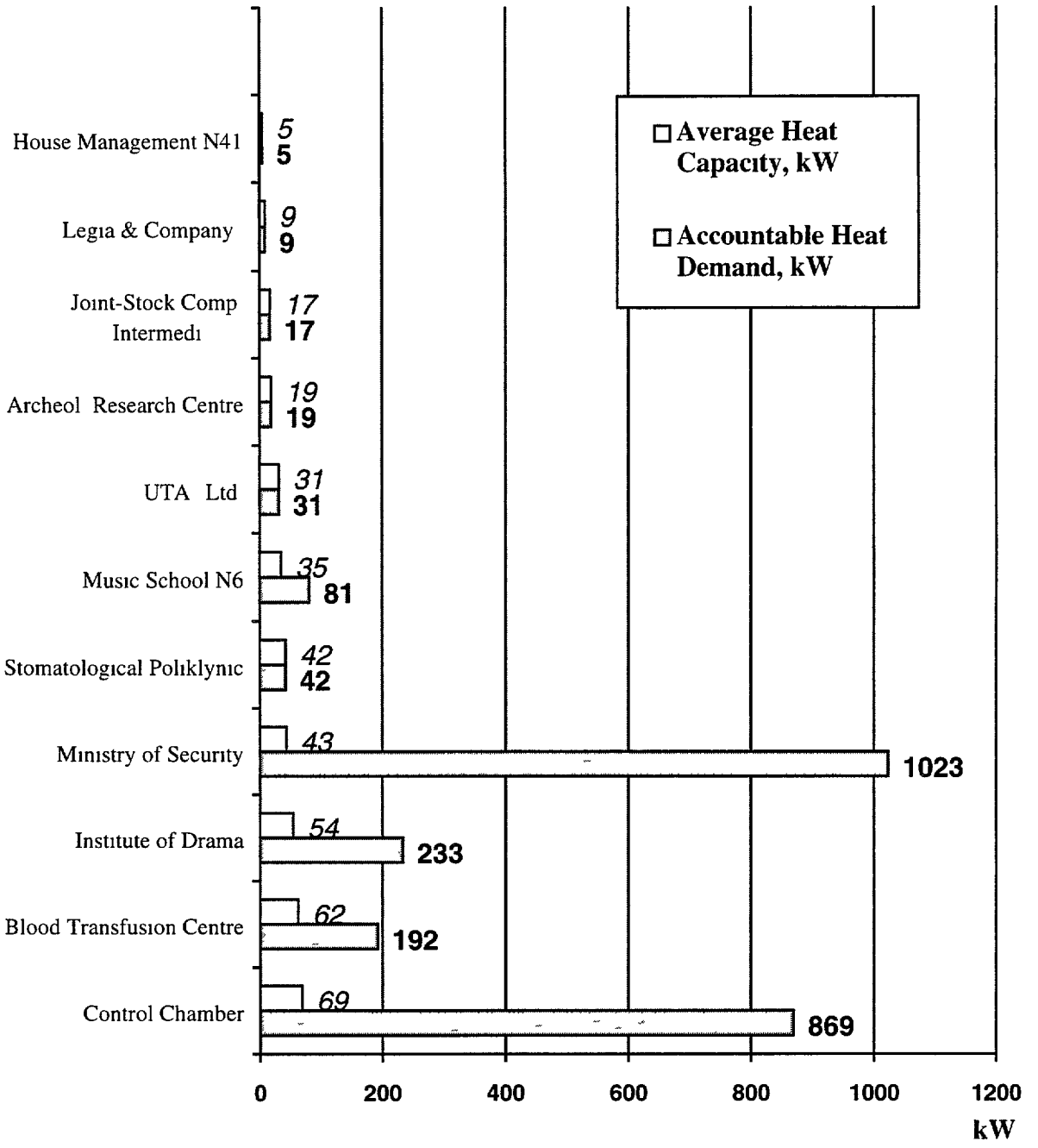


Fig 1 (end) **Heat Demand of Solvent Consumers of Tbilisi CHPP in 1996-1997**

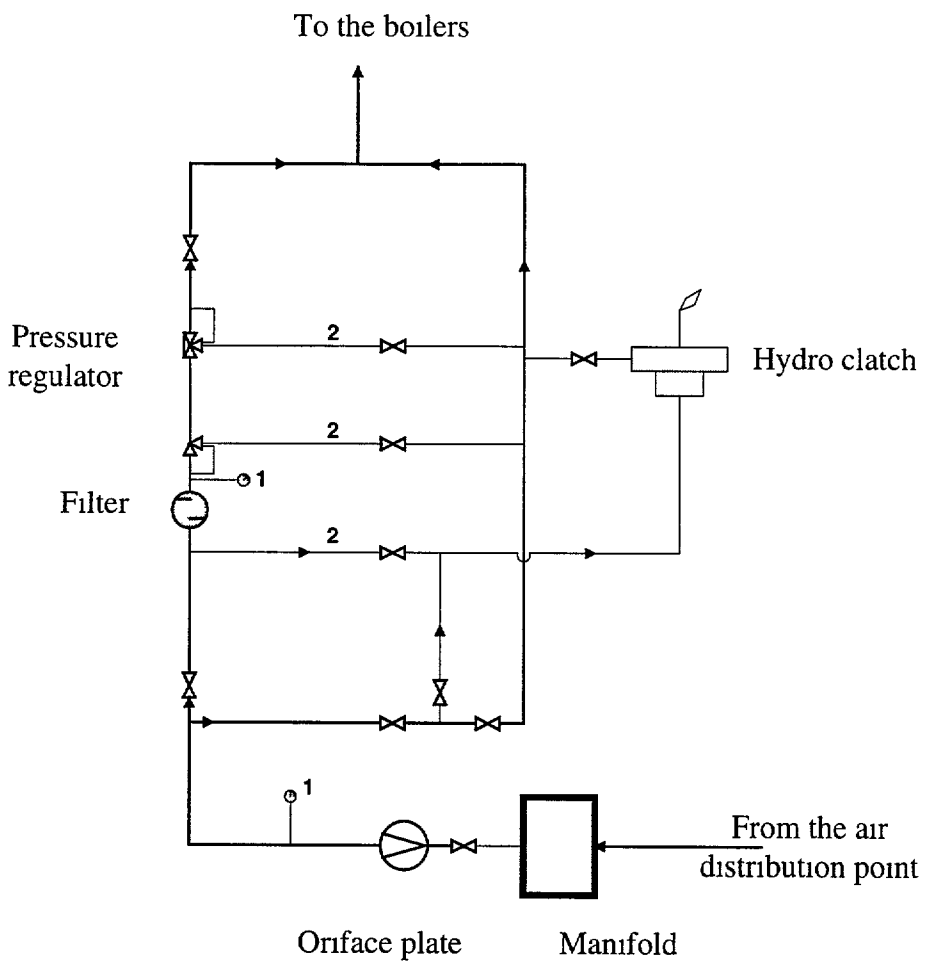


Fig 6 **Scheme of natural gas supply**

1- Pressure gauge,
2- Pulse lines

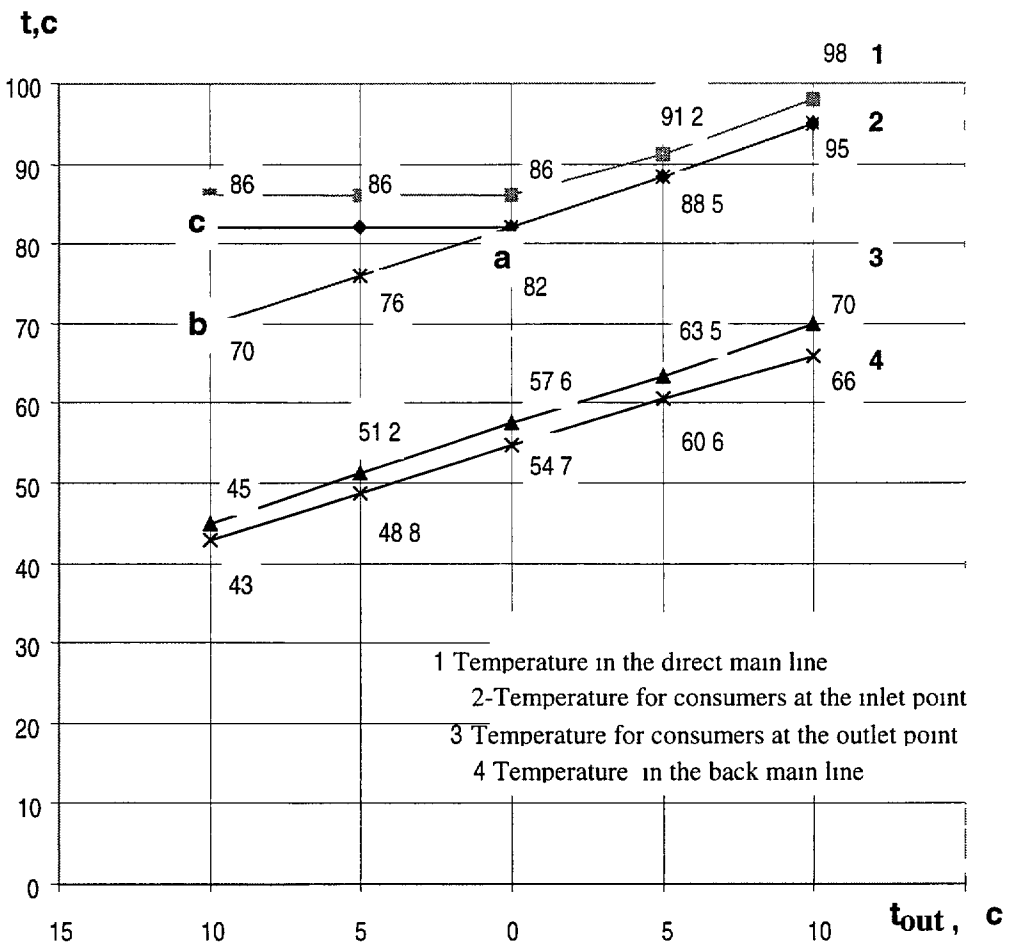


Fig 7 **Temperature Diagram of Network Water**

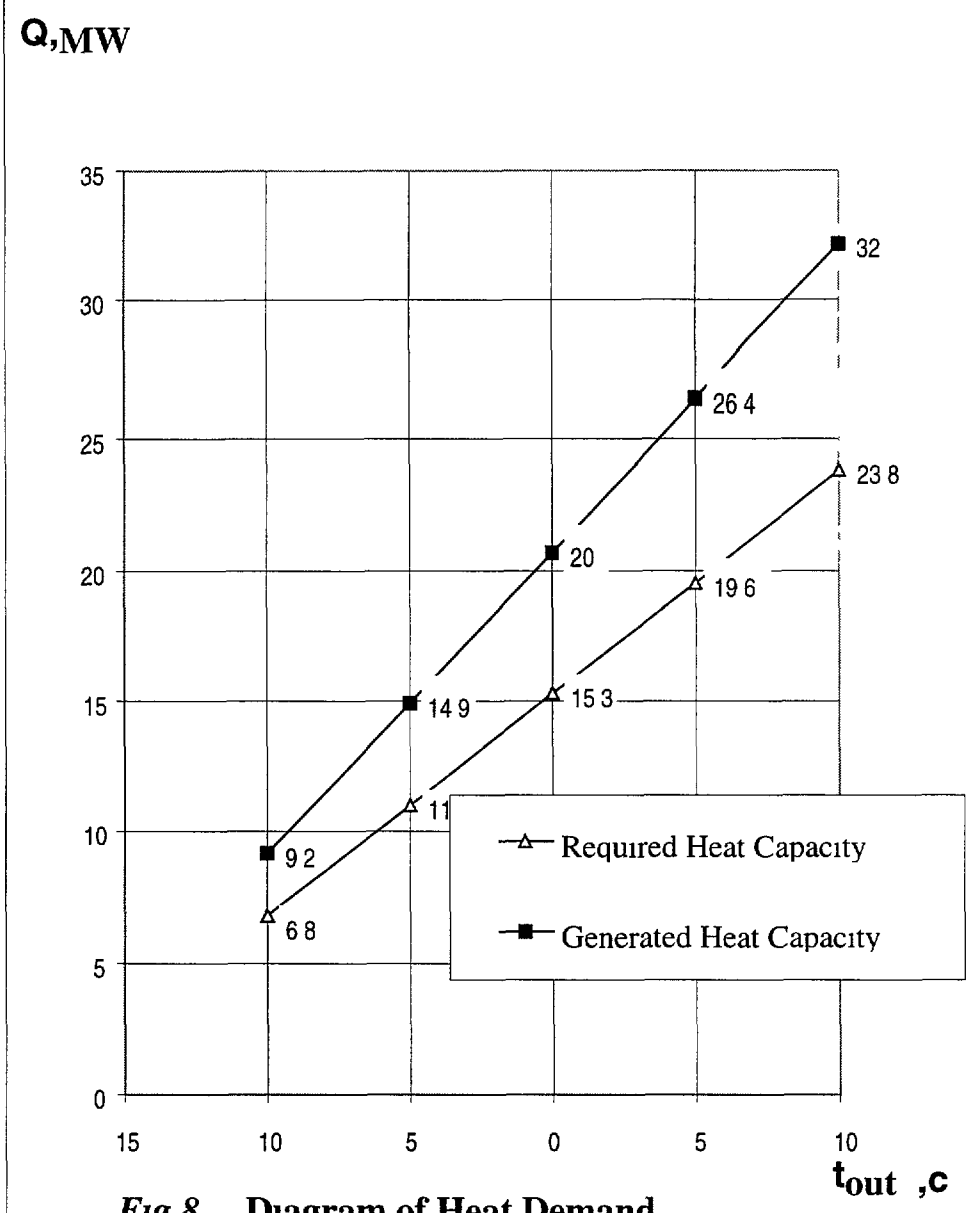


Fig 8 **Diagram of Heat Demand**

136

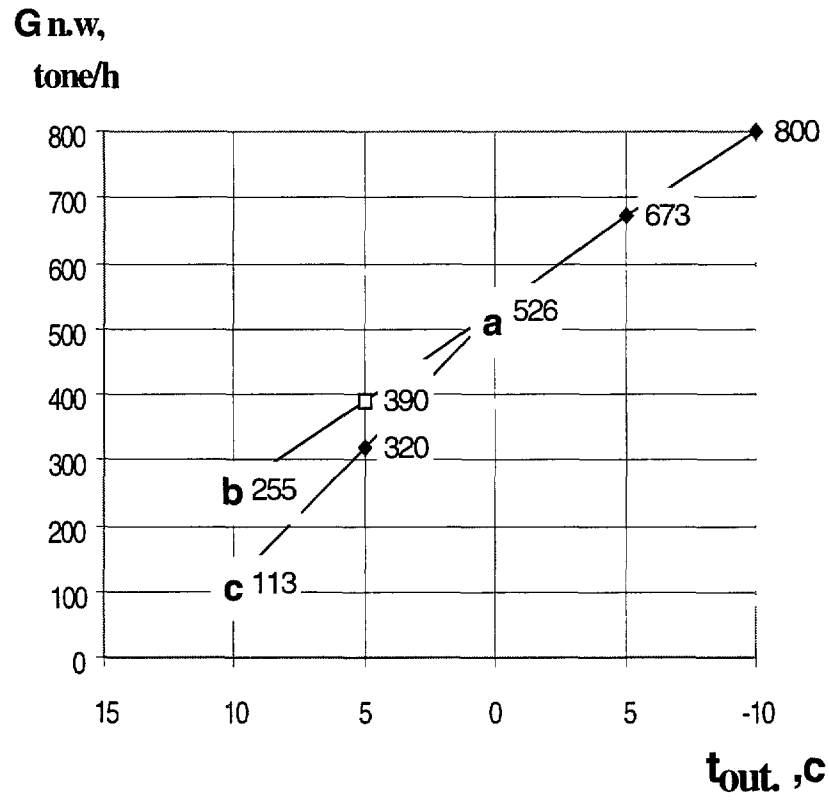


Fig.9 Network Water Discharge

135

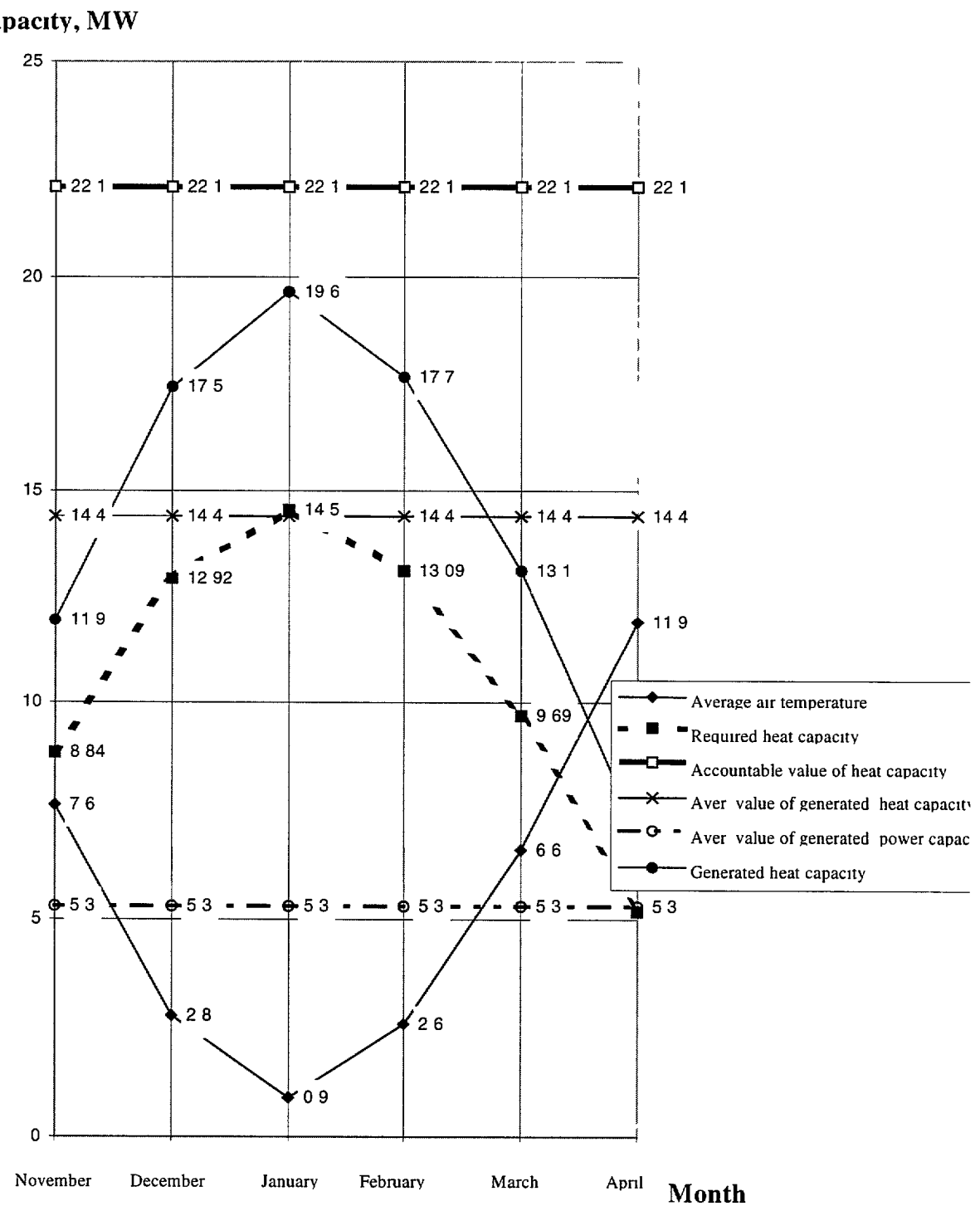


Fig 10 Diagram of Seasonal Heat Demand

131

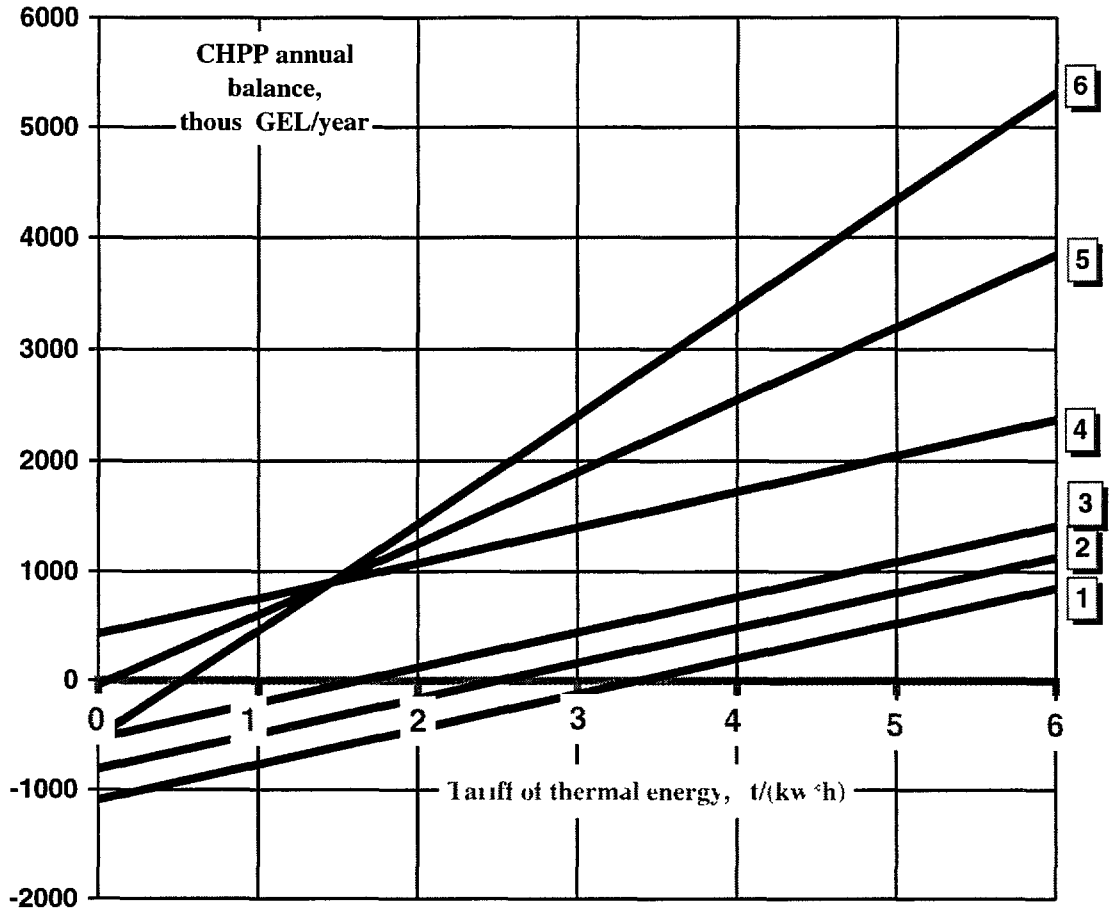


Fig 11 Dependence between the CHPP incomes' annual balance and generated thermal energy tariff during the different modes of plant operation (before reconstruction-modernization)

1 - Option - el power generation 16218 MW*h/year generation of thermal energy - 38880 MW*h/year
2 - Option - el power generation - 34344 MW*h/year generation of thermal energy - 38880 MW*h/year
3 - Option - el power generation - 52470 MW*h/year generation of thermal energy 38880 MW*h/year
4 - Option - el power generation - 114098 MW*h/year generation of thermal energy - 38880 MW*h/year
5 - Option el power generation - 110282 MW*h/year generation of thermal energy - 77760 MW*h/year
6 - Option el power generation 106466 MW*h/year generation of thermal energy - 116640 MW*h/year

137

CHPP TECHNICAL ECONOMICAL PARAMETERS DURING THE DIFFERENT MODES OF TURBINES' OPERATION BEFORE RECONSTRUCTION-MODERNIZATION
OPTION 1

POWER UNITS		**O-6-35**			
Fuel	-	N gas			
Fuel heat capacity	**MJ/n cub m**	**32 682**			
Fuel price without VAT	**GEL/n cub m**	**0 075**			
Operation mode in "cold" period (CP)	-	TK			
Operation mode in "warm" period (WP)	-				
Operation duration CP	**h**	**3600**			
Operation duration WP	**h**				

El capacity, gross, CP	**MW**	**5 3**			5 3
El efficiency, gross, CP	**%**	**41 616**			
El power for station service, CP	**%**	**15**			
El efficiency, net, CP	%	35 3736	0	0	
CF specific consumption for power generation, CP	gCF/kW/h	347 7169	FALSE	FALSE	
NF specific consumption for power generation, CP	n cub m/kW/h	0 312054	FALSE	FALSE	
El capacity, net, CP	MW	4 505	0	0	4 505
El power generation, CP	MW*h	16218	0	0	16218

El. capacity, gross, WP	**MW**				0
El. efficiency, gross, WP	**%**				
El. power for station service, WP	**%**				
El. efficiency, net, WP	%	0	0	0	
CF specific consumption for power generation, WP	gCF/kW/h	FALSE	FALSE	FALSE	
NF specific consumption for power generation, WP	n cub m/kW/h	0	FALSE	FALSE	
El capacity, net, WP	MW	0	0	0	0
El power generation, WP	MW*h	0	0	0	0

Heat capacity, gross, CP	***MW***	***14 4***			14 4
Heat efficiency, gross, CP	***%***	***81 6***			
Heat power for station service + losses in heating main, CP	***%***	***25***			
Heat efficiency, net, CP	*%*	*61 2*	*0*	*0*	
CF specific consumption for power generation, CP	*gCF/kW/h*	*200 9804*	*FALSE*	*FALSE*	
NF specific consumption for power generation, CP	*n cub m/kW/h*	*0 180367*	*FALSE*	*FALSE*	
Heat capacity, net, CP	*MW*	*10 8*	*0*	*0*	10 8
Heat power generation, CP	*MW*h*	*38880*	*0*	*0*	38880

Table - d4 Option 1

Heat capacity, gross, WP	*MW*				0
Heat efficiency, gross, WP	*%*				
Heat power for station service + losses in heating main, WP	*%*				
Heat efficiency, net, WP	*%*	*0*	*0*	*0*	
CF specific consumption for power generation, WP	*gCF/kW/h*	*FALSE*	*FALSE*	*FALSE*	
NF specific consumption for power generation, WP	*n cub m/kW/h*	*0*	*FALSE*	*FALSE*	
Heat capacity, net, WP	*MW*	*0*	*0*	*0*	0
Heat power generation, WP	*MW*h*	*0*	*0*	*0*	0

Seasonal Parameters					
El power generation, CP	MW*h	16218	0	0	16218
Fuel consumption for el power generation, CP	thous n cub m	5060 886	0	0	5060 886
Expenses for fuel purchase (el), CP	thous GEL	379 5665	0	0	379 5665
Thermal power generation, CP	MW*h	*38880*	*0*	*0*	38880
Fuel consumption for thermal power generation, CP	thous n cub m	*7012 67*	*0*	*0*	7012 67
Expenses for fuel purchase (thermal) CP	thous GEL	*525 9502*	*0*	*0*	525 9502
Total fuel consumption, CP	thous n cub m	**12073 6**	**0**	**0**	12073 56
Total expenses for fuel purchase, CP	thous GEL	**905 5167**	**0**	**0**	905 5167
El power generation, WP	MW*h	0	0	0	0
Fuel consumption for el power generation, WP	thous n cub m	0	0	0	0
Expenses for fuel purchase (el), WP	thous GEL	0	0	0	0
Thermal power generation, WP	MW*h	*0*	*0*	*0*	0
Fuel consumption for thermal power generation, WP	thous n cub m	*0*	*0*	*0*	0
Expenses for fuel purchase (thermal), WP	thous GEL	*0*	*0*	*0*	0
Total fuel consumption, WP	thous n cub m	**0**	**0**	**0**	0
Total expenses for fuel purchase, WP	thous GEL	**0**	**0**	**0**	0

Annual Parameters					
El power annual generation	MW*h	16218	0	0	16218
Annual fuel consumption (el)	thous n cub m/year	5060 886	0	0	5060 886
Expenses for fuel purchase (el)	thous GEL/year	379 5665	0	0	379 5665
Thermal power annual generation	MW*h	*38880*	*0*	*0*	38880
Annual fuel consumption (thermal)	thous n cub m/year	*7012 67*	*0*	*0*	7012 67
Expenses for fuel purchase (thermal)	thous GEL/year	*525 9502*	*0*	*0*	525 9502

Table d4 Option 1

Total annual fuel consumption	thous n cub m/year	**12073 56**	**0**	**0**	12073 56
Annual expenses for fuel purchase (total)	thous GEL/year	**905 5167**	**0**	**0**	905 5167

Annual operation-repair expenses	**thous GEL/year**	1000	0	0	**1000**
El share in operation-repair expenses (according to the fuel consumption)	thous GEL/year	419 1711	FALSE	FALSE	419 1711
Thermal share in operation-repair expenses (according to the fuel consumption)	thous GEL/year	*580 8289*	*FALSE*	*FALSE*	580 8289

Total expenses (el)	thous GEL/year	798 7376	0	0	798 7376
El power prime cost	**t/kW/h**	**4 925007**	**FALSE**	**FALSE**	**4 92501**
Accountable profit (el)	**%**	**10**	**10**	**10**	**10**
El power accountable cost	t/kW/h	5 417508	0	0	5 417508
VAT (el)	**%**	**20**	**20**	**20**	**20**
El power estimated tariff	t/kW/h	6 501009	0	0	6 501009
El power *established tariff*	***t/kW/h***	***6***	***0***	***0***	***6***
Income from el power realization (established tariff)	thous GEL/year	973 08	0	0	973 08
VAT (el) in the budget	thous GEL/year	162 18	0	0	162 18
El power cost	**t/kW/h**	**5**	**FALSE**	**FALSE**	**5**
Profit (el)	**thous GEL/year**	**12 16238**	**0**	**0**	**12 1624**
	%	**1 5227**	**FALSE**	**FALSE**	**1 5227**

Total expenses (thermal)	thous GEL/year	1106 779	0	0	1106 779
Thermal power prime cost	**t/kW/h**	**2 846654**	**FALSE**	**FALSE**	**2 84665**
Accountable profit (thermal)	**%**	**10**	**10**	**10**	**10**
Thermal power accountable cost	t/kW/h	3 131319	0	0	3 131319
VAT (thermal)	**%**	**20**	**20**	**20**	**20**
Thermal power estimated tariff	t/kW/h	3 757583	0	0	3 757583
Thermal power established tariff	***t/kW/h***	***3 757583***	***0***	***0***	***3 7576***
Income from thermal power realization (established tariff)	thous GEL/year	1460 948	0	0	1460 948
VAT (thermal) in the budget	thous GEL/year	243 4914	0	0	243 4914
Thermal power cost	**t/kW/h**	**3 131319**	**FALSE**	**FALSE**	**3 131319**
Profit (thermal)	**thous GEL/year**	**110 6779**	**0**	**0**	**110 678**
	%	**10**	**FALSE**	**FALSE**	**10**

Total profit (+) or loss (-)	**thous GEL/year**	122 8403	0	0	**122.8**

CHPP TECHNICAL-ECONOMICAL PARAMETERS DURING THE DIFFERENT MODES OF TURBINES' OPERATION BEFORE RECONSTRUCTION MODERNIZATION
OPTION 2

		POWER UNITS		О-6-35	П-6-35/5		
		Fuel	-	N gas	N gas		
		Fuel heat capacity	MJ/n cub m	32 682	32 682		
		Fuel price without VAT	GEL/n cub m	0 075	0 075		
		Operation mode in "cold" period (CP)	-	TK	K		
		Operation mode in "warm" period (WP)	-				
		Operation duration CP	h	3600	3600		
		Operation duration WP	h				
		El capacity, gross, CP	MW	5 3	5 3		10 6
		El efficiency, gross, CP	%	41 616	25 296		
		El power for station service, CP	%	15	5		
		El efficiency, net, CP	%	35 3736	24 0312	0	
		CF specific consumption for power generation, CP	gCF/kW/h	347 7169	511 8346	FALSE	
		NF specific consumption for power generation, CP	n cub m/kW/h	0 312054	0 459339	FALSE	
		El capacity, net, CP	MW	4 505	5 035	0	9 54
		El power generation, CP	MW*h	16218	18126	0	34344
		El. capacity, gross, WP	MW				0
		El. efficiency, gross, WP	%				
		El. power for station service, WP	%				
		El efficiency, net, WP	%	0	0	0	
		CF specific consumption for power generation, WP	gCF/kW/h	FALSE	FALSE	FALSE	
		NF specific consumption for power generation, WP	n cub m/kW/h	0	0	FALSE	
		El capacity, net, WP	MW	0	0	0	0
		El power generation, WP	MW*h	0	0	0	0
		Heat capacity, gross, CP	*MW*	***14 4***			14 4
		Heat efficiency, gross, CP	*%*	***81 6***			
		Heat power for station service + losses in heating main, CP	*%*	***25***			
		Heat efficiency, net, CP	*%*	*61 2*	*0*	*0*	
		CF specific consumption for power generation, CP	*gCF/kW/h*	*200 9804*	*FALSE*	*FALSE*	
		NF specific consumption for power generation, CP	*n cub m/kW/h*	*0 180367*	*0*	*FALSE*	
		Heat capacity, net, CP	*MW*	*10 8*	*0*	*0*	10 8
		Heat power generation, CP	*MW*h*	*38880*	*0*	*0*	38880

Table d4 Option 2

		Heat capacity, gross, WP	*MW*				0
		Heat efficiency, gross, WP	*%*				
		Heat power for station service + losses in heating main, WP	*%*				
		Heat efficiency, net, WP	*%*	*0*	*0*	*0*	
		CF specific consumption for power generation, WP	*gCF/kW/h*	*FALSE*	*FALSE*	*FALSE*	
		NF specific consumption for power generation, WP	*n cub m/kW/h*	*0*	*0*	*FALSE*	
		Heat capacity, net, WP	*MW*	*0*	*0*	*0*	0
		Heat power generation, WP	*MW*h*	*0*	*0*	*0*	0

		Seasonal Parameters					
		El power generation CP	MW*h	16218	18126	0	34344
		Fuel consumption for el power generation, CP	thous n cub m	5060 886	8325 974	0	13386 86
		Expenses for fuel purchase (el) CP	thous GEL	379 5665	624 4481	0	1004 015
		Thermal power generation, CP	MW*h	*38880*	*0*	*0*	38880
		Fuel consumption for thermal power generation, CP	thous n cub m	*7012 67*	*0*	*0*	7012 67
		Expenses for fuel purchase (thermal), CP	thous GEL	*525 9502*	*0*	*0*	525 9502
		Total fuel consumption, CP	thous n cub m	**12073.6**	**8325.97**	**0**	20399 53
		Total expenses for fuel purchase, CP	thous GEL	**905 5167**	**624 4481**	**0**	1529 965
		El power generation, WP	MW*h	0	0	0	0
		Fuel consumption for el power generation, WP	thous n cub m	0	0	0	0
		Expenses for fuel purchase (el), WP	thous GEL	0	0	0	0
		Thermal power generation, WP	MW*h	*0*	*0*	*0*	0
		Fuel consumption for thermal power generation WP	thous n cub m	*0*	*0*	*0*	0
		Expenses for fuel purchase (thermal), WP	thous GEL	*0*	*0*	*0*	0
		Total fuel consumption, WP	thous n cub m	**0**	**0**	**0**	0
		Total expenses for fuel purchase, WP	thous GEL	**0**	**0**	**0**	0

Annual Parameters						
El power annual generation	MW*h	16218	18126	0	34344
Annual fuel consumption (el)	thous n cub m/year	5060 886	8325 974	0	13386 86
Expenses for fuel purchase (el)	thous GEL/year	379 5665	624 4481	0	1004 015
Thermal power annual generation	MW*h	*38880*	*0*	*0*	38880
Annual fuel consumption (thermal)	thous n cub m/year	*7012 67*	*0*	*0*	7012 67

Table d4, Option 2

Expenses for fuel purchase (thermal)	thous GEL/year	*525 9502*	*0*	*0*	525 9502

Total annual fuel consumption	thous n cub m/year	**12073 56**	**8325 974**	**0**	20399 53
Annual expenses for fuel purchase (total)	thous GEL/year	**905 5167**	**624 4481**	**0**	1529 965

Annual operation-repair expenses	**thous GEL/year**	591 8546	408 1454	0	**1000**
El share in operation-repair expenses (according to the fuel consumption)	thous GEL/year	248 0884	408 1454	FALSE	656 2338
Thermal share in operation-repair expenses (according to the fuel consumption)	thous GEL/year	*343 7662*	*0*	*FALSE*	343 7662

Total expenses (el)	thous GEL/year	627 6549	1032 593	0	1660 248
El power prime cost	**t/kW/h**	**3 870113**	**5 696753**	**FALSE**	**4 83417**
Accountable profit (el)	**%**	**10**	**10**	**10**	**10**
El. power accountable cost	t/kW/h	4 257124	6 266428	0	5 31759
VAT (el)	**%**	**20**	**20**	**20**	**20**
El. power estimated tariff	t/kW/h	5 108549	7 519714	0	6 381108
El power *established tariff*	***t/kW/h***	***6***	***6***	***0***	***6***
Income from el power realization (established tariff)	thous GEL/year	973 08	1087 56	0	2060 64
VAT (el) in the budget	thous GEL/year	162 18	181 26	0	343 44
El power cost	**t/kW/h**	**5**	**5**	**FALSE**	**5**
Profit (el)	**thous GEL/year**	**183 2451**	**-126 2935**	**0**	**56 9517**
	%	**29 19521**	**-12 23071**	**FALSE**	**3 430311**

Total expenses (thermal)	thous GEL/year	869 7165	0	0	869 7165
Thermal power prime cost	**t/kW/h**	**2 236925**	**FALSE**	**FALSE**	**2 23693**
Accountable profit (thermal)	**%**	**10**	**10**	**10**	**10**
Thermal power accountable cost	t/kW/h	2 460618	0	0	2 460618
VAT (thermal)	**%**	**20**	**20**	**20**	**20**
Thermal power estimated tariff	t/kW/h	2 952741	0	0	2 952741
Thermal power established tariff	***t/kW/h***	***2 952741***	***0***	***0***	***2 9527***
Income from thermal power realization (established tariff)	thous GEL/year	1148 026	0	0	1148 026
VAT (thermal) in the budget	thous GEL/year	191 3376	0	0	191 3376
Thermal power cost	**t/kW/h**	**2 460618**	**FALSE**	**FALSE**	**2 460618**
Profit (thermal)	**thous GEL/year**	**86 97165**	**0**	**0**	**86 9716**
	%	**10**	**FALSE**	**FALSE**	**10**

Total profit (+) or loss (-)	**thous GEL/year**	270 2168	-126 2935	0	**143 9**

Table d5 Option 3

CHPP TECHNICAL-ECONOMICAL PARAMETERS DURING THE DIFFERENT MODES OF TURBINES' OPERATION BEFORE RECONSTRUCTION-MODERNIZATION
OPTION 3

		POWER UNITS		**O-6-35**	**П-6-35/5**	**O-6-35**	
		Fuel	-	N gas	N gas	N gas	
		Fuel heat capacity	**MJ/n cub m**	**32 682**	**32 682**	**32 682**	
		Fuel price without VAT	**GEL/n cub m**	**0 075**	**0 075**	**0 075**	
		Operation mode in "cold" period (CP)	-	TK	K	K	
		Operation mode in "warm" period (WP)	-				
		Operation duration CP	**h**	**3600**	**3600**	**3600**	
		Operation duration WP	**h**				
		El capacity, gross, CP	**MW**	**5 3**	**5 3**	**5 3**	**15 9**
		El efficiency, gross, CP	**%**	**41 616**	**25 296**	**25 296**	
		El power for station service, CP	**%**	**15**	**5**	**5**	
		El efficiency, net, CP	%	35 3736	24 0312	24 0312	
		CF specific consumption for power generation, CP	gCF/kW/h	347 7169	511 8346	511 8346	
		NF specific consumption for power generation, CP	n cub m/kW/h	0 312054	0 459339	0 459339	
		El capacity, net, CP	MW	4 505	5 035	5 035	14 575
		El power generation, CP	MW*h	16218	18126	18126	52470
		El capacity, gross, WP	**MW**				0
		El. efficiency, gross, WP	**%**				
		El. power for station service, WP	**%**				
		El. efficiency, net, WP	%	0	0	0	
		CF specific consumption for power generation, WP	gCF/kW/h	FALSE	FALSE	FALSE	
		NF specific consumption for power generation, WP	n cub m/kW/h	0	0	0	
		El capacity, net, WP	MW	0	0	0	0
		El power generation, WP	MW*h	0	0	0	0
		Heat capacity, gross, CP	*MW*	***14.4***			14 4
		Heat efficiency, gross, CP	*%*	***81 6***			
		Heat power for station service + losses in heating main, CP	*%*	***25***			
		Heat efficiency, net, CP	*%*	*61 2*	*0*	*0*	
		CF specific consumption for power generation, CP	*gCF/kW/h*	*200 9804*	*FALSE*	*FALSE*	
		NF specific consumption for power generation, CP	*n cub m/kW/h*	*0 180367*	*0*	*0*	
		Heat capacity, net, CP	*MW*	*10 8*	*0*	*0*	10 8
		Heat power generation, CP	*MW*h*	*38880*	*0*	*0*	38880

Table d5 Option 3

		Heat capacity, gross, WP	*MW*				0
		Heat efficiency, gross, WP	*%*				
		Heat power for station service + losses in heating main, WP	*%*				
		Heat efficiency, net, WP	*%*	*0*	*0*	*0*	
		CF specific consumption for power generation, WP	*gCF/kW/h*	*FALSE*	*FALSE*	*FALSE*	
		NF specific consumption for power generation, WP	*n cub m/kW/h*	*0*	*0*	*0*	
		Heat capacity, net, WP	*MW*	*0*	*0*	*0*	0
		Heat power generation, WP	*MW*h*	*0*	*0*	*0*	0

		Seasonal Parameters					
		El power generation CP	MW*h	16218	18126	18126	52470
		Fuel consumption for el power generation, CP	thous n cub m	5060 886	8325 974	8325 974	21712 83
		Expenses for fuel purchase (el), CP	thous GEL	379 5665	624 4481	624 4481	1628 463
		Thermal power generation CP	MW*h	*38880*	*0*	*0*	38880
		Fuel consumption for thermal power generation, CP	thous n cub m	*7012 67*	*0*	*0*	7012 67
		Expenses for fuel purchase (thermal), CP	thous GEL	*525 9502*	*0*	*0*	525 9502
		Total fuel consumption, CP	thous n cub m	**12073 6**	**8325.97**	**8325 97**	28725 5
		Total expenses for fuel purchase, CP	thous GEL	**905 5167**	**624 4481**	**624 4481**	2154 413
		El power generation, WP	MW*h	0	0	0	0
		Fuel consumption for el power generation, WP	thous n cub m	0	0	0	0
		Expenses for fuel purchase (el), WP	thous GEL	0	0	0	0
		Thermal power generation, WP	MW*h	*0*	*0*	*0*	0
		Fuel consumption for thermal power generation, WP	thous n cub m	*0*	*0*	*0*	0
		Expenses for fuel purchase (thermal), WP	thous GEL	*0*	*0*	*0*	0
		Total fuel consumption, WP	thous n cub m	**0**	**0**	**0**	0
		Total expenses for fuel purchase, WP	thous GEL	**0**	**0**	**0**	0

Annual Parameters					
El power annual generation	MW*h	16218	18126	18126	52470
Annual fuel consumption (el)	thous n cub m/year	5060 886	8325 974	8325 974	21712 83
Expenses for fuel purchase (el)	thous GEL/year	379 5665	624 4481	624 4481	1628 463
Thermal power annual generation	MW*h	*38880*	*0*	*0*	38880

Table -d5 Option 3

Annual fuel consumption (thermal)	thous n cub m/year	*7012 67*	*0*	*0*	7012 67
Expenses for fuel purchase (thermal)	thous GEL/year	*525 9502*	*0*	*0*	525 9502

Total annual fuel consumption	thous n cub m/year	**12073 56**	**8325 974**	**8325 974**	28725 5
Annual expenses for fuel purchase (total)	thous GEL/year	**905 5167**	**624 4481**	**624 4481**	2154 413

Annual operation-repair expenses	**thous GEL/year**	420 3079	289 8461	289 8461	**1000**
El share in operation-repair expenses (according to the fuel consumption)	thous GEL/year	176 1809	289 8461	289 8461	755 8731
Thermal share in operation-repair expenses (according to the fuel consumption)	thous GEL/year	*244 1269*	*0*	*0*	244 1269

Total expenses (el)	thous GEL/year	555 7474	914 2941	914 2941	2384 336
El power prime cost	**t/kW/h**	**3 426732**	**5 044103**	**5 044103**	**4 54419**
Accountable profit (el.)	**%**	**10**	**10**	**10**	**10**
El. power accountable cost	t/kW/h	3 769405	5 548513	5 548513	4 998607
VAT (el)	**%**	**20**	**20**	**20**	**20**
El power estimated tariff	t/kW/h	4 523286	6 658216	6 658216	5 998329
El power *established tariff*	***t/kW/h***	***6***	***6***	***6***	***6***
Income from el power realization (established tariff)	thous GEL/year	973 08	1087 56	1087 56	3148.2
VAT (el) in the budget	thous GEL/year	162 18	181 26	181 26	524 7
El power cost	**t/kW/h**	**5**	**5**	**5**	**5**
Profit (el)	**thous GEL/year**	**255 1526**	**-7 994132**	**-7 994132**	**239 164**
	%	**45 91161**	**-0 87435**	**-0 87435**	**10 03065**

Total expenses (thermal)	thous GEL/year	770 0772	0	0	770 0772
Thermal power prime cost	**t/kW/h**	**1 980651**	**FALSE**	**FALSE**	**1 98065**
Accountable profit (thermal)	**%**	**10**	**10**	**10**	**10**
Thermal power accountable cost	t/kW/h	2 178716	0	0	2 178716
VAT (thermal)	**%**	**20**	**20**	**20**	**20**
Thermal power estimated tariff	t/kW/h	2.61446	0	0	2 61446
Thermal power established tariff	***t/kW/h***	***2 61446***	***0***	***0***	***2 6145***
Income from thermal power realization (established tariff)	thous GEL/year	1016 502	0	0	1016 502
VAT (thermal) in the budget	thous GEL/year	169 417	0	0	169 417
Thermal power cost	**t/kW/h**	**2 178716**	**FALSE**	**FALSE**	**2 178716**
Profit (thermal)	**thous GEL/year**	**77 00772**	**0**	**0**	**77 0077**
	%	**10**	**FALSE**	**FALSE**	**10**

Total profit (+) or loss (-)	**thous GEL/year**	332 1603	-7 994132	-7 994132	**316 2**

Table -d6 Option 4

CHPP TECHNICAL-ECONOMICAL PARAMETERS DURING THE DIFFERENT MODES OF TURBINES' OPERATION BEFORE RECONSTRUCTION-MODERNIZATION
OPTION 4

		POWER UNITS		O-6-35	?-6-35/5	Ò-6-35	
		Fuel	-	N gas	N gas	N gas	
		Fuel heat capacity	MJ/n cub m	32 682	32 682	32 682	
		Fuel price without VAT	GEL/n cub m	0 075	0 075	0 075	
		Operation mode in "cold" period (CP)	-	TK	K	K	
		Operation mode in "warm" period (WP)	-	K	K	K	
		Operation duration CP	h	3600	3600	3600	
		Operation duration WP	h	4080	4080	4080	
		El capacity, gross, CP	MW	5 3	5 3	5 3	15 9
		El. efficiency, gross, CP	%	41 616	25 296	25.296	
		El power for station service, CP	%	15	5	5	
		El efficiency, net, CP	%	35 3736	24 0312	24 0312	
		CF specific consumption for power generation, CP	gCF/kW/h	347 7169	511 8346	511 8346	
		NF specific consumption for power generation, CP	n cub m/kW/h	0 312054	0 459339	0 459339	
		El capacity, net, CP	MW	4 505	5 035	5 035	14 575
		El power generation, CP	MW*h	16218	18126	18126	52470
		El capacity, gross, WP	MW	5 3	5 3	5 3	15 9
		El. efficiency, gross, WP	%	25 296	25 296	25 296	
		El. power for station service, WP	%	5	5	5	
		El. efficiency, net, WP	%	24 0312	24 0312	24 0312	
		CF specific consumption for power generation, WP	gCF/kW/h	511 8346	511 8346	511 8346	
		NF specific consumption for power generation, WP	n cub m/kW/h	0 459339	0 459339	0 459339	
		El. capacity, net, WP	MW	5 035	5 035	5 035	15 105
		El. power generation, WP	MW*h	20542 8	20542 8	20542 8	61628 4
		Heat capacity, gross, CP	*MW*	***14 4***			14 4
		Heat efficiency, gross, CP	%	***81 6***			
		Heat power for station service + losses in heating main, CP	%	***25***			
		Heat efficiency, net, CP	%	*61 2*	*0*	*0*	
		CF specific consumption for power generation, CP	*gCF/kW/h*	*200 9804*	*FALSE*	*FALSE*	
		NF specific consumption for power generation, CP	*n cub m/kW/h*	*0 180367*	*0*	*0*	
		Heat capacity, net, CP	*MW*	*10 8*	*0*	*0*	10 8
		Heat power generation, CP	*MW*h*	*38880*	*0*	*0*	38880

Table -d6 Option 4

		Heat capacity, gross, WP	*MW*				0
		Heat efficiency, gross, WP	*%*				
		Heat power for station service + losses in heating main, WP	*%*				
		Heat efficiency, net, WP	*%*	*0*	*0*	*0*	
		CF specific consumption for power generation, WP	*gCF/kW/h*	*FALSE*	*FALSE*	*FALSE*	
		NF specific consumption for power generation, WP	*n cub m/kW/h*	*0*	*0*	*0*	
		Heat capacity, net, WP	*MW*	*0*	*0*	*0*	0
		Heat power generation, WP	*MW*h*	*0*	*0*	*0*	0

		Seasonal Parameters					
		El power generation, CP	MW*h	16218	18126	18126	52470
		Fuel consumption for el power generation, CP	thous n cub m	5060 886	8325 974	8325 974	21712 83
		Expenses for fuel purchase (el), CP	thous GEL	379 5665	624 4481	624 4481	1628 463
		Thermal power generation CP	MW*h	*38880*	*0*	*0*	38880
		Fuel consumption for thermal power generation, CP	thous n cub m	*7012 67*	*0*	*0*	7012 67
		Expenses for fuel purchase (thermal), CP	thous GEL	*525 9502*	*0*	*0*	525 9502
		Total fuel consumption, CP	thous n cub m	**12073 6**	**8325.97**	**8325 97**	28725 5
		Total expenses for fuel purchase, CP	thous GEL	**905 5167**	**624 4481**	**624 4481**	2154 413
		El power generation, WP	MW*h	20542 8	20542 8	20542 8	61628 4
		Fuel consumption for el power generation, WP	thous n cub m	9436 104	9436 104	9436 104	28308 31
		Expenses for fuel purchase (el), WP	thous GEL	707 7078	707 7078	707 7078	2123 123
		Thermal power generation, WP	MW*h	*0*	*0*	*0*	0
		Fuel consumption for thermal power generation, WP	thous n cub m	*0*	*0*	*0*	0
		Expenses for fuel purchase (thermal), WP	thous GEL	*0*	*0*	*0*	0
		Total fuel consumption, WP	thous n cub m	**9436 1**	**9436 1**	**9436 1**	28308 31
		Total expenses for fuel purchase, WP	thous GEL	**707 7078**	**707 7078**	**707 7078**	2123 123

Annual Parameters					
El power annual generation	MW*h	36760 8	38668 8	38668 8	114098 4
Annual fuel consumption (el)	thous n cub m/year	14496 99	17762 08	17762 08	50021 15
Expenses for fuel purchase (el)	thous GEL/year	1087 274	1332 156	1332 156	3751 586
Thermal power annual generation	MW*h	*38880*	*0*	*0*	38880

Table d6 Option 4

Annual fuel consumption (thermal)	thous n cub m/year	*7012 67*	*0*	*0*	7012 67
Expenses for fuel purchase (thermal)	thous GEL/year	*525 9502*	*0*	*0*	525 9502
Total annual fuel consumption	thous n cub m/year	**21509 66**	**17762 08**	**17762 08**	57033 82
Annual expenses for fuel purchase (total)	thous GEL/year	**1613 225**	**1332 156**	**1332 156**	4277 536
Annual operation-repair expenses	**thous GEL/year**	377 1387	311 4306	311 4306	**1000**
El share in operation-repair expenses (according to the fuel consumption)	thous GEL/year	254 1824	311 4306	311 4306	877 0437
Thermal share in operation-repair expenses (according to the fuel consumption)	thous GEL/year	*122 9563*	*0*	*0*	122 9563
Total expenses (el)	thous GEL/year	1341 457	1643 587	1643 587	4628 63
El power prime cost	**t/kW/h**	**3 64915**	**4 25042**	**4 25042**	**4 0567**
Accountable profit (el.)	**%**	**10**	**10**	**10**	**10**
El power accountable cost	t/kW/h	4 014065	4 675462	4 675462	4 46237
VAT (el)	**%**	**20**	**20**	**20**	**20**
El power estimated tariff	t/kW/h	4 816878	5 610555	5 610555	5 354844
El power *established tariff*	***t/kW/h***	***6***	***6***	***6***	***6***
Income from el power realization (established tariff)	thous GEL/year	2205 648	2320 128	2320 128	6845 904
VAT (el) in the budget	thous GEL/year	367 608	386 688	386 688	1140 984
El power cost	**t/kW/h**	**5**	**5**	**5**	**5**
Profit (el)	**thous GEL/year**	**496 5833**	**289 8535**	**289 8535**	**1076 29**
	%	**37 01822**	**17 63542**	**17 63542**	**23 25289**
Total expenses (thermal)	thous GEL/year	648 9066	0	0	648 9066
Thermal power prime cost	**t/kW/h**	**1 668998**	**FALSE**	**FALSE**	**1 669**
Accountable profit (thermal)	**%**	**10**	**10**	**10**	**10**
Thermal power accountable cost	t/kW/h	1 835898	0	0	1 835898
VAT (thermal)	**%**	**20**	**20**	**20**	**20**
Thermal power estimated tariff	t/kW/h	2 203078	0	0	2 203078
Thermal power established tariff	***t/kW/h***	***2 203078***	***0***	***0***	***2 2031***
Income from thermal power realization (established tariff)	thous GEL/year	856 5567	0	0	856 5567
VAT (thermal) in the budget	thous GEL/year	142 7594	0	0	142 7594
Thermal power cost	**t/kW/h**	**1 835898**	**FALSE**	**FALSE**	**1 835898**
Profit (thermal)	**thous GEL/year**	**64 89066**	**0**	**0**	**64 8907**
	%	**10**	**FALSE**	**FALSE**	**10**
Total profit (+) or loss (-)	**thous GEL/year**	561 474	289 8535	289 8535	**1141**

Appendix A

USAID Delivery Order No 11 Statement of Work

BURNS AND ROE DELIVERY ORDER NO
FY1995

GEORGIA TECHNOLOGY SERVICES SUPPORT

ATTACHMENT NO 1
STATEMENT OF WORK

GEORGIA

SECTION I BACKGROUND

Twelve newly independent states (NIS) emerged from the collapse of the former Soviet Union in 1991 USAID is addressing and managing assistance to these countries through its Bureau for Europe and the New Independent States (USAID/ENI) Funding activities in the energy and energy-related environmental sectors generally support the cost of technical assistance, training, feasibility studies, and limited capital assistance in support of energy-related equipment and collaborative activities with local institutions

USAID/Caucasus is expanding its energy program in Georgia, with the objectives of assisting Georgia's institutional and regulatory reforms needed to attract the private sector, implementing existing conservation and energy efficiency programs in the industrial and residential sectors, and aiding its efforts in developing indigenous energy resources such as geothermal

USAID has recently established a strategy for U S assistance to Georgia for FY 1994-1996 to embark on a path of strong and sustainable economic growth in a market environment, while moving to restore and surpass 1991 GNP and per-capita income levels by the end of the decade

The strategic objectives for 1994-1996 to accomplish this goal are

1) To provide emergency assistance to Georgia's most vulnerable groups and simultaneously develop selected components of a social safety net that will endure beyond the immediate crisis

2) To establish a climate and enabling institutions for efficient, competitive private-sector markets while stabilizing the economy

3) To provide adequate energy for sustainable economic growth and improved quality of life by expanding domestic energy supplies and improving the efficiency of energy consumption

Initial assistance in Georgia has proven there are considerable opportunities to reduce energy consumption and environmental degradation There is also a need to reduce emergency short-term fuel shortage concerns and to increase coordination among the governmental energy sectors

USAID is providing support to Georgia through its Mission in Yerevan (capital of Armenia) and through existing and planned field resident contractors involved in energy efficiency, geothermal assessment, and regulatory and institutional studies Analytical studies are underway in support of funding decisions by the World Bank and the European Bank for Reconstruction and Development (EBRD) USAID is also funding the US Energy Association (USEA)-sponsored utility-to-utility partnerships between U S and Georgian organizations

SECTION II OBJECTIVES AND APPROACH

The objective of this delivery order is to address the critical emergency needs of the energy sector by expanding domestic energy supplies and by

improving the efficiency of energy consumption This objective is to be achieved in terms of demonstrating visible and quantifiable results which can be seen by the average person on the street as urgently needed The scope of work to achieve this objective comprises a number of specific tasks, each having its own objective which are defined below

The work shall be accomplished in two parts In Part I the objective shall be to develop a detailed Work Plan The method shall involve a reconnaissance visit by the Contractor s team to the field to identify the counterpart personnel, obtain needed data investigate specific sites relevant to the work, and undertake other efforts perceived as needed in order to develop further details for the tasks identified below The Contractor will organize the tasks so further defined into a plan of work promising efficient and cost-effective completion, summarize the results, and provide a detailed work statement for each task The plan shall include the identification and qualifications of the personnel selected to perform the work

The Contractor shall perform the work in Part I in collaboration with the USAID Mission in Yerevan Upon completion, the Contractor shall submit the Work Plan to the Mission in Yerevan for review, comment, and approval The Contractor shall attach its estimated budget for completion of the planned work to the Work Plan Upon approval, the Contractor shall perform the approved work as Part II

SECTION III SCOPE OF WORK

Task 1 TBILISI DISTRICT HEATING SYSTEM IMPROVEMENT PROGRAM

1 Summary Description of Work
Perform the appropriate analyses in order to provide technical assistance and limited commodities to (i) develop an short-, medium-, and long-term rehabilitation plan for the Tbilisi district heating system, and (ii) bring more of the Tbilisi DH online by the winter of 1995/96 to service residential customers

2 Relationship to Bureau Strategic Framework
This program lies within Strategic Assistance Area 1 of the Strategic Framework developed by USAID's Bureau for Europe & the New Independent States

> Strategic Assistance Area 1 -- Economic Restructuring Foster the emergence of a competitive, market-oriented economy in which the majority of economic resources are privately owned and managed

Within Strategic Assistance Area 1, the Tbilisi District Heating System Improvement Program activities contribute to the realization of the following Program Objective within the Strategic Framework

> Program Objective 1 6 -- Promote sustainable use of natural resources

For Program Objective 1 6, the relevant indicator for assessing the impact of the Tbilisi District Heating System Improvement Program activities is

> Impact Indicator -- Commercially viable private sector capability developed to provide energy services, including production and distribution

Specific targets that will measure the contribution of the activities towards the attainment of the Program Objective are still under development

3 Background
One of the Government of Georgia's main priorities for the immediate future is the provision of heat to all economically viable consumers as well as to the

most vulnerable consumers, such as hospitals, orphanages, and schools USAID has already funded and work is underway in evaluating and proposing a rehabilitating plan the district heating systems for 23 key hospitals in Tbilisi The resulting proposed rehabilitation work will be funded by a World Bank loan The objective of this task is to provide a rehabilitation plan for the city of Tbilisi and conduct a pilot rehabilitation metering, billing, and collection project

In 1961 the Central Heat and Power Generation Department united all district and regional heat stations in Tbilisi and began the construction of new boiler houses and networks At the present time the Tbilisi Central Heat and Power Generation system is made up of 47 regional and district boiler houses, which represents a capacity of 3,600 Gcal/h and more than one thousand km of piping Although schools are not connected, almost 90% of the town is connected to the district heating system

Due to lack of maintenance, district heating systems in Tbilisi are in poor condition and require considerable investment to be put back in working order Energy is wasted at all stages of distribution - from production to consumption For example, of 326 boilers in Tbilisi, 122 are out of order and should be replaced, out of 1044 km of piping, 300 km are out of order and an additional 170 km are in poor condition, there are no water meters or control valves According to a preliminary analysis by EU consultants, no more than half of the district heating systems in Tbilisi should be rehabilitated Furthermore, the consultants recommend individual heating as the most appropriate short-term solution to the district heating problem, although they project rehabilitation of the district heating systems will be the most profitable solution in the long run

4 Objectives

The objective of this task is to evaluate the condition of the Tbilisi district heating systems and, working with local authorities, to provide immediate, medium and long-term proposals for providing heat, rehabilitating the system, and, where necessary, for switching from district heating to other forms of heating

5 Scope of Work

Specifically, the Contractor will be responsible for the following tasks

1 *Prepare Work Plan* As a first step, the Contractor shall prepare a work plan showing the method whereby, and the schedule in which, the tasks will be accomplished, the personnel qualifications for those who will perform the work, local personnel to be employed or seconded from local organizations, and the schedule by which the work will be performed The work plan shall address all the tasks specified below However, the Contractor, if he deems it necessary, shall undertake a field reconnaissance as a minimal effort in order to prepare the work plan As a result, he may, with justification, modify the tasks below, delete tasks, or add new tasks

