FEASIBILITY STUDY FOR THE IVANO-FRANKIVSK DISTRICT HEATING REPOWERING

Analysis of Options

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1. Executive Summary

As part of the U.S. Initiative on Joint Implementation with the Ukraine Inter-Ministerial Commission on Climate Change, this project was financed by the US Department of Energy. The project was implemented by a team consisting of the US company SenTech, Inc. and the Ukrainian company Esco-West. The main objective of the effort was to assess available alternatives of Ivano-Frankivsk District Heating repowering in the location Industrialna 34 and provide information for I-F's investment decision process. This study provides information on positive and negative technical and economic aspects of available options. Three options were analyzed for technical merit and economic performance:

- Installation of cogeneration system based on Gas Turbine (GT) and Heat Recovery Heat Exchanger with thermal capacity of 30 MW and electrical capacity of 13.5 MW. This Option assumes utilization five existing boilers with total capacity of 221 MW. Existing boilers will be equipped with modern controls. Equipment in this Option was sized for longest operating hours, about 8000 based on the available summer baseload from Industrialna, Symonenka