The Contractor shall prepare a written report detailing the plan and submit this for approval by the the Government of Georgia and USAID

2 *Prepare a USAID Environmental Assessment* Since this task will involve the purchase and installation of a considerable volume of commodities that could potentially result in a significant impact on the environment, a brief environmental assessment as per USAID Environmental Procedures (22 CFR 216) will be prepared to identify potential impacts and actions that can be taken to mitigate any negative environmental consequences This environmental assessment will be submitted to USAID for approval, and those mitigation actions that can be taken by the contractor will be incorporated into the detailed workplan before proceeding

3 *Assess the DH System* Assess the current status of district heating system in Tbilisi through consultation with the Government of Georgia the Municipality of Tbilisi s Heat Committee, international financial institutions, and various Western consultants The Contractor should also refer to any existing studies on the subject done by Georgian or outside consultants Two such reports are "Development of an Energy Policy in Georgia," TA-CIS/92/EGE001, "Interim Report, Sectoral Working Paper No 6, Rehabilitation of Urban District Heating Systems," prepared by Robert Bonnemaison Sofresid-Caliqua, October 1994 and "Development of an Energy Policy in Georgia (TA-CIS/92/EGE001) Final Main Report (Draft)," January 31, 1995 This assessment should include the collection of operating data and the determination of system heat balances

4 *Proposed Rehabilitation Plan* Develop a strategy for district heating rehabilitation and development for Tbilisi for the immediate-, short- and long-term This strategy should address but not be limited to the following

a As most boilers are designed to operate on natural gas which is frequently lacking, the Contractor should evaluate the possibility of converting some or all boilers to other types of fuels (including mazut, coal, and geothermal)

b Identify alternatives for optimizing the district heating system For those systems that must be shut down (in either the long or short term), provide suggestions as to alternative forms of heating This recommendation should be based on a thorough technical and economic comparison in each district with other means of heating The cost of equipment, efficiencies, fuel and maintenance costs should be taken into account

c Evaluate the potential future need for the construction of new capacity

d Include a proposal to run part of the heating units for winter 95/96

e Develop budgetary capital, operating and maintenance cost estimates for the proposed rehabilitation plan A listing of equipment in need of maintenance, repair or replacement should be included

f Identify potential financing sources for system upgrade projects

g The plan should also include the pilot installation and replication of collection, metering, billing, and control systems to support the future commercialization of the DH company

5 *Provide Limited Spare Parts and Materials* Procure critically needed (materials for the pilot project described below should have priority) commodities and spare parts to renovate and operate the boilers and distribution pipelines as follows

a Based on the proposed rehabilitation plan, provide suggested purchase order, including product costs (in US dollars), shipment and delivery, to USAID for approval

b Upon approval by local authorities and USAID, procure the spare parts using USAID funds covered by the purchase order

c As the procurement process proceeds, work together with designated Georgian authorities in order to provide them with training in procurement methods for future use

d Monitor shipment and delivery to end users

Task 2 NATURAL GAS TRANSMISSION SYSTEM UPGRADE

1 Summary Description of Work
Perform the appropriate technical analyses in order to provide technical assistance and limited commodities to (i) assess the condition of the natural gas transmission system providing gas to both Georgia and Armenia, (ii) improve the operational efficiency and safety of the transmission system by reducing losses, improving throughput, and enhancing data acquisition and control systems

2 Relationship to Bureau Strategic Framework
This program lies within Strategic Assistance Area 1 of the Strategic Framework developed by USAID's Bureau for Europe & the New Independent States

Strategic Assistance Area 1 -- Economic Restructuring Foster the emergence of a competitive, market-oriented economy in which the majority of economic resources are privately owned and managed

Within Strategic Assistance Area 1, the Natural Gas Transmission System Upgrade activities contribute to the realization of the following Program Objective within the Strategic Framework

Program Objective 1 6 -- Promote sustainable use of natural resources

For Program Objective 1 6, the relevant indicator for assessing the impact of the Natural Gas Transmission System Upgrade activities is

Impact Indicator -- Commercially viable private sector capability developed to provide energy services, including production and distribution

Specific targets that will measure the contribution of the activities towards the attainment of the Program Objective are still under development

3 Background
With few gas resources of its own, Georgia is dependent on imports from Turkmenistan through pipelines entering via Azerbaijan and Russia The same system providing gas to Georgia also provides gas to Armenia With the breakdown of the Soviet economic system and ethnic strif within Georgia, compounded by the Armenian-Azerbaijan conflict, the gas transmission company has lacked the financial resources to pay for imported gas and to provide proper maintenance for the frequently-sabotaged gas transmission system With the cooling down of conflicts in the region, the opportunity now exists to enhance the operation of the transmission system to increase the delivery of natural gas to customers in both Georgia and Armenia

4 Objectives
The objective of this task are to assist the Georgians to upgrade the existing natural gas transmission system infrastructure to provide natural gas more effectively to industrial commercial, and residential users in both Georgia and Armenia The benefit will be to improve the delivery of energy services to end users

5 Scope of Work
The contractor will be responsible for the following tasks

(1) Preparing a detailed workplan through consultations with USAID/ENI/EEUD/EI, USAID/Caucasus the appropriate Georian departments & ministries Sakgaz, and Saktransgaz EU TACIS, the EBRD, and the World

Bank The workplan will be submitted to USAID for approval

(2) Since this task will involve the purchase and installation of a considerable volume of commodities that could potentially result in a significant impact on the environment, a brief environmental assessment as per USAID Environmental Procedures (22 CFR 216) will be prepared to identify potential impacts and actions that can be taken to mitigate any negative environmental consequences This environmental assessment will be submitted to USAID for approval, and those mitigation actions that can be taken by the contractor will be incorporated into the detailed workplan before proceeding

(3) Review all previous reports on the gas system in Georgia, meet with Saktransgaz and with other consultants as appropriate to discuss the current situation, and visit selected facilities within Georgia to investigate current conditions In concert with Saktransgaz, develop a set of ranked cost-effective technical measures, including a list of limited critical commodities, to increase the volume of gas transmitted to customers in Georgia and to Armenia and submit these proposals to USAID

(4) Once approval has been received from USAID, procure the equipment and train Saktransgaz personnel in O&M as necessary to improve the transmission of natural gas within Georgia Procurement includes coordinating the purchase, shipping, and installation of the equipment

(5) Review and provide technical input to Saktransgaz's current system operations especially in the areas of control, data acquisition, loss assessment, and safety standards Develop a short- to medium-term cost-effective plan for improving the technical operation of the transmission system, including a list of limited critical commodities to be submitted to USAID Upon USAID approval, procure the equipment and train Saktransgaz personnel in O&M as necessary

(6) In cooperation with Saktransgaz, develop a long-term cost-effective plan for improving the technical operation of the transmission system Assist Saktransgaz with developing pre-loan analyses for consideration by the World Bank and other international financial institutions

(7) Training Select participants and provide a two-week workshop for twenty to twenty five managers and technical personnel from Armgaz on "Gas Transmission System Operations in the US and Europe" The course should emphasize features of practical value to the Armenians The Contractor should select participants that have an interest in what is being taught and are offered the opportunity to apply what they learn to advance their careers within the organization The courses should also involve representatives of local institutions, such as business schools or Universities, such that these representatives are trained to teach these subjects to others The proposed candidates for training will be subject to USAID approval

Task 3 SUGDIDI GEOTHERMAL ASSESSMENT

1 Summary Description of Work

Perform the appropriate technical analyses in order to prepare (i) a preliminary analysis and (ii) a pre-loan project assessment of the prospects for establishing a viable, geothermally-fed district heating system in the town of Sugdidi in the Republic of Georgia The results of this work will be provided to the EBRD who will then decide on financing the project

2 Relationship to Bureau Strategic Framework

This program lies within Strategic Assistance Area 1 of the Strategic Framework developed by USAID's Bureau for Europe & the New Independent States

Strategic Assistance Area 1 -- Economic Restructuring Foster the emergence of a competitive market-oriented economy in which the majority of economic resources are privately owned and managed

Within Strategic Assistance Area 1, the Sugdidi Geothermal Assessment activities contribute to the realization of the following Program Objective within the Strategic Framework

Program Objective 1 6 -- Promote sustainable use of natural resources

For Program Objective 1 6, the relevant indicator for assessing the impact of the Sugdidi Geothermal Assessment activities is

Impact Indicator -- Commercially viable private sector capability developed to provide energy services, including production and distribution

Specific targets that will measure the contribution of the activities towards the attainment of the Program Objective are still under development

3 Background

The European Bank for Reconstruction and Development (EBRD) has funded a study of the "Geothermal Resources of the Republic of Georgia" by the Icelandic firm of Virkir-Orkint Consulting Group Ltd of Reykjavik Its report is available and is dated July 1994 The information below is extracted, or otherwise derived, from the information in this report The Virkir-Orkint report is incorporated in this Statement of Work by reference

Sources for geothermal energy are widely distributed throughout the Republic of Georgia These sources have been estimated to have a cumulative potential to provide as much as 100,000 cubic meters (26 million U S gallons) of hot water per day at temperatures ranging from 60°C (140°F) to 108°C (226°F) If the reference temperature for the return of the geothermal water is 35°C (95°F), then the total potentially useful thermal energy from these sources would range from 25,000 to 72,700 Gigacalories per day (99 billion to 289 billion Btu/day) This quantity of thermal energy is equivalent to the combustion at 80% efficiency of 3,100 to 9,100 tons of residual fuel oil (mazut) per day

One particular source is the geothermal area adjacent to the town of Sugdidi, near the seacoast At least eight productive wells are reported, with a total present flow rate of 26,800 m^3 per day, or 310 liters per second (79 5 U S gallons per second) There is conflicting information on flow rates, since another report places this at 14,030 m^3 per day, or 165 liters per second If downhole pumping is employed, which can double or triple the flow, and using the higher flow rate figure, the geothermal energy in this area seems sufficient to support the space heating and hot water needs of a population of 100,000 to 150,000 persons in this area, and possibly also, the thermal energy needs of such industries as chicken farms, vegetable growing, and tea drying

Geothermal reservoir sustainability through reinjection of water could affect the pressure in the reservoir, the temperature in the reservoir, and possibly cause a breakthrough of the cooler water to the production wells Pressure changes can be predicted with reasonable confidence, but reinjection tests lasting some months or years may be necessary in order to test the effect of temperature distribution within the reservoir and the chemistry of the water in terms of potential for the deposition of solids within equipment

The town of Sugdidi is reported to have had a geothermally sourced district heating system in the past but the entire surface piping system has been destroyed and would have to be rebuilt

The Government of the Republic of Georgia has requested that the EBRD assist

in preparing a district heating project for Sugdidi to utilize geothermal energy USAID has agreed to fund a pre-loan project assessment and provide the services of a competent firm to undertake the tasks involved This Statement of Work specifies the initial objective for this assistance and the tasks to be undertaken and completed in order to achieve this objective

4 Objectives

The goal of the work is to complete a pre-loan project assessment of the prospects for establishing a viable, geothermally fed district heating system for the town of Sugdidi in the Republic of Georgia in terms of determining whether or not there is justification for undertaking further, in-depth analysis aimed at financing a project

Accordingly, the initial objectives for the work are

- to undertake a preliminary analysis of the factors and elements which would enter into a more detailed pre-loan assessment meeting international standards of credibility, and which could be viewed by a lending agency as "bankable",

- to specify the tasks to be undertaken to establish such an assessment, and

- to analyze the risks associated with such tasks that the results may not be attractive for financing

5 Scope of Work

The scope of the work shall be limited to exploring and evaluating the elements of a pre-loan assessment to the extent that the more definitive tasks can be identified and specified, and the risks against a successful outcome analyzed The scope of the work shall also encompass the extent to which the geothermal resources at Sugdidi could provide space heating and hot water for the town, and the heating of fish ponds and greenhouses Finally, the scope of work shall consider the institutional aspects of ownership, management, and potential financial attractiveness of the geothermal district heating system

No field testing of the geothermal source is anticipated for the work However, the Contractor may provide equipment not available locally for taking measurements, such as flow rates, temperatures, and water analyses which he believes are needed for the purposes of the work

The work will be done in two phases a preliminary assessment followed by a more detailed pre-loan analysis The work in both phases is similar The difference is that in Phase I, the depth of detail should be the minimum and only enough so that the results can justify undertaking the second phase In Phase II, the level of detail should be adequate to meet the requirements of a lending agency (in this case the EBRD) for the results to be bankable, i e , the lending agency accepts the results and undertakes its loan appraisal process Phase II will only be undertaken if the results of Phase I dictate that such a project is economically viable for an international loan In case Phase II is not undertaken, the Contractor will prepare a revised, scaled-down budget for discussion with and approval by USAID

Phase I Preliminary Analysis of the Potential for Geothermally Sourced District Heating in Sugdidi, Georgia

The Contractor will be responsible for the following tasks

1 *Prepare Work Plan* As a first step, the Contractor shall prepare a work plan showing the method whereby, and the schedule in which, the tasks will be accomplished, the personnel qualifications for those who will perform the work, local personnel to be employed or seconded from local organizations, and the schedule by which the work will be performed The work plan shall address all the activities specified below

However the Contractor, if he deems it necessary, shall undertake a field reconnaissance in order to prepare the work plan He shall also meet with officials of the EBRD for the purpose of consulting with them and discussing results from the pre-loan assessment which the Bank requires in order for the analysis to be internationally credible and "bankable" As a result, he may, with justification, modify the tasks below, delete tasks, or add new tasks

The Contractor shall prepare a written report detailing the plan and submit this for approval by the EBRD, the Government of Georgia, and USAID

2 *Review of Existing Documentation* The Contractor shall review all available documentation, especially the Virkir-Orkint report mentioned in the BACKGROUND above, giving particular emphasis to the nature of the scientific flow measurements, production and maintenance history, past system design, and water chemistry The objective of this review shall be for the Contractor to assure himself that the geothermal potential exists and appears adequate to proceed with the remaining activities In the review, the Contractor shall pay particular attention to distinguishing informed opinion from actual scientific data

3 *Geothermal Resource* The Contractor shall quantify the resource in terms of total flow temperature levels and temperature variations, and chemical analyses of the water This quantification shall be made in terms of artesian flow and on judgment based on experience as to the probable increase in flow from downhole pumping

4 *District Heating System Design* From maps, surveys, and other field investigations, the Contractor shall layout the piping runs for the district heating system, including preliminary line sizing and pumping station design The extent of the system shall be large enough to be compatible with the expected production of thermal energy in the area, such as will be estimated in item 4 below He shall consider two options, one in which the distribution piping is above ground and the other in which the piping is buried In either option, the heat losses from the distribution system and the temperatures of the return water shall be estimated Provision shall be made for optional reinjection of the returned water to the geothermal reservoir

5 *Geothermal Water Production* The Contractor shall establish the requirements for installations and equipment to rehabilitate the eight existing geothermal wells as specified in the Virkir-Orkint report on page 23, in sufficient detail to enable estimation of the geothermal water production rates The requirements shall include, if necessary, new wells for optional reinjection of returned water The Contractor shall prepare preliminary estimates of the capital requirement

6 *Demand Forecast* The Contractor shall review the residential and commercial installations in terms of forecasting the demand for geothermal energy He shall also review the local climatic conditions to provide for prospective seasonal variations in demand Finally he shall determine whether or not the system is to provide the non-return, hot-water requirements of the consumers

The Virkir-Orkint report mentions that the practice in Georgia has been to pipe the radiators in the houses in series i e , as a single loop The prospects are that there is no past history in the area for metering the energy consumption This means there is no easy temperature control within the rooms, except by opening and closing windows with the resulting heat losses The prospects are also that the houses are provided with inadequate insulation and weatherproofing The Contractor shall investigate the balance in investment requirements and corresponding energy consumption savings aimed at optimizing the entire

system in terms of investment requirements, capacity and profitability

7 *Revenue Stream* Countries of the former Soviet Union have a history of highly subsidized pricing policies not necessarily related to actual consumption and lax collection of bills The Contractor shall establish a basis upon which estimates can be made of the prospective revenue streams to the district heating system This basis shall address the ability of the population to pay tariffs which will be needed for sustainable operation of the system The basis shall also consider the means whereby the residential heating system piping could be redone with costs to be absorbed in the tariff structure

The Contractor shall also determine the tariff basis for industrial consumers

8 *Operating Costs* The Contractor shall estimate from the results of the activities above and the required staffing of the production and distribution installations, the expected operating costs of the system including the administrative costs of billing and collections

9 *Ownership* The prospects are that ownership will ultimately reside entirely in a private sector company Initially, through the present organizations, Sakburgeothermia and Geotherm Ltd, some or all of the shares may be owned by the Government of the Georgia Republic The Contractor shall specify the ownership structure and the management needs of the facilities He shall include a description of the company as a potential borrower of a loan from the Bank, including the company's commercial and institutional setup and its relation to the Government and other local authorities

10 *Preliminary Financial Analysis* Based on all information which shall have been established from the completion of the tasks above, the Contractor shall perform computerized discounted cash flow analyses, estimates of internal rates of return on equity investment, and net present values The calculation shall be in spreadsheet form with provision made for sensitivity analyses for the major inputs where significant assumptions have been made

Financial data shall be allocated to local costs and to foreign exchange costs Physical contingencies and financial contingencies, based on international and local inflation rates, shall be added as well as interest during construction

11 *Preliminary Risk Analysis* The Contractor shall perform preliminary risk analyses for the factors in the financial analysis where he has made significant assumptions Significant factors are likely to be such factors as the accuracy of the investment capital estimates, the accuracy of the expected revenue streams, and the ratio between equity and loan capital The risk analysis will show the effect on internal rates of return for variations in these factors

Another risk factor which is primarily technical is the effect of reinjection of return water on the geothermal reservoir characteristics Part or all of the water could be returned, for example, to fish ponds Such an option could impact on the sustainability of the geothermal reservoir for the rate of withdrawal of geothermal water Understanding the prospective behavior of the reservoir could involve a significant test program

The Virkir-Orkint Report discusses such a test program on page 24 as follows

" Pumping the reservoirs with downhole pumps is [a] relatively well-known production method, where the effect of

pumping can be predicted with relatively high confidence The experience from using reinjection in the production of geothermal fluid is much more limited than from pumping Furthermore, the reinjection process is much more complex than pumping The components affected by reinjection are pressure in the reservoir temperature in the reservoir and possibly breakthrough of cold water to production wells, and finally the chemistry of the reservoir fluid and possible depositions within the reservoir In most cases, it is only the pressure changes caused by reinjection which can be predicted with reasonable confidence prior to operation Therefore, reinjection test lasting for some months or years are usually performed before starting reinjection at full scale in order to test the effect on the temperature distribution and the chemistry within the reservoir "
"The reinjection tests so far carried out in Georgia have only lasted for hours or at the most for days The long term reinjection tests should be monitored carefully in order to map the temperature and chemistry effects caused by the reinjection "

On the positive side, it appears that the chemical composition of the geothermal waters in Georgia is in general favorable for utilization Relatively low concentration of dissolved solids means that the geothermal water is usually pure enough for drinking and heat exchangers are not necessary for utilization This is an aspect which the Contractor shall confirm in the case of Sugdidi

12 *Presentation of Findings* The contractor shall organize his findings as a written handout for a tri-partite meeting in Tbilisi among the local authorities, the prospective Company to own the facilities, the EBRD, and USAID He shall organize the presentations of the project during this meeting for a full comprehension by the parties of his results The presentations shall highlight the following

- A complete description of the facilities (including maps as appropriate) which would be constructed, including retrofitting installations in the user's premises, rehabilitation and new installations for extracting the geothermal resource, and the design of the distribution system,

- A complete description of the prospective operations of the system, tariff structures, billings and collections, seasonal variations in the operations, maintenance practices, staffing and training needs, etc ,

- The environmental issues involved in the construction and operation of the facilities, and how they should be resolved,

- A complete discussion of the prospective financial attractiveness of the project, including a listing of the significant assumptions made in the work,

- A discussion of the assumptions and the risks implied in assuming their validity,

- A description of the work efforts needed to resolve the validity of the assumptions as a basis for considering further efforts toward establishing economic viability, and

- The work elements which will still be needed in order to establish technical, economic, and commercial viability for the project to standards acceptable to the Bank

The Contractor shall engage in the discussions following the presentation to receive comments and agree on corrections or revisions to be made to his results The objective of the discussions will be to

establish whether justification exists to undertake a formal pre-loan assessment aimed at financing the project

13 *Report* Upon the conclusion of the meeting, the Contractor shall prepare a final report, in English and in Russian, incorporating the results of the work, the revisions, and a statement of work that should be undertaken should there be a decision to proceed further toward a "bankable" pre-loan assessment If the results of Phase I are positive toward the continuation of pre-loan analysis, the Contractor shall present a Work Plan to USAID for Phase II

Phase II Pre-Loan Assessment

As mentioned above, this work will be done in two phases a preliminary analysis followed by a more detailed pre-loan assessment The work in both phases is similar The difference is that in Phase I, the depth of detail should be the minimum and only enough so that the results can justify undertaking the second phase In Phase II, the level of detail should be adequate to meet the requirements of a lending agency (in this case the EBRD) for the results to be bankable, i e , the lending agency accepts the results and undertakes its loan appraisal process Phase II shall only be undertaken if the results of Phase I dictate that such a project is economically viable for an international loan and USAID and the EBRD indicate to the Contractor in writing that the pre-loan assessment (Phase II) shall proceed The Contractor shall retain the personnel working in the first phase of work in the second phase in order to avoid the cost of a second "learning curve "

A preliminary analysis of the prospects for installing and operating a viable, geothermally-sourced district heating system for the Town of Sugdidi in the Republic of Georgia is expected to demonstrate the practicality of such a facility to the extent that undertaking a formal pre-loan assessment for purposes of obtaining the necessary finance is justified However, this demonstration of practicality is subject to specific assumptions, which are the following

- The number of production wells to supply the needed quantity of geothermal water during peak demand periods have been drilled and provided with the necessary valving and flanges for connection to the district heating piping supply network at the appropriate locations

- Downhole pumps will be used in the geothermal wells to provide a water flow adequate for the expected peak demands on the system over the useful life of the installations

- Spent hot water (the net between flow charged to the system and the flow consumed for non-returnable hot water use) is to be returned for reinjection to the reservoir in order to avoid depletion of the geothermal hot water supply over the useful life of the installations

- The number of reinjection wells required for the return of spent hot water are in place and are provided with valving and flanges for connection to the district heating piping return network at the appropriate locations

- The reinjection of the spent hot water will not effect the continuity of the initial reservoir characteristics and properties, specifically the pressure in the reservoir, the temperature of the water in the reservoir, possible breakthrough of the colder water to the production wells, and the chemistry of the water in terms of its solids deposition properties

- The chemical composition of the geothermal water poses no possibility of solids depositions anywhere in the system which could cause operational

failures despite preventive maintenance precautions

- Previous geothermal-water transmission and distribution installations no longer exist and completely new installations must be built

In essence, the assumptions stated above state that adequate supply of geothermal water at the desired conditions of temperature, pressure, and chemical quality is assured over the projected life of the installations and tnat residual spent hot water can be returned to the reservoir

Accordingly, the objectives of the work are to be the following

- the preparation of a pre-loan assessment of a geothermal energy district heating system in the format depth of detail, and scope (i e , in accordance with international standards for the bankability of the project) suited to submission to an international lending agency for the granting of the loan equity requirement, and

- to provide specified assistance to the business firm designated to implement the project during the period between the granting of the loan and the completion of procurement of the major equipment and materials

The scope of the work shall begin with designing and specifying the connections to the geothermal production wells and to the reinjection wells, and shall include the installation and commissioning of the downhole pumps in the production wells The scope shall include the design and pricing of the piping and insulation within the district to be served including the connections to the residences and establishments of the prospective customers of the services Connections shall be provided with thermal energy consumption meters The scope shall also include in this respect the estimation of the capital investment required in local and foreign currency and the construction and commissioning schedule

The findings and recommendations from the preliminary analysis (Phase I) shall provide the primary inputs to the work This analysis is incorporated in this statement of work by reference

The scope of work shall not address aspects of efficiency in the consumption of heat because of the nature of the piping to the heat radiators Investment for retrofitting the heating systems to eliminate series piping by parallel piping to permit zoned control of heating as a trade off with the cost savings from reducing energy consumption shall be a matter for separate analysis

Specifically, the Contractor will be responsible for the following tasks

1 *Prepare Work Plan* As a first step, the Contractor shall prepare a work plan showing the method whereby, and the schedule in which, the tasks will be accomplished, the personnel qualifications for those who will perform the work, the local counterparts to be employed or seconded from local organizations, and the schedule by which the work will be performed The work plan shall address all the tasks specified below However, in order to prepare the work plan, the Contractor, if he deems it necessary, shall consult with the European Bank for Reconstruction and Development (EBRD) to learn and agree with the specific requirements for internationally credible "bankability" to be addressed As a result he may, with justification modify the tasks below, delete tasks, or add new tasks

The Contractor shall prepare a written report detailing the plan and submit this for approval by the EBRD, the Government of Georgia, and USAID before undertaking any work To provide a context for his work plan, the Contractor shall include and discuss the following aspects in this report

- brief description of the heating subsector and the role of geothermal energy in Georgia and its current use

- a description of how geothermal energy fits into the energy sector of the country

- a discussion of the main issues which exist in the heat subsector and in the utilization of geothermal energy,

- brief description of how the utilization of geothermal energy currently is organized (if at all),

- description of how the geothermal energy subsector is proposed to be organized, and

- description of how the use of geothermal energy has been performing

The Contractor shall submit his work plan to USAID, the EBRD, and the Government of the Republic of Georgia for review and approval before he begins the work planned

2 *Market Analysis* The extent of the market area to be served by the district heating system will have been established from the results of the preliminary analysis (Phase I) The Contractor shall survey the prospective consumers within the area and establish the annual pattern of consumption for heating and for hot water through interviews and past records to the extent these can be found, and from space to be heated, state of the insulation surrounding this space, and historic weather patterns

3 *Tariff Structure* The Contractor shall establish the tariff structure for the district heating services by class of consumer, volume of consumption, and peak demand The structure shall relate to the consumers' abilities to pay He shall determine this structure from a survey based on a realistic sampling of each class of consumer

4 *Revenue Estimate* From the results of the two activities above, the Contractor shall estimate the revenues which the district heating enterprise can expect from the sale of the thermal energy He shall also estimate the expected variations in the revenue stream through a typical year in order that working capital needs can also be estimated

5 *Facilities Design* For the service area identified in the preliminary analysis (Phase I) and from the results of the market analysis above, the Contractor shall map the geothermal-water distribution system and the spent hot water return system, estimate the line sizes, provide for the necessary pumping, locate the lines along the right-of-way, and otherwise consider design factors which a bankable feasibility analysis will require If needed, water reheating equipment shall be installed The product shall be the complete design of an operable and reliable system The lines shall be located aboveground or underground as has been determined from the preliminary analysis (Phase I) The system components shall be specified in the detail required to permit eventual purchase once financing is available

6 *Capital Investment Estimate* The Contractor shall estimate the capital requirement to construct and operate the system, the schedule by which the capital will be disbursed, and the portion which can be spent in local currency This portion shall be estimated using local costs

7 *Operating Cost Estimate* The Contractor shall establish the organizational structure of the enterprise to include all functions which will be required to assure the revenue stream The functions shall include those related to the operation and maintenance of the

system the administrative support functions of billing, bill collection, personnel management, security of the system, financial management, and general management

The Contractor shall specify staffing, salary and wage schedules, any payroll burden in order to estimate the total labor cost for the operations He shall estimate the total operating costs to include consumables, taxes, and interest on working capital

8 *Financial Analysis* Based on the results of the capital and operating costs estimates, the Contractor shall calculate the internal rate of return on the equity capital of the enterprise and the present value of the facilities based on a specified discount rate The calculations shall be performed by computer spreadsheet designed to permit parametric analysis of the major factors entering into the analysis

The major factors to be provided for shall include, at least, variations on the capital investment required, variations on the operating cost estimate, variations on the expected revenue stream, the proportion of this capital which is equity and which is loan

The Contractor shall project the results for the period corresponding to loan repayment in terms of proposed tariffs and resultant income statements, company balance sheets, and sources and applications of funds Issues such as receivables, billings, collections, and loan repayment shall be mentioned and discussed A suitable set of realistic and monitorable financial covenants shall be proposed (such as debt service ratio operating ratio, self-financing ratio, and preparation and auditing of financial statements) Detailed financial statements shall be provided as an annex

9 *Economic Analysis* The Contractor shall analyze the impact of the project on the economy of the country in terms of the following factors

- a description of the project's impact on the country's balance of payments,

- the economic rate of return and net present value for the base case and for each sensitivity test, and

- a brief description of the impact of the project on employment possibilities (if any)

10 *Ownership* The Contractor shall describe the Company to own the enterprise as a potential borrower from the lending agency, including the Company's legal and financial structure, financial strength, qualifications and experiences of the prospective management, his past performance (if any), and sources of the equity to be invested The detail shall be adequate for the lending agency to assess the ability of the ownership to maintain a viable enterprise, able to repay the foreign exchange loan and to raise the local-currency capital

The Contractor shall also describe the regulatory aspects under which the Company will operate as a monopoly in terms of tariff structures and tariff revisions in an inflationary environment The Government's and Company's strategy and development plans for the next ten years shall be identified and discussed

11 *Risk Analysis* The Contractor shall analyze the risks posed by the project on the basis that the assumptions specified above are valid He shall determine the sensitivity of the financial analysis to various assumptions for the main parameters He shall analyze the capability of the ownership to manage and perform such that repayment of the loans made to the project can be repaid in accordance with the terms of the

loan Finally, he shall state clearly the economic and financial assumptions made in order to accomplish the risk analysis

As risks are defined measures to mitigate these risks shall be identified and discussed

12 *Environmental Assessment* An environmental impact study shall be done aimed at assessing the project's environmental impact and recommending solutions to minimize negative impact and maximize positive impact Such a study shall include, but not be limited to

- visual effects of buildings, piping runs, and other installations,
- environmental impact during construction,
- effect on vegetation, wildlife, and aquatic life,
- impact on ground water,
- disposal of geothermal effluent, and
- overall impact on air quality from dissolved gases in the geothermal water (if any)

The environmental study shall be presented as a separate report (or, if not too long, as an annex to the feasibility study) with main findings and recommendations summarize in the main body of the report The environmental assessment shall be done in accordance with USAID and EBRD procedures

13 *Implementation Arrangements* The Contractor shall describe how it is envisaged that the project will be implemented, including any arrangements which have to be in place for its success (such as a project implementation unit or an expatriate project manager) A detailed implementation schedule shall be attached as an annex

14 *Interim Report* The Contractor shall prepare an interim report, in the format of the eventual final report, in which the results and evaluations obtained from the tasks above shall be presented for review by USAID, the EBRD and the Georgian counterpart agency Upon approval the Contractor shall proceed with the additional tasks below

15 *Preparation of Tender Documents* All work below shall be done in accordance with EBRD policies and procedures The Contractor shall consult frequently with the Bank in the interest of properly following its procedures

- The Contractor shall train local personnel in the tender and bid process and/or should endeavor to make use of local personnel that were previously trained in the EBRD tender and bid process

- The Contractor shall arrange for the publication of a procurement notice

- The Contractor shall use the data and results from the tasks specified above supplemented by additional data to be obtained from the prospective owner of the facilities and the EBRD to prepare tender documents in support of the procurement effort The Contractor shall compile bidding packages in accordance with EBRD procedures and submit to the Bank for review and approval

Specifically, bid packages shall include but not be limited to the following invitation for bids, instructions to bidders, general conditions of contract, specific conditions of contract, schedule of requirements technical specifications, bid form and price schedules, bid security form, contract form, and performance security form

The Contractor shall prepare separate, discrete bid packages for

equipment and supplies to cover the entire projected installations Equipment and supplies shall be allocated to each package in a manner that reflects the capabilities of prospective suppliers to manufacture or fabricate

The Contractor shall consult with EBRD personnel and follow EBRD procedures in evaluating and selecting qualified manufacturers and suppliers to be included in the tender, the format and content of bidding packages, including the currency of the related transactions, payment and delivery terms, and the timing of the tender

- Upon approval by the Bank, the Contractor shall publish an invitation to tender in Bank publications and in any other media acceptable to the Bank Competitors shall be given 60 to 90 days to submit tenders

16 *Tender Evaluation and Contract Negotiation Assistance* At the appropriate time, the Contractor shall assist in the procurement process in the following manner

- The Contractor shall train local personnel in the tender evaluation and contract negotiation process and/or should endeavor to make use of local personnel that were previously trained in the EBRD tender evaluation and contract negotiation process

- for each equipment and materials package, review the bidders' tenders and provide technical evaluations of their compliance with the tender documentation and appropriate recommendations regarding the adequacy of each bidder s tender Follow EBRD policies and procedures in the evaluation and ranking of the bidders,

- submit the results of the evaluation and ranking for each equipment and materials package to the Bank for review and approval,

- after selection of the winning bidder for each equipment and materials package, draw up the contract for the procurement, and

- Submit each contract to the bank for review and approval before award

SECTION IV STAFFING AND COORDINATION

There are a number of USAID-funded activities in the Caucasus (Armenia and Georgia) and other NIS countries as well as other donor organizations that may be working in the same or similar areas of the energy sector These include U S and NIS-based institutions, and others, including the World Bank, EC, and EBRD The Contractor is expected to coordinate and cooperate with others as appropriate and to avoid duplication where possible Where duplication cannot be avoided or where task objectives no longer appear productive or appropriate, the Contractor is expected to report back to USAID and to propose work plan adjustments

SECTION V APPROVALS

Within three weeks of award of this delivery order, the contractor will submit an Activity Implementation Plan (AIP) for all tasks Attached should be the Work Plan for each task The contractor shall not execute this AIP until approval is received, in writing, from the AID project officer

SECTION VI DELIVERABLES

Prior to mobilization the contractor shall submit to the Contracting Officer's technical representative (COTR) a written work plan for each separate task and subtask of this work order, as desribed in the Scopes of Work above The work plan must reflect any approved changes in Scope of Work as written here New tasks may be identified as work progresses

Task 1 TBILISI DISTRICT HEATING SYSTEM IMPROVEMENT PROGRAM

1) A detailed workplan to be approved by USAID including timetables, benchmarks, and dates for deliverables

2) An environmental assessment per USAID Environmental Procedures (22 CFR 216)

3) Assessment of the current status of the district heating system in Tbilisi and strategy for district heating rehabilitation and development for Tbilisi for the immediate, short, and long term for approval by USAID

4) Purchase order for approval by USAID

5) Interim and final shipment and delivery report on commodities purchased for boilers and pipelines

6) A Task Completion Report describing the activities completed and results obtained Two copies will be distributed to the USAID representatives in the Caucasus Five copies will be distributed to USAID/ENI/EEUD/EI

Task 2 NATURAL GAS TRANSMISSION SYSTEM UPGRADE

1) A detailed workplan to be approved by USAID, including timetables, benchmarks, and dates for deliverables

2) An environmental assessment per USAID Environmental Procedures (22 CFR 216)

3) A report presenting a set of ranked cost-effective technical measures, including a list of limited critical commodities, to increase the volume of gas transmitted within Georgia and to Armenia

4) A procurement list presenting limited critical commodities that would support gas transmission system enhancement

5) A short- to medium-term cost-effective plan for improving the technical operation of the transmission system, including a list of limited critical commodities

6) A long-term cost-effective plan for improving the technical operation of the transmission system and pre-loan analyses for consideration by the World Bank and other international financial institutions

7) One two-week workshop for twenty to twenty five managers and technical personnel from Saktransgaz on "Gas Transmission System Operations in the US and Europe"

8) A Task Completion Report describing the activities completed and results obtained Two copies will be distributed to the USAID representatives in the Caucasus Five copies will be distributed to USAID/ENI/EEUD/EI

Task 3 SUGDIDI GEOTHERMAL ASSESSMENT

The Contractor shall provide three deliverables at the appropriate time and shall await the review and approval of each deliverable before proceeding with subsequent work They are

Phase I - Preliminary Analysis

1) A detailed workplan to be approved by USAID including timetables, benchmarks, and dates for deliverables

2) Phase I draft and final reports, in both English and Russian

3) A Task Completion Report describing the activities completed and results obtained Two copies will be distributed to the USAID representatives in the Caucasus Five copies will be distributed to USAID/ENI/EEUD/EI

Phase II - Pre-Loan Assessment

1) A detailed workplan to be approved by USAID including timetables, benchmarks, and dates for deliverables

2) An interim document representing the results of the feasibility work suited as an input to decision making by the lending Bank regarding the granting of the loan The depth of detail, analysis, and evaluation in this document shall meet the criteria of the EBRD as to bankability

3) A final report including an updated interim feasibility document supplemented by the tender documents and the subsequent evaluations and rankings of the bids received

4) A Task Completion Report describing the activities completed and results obtained Two copies will be distributed to the USAID representatives in the Caucasus Five copies will be distributed to USAID/ENI/EEUD/EI

SECTION VII REPORTING

In addition to the deliverables indicated above, the contractor shall submit the following reports

(1) Monthly Status Reports These reports are the primary project management documentation monitoring performance progress and shall be submitted no later than ten calendar days after the end of each month The reports shall itemize activities by task and subtask, identifying progress, accomplishments, problems encountered, corrections implemented as a result, and/or alternatives and solutions suggested in order to produce the desired results In addition, person days expended by task and subtask will be reported, itemized between activities in the field and the home office Reports on trips planned within the next 30-45 days should include arrival and departure plans, persons to be involved, persons to be visited and purpose of visit, and any assistance needed to ensure achieving objectives Electronic reporting to the project office will be required

The monthly reports shall include a discussion of progress against USAID performance Indicators and Targets The work plan shall include the Contractor's proposal for measurable and verifiable indicators that will show progress toward achieving the objective

(2) Quarterly Financial Reports The Contractor shall submit quarterly financial reports with all the pertinent information including but not limited to funds authorized and obligated, and actual and accrued expenditures

(3) Final Reports Under this Delivery Order, these reports shall include

lists of contract activity inputs, outputs, and objectives, summary descriptions of each activity undertaken, statistical summaries and analyses of activities and places where these have been undertaken, cost of each activity and summary of cost by place and type of assistance In addition, these reports shall incorporate all contract activity internal evaluations and shall summarize accomplishments, methods of work and recommendations regarding work and/or program continuation This final report shall be submitted within 30 days after completion of each activity

(4) Technical Reports The contractor shall submit technical reports within 30 days after completion of each subtask Each report shall be prepared using the following computer software applications

- DOS 3 1
- Word Perfect 5 0 or 5 1 for word processing
- Lotus 1-2-3 for spread sheets
- DBase III+ for databases and program plan spread sheet
- Harvard Graphics for charts, graphs, etc

SECTION VIII LOGISTICAL SUPPORT

The Contractor shall be responsible for providing or arranging for all logistical support in the U S and Georgia This support is expected to include office space and equipment necessary to perform the services required by this contract

To the extent that the USAID Mission in Armenia and/or the USAID Representation in Tbilisi provide logistic support to the Contractor under this delivery order, the costs of such logistic support shall not be charged by the Contractor to this Delivery Order If, under emergency circumstances, it is necessary for the USAID Mission to pay for any in-country costs on behalf of the Contractor in order to facilitate implementation of any activities under this contract, the Mission may bill the Contractor for such costs for onward charge to the contract

SECTION IX COUNTERPARTS

Substantial professional resources, both organizational capabilities and individual talent, public and to some degree private, are available in Georgia It is expected that Georgian government entities will participate and make significant contributions towards the identification, design, planning, review, evaluation, and approval of work performed under the contract Additionally, it is anticipated that private Georgian entities and professional individuals participate in the work performed through subcontracts and employment arrangements with the contractor as appropriate

SECTION X IMPLEMENTATION

The chances of successful implementation of this contract will be enhanced by assuring continuity in U S support for energy sector technology and services, requiring that all new U S advisors and consultants be committed and exceptionally well qualified and that required technical assistance be provided in a timely manner

Successful implementation also depends on the direct contact between all US professionals assigned to the work with local counterparts and field conditions It is therefore expected that trips to the field be of sufficient duration to ensure proper understanding of field conditions and that teams on assignments brief the USAID Representation in Tbilisi prior to departure and provide the USAID Representation in Tbilisi as well as USAID/Caucasus in

Yerevan with appropriate documentation and preliminary analyses It is also expected that generally no professionals should be made part of the work unless they have spent a substantial level of effort in the field for the tasks being implemented

In addition it is highly effective both from the quality of the work and the total cost of the effort that in most situations where a significant number of activities are scheduled to take place in one location, the contractor implement the delivery order with a small number of professionals continuously present in the field locations

Appendix B

References – Lists of Studies, etc

LIST OF STUDIES

Title	Organization	Author	Date
Development of Energy Policy in Georgia Interim Report Sectoral Working Paper No 1 Electricity Sector Review	TA-CIS SEED/KANTOR	Costas Mitropoloulos	July 1994 FEBRUARY 1995
Development of Energy Policy in Georgia Interim Report Sectoral Working Paper No 2 Rehabilitation and Extension of the Hydroelectric System	TA-CIS SEED/KANTOR	Pierre-Andre Dutoit	July 1994
Development of Energy Policy in Georgia Interim Report Sectoral Working Paper No 3 Oil Sector Review	TA-CIS SEED/KANTOR	Charalambos Dolkas Anastslos Sophos	August 1994 FEBRUARY 1995
Development of Energy Policy in Georgia Interim Report Sectoral Working Paper No 4 Gas Sector Review	TA-CIS SEED/KANTOR	Evangelos pengils Anastaslos Sophos	August 1994 FEBRUARY 1995
Development of Energy Policy in Georgia Interim Report Sectoral Working Paper No 5 Assessment of Coal Resources (french version)	TA-CIS SEED/KANTOR	Camille Geraud ENGLISH VERSION	July 1994 FEBRUARY 1995
Development of Energy Policy in Georgia Interim Report Sectoral Working Paper No 6 Rehabilitation of Urban District Heating Systems	TA-CIS SEED/KANTOR	Robert Bonnemaison Sofresid-Caliqua	October 1994 APRIL 1995
Development of Energy Policy in Georgia Interim Report Sectoral Working Paper No 7 Perspectives for the Development of Renewable Energy Resources	TA-CIS SEED/KANTOR	Bernard Meunier	August 1994
Development of Energy Policy in Georgia Interim Report Sectoral Working Paper No 9 ENERGY PRICES AND TARIFFS	TA-CIS SEED/KANTOR	John Hasapakis Anastasios Sophos	August 1994 JUNE 1994
Development of Energy Policy in Georgia Final Main Report (Draft)	TA-CIS SEED/KANTOR	FINAL APRIL 25, 1995	January31 1995
Restructuring and Adaptation to Market Economy Reform of Managememt Methods for Sakenergo, Georgia Final Report	TA-CIS ESB INTERNATIONAL		January 1994
Development of Energy Policy in Georgia Interim Report Sectoral Working Paper No 8 Household Energy Survey Vol's I, II, III	TA-CIS SEED/KANTOR		February 1995

1/13

LIST OF STUDIES

Title	Organization	Author	Date
EBRD Interim Report Georgia Power Rehabilitation Project	B&R	N/A	July 1994
Georgia Energy Situation and Needs in the Coming Winter	RMA	Evgeny Guterman Niels R Wolter	November 1993
Geothermal Resources in the Republic of Georgia	EBRD VIRKIR-ORKINT CONSULTING GROUP LTD		July 1994
Project Study of Power Station in Georgia Technical-Economical Report	"Energykselprojekt SAKENERGO		1994
Aide-Memoire	WORLD BANK Energy Mission		March 28, 1995
EXPLOITATION OF TKIBULI COAL DEPOSITS FOR ENERGY USES IN INDUSTRY AND HOUSEHOLDS TAKING INTO ACCOUNT THE RELATED ENVIRONMENTAL ASPECTS	EC-TACIS EGE/95/02 GEORGIA	COMPONENT 4	1995

"Study of Tbilisi Heat Supply Systems. Rehabilitation and Development Opportunities"

"Volume 1 - Main Characteristics of the Centralized (District) Heating System of Tbilisi, Audit, Analyses and Recommendations"

"Volume 2 - (Annexes to Volume 1) Maps and Schemes"

"Volume 3 - Survey of Power Resources in Georgia Current State and Prospects of the Utilization".

"Volume 4 - Conditions of the Heat Supply of 23 Selected Tbilisi Hospitals, Audit and Analyses" Prepared by ARCI Studio, Ltd, for Burns and Roe Enterprise, April - May 1995, Republic of Georgia

LIST OF REFERENCE STUDIES 11/97

1. Joint Energy Alternatives Study (JEAS) Final Report Revision 25 April 1995, Joint Electric Power Alternatives Study, June 1995 Final Report appendices, Prepared for: Energy Policy Committee of the U.S.-Russia Joint Commission on Economic and Technological Cooperation.
2. Georgia Electricity Law (Translate)
3. Ministries Plan for Rehabilitation by 2000 (Translate) forcasts for demand and supply
4. Hydroplant Rehabilitation and Consideration (Translate) of Georgian Power Sector (>300 pages), includes civil, mechanical, T+D, 3 German Companies, ICEE, BEA, ect. KFW money, govt financed, Govt. LCP for hydroplants.

5.	92.R.4.2	Power Station Investment Plan	Sakenergo	FIDIMI Consulting S.p.A. (Italy)
6.	94 R	Interconnection of Caucasian and Turkey Electricity Supply Networks	SAKENERGO	Verbunden Lahmeyer Int (Austria)
7.	93 R	Improvement of the System Operational Planning, Operation and Control Practices in Caucasus and Central Asia Countries	SAKENERGO	ENDESA (Spain)
8.	93 R	Technical and Organizational requirement for Extended Economy and Security of the Power System Operation	SAKENERGO stock company "PONTOELI"	ELSAMPROEKT (De nmark)
9.	95 N 1	Technical Assistance to the Ministry of Fuel and Energy	Ministry for Fuel and Energy	COWI (Denmark)
10.	95N 1.2	Assistance on the Industry and Consumer Level	Ministry of Economy (Sience and Technology Department)	Jaakko Poyry (Finland)

11. Thesis on Coal in Georgia, 1994 REVAZ ARVELADZE Deputy Minister of Energy
12. Coal Mines Rehabilitation Proposal for 125 MW Power Plant, Czech Company SKODA (VW) funded by KFW German Govt Bank. 1997 final, for Tender.
13. POWER REHABILITATION REPORT, WORLD BANK, MAY 8, 1997

ARCI Consulting

Technical Report

Study of Tbilisi Heat Supply Systems: Rehabilitation and Development Opportunities. Georgia.

Phase II
Selected Design Solutions and Cost Estimations

- Rehabilitation of 4 District Heating Stations in Tbilisi on the basis of existing equipment (alternative options)
- Increase efficiency of the utilization of Lisi Geothermal Deposit in Tbilisi
- Rehabilitation of 11 municipal hospitals in Tbilisi

Draft

Prepared under subcontract to: Burns & Roe Enterprises, Inc
Continuation of Purchase Order No: 5825 - 321

MARCH
Tbilisi, 1996

176

Table of Contents

The Assesment of Selected Tbilisi District Thermal Stations

Introduction	1
DTS No 27	2
DTS No 9	9
DTS No 10	22
DTS No 25	37

The Assesment of Increase Efficient Utilization of the Lisi Geothermal Deposit 63

The Assesment of the Heating Systems in 11 Selected Tbilisi Hospitals

The Orphonage in Tbilisi	72
Clinical Hospital No 4	78
Burns Center	83
Oncological Center	89
Maternity Hospital No 3	96
Municipal Mental Hospital	103
Municipal Hospital for Tuberculosis	108
Maternity Hospital No 5	113
Maternity Hospital No 4	120
Maternity Hospital No 1	126
Hospital for Infections Diseases	133

177

Appendix C

Trip Reports

USAID EXIT INTERVIEW
Friday, 15 March, 1996

A trip to Tbilisi began on Friday, 23 February for three weeks to begin work on the following three new delivery orders

D O No 11 Tbilisi District heating System Improvement Program

D O No 24 Natural Gas Transmission System Upgrade

D O No 25 Zugdidi Geothermal Assessment

The Delivery Order 8 report text for Tbilisi District Heating System and Hospitals optimization has been translated to Georgian and distributed. Trips were made to see the four hospital boiler rooms rehabilitation with USAID funds Maternity Hospitals 4 and 5, Republican Mental Hospital and Republican Burns Hospital Maternity Hospital No 4 boiler room has been transferred from Municipal ownership to hospital ownership and the hospital elected to keep a steam boiler to rehabilitate Maternity Hospital No 5 chose to spend their own funds to rebuild 2 gas fired steam boilers and are advertising on TV for obstetrics and gynaecological services in warm and comfortable surroundings We were interviewed for a TV program explaining the USAID and World Bank programs The Mental Hospital expended additional funds for repair work and developed a Dutch design proposal for heated greenhouses for patient work therapy and revenue income. The Burns Hospital is planning to invest in remodelling of one floor of a wing this summer to start performing elective plastic reconstructure surgery for paying patients This indicates that the small seed money investments by USAID and World Bank in worthy projects are paying off with growing entrepreneurial free market activities which the public at large can see and benefit from

A very important finding is that the private firm Geothermia Ltd is spending about $45,000 of their own funds to install a pipeline as a result of a two month design proposal for the Lisi District geothermal well 5-T thermosyphon project The purpose of this project is to run tests for about one to two months to determine hydraulic characteristics of system for location of hot water storage reservoir based on optimum well production, quantity of methane release, resource drawdown and recharge Depending on results of tests to determine location of tank, anywhere from 50 000 to 80, 000 people can be supplied with hot water Construction of the tank, piping and controls is estimated at about $600,000 and would result in equivalent natural gas savings of about $2-2.5 million per year The significant advantage of this installation is that no electricity is required for pumping, relying solely on gravity to supply the water The tank was previously announced for informal bid proposals to three qualified contractors One contractor supplied an exceptional proposal complete with drawings and colour renderings

Two alternate locations have been selected and approved by the Municipal government for location of storage reservoir. Two options for 2,000 m^3 tanks were considered, above ground steel tank which would take two months to erect or underground concrete tank which would take four months to construct. There is no cost advantage of steel vs concrete. Technical advantages are in favour of the underground concrete tank not requiring corrosion protection and insulation which is an advantage for long term reliability and lower maintenance. However, there is an urgent need for an additional $45,000 required for completion of siphon system testing and other test equipment for resource assessment.

Two experts from International Gas Consultants (IGC) visited Sakgas, Saktransgas, border metering stations, compressor station and other natural gas facilities to make observations and gather information for the assessment and recommendations for rehabilitation of the natural gas transmission systems.

Jim Koenig, Geologist from Geothermia, ARCI Consultants, Geothermia Ltd and Burns and Roe engineers and geologists made a three day trip to Zugdidi to inspect the geothermal wells, gather information and meet with the Mayor, Municipal government officials and principals of several major enterprises which will be consumers of hot water. Geothermia Ltd. provided a wealth of data and drawings for Geothermex to analyze for assessment of the geothermal resource They also provided a complete design package for the expansion for a large greenhouse complex which was never completed. The city and the hospitals and enterprises representatives agreed to provide information for previous and present conditions and future plans It will be necessary to perform flow and injection tests for resource assessment.

Several preliminary draft proposals for rehabilitation of selected Tbilisi thermal stations have already been completed by ARCI and several more proposals are in the process of development. Inspection visits were made to Thermal Stations 27, 9, 10, 25 and the. Tbilisi Thermal Electric Power Station. Additional prospects for proposing rehabilitation projects will be developed in greater detail for the final report.

A visit was made to School No 36 (Grades 1-10) to see the new coal burning boiler provided by the UK know-how fund, CRE Group through Ashwell Engineering Services The screw feeders, blowers, controller and instruments and boiler design drawings were supplied from the UK. The boilers (2) were fabricated in Tbilisi by the firm Bericoni under license The first four are free, than 10% of boils cost to Ashwell. The school is five floors and many windows are broken and boarded up, badly in need of weatherization. They only run the boilers about five hours per day when there is electricity to run motors for the screws, blowers and pumps and controllers One boiler is for the school and the other, not yet operational is for the police building next door

The crushed coal they receive from Tkibuli mine costs 85 Laris (68$) per metric tonne The operators have to screen the coal to 30-5 mm size for reliable performance of the screw About 40% of the coal is rejected fines to keep from plugging the screw

180

Environmental monitoring of flue gas emissions are measured for sulphur oxides (SO_x), nitrogenoxides (NO_x), carbon monoxide (CO), and particulate

We had very interesting discussions with Nellie Verulava, Energy Energy, from the Tbilisi Clean Coal Technology Institute She is involved in the UN-EC IMPACT Program and working on applications for utilising Georgia coal They are very interested in fluidized bed boiler application to recover over one million TONNES of *shlam* (calm) at Tkibuli They are also interested in possible application of coal slurry or orimulsion for transporting the fuel These applications may be more appropriate for use in Kutaisi or Western Georgia

This brief report is only a summary of highlights of a very busy and productive visit A more detailed trip report will follow

John E. Hallberg

Prepared by John Hallberg, PE
Burns and Roe Enterprises Inc

IDEA

LIST OF STUDIES

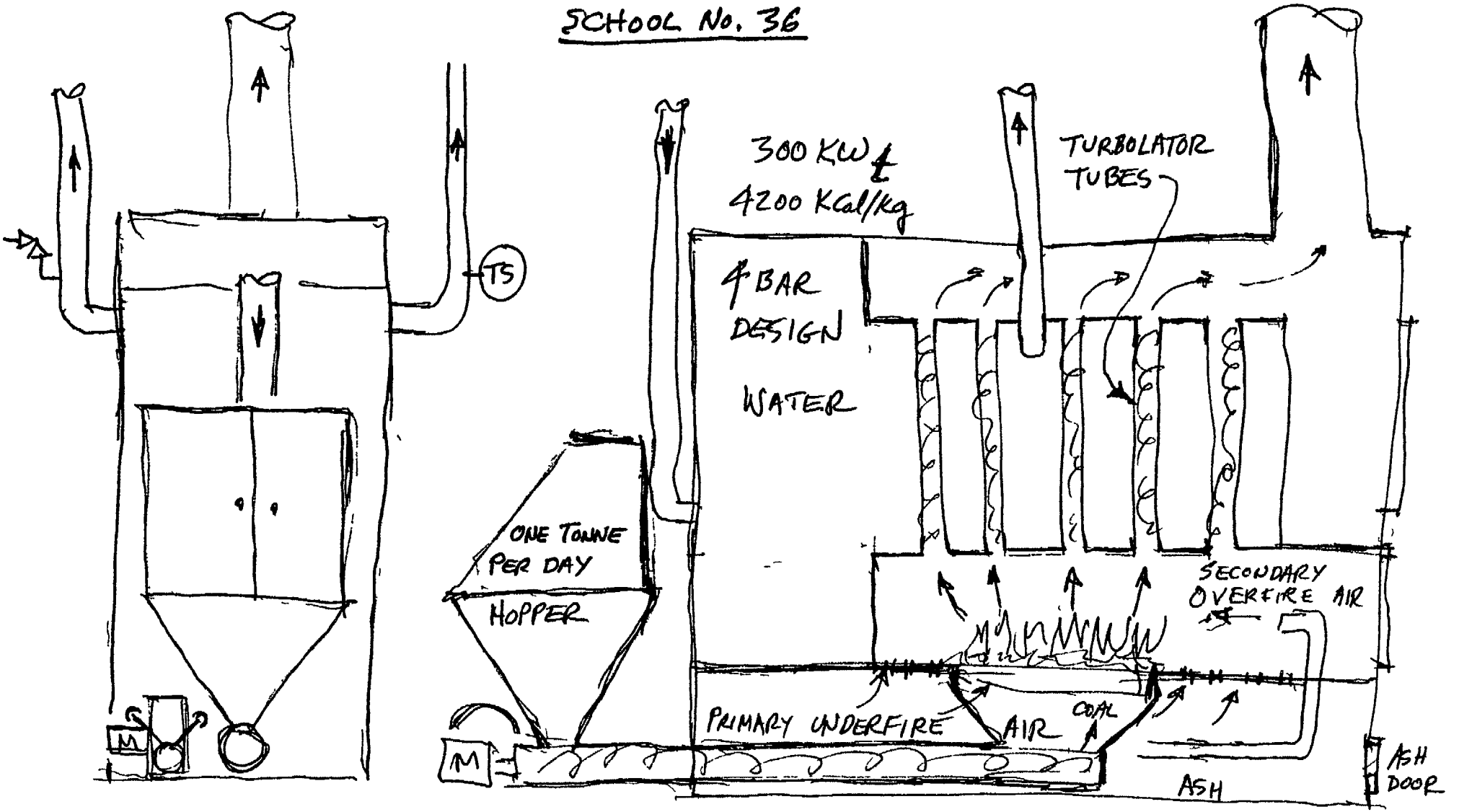
15 MARCH, 1996

Title	Organization	Author	Date
Development of Energy Policy in Georgia Interim Report Sectoral Working Paper No 1 Electricity Sector Review	TA-CIS SEED/KANTOR	Costas Mitropoloulos	July 1994 FEBRUARY 1995
Development of Energy Policy in Georgia Interim Report Sectoral Working Paper No 2 Rehabilitation and Extension of the Hydroelectric System	TA-CIS SEED/KANTOR	Pierre-Andre Dutoit	July 1994
Development of Energy Policy in Georgia Interim Report Sectoral Working Paper No 3 Oil Sector Review	TA-CIS SEED/KANTOR	Charalambos Doikas Anastslos Sophos	August 1994 FEBRUARY 1995
Development of Energy Policy in Georgia Interim Report Sectoral Working Paper No 4 Gas Sector Review	TA-CIS SEED/KANTOR	Evangelos pengilis Anastaslos Sophos	August 1994 FEBRUARY 1995
Development of Energy Policy in Georgia Interim Report Sectoral Working Paper No 5 Assessment of Coal Resources (french version)	TA-CIS SEED/KANTOR	Camille Geraud ENGLISH VERSION	July 1994 FEBRUARY 1995
Development of Energy Policy in Georgia Interim Report Sectoral Working Paper No 6 Rehabilitation of Urban District Heating Systems	TA-CIS SEED/KANTOR	Robert Bonnemaison Sofresid-Caliqua	October 1994 APRIL 1995
Development of Energy Policy in Georgia Interim Report Sectoral Working Paper No 7 Perspectives for the Development of Renewable Energy Resources	TA-CIS SEED/KANTOR	Bernard Meunier	August 1994
Development of Energy Policy in Georgia Interim Report Sectoral Working Paper No 9 ENERGY PRICES AND TARIFFS	TA-CIS SEED/KANTOR	John Hasapakis Anastasios Sophos	August 1994 JUNE 1994
Development of Energy Policy in Georgia Final Main Report (Draft)	TA-CIS SEED/KANTOR	FINAL APRIL 25, 1995	January31 1995
Restructuring and Adaptation to Market Economy Reform of Managememt Methods for Sakenergo, Georgia Final Report	TA-CIS ESB INTERNATIONAL		January 1994
Development of Energy Policy in Georgia Interim Report Sectoral Working Paper No 8 Household Energy Survey Vol's I, II, III	TA-CIS SEED/KANTOR		February 1995

LIST OF STUDIES

Title	Organization	Author	Date
EBRD Interim Report Georgia Power Rehabilitation Project	B&R	N/A	July 1994
Georgia Energy Situation and Needs in the Coming Winter	RMA	Evgeny Guterman Niels R Wolter	November 1993
Geothermal Resources in the Republic of Georgia	EBRD VIRKIR-ORKINT CONSULTING GROUP LTD		July 1994
Project Study of Power Station in Georgia Technical-Economical Report	"Energykselprojekt SAKENERGO		1994
Aide-Memoire	WORLD BANK Energy Mission		March 28, 1995

SCHOOL No. 36



ASHWELL ENGINEERING SERVICES
LISCENSEE – BARACONI, TBILISI
TEL 0116-276-7151 FAX 0116-276-3636

ENERGY ENGR. VERULAVA
IMPACT PROGRAM-CLEAN COAL TECHNOLOGY

WED 13 MARCH 1996

USAID Exit Interview

Friday, 7 June, 1996

A trip to Tbilisi, Georgia began on Friday, 24 for two weeks to work with ARCI Consultants, the Burns and Roe local subcontractor on the following delivery orders

D O No 11 Tbilisi District Heating System Improvement Program
D O No 25 Zugdidi Geothermal Assessment

As a result of work accomplished during the March trip to Tbilisi and Zugdidi ARCI submitted proposals for consulting services to prepare several detailed rehabilitation projects for both delivery orders They also submitted proposal cost estimates for performing necessary geothermal well flow tests for Lisi deposit in Tbilisi and Zugdidi thermal water deposit resource assessments

Objectives accomplished during this trip are the following
- Review, clarify and expand on ARCI proposals
- Prepare Table of Contents and outlines for reports
- Define work tasks for preparing reports
- Discuss proposed pilot metering projects

ARCI submitted nine proposals for district heating system projects for Tbilisi

1 Thermal Station No 9 Rehabilitation,
2 Maternity Hospital No 5 Heating system expansion,
3 Greenhouse Project for Mental Hospital Boiler Plant,
4 Maternity Hospital No 4 Boiler Plant and Laundry/Bathhouse,
5 Oncology (cancer) Hospital Cogeneration Diesel Project,
6 Decentralized heating boilers for schools,
7 Lisi geothermal project, Phase II - re-injection
8 Solar hot water system project for selected hospitals,
9 Pilot metering project with decentralized cogeneration

ARCI was asked to include two more proposals to summarize the balance of thermal stations and hospitals for conceptual description of a few more potential rehabilitation projects and discuss the long term strategy for preservation of existing capital equipment

Preliminary Tables of Contents and outlines were developed to guide writing of the reports for USAID EBRD and World Bank In addition a simple working project milestone and cash flow schedule and action item list were prepared The next milestone is to meet in Tbilisi sometime between July 26-August 9 with USAID EBRD and Geothermia

The purpose is to deliver a required written handout presenting the status and result of assessment of the Zugdidi project, incorporate comments and get approval to proceed with the second phase Pre-loan assessment for EBRD In addition, meetings with ARCI and other participants will be held to continue preparation of the Tbilisi District Heating D O No 11 report

A significant point of discussion was the selection and survey of a potential group of residential consumers in 4 fifteen-storied high rise apartment flat buildings for installation of a demonstration pilot metering project Out of 350 families, only five did not agree with metering for payment of guaranteed utility services The proposal is to install prepay electric and gas meters and automatic read BTU (Kcal) meters for heat and hot and cold water consumption An important consideration for guaranteed supply is the need for back-up power and fuel supply owned and operated by a private enterprise for this experiment to be a success As a holdover from the socialistic system people do not believe in much of what the government says and the prospect for reliable electricity, gas and water supplies during winters is a future hope As a result, an integrated backup combined heat and power source is considered for this group of buildings The guaranteed electricity and water supply is necessary for boiler fans, water pumps, controls, building elevators and lighting, fuel pumps, etc Diesel oil storage will be the backup fuel source

In order for the rehabilitation proposals to be economically justified it is necessary to have financially solvent hosts for thermal and/or electrical loads Therefore the primary objective has been and is to seek out commercial or entrepreneurial activities to provide the revenue steam necessary to provide the payback to support the financing of these projects For combined heat and power (CHP) systems it is also necessary to have the thermal loads to provide a reasonably level daily load profile An important source for the thermal loads is in the food sector for production, processing and refrigeration

Lastly, a critical schedule concern is to obtain the funds, equipment and construction needs for completion of flow tests of the Tbilisi Lisi and Zugdidi geothermal resource assessments These flow tests are a prerequisite for quantifying of resources for EBRD and multi-national bank financing of these projects

Prepared by

John E Hallberg, PE

Burns and Roe Enterprises, Inc

June 6, 1996

ACTION ITEMS - THINGS TO DO

1 Questionaire for Zugdidi (let consumers do work)
2 Residential Survey in Tbilisi (on disk) - May be useful information or questions
3 Zugdidi drinking water - what projects?
4 Electrical Supply - Status of Inguri and Rioni Projects?
5 Fiberglass pipe - vendors info, prices, sources
6 Heat Pumps - Vendor info, prices, sources
7 Solar Equipment - Vendor info, prices, sources
8 Gas Turbines - 1-5 MW - Hospitals, etc
5-20 MW - Thermal Station (Need vendor info in Russian)
9 Vacuum Degasification
10 Down-hole pumps argument
11 Proposal 10 - Potential Projects TS4 & 19 University
TS17 & 44 Rehab ? Cogen?
12 Proposal 14 - Long Term Strategy
A Capital preservation $/Gcal x 38TS = ?
B Distribution Systems $/M x L = ?
13 Info on Zugdidi World Bank Weatherization Projects
14 Info on Zugdidi Joint Venture Investments - German, etc
15 Info on Zugdidi other doner organizations and actions
16 Info on Ministry of Agriculture Activities and data
17 Info on GE 100 MW Combined Cycle Proposal - where?
18 Info on potential commercial consumers of heat and power
19 Info on Greenhouse Glass Substitute Plastics
20 Qualifications Package on Geothermia

June 6, 1996

POTENTIAL COMMERCIAL CONSUMERS OF HEAT & POWER

FOOD TECHNOLOGY INFORMATION

1 Greenhouses - products, tomatoes, strawberries, cucumbers, citrus, beans, etc

2 Mushroom Production - technology, equipment

3 Drying - vegetables, fruits, papaya, onions, garlic, etc

4 Chicken - meat and egg production, refrigeration, heat and hot water

5 Silviculture - fish ponds

6 Refrigeration - ice making, cold storage

7 Bakeries -

8 Dairy Products - Heat and Power, Refrigeration, Cheese Making

9 Meat Processing & Storage

10 Food Processing - cooking, canning, freezing

Other

Laundries, Bath houses, Manufacturing, etc

ПОТЕНЦИАЛЬНЫЕ КОММЕРЧЕСКИЕ ПОТРЕБИТЕЛИ ТЕПЛА И ЭЛЕКТРОЭНЕРГИИ

Информация по пищевой технологии

1 Теплицы - помидоры, клубника, огурцы, цитрусы, фасоль, и другие

2 Грибы - технология, оборудование

3 Высушивание - овощи, фрукты, папайя, лук, чеснок и др

4 Птицеводство - производство мяса и яиц, замораживание, теплоснабжение и подача горячей воды

5 Лесоводство - пруд для разведения рыб

6 Замораживание - производство льда, холодное хранение

7 Молочное производство - сыр, молоко, теплоснабжение и подача электроэнергии

8 Хлебопекарня

9 Мясопроизводство, хранение

10 Пищевая промышленность - приготовление, консервирование, замораживание

Другие
Прачечные, бани, производство

June 6, 1996

DELIVER ORDER NO 25
GEOTHERMAL DISTRICT HEATING
ZUGDIDI, GEORGIA

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

- 1 1 Introduction
- 1 2 Principal Findings
- 1 3 Recommendations

2 0 BACKGROUND

- 2 1 Importance of Geothermal Energy in Georgia
- 2 2 Geothermal Energy Organization Structure
- 2 3 History of Zugdidi Geothermal Development

3 0 EXISTING DATA ON ZUGDIDI THERMAL WATER RESOURCE (Assessment)

- 3 1 Regional Geography and Climate
- 3 2 Regional and Local Geology
- 3 3 Regional Hydrology and Geothermal Data
- 3 4 Agressive Properties of Thermal Water
- 3 5 Necessity for Re-injection Tests
- 3 6 Results of Previous Re-injection Tests
- 3 7 Hydrogeological Map
- 3 8 Topographic Plan of Wells, Pipelines and Equipment
- 3 9 Well Sections and Data Tables
- 3 10 Unfinished Project Proposals (greenhouses)
- 3 11 Present condition of facilities
  - Wells & Equipment
  - Electrical Supply
  - Water Supply
  - Consumer Heating Systems
- 3 12 Well Flow and Re-injection Tests

4 0 CONSUMER MARKET SURVEY

- 4 1 Queationnaire and Data Collections
- 4.2 Consumer Profiles and Thermal Loads
- 4.3 Municipal Infrastructure
- 4 4 Potential Enterprise Markets for Thermal Water

June 6, 1996

5.0 RENOVATION AND DEVELOPMENT PLANS (Engineering)

- 5.1 Priority I - Zugdidi Resource Distribution System
- 5 2 Priority II - Tsaishi Resource Distribution System
- 5 3 Evaluation of Heat Pump Applications
- 5 6 Evaluation of Refrigeration Applications
- 5 7 Comparison of Alternative Systems
- 5 8 Annual Monthly Thermal Load Profiles
- 5 9 Specification for Equipment and Materials
- 5 10 Commercial Project Proposals (detailed in appendix)
- 5 11 Domestic Highrise Pilot Rehabilitation Proposal (detailed in appendix)
- 5 12 Environmental Considerations

6 0 PRELIMINARY FINANCIAL ANALYSIS

- 6 1 Capital and Operating Costs
- 6 2 Revenue Requirements, Tariffs, and Earnings
- 6 3 Proforma Risk Analysis and Pay Back
- 6 4 Sources of Financing

7 0 INSTITUTIONAL AND ORGANIZATIONAL REQUIREMENTS

- 7.1 Governmental and Legal Reforms
- 7 4 Private Heat Supply Company

8.0 CONCLUSIONS AND RECOMMENDATIONS

APPENDICES

ЗАКАЗ О ПОСТАВКЕ

Геотермальное регионалоное отопление

Зугдиди, Грузия

СОДЕРЖАНИЕ

1 0 Итоговыи документ

1 1 Введение
1 2 Основные выводы
1 3 Рекомендации

2 0 Общии обзор

2 1 Значение геотермальнои энергии для Грузии
2 2 Структура организации геотермальной энергии
2 3 История развития Зугдидской геотермальной системы

3 0 Существующие данные о Зугдидском геотермальном месторождении (Оценка)

3 1 Географический и климатический обзор местности
3 2 Геологический обзор местности
3 3 Гидрологические и геотермические данные
3 4 Агрессивные качества термальной воды
3 5 Необходимость проведения реинъекционных тестов
3 6 Результаты предыдущих реинъекционных тестов
3 7 Гидрогеологическая карта
3 8 Топографическии план скважин, трубопроводов и оборудования
3 9 Части скважин и таблица данных
3 10 Предложения незавершенных проектов
3 11 Нынешнее положение сооружения
-скважины и оборудование,
-электроснабжение,
-подача воды,
-отопительные системы потребителей
3 12 Поток скважины и реинъекционные тесты

4 0 Описание рынка потребителей

4 1 Информация
4 2 Виды потребителей и термальные нагрузки
4 3 Муниципальная инфраструктура
4 4 Потенциальный рынок предприятии для термальных вод

5 0 Планы по реконструкции и развитию

- 5 1 N 1 Распределительные системы Зугдидского месторождения
- 5 2 N 2 Распределительные системы Цайшского месторождения
- 5 3 Возможности использования теплонасосов
- 5 4 Возможности использования охлаждения
- 5 5 Сравнение альтернативных систем
- 5 6 Типы нагрузок за год, месяц
- 5 7 Спецификации оборудования и материалов
- 5 8 Коммерческие предложения по проекту (детальные предложения прилагаются)
- 5 9 Местные проекты по восстановлению (детальные предложения прилагаются)
- 5 10 Окружающая среда

6 0 Предварительный финансовый анализ

- 6 1 Капитальные и текущие затраты
- 6 2 Прибыль, тариф и зарплаты
- 6 3 Анализ возможного риска и окупаемость
- 6 4 Источники финансирования

7 0 Административные и организационные требования

- 7 1 Государственные и правовые реформы
- 7 2 Частные компании по теплоснабжению

8 0 Заключения и рекомендации

June 6, 1996

DELIVERY ORDER NO 11
DISTRICT HEATING SYSTEMS REHABILITATION
TBILISI, GEORGIA

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

- 1 1 Introduction
- 1.2 Principal Findings
- 1 3 Recommendations

2.0 BACKGROUND

- 2 1 Objectives of Delivery Changes
- 2 2 Scope of Work

3 0 REHABILITATION PROJECT PROPOSALS

- 3 1
- 3 2
- 3.3
- 3 4
- 3 5
- 3 6
- 3.7
- 3.8
- 3.9 - etc

4 0 POTENTIAL REHABILITATION PROJECTS (identify)

- 4 1 Industrial, Commercial and Government Consumers
- 4 2 Decentralized Heat (and Power)
- 4 3 Conceptual Projects

5 0 LONG TERM STRATEGY

- 5 1 Capital Preservation
- 5 2 Distribution Systems

6 0 CONCLUSIONS AND RECOMMENDATIONS

APPENDICES

ЗАКАЗ О ПОСТАВКЕ N 11

Восстановление районных отопительных систем
Тбилиси, Грузия

СОДЕРЖАНИЕ

1 0 Итоговый документ

1 1 Введение
1 2 Основные выводы
1 3 Рекомендации

2 0 Общий обзор

2 1 Цель заказа о поставке
2 2 Объем работ

3 0 Предложения о восстановлении объекта

3 1
3 2
3 3
3 4
3 5 (Детальные предложения, 9)
3 6
3 7
3 8
3 9

4 0 Потенциальные проекты по восстановлению (определить)

4 1 Коммерческие, государственные и производственные потребители
4 2 Децентрализованное тепло (электричество) (10)
4 3 Концептуальные проекты

5 0 Долговременная стратегия

5 1 Капитальная консервация (концептуальная оценка) (11)
5 2 Распределительные системы

6 0 Заключения и рекомендации

SCHEDULE + CASHFLOW

5-28-96

ZUGDIDI 5911-01

PUMPING STATION EQPMT
ELECTRICAL EQPMT
WELLHEAD EQPMT
DISTRIBUTION PIPING
INSTALLATION — 5 WEEKS — $14,500

TESTING — 8 WEEKS — $54,100

FIRST STAGE

ARCI — SUBTASK 1, ACTIVITIES 1, 2, 3 — 5 WEEKS — $8,410

SECOND STAGE

SUBTASK 1, ACTIVITIES 4, 5 / SUBTASK 2+3 — 9 WEEKS — $33,345

JULY 24 TO AUG 9 MEETING
EBRD, USAID, GEOTHERMI
BREI + ARCI

TBILISI 5925-01

REHAB WELL 1-L
REHAB WELL 5-T VALVES
METERING DEVICES INSTALL — 4 WEEKS — $29,000

TESTING — 5-8 WEEKS — $16,000

JULY 24 TO AUG 9 MEETING USAID

CONSTRUCTION – TANKS + PIPING + CONTROLS — 16 WEEKS — $599,000 1995 PRICES

ARCI – 9 PROPOSALS — 12 WEEKS — $35,390

196

График финансирования

28 05 1996

Зугдиди 5911-01
Насосное оборудование станции
Электрооборудование
Оборудование для напора скважины
Распределительный трубопровод

/Монтаж	/Проверка
5 недель	8 недель
$114 500	$ 54 100

Первый этап	Второй этап	
Арси, подзадача 1, действия 1,2,3/	подзадача 2, действия 4,5	
5 недель	(подзадача2+3, июль 24-авг 9)	
$8 410	9 недель	Встреча с EBRD,
	$33 345	USAID, BREI, ARCI
		Геотермия

Тбилиси 5925-01
Реабилитационная скважина N 1-L

Реаб скв N 5-T, клапаны/	Проверка/	Строит -резервуар+труб +контр
4 недели	5-8 недель	16 недель
$29 000	$16 000	$599 000 по ценам 1995 года

июль 24-авг 9
встреча с USAID

АРСИ - 9 предложений
12 недель
$35 390

June 6, 1996

PER CAPITA POWER CONSUMPTION 1989

23,700 kwh	Norway
16,000 kwh	Sweden
10,900 kwh	USA
6,800 kwh	Germany
6,700 kwh	France
5,600 kwh	Soviet Union
3,600 kwh	Georgia

---

0 - 50 kwh/month 3.1 c/kwh	350 Families
51 - 130 kwh/month 4 1 c/kwh	x4.5
131→ kwh/month 4 9 c/kwh	1575 Persons

Natural Gas		Heat
1995 was $80 / 1000m^3	→	$22 70 - $24 60 / Gcal
June 1996 $65 / 1000m^3	→	$18 44 - $20 00 / Gcal

No. 2 Diesel Oil

$200 / Tonne	→	$34 50 - $36 00 / Gcal

Water Consumption

120L / Day Hot
225L/ Day Cold

Heating Demand

1200 w/ Person in Tbilisi
1900 Hrs / Year

198

Потребление электроэнергии по данным 1989 на душу

Норвегия - 23 700 квт/час
Швеция - 16 000 квт/час
США - 10 900 квт/час
Германия - 6 800 квт/час
Франция - 6 700 квт/час
СССР - 5 600 квт/час
Грузия - 3 600 квт/час

0-50 квт/час/месяц	3 1 цент/квт ч	350 семей x 4 5=1575
51-130 квт/час/месяц	4 1 цент/квт ч	
131--- квт/час/месяц	4 9 цент/квт ч	

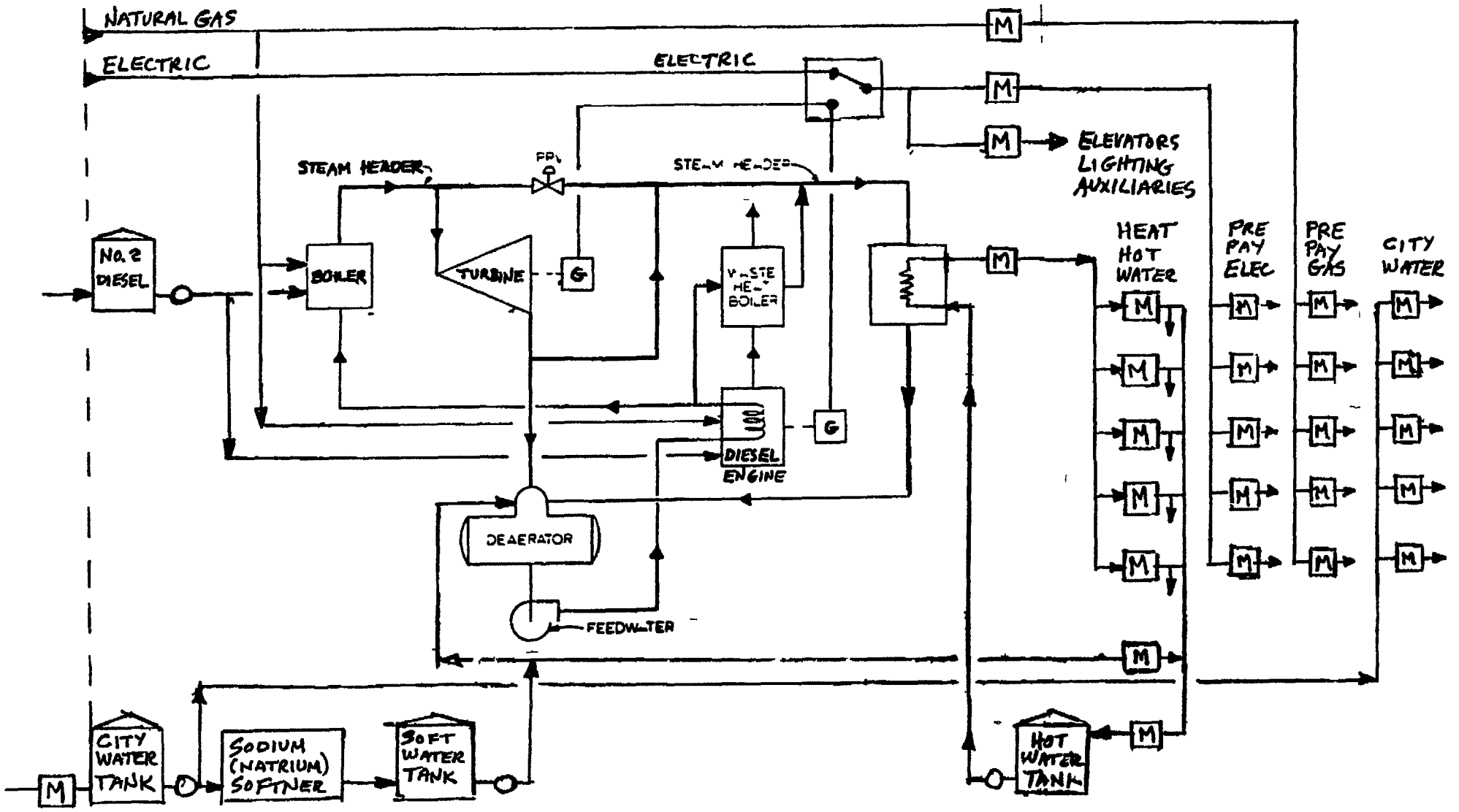
Природный газ	Тепло
В 1995 - $80/1000 м^3----------	$22 70 - $24 60/Гкал
Июнь 1996 - $65/1000 м^3 ---	$18 44 - $ 20 00/Гкал

N 2 Дизельное топливо
$ 200/т -------$34 50 - $ 36 00/Гкал

Потребление воды
120 л/день - горяч
225 л/день - холод

Отопление
1200 ватт/чел в Тбилиси
1900 час/год

TBILISI 6-3-96



PILOT METERING + COGENERATION PROJECT

Wed 5 June 96

TURBINE STEAM RATE

16 - 34 LBS/KWH BACKPRESSURE

6.7 - 24 LBS/KWH CONDENSING

$$\dot{m}_s = \frac{2545}{h_1 - h_2} \text{ LBS/HP-HR}$$

3414 BTU/KWH

---

1 BAR = 14.5038 LB_f/IN^2

1 PSI = 2.044 "Hg @ 70°F

1 "Hg = 0.489 PSI @ 70°F

1 Kg = 2.2046 LBS

1 MPa = 145.038 PSI

1 MW_t = 3.412×10^6 BTU

1 GCal = 3.968×10^6 BTU

GPM = 4.4081 × M TONNES/HR

1 GAL = 3.785 ℓ

1 ℓ = 0.2642 GAL.

USAID Exit Interview
Friday, 9 August 1996

A trip to Tbilisi, Georgia began on Tuesday, 23 July 1996 for 17 days to work with ARCI Consulting, the Burns and Roe local subcontractor on the following delivery orders

D o No 11 - Tbilisi District heating System Improvement Program
D o No 25 - Zugdidi Geothermal assessment

The purpose of this trip was to meet with EBRD to present findings of Zugdidi Geothermal Phase I preliminary assessment, discuss EBRD loan requirements, and continue preparing Tbilisi District Heating rehabilitation proposals

Other than preliminary data gathering and preparation of a testing cost estimate, ARCI has not yet been authorized to work on Zugdidi However, ARCI has been released to prepare design and cost estimates for three Tbilisi district heating thermal station rehabilitation projects Main focus has been directed to develop annual electrical and thermal load profiles and obtain vendor data and budgetary cost estimates and prepare conceptual designs and space layout requirements

Technical reports and drawings containing original data and design information describing the Zugdidi geothermal resource and distribution systems were obtained from Sakburgeothermia during the last trip and translated from Russian to English Based on review of this information, discussions with Georgian geologists and visual inspection of wells, GeothermEx submitted a partial preliminary report on 25 July

A very important recommendation is that flow and injection testing should be conducted in order to make a realistic assessment of the potential magnitude and life of the geothermal resource About $250,000 is estimated for the program of which more than half will be for permanent installed materials and equipment If this testing cannot be done for the EBRD pre-loan assessment, then the Zugdidi project may have to be extended in two or more phases with some of testing being included during a limited first phase utilization of hot water for schools and residential consumption Burns and Roe and ARCI will evaluate and present by mid-September a strategy for development of project

As soon as ARCI starts working on the Zugdidi project, specialists will gather local information required as part of market survey to determine residential and commercial demand forecasts for thermal energy and revenue requirements This will include determination of ownership structure and relationship for institutional and commercial enterprises

A specification and requisition for purchase of a computer and "Heatmap" software program for modeling the Zugdidi wells and district heating distribution system has been prepared

By mid September ARCI and Burns and Roe will identify several more critical heating supply rehabilitation projects for Tbilisi under Delivery Order No 11 procurement budget which can be implemented by winter this year Some possible examples are

- Maternity Hospital No 5 - repair two gas fired hot water boilers, install pipeline to orphanage, repair heating distribution Benefits high visibility to public, additional revenue for hospital from state

- Maternity Hospital No 4 - reconstruct two boilers, construct public laundry and bath-house Benefits high visibility to public, additional revenue for hospital from private citizens

In addition, the following activities will be worked on over the next eight to twelve weeks

- Prepare Delivery Order No 8 Completion report
- Initiate/implement critical heating supply rehabilitation projects for Tbilisi winter
- Complete proposal and cost estimate for pilot metering project
- Initiate Lisi geothermal flow tests
- Complete Tbilisi district heating rehabilitation proposals
- Locate funds for Zugdidi flow tests
- Prepare and distribute Zugdidi market survey questionnaire
- Finalizing Delivery Order No 11 Tbilisi District Heating Rehabilitation Preliminary Draft Report

Vendor support for equipment data and pricing has been good However, the time difference and communications problems make it difficult to obtain information from Tbilisi quickly It is much easier to communicate with US and European vendors from the US to gather needed data and send it to ARCI in packets

The next trip to Tbilisi is scheduled for last week of October or early November to follow up, assist and expedite the previous discussed activities

Prepared by
John E Hallberg P E
Burns and Roe Enterprises, Inc

Meeting Notes
Tuesday, 30 July, 1996

A meeting was held at the Metekhi Hotel at 7 PM to discuss status of USAID Delivery Order No 25 - Zugdidi Geothermal Project assessment for EBRD financing

Attendees.

Lars Hultin	European Bank for Reconstruction and Development
John E Hallberg	Burns and Roe Enterprises
Alexander Arobelidze	ARCI Consulting
Ivane Zazashvili	SAKTRANSGAZ
David Bakashvili	SAKBURGEOTHERMIA

The purpose of the meeting was intended to present to EBRD our findings during the first phase assessment However, ARCI has not yet been authorized to proceed with their scope of work Therefore, a brief summary of preliminary work accomplished to date was presented The preliminary report for EBRD/USAID review will have to be submitted later this year

We first discussed the problem of trying to determine the present organizational structure and chain of command of various departments involved in geothermal energy ARCI Consulting will describe the ownership structure and institutional reforms in the preliminary report As understood at this time, ownership is primarily state, with division of responsibility indicated as follows

30% Sakburgeothermia
Exploitation
Care of 90% of geothermal wells
Own two drilling rigs

50% Municipality
Distribution

20% Geothermia, Ltd (Quasi-private)
Operation

As discussed during this meeting, the following EBRD criteria and suggestion should apply to the Zugdidi geothermal district heating project

1 Financing is for public project ($10 million minimum)

2 Loan is to the Government with guarantees through Minister of Finance

3 The Ministry of Energy shall declare the Zugdidi geothermal district heating rehabilitation project as a priority

4 It is suggested to incorporate the majority of resource testing expenses within the project cost as part of normal startup testing

5 It is suggested to propose ownership structure by means of Joint Stock Company with 51% minimum government ownership It will be advantageous to include the thermal recipient commercial enterprises to participate An example is the joint venture German-Georgian tea factory

7 A business plan with thorough market research as backup shall be submitted

8 Some terms of the loan
- Interest rate - 1% above LIBOR, variable
- One percent front end fee
- One percent interest on unused funds
- Period of loan - 15 years
- Interest payment due immediately upon signing
- Up to two year grace period for principal payments while project is completed, ready to operate

9 If project is not selected for public financing, a backup strategy shall be investigated to seek private project financing from EBRD and other sources EBRD will only provide 35% financing with $10 million minimum loan for private projects This means a $30 million private development project possibly incorporating secondary financing for the large thermal host enterprises It would help to find foreign investment through joint ventures of a large holding company to secure this sum of investment However, the potential returns from the enterprises revenues could be very attractive to investors, and export of quality food products could secure badly needed hard currency for Georgia

USAID Delivery Order No 25
Zugdidi Geothermal Assessment
Status 30 July, 1996

Introduction.

- The government of the Republic of Georgia has requested that the EBRD assist in preparing a district heating project for Zugdidi to utilize geothermal energy
- The EBRD funded a study "Geothermal Resources in the Republic of Georgia" by the Icelandic firm of Virkir-Orkint Consulting Group Ltd of Reykjavik which included a discussion of the resource at Zugdidi
- USAID has agreed to fund a pre-loan assessment by Burns & Roe Enterprises Inc and its subcontractors to undertake specified tasks

Scope of Work - Phase I

- Review existing documentation
- Quantify geothermal resource
- Prepare district heating system design
- Residential and commercial demand forecast
- Conduct market survey
- Preliminary financial analysis
- Ownership structure - institutional and commercial
- Preliminary risk analysis

Preliminary Results

- Two trips were made to Zugdidi (October, 1995 and February 1996) by Burns & Roe, ARCI and Geothermia
- Geothermal wells were visually inspected
- Technical reports and drawings were obtained and translated into English
- Meeting were held with government, municipal and commercial enterprise officials
- Preliminary data was submitted by entities
- Preliminary report prepared by GeothermEx
- Flow test design and cost estimate prepared

Findings and Recommendations

- There is great potential for developing the resource
- There is great potential for developing the commercial enterprises as thermal consumers to financially support the financing
- A testing program as recommended by Geothermex must be implemented to quantify the resource before continuing with the detailed assessment

USA Humanitarian Aid to Georgian Energy System

Energy deficiency in Georgia turned into an unsurpassable problem During summer, when there is heat and floods, the country has some hydro power supply, but as soon as the flood is over and winter comes, electricity is supplied to the population during a few limited hours Nobody knows for how long this situation is going to last, nobody knows when to expect a significant change

Though it is well known that a lot of money (loans and humanitarian aid) has been spent for energy purposes during the last few years, if we consider only sums granted by the US government, it is already a considerable amount

USAID, Agency for International Development is the general coordinator of American humanitarian aid The Agency employed a US company "Burns and Roe" to accomplish a program of studies and some part of rehabilitation work In 1994 aid of 4,5 million dollars was assigned for the assistance program a part of which was used to purchase materials and equipment, while the rest of the sum was used to prepare tender documents for three projects

1 Water Treatment Facility for Tbilisi Power Plant,
2 Condenser Tube Cleaning System for Tbilisi Power Plant,
3 Replacement of turbine and governor at Rioni Hydro Power Plant

The tender documents were prepared in accordance with the rules of European Bank and World Bank and include technical and legal parts

The program financed by 1995 budget included a study of Tbilisi district heating system "Burns and Roe" repaired boilers for Maternity Hospitals N 4 and N5, City Mental Hospital and Burns Center This program is planned to be continued in 1996

The company also studied the possibilities of heating Tbilisi residential districts by means of geothermal energy There is an opinion that this way it is possible to heat region with 120 000 population in Tbilisi

Similar studies were carried out in the city of Zugdidi Zugdidi municipality is ready to direct some funds to heat Zugdidi schools and hospitals by means of geothermal water It is even more promising to use geothermal water for industrial purposes

"Burns and Roe" specialists will also study the gas supply system (condition of the pipeline and the pump stations) and prepare technical documentation This problem is common for Georgia and Armenia

The company performed inspection and verification program and prepared inspection documents for Unit N 10 at Tbilisi Thermal Power Plant

At present the issue of allocation of large loans for Georgia by World Bank and European Bank is being discussed The loans will be used for rehabilitation programs of Unit N 10 (Tbilisi Thermal Power Plant) and hydro power stations The hydro power plants selected for rehabilitation program are Khrami 2, Tkibuli, Lajanuri and Vartsikhe "Burns and Roe" specialists worked out several options of the projects

There are also plans to rehabilitate Georgian power network The Feasibility Report for this project was also prepared by "Burns and Roe" And even this is not a complete list of "Burns and Roe" activity in Georgia

Galya Gotoua, Reporter

"Droni" (Times) -Tbilisi, Georgia
Article published 23-26 July,1996

USAID Exit Interview
Friday, 22 November, 1996

A trip to Tbilisi, Georgia began on Friday, 1 November to work with the Burns and Roe Enterprises Inc local staff and ARCI Consulting, the local subcontractor consultant engineers on the following USAID delivery orders

D O No 11 - Tbilisi District Heating System Improvement Program,
D O No 25 - Zugdidi Geothermal Assessment

The main purpose for this trip was to review and initiate several critical heating supply rehabilitation proposals identified by last September and detailed by ARCI for completion this winter Tighter procurement requirements by USAID for Georgia will lengthen the time for issuing purchase orders to contractors and signing of contracts Therefore, it is not likely that these heating projects will be completed this winter A summary list of recommended proposals with description is attached

ARCI was given partial authorization in mid October to begin work on Zugdidi assessment A survey has been started for making an assessment of existing wellfield equipment, wellhead valve trees, distribution piping and consumers facilities Historical background of the Zugdidi geology and geothermal development has been completed and much original data has been obtained "Geothermex", the "Burns and Roe" subcontractor providing geology expertise, submitted a questionnaire for inventory of geothermal test equipment and geochemistry test requirements for Geothermia to provide answers Much capability may be available in Georgia from Sakburgeothermia or Sakgaz Since there are no USAID funds provided for testing, it is crucial for the preparation of a credible assessment of the resource that at least the most rudimentary tests could be conducted, to be monitored by Geothermex Reference is made to the last USAID exit interview memo dated Friday, 9 August, 1996 with attached EBRD meeting notes dated 30 July, 1996, to avoid repetition

Prepared by
John E Halberg P E
Burns and Roe Enterprises Inc

Meeting Notes
Wednesday, 20 November, 1996

Attendees
Caryle Cammisa, Development Coordinator
USAID /Caucasus/ Tbilisi
Zurab Menteshashvili, Manager, BREI Tbilisi
John E Hallberg P E, Task Leader

Subject D O No 11, Tbilisi District Heating System Development Program
"Cost effective solutions for meeting critical emergency heating needs by means of rehabilitation "
"Provide critical needed spare parts and materials"

Discussion
The purpose of this meeting was to coordinate with USAID - Tbilisi to present several rehabilitation and maintenance proposals for approval to use USAID funds, which are in place, to meet critical heating needs for this winter Ms Cammisa was informed that BREI Tbilisi just received a summary of USAID changes in approach to procurement, outlining key requirements and issues Because of the requirement for all procurement activities to be executed in Washington, D C , it is unlikely that any of this work can be completed for this winter

Ms Cammisa addressed the USAID focus on how these small rehabilitation projects can contribute to the market development of the Georgian economy in that it gives local contractors the opportunities to gain experience in free market activities, such as competitive bidding, negotiating, contracts, and international procurement It also contributes to business development and local employment

Ms Cammisa was shown the English translations of design documents of several proposals prepared by ARCI Consulting, the BREI local subcontractor, in Georgian However, the original documents have not yet been prepared in typewritten form suitable for submittal to contractors as tender documents ARCI is awaiting BREI authorization based on USAID approval, unless the new procurement guidelines require this work to be completed in Washington, D C

Ms Cammisa expressed concern about the amount of time the new procedures will take, that nothing is likely to be accomplished for this winter, and that it is important to maintain USG assistance visibility at this time Also, she wanted to know what the cost impact will be for these additional layers of administrative involvement She was informed that each procurement specialists trip to Tbilisi would add about $8000 per trip in travel, lodging and per diem and at least two trips would be required Mr Bill Smith, USAID, Manager - Transcaucasis Energy Programs from Regional Office - Yerevan will be in Tbilisi next week Ms Cammisa said he is very interested in the magnitude and seriousness of the heating problems in Tbilisi, and they plan to discuss these issues and

visit some of the thermal stations, and wanted suggestions of where to go BREI offered to bring ARCI and show them two or three of the largest and newest multi-million dollar facilities which haven't operated since 1991, haven't been preserved, and have sustained substantial damage

Ms Cammisa stated that she will discuss the procurement issues with Mr Smith She said that the US Embassy may have an interest in expediting some of the winter 96-97 rehabilitation work She also requested BREI to attend the EC coordination meeting on Friday, 22 Nov at 10 30 AM to present a general overview of the work BREI is doing in Georgia She stated that representatives from USAID, World Bank, U K , Germany, Hagler Bailly and sometimes other contractors attend She would like to see BREI become more involved in these meetings and will be in regular contact with Mr Menteshashvili about future meetings

Notes prepared by
John E Hallberg P E
Senior Mechanical Engineer
Burns and Roe Enterprises Inc

w/attachment

cc USAID, per request
Zurab Menteshashvili, BREI/ Tbilisi
Douglas Tuckhorn, BREI/ D C
Glenn Fick, BREI/ D C
Sam Gerges, BREI/ D C

11-22-96

SUMMARY
Winter 1996-1997 Heating System
Rehabilitation Proposals

Description	**Budget Estimate**
1 **School No 169** - install a decentralized hot water heating system with gas fired hot water boilers, preassembled and skid mounted in an outdoor water proof metal enclosure	$ 14,589
Benefits high visibility to public, heated school rooms for children, business development for Georgian contractor, substantial energy savings, using cleaner burning gas vs more expensive diesel oil	
2 **School No 182** - install a decentralized hot water heating system with gas fired hot water boilers, preassembled and skid mounted in an outdoor water proof metal enclosure	$ 14,589
Benefits high visibility to public, heated school rooms for children, business development for Georgian contractor, substantial energy savings using cleaner burning gas vs more expensive diesel oil	
3 **Maternity Hospital No 5**- repair two gas fired hot water boilers, repair gas supply piping add gas meter	$ 9,600
Benefits high visibility to public, additional revenue to the hospital from state, business development for local contractors, energy savings using clean burning gas	
4 **Maternity Hospital No 4** - repair two gas boilers and pumps, repair water softener equipment, distribution piping, insulation, add meters	$8,789
Benefits high visibility to public, additional revenue to the hospital from private citizens to pay for fuel, energy savings using cleaner burning gas vs more expensive diesel oil, private sector business development	
5 **Burn Hospital** - installation of solar collector hot water supply system	$ 25,320
Benefits high visibility to public, energy savings by reducing consumption of natural gas and diesel oil, no environmental emissions, business development and employment	

6 **Lisi Geothermal Well Thermosiphon** - completion of piping, repairs to wellhead tree valves, install instruments for monitoring resource level and draw down during changes to production flow $45,000

Benefits high visibility to public, improve and increase hot water supply to Lisi district, obtain flow test data for next phase development, business development for local contractor, employment, no use of fuel or power, no environmental pollution

7 **Thermal Station No9** -Provide substantial contract maintenance support and materials to repair boilers, controls, equipment and piping, to be able to operate the plant and supply heat to central Tbilisi government buildings, private business, banks and schools $ 50,000

Benefits very high visibility, gain attention for privatizing this energy supplier, show profitability of this facility as incentive to finance proposed $ 5,500 000 rehabilitation, cogeneration repowering and power and heat metering project

USAID Exit Interview
Friday, 14 February, 1997

A trip to Tbilisi, Georgia began on Friday, 31 January to work with the Burns and Roe Enterprises Inc, local staff and ARCI Consulting, the local subcontractor Consultant engineers on the following USAID delivery orders

D O No 11-Tbilisi District Heating System Improvement Program
D O No 25 Zugdidi Geothermal Assessment

Status of D.O. No.11
Seven of nine project design proposals were completed last November 1996 of which six were intended for winter heating systems rehabilitation work BREI is awaiting approval from USAID to issue a purchase order to ARCI for Construction management services for the six projects (see attached list) Because of tightened purchasing requirements, this work will not be completed for this winter ARCI is still awaiting a purchase order for preparing the D O No 11 rehabilitation proposals before completing the remaining two sub-task reports

One sub-task required by USAID in the delivery order is to prepare a design proposal for a pilot metering installation and program for billing, payment and control of energy consumption (for electricity, gas, heat and water)

It was rumored last year that another metering project was being implemented in Tbilisi USAID informed BREI this trip that the World Bank was financing a metering project Subsequently, Hagler Bailly indicated that TACIS/KANTOR with NRECA had an office at Sakenrgo BREI had a meeting with NIKOS TSAKALIOIS of KANTOR and found out that a metering project started October, 1996 and will be completed by July, 1997, with information gathering to follow This metering project is titled "Payment Discipline and Financial Management in the Georgian Electricity Sector" The part of metering program for Tbilisi involves 200 residential families and 6 commercial establishments in KRTSANISI district This example of having to dig for information indicates a need for better coordination and sharing of information about projects in Georgia

Status of D.O. No.25
ARCI completed Phase I and sub-tasks 1 and 2 of Phase II They are still awaiting a purchase order for this work The remaining sub-tasks and Phase III report entails the local survey work, wellfield assessment and minimal testing with Geothermex wellfield engineer presence This work will Include preparation of business plans, financial analysis and presentation of necessary reforms for government restructuring, leading to support of joint ventures and/or privatization of commercial Enterprises as required by EBRD

As soon as purchase orders are issued, a trip to Zudidi by BREI, ARCI, Geothermia and Gothermex will be scheduled, hopefully by April, 1997

Prepared by
John E Hallberg P E
Burns and Roe Enterprises Inc

11-22-96

SUMMARY
Winter 1996-1997 Heating System Rehabilitation Proposals

Description	Budget Estimate
1. School No 169 - install a decentralized hot water heating system with gas fired hot water boilers, preassembled and skid mounted in an outdoor water proof metal enclosure.	$ 14,589
Benefits high visibility to public, heated school rooms for children, business development for Georgian contractor, substantial energy savings, using cleaner burning gas vs more expensive diesel oil	
2. School No 182 - install a decentralized hot water heating system with gas fired hot water boilers, preassembled and skid mounted in an outdoor water proof metal enclosure	$ 14,589
Benefits· high visibility to public, heated school rooms for children business development for Georgian contractor, substantial energy savings using cleaner burning gas vs more expensive diesel oil	
3. Maternity Hospital No 5- repair two gas fired hot water boilers, repair gas supply piping add gas meter	$ 9,600
Benefits: high visibility to public, additional revenue to the hospital from state, business development for local contractors, energy savings using clean burning gas.	
4 Maternity Hospital No 4 - repair two gas boilers and pumps, repair water softener equipment, distribution piping, insulation, add meters	$8,789
Benefits: high visibility to public, additional revenue to the hospital from private citizens to pay for fuel, energy savings using cleaner burning gas vs more expensive diesel oil, private sector business development	
5. Burn Hospital - installation of solar collector hot water supply system	$ 25,320
Benefits: high visibility to public, energy savings by reducing consumption of natural gas and diesel oil, no environmental emissions, business development and employment	

6. **Lisi Geothermal Well Thermosiphon** - completion of piping, repairs to wellhead tree valves, install instruments for monitoring resource level and draw down during changes to production flow $45 000

Benefits: high visibility to public, improve and increase hot water supply to Lisi district, obtain flow test data for next phase development business development for local contractor, employment, no use of fuel or power, no environmental pollution

7 **Thermal Station No9.** -Provide substantial contract maintenance support and materials to repair boilers, controls, equipment and piping, to be able to operate the plant and supply heat to central Tbilisi government buildings, private business, banks and schools $ 50 000

Benefits very high visibility, gain attention for privatizing this energy supplier, show profitability of this facility as incentive to finance proposed $ 5,500,000 rehabilitation, cogeneration repowering and power and heat metering project

Burns and Roe Enterprises, Inc.
27 Rustaveli Ave Tbilisi, 380008, Georgia, Tel (99532) 93 58 99, Fax (99532) 99 06 89
ბერნს ენდ როუ ენტერპრაიზის, ინკ.
რუსთაველის გამზ.27 თბილისი 380008, საქართველო ტელ (99532) 93-58-99 ფაქსი (99532) 99-06-89

Tbilisi, Republic of Georgia
e-mail JJJ@BRE kheta.ge, BRET@bre ge
Telephone 99532 93 58 99
Reply Fax 99532 99 06 89

Date 19 May, 1997 **Time 17 30** **W O #5908-02**

TO Douglas Tuckhorn *cc*	*FROM Zurab Menteshashvili*
Subject Possible projects	*Reference*
Number of Pages (including cover sheet) 4	

Dear Doug

We could identify and develop/or participate in various projects of different scales and directions Our main lack of competence is in approach to potential investors
Otherwise we can initiate many different projects which will be highly beneficial from the point of view of reform policy / environment, energy saving and efficiency, and could conform with plans and intentions of different international agencies including restructuring privatization etc

High qualification and relations of our engineers are the valuable assets which should be utilized to full extent They have participated in many projects and have a good knowledge in many aspects of energy sector

Let me give you some examples

1) Repowering of old Gardabani units
This is a Temur Mikiashvili's idea With kind assistance of John Hallberg he has done a preliminary evaluation

Description
There is a great deficit of base power in Georgian power system which is one of the main obstacles on the way to country's development Base power is produced at Gardabani Thermal Power Plant (GTPP) by old steam turbine units #3 and #8 (capacity ~120MW each) and a new unit #9 (250-300MW)
The old units are in a rather poor condition and have low efficiency Rehabilitation of unit #10 is underway but this will be insufficient to meet the country s need for base power

It is proposed to reconstruct one or several old unit(s) into a combined cycle plant(s) by dismantling and replacing the old obsolete boiler(s), adding new gas turbine generators

This idea is new and has not been considered by Sakenergo or Government However it is very likely that soon it will become popular, since it is in line with international practice and has especially many advantages in our particular case

- The project will reduce the great deficit of **base power** in Georgian Electric Power System by 150MW (per one unit)
- The **efficiency** of the resulting plant will be much higher then that of existing units (more than 50% vs existing 30%)
- The project can utilize the **existing steam turbines**, existing plant facilities and constructions
- We can probably apply experience of B&R gained from Russian study two years ago
- The expected cash flows of the project and comparison with other options show the high profitability of our proposal

I have mentioned this idea to Bill Smith who was quite interested and told that USAID wants to make its activity 'visible' The USAID funded feasibility study for the proposed project could be highly visible

Now this must be even more true, since the recent matter with Transgaz has not added much to positive visibility of AID

2) **Tbilisi heat-power plant study**

This is a 16MW old heat power plant which supplies power and heat to a small district in the center of city It is now a government owned joint stock company, 50% of shares will be sold in near future The personnel will be offered considerable number of shares Presently the management is looking for a chance to perform a feasibility study for rehabilitation of the plant and to prepare a business plan in order to attract investments Our engineers and ArCi will probably start the initial stage a pre-feasibility evaluation The idea of combined cycle plant will be most likely applicable in this case also

There will be a plenty of such work in future, since the privatized enterprises will need the evaluation technical auditing and recommendations for improvement of their assets

3)Coal-fired power plant near Tkibuli (West Georgia)

Tkibuli is an old developed region of coal mining situated in West Georgia Currently the mines are not operating In the government a priority is given to possibility of construction of coal-fired thermal power plant near Tkibuli The estimates show that the coal will be enough for at least 30 years operation of 100MW plant This project is popular in government since

- it provides a source of base power for developed industrial region (presently the only base power station is in East Georgia)
- utilizes the cheap local coal
- provides employment for a great number of workers and perspectives of further industrial development (production of gypsum, concrete etc)

Zurab had a discussion with deputy head of Saknakhshiri (Georgian Coal - department under Ministry of Fuel and Power) There is no developed project yet Some German investors are ready to conduct a feasibility study for mines and probably will contribute 25% financing for the whole project in case there will be other investors

There is a need for feaibility study related with coal fired power station, because currently rather little is known here about technical and economical parameters of this kind of plant These project (preparation of feasibilty study) is also of the scale that fits well in USAID funded project s size and this subsector of energy sector of Georgia (coal and associated plant) have not been covered yet bu USAID This might be an advantage

BREI UKRAINE LUGANSK CFB PROPOSAL

4) Pilot project for establishing a heat and power metering&collection system in a selected district of Tbilisi (You have discussed it several times with ARCI)

D.O. 1

It seems that this project conforms very well with AID objectives of increasing economic efficiency restructuring and private sector participation in the enegy sector
it promotes market oriented mentality energy saving and environmental awareness of the population

5) TACIS is going to establish an energy saving office in Tbilisi and there is a tender announced We were visited by a potential bidder who was looking for a future basis for their activities and was seeking for cooperation There is a chance to contact other bidders as well and to offer our services One of our engineers (Otar Vezirishvili) is already working as an expert in TACIS project

6) Batumi heating & cooling project (see attached)

7) Using experience of our engineers we can also become involved in some other activities related with determination of optimal seasonal and daytime tariffs for heat and electric power fuel metering systems at Gardabani Thermal Plant energy saving measures & alternative power sources

In all of these fields there are new ideas suggestions or designs developed to some extent

We plan to discuss some of these issues with local USAID here and to somehow correlate with their future plans We can also continue to explore possibilities in the mentioned directions however it would be very helpful if we had at least a slight idea about B&R possible plans in Georgia and also if you could provide us an advise on what could be the possible financing sources for the above activities

It is very likely that many if not all of these projects will be implemented sooner or later regardless to our participation So it would be a pity to miss a train
We could apply more targeted efforts in different directions and the time is **now**!!

Best regards

Murman/Zurab

Heat and Cooling Supply to Batumi Central Blocks on the Basis of Heat Pump and Batumi Thermal Power Plant

Place of project implementation Batumi, city with developing economical infrastructure, is capital of Adjara Autonomic Republic (Georgia) Batumi is situated on the Black Sea coast close to border between Georgia and Turkey in the subtropical health resort and tourism zone Batumi is one of the main ports of Georgia Oil processing plant, Autonomic Republic Government and Cultural Centers are situated in Batumi

Problem of city heating Heat supply to the central blocks of Batumi is arranged by means of low capacity thermal stations that are using fuel oil (mazut) This method of heating is not effective from economical and ecological viewpoints Exhausts damage Batumi, one of the main health resorts and tourism centers of Georgia Therefore, modernization of the heating system is very important today for Batumi

Possible results of project realization Heat supplying complex system in Batumi on the basis of suggested project guarantees economy of fuel and energy resources and improves ecological situation in the region

Project parameters 200 Gcal per hour heat and 20 Gcal per hour cooling is planned for air conditioning by means of absorptive heat pumps and Batumi Heat Power Plant According to preliminary calculations approximately 22000000$ are needed for project realization Loan can be repaid during 3,5 years Fuel economy equals to 120000 tones of conventional fuel per year

Works required Working project to be designed, Heat pump installation in Batumi Power Plant to be carried out, Heat routes to be rehabilitated and extended in Batumi central blocks

Potential consumers City municipal building blocks, Oil processing plant

Partners during project design Group of Georgian specialists

Guarantees Loan repayment conditions and guarantee conditions will be agreed in contract with foreign investors according to the norms of Adjara Autonomic Republic legislation

Realities Group of project authors has preliminary agreement with Batumi Communal Administration Department about necessity of suggested project However, local financial resources are insufficient for project realization aims Participation of foreign investors is needed

Note This project was awarded prize of Ministry of Fuel and Energy of Georgia on the annual competition

Burns and Roe Enterprises, Inc.
27 Rustaveli Ave , Tbilisi, 380008, Georgia, Tel (99532) 93 58 99 Fax (99532) 99 06 89
ბერნს ენდ როუ ენტერპრაიზის, ინკ.
რუსთაველის გამზ 27 თბილისი 380008 საქართველო ტელ (99532) 93-58-99 ფაქსი (99532) 99-06 89

Tbilisi, Republic of Georgia
e-mail BRET@bre ge
Telephone 995 32 93 58 99
Reply Fax 995 32 99 06 89

Date May 15, 1997 **Time** **W O #5908-02**

TO Doug Tuckhorn	*FROM Murman Margvelashvili*
	Reference
Number of Pages (including cover sheet) 2	

Doug

We have a strong feeling that the country is at the start of fast development and there are many different projects emerging Having some experience and a very good team of engineers knowing people around, with a more active attitude we can take part in many of these However we didn t have any feeling on what the B&R plans for future could be

We want to use the time before your arrival for active information exchange in order to make your trip maximally effective and beneficial

There are several types of activities in which we could participate

1) Our engineers are working on pre-feasibility studies of some projects which seem very attractive from different points of view (technical, economical political) There is a hope that at least some of these could be interesting for international donors or other financial agencies
2) There are activities of other companies where B&R could participate as a subcontractor (like TACIS energy saving office) or work in cooperation (ARCI)
3) Many plants are in need of feasibility studies and different kinds of technical evaluation (to identify rehab measures, prices for privatization etc)
4) There are many new projects around with a great deal of engineering

We will be sending more detailed information in each of these fields

We hope to have contact USAID on the issue of their policy in the region however I don t think they have developed any comprehensive approach yet (c f the page we received on our request for a policy document) *

It would be very helpful to have your comments and some guidelines
If B&R is really interested in our region, we believe with thorough and careful joint effort we could build up a reputation of the company as one of the most effective and reliable partners in the energy sector

Murman/Zurab

საქართველოს პარლამენტი

გარემოს დაცვისა
და
ბუნებრივი რესურსების
კომიტეტი

380018 თბილისი რუსთაველის გამზირი 8
ტელეფონი 99-81 27
ფაქსი : 99-56-41
ელ ფოსტა : epnrcmt@parliament.ge

PARLIAMENT OF GEORGIA

ENVIRONMENTAL PROTECTION
AND
NATURAL RESOURCES
COMMITTEE

8 Rustaveli Ave Tbilisi 380018 Georgia
Telephone +995 (8832) 998 127
Telefax +995 (8832) 995 641
Internet epnrcmt@parliament.ge

№ 19/ 5369

18 , დეკემბერი 1996

[illegible]

To Otar Vardigoreli
President
Geothermia, Ltd

TRANSLATION

From Givi Gigineishvili
Head of Committee
Environmental Protection and
Natural Resources Committee

December 18, 1996

Dear Mr Vardigoreli,

As you know, there was a wide conference held on the issues of utilization of existing geothermal water resources on December 6, 1996, in Environmental Protection and Natural Resources Committee of the Georgian Parliament

We are sending you the decisions made by the Committee (enclosed) regarding the issues mentioned above

(Two appendicies)

Respectfully Yours

Givi Gigineishvili
Head of the Committee

222

CONCLUSIONS

of the Conference of the Environmental Protection and Natural Resources Committee of the Georgian Parliament on Utilization of Existing Geothermal Water Resources in Tbilisi

Hereby, the Environmental Protection and Natural Resources Committee of the Georgian Parliament confirms,

-its willingness to support the provisions stated forth in the document Agenda of the XX1 Century" of the "Program of the 21 Century Global Sustainable Development" adopted by the UN international conference held in 1992 in Rio-de-Janero,

Provided that the Committee considers the Decree of the President of Georgia on setting the Committee for Sustainable State Development,

and it is based on the following assumptions,

-Georgian geothermal water resources are valuable natural renewable energy resourses,
- rational and efficient development of the Georgian geothermal water resources is the significant factor in sustainable development of the state,
-rational utilization of the existing geothermal energy in Georgia is available and urgent at the present moment,
- development of the Georgian geothermal water resources is allowable from the environmental point of view,
- there is a state entity available (i e Ministry of Energy of Georgia) which is supposed to implement state policy in energy sector,
-there is a market-economy-oriented legal mechanism (i e Law of the Georgian Parliament on Underground Resources) available at the moment in Georgia which is involved in the existing geothermal water extraction and distribution,
- energy sector is considered to be the priority branch, international funding organizations are being informed of this issue,
-the German Government is greatly interested in rehabilitation of the Georgian energy sector and through investing policy (about 40 mil DM being already spent) the German party renders its assistance in three directions power energy generation, power transmission lines and thermal supply

Thus, the Committee thinks it reasonable

1) to consider utilization of the alternative energy resources, including geothermal waters as significant component of the renewable resources, as the priority issue for heat supply source to those local entities and districts, where it is allowable from the environmental and efficiency points of view,
2) to support any undertaking regarding the development of the geothermal water resources aimed at providing the Georgian population with heat supply,
3) to support the project proposed by the company "Geothermia" on Utilization of geothermal Waters in Tbilisi, particularly, Lisi lake area, and is aimed at providing the Tbilisi population with heat supply,
4) to apply to the Georgian Ministry of Trade and Foreign Economic Relations (K Zaldastanishvili, the Minister) to render its assistance in implementation of efficient investment projects which are designed by the German party jointly with the company "Geothermia" to contribute to existing geothermal water resources development in Tbilisi,
5) to apply to the Georgian Ministry of Energy and Fuel (D Zubitashvili, the Minister) to submit the said issue to the President of Georgia in order to make utilization of the energy sources, particularly the geothermal energy source, a priority task in supplying the Georgian population with heat,
6) to apply to Tbilisi Municipality (B Shoshitaishvili, the Mayor) and the State Department for Land Managment (Z Gegechkori, the Head) to allot certain land plots to the company "Geothermia" by the moment the project is being realized

საქართველოს
სამბრობ-ენერგეტიკის
სამინისტრო

MINISTRY FOR
FUEL AND ENERGY
OF GEORGIA

საქართველო, 380007 თბილისი, ლერმონტოვის ქ 10, ტელ 931384, ტელ./ფაქსი: 770045, ტელექსი. 212264 ATOM SU, ფაქსი 933542.
10, Lermontov Str., 380007, Tbilisi, Georgia, Tel. (995 32) 931384, Tel./Fax (995 32) 770045, Telex. 212264 ATOM SU, Fax. (995 32) 933542

№ 02/252 «21» 05 1997 г.

Dr Subir K Sanyal
President, GeothermEx Inc
5221 Central Ave , Suite 201, Richmond,
Ca 94804 USA Fax (510) 527-8164

Dear Dr Sanyal,

The Ministry for Fuel and Energy of Georgia determints the development policy of Renewable Energy including Geothermal Energy in Georgia

The Ministry will support in every possible way under mutually favorable conditions the co-operation among the Georgian party and "GeothermEx, Inc" and "Burns and Roe, Inc" which are extremly experienced in exploration, construction of geotermal fields in many countries, and which are familiar with Lizi and Zugdidi fields data in Georgia

Sincerely,

Minister
David Zubitashvili R. Abuladze

საქართველოს
სამთბო-ენერგეტიკის
სამინისტრო

MINISTRY FOR
FUEL AND ENERGY
OF GEORGIA

საქართველო, 380007 თბილისი, ლერმონტოვის ქ 10, ტელ 931384, ტელ./ფაქსი. 770045, ტელექსი 212264 ATOM SU, ფაქსი 933542
10, Lermontov Str., 380007, Tbilisi, Georgia, Tel. (995 32) 931384, Tel./Fax (995 32) 770045, Telex 212264 ATOM SU, Fax (995 32) 933542

№ 02/251 „21" 05 1997

Mr Charles Curtis,
1000 Independenece Ave , SW, Washington DC,
20585 USA Fax (202) 586-9260

Dear Mr Charles Curtis,

I am contacting you to ask for your cooperation in order to implement the project which would be of great benefit to the city of Tbilisi

This project concerns hot water supply for 300 000 families in the residential district and heating systems for kindergartens, schools and hospitals in the area as well

Eight geothermal wells had been drilled for this purpose during 1980's before Georgia entered into its period of economic chellenges We are very interested in using these existing wells in order to increase the hot water supply to the city Implementation of this project could replase 50 000 tons of oil per year (65MW of energy) which would decrease carbon dioxide emission and would allow our country to fulfill its obligations according to the Global Climate Change Treaty, which Georgia has signed up It could serve as a possible project for the US International Joint Implementation Programme and could assist companies involved in Geothermal Energy and distinct heating supply

I ask that you give careful consideration to this reguest for cooperation on the project which, we do believe, could be of great benefit to both countries

Sincerely,

Minister
David Zubitashvili R Arveladze

Professor Guram Buachidze
Acadewy of Sciences

MEETING NOTES
Tuesday, 27 May, 1997

Location. ARCI Office, Tbilisi, Georgia

Attendees. John E Hallberg, BREI (Ca)
Zurab Menteshashvili, BREI (T)
Alexander Arobelidze, ARCI
Dimitri Kostiadi, ARCI
Kakha Karumidze, ARCI

Subject D O 11, Tbilisi District Heating Improvement Program

Discussion

Alexander informed us that ARCI was awarded a tender for rehabilitation of TS-9 (for privatization) for providing heat to the parliament building this winter This is a reduced scope heat only project for our Subtask 1 Thermal Station No 9 Rehabilitation Proposal Our proposal is still valid and could be an extension of this work In fact, it may be even more attractive for financing as a private investment and improved fuel utilization efficiency by cogeneration

Sakenergo bid against their offer by proposing to supply heat from the Tbilisi Thermal Electric Station (TES) This station has become a hot topic of discussion in the government for rehabilitation (repowering) and privatization

Alexander suggests to add TES as a rehabilitation proposal to our report They would use the funds from Subtasks 3+4 to prepare the proposal They will use the funds from Subtask 2 to prepare the summery description only of Subtasks 2,3 and 4 projects, since these three hospitals are already privatized and self-sufficient

There is a real concern about the results of privatization and the disposition of assets TS No 8 was recently privatized and nobody knows what the owner will do with plant May be demolish? There needs to be some prerequisites for privatization to insure success, such as a business plan, management structure, accounting system, financial backing, etc ARCI scope of work for D O 11 does not include any requirements for developing privatization plans However, the delivery order addresses strategic objectives for our work, which implies that we should at least discuss the necessity for the recipients of financing to meet the necessary prerequisites (See attached)

ARCI is becoming more frustrated and disillusioned with the fact that it has been over a year and ARCI still does not have a contract to complete the engineering for both D O 11 and D O 25 ARCI has been working on many other projects for World Bank, Municipal

government and other Contractors, and they can see that the Europeans are far ahead of us in development of real projects for privatization

ARCI would very much like to Continue a working relationships with BREI and USAID, however, it is no secret that they are actively seeking another engineering consultant to team with, preferably European, to take the opportunities BREI and USAID are losing for American Business prospects

CLARIFICATION 27 MAY,1997

DELIVERY ORDER No 11

Tbilisi District Heating System Improvement Program

SCOPE OF WORK

1 Develop short, medium and long term rehabilitation plan
2 Strategic Objectives
   a Strengthen institutions and energy management capabilities and establish a climate for efficient competitive private-sector markets
   b Foster the emergence of a competitive, market-oriented economy in which the majority of economic resources are privately owned and managed
   c Result in Commercially viable private sector capability developed to provide energy services, including production and distribution
3 Rehabilitation Plan
   a Develop proposals
   b Develop budget capital, operating and maintenance cost estimates
   c Identify potential financing sources
   d Pilot Project-metering, billing, payment and control system to support future commercialization of the district heating company (Privatization)
4 Assessment Resources
   a Government of Georgia
   b Tbilisi Municipal Heat Committee
   c International financial institutions
   d Western Consultants
   e Existing studies
   - Development of an Energy Policy in Georgia TACIS/92/EGEOO 1
   - Interim Report, Sectorial Working Paper No 6, Rehabilitation of Urban District Heating Systems, October, 1997
   - Development of an Energy Policy in Georgia, TACIS/92/EGEOO 1/ Final Main Report (Draft)

MEETING NOTES
Friday, 23 May, 1997

Location Geothermia, Ltd Office, Tbilisi, Georgia

Attendees Otar Vardigoreli Geothermia, Ltd
Nodar Tsertsvadze Geothermia, Ltd
Guram Buachidze Geothermia, Ltd
Levan Tsertsvadze Geothermia, Ltd
David Bachakashvili Sakburgeothermia
Edvardo Granados GeothermEx (Ca)
John Hallberg BREI (Ca)
Zurab Menteshashvili BREI (T)

Subject D O 2 Zugdidi Geothermal Well Testing

Discussion

Ed Granados of Geothermex discussed his observations and assessment of the condition of existing wells which we inspected at Zugdidi and Tsaishi There was agreement on the selection of wells for flow and pressure tests and observation well level tests and the need to rehabilitate the well head pipe tree and valves on five artesian wells Geothermia provided well temperature profile and geologic data for seven wells, which BREI Tbilisi will provide copies for Geothermex Data for additional wells will be provided later

Geothermex will send drawings of a wier box and tank size along with a test plan in late June The wier box can be fabricated from existing salvage steel plate from the area A proper size surge flash tank can also be salvaged from the area

ARCI will review the previous cost estimates for repair to wells, rental of locally available mechanical level recorders, analyses, etc Also, Geothermex will evaluate the need for renting a well logging rig, and how long required if needed as this is the largest cost item

BREI will proceed with the request for funds so that this work can start It will require about four to six weeks to repair the wells The actual flow tests and resource testing and sampling will take six to eight weeks to complete Since D O 25 has been extended to January,1998, there are only seven months to complete the pre-loan assessment report for EBRD

Geothermia requested that Eduardo Granados return to provide oversite and witnessing of the start of testing, as he is quite familiar with the wells and resource and design of the well test plan

Geothermia has again expressed Concern about protection of proprietary data which the principals have spent many years developing and hold ownership to This goes back to over a year ago when Guram was pressing BREI for some kind of Contract or written agreement or memo of understanding This document would define the parties, scope of work, duties and responsibilities, protection of proprietary information and intellectual property, performance , guarantees and disclaimers The parties shall be USAID+EBRD, BREI+ARCI, and Geothermia, the "Company" and Sakburgeothermia

MEETING NOTES
Friday, 23 May, 1997

Location USAID office, Tbilisi, Georgia

Attendees: Caryle Cammisa, USAID Development Coordinator
John E Hallberg, BREI (Ca)
Zurab Menteshashvili, BREI (T)
Eduardo Granados, GeothermEx (Ca)

Subject Delivery Order No 11,24,25 status

Discussion

Ed Granados of GeothermEx gave a description of our trip to Zugdidi for inspection of the geothermal wells, assessment of repair work needed for testing, getting additional well data from Geothermia and agreements with Geothermia on preparation of a test plan About $25,000 is needed for repair of five well heads and getting other equipment

Ms Cammisa stated that she is very interested in the Zugdidi project and mentioned recent discussions with other groups, such as UNDP and US-ECRE energy trade delegation She asked if BREI needs any assistance in expediting P O 's for repairing the well-heads for testing It will require four to six weeks to perform the work after receiving funds It is very important to complete these tests so Geothermex can complete the resource assessment The flow testing and sampling of wells will require six to eight weeks to complete It is necessary to obtain this information for completing the pre-loan assessment report for EBRD D O 25 has been extended to January 1998, so this leaves only about seven months to complete ARCI still does not have a contract after one year of work, and still must prepare a business plan and privatization plans, etc representing about 30-40% of their scope of work

We discussed some of the factors concerning cancellation of the D O 24-Natural Gas Transmission system upgrade Ms Cammisa stated that USAID decided to cancel D O 24 because Parliament passed a decree that the natural gas transmission system will never be privatized because of the national security However, it is reported that Transgas is presently in the process of reform, recently separated from the Ministry of Fuel & Energy, corporized as International Gas Corporation, and lobbying Parliament to be removed from the list of strategic industries

Ms Cammisa stated that Transgas is getting a 10% transit fee, which 10 % of about $ 350,000 per day of gas (5,000,000 cu m/day)[1] should represent enough money to get all the equipment they needed However, the apparent reality is that very little cash changes hands The 10% transit fee is accounted as gas, of which 6 to 7% is in losses Of the remaining 3-4%, much of the gas is bartered for steel pipe, cement, power, etc Apparently, Transgas gets very little actual cash revenue to offset the high maintenance costs which they report cannot be meet

1 There are discrepancies in the reported volume of gas being transported, from 3 to 12 million cubic meters per day and prices of $55 to $85 per thousand cubic meters Maximum capacity of the pipeline at design operating pressure is 50 million cubic meters per day However, maximum capacity cannot be reached because of design derating due to corrosion, pipeline damage and inability of compressors to operate due to low pipeline pressure

Ms Cammisa is of the opinion that the IGC report was not an assessment of the condition of the gas pipeline, but that it is only a list of recommendations for procurement It was reported that IGC was unable to tour the mountain sections of the pipeline during their February, 1996 visit due to snow cover However, Transgas provided numerous 1995 color photographs as evidence of the serious conditions of washouts and exposure of the pipeline in difficult terrain two years ago Also, the lack of electric power over the past several years, which is necessary for the cathodic protection systems, and the continued deterioration of insulation will greatly accelerate corrosion and extensive failures, possibly requiring replacement of much of the pipeline USAID apparently did not consider the consequences of a complete failure of the pipeline for supply of gas to Georgia and Armenia Already the 700 mm pipeline to Armenia is reported to be out of service due to corrosion failure

Cancellation of D O 24, in which funds were in place for badly needed rough terrain equipment and in which much work and time had already been expended, is counterproductive to insuring a reliable supply of natural gas to Georgia and Armenia BREI has supplied substantial amounts of data and information to USAID as part of its responsibility for executing D O 24 BREI was not informed what reasons superseded the security of gas supply, but there must be more constructive ways to exert leverage for privatizing Transgas A reliable supply of gas is of prime importance in support of the success of the ongoing institutional reforms and privatized energy projects, some of which are proposed in D O 11

Ms Camissa stated that it is Gordon Weynands call if it is possible to transfer some of D O 24 remaining procurement funds to D O 25 (This may not be true, as these funds may disappear, never to be seen by us again)

It was suggested that we investigate the World Bank Municipal Development Plan Documentation for possible loans related to improvement of the municipal infrastructure in Zugdidi This funding could be in addition to the EBRD loan

EPRI also has some energy related program in Georgia

We discussed the pilot metering project which is part of D O 11 ARCI does not have a contract yet for this work and will not start until authorized This project is dependent on a reliable supply of natural gas

We were asked what is the status of the 1996 winter rehabilitation projects Because of the increased USAID procurement procedures, BREI Washington is still working on it Since D O 11 extension ends in January 1998 it is possible these projects may not be realized

სახელმწიფო კომპანია
„საქტრანსგაზმრეცვი“
„САКТРАНСГАЗМРЕЦВИ“
GEORGIAN STATE COMPANY
SAKTRANSGASMRETSVI
თბილისი, 380077 დელისის III შესახვევი 22
Тбилиси 380077 Делисский III пер 22
22 Delisi III Lane 380077 Tbilisi
Tel (+995 32) 93-29-81, 99-66-83
Fax (+995 32) 22-77 46

№ 02-3/785

29 05 1997

(TRANSLATION)

To Paula Finey
USAID Representative in Georgia

From I Zazashvili
General Director
Saktransgasmretsvi

cc Douglas D Tuckhorn
Program Manager
Burns and Roe Enterprises, Inc

David Zubitashvili
Minister
Ministry of Energy and Fuel of Georgia

Tbilisi, May 29, 1997

Dear Ms Feeney,

We would like to note that your letter of May 12, 1997 has caused our surprise and regret more because the idea to render an assistance to us was your initiative, whereas we have not breached any conditions specified by the assistance program

As you know, the Georgian main gas pipeline has been installed in the region with most complicated landscape conditions where the roads in winter and other seasons are often impassable, and it serves Georgian, as well as Armenian gas supply For years due to financial shortages there has not been any preventive-rehabilitation works carried out for this system, moreover, the recent april flood has deteriorated the system Therefore, it needs to be rehabilitated urgently, otherwise reliable and sustainable gas supply would not be provided, especially in winter time

Under these circumstances, we think the cancellation of the assistance program at the moment will sharply reduce our ability to carry out an urgent rehabilitation works to get prepared for coming winter

Of course, we are very grateful to you for the chromatograph and leake detectors which you had kindly provided to us But the main and most badly needed help from your part would be the provision of emergency utility trucks for us The absence of such equipment makes extremely difficult to deliver the required material and equipment to the failure sites This would really be a help not only for Georgia but for Armenia, as well

In addition to the sharp tone of your letter, we are surprised by the fact that despite the similarity of Georgian and Armenian gas industry structures, including accounting systems, Armenian gas industry will receive humanitarian aid, while we will not, even though *Saktransgasmretsvi accounting system has not changed since you have promised to render your assistance!*

As far as the reforms in commercial, privatization, legislation issues and establishment of transparent accounting, financial and management system, are concerned, Saktransgasmretsvi is ready and willing to take active participation in these issues

We would like to inform you, also, that Saktransgasmretsvi is implementing the computerization program in dispatch services accounting which will make the relevant information widely available

Based on the above, we hope you will consider the deteriorated technical condition of the existing Georgian gas lines and the high responsibility regarding gas supply to critical sites in Georgian and Armenian systems and review the possibilities of renewing the mentioned program, hopefully, with positive results for us

Sincerely Yours
I Zazashvili
General Director

Meeting Notes
Tuesday, 30 July, 1996

A meeting was held at the Metekhi Hotel at 7 PM to discuss status of USAID Delivery Order No 25 - Zugdidi Geothermal Project assessment for EBRD financing

Attendees.

Lars Hultin	European Bank for Reconstruction and Development
John E Hallberg	Burns and Roe Enterprises
Alexander Arobelidze	ARCI Consulting
Ivane Zazashvili	SAKTRANSGAZ
David Bakashvili	SAKBURGEOTHERMIA

The purpose of the meeting was intended to present to EBRD our findings during the first phase assessment. However, ARCI has not yet been authorized to proceed with their scope of work Therefore, a brief summary of preliminary work accomplished to date was presented. The preliminary report for EBRD/USAID review will have to be submitted later this year

We first discussed the problem of trying to determine the present organizational structure and chain of command of various departments involved in geothermal energy ARCI Consulting will describe the ownership structure and institutional reforms in the preliminary report. As understood at this time, ownership is primarily state, with division of responsibility indicated as follows

30% Sakburgeothermia
Exploitation
Care of 90% of geothermal wells
Own two drilling rigs

50% Municipality
Distribution

20% Geothermia, Ltd (Quasi-private)
Operation

As discussed during this meeting, the following EBRD criteria and suggestion should apply to the Zugdidi geothermal district heating project.

1 Financing is for public project ($10 million minimum)

2 Loan is to the Government with guarantees through Minister of Finance

3 The Ministry of Energy shall declare the Zugdidi geothermal district heating rehabilitation project as a priority

4 It is suggested to incorporate the majority of resource testing expenses within the project cost as part of normal startup testing

5 It is suggested to propose ownership structure by means of Joint Stock Company with 51% minimum government ownership It will be advantageous to include the thermal recipient commercial enterprises to participate An example is the joint venture German-Georgian tea factory

7 A business plan with thorough market research as backup shall be submitted

8 Some terms of the loan
- Interest rate - 1% above LIBOR, variable
- One percent front end fee
- One percent interest on unused funds
- Period of loan - 15 years
- Interest payment due immediately upon signing
- Up to two year grace period for principal payments while project is completed, ready to operate

9 If project is not selected for public financing, a backup strategy shall be investigated to seek private project financing from EBRD and other sources. EBRD will only provide 35% financing with $10 million minimum loan for private projects. This means a $30 million private development project possibly incorporating secondary financing for the large thermal host enterprises It would help to find foreign investment through joint ventures of a large holding company to secure this sum of investment. However, the potential returns from the enterprises revenues could be very attractive to investors, and export of quality food products could secure badly needed hard currency for Georgia.

USAID EXIT INTERVIEW

Thursday, 5 June, 1997

A trip to Tbilisi Georgia began on Sunday, 15 July to work with the Burns and Roe Enterprises staff, ARCI Consulting, Geothermia, Geothermex and Sakburgeothermia on the following USAID Delivery Orders

D O No 11 - Tbilisi District Heating System Improvement Program
D O No 25 - Zugdidi Geothermal Assessment

The main purpose of this trip was to travel to Zugdidi with representatives of the previous mentioned firms to inspect the geothermal wells at Zugdidi and Tsaishi assess the conditions of wellhead valves and piping and determine what repairs are needed

Personnel traveling to Zugdidi

David Bachakashvili - Director, Sakburgeothermia
Nodar Tsertsvadze - Geologist, Geothermia
Eduardo Granados - Manager, Drilling Services, Geothermex
Zurab Menteshashvili - Manager, BREI (Tbilisi)
John Hallberg - Task Manager, BREI (W)
Dimitri Costiadi - Project Manager, ARCI Consulting

The Geothermex Manager of Drilling Services, Eduardo Granados had discussions with the principals of Geothermia and Sakburgeothermia on developing a test plan for obtaining valid temperature, pressure, flow and level data for modeling and performing an assessment of the geothermal hot water resource Geothermex will submit the geothermal test plan by last week of June

Geothermia ARCI and BREI - Tbilisi engineers are updating the Bill of Materials and cost estimate for repair to wells, supply test requirements and perform laboratory analyses

The most serious problem jeopardizing the continuation and completion of D O No 11 and D O No 25 are obtaining contracts or authorizations for ARCI to complete their work One of the requirements stated in the delivery orders is to identify the services of local expertise to be employed

ARCI Consulting successfully completed a detailed survey of 47 district heating thermal stations in Tbilisi during 1996 as part of the Scope of Work in D O No 8 as a subcontractor to BREI D O No 11 is a continuation of D O No 8 and ARCI has maintained continuity by preparing rehabilitation proposals for D O No 11 and D O No 25 for over a year without a contract The problems in USAID office of procurement in Washington D C needs to be resolved soon

We were informed that Tbilisi Thermal Electric Station (TES) is in the process of privatization and the management wants to prepare a proposal for repowering as a combined cycle system We also heard that Sakenergo is interested in repowering the older Gardabani units with gas turbine combine cycle units using the existing steam turbines and balance of plant

We also heard that Parliament had requested tenders for rehabilitation of Thermal Station No 9 for privatization and supply of heat to the Parliament building, hopefully a paying customer This was to be a proposal for repowering already prepared by ARCI to be included in D O No 11 report, but Parliament could not wait However, the cogeneration part of the project could be a next phase if the new owners are interested

These projects would result in substantial fuel savings by increasing plant efficiency from about 26% to over 55% The problem is how to justify the financing of such potentially high risk investments, considering the present economic problems Maybe Georgia could sell some of the power to Turkey for a realistic price margin to cover the cost of generation They could get badly needed hard currency to pay for the fuel and have excess capacity for heat and power

There was a lot of discussions and questioning about the reasons behind the USAID decision to cancel D O No 24 for supplying a moisture analyzer, four utility trucks rough terrain excavator and a rough terrain truck mounted crane to Transgas for making repairs to the 1200 mm (48 in) pipeline in the mountains The stated reason was that Transgas was not moving fast enough toward privatization and demonstration of "transparent accounting, financial and management systems" However preventing Transgas from having badly needed equipment at this time to be able to more rapidly and efficiently make repairs to the increasingly deteriorating conditions of the pipeline does not seem to be the best way to exert pressure for privatization Maybe continued jawbone diplomacy and positive support would be more effective

These people have very little experience in Western style management systems and procedures And to our knowledge, there has not yet been any professional involvement with Transgas by Haggler & Bailey, TACIS or other organizations to work with them on institutional reforms, organizational structures, legal and financial systems and recommendations for privatization The size of the gas transmissions system alone probably would have an asset replacement value of more than seven billion dollars and the problems with establishing a private corporation of this size are very complex There are rumors that Transgas is holding discussions with Gasprom and Turkey to form a consortium for selling Russian gas to Turkey

BREI and ARCI have been working with Geothermia and Sakburgeothermia for the past year on the task of defining the restructuring of a new private company for operation of the geothermal systems in Tbilisi and Zugdidi-Tsaishi (D O No 11+D O No 25) for preparing the D O No 25 pre-loan assessment report for EBRD One of the D O No 25 requirements is to "Describe the company to own the enterprise as a potential borrower from the lending agency including the company s

legal and financial structure, financial strength qualifications and experience of the prospective management "

Sakburgeothermia is presenting a subsidiary of Transgas located in the same building and previously having responsibilities for drilling and development of geothermal wells in Georgia Their only remaining assets are two drilling rigs and related equipment which is deteriorated and next to useless (scrap)

The previous discussion of some of the issues related to institutional reforms and privatization of the energy enterprises, which BREI, ARCI and others are working on, leads us to believe that progress is being made albeit slowly, and now is not the time to back out of providing support to the enterprises struggling to achieve these goals

Notes prepared by
John Hallberg, PE
Burns and Roe Enterprises, Inc

Trip Report

USAID EXIT INTERVIEW
Thursday, 6 November, 1997

A trip to Tbilisi, Georgia began on Sunday, October 19 to work with the Burns and Roe Enterprises staff, ARCI Consulting, Geothermia, Geothermex and Sakburgeothermia on the following USAID Delivery Orders

D O No 11 - Tbilisi District Heating System Improvement Program
D O No 12 - Zugdidi Geothermal Assessment

The main purpose of this trip was to travel to Zugdidi with representatives of the previous mentioned firms to inspect the repairs to the geothermal wells at Zugdidi and Tsaishi, witness the start of well testing program and meet with Government officials

It was intended to see start of work at two maternity hospitals, Burn Hospital, Lisi Geothermal and two schools However, contracts have not yet been signed for contractors to start work It is hoped that this work can be completed before winter

An additional goal was to identify and obtain studies and reports which will be useful as input and reference material for the proposed Delivery Order No 31 - Georgia Least Cost Development Plan for the Power Subsector

Personnel traveling to Zugdidi

David Bachakashvili - Director, Sakburgeothermia
Otar Vardigoreli - President, Geothermia, Ltd
Guram Buachidze - Geologist, Geothermia, Ltd
Nodar Tsertsvadze - Geologist, Geothermia, Ltd
Levan Tsertsvadze - Geologist, Geothermia, Ltd
Eduardo Granados - Manager, Drilling services, Geothermex
Zurab Menteshashvili - Manager, BREI (Tbilisi)
John Hallberg - Task Manager BREI (W)
Dimitri Costiadi - Project Manager, ARCI Consulting
Kakha Karumidze - Project Engineer, ARSI Consulting

Government officials met in Zugdidi

Murtaz Bokuchava - Deputy Governor
Tengiz Chitanava - Vice Mayor - Economic affairs
Mamuka Nadaraia - Vice Mayor, Zugdidi
Konstantin Tsitsava - Tsaishi Governor
Shalva Kvaratskhelia - Director of School
Avto Lomidze - Local engineer in charge of geothermal wells

Meetings were held in Tbilisi with the following officials and consultants

John Lynn -	TACIS Team Leader, Coordinating Unit
Irma Khvedeliani -	Task Manager, Energy and Transport
Horst Meinecke -	International Project Finance, Price Waterhouse
Katherine Hardin -	Price Waterhouse
J Levi Hanson -	Price Waterhouse
Joseph W Sloan -	Hagler Bailly (Metering Expert)
Baadur Chkhaidze -	SAKENERGO, Department of Renewable Energies
Jerome Cassiers -	First Secretary, European Union
Hunter Monroe -	Resident Representative, IMF
Amiran Kashakashvili -	Vice Director, Georgian Coal Department, Ministry of Fuel and Energy

Attached is a list of Studies and Reports, which may be of value for proposed Delivery Order No 31

Notes Prepared by

John E. Hallberg, P E.
Burns & Roe Enterprises, Inc

USAID EXIT INTERVIEW
TRIP REPORT
Thursday, 18 December, 1997

A trip began on Thursday, 11 December to Tbilisi for eight days to work on the following delivery orders

D O No 11 Tbilisi District Heating System Improvement Program
D O No 25 Zugdidi Geothermal Assessment

USAID-Tbilisi expressed concerns and criticism about BREI and the subcontractors' and Zugdidi government officials performance on the Zugdidi Geothermal Assessment for EBRD BREI did in fact coordinate adequately with local government officials as described in every trip report covering previous trips to Zugdidi USAID-Tbilisi also objected to BREI coordination and cooperation with other donor organizations, as well as GOG Agencies and quasiprivate companies

USAID-Tbilisi requested that BREI and its consortium members and subcontractors ask for permission to contact other donor organizations This will severely restrict the ability to expeditiously complete USAID Delivery Order tasks It is hoped that USAID-Tbilisi will grant permission for daily coordination requirements in a timely manner

The balance of time was spent working with ArCi Consulting on review and comment on progress of reports for D O 11 and D O 25 Visits were made to inspect progress of work at Maternity Hospital No 5 and a tour of the district where metering demonstrative zone project will be implemented ArCi Consulting has been working with the municipal government, Telasi and other agencies, and they have all been very cooperative and supportive of this project for providing a guaranteed metered supply of electricity, gas and heat to residents, a kindergarten and possibly some commercial enterprises The gas distribution system in this district has been largely rehabilitated, and there are dedicated electrical feeders which will insure a reliable supply of power

Maternity Hospital No 5 work will be completed in about two days One gas fired boiler is presently operating

Maternity Hospital No 4 work has started on rehabilitation of two gas fired boilers Work should be completed by end of year

Burn Hospital work started one week ago and will take about 8 weeks to complete installation of solar hot water system, about end of January

Lisi geothermal contract has been issued 5 Dec , and work will start on 5 January after Georgian Christmas

Zugdidi flow tests are proceeding successfully, and will be completed about 5 to 10 January

BREI personnel attended the donor coordination meeting on Friday, 12 December, and the US Business Roundtable on Wednesday, 17 December, 1997

Next trip to Tbilisi and Yerevan is tentatively planned for early February, 1998

Notes prepared by

John E Hallberg, P E
Task Manager
Burns and Roe Enterprises, Inc

USAID EXIT INTERVIEW
TRIP REPORT
Monday, 23 February, 1998

A visit to Tbilisi, Georgia on Friday, 13 February, for eleven days with departure on Tuesday, 24 February, 1998 to work on the following Delivery Orders
D O No 11 - Tbilisi District Heating System Improvement Program
D O No 25 - Zugdidi Geothermal Assessment
D O No 31 - Georgia Power Sector Least Cost Investment Plan

A no cost extension until 30 June 1998 was granted for D O No 11 Rehabilitation work on Maternity Hospitals No 4 and No 5 boiler rooms has been completed The Burn Hospital Solar Hot Water System will be completed the week ending 27 February Lisi Geothermal wells repair and construction work are close to completion for start of thirty day testing of resource Tender bids were received and sent to Washington 15 Feb 1998 for evaluation for installing gas fired autonomous boilers in School No 130 and Kindergarten No 87 (Digomi Demonstration Zone) It is hoped that contracts will be signed by week ending 27 February in order to start construction and meet Contract dates Documents and specifications for Demonstration Zone electricity and gas metering project are being prepared The schedule for completing procurement and installation by 30 June is very tight

The Digomi district gas distribution system has been rehabilitated by city municipality and the electricity supply is reliable, however Telasi does not want to guarantee for 24 hours The area selected is a representative mix of apartment buildings, a kindergarten and shops Gas meters will be installed in 500 flats Electric meters pose a difficult problem, and several options have been considered install tamper proof prepay meters, remove old meters and install new wiring and meters in central location, metering groups of flats with communal payment as defined in new Civil Code It appears obvious what will happen to electricity demand, when presently gas price is less than half the price of electricity and kerosene, it's more efficient, and safer than make shift electric and kerosene stoves and heaters It has taken longer than expected to get all the approvals, agreements and authorizations from the tenants, Municipality, Tbilisi and other agencies to implement this Delivery Order requirement.

It is very important for non-engineer, non-technical USAID personell to realize that any kind of Engineering-Construction project in any highly developed civilized society anywhere in the world is subject to the laws, codes and standards of that society, and no work can even be started without first obtaining the necessary permits, approvals and authorizations All of the delays to the Delivery Orders have been beyond the control of Burns and Roe as a result of waiting for approvals and authorizations from Government agencies, including USAID

A no cost extension until 1 August, 1998 was granted for D O No 25 The Zugdidi-Tsaishi well flow testing was completed 20 January, 1998 and last of flow data

transmitted to Geothermex Results of chemical and gas analysis of well samples were received from Geothermia on Friday, 20 February, and transmitted to Geothermex They are presently computer modeling the resource and should complete this report by mid-March

Generic technical specifications for materials and construction are being prepared for EBRD Tender documents, as required in the Delivery Order It should be remembered that numerous delays to this Delivery Order No 25 were beyond the control of Burns and Roe due to excessive time for USAID/CO Washington, D C authorization of construction subcontracts

Delivery Order No 31 - Georgia Power Subsector Least Cost Investment Plan was authorized 30 January, 1998 Therefore, a Burns and Roe Team organization meeting was held on Monday, 16 Feb in Tbilisi to discuss strategy, required meetings with counterpart organizations and personal, and preparation of lists of information needed for input to the IPM Model

A USAID Kick-off meeting was held on Tue , 17 February to introduce assignment of the project team members, Mr Brooks Howell, Project Manager, Mike Saunders, Harza (Hydro) and other members of Burns and Roe staff USAID was requested to arrange for meeting with Ministry of Energy and other governmental officials to get support in obtaining data

The first Kick-off meeting with GOG persons arranged by USAID - Tbilisi mission was held at the Metekhi Palace Hotel Turn-out was very good as shown on attached list of attendees, considering the short notice Handouts describing different tasks and information needs for the Least Cost Investment Plan in English and Georgian were handed out to attendees A copy of the information needs list for thermal and renewable energy options is attached After brief introduction by Douglas Tuckhorn, BREI Managing Director, Caryle Cammissa, USAID/Tbilisi mission, and Iqbal Chaudhry, COTR/USAID Washington, Mr Brooks Howell, BREI Project Manager gave a presentation describing the Integrated Planning Model (IPM) to be used for modeling the power subsector investment needs A question and answer period followed the presentation

Three Georgian officials gave lengthy discussions about several issues which they considered important The Director of Energy Institute, Mr Nodar Kereselidze emphasized the following three main issues

1 Natural gas supply to Georgia was curtailed or completely cut off during 1993-1994 Previously 20% of electricity was for domestic household use, now more than 70% is used for heating, cooking and hot water (Note Forty six district heating thermal stations representing about 2927 MW thermal have been shut down since 1993 without any capital preservation of boilers and distribution systems BREI/ARCI survey and technical assessment in 1995 identified only 7 facilities that at that time had a chance of rehabilitation without extensive investment About 18 other stations would require massive investments and reconstruction to be useful The remaining stations were not considered worthwhile to rehabilitate In addition, much of the hot

water (single pipe) distribution piping and radiators in apartment buildings have corroded beyond repair and some have been removed There are more than 300,000 families in about 5000 apartment buildings which previously were supplied hot water district heating These families have now substituted electric heating and kerosene heaters for lack of natural gas, and it appears that the only realistic hope for restoring heat and hot water is a mix of some district heating stations rehabilitation or repowering, some decentralized gas fired building heating boilers, and more important, restoration of metered natural gas supplies to individual apartment flats for cooking, heating and possibly hot water heaters In parallel, it is necessary to upgrade and restore electricity metering and payment collection When tenants realize that natural gas is less than half the price of electricity and kerosene, there is an incentive to install relatively inexpensive natural gas heaters in their flats These heaters are not much more expensive than the kerosene and propane heaters purchased from Turkey, South Korea and Iran)

2 It will be very difficult to overcome the present inertia of consumer attitude and energy use patterns set over the past five years Thousands of electric, kerosene, propane, wood and coal heaters and stoves have been purchased out of desperation for heat and citizens will be hard pressed to again be asked to voluntarily spend limited or non-existent income for new gas heaters, gas meters or electricity meters Therefore, the Least Cost Investment Plan must consider the new trends in Georgian economic development with the problem of having increased electricity supply with the problem of non-solvent consumer demand

3 The most important issue to address the previous discussion is the necessity to maximize upgrading and installation of metering and increasing of payment collection discipline This is important not only for electricity, but for natural gas and also hot and cold water consumption This appears to be the only realistic way to monitor and control the shift in forms of energy demand consumption by means of the price system

The Head of Department of Renewable Energy, Ministry of Fuel and Energy, Mr Simon Sharabidze, asked questions about renewable energy, how it will be studied in program, will any projects be included, and how renewable energy will offset increases in electricity consumption

Because of the large potential for wind energy in Georgia, several wind farm projects of 20-30 MW already developed will be included for supply side evaluation in the model

There is a large potential of geothermal hot water energy in Georgia for use in district heating and commercial use for greenhouses, tea drying, chicken production, refrigeration and processing of fruit and meat products, etc This energy will be considered on the demand side as an offset to electricity supply, and for fossil fuel greenhouse gas (CO_2) reduction credit

Solar energy photovoltic applications are limited to remote locations for communications and cathodic protection systems on natural gas and petroleum

product pipelines Solar energy for hot water and thermal storage hot air systems has been and is used throughout Georgia in houses and some commercial buildings There is significant potential for more widespread use of this energy source throughout Georgia, and the technology and talent is existing However, the existing manufacturing facilities and equipment are defunct and in need of investment The potential for solar energy heating and hot water consumption can be considered on the demand side

There have been several studies and proposals for rehabilitation of the Tkibuli coal mines near Kutaisi, and proposals real or rumored of building a 50 MW to 100 MW circulating fluidized bed boiler power plant There is information from Amiran Kashakhashvili, Vice Director of Georgian Coal Department, Ministry of Fuel and Energy, that a delegation of experts from Skoda (Czechoslovakia) funded by KFW made an assessment of mines and a proposal for rehabilitation of mine and construction of a 100 MW circulating fluidized bed boiler power plant If results of this study can be obtained, the results and cost data can be inputed to the study However, at this time it does not appear to be a cost effective investment based on known information It would seem that a more effective use of this coal would be to burn in simple, inexpensive vertical fire tube hot water boilers for heating of schools, hospitals, old peoples homes, apartment and government buildings, etc in outlying towns and villages This type boiler is presently being used in an elementary school in Tbilisi very successfully, with a second boiler supplying heat to a nearby police station

There is a UNESCO Project in Aspindza, southern Georgia for implementing a number of small non-traditional alternative energy projects, including a small wind generator, geothermal power, solar house, biogas generator etc However, this project will not impact the present study

Also, the city of Tbilisi has studied and proposed the collection of landfill methane biogas for use in a small power plant (5-10 MW)

The director of the Hydro Institute Mr A Chitanava discussed the issue of need for a balanced transmission system and regional reliability Now, if one critical transmission link goes down, the whole country goes down This issue will be addressed in the study

As mentioned earlier, the Department of Renewable Energy Utilization in "Sakenergo Generation" has developed a number of projects with cost estimates for wind power, submitted to the Foreign Trade Ministry, looking for funding Their cost estimates are for generators and controls, include shipping cost from Denmark for 500 kW - 1 5 MW machines and include local labor and materials for foundations, structural and electrical complete to the grid They estimate $850 to $1 000/kW turnkey, which is lower labor costs compared to Europe/USA cost of about $900 - $1200/kW turnkey, with total generating cost of about $ 0 04 to $ 0 045 /kWh, based on 20 MW to 30 MW wind farm minimum This information can be verified and provided for input to the model It is understood that DOE/WIND delegation has been providing cooperation and assistance to Georgia USAID/Tbilisi will provide names of contacts

Names of potential wind power plants

30-50 MW Tbilisi-Samgori
50 MW Kutaisi - regional government very interested
50 MW Likhi (Rikhoti pass) 100 MW potential
30 MW Batumi

It should be noted that Georgia has more than 50 years (1936 - 1986) wind observations from 145 weather stations The selected projects have wind velocities over 3 5 - 5 0 m/s with durations in excess of 5 000 hours/year

A trip was made to Rustavi Matallurgical Mill power plant to meet with Director, Deputy Director, Chief Engineer and other staff See attached general schematic diagram for equipment A Steam flow diagram and electrical one-line diagram and site plan were loaned for making copies They provided some detailed lists of equipment condition assessments (mostly boilers) and budget estimates for required repair works They will provide additional detailed data as requested on questionnaire It is known that GE made proposal in 1997 for repowering of the Rustavi power plant with combined cycle gas turbine installation This information will be considered if available

Notes prepared by,

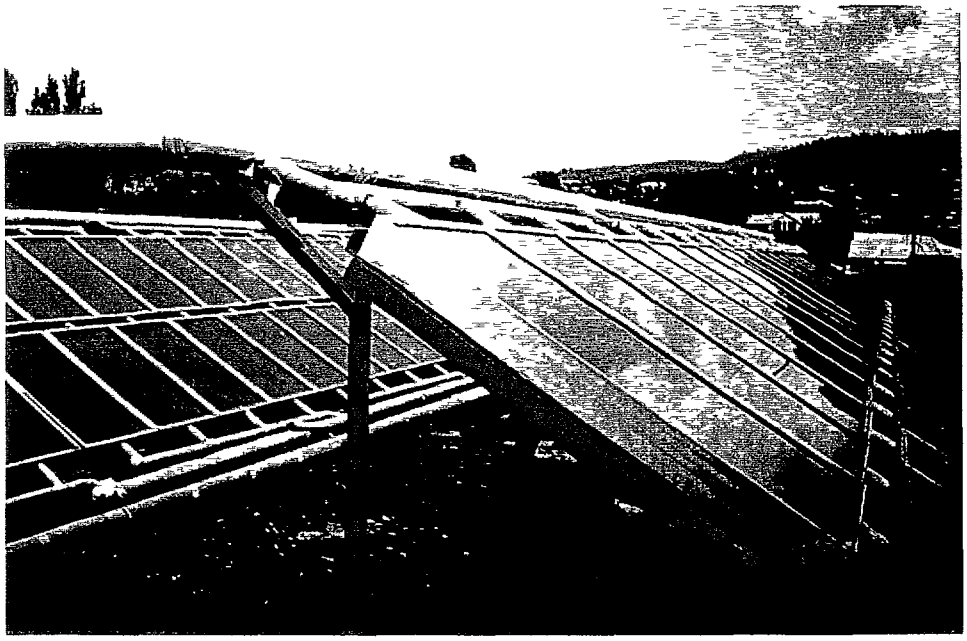
John E. Hallberg

John E Hallberg PE
Task Manager
Burns and Roe Enterprises

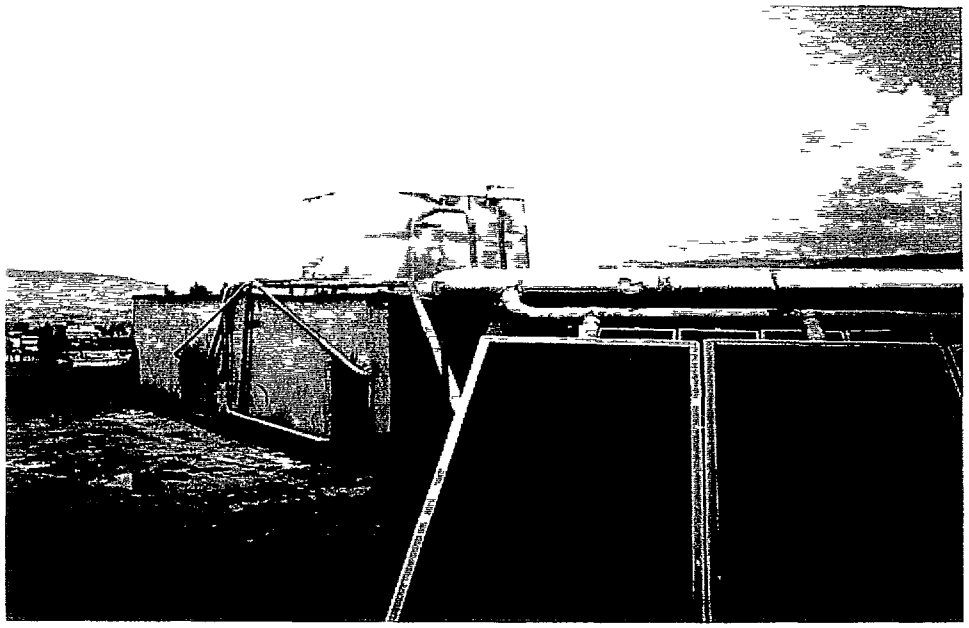
Appendix D

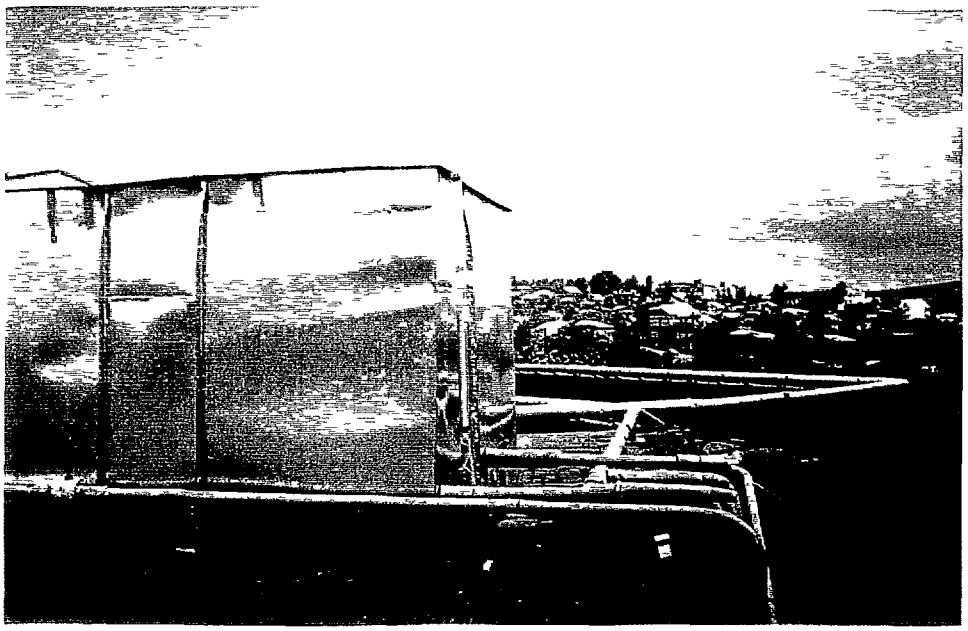
Photographs

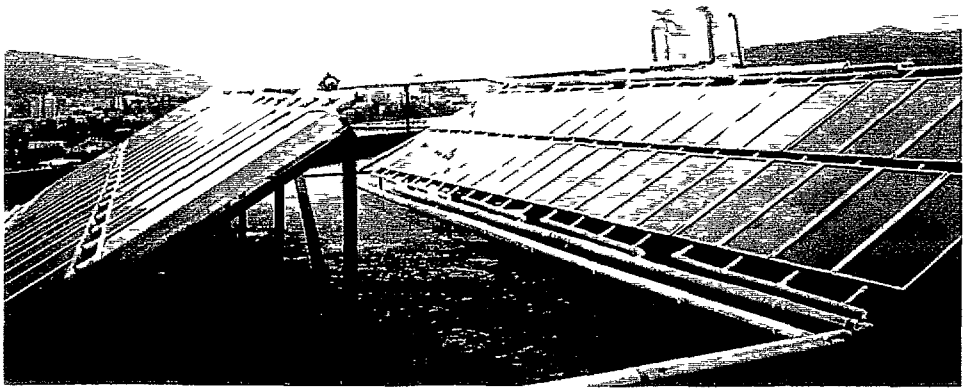
Solar Energy Collector System for Hot Water Supply to the Burnt Center in Tbilisi



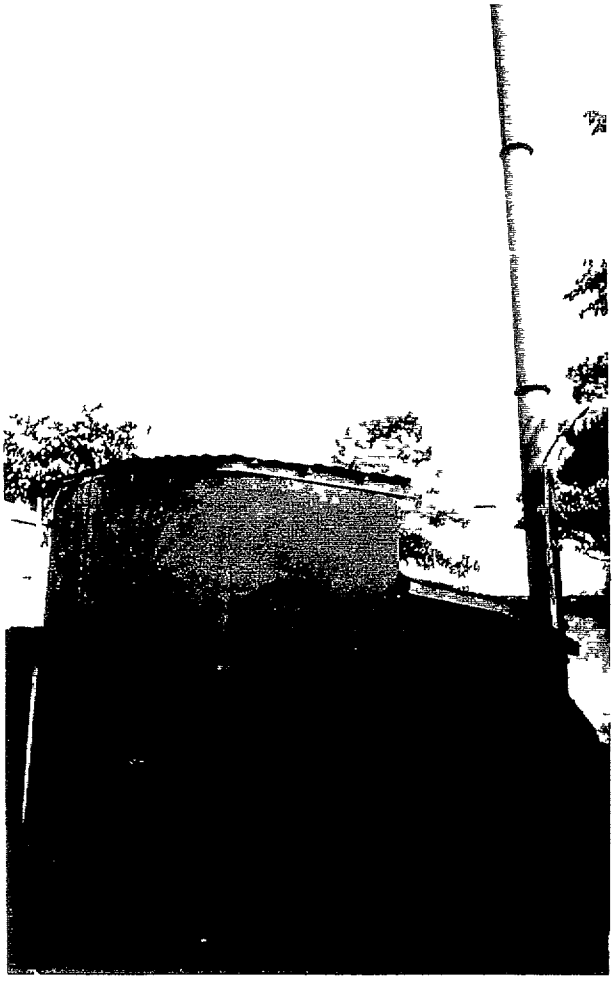
Solar Energy Collector System for Hot Water Supply to the Burnt Center in Tbilisi

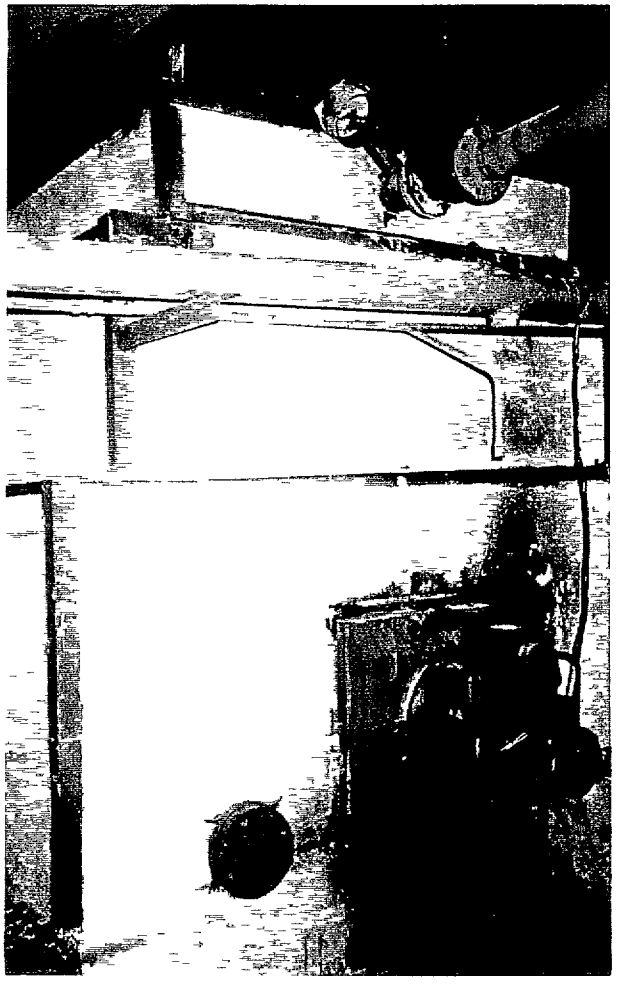


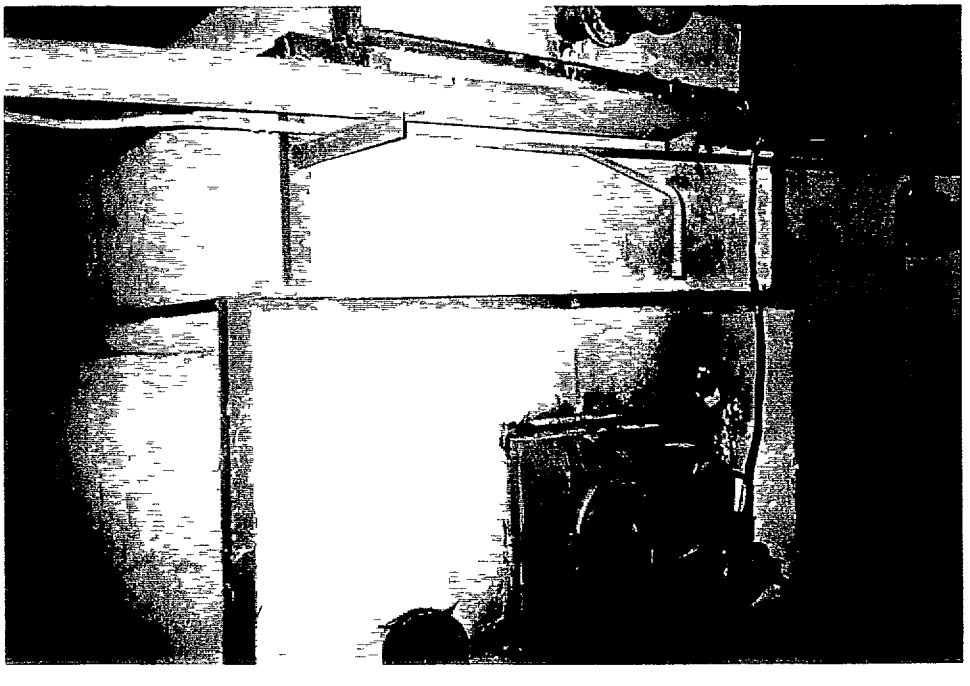


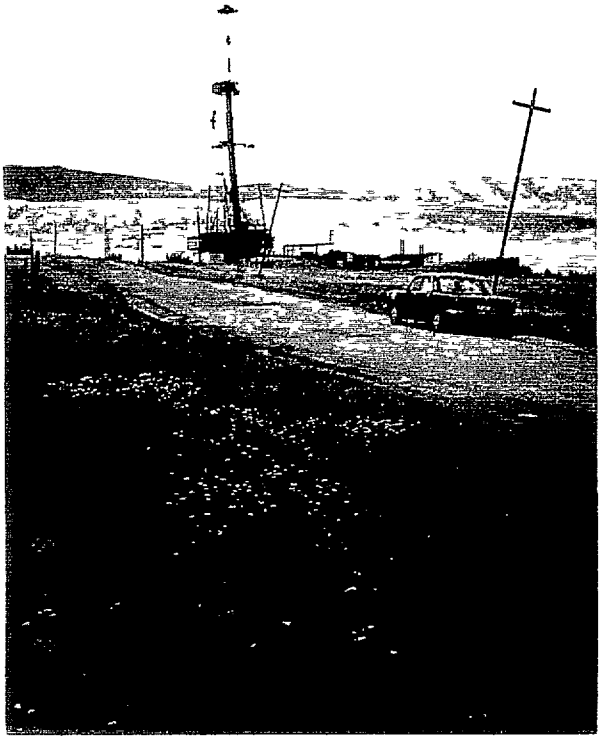


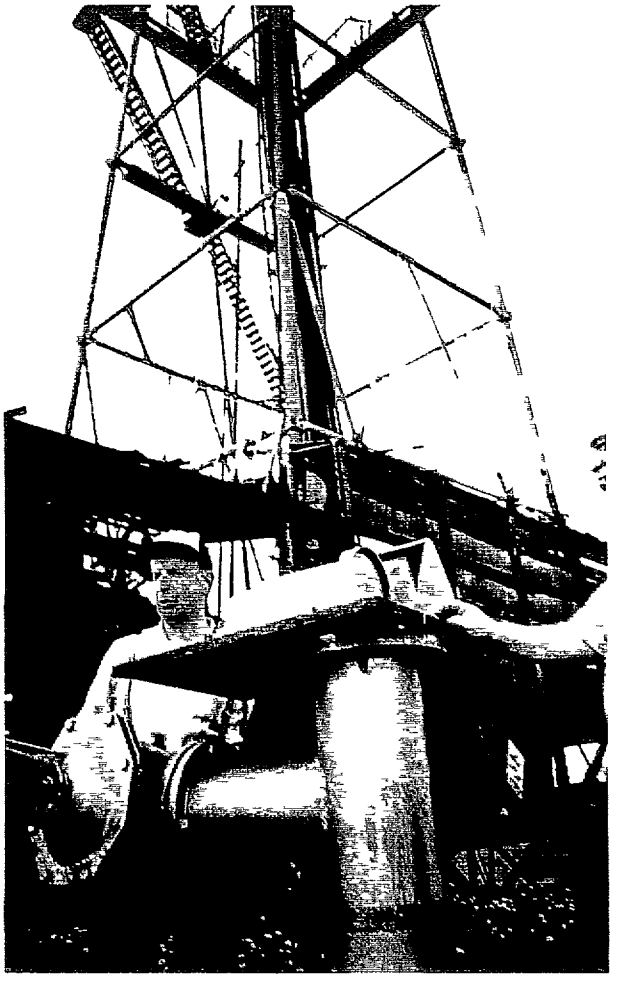
Rehabilitation of the heating system at the Burnt Center in Tbilisi

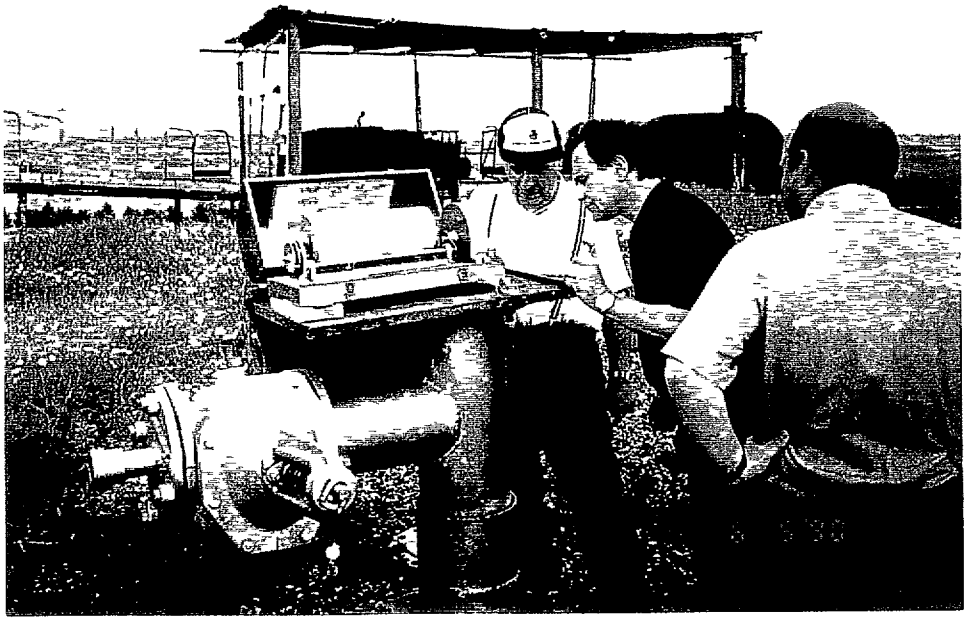


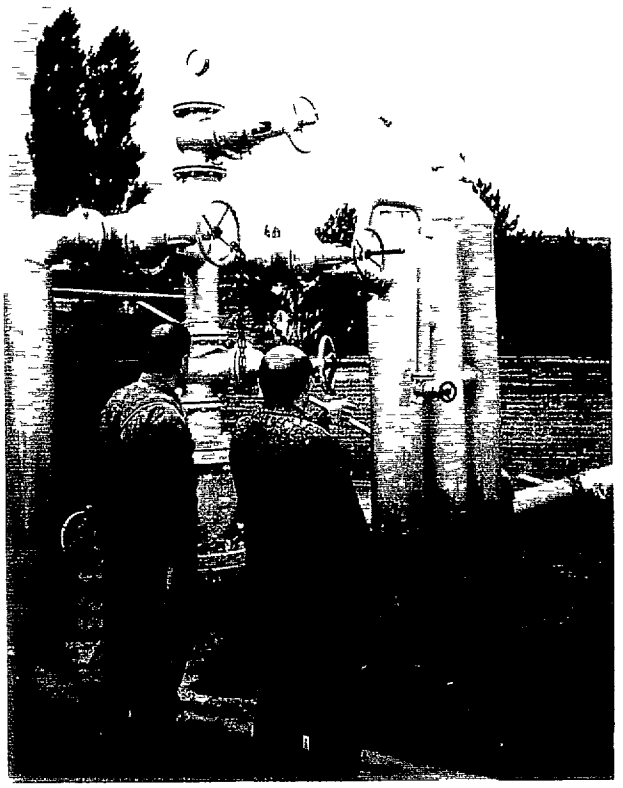


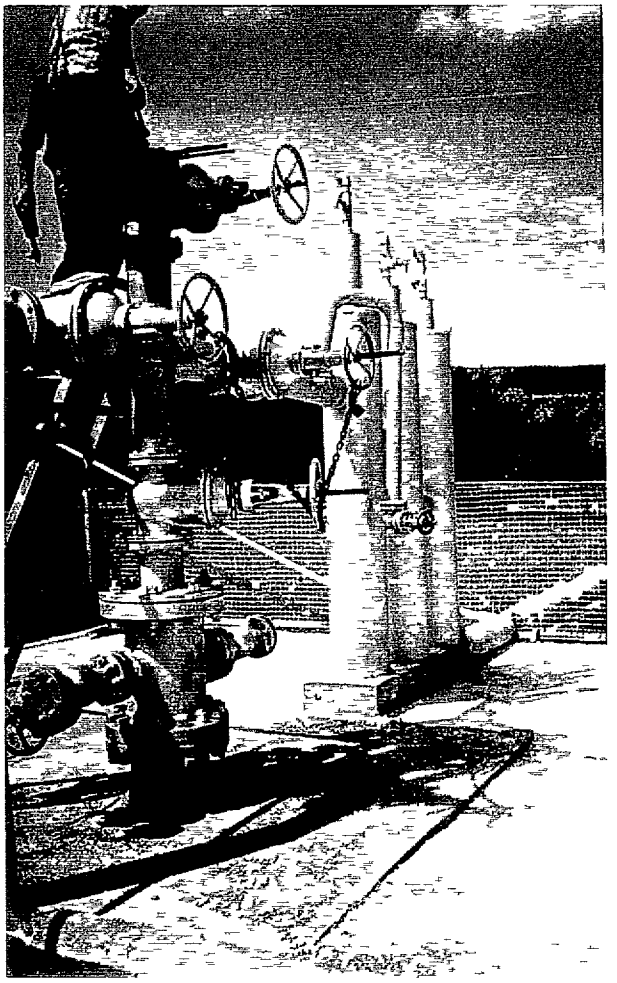


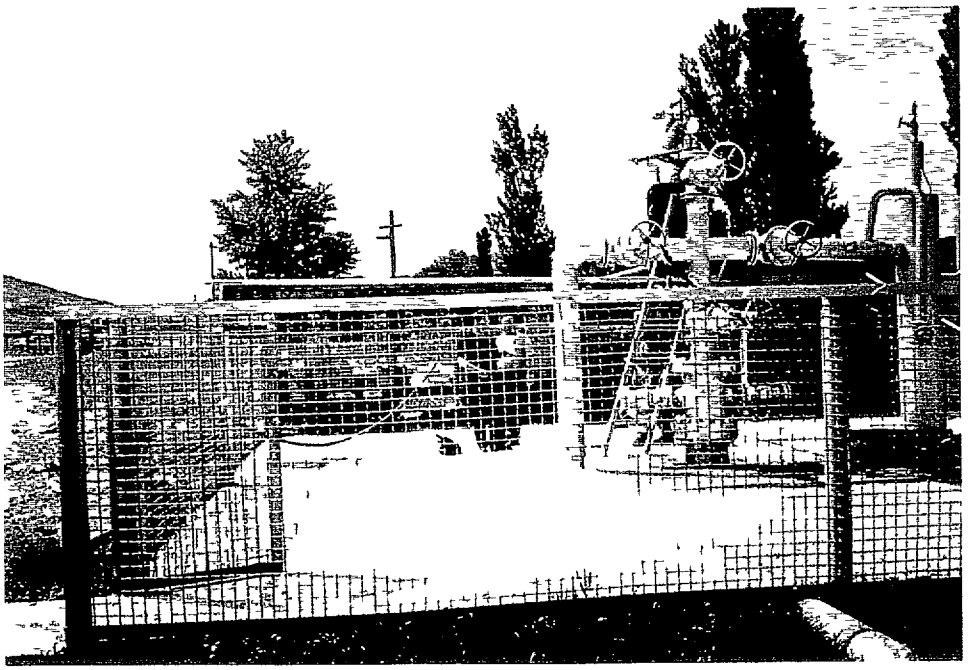


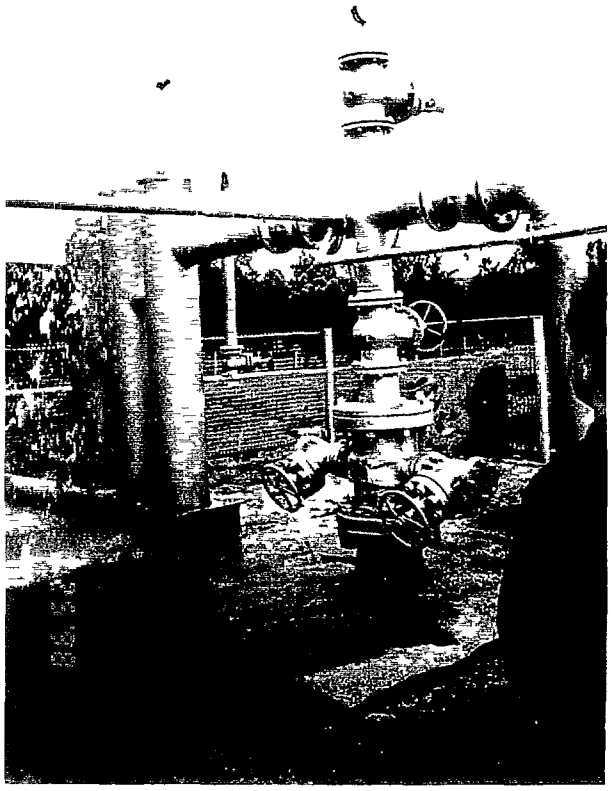




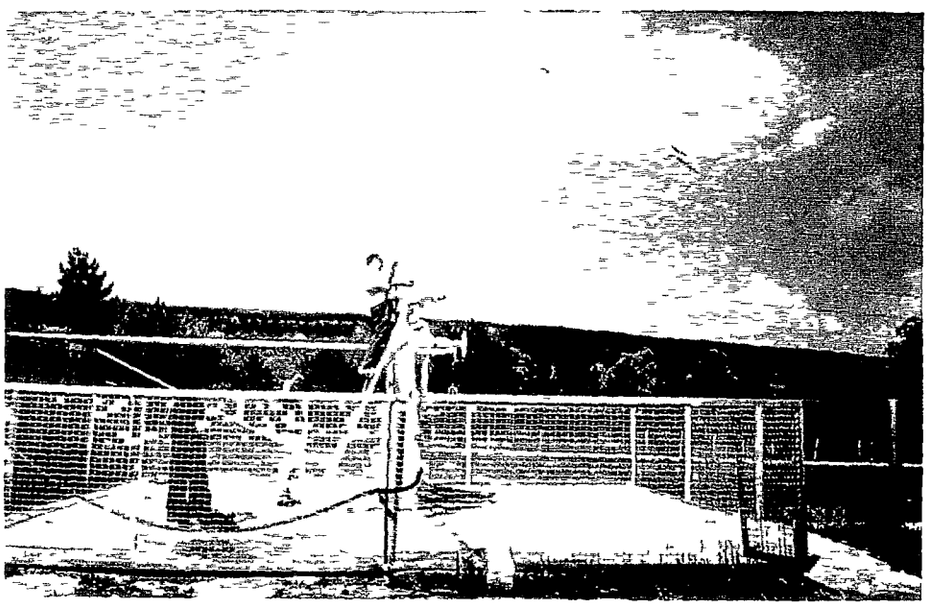


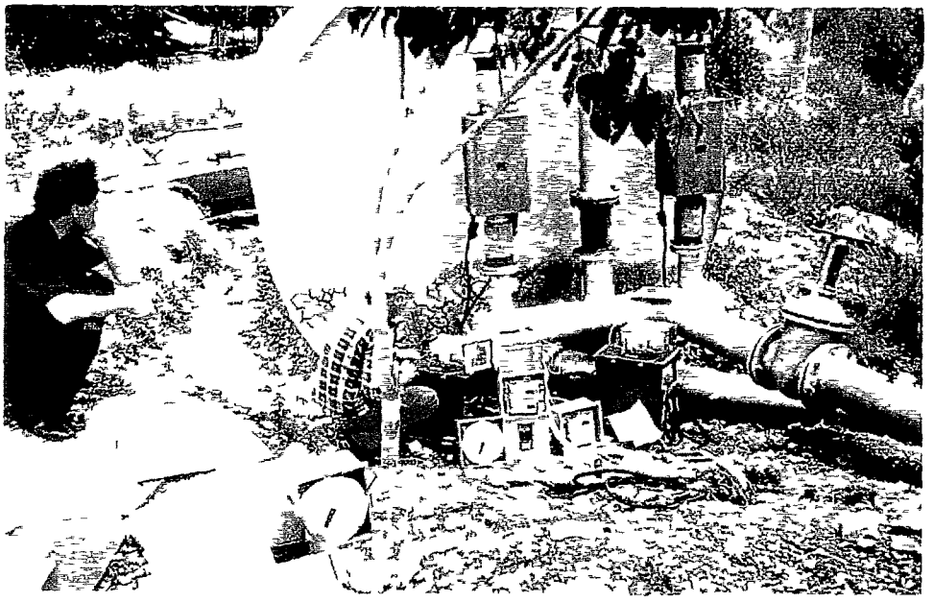




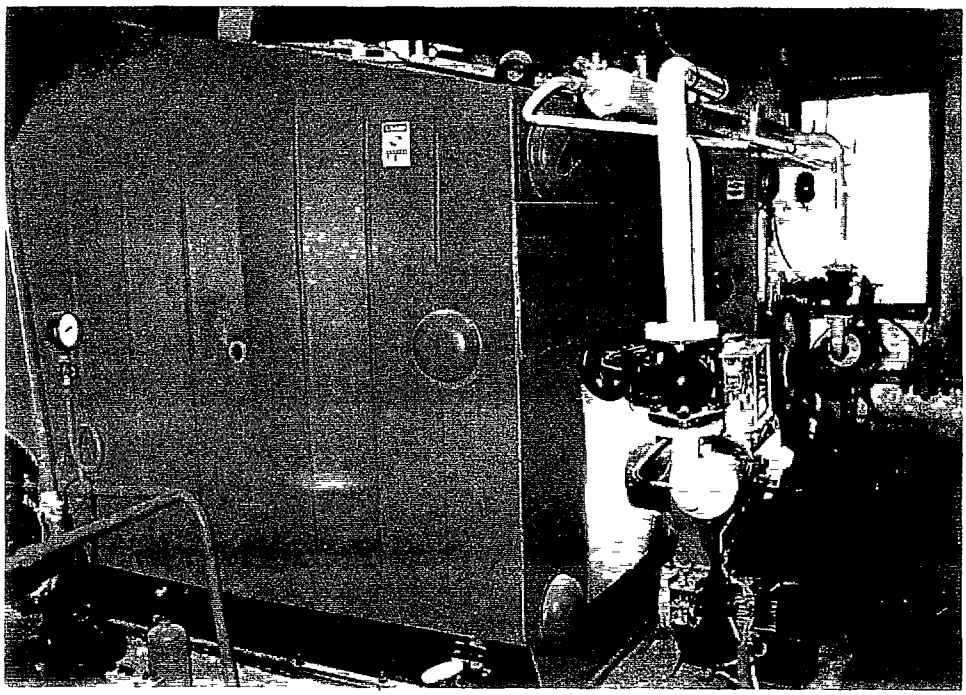


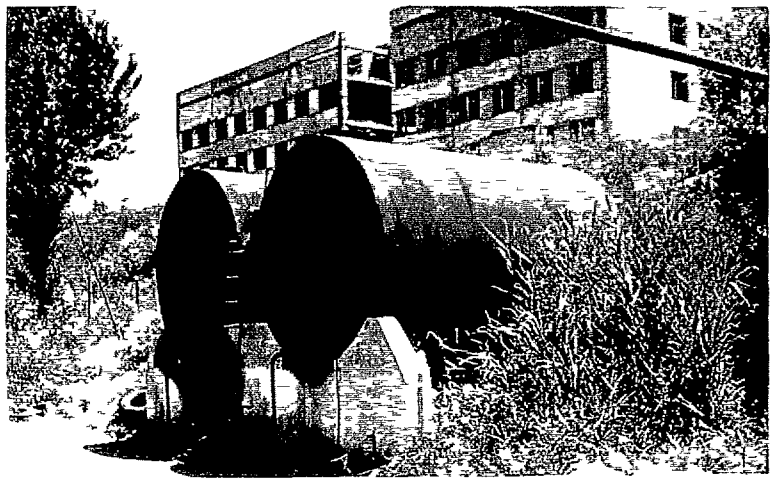
Production Increase of the Lısı Geothermal Deposit by Hydro Sıphon Method

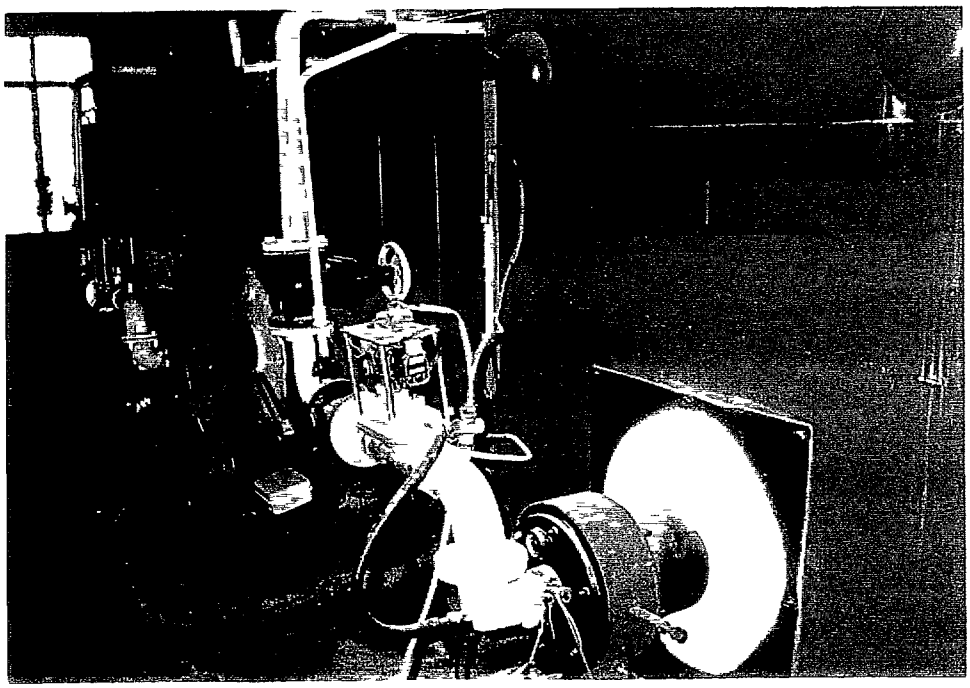




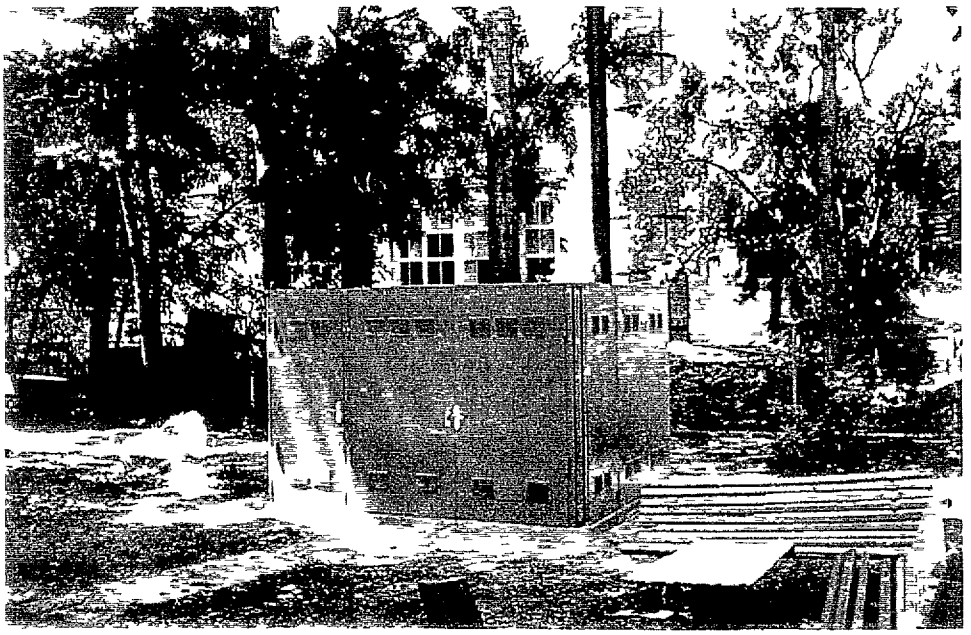
Rehabilitation of the heating system at the Maternity House #5 in Tbilisi

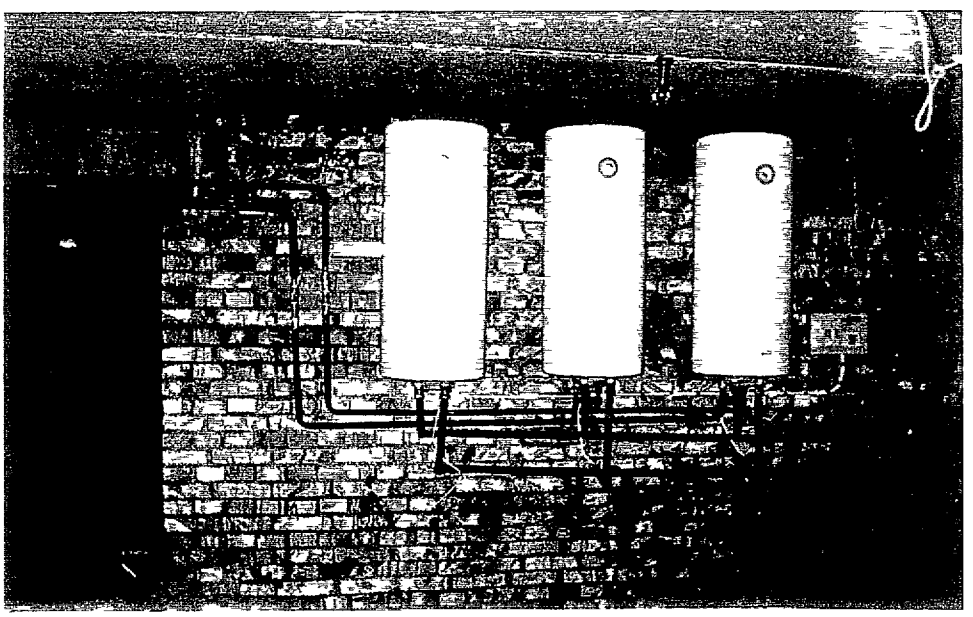


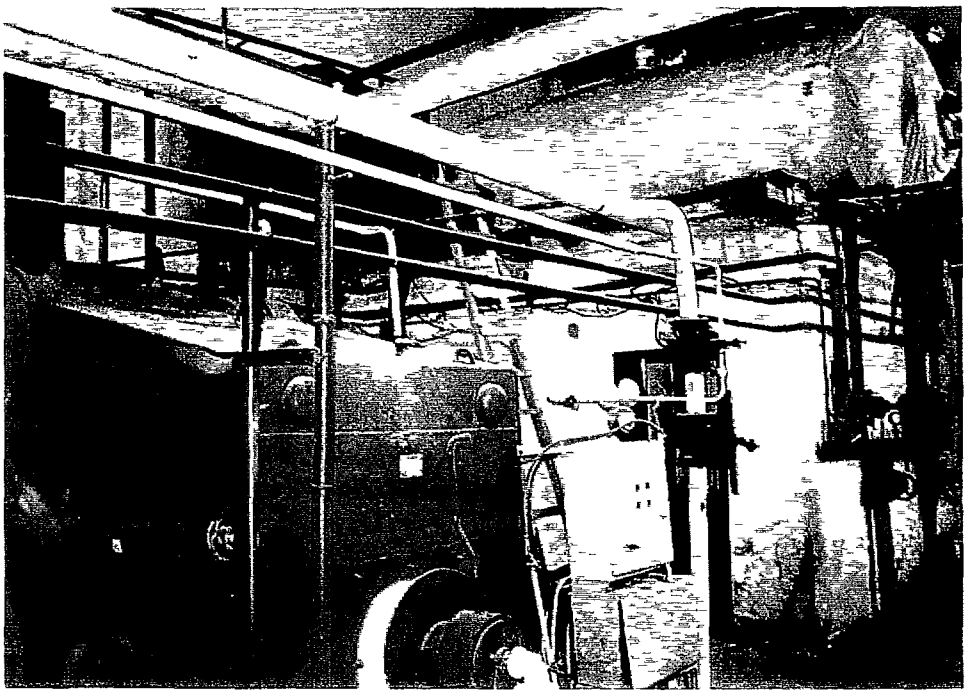


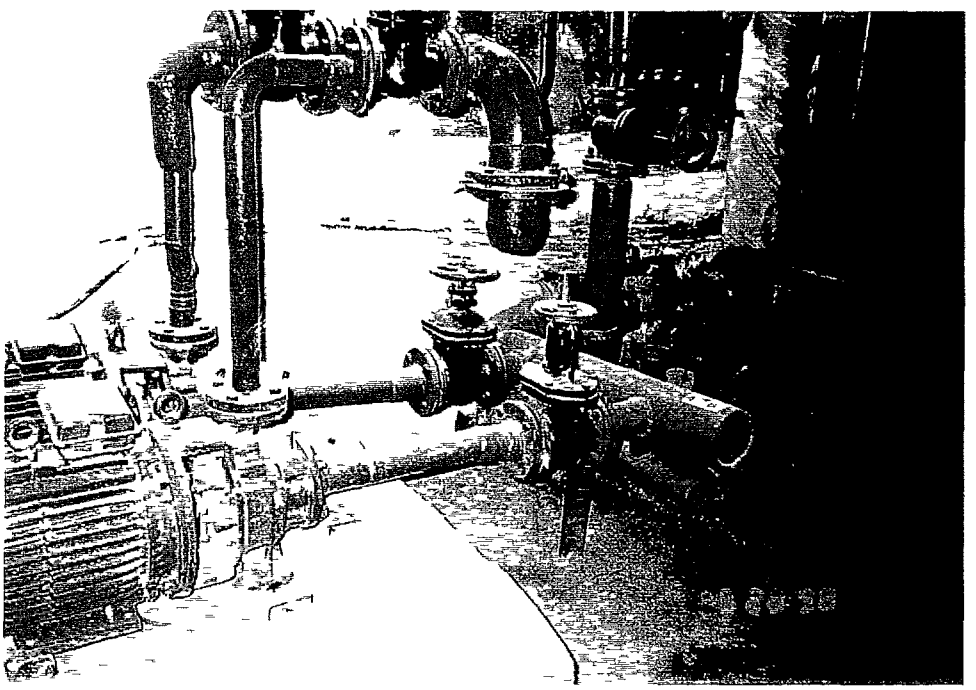


Rehabilitation of the heating system at the Kindergarten #97 in Tbilisi

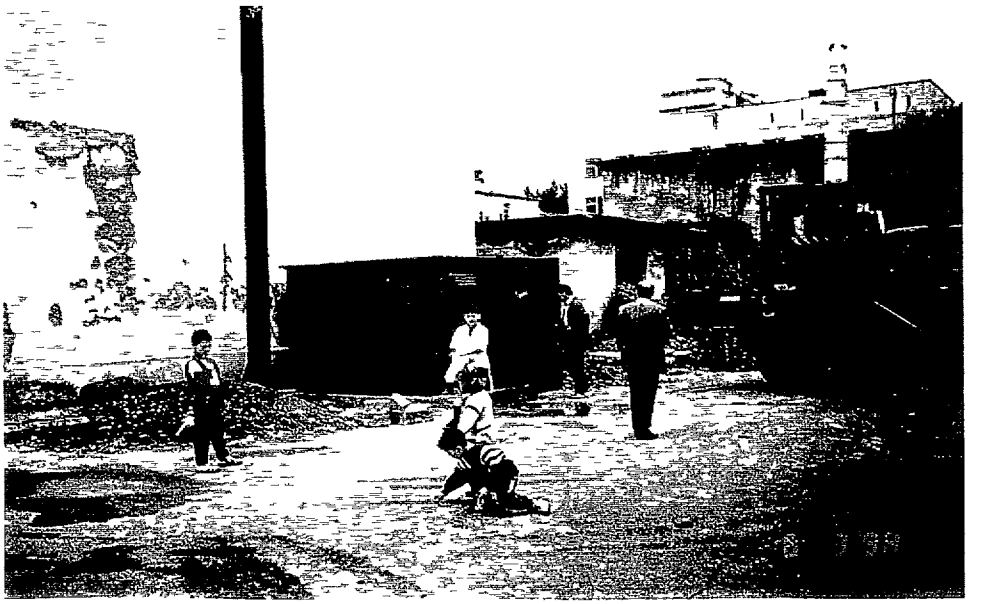




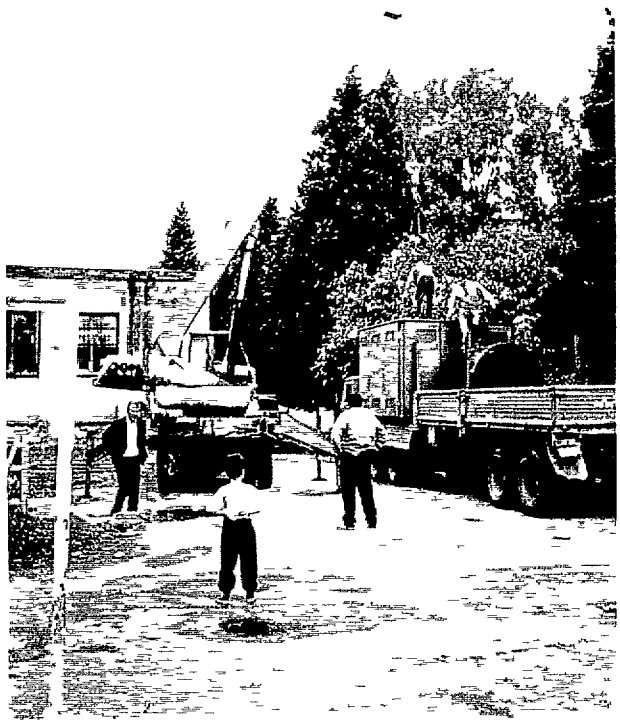




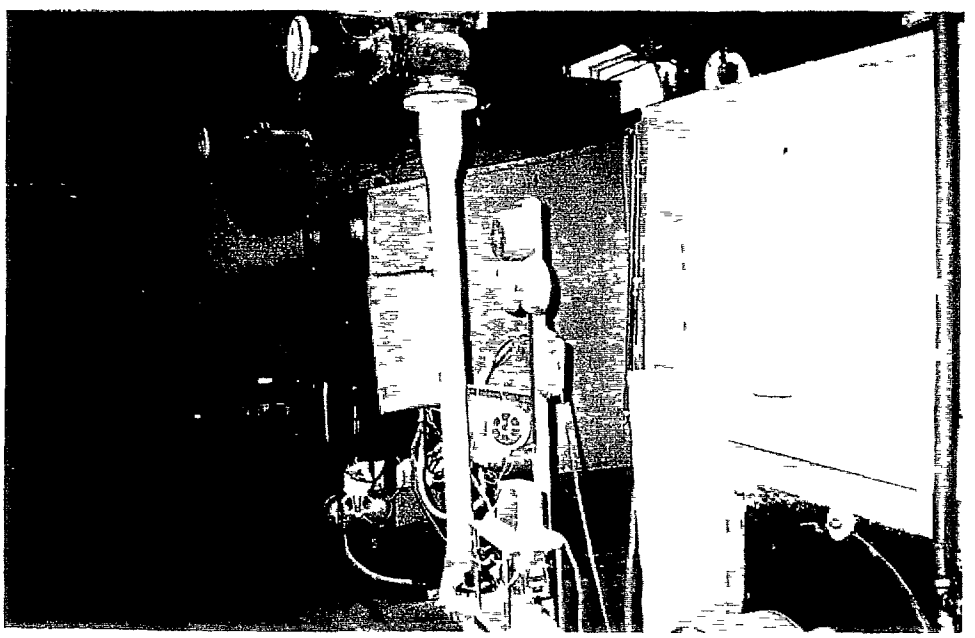
Rehabilitation of the heating system at the Secondary School #130 in Tbilisi

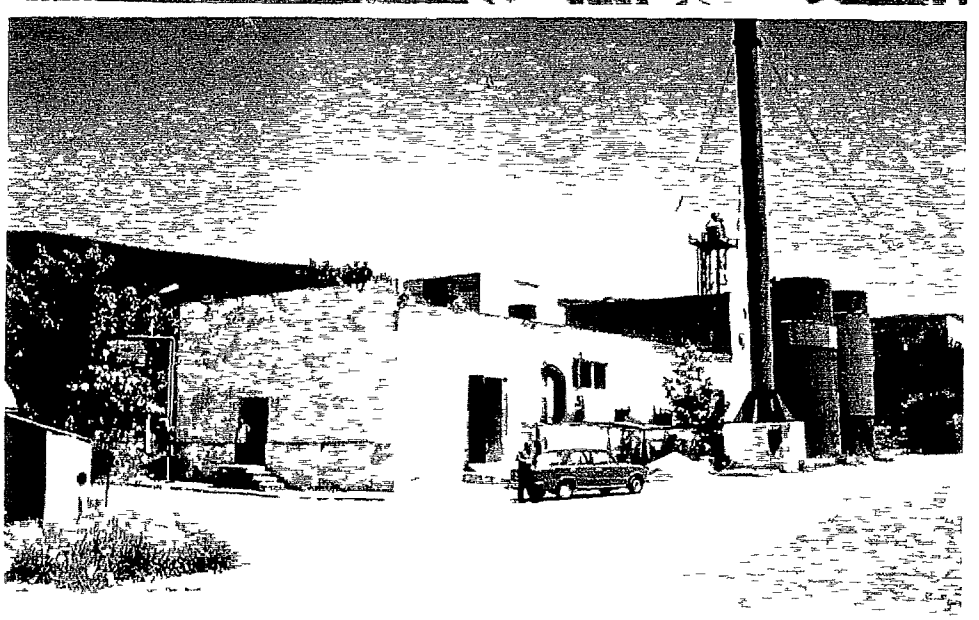


Rehabilitation of the heating system at the Secondary School #130 in Tbilisi



Rehabilitation of the heating system at the Mental Hospital in Tbilisi





Appendix E

1. Subtask 1 – District Heating Thermal Station No 9 Rehabilitation
(Cogeneration opportunities)

2 Subtask 5 – Heat Supply System Rehabilitation for the Oncology Center (Cancer) Hospital
(Cogeneration opportunities)

3 Reference to Technical Report Previously Submitted March 1996 Phase II – Selected Design Solutions and Cost Estimates

4 Miscellaneous Information about Potential District Heating Projects

Development, Investment & Engineering

ARCI Consulting

Delivery Order 11 Task 1
Tbilisi District Heating System Improvement Program

Subtask 1
District Thermal Station No 9 Rehabilitation
(Co-generation opportunities)

Technical Report

Prepared under subcontract to Burns & Roe Entarprises, Inc

Tbilisi, 1996

264

The Aim of the Expertise

The aim of the expertise is to study the possibility of an efficient application of cogeneration (joint process of thermal and power energy generation) as one of the means of heat supply system rehabilitation in Tbilisi

Efficiency of the cogeneration method was not questioned as it was sufficiently proved by experience The aim of this work was to find a particular solution to heat supply problems based on an example of one Tbilisi region Besides engineering and technical aspects of the problem many other factors have to be dealt with that are typical for social-economic situation in Georgia at the time when the experiment was performed

- Low solvency of thermal and power energy consumers,
- Lowered tariffs for electric power established by the Georgian government
- Market prices for all types of fuel that are close to world prices
- Absence of thermal energy market and as a result, absence of tariffs for services of centralized systems of heat supply
- Inadequacy of legislative and standartization bases for regulating relationship between consumers of communal service and producers
- Low efficiency of the communal services fee collection system
- State monopoly in the energy system sphere

Influence of the above mentioned factors can neutralize the effort to find an efficient solution of the problem But even in this case the recommendations of the expertise will give answers to the following questions

- Which tariffs for thermal and power energy will let us achieve production efficiency ?
- If the centralized heat systems can operate under the current conditions ?
- What changes are necessary in the relations between producers and consumers of communal services?
- What changes in property forms are necessary in the energy sector of Georgia

Choice of Expertise Site

Choice of a Tbilisi region for expertise is very important and has to meet the following requirements

- Compact location of solvent consumers of centralized heat supply system in the chosen Tbilisi region
- Minimal distance between chosen consumers and existing district thermal station
- Existence of reserve consumers in the chosen Tbilisi region increase of solvency of which can be expected in the nearest future,
- Technical suitability of installing cogenerating equipment in the chosen thermal station

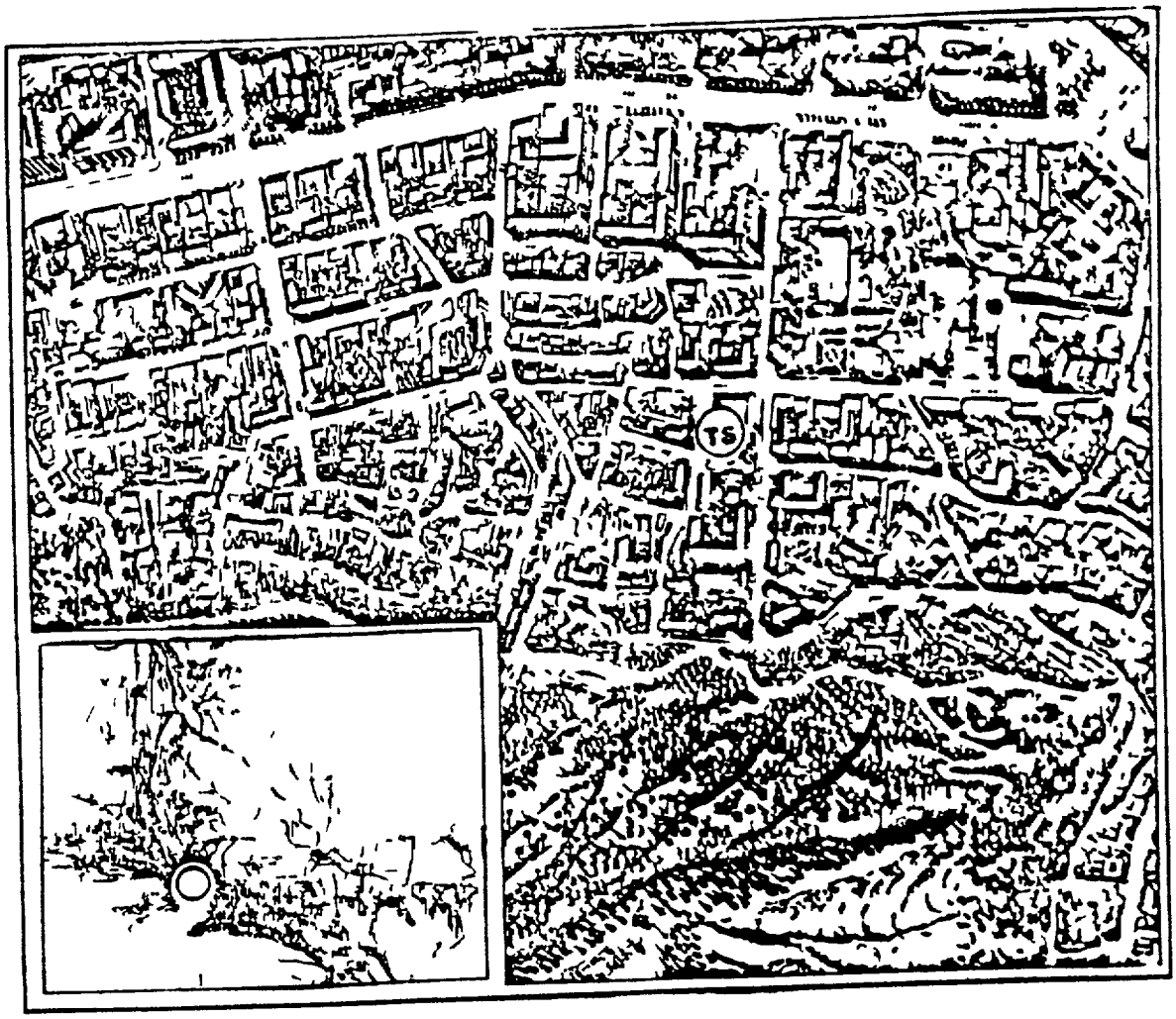
BEST AVAILABLE COPY

26

- Comparatively regular demand for thermal energy during the year
- Possibility to regulate daily changes in power demand by means of redistributing surplus to reserve consumers

As a result of comparing several options most responding to all demands is to choose a region in the center of Tbilisi serviced by Thermal Station N 9

Birdseye view of central part of Tbilisi



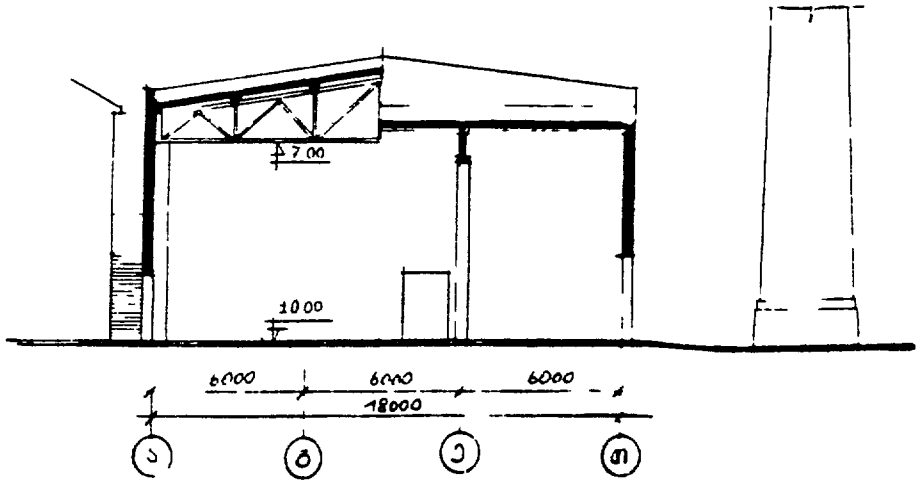
It must be noted that at the previous stage all necessary investment calculations for the rehabilitation of Thermal Station N 9 and protection of the existing equipment were carried out The availability of this information allows us to compare two options of the rehabilitation of Thermal Station N 9

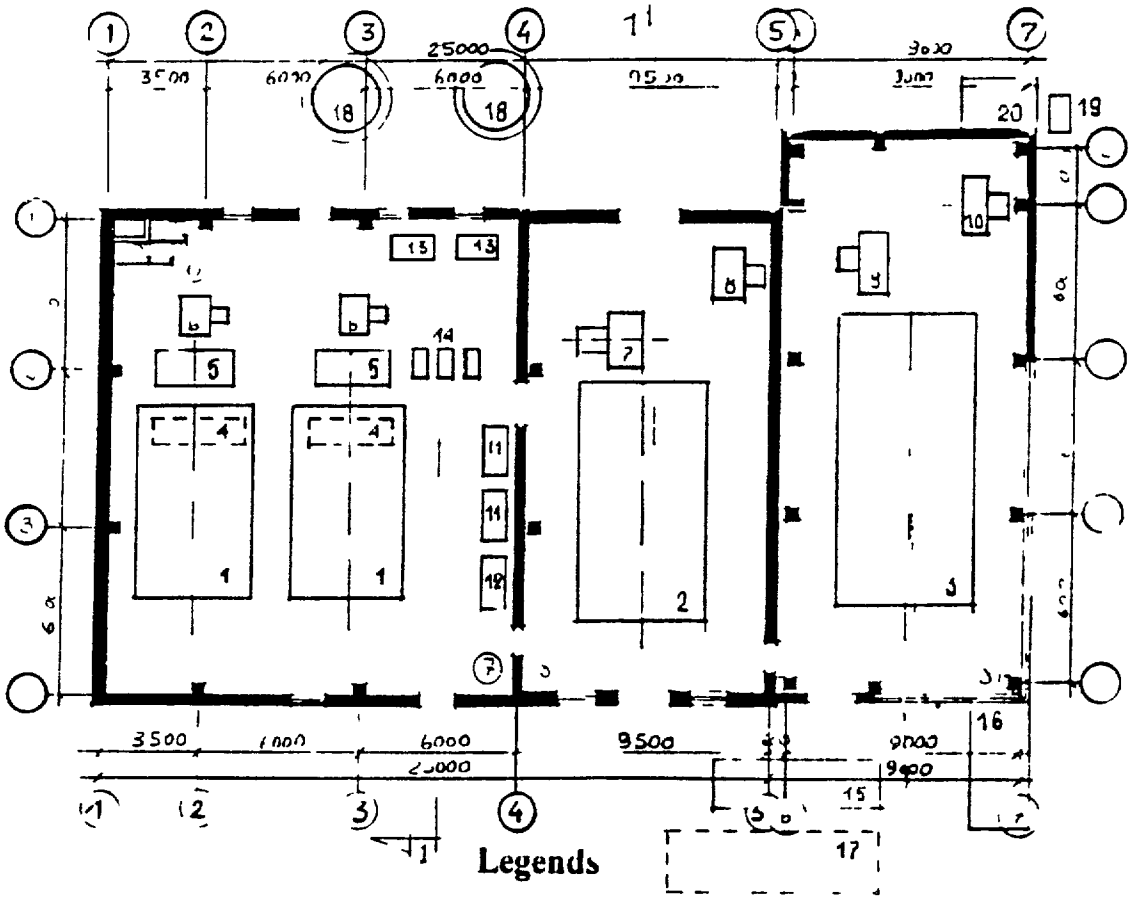
- with using of the existing equipment
- with using of new cogeneration equipment

Description of District Thermal Station N 9

District Thermal Station N 9, built in 1969, was equipped with two steam boilers DKBP-10/13 of 10 t steam/hour capacity each (6 5 kcal/hour = 7 54 MW h) In 1987 the building of Thermal Station N 9 was expanded and additionally equipped with a water heating boiler KBI M-20 capacity - 20 kcal/hour (23 2 MW) In 1991 one more water heating boiler was installed KBI M-30 capacity - 30 kcal hour (34 8 MW) Since 1992 after the gas supply was stopped District Thermal Station N 9 does not operate

267





Legends

1 Steam boiler DKVR 10-13
2 Water heating boiler KV-GM 20
3 Water heating boiler KV-GM 30
4 Fans D-10
5 Economizers
6 Smoke exhausters DN-10
7 Smoke exhauster DN-17
8 Fan VDN-12,5
9 Smoke exhauster DN-17
10 Fan VDN-15
11 Circulation pumps G200-95 2 items
12 Circulation pump 1sN-1000 1 items
13 Cold water pumps D200-95 2 items
14 Feed pumps KM45-55 3 items
15 Water treatment facility a) Deaerator V-25 m b) cationite filter d600 2 items c) salt solvent 1 item
16 Mazut supply system a) mazut pumps 3B 4-25-2 items b) mazut heaters PM-6-25 c) mazut filters 2 items
17 Mazut underground reservoir V-80 m
18 Brick smoke pipes H-25 m D-2.0 m
19 Salt solution pump K20-30
20 Salt solution reservoir

268

Table N 1 Technical condition of District Thermal Station N 9 main equipment for April - May 1995

Heat capacity of the TS (Gcal h)	Consumption load TS (Gcal/h)	Boilers									
		Water heating boilers					Steam boilers				
		Type	Quantity	Unit capacity (Gcal h)	Installation data	Designed nominal consumption of fuel	Type	Quantity	Unit capacity (tons h)	Installation data	Designed nominal consumption of fuel
63 0	25 4	КВГ М 20 КВГ М 30	1 1	20 30	1987 1991	2520 3680	ДКВР 10 13	2	10	1964	840

Fuel consumption in the best last year		
Natural gas (1000 m)	Mazout (tons)	Note
6692	5064 8	According to the Heating Department data from 1991

Pumps					
Heating network					
Type	Quantity	Unit Capacity G(m h)	Head H (m)	Capacity N (KW)	Note
3B 200 ШН 1000	2 1	500 1000	120 180	200 630	In operating state

Pumps					
Feeding system					
Type	Quantity	Unit capacity G(m h)	Head H (m)	Capacity N (KW)	Note
КМ45 55 Д 200 95 Д200 95	2 1 1	45 200 200	55 95 95	15 110 110	In bad state In operat (cold water) Damaged (cold water)

Pumps					
Water treatment system					
Type	Quantity	Unit Capacity G(m h)	Head H (m)	Capacity N (KW)	Note
2X-9Д	1	9	11	55	In operating state

BEST AVAILABLE COPY

26 '1

Pumps					
Fuel system (mazout)					
Type	Quantity	Unit Capacity G(m^3/h)	Head H (m)	Capacity N (KW)	Note
3B 4 25	2	6 4	250	7 5	In operating state

Fans and exhaust fans					
Type	Quantity	Unit Capacity G(m^3/h)	Pressure H (kg/m)	Capacity N (KW)	Note
B ДН 15	2	50000	350	55	In operating state
ДН 15	2	50000	226	40	
ДН 10	2	19600	221	30	
B ДН 8	2	6300	106	5 7	

Water heaters								
Steam-water			Water water			Mazout heating		
Type	Quantity	Note	Type	Quantity	Note	Type	Quantity	Note
ПП 1 35 2 II F=35 3 m^2	2	Needs repairs	-	-	-	ПМ 6 25	2	In operat state

Deaerator			
Type	Quantity	Volume V (m^3)	Note
ДС А 75 25	1	25	

Economizer		Natrium Filters for Water Treatment			
Type	Note	Quantity	Diameter d (mm)	Height (m)	Notes
Two units	In operating state	2	2000	4	In operating state

Brine solvent				Tanks					
				Water			Mazout		
Quantity	Diameter d (mm)	Height h (m)	Notes	Volume V (m^3)	Quantity	Note	Volume V (m)	Quantity	Note
1	1000	2	In oper state	400	1	Ferro-concrete under-ground	80	1	Metal under ground

270

Chimney Stack				Transformer				
Material	Diameter d (mm)	Height h (m)	Notes	Type	Capacity N (kW)	Quantity	Installation date	Notes
Brick	2	20	Two units	III 1000 10	1000	2	1987	Double way feeding In good condition

Inner piping	Thermal net			
	Pipe d (mm)	Lenght 2xl (m)	Degree of depr	Notes
20% of pipes need to be replaced	400 350 300	2x 977 2x 5900 2x 6700	0	Non accessible channels partially without channels
	250 200 150	2x 2860 2x 3680 2x 3110	42	
	100 80 50	2x 3060 2x 5900 2x 7543	85	

Building Structure of the Boiler House			
Main Structure		Roofing	Real State
columns/walls	roof		
Ferroconcrete pilers Ferroconcrete panel and brick walls	Ferroconcrete girder trusses	Ferroconcrete unit construction slabs	The static stability of the building is preserved Requires roof insulation repair windows glass replacement repair and renovation of the interior

At present the both water heating boilers are operable and need some minor repair Civil constructions of District Thermal Station N 9 building correspond to stability requirements but need extensive rehabilitation

27'

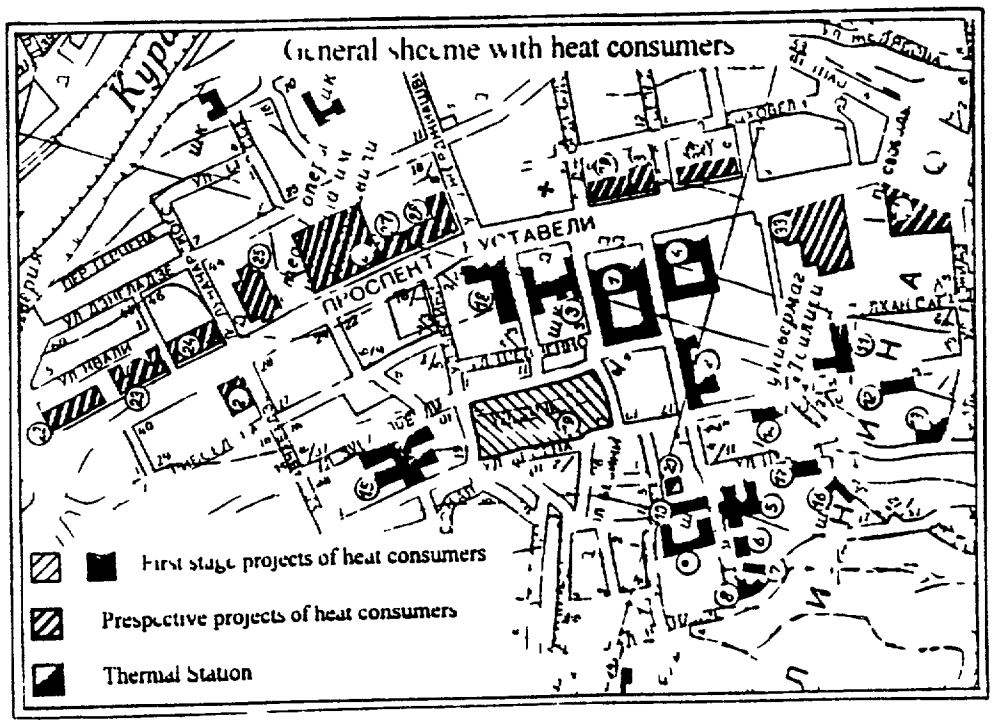
List of Consumers of Thermal Energy

1 Parliament of Georgia
2 Ministry of State Security
3 School
4 Palace of Youth
5 Ministry of Foreign Affairs
6 Counellor Department
7 Hotel
8 Out Patients' Clinic
9 School
10 Municipal Enterprise Tbomeurneoba
11 Cabinet of Ministers of Georgia
12 Bank
13 Tax Inspection of Georgia
14 Kindergarten
15 Supreme Court of Georgia
16 School
17 Kindergarten
18 Ministry of Communications (being under construction)
19 Residential Block

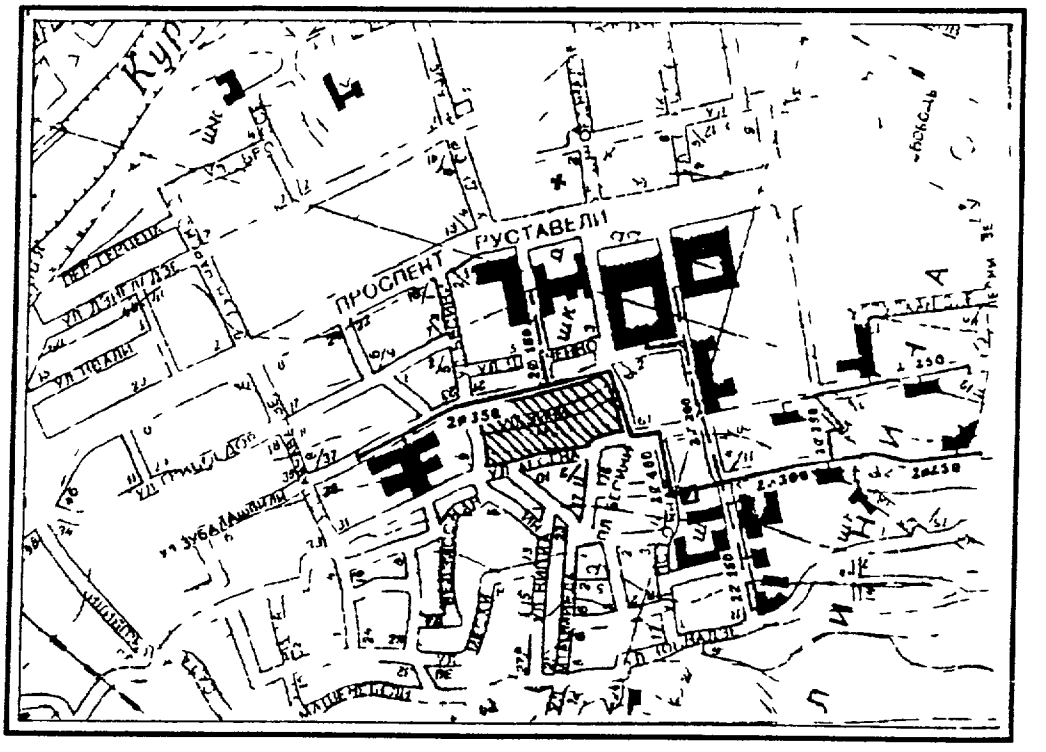
20 District Thermal Station N9

List of Future Consumers of Thermal Energy

21 Ministry of Justice
22 Central Telegraph
23 Governmental Agencies
24 Bank
25 National Opera
26 Academic Theater
27 Condominium
28 Hotel
29 Hotel
30 Cinema
31 Residential Block
32 National Historical Museum
33 Supermarket



Project of rehabilitated thermal networks.

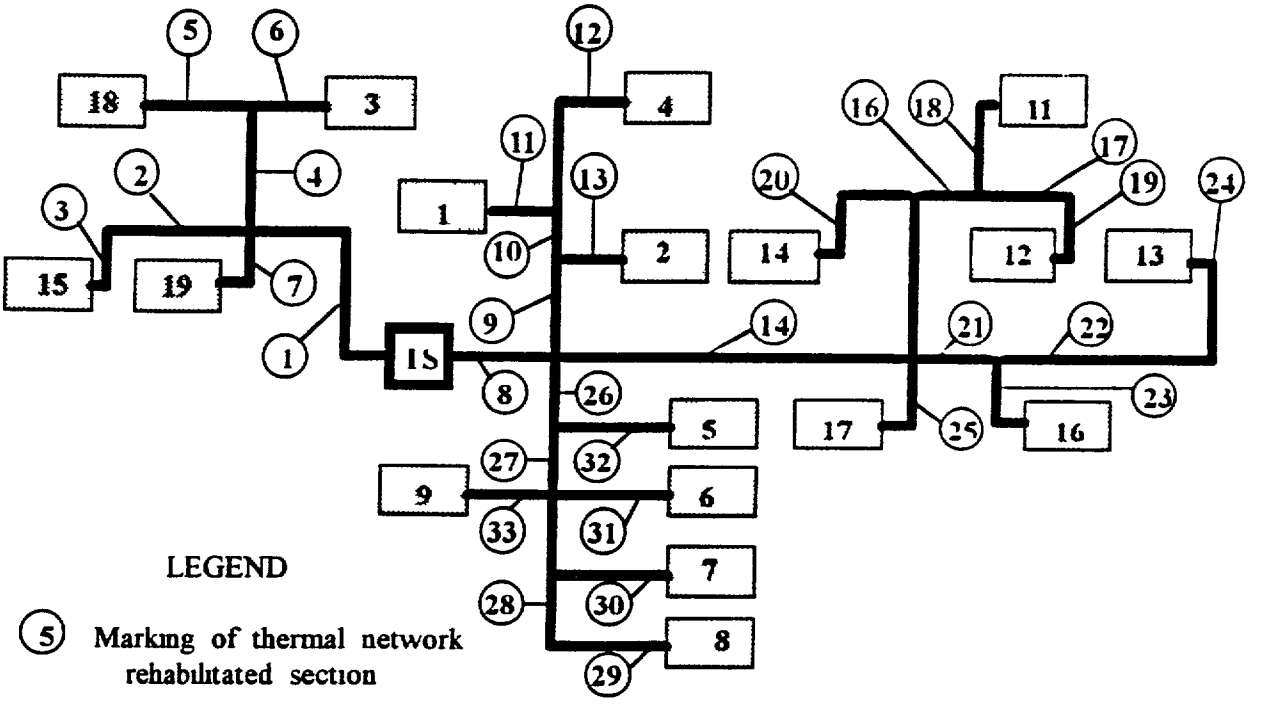


LEGEND

——— Existing thermal networks

— — — Designed thermal network.

Rehabilitation scheme of thermal network.



LEGEND

(5) Marking of thermal network rehabilitated section

[6] Marking of heat consumer

Legend of district thermal network to be rehabilitated

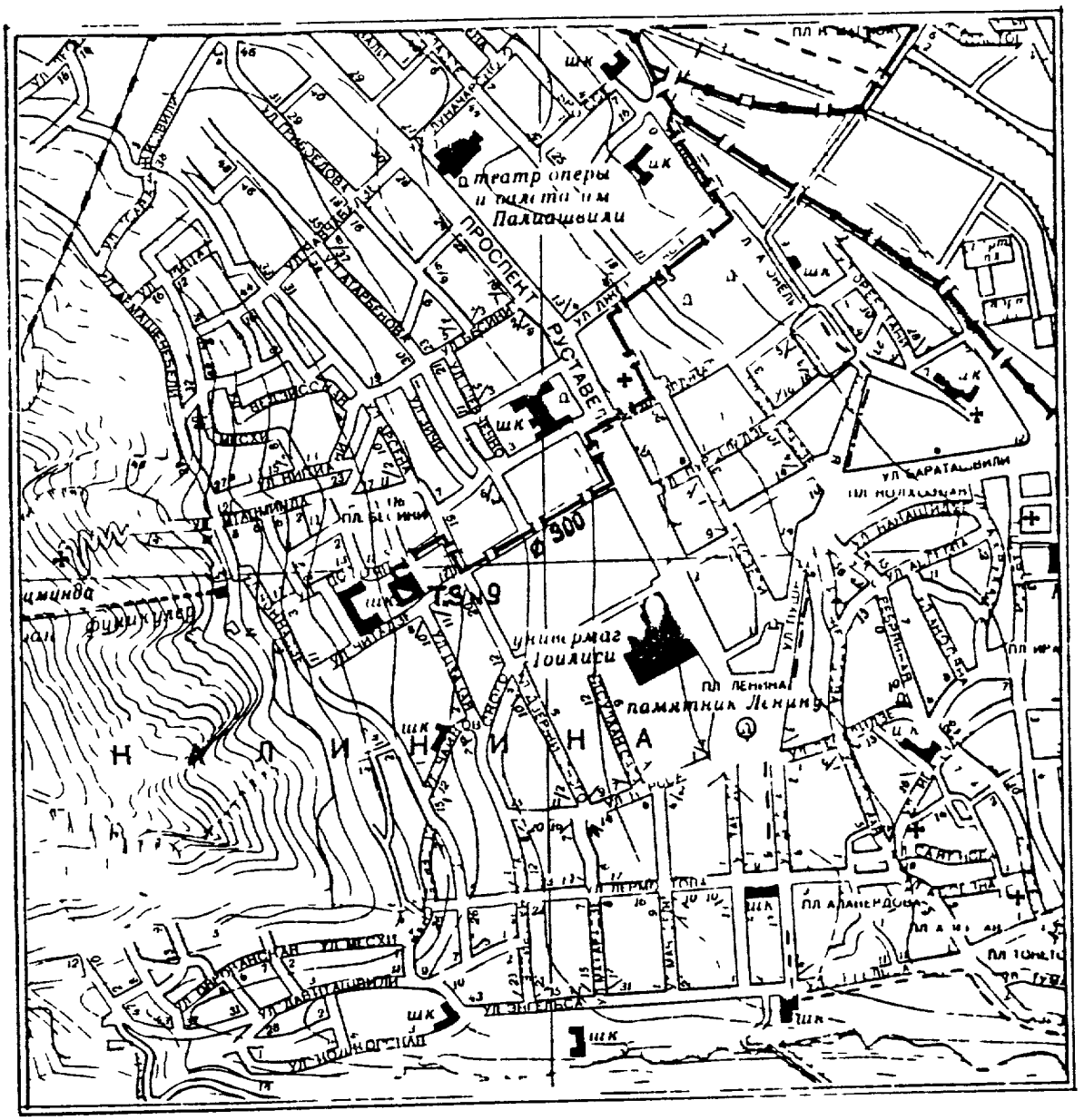
Section N	Section length L m	Pipe diameter 2D mm	Type of piping	Line condition	Note
1	320	400	With channel	Acting	
2	200	350	— " —	— " —	
3	20	100	— " —	Reconstruction	Channel and piping are replaced
4	160	150	— —	To be constructed	
5	20	100	— " —	— " —	
6	20	100	— " —	— " —	
7	240	100	— " —	Reconstruction	Channel and piping are replaced
8	50	300	— —	Acting	
9	110	200	— " —	To be constructed	
10	100	200	— —	— —	
11	200	150	— —	— " —	
12	130	100	— " —	— " —	
13	10	150	— —	Reconstruction	Channel and piping are replaced
14	150	300	— " —	Acting	
15	130	250	Without channel	— " —	
16	50	250	— " —	— " —	
17	180	250	— " —	— —	
18	65	125	— —	— —	
19	15	80	With channel	— —	
20	60	80	— " —	To be constructed	
21	50	250	— " —	Acting	
22	200	250	— " —	— " —	
23	80	80	— " —	To be constructed	
24	15	80	— —	Acting	
25	10	80	— —	To be constructed	
26	50	150	— " —	— " —	
27	50	150	— " —	— " —	
28	40	100	— " —	— " —	
29	50	80	— " —	— " —	
30	10	80	— " —	— —	
31	10	80	— —	— —	
32	10	80	— " —	— " —	
33	15	100	— " —	— " —	

Notes 1 Prevented works are performed for acting sections

2 Sections to be constructed will be put in inaccessible channels

2/4

Scheme of gas supply rehabilitation



Legends

Existing medium pressure gas pipeline

Designed medium pressure gas pipeline

Approximate expenses for rehabilitation of TS N9 with using of existing equipment are given in Table N 2

Table N 2

N	Types of works	Cost in US $
1	Construction works	60 0
2	Rehabilitation of existing equipment	55 0
3	Rehabilitation of energy supply system	45 0
4	Repair and construction of thermal network	560 0
5	Construction of new line of gas piping	250 0
	TOTAL	910 0

Method of Determination of Optimal Efficiency of Cogeneration Equipment for Thermal Station N 9

Estimation of cogeneration equipment capacity takes into consideration thermal and power energy demand

I Estimation of thermal energy demand

Table N 3

TS N 9 consumers demand in thermal power

N	Name of consumer	Demand in thermal power (Gcal/h)				Note
		$Q_{heat\ max}$	$Q_{ave\ mont}$	$Q_{hot\ water}$	Q_{air}	
1	Parliament	4 6	2 44	0 35	1 00	
2	Ministries of Communication and Security	1 3	0 70	0,20	-	
3	School N1	2 0	1 06	1 00	-	
4	Palace of Youth	2 0	1 06	0 10	-	
5	Ministry of foreign affairs	0 8	0,42	0 10	-	
6	Caunceior department hotel	0 3	0 16	0 10		
7	Dormitary	0 3	0 16	0 10	-	
8	Out-patients clinic	0 2	0 11	0 12	-	
9	School N47	0 2	0 11	0 05	-	
10	Thermal stations	0 2	0 11	-	-	
11	Cabinet of ministers	1 7	0 90	0 20	0 70	
12	Absolutbank	0 1	0 06	0 05	-	
13	Tax inspection	0 1	0 06	0 05	-	
14	Kindergarten	0 1	0 06	0 05	-	
15	Supreme court	0 5	0 32	0 05	-	
16	School of Physics-mathematics	0 4	0 21	0 08	-	
17	Kindergarten	0 1	0 06	0 05	-	
18	Ministry of communication (reconstruction)	2 5	1 33	0 15	0 70	
19	Residential block	-	-	(0 80)	-	
	TOTAL	17 4	9,23	2,80 (3 60)	[illegible] 00	Only in summer time

Table N 4 Temperature characteristics of climate conditions in Tbilisi

External air temperature °C											
Average/month											
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
0 9	1 2 6	6 6	11 9	17 3	21 1	24 4	24 2	19 6	13 8	7 6	2 8

Temperature range average/maximal per month °C											
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
7 9	8 1	9 2	10 8	10 9	11.5	11.8	12.1	10.8	10 2	8 2	8
20 5	19 9	21 6	21 5	21	18 7	19 9	20 3	23 6	21 4	20	19 1

								Period with average air temperature					
				Probability of the coldest days %		Probability of cold five days %		< 8° C		10° C			
Average annual	Absolute minimum	Absolute Maximal	Average maximal of the hottest month	0 28	0 92	0 98	0 92	Duration of the days	Average temperature C	Duration of the days	Average temperature C	Average of the coldest period C	Duration of the period with average daily 10 C
12 7	23	40	30 8	14	10	11	-8	152	4 2	154	4 _	0	0

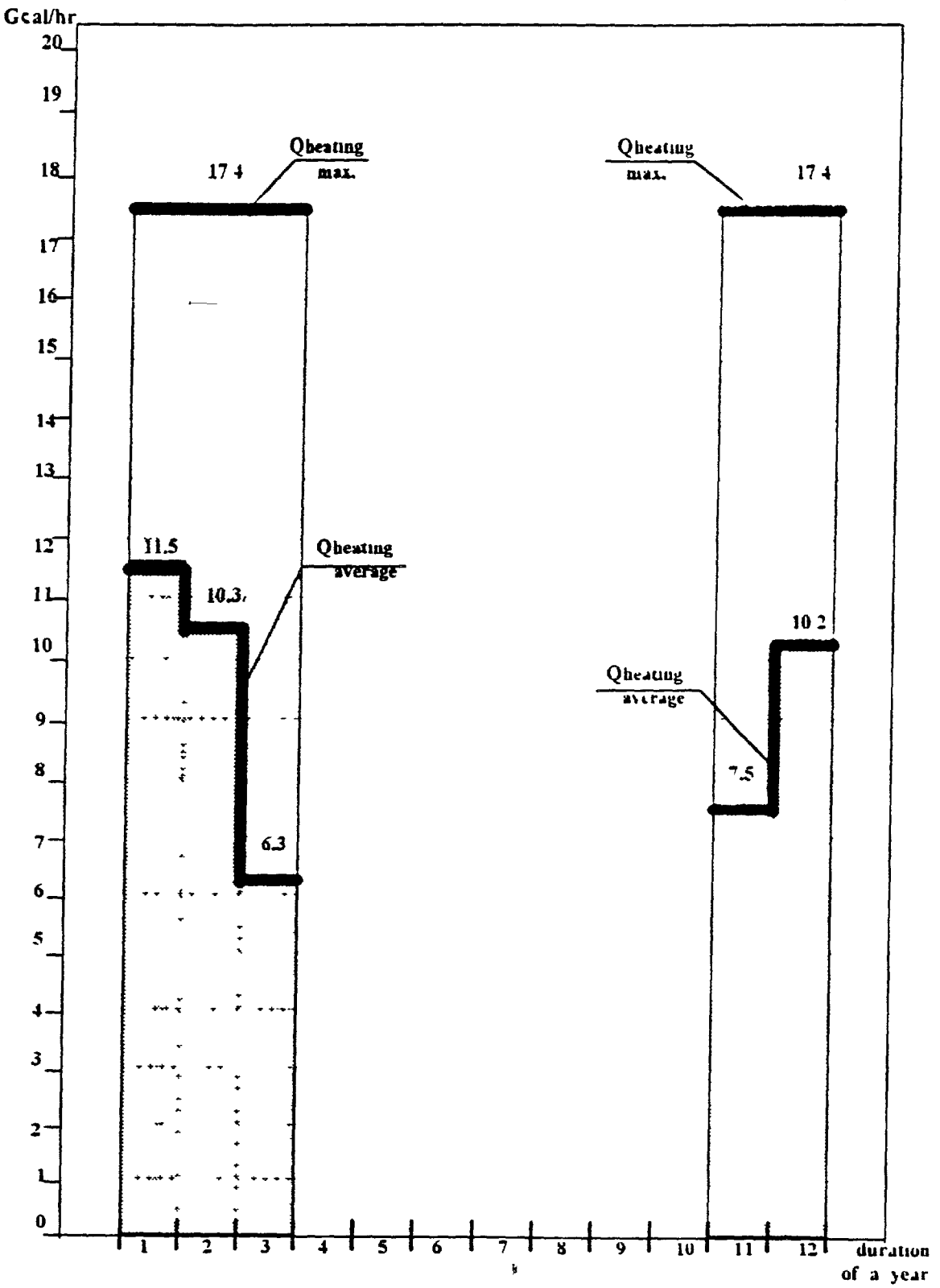
Average air temperature duration			
Air temperature intervals °C	Average annual duration / hours	Air temperature intervals °C	Average annual duration hours
-16 -14 1	0	12 13 9	552
-14 -12 1	9	14 15 9	605
-12 -10 1	9	16 17 9	651
-10 -8 1	18	18 19 9	648
-8 -6 1	53	20 21 9	614
-6 -4 1	96	22 23 9	491
-4 -2 1	175	24 25 9	403
-2 -0 1	298	26 27 9	263
0 1 9	500	28 29 9	201
2 3 9	622	30 31 9	131
4 5 9	657	32 33 9	70
6 7 9	596	34 35 9	19
8 9 9	587	36 37 9	0
10 11 9	517		

The following tables of thermal power demand according to the months had been compiled based on the data of required amount of thermal power and with taking into account the climatic conditions of Tbilisi

278

The annual profile of thermal energy demand for heating system.

Table-5

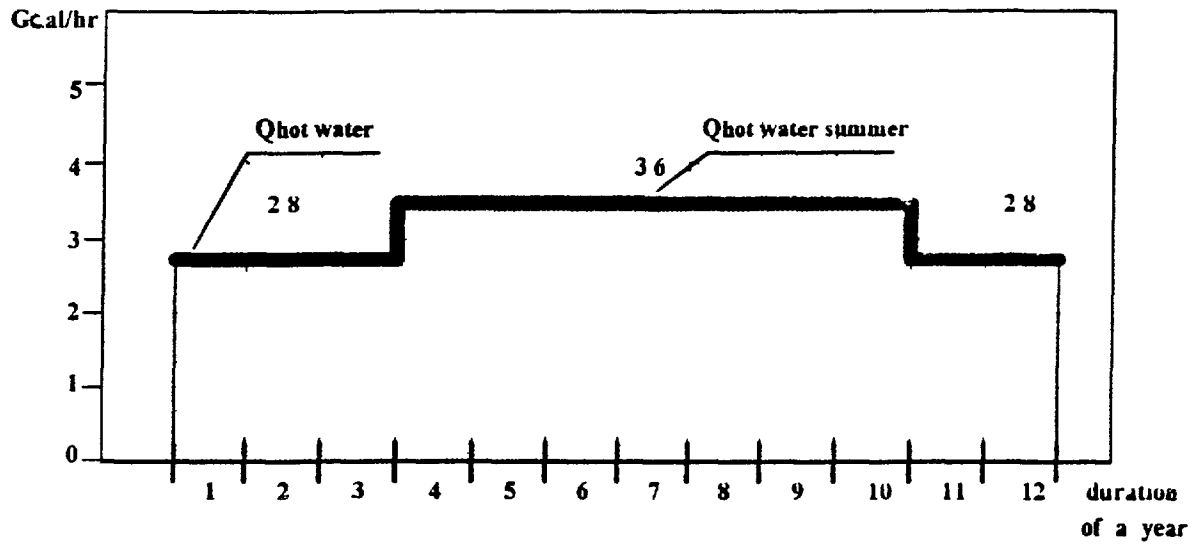


$Q_{heating\ max}$ ——max. heating load curve

$Q_{heating\ average}$——heating average monthly loads

The annual profile of thermal energy demand for hot water supply system.

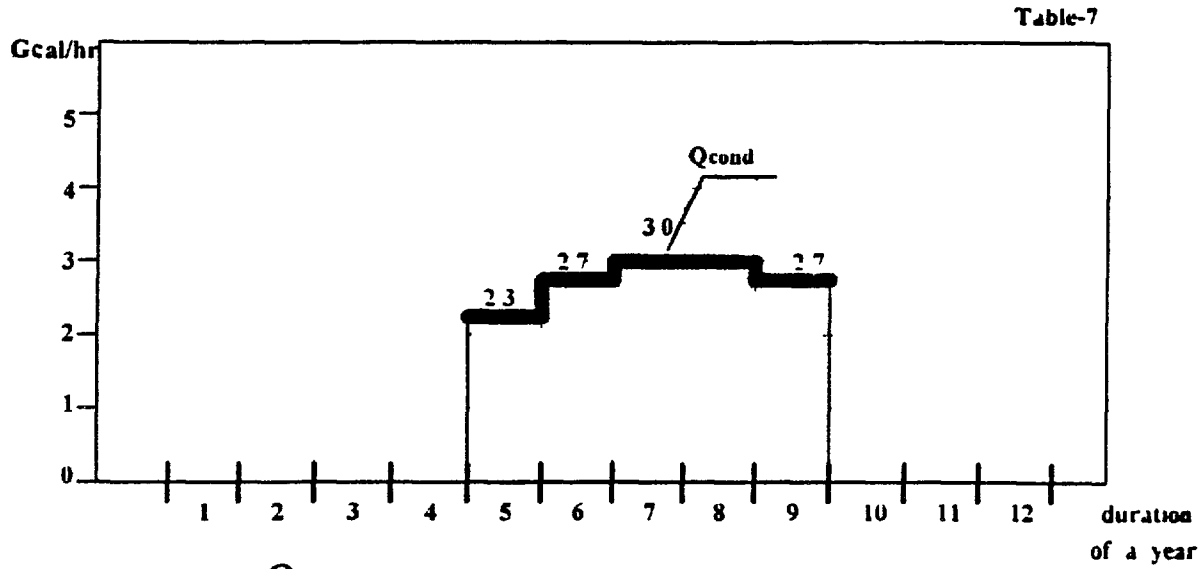
Table-6



$Q_{hot\ water}$—hot water loads for winter
$Q_{hot\ water\ summer}$——hot water loads for summer

The annual profile of thermal energy demand for air conditioning.

Table-7

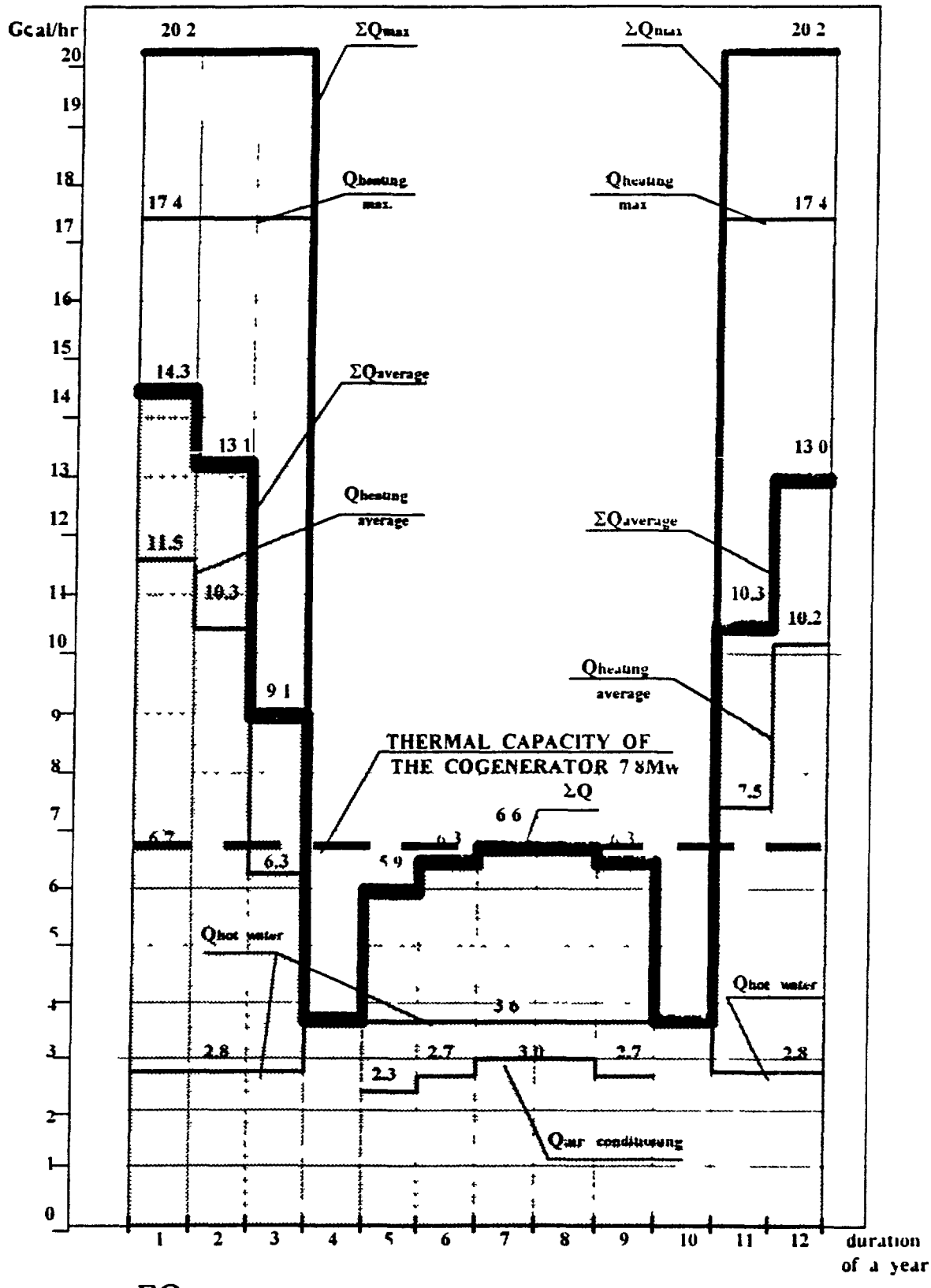


Q_{cond} —air conditioning load curve

280

The curve of total annual thermal energy demand.

Table-8



ΣQmax -total annual profile at maximum load

ΣQaverage-total annual profile for average monthly load

ΣQ–load curve for summer time

281

CONCLUSIONS

- Cogeneration system output according to the thermal component capacity should be within 7 0 MW - 8 0 MW and useful utilization of thermal power generated during the year will not be less than 90%, at that
- It is reasonable to utilize existing boilers of КВГМ type during the heating season for peakshaving purposes
- Utilization of the existing water heating boilers can provide thermal power in case of emergency when there is need to stop of the cogenerator it also enables to be limited with installation of one cogeneration system only
- With creation of new solvent consumers (see reserve consumers list) increased consumption of thermal power can be provided by more intensified operation of the water heating boilers When additional heat power demand increases up to 160 MW it is reasonable to replace one of the water heating boiler with another cogenerator
- In using combined "cogenerator system+water heating boilers' the dimensions of the cogenerator system should enable its installation in the place of disassembled steam boilers (sizes 15mx18m and the height is 7 m)

NOTE It should be noted that operation of the existing water heating boilers is connected with the significant overconsumption of the fuel It is caused by old-fashioned design of the boilers and also, by the fact that to reach 85-90% efficiency water temperature at the discharge should be not less than 130^{0}C However the quality of the existing district thermal piping (which are supposed to be partially used) do not enable to use water with temperature more than 90-95^{0}C Thus the boiler efficiency will be lowered down to 65-70% which causes high fuel consumption

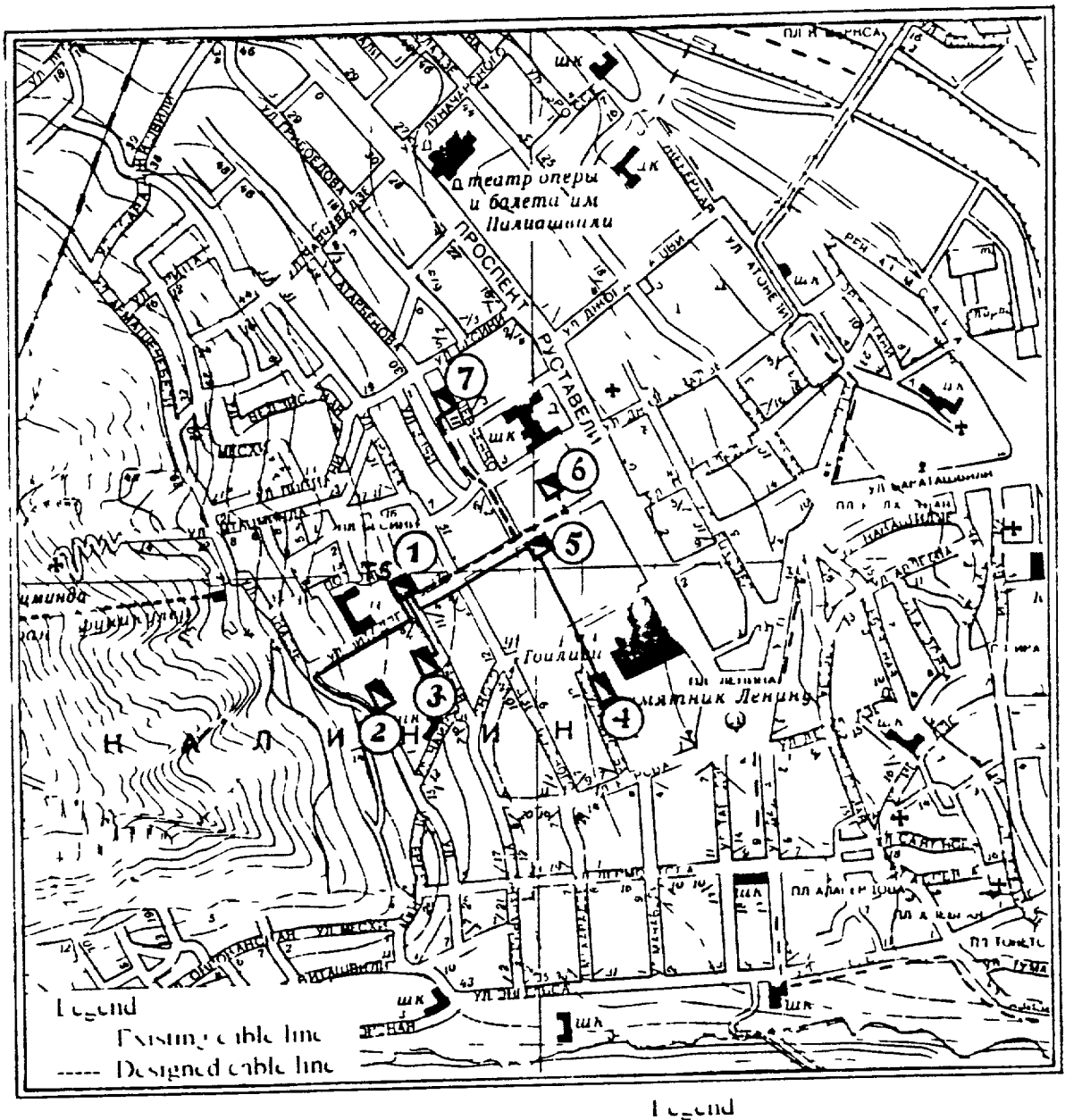
II Electric Power Demand Estimation

In order to calculate power demand rate it is necessary to select optimal scheme of the consumers supply For this very purpose there had been reviewed three options In all of the options it should be taken into account that at the present moment all potential consumers are supplied with power from the city power grid Consequently turning to new source of power is supposed to attract the consumers by possibility of increasing power supply reliability (it is a very acute issue in the conditions of power system crisis in Georgia) with preserving power supply tariffs

Option 1

Generated power distribution (sales) between the specific (regular) consumers

Scheme of power distribution - Option I



Legend

1 Transformer substation N4073
2 Transformer substation N4551
3 ____ ____ ____ ____ N4202
4 ____ ____ ____ ____ N4100
5 ____ ____ ____ ____ N4028
6 ____ ____ ____ ____ N1 10
7 ____ ____ ____ ____ N1 40

Following advantages and negative sides could be distinguished in above diagram

Advantages

- Possibility to sell generated power by retail prices
  to the population 1 kW h - 0 025 lari (=$0 02)
  all other consumers 1 kW h - 0 045 lari ($0 036),
  in difference with the wholesale tariff equaling to 1 kW h - 0 024 lari ($0 0192)
- There are no problems regarding frequency synchronization for power generated from cogenerator in case city grid power frequency decrease
- Increase of reliability of power supply for the specific (regular) consumers

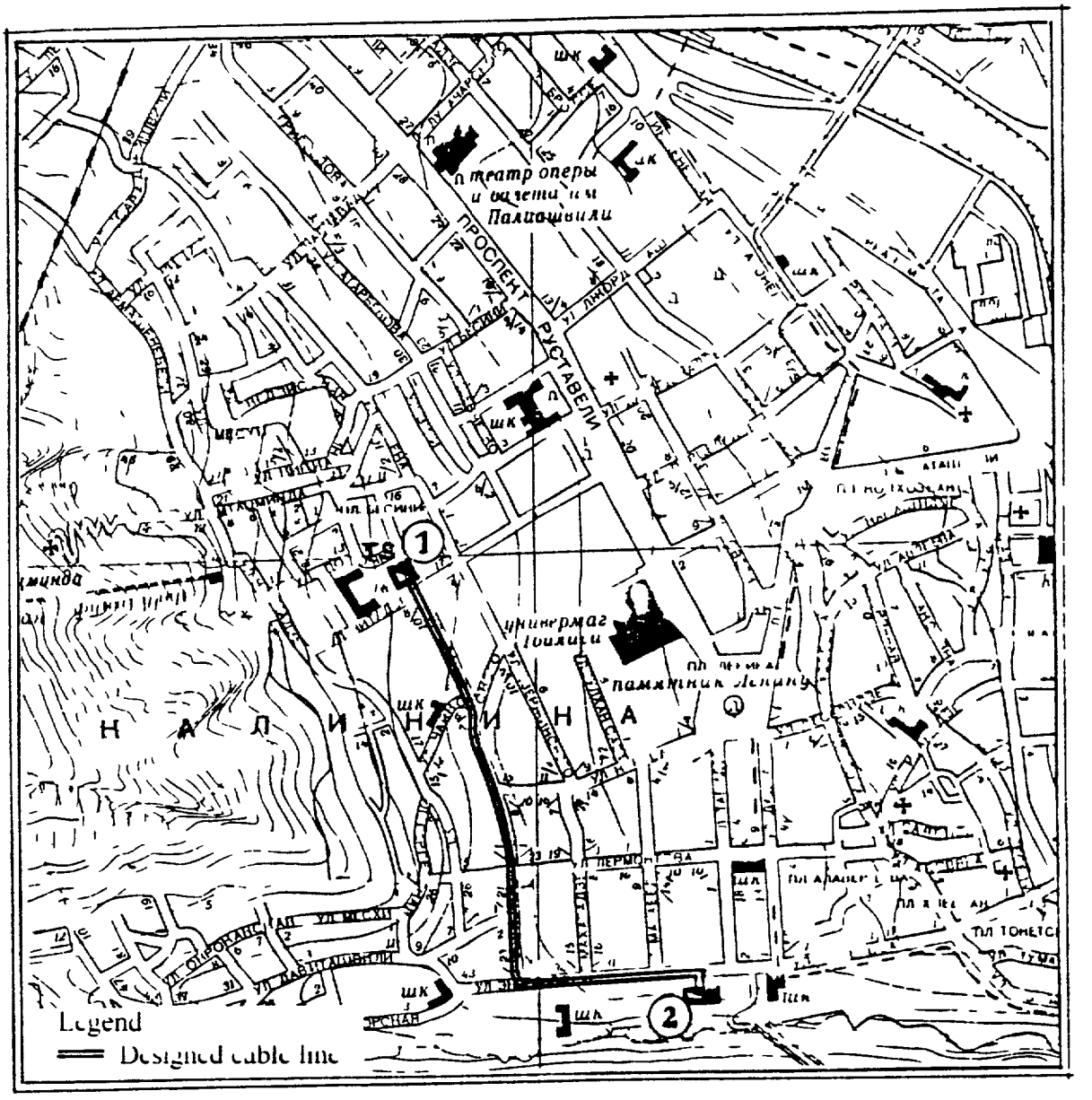
Disadvantages

- Problems connected with excess power sales at night times
- Necessity of reserve consumers availability for excess power sales at night times (pumping stations of the city water supply systems, Metro stations TV-radio retranslators, telephone stations, etc)
- Significant capital costs for setting independent power network systems and respective operating costs
- Administrative issues regarding collection of payments from the consumers for consumed power

<u>Option II</u>

Sales of all generated power to the city (district) power system

Scheme of power distribution - Option II



BEST AVAILABLE COPY

Legend
1 Transformer substation N4673
2 Transformer substation Sololaki

Following advantages and negative sides could be distinguished in above diagram

Advantages

- Possibility of even sales of all generated power during a day
- Simplified system of power network
- Decreased demand for uninterrupted operation of the cogenerator enabling installation of one cogeneration system
- Simplified payment collection system for power consumption from one wholesale consumer

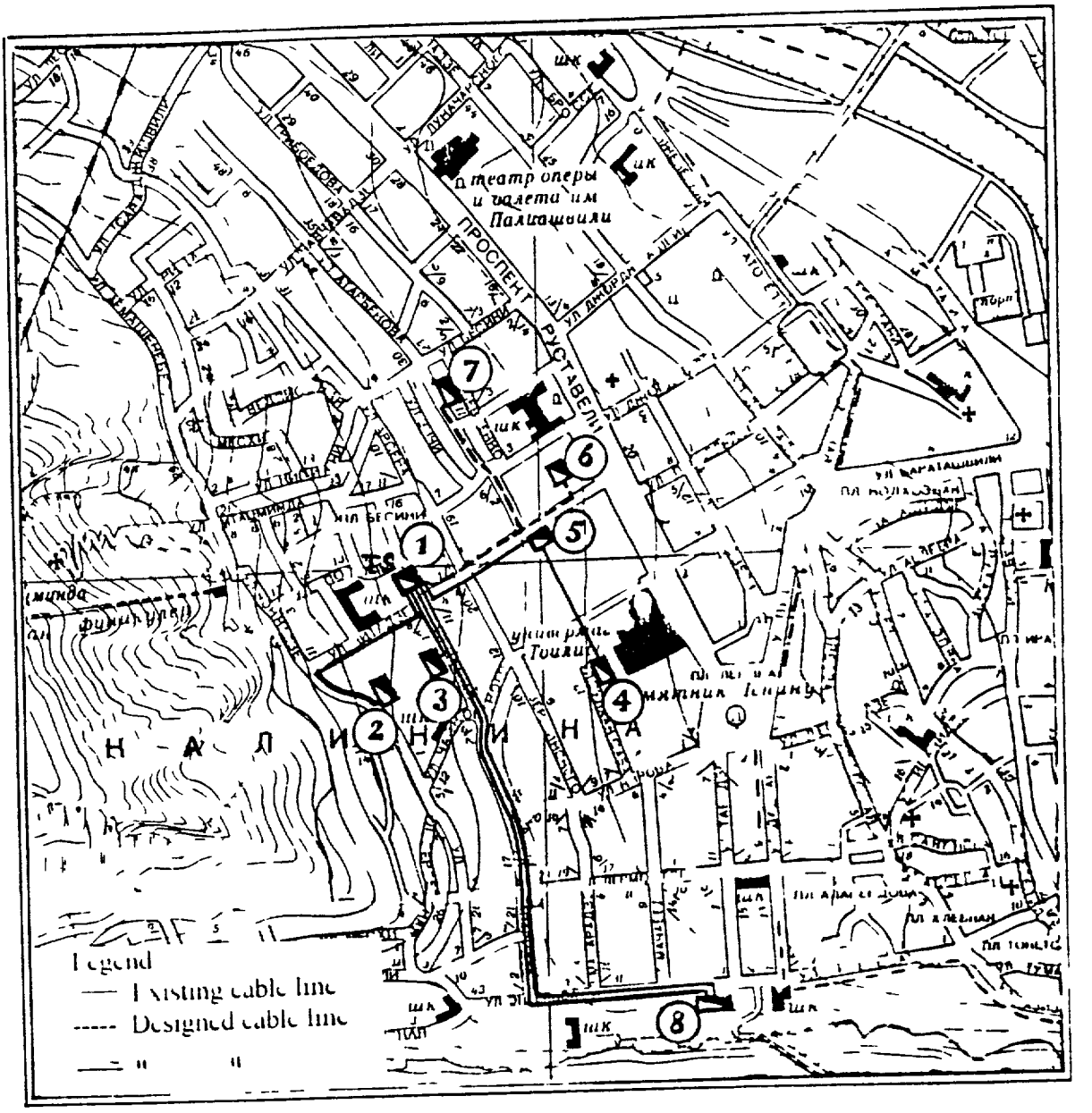
Disadvantages

- Generated power sales by unified wholesale tariff - 1 kW h - 0 024 lari ($0 0192)
- Possible problems connected with power frequency synchronization in case of city power frequency changes (City power frequency fall down to 46-47 Hz were usual during the period from 1992 to 1995 At present the situation has improved and at Sakenergo they hope to gain final stabilization)

Option III

Sales of basic amount of generated power to the city (district) power system with distribution of the power portion between the limited number of regular consumers

Scheme of power distribution - Option III



Legend

1 Transformer substation N4673
2 Transformer substation N4551
3 N4202
4 N4100
5 N4028
6 N1-10
7 N1-40
8 Sololaki

BEST AVAILABLE COPY

General conclusions of the power demand estimation and selection of the optimal scheme of its distribution

- Recommended Option III of the generated power distribution enables to partially neutralize negative sides of Options I and II preserving their main advantages
- Amount of generated electric power (with recommended distribution scheme) does not affect the determination of cogenerating system capacity

General conclusions on determining optimal output of cogenerating systems for TS No 9

- Optimal output of the cogeneration system for TS No 9 should be defined based on thermal component

288

Pricing Analysis for Thermal and Electrical Power

I. Cost of thermal power

Cost estimations of thermal power made by Municipal enterprise Tbomeurneoba (enterprise which had to ensure functioning of district heating systems of Tbilisi) reflect dynamics of changes in pricing conditions for recent years

Table N 9 Expenditure for production of 1 Gcal (1 163 MW h) of thermal power in 1993

N	Name of expenditure	Unit of measure	Standard 1 Gcal	Unit cost	Expenses 1 Gcal	Same in %
1	Fuel (gas)	m^3	171	45-00	7697	91 20
2	Electric power	kW h	39	10-10	390	4 62
3	Water	m^3	1 5	16-00	24	0 28
4	Salt	kg	1 5	1 20	2	0 02
5	Depreciation	Rouble	-	-	100	1 18
6	Salary		-	-	60	0 71
7	Salary adding		-	-	24	0 28
8	Reimbursement of own operating capital (Mazout purchase)		-	-	125 0	1 48
9	Other expenses		-	-	20 0	0 23
	Total expenses	Rouble	-	-	8440	100 0

Note

Prices given in Roubles of CIS for 01 01 1993 - 400 roubles=$1 i.e. 1Gcal $21 1

Table N 10 Expenditure for production of 1 Gcal (1 163 MWt h) thermal power for 01 05 1994

N	Name of expenditure	Unit of measure	Standard 1 Gcal	Unit cost thous coupons	Expenses 1 Gcal thous coup	Same in %
1	Natural gas	m^3	140	37 0	5180 0	68 16
2	Electric power	kW h	39	5 5	214 0	2 82
3	Water	m^3	3,6	4 0	14 4	0 19
4	Salt	kg	3 6	15 0	54 0	0 71
5	Materials	Thous coupons			8 0	0 10
6	Depreciation				12 0	0 16
7	Repair fund				1600 0	21 05
8	Salary				51 0	0 67
9	Salary adding				20 4	0 27
10	Other expenses				445 7	5 87
	Total expenses	Thous coupons			7600 0	100 00

289

Note
Prices given in thous coupons of Georgia for 01 05 1994 - 350 000 coupons=$1 i e
1Gcal-$21 7

Table N 11 Expenditure for production of 1 Gcal (1 163 MW t h) thermal power for 01 05 1995

N	Name of expenditure	Unit of measure	Standard 1 Gcal	Unit cost thous coupons	Expenses 1 Gcal thous coupons	Same in %
1	Natural gas	m^3	184 3	130 0	23959 0	74 87
2	Electric power	kW h	39	45 0	1755 0	5 48
3	Water	m^3	3 6	200 0	720 0	2 25
4	Salt	kg	3 6	200 0	720 0	2 25
5	Materials	Thous coupons			400 0	1 25
6	Depreciation				120 0	0 37
7	Repair fund				1800 0	5 63
8	Salary				1440 0	4 50
9	Salary adding				576 0	1 80
10	Other expenses				550 0	1 72
	Total expenses	Thous coupons			32000 0	100 00

Note
Prices given in thous coupons of Georgia for 01 05 1995 - 1 300 000 coupons-$1 i e
1Gcal=$24 7

Using this method for thermal power cost calculation for 01 08 1996 we ll get
1Gcal - $22 5

It should be taken into account that potential consumers of Thermal Station N9 will require to ensure reasonability of their heat supply from TS N9 in comparison with possibility of arrangement and operation of individual boiler house on diesel fuel (using of natural gas for individual heat systems in considered district of Tbilisi is connected with considerable expenditures on rehabilitation of gas supply system) To justify price competitiveness of district heat supply in comparison with the operation of individual boiler house it is enough to perform following calculations

> In case of using diesel at price $180 per tone the price of 1Gcal is $26 5-27 5 providing that fuel component in cost on thermal power is 75% and fuel is burning in boiler with efficiency-85%

To take into account profitability of investments for arrangement of individual boiler house the cost of 1Gcal will be not less then $30 So tariff on thermal power of Thermal Station N9 could be fixed on level 1Gcal - $30 (1MW h - $25 80)

II. Electric Power Cost

At present electric power tariff is subject to state regulation The dominating electric power generation in Georgia is maintained (through hydropower plants and thermal power plants) by state company "Sakenergo - generatsia"

Another state company "Sakenergo - gadatsema" is the main supplier of electric power to the large consumers (residential areas, large enterprises)

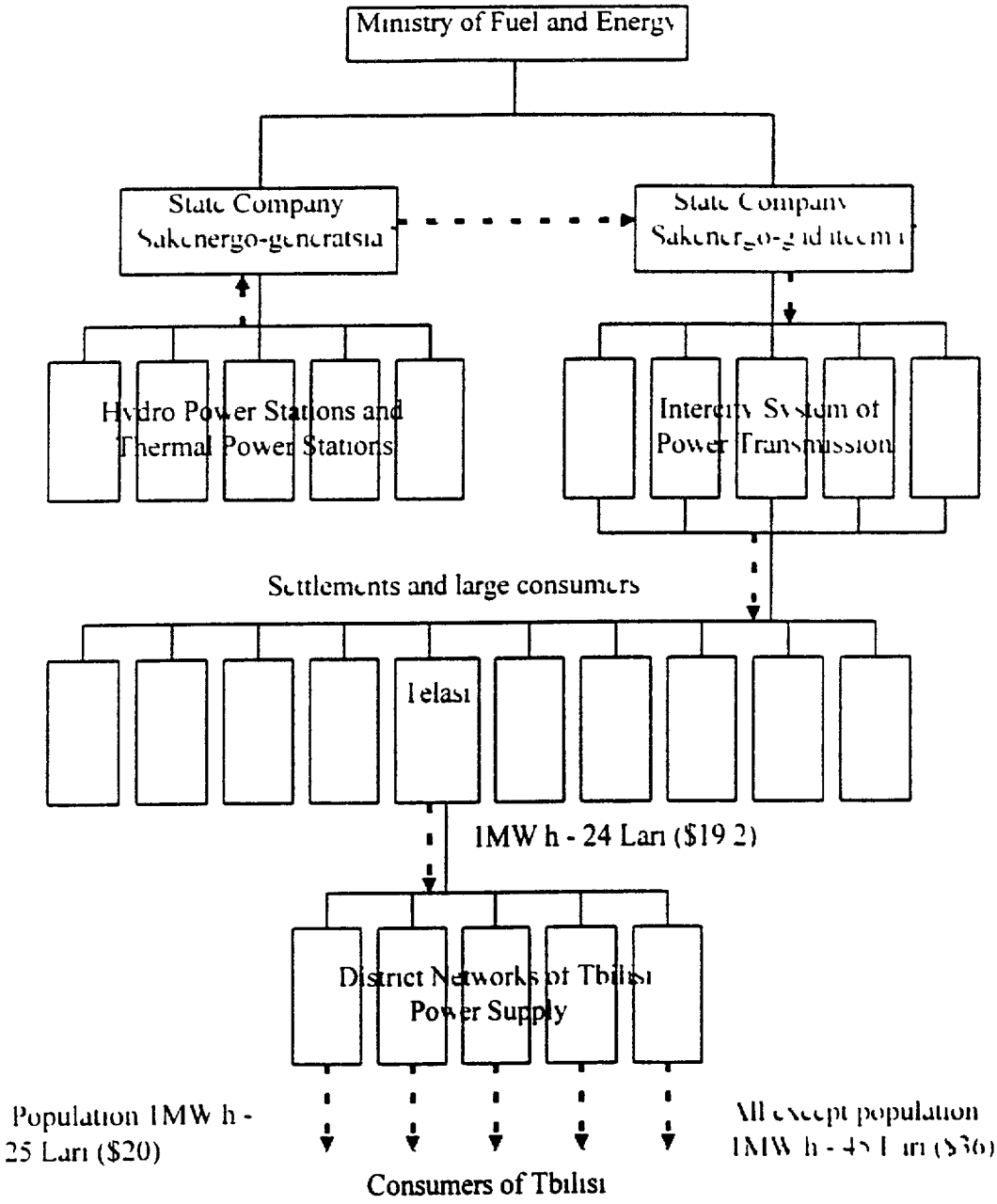
Municipal enterprise "Telasi" purchases electric power from 'Sakenergo - gadatsema by the price 1MW h - 21 lari ($16 8) and is responsible for distribution and sales to the Tbilisi districts

In August 1996 the process of demonopolization of the most lower stage of the system has been started The private companies are given opportunities to lease the regional systems of electric power supply of Tbilisi The private companies purchase electric power from 'Telasi' at the price of 24 lari ($19 2) per 1 MW h and maintain distribution and sales of the power among the district consumers

- to population at the price of 25 lari ($20) per 1 MW h

- to other consumers at the price of 45 lari ($36) per 1MW h

Electric Power Production and Distribution Diagram



It should be noted that 'Sakenergo-generatsia sets the tariff for electric power as average value of prices for power generated in hydro and thermal power stations

Capacity of all power plants in Georgia by 1990 reached 4 388 MW Capacity of hydroelectric plants reached 61% or 2 674 MW At hydropower plants in 1989 there was produced 6 3 billion kW h energy or 43% of the total annual power generation in Georgia

Seasonal hydropower plants share is rather significant in the power system of Georgia According to their type of work these hydropower plants sharply decrease power generation in autumn-winter period This puts energy system in extremely hard state

Table N 12

Power Generation in Georgia in 1995

	Power generation in MW h by months				Annual Total
Power plant type	1-3	4-6	7-9	10 12	
Hydropower plant	1155 5	1669 4	1694 8	1687 3	6207
Thermal power st	306 8	90 7	-	305 7	705 2

In review of the power energy system in Georgia prepared in the framework of TACIS Program the following data on power generation in July 1994 are given

Table N 13

Average Values of Power Generation Costs in Georgia

	Thermal Electric Plant		Hydro Electric Plant	
	($/MW h)	%	($ MW h)	%
Fuel	43 60	95 8		
-wage	0 33	0 7	0 05	28
-social insurance	0 13	0 3	0 02	12
-repairs	0 92	2 0	0 05	28
-Amort /depreciation	0 04	0 1	0 02	1 2
-services/third parties	0 38	0 8		
-other materials	0 10	0 2	0 02	10
-energy	0 01		0 00	2
-other	0 07	0 1	0 01	6
Total	45 53	100	0 17	100

If we take into account that hydro power costs are indicated in the review not properly then we shall have to increase ten times i e $1 7 per 1MW h (which is closer to common expenses for hydrogeneration)

293

Using Tables N 12 and N 13 data one can establish average cost for power generation in Georgia in 1995 equalling to 1 MW h ≈ $ 6 2

This low value of average costs for power generation is caused by forced decrease of intensity of thermal power plant operation

In case the power production rate is increased up to the level of 1989 year average expenses will increase about five times

Thus we can conclude the following

- Energy system rehabilitation process in Georgia will inevitably increase tariffs for power energy

Selection of Analogues for Cogeneration System Equipment for TS No 9

Knowing required capacity of cogeneration equipment by the value of thermal component it is possible to select appropriate equipment for TS No 9 considering the following requirements

- rather low capital costs per thermal power capacity unit
- limited dimensions of the equipment to fit the size of the existing building

These requirements are followed in the best way in the case of cogenerations with gas turbine engines

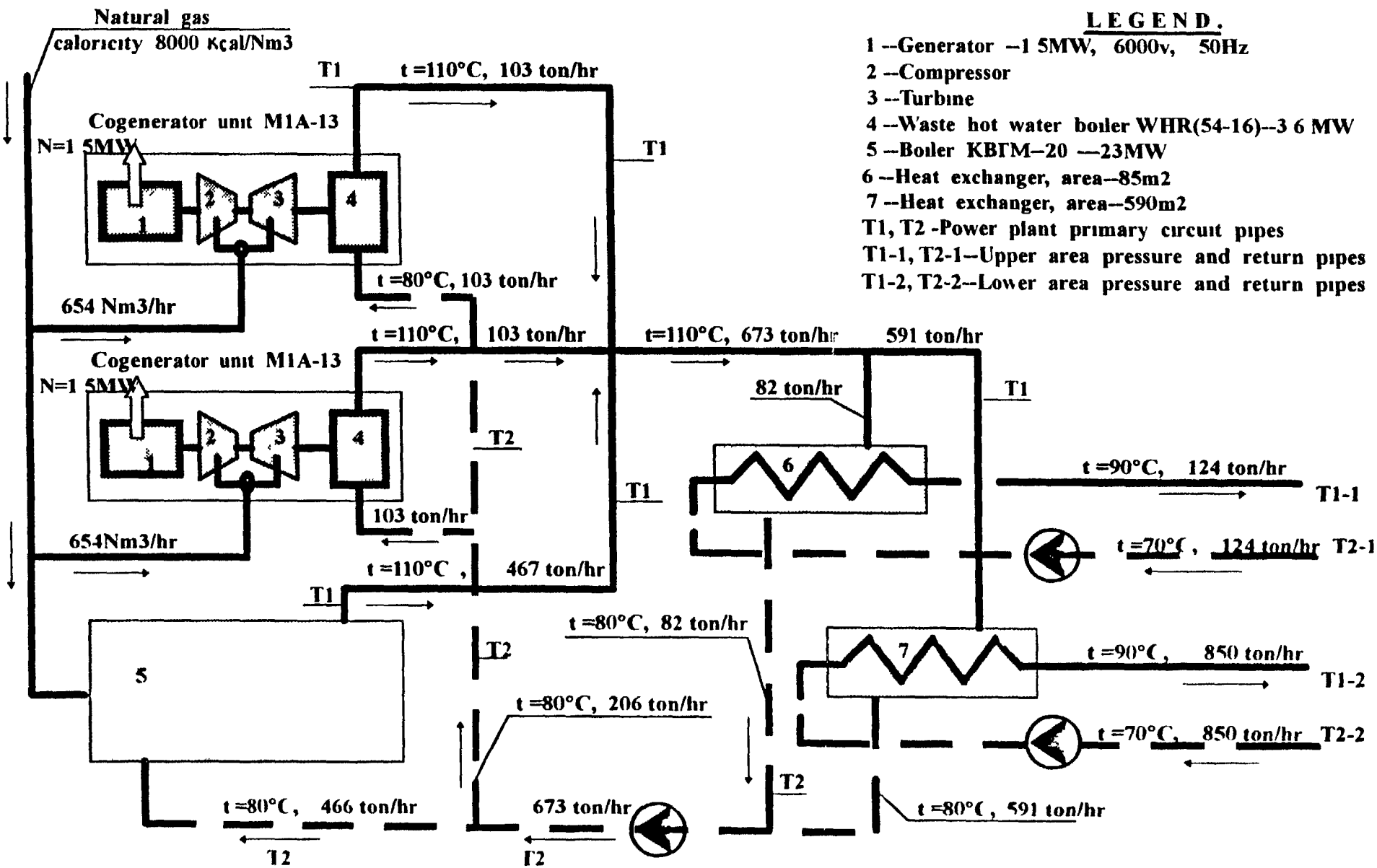
Table N 14

TURBOGENERATOR	
Type of the turbine	M1A-13
Manufacturer	Kawasaki Japan
Thermal capacity	3617 kW *
Shaft power	1550 kW
Electric power at the generator terminal	1473 kW
Rotation rate of turbine shaft	22 000 rot/min
Rotation rate of electric generator	1500/1800 rot/min
Voltage at electric generator terminals	6000 V
Frequency	50 Hz
Turbine characteristics	
a) Electric efficiency	25 5 %
b) Specific flow rate of conventional fuel (Q_{const} = 7 000 Kcal/kg)	0,482 kg/kW h
c) Gas fuel specific (8 000 Kcal/cm ^{3})	0 422 Nm^3/kW/h
d) Gas fuel volume flow rate	654 1 Nm^3/h
e) Initial gas temperature Gas temperature after turbine	990^{0}C 518^{0}C
f) Total flow rate of gas in the turbine	8 1 kg/sec
g) Pressure ratio	9 4
i) Quantity of combustion chamber	1
Turbine generator parameters	2 4 x1 5x1 6 m
price (basic version)	$ 1 132 000
equipment for two types of fuel	$ 50 000
natural gas pressure elevating compressor	$ 45 000
Silencer	$ 5 000
Noise level	~ 90 low
*including 15% of thermal loss	

Table N 15

HEAT RECOVERY	
Type of heat recovery	WHR-1
Manufacturer	Jonston Boiler Company
Model	54-16
Number of gas path	2
Gas temperature -input -output	518^{0}C 140^{0}C
Thermal power	3490 kW
IN STEAM PRODUCTION REGIME	
Charachteristict of saturated steam pressure temperature	 0,784 MPa 169^{0}C
Feed water temperature	100^{0}C
Steam productivity	2 14 kg/sec (7 698 t h)
WATER HAETING REGIME	
Water temperature-input -output	65^{0}C 95^{0}C
Water consumption	27 8 kg/sec (99 9 t h)
Dimentions	L W D 5 72x1 8x2 06 m
Price	95 000 $
TURBINE AND HEAT RECOVERY CONNECTING DIFFUSOR	
Sizes	L D 1 x 1 2
Price	10 000 $
TOTAL	1 387 000 $

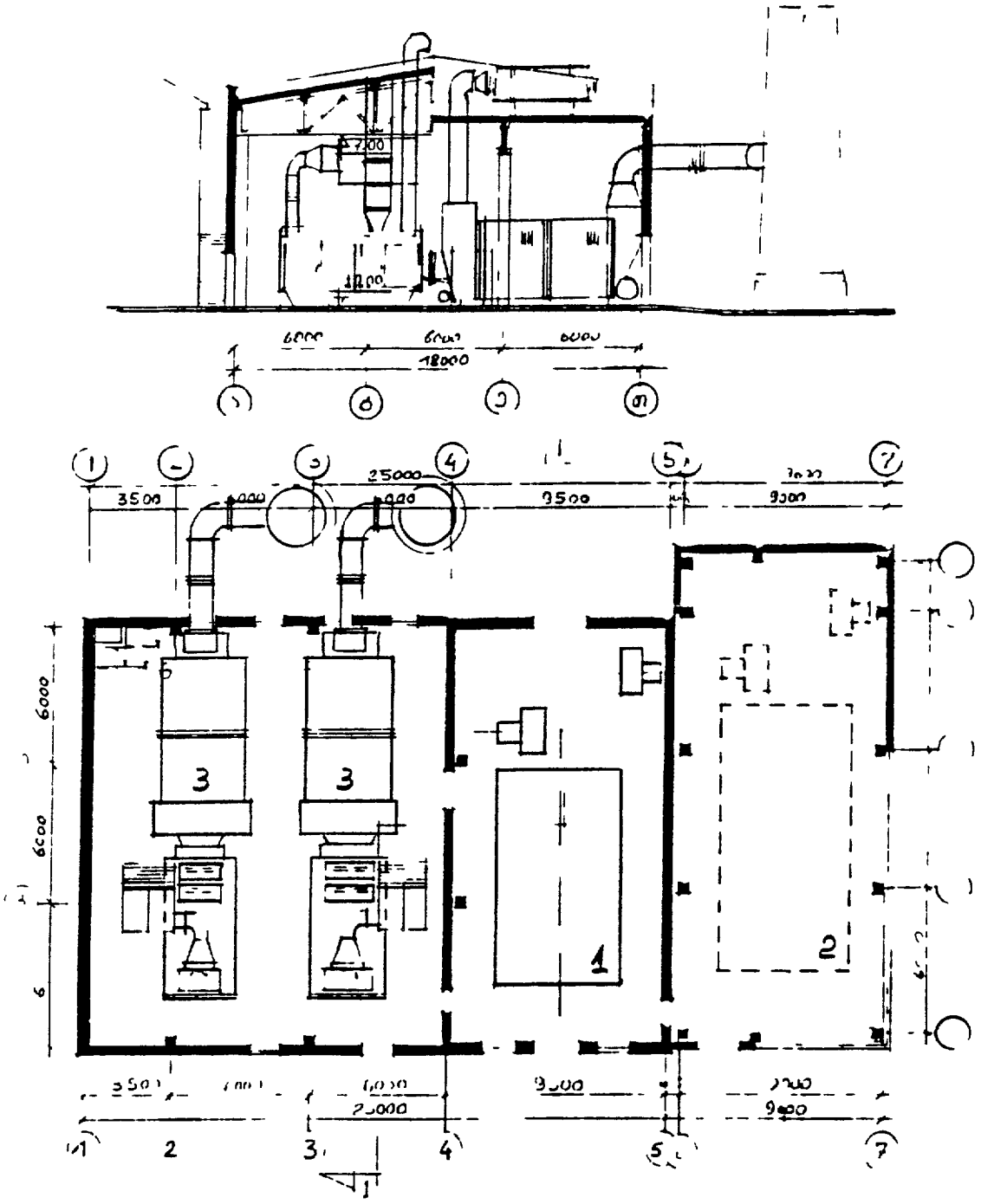
296



LEGEND.

1 --Generator --1 5MW, 6000v, 50Hz
2 --Compressor
3 --Turbine
4 --Waste hot water boiler WHR(54-16)--3 6 MW
5 --Boiler KBTM--20 ---23MW
6 --Heat exchanger, area--85m2
7 --Heat exchanger, area--590m2
T1, T2 -Power plant primary circuit pipes
T1-1, T2-1--Upper area pressure and return pipes
T1-2, T2-2--Lower area pressure and return pipes

297



Legends of the Equipment

1. Existing water boiler KVGM-20
2. Existing water boiler KVGM-30
3. Gas-turbine-generator of type MIA-13 with heat recovery WHR 1-2 items

298

Table N 16

TURBINE GENERATOR

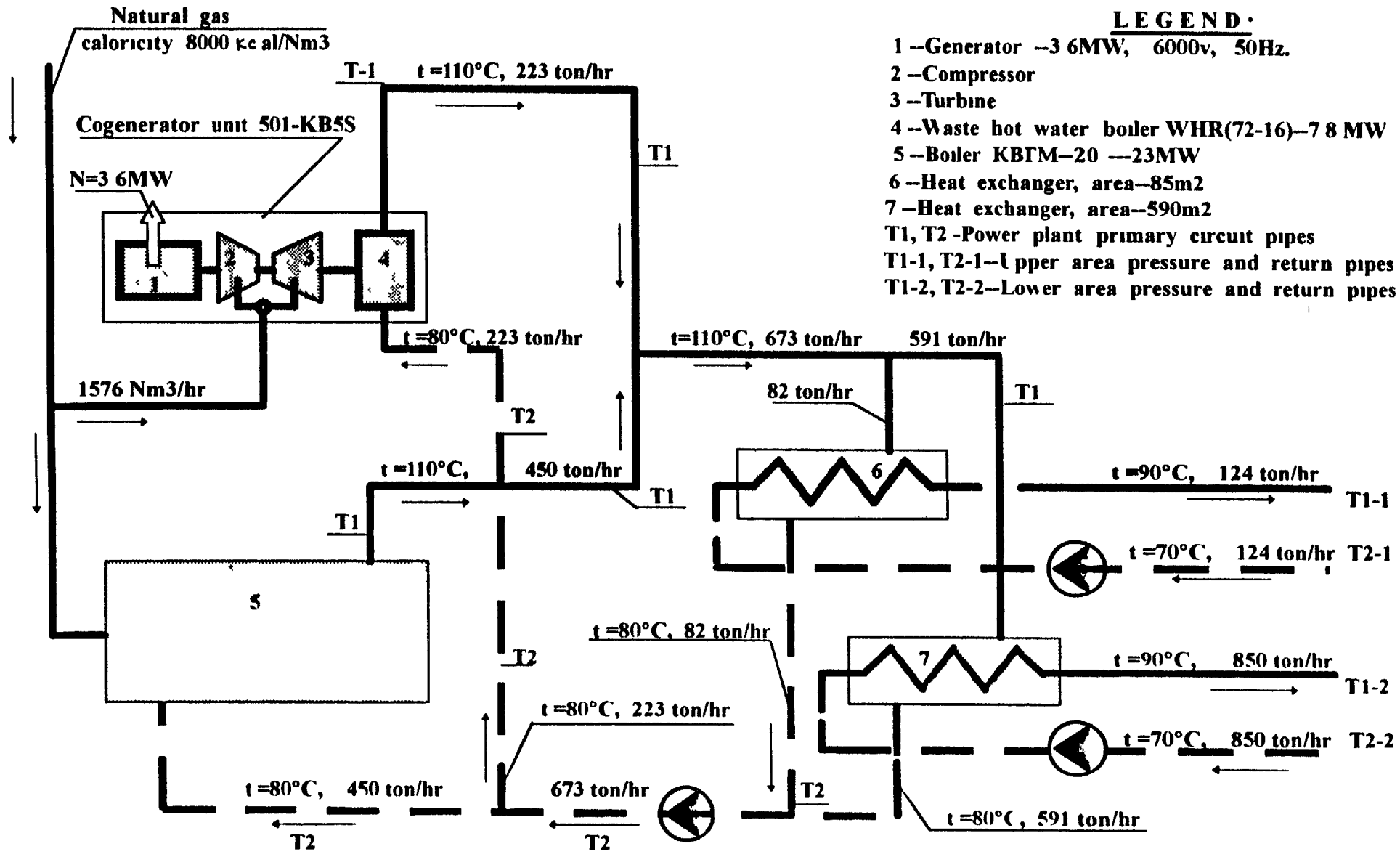
Type of the turbine	501-KV 5 S
Manufacturer	Allison Engine Company
Thermal capacity	7 800 kW
Shaft power	4317 5 kW
Electric power at the generator terminal	4103 kW
Rotation rate of turbine shaft	14 200 rpm
Rotation rate of electric generator	1 500/1 800
Voltage at electric generator terminals	6 000 V
Frequency	50 Hz
Turbine characteristics	
a) Electric efficiency	29 5%
b) Specific flow rate of conventional fuel (Q_{const} = 7,000 Kcal/kg)	0 417 kg/kW/h
c) Gas fuel specific (8 000 Kcal/cm^3)	0 365 Nm^3/kW/H
d) Gas fuel volume flow rate	1,576 1 Nm^3/h
e) Initial gas temperature Gas temperature after turbine	 579 ^{0}C
f) Total flow rate of gas in the turbine	15 6 kg/sec
g) Pressure ratio	10 1
i) Quantity of combustion chamber	6
Turbine generator parameters	7 5 x 2 7 x 3 m
price (basic version)	$ 1 791 837
equipment for two types of fuel	$ 85 000
natural gas pressure elevating compressor	$ 7 000
Silencer	$ 7 000
Noise level	~ 90 low
TOTAL including 15% of thermal loss	$ 2 048 837 $ 499$/kW

299

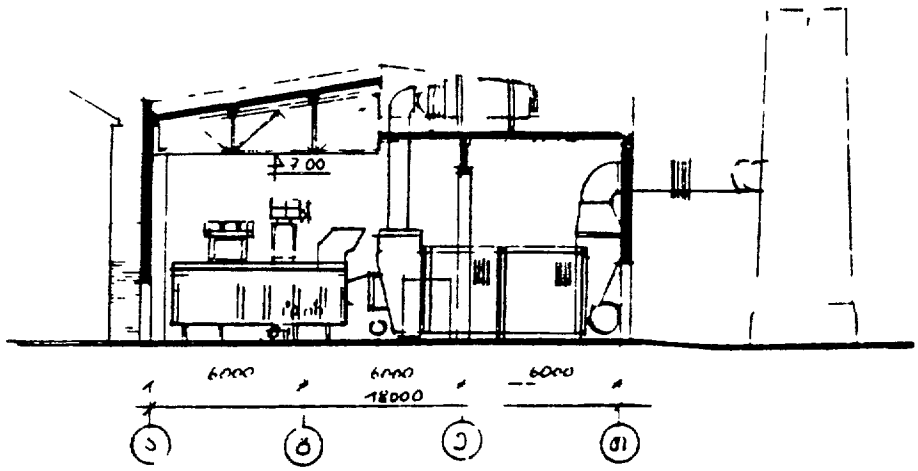
Table N 17

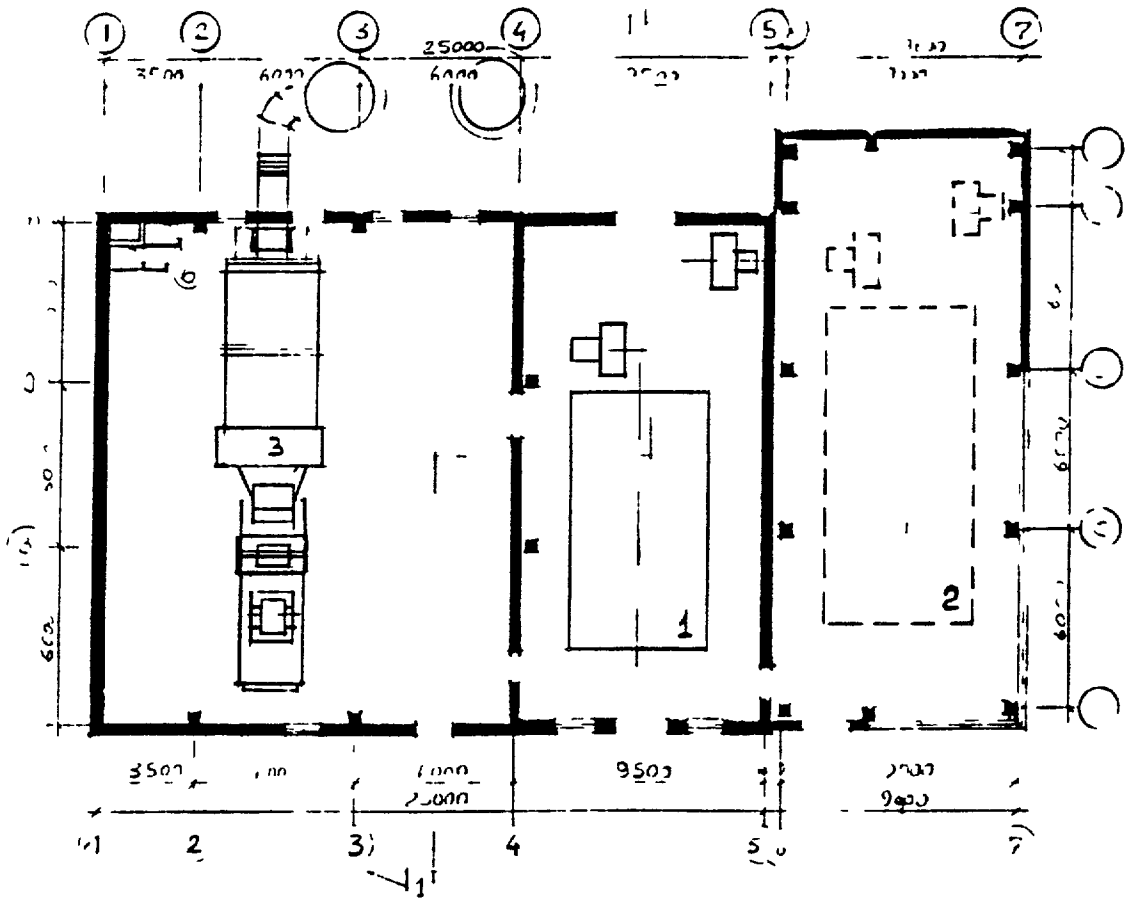
HEAT RECOVERY	
Type of heat recovery	WHR-1
Manufacturer	Jonston Boiler Company
Model	72-16
Number of gas path	2
Gas temperature -input -output	579^{0}C 140^{0}C
Thermal power	7807 2 kW
IN STEAM PRODUCTION REGIME	
Charachteristict of saturated steam pressure temperature	 0,784 MPa 169^{0}C
Feed water temperature	100^{0}C
Steam productivity	4 78 kg/sec (17 22 t/h)
WATER HAETING REGIME	
Water temperature-input -output	65^{0}C 95^{0}C
Water consumption	62 kg/sec (223 6 t/h)
Dimensions	6 12x2 24x2 57 m
Price	148 000 $
TURBINE AND HEAT RECOVERY CONNECTING DIFFUSOR	
Sizes	1 3 x 1 7
Price	14 000 $

300


Natural gas
caloricity 8000 kc al/Nm3
Cogenerator unit 501-KB5S
N=3 6MW
1576 Nm3/hr
T-1
t =110°C, 223 ton/hr
T1
t =80°C, 223 ton/hr
t=110°C, 673 ton/hr
591 ton/hr
82 ton/hr
T2
t =110°C,
450 ton/hr
t =90°C, 124 ton/hr
T1-1
t =70°C, 124 ton/hr
T2-1
t =80°C, 82 ton/hr
t =90°C, 850 ton/hr
T1-2
t =80°C, 223 ton/hr
t =70°C, 850 ton/hr
T2-2
t =80°C, 450 ton/hr
673 ton/hr
t =80°C, 591 ton/hr
LEGEND·
1 --Generator --3 6MW, 6000v, 50Hz.
2 --Compressor
3 --Turbine
4 --Waste hot water boiler WHR(72-16)--7 8 MW
5 --Boiler KBГM--20 ---23MW
6 --Heat exchanger, area--85m2
7 --Heat exchanger, area--590m2
T1, T2 -Power plant primary circuit pipes
T1-1, T2-1--Upper area pressure and return pipes
T1-2, T2-2--Lower area pressure and return pipes

30 -





Legends of the Equipment

1 Existing water boiler KVGM 20
2 Existing water boiler KVGM-30
3 Gas-turbine-generator of type 501-KV5S with heat recovery WHR-1

302

Calculation of investments economic effectiveness (recoupment period) on rehabilitation of TS N9 with installation of cogeneration with gasturbine motor of type M1A-13 x 2 (Kawasaki)

1 Capital costs and duration of rehabilitation works	
1 1 TS N9 building and existing equipment reconstruction expenses including water heating boiler rehabilitation of type КВГМ-20 and dismantle steam boilers dismantling of type DKVR thous $	285 0
1 2 Cogeneration equipment installation expenses thous $	3 900 0
1 3 TS N9 gas supply equipment rehabilitation expenses thous $	250 0
1 4 Thermal energy (district heat network) distribution system rehabilitation expenses thous $	560 0
1 5 Electric power distribution system arrangement expenses thous $	95 0
1 6 Total capital costs thous $	5 090 0
1 7 Rehabilitation period years	1 5
2 Thermal and electric power generation	
2 1 Normal thermal capacity of water heating boiler of type KVGM-20 MW	25 0
2 2 Operation duration of water heating boiler per year (In period of peak leads taking off) h	3650
2 3 Using coefficient of water heating boiler rated capacity	0 57
2 4 Annual thermal power generation by water heating boiler MW h (Item 2 1x Item 2 2 x Item 2 3)	47 552
2 5 Cogeneration equipment rated thermal capacity MW	7 2
2 6 Operation duration of cogeneration equipment per year h	8 60
2 7 Using coefficient of generation equipment rated capacity	0 95
2 8 Annual thermal power generation by cogeneration equipment MW h (Item 2 5x Item 2 6 x Item 2 7)	59 918
2 9 Cogeneration equipment rated electric power MW	2 95
2 10 Annual electric power generation by cogeneration equipment MW h (Item 2 9x Item 2 6 x Item 2 9)	24 550
3 Operation expenses	
3 1 Cost of 1000 m³ natural gas $	56 4
3 2 Natural gas consumption for generation of 1 MW h thermal energy at water heating boiler operation 1000 m³	0 165
3 3 Fuel component share in cost of generation and distribution of 1 MW h thermal energy at water heating boiler operation %/100	0 75
3 4 Cost of generation and distribution of 1 MW h thermal energy at water heating boiler operation $ ((Item 3 1 x Item 3 2) Item 3 3)	19 0

30

3 5 Natural gas consumption for generation of 1 MW h thermal energy at cogeneration equipment operation, 1000 m^3	0 181
3 6 Fuel component share in cost of generation and distribution of 1 MW h thermal energy at cogeneration equipment operation %/100	0 75
3 7 Cost of generation and distribution of 1 MW h thermal energy at cogeneration equipment operation, $, [(Item 3 1 x Item 3 5 x (1-Item 3 6)]	3 91 (Fuel total cost is conventionally enclosed in electric power cost)
3 8 Natural gas consumption for generation of 1 MW h electric power at cogeneration equipment operation, 1000 m^3	0 422
3 9 Fuel component share in cost of generation and distribution of 1 MW h electric power at cogeneration equipment operation, %/100	0 90
3 10 Cost of generation and distribution of 1 MW h electric power at cogeneration equipment operation, $ ((Item 3 1 x Item 3 8) Item 3 9)	40 5
3 11 Expenses for generation and distribution of thermal energy produced at water heating boiler operation per year, thous $ (Item 3 4 x Item 2 4)	909 188
3 12 Expenses for generation and distribution of thermal energy produced at cogeneration equipment operation per year thous $ (Item 3 7 x Item 2 8)	234 279
3 13 Expenses for generation and distribution of electric power produced at cogeneration equipment operation per year, thous $ (Item 3 10 x Item 2 12)	994 275
4 Incomes from thermal and electric power sales	
4 1 Tariff on 1 MW h thermal power, $	25 5
4 2 Thermal power sales share from annual generation at water heating boiler operation, %/100	0 95
4 3 Thermal power sales share from annual generation at cogeneration equipment operation %/100	0 90
4 4 Income from thermal power sales per year, thous $ (Item 4 1 x Item 2 4 x Item 4 2) +(Item 4 1 x Item 2 8 x Item 4 3)	2 564 148
4 5 Daytime tariff on 1 MW h electric power $	35 0
4 6 Night tariff on 1 MW h electric power, $	19 2
4 7 Electric power share, sold by daytime tariff during the year %/100	0 30
4 8 Electric power share, sold by night tariff during the year, %/100	0 70
4 9 Income from electric power sales per year, thous $ (Item 4 5 x Item 2 10 x Item 4 7) +(Item 4 6 x Item 2 10 x Item 4 8)	587 727

5 Economic effectiveness of investments	
5 1 Annual income from thermal power sales thous $ (Item 4 4 - Item 3 11- Item 3 12)	1 420 681
5 2 Annual income from electric power sales thous $ (Item 4 9 - Item 3 13)	(-406 548)
5 3 Annual income from TS N9 operation, thous $ (Item 5 1 + Item 5 2)	1 014 133
5 4 Investments payback period since TS N9 operation starting year (Item 1 6/ Item 5 3)	5 0
5 5 Investments payback period since TS N9 rehabilitation starting year (Item 5 4 + Item 1 7)	6 5

Option of calculation of economic effectiveness of investments in case of tariff increase for electric power

4 Incomes from thermal and electric power sales	
4 1 Tariff on 1 MW h thermal power $	25 5
4 2 Thermal power sales share from annual generation at water heating boiler operation %/100	0 95
4 3 Thermal power sales share from annual generation at cogeneration equipment operation %/100	0 90
4 4 Income from thermal power sales per year thous $ (Item 4 1 x Item 2 4 x Item 4 2) +(Item 4 1 x Item 2 8 x Item 4 3)	2 564 148
4 5 Daytime tariff on 1 MW h electric power $	60 0
4 6 Night tariff on 1 MW h electric power $	32 0
4 7 Electric power share sold by daytime tariff during the year %/100	0 30
4 8 Electric power share sold by night tariff during the year %/100	0 70
4 9 Income from electric power sales per year thous $ (Item 4 5 x Item 2 10 x Item 4 7) +(Item 4 6 x Item 2 10 x Item 4 8)	991 820
5 Economic effectiveness of investments	
5 1 Annual income from thermal power sales thous $ (Item 4 4 - Item 3 11- Item 3 12)	1 420 681
5 2 Annual income from electric power sales, thous $ (Item 4 9 - Item 3 13)	(2 455)
5 3 Annual income from TS N9 operation, thous $ (Item 5 1 + Item 5 2)	1418 226
5 4 Investments payback period since TS N9 operation starting year (Item 1 6/ Item 5 3)	3 59
5 5 Investments payback period since TS N9 rehabilitation starting year (Item 5 4 + Item 1 7)	5 09

30

Calculation of investments economic effectiveness (recoupment period) on rehabilitation of TS N9 with installation of cogeneration with gasturbine motor of type 501-KV-5S (Allison)

1 Capital costs and duration of rehabilitation works	
1 1 TS N9 building and existing equipment reconstruction expenses including water heating boiler rehabilitation of type КВГМ-20 and dismantle steam boilers dismantling of type DKVR thous $	285 0
1 2 Cogeneration equipment installation expenses thous $	3100 0
1 3 TS N9 gas supply equipment rehabilitation expenses thous $	250 0
1 4 Thermal energy (district heat network) distribution system rehabilitation expenses thous $	560 0
1 5 Electric power distribution system arrangement expenses thous $	95 0
1 6 Total capital costs thous $	4 290 0
1 7 Rehabilitation period years	1 5
2 Thermal and electric power generation	
2 1 Normal thermal capacity of water heating boiler of type KVGM-20 MW	23 0
2 2 Operation duration of water heating boiler per year (In period of peak leads taking off), H	3 650 0
2 3 Using coefficient of water heating boiler rated capacity	0 51
2 4 Annual thermal power generation by water heating boiler MW h (Item 2 1x Item 2 2 x Item 2 3)	43 147 0
2 5 Cogeneration equipment rated thermal capacity MW	7 8
2 6 Operation duration of cogeneration equipment per year h	8 760
2 7 Using coefficient of generation equipment rated capacity	0 95
2 8 Annual thermal power generation by cogeneration equipment MW h (Item 2 5x Item 2 6 x Item 2 7)	64 912
2 9 Cogeneration equipment rated electric power MW	4 1
2 10 Annual electric power generation by cogeneration equipment MW h (Item 2 9x Item 2 6 x Item 2 9)	34 120
3 Operation expenses	
3 1 Cost of 1000 m^3 natural gas, $	86 4
3 2 Natural gas consumption for generation of 1 MW h thermal energy at water heating boiler operation, 1000 m^3	0 165
3 3 Fuel component share in cost of generation and distribution of 1 MW h thermal energy at water heating boiler operation %/100	0 75
3 4 Cost of generation and distribution of 1 MW h thermal energy at water heating boiler operation $ ((Item 3 1 x Item 3 2)/Item 3 3)	19 0

306

3 5 Natural gas consumption for generation of 1 MW h thermal energy at cogeneration equipment operation 1000 m^3	0 202
3 6 Fuel component share in cost of generation and distribution of 1 MW h thermal energy at cogeneration equipment operation %/100	0 75
3 7 Cost of generation and distribution of 1 MW h thermal energy at cogeneration equipment operation $ [(Item 3 1 x Item 3 5 x (1-Item 3 6)]	4 36 (Fuel total cost is conventionally enclosed in electric power cost)
3 8 Natural gas consumption for generation of 1 MW h electric power at cogeneration equipment operation 1000 m^3	0 365
3 9 Fuel component share in cost of generation and distribution of 1 MW h electric power at cogeneration equipment operation %/100	0 90
3 10 Cost of generation and distribution of 1 MW h electric power at cogeneration equipment operation, $, ((Item 3 1 x Item 3 8)/Item 3 9)	35 04
3 11 Expenses for generation and distribution of thermal energy produced at water heating boiler operation per year, thous $, (Item 3 4 x Item 2 4)	819 793
3 12 Expenses for generation and distribution of thermal energy produced at cogeneration equipment operation per year thous $ (Item 3 7 x Item 2 8)	283 016
3 13 Expenses for generation and distribution of electric power produced at cogeneration equipment operation per year, thous $ (Item 3 10 x Item 2 12)	1 195 565
4 Incomes from thermal and electric power sales	
4 1 Tariff on 1 MW h thermal power $	25 8
4 2 Thermal power sales share from annual generation at water heating boiler operation %/100	0 95
4 3 Thermal power sales share from annual generation at cogeneration equipment operation %/100	0 903
4 4 Income from thermal power sales per year thous $ (Item 4 1 x Item 2 4 x Item 4 2) +(Item 4 1 x Item 2 8 x Item 4 3)	2 564 790
4 5 Daytime tariff on 1 MW h electric power $	35 0
4 6 Night tariff on 1 MW h electric power $	19 2
4 7 Electric power share, sold by daytime tariff during the year %/100	0 30
4 8 Electric power share sold by night tariff during the year %/100	0 70
4 9 Income from electric power sales per year thous $ (Item 4 5 x Item 2 10 x Item 4 7) +(Item 4 6 x Item 2 10 x Item 4 8)	816 853

5 Economic effectiveness of investments	
5 1 Annual income from thermal power sales thous $ (Item 4 4 - Item 3 11- Item 3 12)	1 461 981
5 2 Annual income from electric power sales, thous $ (Item 4 9 - Item 3 13)	(-378 732)
5 3 Annual income from TS N9 operation, thous $ (Item 5 1 + Item 5 2)	1 083 249
5 4 Investments payback period since TS N9 operation starting year (Item 1 6/ Item 5 3)	3 96
5 5 Investments payback period since TS N9 rehabilitation starting year (Item 5 4 + Item 1 7)	5 5

Option of calculation of economic effectiveness of investments in case of tariff increase for electric power

4 Incomes from thermal and electric power sales	
4 1 Tariff on 1 MW h thermal power $	25 8
4 2 Thermal power sales share from annual generation at water heating boiler operation %/100	0 95
4 3 Thermal power sales share from annual generation at cogeneration equipment operation %/100	0 903
4 4 Income from thermal power sales per year, thous $ (Item 4 1 x Item 2 4 x Item 4 2) +(Item 4 1 x Item 2 8 x Item 4 3)	2 564 790
4 5 Daytime tariff on 1 MW h electric power, $	60 0
4 6 Night tariff on 1 MW h electric power $	25 0
4 7 Electric power share sold by daytime tariff during the year %/100	0 30
4 8 Electric power share sold by night tariff during the year %/100	0 70
4 9 Income from electric power sales per year, thous $ (Item 4 5 x Item 2 10 x Item 4 7) +(Item 4 6 x Item 2 10 x Item 4 8)	1 211 260
5 Economic effectiveness of investments	
5 1 Annual income from thermal power sales thous $ (Item 4 4 - Item 3 11- Item 3 12)	1 461 981
5 2 Annual income from electric power sales, thous $ (Item 4 9 - Item 3 13)	15 695
5 3 Annual income from TS N9 operation thous $ (Item 5 1 + Item 5 2)	1 477 676
5 4 Investments payback period since TS N9 operation starting year (Item 1 6/ Item 5 3)	2 9
5 5 Investments payback period since TS N9 rehabilitation starting year (Item 5 4 + Item 1 7)	4 5

307

Development, Investment & Engineering
ARCI Consulting

Delivery Order 11 Task 1
Tbilisi District Heating System Improvement Program

Subtask 5
Heat Supply System Rehabilitation
for the Oncology Center (cogeneration opportunities)

Technical Report

Prepared under subcontract to Burns & Roe Entarprises, Inc

Tbilisi, 1996

309

Aim of Expertise

The aim of the present expertise is to consider possibilities of efficient utilization of low capacity cogenerating devices in the thermal and power supply systems of the separate buildings (or the set of buildings) based on the example of the Oncological (Cancer) Center in Tbilisi

By the term ' efficient utilization" there should be understood the solution of the following problems

- selection of real analogues of cogenerating equipment meeting Oncological center demands for thermal and power energy,
- utilization of excess thermal energy generated by the cogenerating equipment during hot and warm seasons of the year
- utilization of excess power energy generated by the cogenerating equipment at night times
- determination of mutually beneficial conditions in the relations between the Oncological Center and consumers of excess thermal and power energy generated by cogeneration equipment

Review of the State of the Oncological Center

The problems which the Oncological Center is facing today clearly depict the processes in the system of Health Care of Georgia by the moment the expertise was carried out

The Oncological Center is operating since 1977 It is designed for simultaneous service of 600 patients (excluding the visitors taking out-patient treatment course) Oncological Center represents the complex of buildings the total construction volume of which is 125 630 m^3 with the total area of 28780 m^2 The construction of the Oncological Center coincided with the period in Georgia, when it became fashionable to construct large medical centers As was proved later these centers were not filled Oncological Center loading rarely reached service rate of 400 patients

Social and economic crisis followed by collapse of totalitarian system was reflected on the total service of the Health Care system of Georgia Transition period from free medical service to the paid one is very painful

It should be noted that reform in Health Care system takes place against the background of rather insolvent abilities of the majority of the population and with absence of effective health insurance system available here

In 1995 Georgian State approved the program of state support of health care system during the transition period This program provides budget funding of several types of medical services to the population by the fixed state prices for the treatment of the most acute forms of the oncologic disease

310

It should be noted that recently the number of patients taking hospital treatment course has reduced sharply

The process dynamics could be traced through statistic data of annual number of the patients having taken hospital treatment course in the Oncological Center during the last decade

1985	-5 807	patients	1990	-5 873
1986	-6 183		1991	-5 717
1987	-6 266		1992	-4 965
1988	-5 783		1993	-4 022
1989	-5,531		1994	-3 588

The number of patients of the Oncological Center in 1995 was 2 560 It is natural that reduction of the number of patients caused reduction of the hospital area utilization This factor directly affects the thermal supply system rehabilitation in Oncological Center With self funding practice this problem was to be solved solely by the management bodies of the hospital Getting ready for the heating season in winter 1996-1997 the management bodies of the hospital started to rehabilitate autonomous boiler providing heating supply of the whole hospital until 1992

At the same time, taking into account patient number reduction there are reasonable measures conducted for reduction of heated spaces For this very reason part of the main building is being conserved, which will enable to reduce the number of beds in use down to 300 Besides the medical and engineer-technological equipment is being re-dislocated which will result in conservation of the excess area

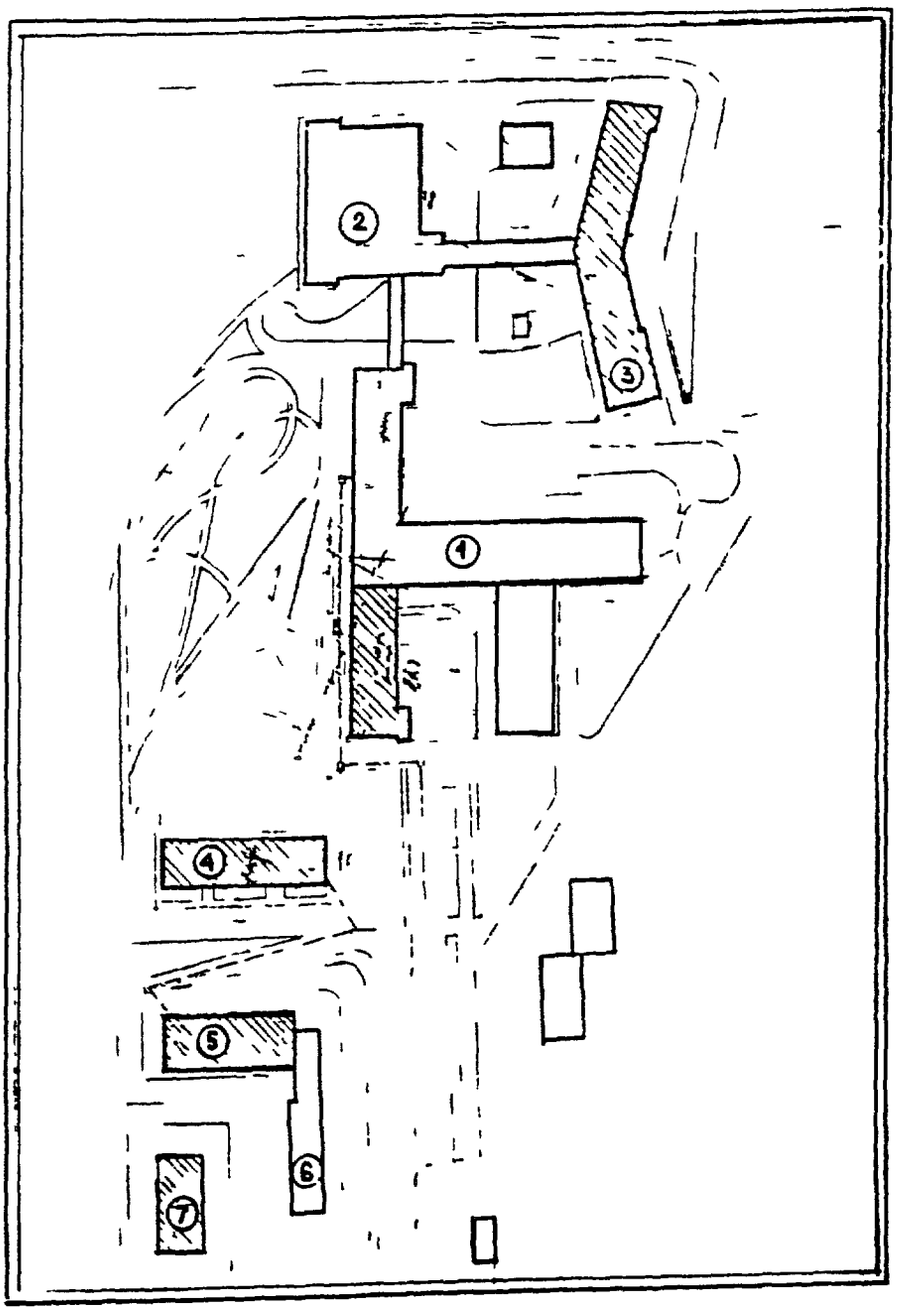
These measures enable to reduce the heated area of the hospital down to 10 000 m^2 (44 700 m^3) i e by 35% of the total area

Autonomous boiler of the Oncological Center was equipped by 7 water heating boilers of НИИСТУ-5АГ type with 0 8 Gcal/hour output These boilers are not operating now but they could be rehabilitated (which is being performed at the moment) It should be also noted that the simple construction of НИИСТУ-5АГ type does not provide their efficiency more than 65% They are designed for natural gas-fired operation as well as operation on fluid fuel However bearing in mind the fact that reconstruction of the existing (not operating) medium pressure gas piping requires large sums which are not available, so it s planned to operate boiler on diesel fuel

One factor is worth noting here Due to general power crisis there are frequent outages of power supply from the city system especially during winter time In these cases two diesel generators are being switched their capacity is 200 kW each Power amount generated by two diesel generators is enough for the hospital supply providing that power is not used for the heating purposes of the hospital

311

MASTER PLAN OF THE ONCOLOGICAL CENTER

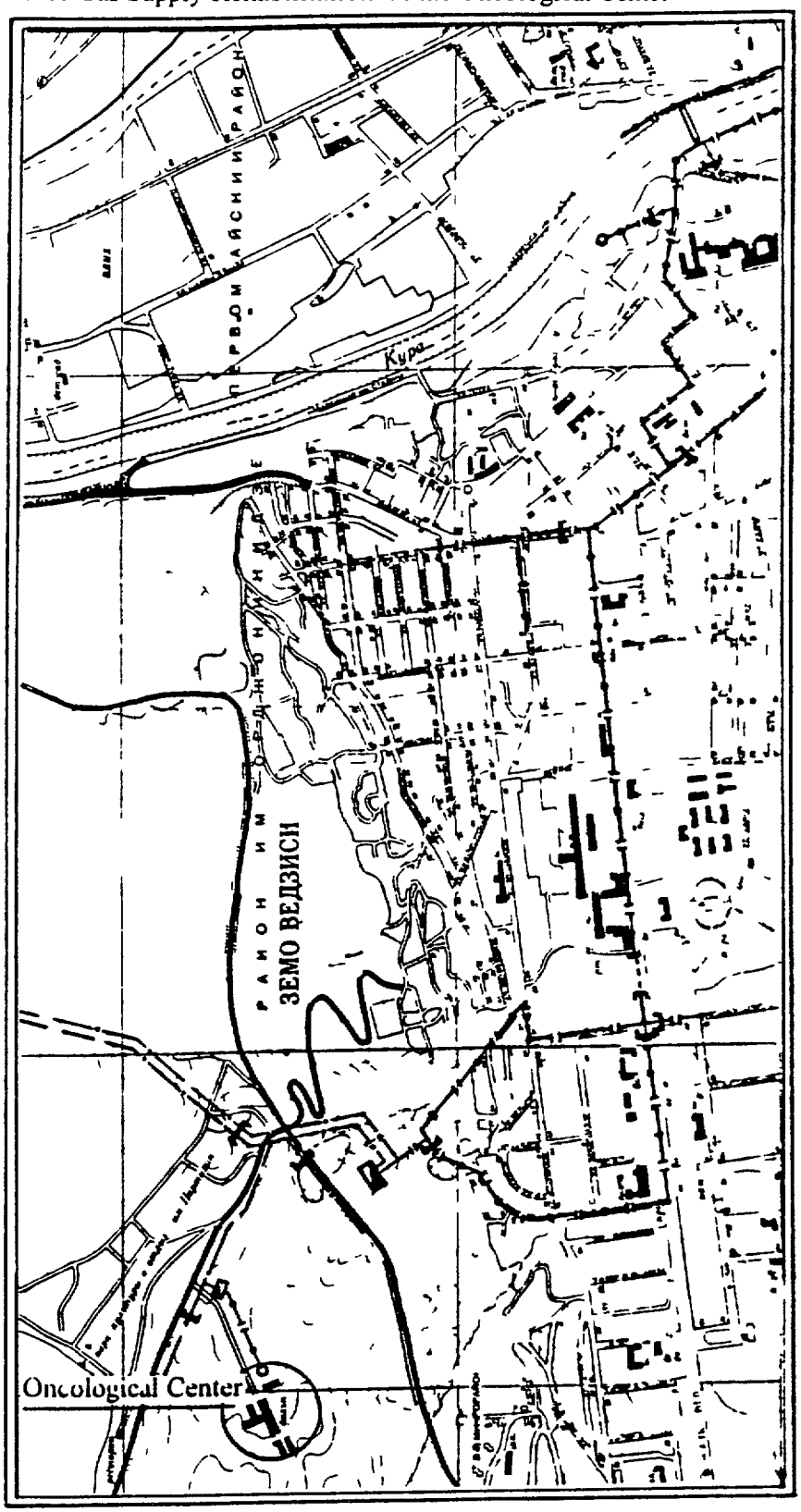


Legends.

1 Main building - 2 029 m^2/88 770m^3
2 Diagnostics building - 2 200 m^2/9 700m^3
3 Radiological building - 3 060 m^2/13,380m^3
4 Vivarium - 2 150 m^2/8 870m^3
5 Administrative building - 450 m^2/3 200m^3
6 Boiler - 365/1 650
7 Pathologic and anatomy building - 260m^2 1 170m^3
☐ - building to be conserved - 10,035 m^2/44 690m^3

312

Diagram of Gas Supply Rehabilitation Of the Oncological Center



Legends.

- -gas piping of low pressure
- -gas piping of high pressure
- -substation of gas distribution
- -sites of non-operational gas piping cutting-off
- -gas piping enabling to be rehabilitated

Review of the Possibilities of Cogenerator Equipment Utilization in Heating Supply System Rehabilitation of the Oncological Center

The measures held by the management bodies of the hospital should be approved if they are viewed as emergency, i e they are aimed at solution of the heating supply for the nearest future

It is clear, that such emergency solution is caused by lack of finances for more serious measures

Particularly the following power saving measures are planned

- heat distribution system modification in the buildings enabling to reduce intensive heating rate of the areas not in permanent use (Such situation may rise quite often as the loading rate does not exceed 100 beds in certain periods)
- thermal insulation quality modification for the enclosing constructions (first of all hermetically sealed window and external door frames)

However even if the power saving measures are being ignored (as they are not basic task of the present expertise) then in the long-term the emergency solution of the heating supply problem in the Oncological Center will acquire the following disadvantages

- high self-cost of heating power caused by utilization of expensive diesel fuel and low efficiency of the boilers of НИИСТУ-5АГ" type
- necessity to consume additional amount of diesel fuel for emergency power generators operation during the power outage from the city system (power crisis can last very long)

Such assumption enables to consider possibilities of mixed process of heat and power energy production i e cogeneration

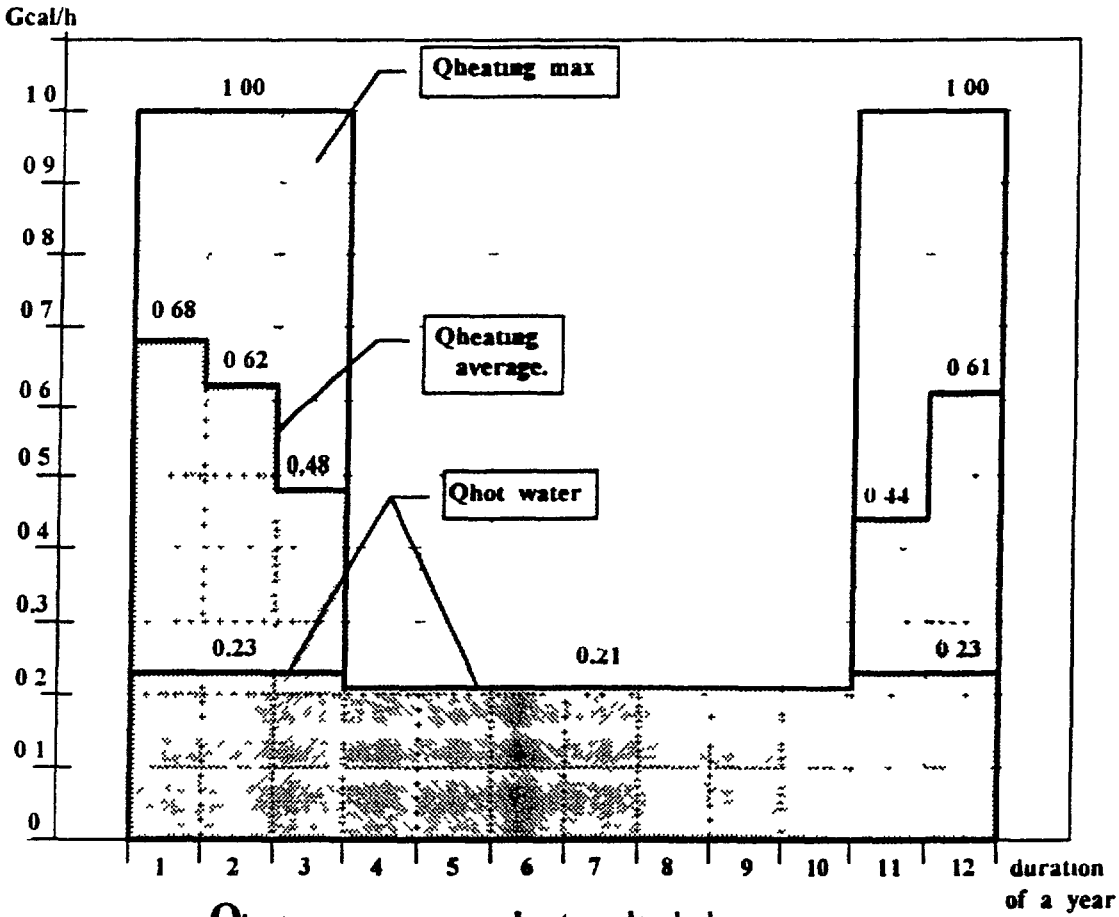
Based on the data on heat and power energy consumption in the Oncological Center with the load rate of 300 beds being occupied, the appropriate cogenerating equipment had been selected

Comparison of technical characteristics of the selected cogenerators with seasonal and daily data of consumption rate in the Oncological center make us conclude the following

- cogenerator operation within the year at the rated capacity will lead to significant re-production of heat power starting from April till October
- daily operation of cogenerator at the rated capacity will lead to significant re-production of heat power from 17 00 to 9 00

314

The annual profile of thermal energy demand for heating system.

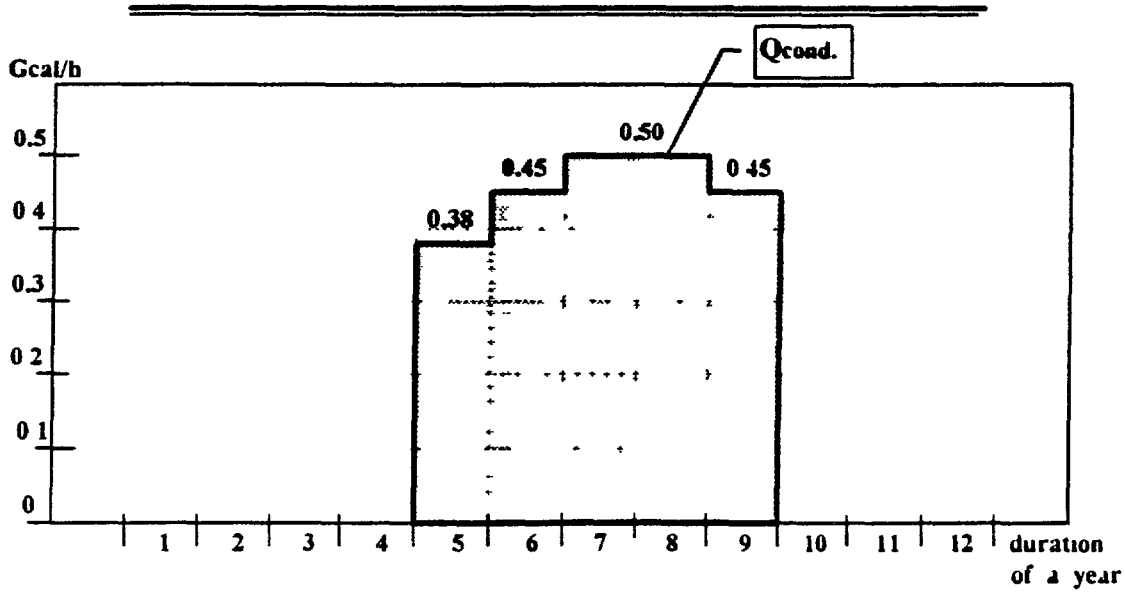


$Q_{heating\ max}$——max. heating load diagram.

$Q_{heating\ average}$——heating average monthly loads.

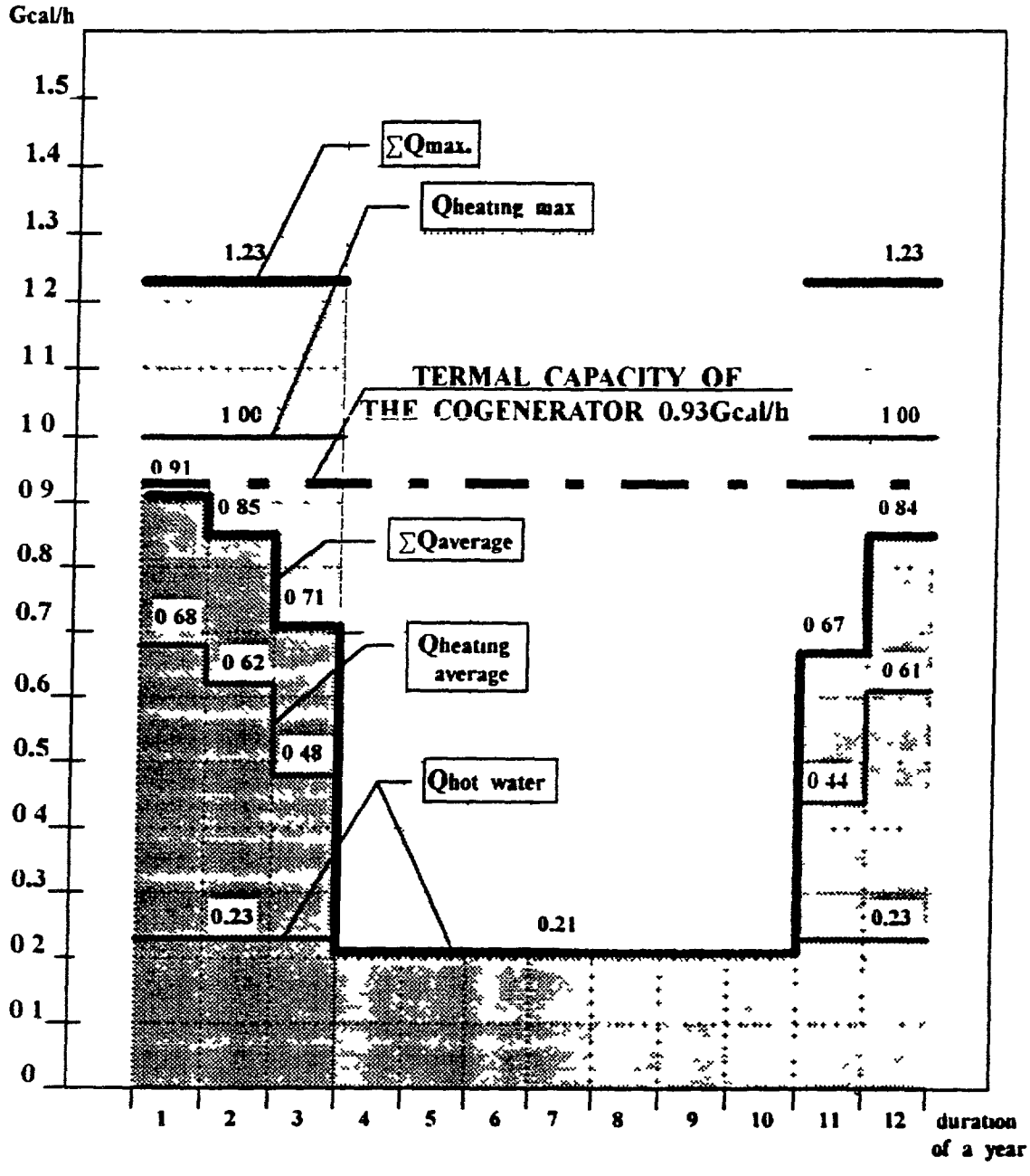
$Q_{hot\ water}$——hot water loads for winter and summer.

Demand of cooling for the air conditioning system.



Q_{cond} —The demand of cooling in summer period

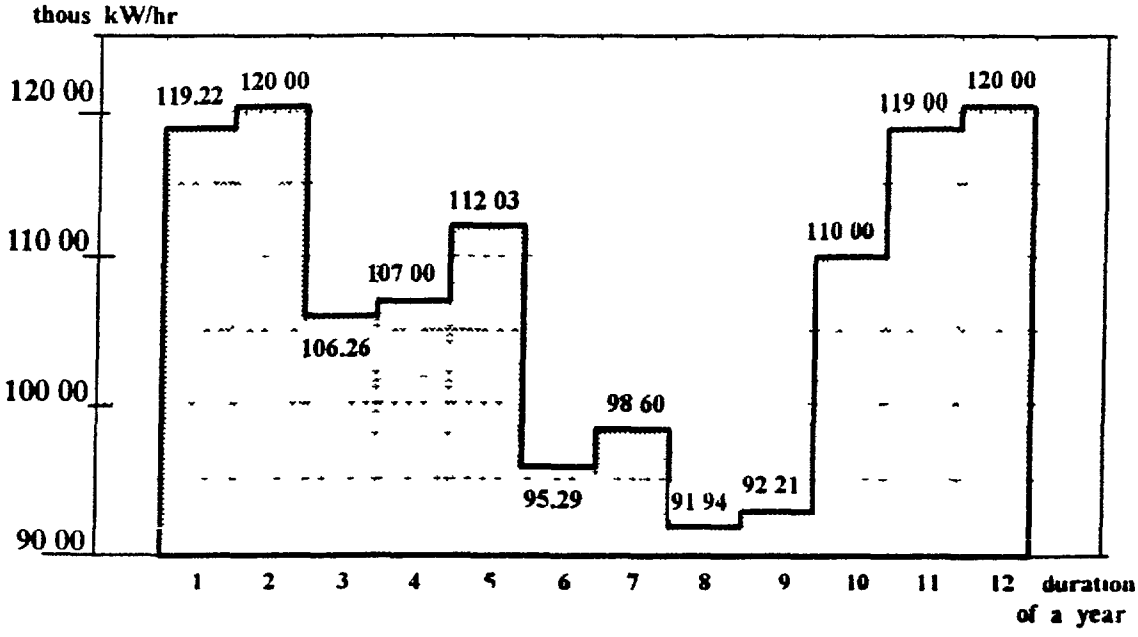
The curve of total annual thermal energy demand.



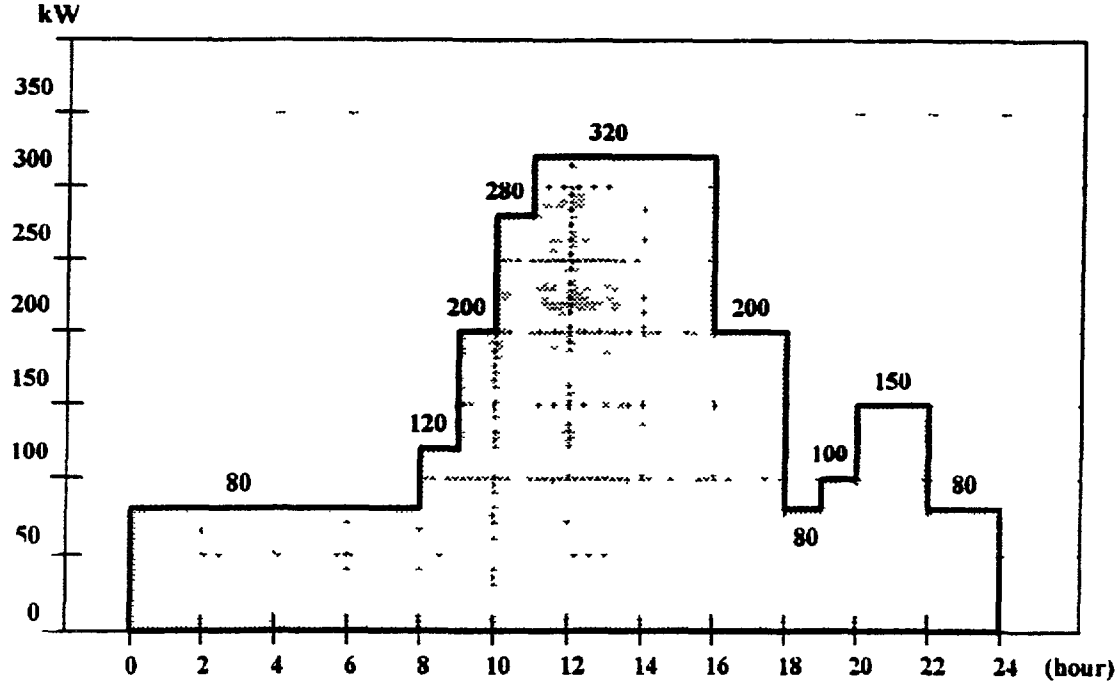
∑Qmax.– total annual profile at maximum load

∑Qaverage–total annual profile for average monthly load

Consumption of electric power (without using electric heaters).



Day/night oscillations of the electric consumption.



Parameters of Equipment

TURBINE GENERATOR	
Type of the turbine	Astarou IV
Manufacturer	Turbomeca Bordes France
Thermal capacity	1 082 kW
Shaft power	330 kW
Electric power at the generator terminal	280 kW
Rotation rate of turbine shaft	1 500/1 800 rpm
Rotation rate of electric generator	1 500/1 800 rpm
Voltage at electric generator terminals	400 V
Frequency	50 Hz
Turbine characteristics	
a) Electric efficiency	19 9%
b) Specific flow rate of conventional fuel (Q_{const} = 7,000 Kcal/kg)	0 618 kg/kW h
c) Gas fuel specific (8 000 Kcal/Nm^3)	0 540 Nm^3/kW/H
d) Gas fuel volume flow rate	178 Nm^3/h
e) Initial gas temperature Gas temperature after turbine	 490 ^{0}C
f) Total flow rate of gas in the turbine	2 55 kg/sec
g) Pressure ratio	5 6
Turbine generator dimensions	3 3 x 1 3 x 1 5 m
HEAT RECOVERY	
Type of heat recovery	WHR-1
Manufacturer	Jonston Boiler Company
Model	48-12
Number of gas path	1
Gas temperature -input -output	490^{0}C 140^{0}C
Thermal power	1 082 kW
IN STEAM PRODUCTION REGIME	
Charachteristict of saturated steam pressure temperature	 0 784 MPa 169^{0}C
Feed water temperature	100^{0}C
Steam productivity	0 66 kg/sec (2 4 t h)
WATER HEATING REGIME	
Water temperature-input -output	65^{0}C 95^{0}C
Water consumption	8 6 kg/sec (30 96 t/h)
Dimensions	4 39 x 1 63 x 1 91 m
TURBINE AND HEAT RECOVERY CONNECTING DIFFUSOR	
Sizes	1 3 x 1 7
TOTAL PRICE	280 000 $

Reduction of generated heat or power amount through adjusting the operation regimes of the cogenerator is allowable within the insignificant limits as otherwise the following problems may arise

- reduction of cogenerator efficiency,
- possibilities of deficiency in heat or power,

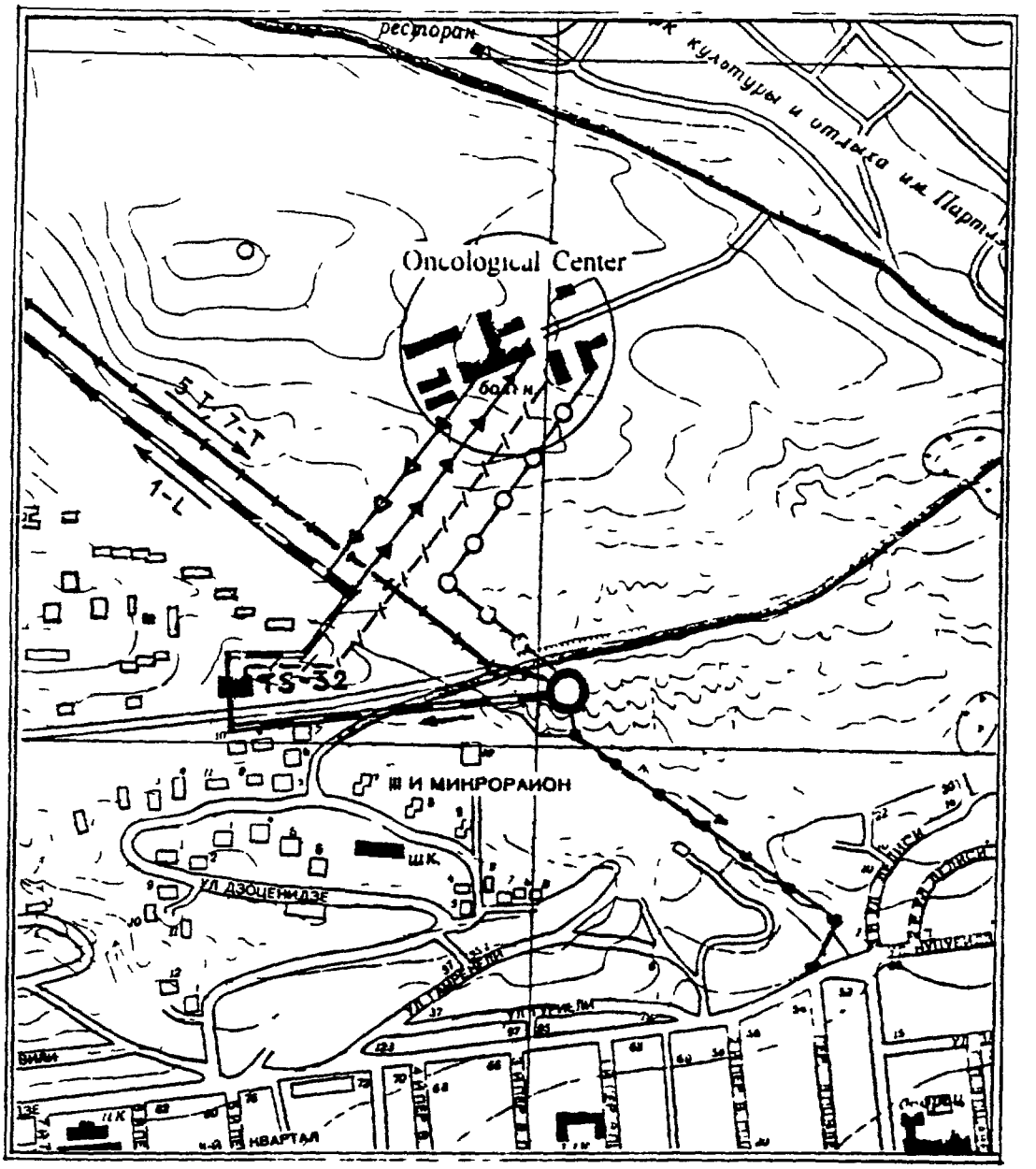
The only rational decision of the said problems could be sales of excess power to the interested external consumers For this very reason it is worth to combine cogenerating system of heat and power supply of the Oncological Center with the recirculation geothermal system of Lisi deposit (see technical report of ARCI Consulting of 1996, Delivery Order No 11, task 1, Subtask 7)

The proposed connection between two independent systems can provide the following advantages

- possibilities of utilization of excess heat generated by the cogenerator through supply (sales) of heated water to the distribution system of geothermal brine at any season
- possibility of utilization of excess electric power generated by the cogenerator through supply (sales) of power to geothermal system at any season
- possibilities of utilization of power of cooled geothermal water subjected to reinjection into the geothermal deposit for the Oncological Center air-conditioning

31

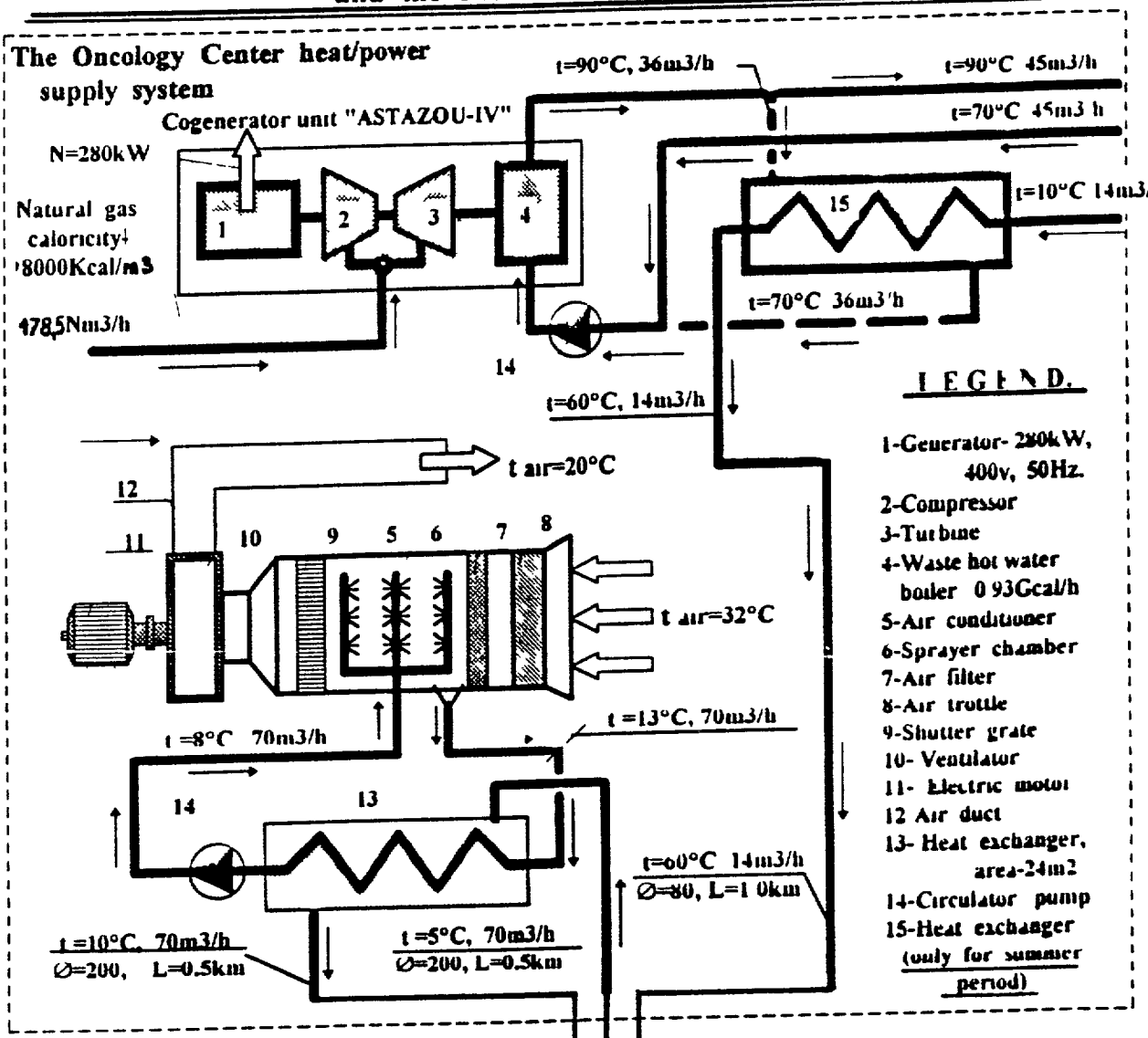
Diagram of Coupling of Thermal-power System of the Oncological Center with Lisi Geothermal System

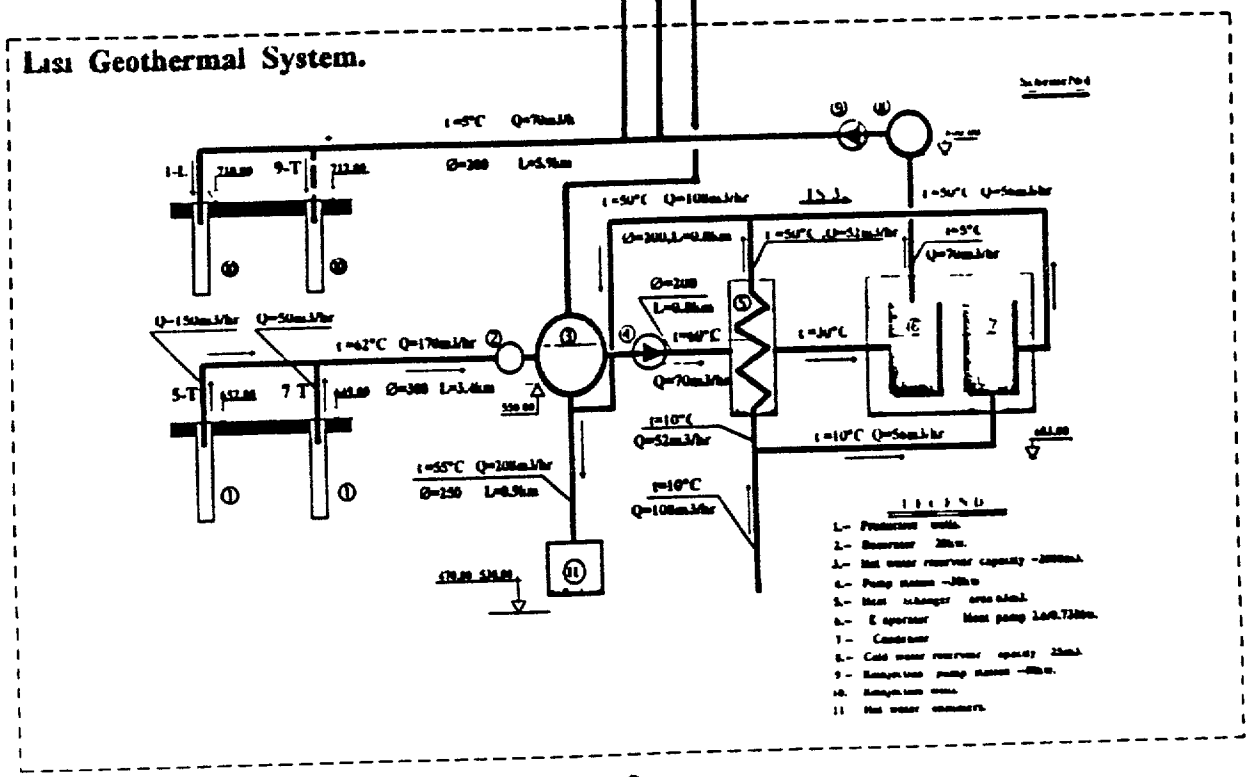


Legends.

- -supplying geothermal piping
- -reverse piping for cooled geothermal water reinjection
- -distribution piping for hot water
- -supplying piping of cooled geothermal water
- -reverse piping of treated water in the water conditioning system
- -piping for excess utilization of thermal power generated by cogenerator of the Oncological Center
- -low voltage cable line for excess utilization of power generated by cogenerator of the Oncological Center

The scheme for the connection of the Oncology Centr heat/power supp. and the Lisi Geothermal System





32

Comparative Analysis of Efficiency of Existing (Traditional) Thermal-Power Supply System of the Oncology Center with the Proposed (Cogeneration) System

In order to carry out comparative analysis of efficiency of the existing system of thermal-power supply with the proposed cogeneration one it is necessary to determine operating costs of each of them

I The existing system of thermal-power supply of the Oncological Center has the following characteristics

- thermal power demand for heating amounts to 2038 Gcal annually (providing that the amount of beds is reduced down to 300 and the part of the building space is conserved)
- thermal power demand for hot water supply amounts to 1887 Gcal annually
- power demand is 1440 MW h annually
- heat supply is provided by НИИСТУ-5АГ type boiler operation (the boilers are being rehabilitated by the management of the hospital)
- power supply is provided from the city grid,
- power supply during outages is provided by two diesel generators of 200KW capacity each (outages rate makes 400-600 hours annually)
- self cost of thermal power with НИИСТУ-5АГ type boiler operation makes

$$\frac{3\,600 \times 0\,18 \times 1\,000}{41{,}050 \times 0\,65 \times 0\,75} = \$\,32{,}38 \text{ per MW h } (\$\,37\,54 \text{ per Gcal})$$

where	$ 0 18	is the price of 1 kg of diesel fuel
	41 050 KJ/kg	heat generating capacity of the fuel
	65%	boiler efficiency
	75%	fraction of fuel component included into thermal power cost

- tariff of the power from the city grid is $36 per 1 MW h
- self-cost of diesel-generator power is $ 70 per 1 MW h

Thus annual expenses for heat and power supply are equal

Heating expenses

$ 37 54 x 2 038 Gcal = $ 76 506

Hot water supply expenses

$ 37 54 x 1 887 Gcal = $ 70,838

326

Cost of power supply from the city grid

$ 36 0 x 1,440 MW h x 0 95 = $ 49,248

Cost of power supply during the outages (diesel generators)

$ 70 0 x 1 440 MW h x 0 05 = $ 5 040

Total annual costs **$ 201,632**

II We propose the system of thermal power supply of the Oncological Center with cogeneration system, having the following characteristics

- amount of thermal power generated annually (with annual operation coefficient of the cogenerating equipment equal to 0 97) is 7,794 Gcal,
- amount of power generated annually (with annual operation coefficient of the cogenerating equipment equal to 0 97) is 2 347 MW h,
- annual cost of cogenerator operation is equal to

$$\frac{36\ 4 \times 1{,}496}{0\ 85} = \$\ 152{,}064$$

where	$ 86 4	is the price of 1000 m^3 of gas,
	1 496 000 m^3	is annual consumption of natural gas
	85%	fraction of fuel component included into the cogenerator operation expenses

Thus it became possible to define that by spending $ 152 064 annually on operation of cogenerator the thermal and power energy is generated in excess amount

annual thermal power excess

7 794 Gcal - (2038Gcal + 1 887 Gcal) = 3 869 Gcal

annual power energy excess

2,347 MW h - 1,440 MW h = 907 MW h

Due to the designed connection of thermal-power system of the Oncology Center with Lisi geothermal system, it is possible to sell great part of excess thermal and power energy generated by cogenerator

Income from sales of excess energy supplied to the geothermal system as hot water ($t=60^0C$) can make annual amount as follows

223

$ 0 35 x 70,000 m^3 =$ 24,500

where $ 0 35 -is the cost of 1 m^3 heated water up to 60 ^{0}C (self cost of 1 m^3 heated water up to 60 ^{0}C in the geothermal system is $ 0 36)

70 000 m^3 -is the amount of water heated up to 60 ^{0}C obtained through annual utilization of excess thermal power

Income from sales of excess energy, supplied to the Lisi geothermal system can make annual amount as follows

$ 30 0 x 907 MW h x 0 80 = $ 21 768

where $30 0 -is the cost of 1 MW h which is $ 6 cheaper than the existing tariff for the power energy

0 80 -is excess power energy sales coefficient

Consequently by selling the part of excess power we could reduce expences on cogenerator operation down to $105 796 annually ($152 064 - $24 500 - $21 768)

Thus the comparative analysis of the existing system of thermal and power supply of the Oncology Center and the potential cogeneration system enables us to state that cogeneration system operation can save about $ 95 836 annually ($201 632 - $105 796)

It should be added here as well that the connection between the thermal-power system of the Oncology Center and Lisi geothermal system enables to use cold water energy (obtained at the thermal pump discharge of the geothermal system) for air conditioning of the Oncology Center and can save electric power by $ 20 000 annually

To conclude the comparative analysis it is worthwise to make approximate budget estimation of the capital costs for installation of cogenerator and appropriate communications

1	Purchase and installation of the set of cogenerator equipment	-$ 320 000
2	Reconstruction and rehabilitation of the gas supply system	-$ 40 000
3	Thermal piping installation from the Oncology Center up to geothermal system tank (d=80mm, L=1,000 m)	-$ 20 000
4	Power cable installation from the Oncology Center up to district Thermal Station No 32 (0 4 kW L-600 m)	-$ 10 000
Total		**$ 390,000**

Conclusions

Capital costs for cogenerator installation will be paid back within 4 5-5 years by reducing operating costs in comparison with those of operation of the existing thermal-power system of the Oncology Center

Set of Proposals on Local Consulting Services
For Burns and Roe Delivery Order No. 11
Task 1. Tbilisi District Heating System Improvement Program
May 9, 1996

During compiling of the present proposals, we have applied the method of investigating new decisions together with examination results obtained in advance The approach like this enables to view new aspects of the issue, as well as to trace the course of events in the development of Georgian economy and changes in the social manner of thinking For instance possibility of emergency rehabilitation of heat supply facilities in 1995 we refrained from natural gas utilization Those times any offers of gas supply system restoration in nearest future was supposed impossible However, the situation has changed so that natural gas utilization in the heating system seems quite real But the efficient operation of gas supply system within Tbilisi is practicable only with sufficient amount of solvent consumers available The heat generating facilities can and must be such kind of consumers System of heat supply is particularly aimed at natural gas utilization, as the source of the most effective and pure fuel from the ecological point of view In its turn, system also needs the increased demand Thus, rehabilitation of both gas and heat supply systems are interrelated in direct interdependence Under the circumstances, we thought it advisable to concentrate our attention on gas utilization and this intention is reflected in most of the proposals It would be useful to implement modernization in three hospitals which had been rehabilitated through USAID and Burns and Roe assistance This would enable to establish permanent solvent consumers of gas in various regions of the city and help to develop gas supply system in adjacent territories, as well

It should be noted that gas supply system rehabilitation will lead to utilization of gas turbine co-generating installations This can positively influence solution of power supply problem At the initial stages of examination, the possibilities of emergency rehabilitation of heat supply with the simplest methods possible and minimum capital costs, was being studied Present proposals, mainly, are based on the same facilities study with rather up-graded technology utilization co-generation, helio systems, advanced types of boilers, etc This decision would enable to carry out comparative analysis of new results with previous examination recommendations

The present proposal contains following tasks

- Rehabilitation of district Thermal Stations with co-generation use (proposal No 1),
- Rehabilitation of individual boilers with natural gas or co-generation use (proposal No 2, 3, 4, 5),
- New individual boilers installations (on the basis of advanced technological equipment),
- Utilization of regenerating energy resources (geothermal and helio energy) (proposals No 6, 7),
- Complex rehabilitation of public services in the demonstrative area in Tbilisi (power, gas, heat supply systems) (proposal No 8)

325

If necessary, any changes or priorities could be inserted in the given letter of proposals For this very reason, it should be noted which task is worth paying attention to The studies under above listed tasks are supposed to start from the first half of May including first half of August

Proposal No 1. District Thermal Station Rehabilitation (TS No 9)

A. Description of the Task

At the initial stage of Tbilisi District Heating Study, we compiled justification of TS No 9 Rehabilitation advisability The mentioned justification was based on availability of compact location of solvent consumers The study recommendations considered only partial rehabilitation of TS No 9 (up to 12 Gkal/hour output) because of a limited volume of the existing mazout tank At the present moment it became possible to supply the boiler with natural gas That allows to view the opportunity of TS No 9 rehabilitation with gas turbine co-generating installation

B. Contents of the Report

1 Heat and power supply demand of TS No 9,
2 Design solution for re-equipment of TS No 9,
3 Design solution for the reconstruction of the existing distributing heat, power and gas systems,
4 Estimated specifications of required equipment, materials and types of work,
5 Capital investments needed, operating costs, tariff structures cost recovery and return on investment,
6 Recommendations of property form changes in the operating enterprise,
7 Recommendations on relationships framework for operating enterprise, local authorities and the consumers

Proposal No 2. Improvement of Rehabilitated Heat Supply System of Maternity House No 5

A. Description of the Task

Within the frames of heat supply system rehabilitation program of Tbilisi, the rehabilitation works in Maternity House No 5 heat supply system have been performed, which made it possible to operate two boilers on diesel fuel, out of four installed boilers in the boiler house

At a present moment there showed possibility of natural gas supply to the boiler house It enables rehabilitation or replacement of the remaining two boilers The modification like this will increase efficiency of the equipment utilization and ensure reliability of heat supply system by possibility of consumption of two types of fuel natural gas and diesel fuel

B. Contents of the Report

1 Design solution for the gas supply system of the boiler house,
2 Design solution for the rehabilitation, or replacement of two boilers operating on natural gas,
3 Estimated specifications of required equipment, materials and types of work.

Proposal No 3. Improvement of Rehabilitated Heat Supply System of Psychiatric Hospital

A. Description of the Task

Within the frames of heat supply system rehabilitation program of Tbilisi, the rehabilitation works in the Psychiatric Hospital heat supply system have been performed The performed works enabled to operate two boilers on diesel fuel There are four more boilers in the boiler house which are designed to function on natural gas

At the moment, there appeared possibility of natural gas supply to the boiler house The improvement like is thought to increase efficiency of the equipment utilization and provide for reliability of heat supply systems by utilizing two types of fuel, natural gas and diesel fuel

Improvement of the boiler house will also increase its capacity which would enable the hospital authorities to set green house economy Green house would serve as fresh vegetable source for the patients, and also as a source of additional income after vegetable sales Engagement of the patients in taking care of the plants in the green house would serve as therapeutic treatment in the hospital

B. Contents of the Report

1 Design solution for gas supply design of the boiler house,
2 Green house project,
3 Estimated specifications of required equipment, material and types of work,
4 Pro-forma financial analysis for the green house operation

Proposal No 4. Improvement of Rehabilitated Heat Supply System of Maternity House No 4

A. Description of the Task

Within the frames of heat supply system rehabilitation program of Tbilisi, the rehabilitation works in Maternity House No 4 heat supply system have been performed The performed works enabled to operate two boilers (out of five, installed in the boiler house) on diesel fuel It is worth noting, that during the rehabilitation works, there was found hidden damage of the heat exchanger The damage was not

eliminated, as this type of work was not provided for in the contract with the contractor

At the moment, there appeared possibility of natural gas supply to the boiler house This enables to rehabilitate, or replace remaining two or three boilers, also to replace the damaged heat exchanger The improvement like this would increase efficiency of the equipment utilization by two types of fuel, natural gas and diesel fuel Improvement of the boiler house will also increase its capacity which would enable the hospital authorities to arrange bath-house and laundry to serve the residents of the city

B. Contents of the Report

1 Design solution for the gas supply design of the boiler house,
2 Design solution for rehabilitation or replacement of two-three boilers operating on natural gas,
3 Design solution for damaged heat exchanger replacement,
4 Bath-house and laundry equipment,
5 Estimated specifications of required equipment, material and types of work,
6 To calculate profit from bath-house and laundry operation

Proposal No 5. Heat Supply System Rehabilitation in the Oncological Center

A. Description of the Task

At the initial stage of the examination we studied possibilities of heat supply system rehabilitation in the Oncologycal Center In the examination results it was recommended to replace existing worn boilers by new boilers of Russian production It should be noted, that Oncological Center has deficiency in not only heat, but also power supply Therefore, considering previous conclusions and the new approaches, we propose to work out the problem solution ways based on utilization of individual diesel co-generating equipment

B. Contents of the Report

1 Heat and power supply consumption,
2 Basic scheme of equipment installation,
3 Estimated specifications of required equipment, material and types of work
4 Capital costs, operating expenses and profitability

328

Proposal No 6. Autonomous Heat Supply Systems in the Schools

A. Description of the Task

The current conditions of the centralized heating system of heat supply in Tbilisi does not provide much for its significant rehabilitation Under the circumstances, the only way to rehabilitate heat supply systems urgently at schools, kindergartens and hospitals is to install independent heating systems In this connection, WB through its Agency for the development of Municipal Service located in Tbilisi, carries out study of 50 schools By test results it is envisaged to select several schools for implementing appropriate measures As alternative, we propose to carry out this study at 5-6 schools in Tbilisi based on the following approach

At the initial stage of the study, it is advisable to inspect 5-6 schools in order to

- Estimate thermal insulation conditions of the buildings (walls, roof, floors, windows, doors, etc),
- Evaluate the conditions of the inner network and installations (piping, radiators, accessories, etc),
- Determine the sites for installation of autonomous boilers and tanks for diesel fuel considering fire extinguishing measure requirements

Inspection result analysis will enable to select two schools, technical conditions of which will be viewed as satisfactory At the second stage of the study there will be developed the design solutions for the two selected schools The experience gained with heat supply system examination in the hospitals will guide us to come to the right decision For instance, technical task of the Agency for development of Municipal Services envisages autonomous boiler equipment installation in the existing buildings of the schools But based on the previous experience, we got assured that significant portion of capital investments is spent for construction and repair works of boiler premises At schools this sums might be higher, as there will rise necessity of repairing and utilizing the premises which had not been previously used for boiler purposes Considering this fact, it is reasonable to install boiler equipment in compact cheap metal containers with 6-8 m^2 of area The container like this can be located at the external wall of the building on the area with all communications arranged Opening walls of the container will provide convenient operation of the equipment Containerized-boiler can be assembled as on site, also in plants

It should be noted, that boiler installation in the school buildings excludes possibilities of natural gas utilization in future (under fire protection requirements) This restriction will not refer to the external "lean to" containerized boilers Thus, in case natural gas supply is restored, the boilers installed in the containers can be easily re-equipped for gas utilization Summing up all advantages of container-boilers we can predict, that they will be widely used

309

B. Contents of the Report

1 Justification of selecting two schools based on the results of 5-6 school inspection,
2 The design solution of independent heating system for two schools based on containerized-boiler,
3 Estimated specifications of required equipment, materials and types of work providing for damage elimination of the existing inner heating network and installations,
4 Estimated specifications of required equipment, material and types of work for containerized-boiler construction,
5 Calculation of operating expenses

Proposal No 7. To Create Recirculating Geothermal System at Lisi Deposit

At the previous stage of Tbilisi District Heating Study, we submitted justification for geothermal system creation applying the method of hydrosiphon Hydrosiphon system considers geothermal water utilization for hot water supply Simplicity of hydrosiphon system construction and minimum operating costs are sure to provide for high profitability of the business with low tariff for hot water

Opportunity of direct use of geothermal water is connected with active natural regeneration of geothermal resources of the deposit In order to specify regeneration dynamics of the deposit, in the conclusions of the previous examination, there were recommendations on arrangement and performance of the appropriate tests Possibility of obtaining positive results of the tests proving operating properties of hydrosiphon system is rather high However, it is more reasonable to expect also, that continuous utilization of the deposit with direct consumption of geothermal resources can be unacceptable For this very reason we propose to work out possibilities of recirculating system creation This would ensure regeneration of geothermal resources of the deposit

B. Contents of the Report

1 Recirculation system scheme based on existing piping utilization, also facilities which were provided for in the hidrosifon scheme
2 Specifications of required equipment, material and types of work
3 Required capital investments, operating costs, tariff structures and terms of profitability of the design solutions
4 Environmental impact assessment conditions
5 Characteristics of a private company claiming on deposit development and operation
6 Recommendations on arranging relations between operating enterprise, local authorities and consumers

Proposal No 8. To Produce Helio Energy Systems of Heat Supply in the Hospitals

A. Description of the Task

Researches of solar energy conversion into heat source were started by the end of 40-ies and beginning of 50-ies in Georgia Within the period of 1955-1957, there were built 17 helio installations in various regions of Georgia, aiming at hot water supply However, later this system was not developed New interests towards the practical application of helio technical installations was outlined by beginning of 80-ies in connection with necessity to decrease fuel energy balance deficiency and acute ecological problems Starting from 1984 up to 1990 there were installed more than 300 systems of solar heat supply with total area of solar collector exceeding 46,000 m^2 After certain period of time, most of the these installations were damaged due to imperfect current or capital repairs, poor operation and their low quality

At the present moment, under existing sharp economic crisis, the solar energy problem requires due attention. In this connection we propose to accomplish inspection of three hospitals in Tbilisi Republican Clinical Hospital, Oncological Center and Burns Center

Inspection task lies in studying the possibilities of solar system installation in heating supply Based on the results of the inspection, there will be selected one hospital which would be most convenient for solar energy system installation Appropriate design solution will be worked out for the selected hospital

B. Contents of the Report

1 Justification of selecting one of three inspected hospitals,
2 Design solutions for solar energy equipment installation,
3 Estimated specifications for required equipment, materials and types of work,
4 Proforms of financial analysis, specified costs, cash flows

Proposal No. 9. Program of Establishing Demonstrative Zone of Public Services in Tbilisi

Description of the Issue

At the given moment public services in Georgia is in critical condition The reasons of it could be as follows

- Sharp rise in energy resources cost (about the world prices), resulting in the rise of utilities cost (power, water, gas and heat supply, etc),
- Insolvency of utilities consumers of all categories,
- Technical defects of utilities supply system to the consumers Shortage of equipment enabling to measure individual actual volume of various services consumption,

321

- Absence of legislative basis defining the relations between the suppliers of services and service consumers

Under the circumstances, there appeared a "damned circle" of unsolved problems, when the suppliers cannot provide the production without being properly paid while the consumers are unable to pay for actual price of provided services due to low solvency As a result, public services crisis grows on, which will inevitably cause final deterioration of the existing infrastructure Gas and heat supply systems are in most acute state In fact, their production was terminated in 1994 Therefore, the power supply system became overloaded, the operation of which is not quite reliable in the rate like this

Purpose of the Program

The purpose of the present program is to find possibilities in solving the problem facing public services To find the solution for the said problem, it is necessary to identify and rely on those consumers of the services, who are able to pay for them For this very reason it is recommended to provide the solvent consumers with additional conditions

- Public services producers should be financially liable for their consumers for reliability and quality of the services,
- Offered services cost should be reasonable for the consumers against the expenses incurred during the self-supply,
- Service cost should be determined based on the volume of actual individual consumption of the services

To implement the task, it is essential to perform the following

- to set certain densely populated areas with the solvent consumers in Tbilisi,
- to design implementation of appropriate technical and institutional measures in these places

It may happen so, that solvent consumers distribution may not coincide with technical potential of the public service entities of the city to provide reliable services In this respect, it is worth considering options of creating several areas to find final solution It should be noted, that by now, there had been made some attempts by certain public service entities in setting relations with solvent consumers But these attempts were not coordinated between various sectors of public services The principle difference of the present proposal lies in setting special areas in which maximum of public services could be provided It would enable consumers to save finances by rational usage of each type of energy resources There are mass media information advertising high quality public services of the city, in case payments are made timely

However, they are not supported by the population owning sufficient experience not to rely on promises from the part of the government authorities Owing to socialistic way of thinking, the residents identify public service entities with state authorities Development of the demonstration areas will create totally different effect which would enable people to choose the degree of comfort according to their own

solvency These areas could serve as sources for rehabilitation of public services system Such test fields are absolutely necessary for both the suppliers of services and the consumers

Designed measures

In order to select demonstrative areas, it is desirable to carry out feasibility study in the following directions

- To find in the city densely populated areas with solvent residents,
- To find in the city areas enabling restoration of natural gas supply avoiding serious technical difficulties,
- To find in the city areas providing reliable power supply avoiding serious technical difficulties,
- To find in the city areas enabling rehabilitation of already existing, or creation of new sources of heat supply

After analysis of the given information, it will be possible to select area having a complex of all said essential features Thus, choosing the demonstrative area, it will be recommended to co-ordinate the offer with public service entities in the city which are interested in the point-in-question and also with supposed consumers Further steps of the study will be focused on elaboration of technical and institutional components of the program with the following outputs

A. Technical components.

- Design solutions for upgrading of external power supply system from transformer sub-station to consumers,
- Design solution for upgrading of power distribution inner system in the buildings and installation of group and individual prepaid meters of power energy,
- Design solution for upgrading of external gas supply system from gas distributing facility (substation) to consumers,
- Design solution for upgrading inner system of gas supply in the buildings and installation of individual gas meters,
- Design solution for rehabilitation of the existing heat source, or creating new group source of heating,
- Design solution for upgrading of inner heat supply system in the buildings considering possibilities of transition from successive to parallel piping distributors,
- Budget estimation and specifications of basic equipment and materials for suggested types of work

B. Institutional components.

- Action plan for the program implementation,
- Pro-forma cash flow based on types of tariffs and the consumers' solvency,
- Environmental impact assessment including building exterior considerations,
- Recommendations on the changes in an ownership structure, the legal and organizational forms for the suppliers and consumers

DECEMBER, 1996

CONCLUSIONS

of the Conference of the Environmental Protection and Natural Resources Committee of the Georgian Parliament on Utilization of Existing Geothermal Water Resources in Tbilisi

Hereby, the Environmental Protection and Natural Resources Committee of the Georgian Parliament confirms:

-its willingness to support the provisions stated forth in the document Agenda of the XX1 Century" of the "Program of the 21 Century Global Sustainable Development" adopted by the UN international conference held in 1992 in Rio-de-Janero,

Provided that the Committee considers the Decree of the President of Georgia on setting the Committee for Sustainable State Development,

and it is based on the following assumptions.

-Georgian geothermal water resources are valuable natural renewable energy resourses,
- rational and efficient development of the Georgian geothermal water resources is the significant factor in sustainable development of the state,
-rational utilization of the existing geothermal energy in Georgia is available and urgent at the present moment,
- development of the Georgian geothermal water resources is allowable from the environmental point of view,
- there is a state entity available (i e Ministry of Energy of Georgia) which is supposed to implement state policy in energy sector,
-there is a market-economy-oriented legal mechanism (i e Law of the Georgian Parliament on Underground Resources) available at the moment in Georgia which is involved in the existing geothermal water extraction and distribution,
- energy sector is considered to be the priority branch, international funding organizations are being informed of this issue,
-the German Government is greatly interested in rehabilitation of the Georgian energy sector and through investing policy (about 40 mil DM being already spent) the German party renders its assistance in three directions power energy generation, power transmission lines and thermal supply

Thus, the Committee thinks it reasonable

1) to consider utilization of the alternative energy resources, including geothermal waters as significant component of the renewable resources, as the priority issue for heat supply source to those local entities and districts, where it is allowable from the environmental and efficiency points of view,

2) to support any undertaking regarding the development of the geothermal water resources aimed at providing the Georgian population with heat supply,

3) to support the project proposed by the company "Geothermia" on Utilization of geothermal Waters in Tbilisi, particularly, Lisi lake area, and is aimed at providing the Tbilisi population with heat supply,

4) to apply to the Georgian Ministry of Trade and Foreign Economic Relations (K. Zaldastanishvili, the Minister) to render its assistance in implementation of efficient investment projects which are designed by the German party jointly with the company "Geothermia" to contribute to existing geothermal water resources development in Tbilisi,

5) to apply to the Georgian Ministry of Energy and Fuel (D Zubitashvili, the Minister) to submit the said issue to the President of Georgia in order to make utilization of the energy sources, particularly the geothermal energy source, a priority task in supplying the Georgian population with heat,

6) to apply to Tbilisi Municipality (B Shoshitaishvili, the Mayor) and the State Department for Land Managment (Z Gegechkori, the Head) to allot certain land plots to the company "Geothermia" by the moment the project is being realized

საქართველოს
საწვავ-ენერგეტიკის
სამინისტრო

MINISTRY FOR
FUEL AND ENERGY
OF GEORGIA

საქართველო, 380007 თბილისი, ლერმონტოვის ქ.10, ტელ: 931384, ტელ./ფაქსი: 770045, ტელექსი: 212264 ATOM SU, ფაქსი 933542.
10, Lermontov Str., 380007, Tbilisi, Georgia, Tel. (995 32) 931384, Tel./Fax: (995 32) 770045, Telex: 212264 ATOM SU, Fax (995 32) 933542.

№ 02/252 «21» 05 წელი 2

Dr Subir K. Sanyal
President, GeothermEx Inc
5221 Central Ave , Suite 201, Richmond,
Ca 94804 USA Fax· (510) 527-8164

Dear Dr Sanyal,

The Ministry for Fuel and Energy of Georgia determints the development policy of Renewable Energy including Geothermal Energy in Georgia

The Ministry will support in every possible way under mutually favorable conditions the co-operation among the Georgian party and "GeothermEx, Inc" and "Burns and Roe, Inc" which are extremly experienced in exploration, construction of geotermal fields in many countries, and which are familiar with Lizi and Zugdidi fields data in Georgia

Sincerely,

Minister
David Zubitashvili R. Abuladze

საქართველოს
საწვავ-ენერგეტიკის
სამინისტრო

MINISTRY FOR
FUEL AND ENERGY
OF GEORGIA

საქართველო, 380007 თბილისი, ლერმონტოვის ქ.10, ტელ 931384, ტელ./ფაქსი. 770945, ტელექსი: 212264 ATOM SU, ფაქსი 933542
10, Lermontov Str., 380007, Tbilisi, Georgia, Tel. (995 32) 931384, Tel./Fax. (995 32) 770945, Telex: 212264 ATOM SU, Fax: (995 32) 933542

№ 02/251 „21" 05 1997

Mr Charles Curtis,
1000 Independenece Ave., SW, Washington DC,
20585. USA Fax (202) 586-9260

Dear Mr Charles Curtis,

I am contacting you to ask for your cooperation in order to implement the project which would be of great benefit to the city of Tbilisi.

This project concerns hot water supply for 300 000 families in the residential district and heating systems for kindergartens, schools and hospitals in the area as well

Eight geothermal wells had been drilled for this purpose during 1980's before Georgia entered into its period of economic challenges We are very interested in using these existing wells in order to increase the hot water supply to the city Implementation of this project could replase 50 000 tons of oil per year (65MW of energy) which would decrease carbon dioxide emission and would allow our country to fulfill its obligations according to the Global Climate Change Treaty, which Georgia has signed up It could serve as a possible project for the US International Joint Implementation Programme and could assist companies involved in Geothermal Energy and distinct heating supply

I ask that you give careful consideration to this reguest for cooperation on the project which, we do believe, could be of great benefit to both countries

Sincerely,

Minister
David Zubitashvili R Arveladze

Professor Guram Buachidze
Acadewy of Sciences

33

Burns and Roe Enterprises, Inc.
27 Rustaveli Ave , Tbilisi 380008, Georgia, Tel (99532) 93 58 99, Fax (99532) 99 06 89
ბერნს ენდ როუ ენტერპრაიზის, ინკ.
რუსთაველის გამზ.27 თბილისი 380008, საქართველო ტელ (99532) 93 58-99 ფაქსი (99532) 99-06-89

Tbilisi, Republic of Georgia
e-mail JJJ@BRE kheta ge, BRET@bre ge
Telephone 99532 93 58 99
Reply Fax 99532 99 06 89

Date· 19 May, 1997 **Time: 17 30** **W O #5908-02**

TO Douglas Tuckhorn *cc*	*FROM Zurab Menteshashvili*
Subject Possible projects	*Reference*
Number of Pages (including cover sheet) 4	

Dear Doug

We could identify and develop/or participate in various projects of different scales and directions Our main lack of competence is in approach to potential investors
Otherwise we can initiate many different projects which will be highly beneficial from the point of view of reform policy / environment, energy saving and efficiency, and could conform with plans and intentions of different international agencies including restructuring, privatization etc

High qualification and relations of our engineers are the valuable assets which should be utilized to full extent They have participated in many projects and have a good knowledge in many aspects of energy sector

Let me give you some examples

1) Repowering of old Gardabani units
This is a Temur Mikiashvili's idea With kind assistance of John Hallberg he has done a preliminary evaluation

Description
There is a great deficit of base power in Georgian power system which is one of the main obstacles on the way to country's development Base power is produced at Gardabani Thermal Power Plant (GTPP) by old steam turbine units #3 and #8 (capacity ~120MW each) and a new unit #9 (250-300MW)
The old units are in a rather poor condition and have low efficiency Rehabilitation of unit #10 is underway but this will be insufficient to meet the country's need for base power

It is proposed to reconstruct one or several old unit(s) into a combined cycle plant(s) by dismantling and replacing the old obsolete boiler(s), adding new gas turbine generators

This idea is new and has not been considered by Sakenergo or Government However it is very likely that soon it will become popular, since it is in line with international practice and has especially many advantages in our particular case

- The project will reduce the great deficit of **base power** in Georgian Electric Power System by 150MW (per one unit)
- The **efficiency** of the resulting plant will be much higher then that of existing units (more than 50% vs existing 30%)
- The project can utilize the **existing steam turbines**, existing plant facilities and constructions
- We can probably apply experience of B&R gained from Russian study two years ago
- The expected cash flows of the project and comparison with other options show the high profitability of our proposal

I have mentioned this idea to Bill Smith who was quite interested and told that USAID wants to make its activity 'visible" The USAID funded feasibility study for the proposed project could be highly visible

Now this must be even more true, since the recent matter with Transgaz has not added much to positive visibility of AID

2) **Tbilisi heat-power plant study**

This is a 16MW old heat power plant which supplies power and heat to a small district in the center of city It is now a government owned joint stock company, 50% of shares will be sold in near future The personnel will be offered considerable number of shares Presently the management is looking for a chance to perform a feasibility study for rehabilitation of the plant and to prepare a business plan in order to attract investments Our engineers and ArCi will probably start the initial stage a pre-feasibility evaluation The idea of combined cycle plant will be most likely applicable in this case also

There will be a plenty of such work in future, since the privatized enterprises will need the evaluation technical auditing and recommendations for improvement of their assets

3)Coal-fired power plant near Tkibuli (West Georgia)

Tkibuli is an old developed region of coal mining situated in West Georgia Currently the mines are not operating In the government a priority is given to possibility of construction of coal-fired thermal power plant near Tkibuli The estimates show that the coal will be enough for at least 30 years operation of 100MW plant This project is popular in government since

- it provides a source of base power for developed industrial region (presently the only base power station is in East Georgia)
- utilizes the cheap local coal
- provides employment for a great number of workers and perspectives of further industrial development (production of gypsum, concrete etc)

Zurab had a discussion with deputy head of Saknakhshiri (Georgian Coal - department under Ministry of Fuel and Power) There is no developed project yet Some German investors are ready to conduct a feasibility study for mines and probably will contribute 25% financing for the whole project in case there will be other investors

There is a need for feasibility study related with coal fired power station, because currently rather little is known here about technical and economical parameters of this kind of plant These project (preparation of feasibility study) is also of the scale that fits well in USAID funded project's size and this subsector of energy sector of Georgia (coal and associated plant) have not been covered yet bu USAID This might be an advantage

BREI UKRAINE LUGANSK CFB PROPOSAL

4) Pilot project for establishing a heat and power metering&collection system in a selected district of Tbilisi (You have discussed it several times with ARCI)

D.O. 11

It seems that this project conforms very well with AID objectives of increasing economic efficiency, restructuring and private sector participation in the enegy sector
it promotes market oriented mentality, energy saving and environmental awareness of the population

5) TACIS is going to establish an energy saving office in Tbilisi and there is a tender announced We were visited by a potential bidder who was looking for a future basis for their activities and was seeking for cooperation There is a chance to contact other bidders as well and to offer our services One of our engineers (Otar Vezirishvili) is already working as an expert in TACIS project

6) Batumi heating & cooling project (see attached)

7) Using experience of our engineers we can also become involved in some other activities related with determination of optimal seasonal and daytime tariffs for heat and electric power fuel metering systems at Gardabani Thermal Plant energy saving measures & alternative power sources

In all of these fields there are new ideas suggestions or designs developed to some extent

We plan to discuss some of these issues with local USAID here and to somehow correlate with their future plans We can also continue to explore possibilities in the mentioned directions however it would be very helpful if we had at least a slight idea about B&R possible plans in Georgia and also if you could provide us an advise on what could be the possible financing sources for the above activities

It is very likely that many if not all of these projects will be implemented sooner or later regardless to our participation So it would be a pity to miss a train
We could apply more targeted efforts in different directions and the time is **now**!!

Best regards

Murman/Zurab

Heat and Cooling Supply to Batumi Central Blocks on the Basis of Heat Pump and Batumi Thermal Power Plant

Place of project implementation Batumi, city with developing economical infrastructure, is capital of Adjara Autonomic Republic (Georgia) Batumi is situated on the Black Sea coast close to border between Georgia and Turkey in the subtropical health resort and tourism zone Batumi is one of the main ports of Georgia Oil processing plant, Autonomic Republic Government and Cultural Centers are situated in Batumi

Problem of city heating Heat supply to the central blocks of Batumi is arranged by means of low capacity thermal stations that are using fuel oil (mazut) This method of heating is not effective from economical and ecological viewpoints Exhausts damage Batumi, one of the main health resorts and tourism centers of Georgia Therefore, modernization of the heating system is very important today for Batumi

Possible results of project realization Heat supplying complex system in Batumi on the basis of suggested project guarantees economy of fuel and energy resources and improves ecological situation in the region

Project parameters 200 Gcal per hour heat and 20 Gcal per hour cooling is planned for air conditioning by means of absorptive heat pumps and Batumi Heat Power Plant According to preliminary calculations approximately 22000000$ are needed for project realization Loan can be repaid during 3,5 years Fuel economy equals to 120000 tones of conventional fuel per year

Works required Working project to be designed, Heat pump installation in Batumi Power Plant to be carried out, Heat routes to be rehabilitated and extended in Batumi central blocks

Potential consumers City municipal building blocks, Oil processing plant

Partners during project design Group of Georgian specialists

Guarantees Loan repayment conditions and guarantee conditions will be agreed in contract with foreign investors according to the norms of Adjara Autonomic Republic legislation

Realities Group of project authors has preliminary agreement with Batumi Communal Administration Department about necessity of suggested project However, local financial resources are insufficient for project realization aims Participation of foreign investors is needed

Note This project was awarded prize of Ministry of Fuel and Energy of Georgia on the annual competition

JOHN HALLBERG
ZURAB MENTESHASHVILI

FRIDAY, MAY 15, 1998

GEF - GLOBAL ENVIRONMENTAL FUND - MEDIUM-SIZE PROJECTS
UP TO $1,000,000 FAST TRACK

ONLY DO THESE PROJECTS IF OFFICIAL REQUEST FROM GOVERNMENT
"CLIMATE CHANGE FOCAL POINT" - IN "MINISTRY OF ENVIRONMENT"
"CENTER FOR CLEAN TECHNOLOGY"

PETER GARFORD - EBRD CONSULTANT - FEASIBILITY STUDY
TBILISI THERMAL ELECTRIC STATION (TES) RE-BUILD/RE-POWER

Anders Risberg
Programme Officer
United Nations Development Programme

UN Country Office in Georgia
9 Eristavi Str
Tbilisi 380079
Georgia

Tel (995 32) 99 85 58, 25 11 26/28/29/31
Sat Tel . (1-908) 739 39 24 ext 141
Fax 25 02 71/72
Sat Fax· (995 32) 00 10 77/00 11 27 ext 182
E-mail. anders.risberg@undp org ge

U.N. WAS APPROACHED TO PREPARE FEASIBILITY STUDIES
INTERESTED IN DISTRICT HEATING PROJECTS.
1. SABUTELO GEOTHERMAL
2. TES REHABILITATION / REPOWERING
WILL PAY UP TO $25,000 FOR PROJECT FORMULATION PROPOSAL

MAY 15, 1995

Summary of Project Objectives and Description

The objective of the project is to identify and propose measures to remove those barriers that impede the undertaking of actions to improve energy efficiency, thereby decreasing the emission of GHG at the Tbilisi Thermal Station and bringing global environmental benefits The project will address such issues as enhancing demand side management, institutional strengthening, including resource planning and administration capabilities and legal, regulatory and policy changes The objective of the full scale project to be developed with the PDF resources requested is to remove barriers to energy efficiency in district heating and hot water supply in Georgia, thereby decreasing the consumption of fossil fuels and lowering emissions of green house gases and their effect on Climate Change, also facilitating government and private investments, national as well as international Close co-operation will be sought with the EBRD and WB, ensuring that the project follows the guidelines, policies and future plans of these organisations in Georgia

A detailed analysis of the existing barriers and formulation of a strategy for measures to remove these will be undertaken during the proposed PDF phase Some of the key barriers and measures to be addressed are

1 Reducing the technical, economic, financial and institutional uncertainties with respect to energy efficiency measures applied to district heating and hot water supply,

2 Disseminating information and providing training for stakeholders on the available technical measures to improve the energy efficiency of municipal district heating and hot water supply,

3 Through public awareness campaigns create incentives on supply and demand side to improve and invest in energy efficiency,

4 Strengthening the local capacity to conduct technical, economic, financial, environmental and social feasibility studies and providing training on financial mechanisms used in the energy sector, including project financing, energy service companies and privatisation,

5 Strengthening local capacity in resource management and energy efficiency, e g setting and collection of tariffs, insulation of buildings and economics of natural resources,

6 Strengthening the local capacity to incorporate environmental considerations, e g through conducting Environmental Impact Assessments, in all stages of planning of district heating and water supply, i e from strategy to implementation,

7 Strengthening the institutional, legislative and regulatory framework to support energy efficiency,

8 Improving the climate and enhance the interest among potential investors in the energy sector, supporting the process of privatisation, and

9 Based on the results of the study, identify a demonstration project to prove the technical, economic, financial environmental, as well as social opportunities of energy efficiency in district heating and hot water supply

From a technical point of view the project is expected to deal with issues such as

1 Optimisation of the size and coverage of the centralised co-generation and district heating system, by taking into account technical, economic and environmental aspects,

2 Improving energy efficiency in the existing district heating and hot water supply plants by better control maintenance insulation and upgraded equipment,

3 Improving insulation and maintenance of the district heating pipe lines,

4 Consumption based metering and billing,

5 Improved temperature and flow control systems and other specific demand side energy efficiency measures,

6 Up graded standards and codes of practice for construction and renovation of buildings

New applications and financial arrangements will first be tested in a small scale, and experiences learnt will be fed back into the process

Specific attention will throughout the project be paid to co-ordinating the undertaken activities with those on-going or planned by national and international institutions, also paying attention to privatisation

II Description of Proposed PDF Activities

Initially a study will be carried out as to specifically identify the most urgent problems to be tackklesd, suggesting short and long term measures To formulate a project proposal for the main project the following activities have been identified as necessary

1 Identify all the key stakeholders, develop a plan for their involvement and undertake measures to facilitate their participation from the beginning of the project,

2 Collect information and data to perform a preliminary analysis of the technical potential and available measures to improve the energy efficiency in district heating and hot water supply,

3 Based on technical analysis and the general development plan of the district heat and hot water supply undertake a preliminary assessment of the economically feasibility of improving energy efficiency, estimating the environmental benefits of such improvements,

4 Identify all the key barriers to improve the energy efficiency of the district heating and hot water supply in Georgia, and estimate the extent to which these barriers hamper the implementation of relevant energy efficiency measures These barriers might include, *1) high up-front capital cost and access to suitable credits 2) lack of incentives and price distortions to invest and implement otherwise feasible energy efficiency measures 3) lack of information and capacity to formulate bankable project proposals 4) non supportive legislative and regulatory framework 5) risks and transaction costs which are too high for the potential investors 6) lack of managerial and technical capacity in the concerned power sector 7) lack of awareness among the public about energy efficiency and it s correlation to health and environment and 8) lack of experience with concrete projects demonstrating not only the technical but also the economic environmental and financial feasibility of selected energy efficiency measures and financial arrangements*

5 Formulate a strategy and a proposal for a set of measures to overcome all the identified barriers,

6 Based on the analysis of the technical potential and measures to improve the energy efficiency of the municipal heat and hot water supply, select a set of measures for further analysis,

7 Conduct targeted studies of the feasibility of the selected measures taking into account technical, economic, financial and social aspects

8 Based on the analysis above, select a set of measures to be implemented and demonstrated during the next phase of the project,

9 Identify and mobilise local and international, partners for co-operation and co-funding of the project, e g private investors, the World Bank, the EBRD, and bilateral donors,

10 Formulate a project brief for the main project based on the results of the PDF phase and the specific GEF requirements,

11 Undertake an independent evaluation of the proposal identifying potential risks that can prevent meeting the short or long term objectives of the project, suggesting changes that should be made to meet those objectives

III PDF Outputs

The output of this PDF B phase will be a proposal for the main project demonstrating the ability to achieve the goals set forth in the project, i e

1 An assessment of the economically feasible energy saving potential in district heat and hot water supply in Georgia the quantity of financial resources required, and the contribution that fulfilling the goals of the project would make in mitigating greenhouse gases in Georgia,

2 A plan for the involvement of all key stakeholders, including relevant governmental and non-governmental institutions, representatives of interest groups affected by proposed energy efficiency measures, potential national and international sources of financing, equipment manufactures etc

3 A description of all the key barriers relevant to the project, and a strategy and proposed set of measures on how to remove those barriers,

4 A technical, economic, social and environmental feasibility study of the proposed measures,

5 A detailed incremental cost analysis following GEF guidelines,

6 A financial plan and agreement on co-funding to cover baseline costs of the project,

7 A strategy and plan for project management and implementation,

8 A plan and set of measures for monitoring and evaluating the programmatic benefits of the project

IV Eligibility

Georgia is experiencing an acute energy crisis, and the political instability of recent years have had a detrimental influence on all components of the energy sector, resulting in severe economic and social downgrading of the country Georgia has been meeting a declining share of its primary energy needs from domestic production, from close to 50% in the early 1980s to only 10-15% in the pre-crisis years After the break up of the Soviet Union and the sharp increase in prices of energy imports, Georgia quickly accumulated a significant external debt and payment arrears, and could not sustain the needed level of energy imports and supply Together with poor maintenance and low collection of payments this has put the energy sector in disarray and inadequate energy supply has become a major impediment to economic recovery Georgia ratified the Climate Change Convention on October 27, 1994

V National Level Support

The main objectives of the Government policy in the power sector in the short term are to increase power supply and improve collection of payments - the two major conditions for resolving the current energy crisis The Government has been developing a reform strategy for the sector, which addresses its institutional, financial and structural problems The main objectives, principles and policies of this strategy are outlined in the Government's Letter of Sector Development Policy (LSDP) The LSDP states that the Government s strategy to achieve sustainable efficiency in the power sector will be based on (i) a corporate, commercial and decentralised power industry, (ii) implementation of commercial practices and enforcement of payments, (iii) economic pricing of electricity with due regard to poor residential users, (iv) establishment of a legal and regulatory framework to promote competition and private sector participation, including instituting and independent regulatory agency, (v) optimising the use of resources by fostering least cost development plans, (vi) focusing investments in the short and medium term on the economic rehabilitation of existing facilities and completion of economically viable but partially completed projects (vii) promotion of efficient use and conservation of heat and electricity, and (viii) protection of the environment in energy production and use

A National Environmental Action Plan is being established and in accordance with its priorities the Ministry for Fuel and Energy has adopted as one of its priorities to increase energy efficiency, coinciding with the Governments goal of mitigating GHG emissions

The third Conference of Parties to the UNFCCC was held in Kyoto in December 1997 and a protocol on commitments for Annex I Parties established policies and measures requiring agreement and international co-ordination to meet emission commitments Even though Georgia, a country in transition, is not liable to emissions abatements the country has given the Ad-hoc Group on the Berlin Mandate (AGBM) several proposals for voluntary commitments for reducing Green House Gas (GHG) emissions As part of the activities to prepare the first national communication to the FCCC the government of Georgia is actively exploring those strategies and activities that simultaneously benefit the local and global environment

The GEF project "Enabling Georgia to fulfil its commitments to the UNFCCC" is under implementation This project enables Georgia to prepare its first national communication to the Conference of the Parties (OcP) of the UNFCCC The components of the project are (a) an inventory of greenhouse gases following the guidelines adopted by the CoP, (b) an assessment of potential impacts of climate change in Georgia, (c) an analysis of potential measures to abate the increase in greenhouse gas emissions in Georgia and to adapt to climate change, (d) preparation of a national action plan to address climate change and its adverse impacts, and (e) preparation of the first national communication of Georgia to the CoP The 'Energy Efficiency in Tbilisi District Heating and Hot Water Supply' project proposal is the result of a conference held within the frame of the project "Enabling Georgia to fulfil its commitments to the UNFCCC" The project has been elaborated in co-operation between the Ministry of Environment and the Ministry of Fuel and Energy and their underlying agencies and NGO's, and the full support and engagement of these two ministries has been secured for the implementation of the project Before implementation of the project, it will also be approved by the Georgian Foreign Advisory Investment Council, which consists of the Cabinet of Ministers and is headed by the President of Georgia Full engagement and support is also secured from the municipality of Tbilisi The Government and the Tbilisi city administration has also confirmed that they are prepared to contribute financially to the project While during the PDF phase this co-financing will be in kind, there is a commitment to contribute in cash to the implementation of the main project

VI Items to be Financed

Activity

1 Identify all the key stakeholders, develop a plan for their involvement and facilitate their participation,
2 Collect information and undertake a preliminary analysis of the technical potential and measures
3 Undertake a preliminary assessment of the economically feasible potential
4 Identify all the key barriers to improve the energy efficiency of the district heating and hot water supply
5 Formulate a strategy and a proposal for a set of measures to overcome the barriers identified
6 Select a set of measures for further analysis
7 Conduct targeted feasibility studies of the selected measures
8 Select a set of measure to be implemented and demonstrated at the first phase of the project
9 Identify and mobilise local and international partners for co-operation and co-funding of the project
10 Formulate a project brief for the main project, based on the PDF outputs
11 Undertake an independent evaluation of the proposal

VII Special Features

Until the end of the break up of the Soviet Union almost 90% of buildings in Tbilisi were connected to the District Thermal Heating Systems where as today only a fragment of buildings are connected to the poorly maintained remnants of the District Heating Systems and Hot Water Supplies This has resulted in the population resorting to substituting the previously established systems with electrical appliances for heating and cooking, with high power consumption adding pressure on the scarce electricity supplies creating an overload on the existing electricity distribution system, through

accidents posing imminent danger to human lives Further, electrical heating is a very expensive method of heating, consuming considerably larger amounts of fuel than traditional heating systems, and considering Georgia is an importer of natural gas and hydrocarbon fuels, putting excessive strains on the balance of payments of the Georgian economy

Another source of domestic heating supply is the use of wood stoves, kerosene- and liquid gas heaters The indiscriminate and uncontrolled cutting of forest for wood fuel is one of the major environmental problems in Georgia, and indoor and outdoor pollution from the use of wood, kerosene and liquid gas causes serious detrimental affect on human health and the environment in Georgia

In the short to medium term general investment priorities are to restore the system capacity through enhanced maintenance, repair and rehabilitation, and to this end the Georgian Government has paid particular interest in improved energy efficiency in District Heating and Hot Water Supply in Tbilisi

TBILISI MUNICIPALITY

2 Liberty square, 380009, Tbilisi, Phone 996-560

ORDER

May 28, 1998

On Support of Implementation of the Demonstration Zone Project in Digomi District II, Tbilisi Proposed by the Company "Burns And Roe Enterprises, Inc "

1 Municipality supports the Demonstration Zone Project to be implemented in the territory of Digomi District II, Tbilisi by the company "Burns and Roe" with funding provided by US Agency for International Development The project includes the following

- Modernization of power supply systems to the blocks of flats and installation of reliable electric meters,
- Installation of gas meters in the apartments,
- Installation of gas heaters in apartments and public places,
- Arrangement of geothermal bath in the building of the thermal Station #5

2 Municipality notes

2 1 The importance of the project that allows to select optimal solutions for upgrading power distribution system and establish market relations with consumers in the sphere of communal services

2 2 High professional level of the proposed Demonstrative Zone Project prepared by "Burns and Roe" and its subcontractor company "ARCI Consulting"

4 Municipality requests the Energy Commission of the Tbilisi Municipality to monitor the implementation of the project and analyze its results

5 Municipality requests the municipal enterprises "Telasi" and "Tbilgasi" to provide necessary assistance to the company "Burns and Roe" and its subcontractors during implementation of this project

6 Municipality requests the Gamgeoba of Didube District (Local Authority) to take measures for establishing of Residents' Associations on the territory of the Demonstration Zone according to provisions of new Civil Code of Georgia

7 Municipality puts responsibility to control fulfillment of this Order on Mr T Chincharauli, Chief Adviser of the Municipality on Energy Issues

Premiere of the Tbilisi Municipality Z Bibileishbili

185

REPUBLIC OF GEORGIA

ქალაქ თბილისის მუნიციპალიტეტი

28.05.98 № 185

Liberty square 380009, Tbilisi tel: 992-100

მ ა ნ ქ ა რ ბ ო ლ ო ბ ა

კომპანია „ბერნს ენდ როუს" მიერ
თბილისში, დიღმის მასივის მე-2 კვარტალის
ტერიტორიაზე „ახალშენსტრაცია ზონის"
პროექტის შესახებ

1 მოწონებულ იქნეს აშშ საერთაშორისო განვითარების სააგენტოს (USAID) დაფინანსებული კომპანია „ბერნს ენდ როუს" მიერ თბილისში, დიღმის მასივის მე-2 კვარტალის ტერიტორიაზე „ახალშენსტრაცია ზონის" წარმოდგენილი პროექტი, რომელიც ითვალისწინებს:

- მრავალბინიანი საცხოვრებელი სახლების ენერგომომარაგების სისტემების მოდერნიზაციას და სახლების აღჭურვას ელექტროენერგიის ხაოიანი მრიცხველებით,
- ბინების აღჭურვას ბუნებრივი გაზის საყოფაცხოვრებო მრიცხველებით;
- ბინებსა და საზოგადოებრივ ნაგებობებში გაზის ინდივიდუალური გამათბობელი საშუალებების დამონტაჟებას.
- რაიონულ საქვაბე ჩაში გეოთერმული წყლის გამოყენებით ბანაობის მოწყობას.

2. ადგინშნოს:

2.1 „ახალშენსტრაცია ზონის" პროექტის აქტიურ-ლეგალურობა, იმ ოპტიმალური ღონისძიებების შერჩევა და განხორციელებაში, რომლებიც საშუალებას მოგვცემენ მოვუსინჯოთ ხანაზარი [illegible] ... [illegible]

2.2 კომპანია „ბერნს ენდ როუს" და [illegible] ... [illegible]

BEST AVAILABLE COPY

4. დაეკვალოთ მუნიციპალური საწარმოების „ოდელასს" და „ბილოდასს" შერწყმა აღმოიფხვრას კომპანია „ბერნს ენდ როუს" და მის ქვემოთაგარდების პროექტის განხორციელებაში.

5. დაეკვალოს ქობულეთის დიდებულ [redacted] ლონისძიებები ადგილობრივი ზონის [redacted] საქართველოს ახალი საშოქალაქო კოდექსის შესაბამისად ბინების შესაკეთებლად ამხანაგობების ჩამოყალიბებლად.

6. კონტროლი განკარგულების შესრულებაზე – დაეკვალოს მუნიციპალიტეტის მოადგილეს ეკონომიკურ საკითხთა დარგში ბ-ნ ი. ქანქარაშვილს.

ქობულეთის
მუნიციპალიტეტის პრეზიდენტი

BEST AVAILABLE COPY

PRESS RELEASE

MAY 19, 1998

The United States for International Development (USAID) has provided funds over the past four years for energy related technical assistance and urgently needed rehabilitation of heating systems at four hospitals and two schools in Tbilisi The work involved repair of boilers and equipment at Maternity Hospitals No 4 and No 5, the Burn Hospital and Tbilisi Mental Hospital Also, a solar collector was installed at the Burn Hospital which will provide about 40% of hot water needs each year

The most recent project is for a pilot demonstrative zone in Digomi district to install electric and gas meters and supply geothermal hot water to the central communal bath house There are 18 buildings in this district which vary from 5 to 14 floors, with from 60 to 130 flats per building totaling 1283 flats housing about 6000 people The reasons for selecting the Digomi district are the following

- Power distribution is typical for Tbilisi
- Gas supply system has been rehabilitated
- Representative cross-section of Tbilisi population
- Typical 18 building district
- USAID funded gas fired hot water boiler installed at kindergarten
- Available geothermal hot water supply can be expanded
- District heating thermal station No 5 in district is attractive investment opportunity for privatizing and rehabilitating

About 334 electric meters will be installed in locked boxes in entrance areas for metering one, three, fifteen or thirty families per meter Existing meters will remain in apartments and separate meters are installed for elevators and some common entrance lighting There will be 483 gas meters installed in flats which do not have meters The communal bath house will be repaired and geothermal hot water will be supplied and metered

USAID has supported these projects to demonstrate to the population at large the measurable results and benefits for the Georgian people The demonstrative zone project is of special importance to USAID, as well as to the government of Georgia and the Municipality, because it is the first known project in the CIS which integrates gas and hot water metering as well as electric metering in the same project

Other organizations and consultants are watching the progress of this project which will provide much valuable information for implementing metering programs in other districts, such as

- Equipment and labor costs for metering in different types of buildings
- The effect of gas supply on electric consumption
- If payments for electricity and gas will improve

This project is an important example which lays the framework for the present ongoing reforms being developed for the accounting and management systems needed for the monitoring, billing and collection of tariffs for energy The project will also promote the development of energy management capabilities and organizational discipline needed for privatization in the energy sector

inform usa

Letter text for Merrill-Lynch

USAID has funded numerous small projects for urgently needed rehabilitation of boiler heating systems in four hospitals and two schools as a result of shutting down of the district heating thermal stations in Tbilisi A current project will be implemented for installing electric and gas meters and a few gas furnaces in 18 buildings in the Digomi district of Tbilisi as a pilot project In addition, geothermal hot water will be supplied and metered to the communal bath house

One objective of this project is to provide a reliable supply of electricity and gas to 1283 flats housing about 6000 people The goal is to promote improvement in equitable billing and increased collection of tariffs for the actual energy used in each flat The municipal government of Tbilisi is in support of this project and will place a priority on supply of electricity and gas to this district

This is the first known metering project in the CIS in which an integrated approach is taken to supplying both electric and gas meters in the same project The purpose is to observe the effect which much less expensive gas consumption for cooking, heating and hot water will have on the consumption of electricity for the same purpose It is estimated that about 300,000 families in Tbilisi have at least one 1 kW or larger heater, and many have electric hot water heaters of 1kW to 3 kW It is estimated that recent winter loads due to using electricity in place of gas for cooking, heating and hot water is at least 300 MW

The cost of the Pilot Demonstrative Zone Metering Project is about $170,000 The value of work and meters installation in the Digomi district is insignificant compared with the estimated value of Telasi assets

If you have any questions please call

merrill ltr

Georgia Energy Brigades

A joint project by Georgia Greens, IIEC-Europe and Hnuti DUHA

Saving energy

Staying warm

Building the future

Your guide

SIMPLE WAYS TO SAVE ENERGY AT HOME

iiec International Institute For Energy Conservation

Hnuti DUHA

Funded by Know How Fund and OSGF

KNOW HOW FUND

OSGF

THE COST OF ENERGY

Georgia has a great shortage of energy but much of the energy produced here is wasted It is wasted in production, transmission and use by people in their homes, at work and in industry The amount of energy needed to produce goods and services in Georgia is 4-5 times higher than in the countries of the West

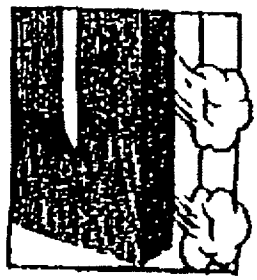
As well as wasting energy this is wasting money Electricity prices are rising, and kerosene and gas is expensive especially in winter

The production and use of energy has a big impact on the environment and the people In Georgia, this includes

- pollution from the Gardabani power station,
- more and more trees being chopped down for energy for cooking and warmth and
- the threat of the destruction of nature by the building of large hydropower stations

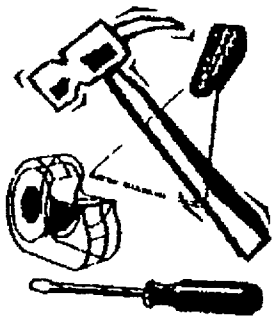
Internationally there is also a lot of concern about energy and emissions Burning coal, gas, oil or petrol and wood for energy releases carbon dioxide and nitrous oxide into the 'blanket' of gases surrounding the earth This 'blanket' is now becoming so thick that global temperatures are increasing leading to global climate change World scientists predict the effects will include rising sea levels and more land covered by seas and oceans, weather catastrophes and crop losses For some species adaptation and survival could become very difficult

STAYING WARMER



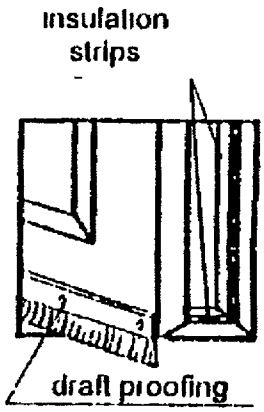
Much of the heat produced in houses and apartments escapes through doors, windows, walls, ceilings and floors You can help stop this loss by 'insulating' your home ie by sealing your home to stop heat escaping and to keep cold air outside

SIMPLE THINGS TO DO



Fix doors and windows!

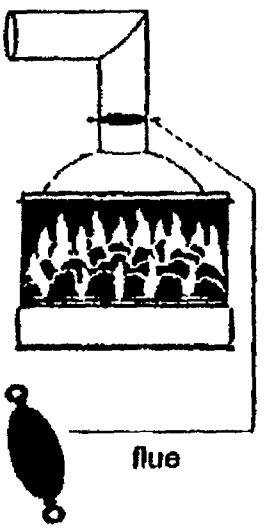
- tighten hinges, sandpaper frames and fix latches so outside windows and doors close properly and stay closed
- seal gaps between the glass and the frame with scotch (on both sides) or putty
- seal cracked glass with two layers of scotch tape on both sides of the glass
- seal the gap between the window and frame and the door and the frame with cardboard or tin folded in a 'V' or with strips of leather, felt or foam
- stop heat loss from under doors by building wooden thresholds and using soil in a tube of material
- use newspaper or foam to fill gaps between floorboards and where the floor joins the wall, use carpets if possible
- if the room is too hot, turn off the heating or reduce the amount of heat instead of opening windows or doors
- to freshen air, leave doors and windows open for only five minutes, two times a day



Switch off!

- turn off lights when rooms are not being used and appliances (such as the TV) if they are not being used

FOR WOOD STOVES ...

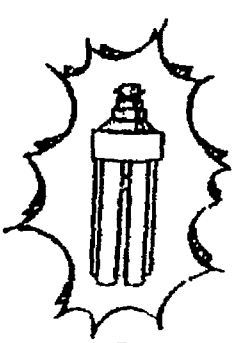


- use dry wood not wet wood as this burns hotter
- once the fire is hot do not fill the stove with wood but add a few pieces at a time to keep it hot
- use an electric fan to blow the heat from the stove into the room so it does not all go up the chimney
- install devices to control air flow so wood will burn hotter and more slowly

MORE EXPENSIVE THINGS TO DO

(all technologies have already been installed in Georgia)

wall insulation



compact fluorescent light bulbs

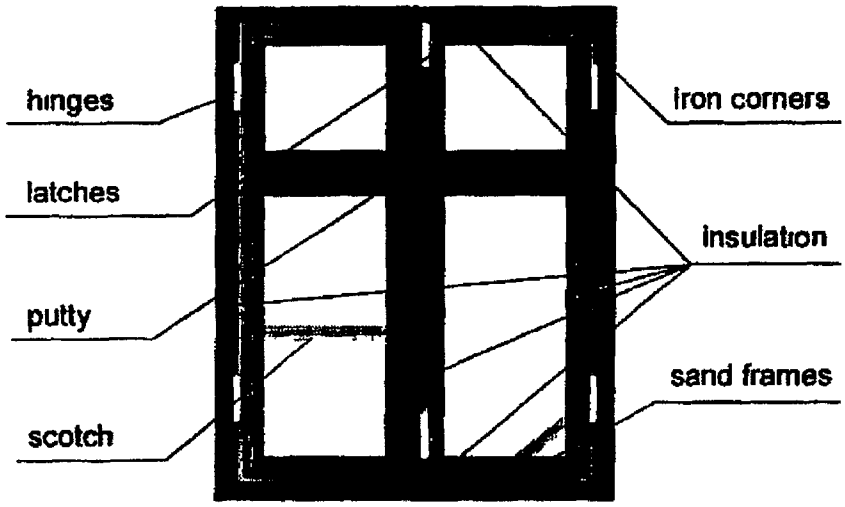
- if you buy a boiler for hot water, buy one with a device (a thermostat) that allows you to control the maximum temperature of the water so it is not kept hotter than needed
- if you install a central heating system, get one with temperature controls on individual radiators and a thermostat
- install double glazing - this can halve the heat loss through windows
- install up to 150mm of insulation material such as mineral wool in ceilings
- clad defective outside walls
- install insulation material in wall cavities
- install carpets with thick underlay
- install energy saving lightbulbs - these are as bright as ordinary bulbs and only use one quarter of the electricity (available in the technical markets)

BUT IT IS EASY HAVE MORE FOR LESS ENERGY

Energy provides us with a service More efficient ways of producing and using energy means

- we need less energy resources to produce the same service
- we can have a higher level of service with the existing amount energy

This technology does not have to be expensive or complicated and can save you money



INTRODUCING THE GEORGIA ENERGY BRIGADES

In houses and flats in Central Europe, up to 50% of generated heat is lost through doors and windows In Georgia, because of the poor state of doors and windows, this can be as high as 70% The Georgia Energy Brigade project uses trained volunteers from Georgia Greens to repair window frames, install glass and putty and to use machines to install silicon insulation strips to seal out the wind and stop heat loss The silicon insulation used will last for 20 years

THE AIMS OF THE PROJECT ARE TO

- provide help for those suffering the most from the lack of energy
- to raise public awareness about the advantages of energy conservation
- to encourage and assist commercial interest in the installation of insulation and the production of the silicon insulation here in Georgia

Temperature increases of up to 5 degrees C were found following two demonstration projects completed by the Georgia Energy Brigades in February 1998, one at a boarding school for children with mental disabilities at Temka, Tbilisi the other at a kindergarten in Akhalsikhe At Akhalsikhe, window repairs and a second pane of glass increased temperatures by 3 degrees, while insulation gave a further increase of 2 degrees At Temka, the overall increase in temperature was between 3 and 4 degrees. The cost of materials for each door or window was US$17 at Akhalsikhe and US$[illegible] at Temka.

For further information on energy saving, and Georgia Energy Brigade installations or to be a Georgia Greens volunteer contact

Tbilisi
Levan Tavartkiladze and Jimi Dabrundashvili
Green House
Mushtaid Park
D Agmashenebeli Ave 182
Tel 35 19 14
Fax 35 16 74

Akhalsikhe
Khatuna Khomladze
Gamrekeli 9
Tel 2 11 00 (h) 2 28 91 (w)

Ilya Beridze
Shevchenko 117

GEB

Printed on the recycled paper

Mission accomplie

Dans le premier numero d **Energies pour le Monde Infos** nous vous presentions le projet alors en cours pour l installation de douches chaudes dans un orphelinat de Tbilissi Quelques mois plus tard les travaux sont termines et les petits pensionnaires peuvent desormais beneficier comme prévu de deux douches ainsi que d eclai rage le soir

Les equipements arrives en Georgie au mois de juin ont pu être installes cet ete et une mission technique de verification a ete conduite fin aout Le grand jour de l inauguration a ete fixe au 1 septembre A cette occasion le Pnud (Programme des Nations unies pour le develop

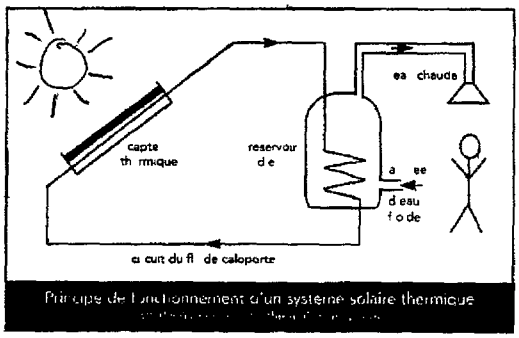
Au premier plan les modules solaires photovoltaïques au second plan les capteurs solaires thermiques

L'ENERGIE SOLAIRE *SOLAR ENERCY*

Il existe deux manieres d'utiliser les rayons du soleil

The use of solar energy can be beneficial in two ways

La conversion thermique/ *By thermal conversion*
en transformant le rayonnement solaire en chaleur
by transforming solar radiation into heat

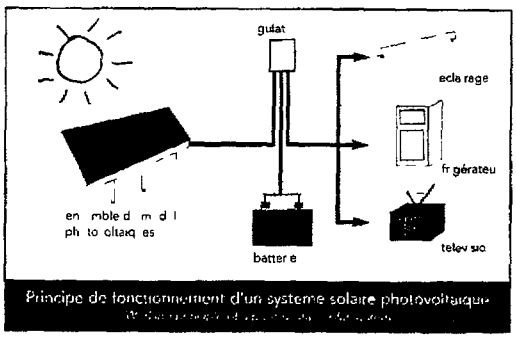


Principe de l fonctionnement d'un systeme solaire thermique

Un materiau absorbant la lumiere piege la chaleur du rayonnement solaire dans un fluide caloporteur c'est un **capteur thermique** Le fluide ne gelant pas meme en hiver il achemine la chaleur vers un réservoir d eau Cette eau ainsi chauffee est utilisee pour des usages domestiques

Light absorbing material traps the he t of the sun s radiation m a heat e changing fluid this is the thermal collector The fluid which doesn't freeze eve w nte di patches the heat to water tank This water heated in this way can the b used for various domestic uses

La conversion photovoltaïque/ *By photovolta c conversion*
en transformant le rayonnement solaire en electricite
by transforming the sola radiation into electricity



Principe de fonctionnement d'un systeme solaire photovoltaïque

Un materiau semi conducteur (constituant principal du **module photovoltaïque**) soumis a un rayonnement solaire libere de l electricite Elle peut etre utilisee directement pour l éclairage l alimentation d un refrigerateur d une television le pompage d eau ou stockee dans des batteries pour un usage ultérieur

S m -conducto m t al (principal compon t of the photovoltaic module) subm tt d to lar ad ti n fre elect city Th ca be d'rectly sed for lighting supplying refri gerator telev sion set, wate pump et o stored batte e to b us d t a l ter time

Approximately 20% of the submitted projects have found a respon se just to give you an idea of the size of the task at hand ! Regarding how our actions develop and spread this simply signifies that the Fondation within a same country concentrates its action human and financial rather than dispersing t Everywhere we go we plead on behalf of a pedagogy of proximity The essential fact remains that in seven years the Fondation has been able to control its growth Today it is not only initiated in numerous projects but it has been able to locally find the necessary relays enabling the installed sites to function without its continued presence

GEORGIA Mission accomplished *In the first issue of* ***Energies pour le Monde Infos*** *we told you about the project that was then underway to install hot showers in an orphanage in Tbilissi Well its a few months later and the work is now completed and as planned the orphans can now use the two showers and the eve ning lighting system*

The equipment arrived in Georgia in June and was able to be ins talled over the summer A technica check mission was performed at the end of August The big inauguration day was set for September 1 The UNDP (Un ted Nations Development Programme) Eneco (the local association) and the Fondation represented by Emmanuelle Jorigr a Head of Projects took part in a joyous celebration including key personalities the children members of NGOs industrialists and an accordionist who was able to create a festive atmosphere equal to the mportance of the even !

Photo In the foreground the photovoltaic array and in the back ground the solar thermal collectors

pement) Eneco (l association locale) et la Fondation Energies pour le Monde representee par Emmanuelle Jorigne, responsable de projets ont participe a une joyeuse manifestation ou se sont retrouves des personnalites des enfants des membres d ONG des industriels et un accordeoniste qui a su creer une ambiance a la hauteur de l evenement ! ■

La cour de l orphelinat de Tbilissi le jour de l inauguration des installations Accompagnes par un accordeoniste les enfants ont chante pour animer la ceremonie *The courtyard of the Tbilissi orphanage on the day of the inauguration of the installations Accompanied by an accordionist the children sang to light up the ceremony in their own way*

Bon à découper et à renvoyer à :

Coupon to be returned to

Fondation Energies pour le Monde - 146, rue de l'Universite, 75007 Paris

Reconnue d utilite publique Decret du 8 mars 1990/*State approved status on March 8 1990*

FAX 331 - 44 - 18 - 00 - 36

Je soutiens les projets de la Fondation et adresse un cheque de

I support the projects of the Foundation and have enclosed a check for the following amount

❑ 200 F ❑ 500 F ❑ 1 000 F ❑ 2 000 F ❑ Autre/*Other*

Nom/*Name* Prenom/*First name*

Adresse/*Address*

Code postal/*Zip code* Ville/*City*

Vous pouvez beneficier d une reduction de vos impots egale a 50 % de votre don dans la limite de 6 % de votre revenu/*You can benefit from a ta reduction of up to 50% of your donation but this sum must not be higher than 6% of your income*

Je recevrai un reçu pour deduction fiscale/*I will receive a certificate of my donation*

Vos coordonnées font l objet d un traitement informatise Vous disposez d un droit d acces a ce fichier et de recti fication conformement a la loi du 6 janvier 1978/*Your address has been recorded onto a data base You have the legal right to view and modify this file in accordance with the law of January 6 1978*

30

Vous avez reçu, au mois de juin, le premier numéro d'**Energies pour le Monde Infos**. Nous vous en avions promis un deuxième cette année : le voici.

Vous y trouverez, comme la première fois, des informations sur nos actions, dans de nombreuses régions du monde. Des propositions de réflexion, aussi. Car la Fondation Energies pour le Monde n'a pas pour seule mission d'intervenir au coup par coup : elle veut être également un lieu d'échange, d'ouverture, de concertation, où puissent s'élaborer des solutions énergétiques pour l'avenir.

Prenons un exemple très actuel, celui de la pollution de l'environnement. Un bien grand mot qui, dans l'esprit occidental, évoque instinctivement l'air chargé d'impuretés des grandes cités ou le "trou" dans la couche d'ozone... Bien sûr, ces problèmes, à l'échelle mondiale, existent et méritent qu'on s'y intéresse. Mais il existe aussi d'autres formes de pollutions, plus sournoises et discrètes, et dont les médias se font bien peu l'écho. Elles concernent pourtant un à deux milliards d'individus, répartis dans les pays du tiers monde. Je pense à la pollution presque occulte qui dégrade insidieusement l'environnement dans des territoires à densité de population très faible. Là, ce ne sont ni les automobiles ni les grands complexes industriels qui sont responsables. Il y a seulement les contraintes qui pèsent sur les villageois et l'absence de solutions à leur portée : ils ont besoin de couper du bois pour cuire leurs aliments sans pouvoir maîtriser l'avenir du hameau lorsque la forêt sera épuisée. Ils consomment parfois l'eau de puits polluée par la présence d'animaux, sans autres choix, malgré les conséquences sur leur santé. Cette pollution, qui nous paraît si minime, ne doit pourtant pas être ignorée, car les populations touchées, qui vivent dans un dénuement extrême, sont très fragiles. Que l'eau du puits soit polluée, que les réserves en bois s'épuisent, et c'est tout un village forcé de déménager plus loin, avec ce que cela suppose d'effets dramatiques pour les personnes les plus faibles.

C'est pour ces populations aux conditions de vie précaires que la Fondation Energies pour le Monde travaille. En mettant à leur disposition une pompe pour un puits ou un cuiseur approprié, la Fondation contribue à maintenir les villages en place, à améliorer les conditions de vie, à limiter les problèmes de santé et, plus largement, à éviter les coupes végétales inutiles ou à mieux respecter les écosystèmes, même les plus humbles. Car l'environnement, on ne doit jamais l'oublier, n'est pas seulement l'affaire des grandes villes industrialisées. Et les problèmes de grande envergure ne doivent pas masquer ceux des zones rurales isolées des pays du Sud. Pour ceux-ci, les solutions sont aujourd'hui connues. Et la Fondation s'est donné pour tâche de les rendre accessibles.

Alain Liébard
Président

A word from the President *In June you received the first issue of* ***Energies pour le Monde Infos*** *At that time we promised you a second issue this year well here it is*

In this one as in the first you ll find information about our actions in numerous regions all over the world You ll find that it contains food for thought as well Because the mission of the Fondation Energies pour le Monde isn t to only make one on one interven tions It also wants be a place for exchange ouverture and concer tation where the energy solutions of the future can be prepared Just consider an example of something that s taking place right now the pollution of the environment A very big word that in the Occidental mind instinctively brings to mind the air charged with impurities of the big cities or the «hole» in the ozone layer Naturally these problems do exist on a planetary level and of course merit that we look into them But other less obvious and more discrete forms of pollution also exist that the media only talk little about And yet two billion people are concerned by this «other» pollution throughout the Third World countries I m thin king of the almost hidden pollution that s insidiously degrading territories that are only little inhabited There aren t any cars or big industrial complexes responsible there in this case There are only the constraints that weigh on the villagers and the absence of solutions that are within their reach They need to cut wood in order to cook their food but it s impossible for them to control the future of the settlement once the forest has been used up They sometimes drink water from wells that have been polluted by the presence of animals without any other choice despite conse quences to their health This pollution seems so minimal to us but it mustn t be ignored because the populations touched by it and living in extreme destitution a e very fragile

The Fondation Energies pour le Monde is working for these people whose living conditions are so precarious By making a pump for a well or an appropriate cooker available to them the Fondation is contributing to keeping the villages in place to improving living conditions tc limiting health problems and to a larger degree by preventing useless vegetal cutting or by better respecting the ecosystems as humble as they may be It should never be forgotten that the er vironment isn t only the concern of the big industrialized cities And the large-scale problems must never hide those of the isolated rural areas of the countries of the South The solutions for them are known today and the Fondation has given itself the job of making these solutions acces sible ***Alain Liebard*** *President*

BEST AVAILABLE COPY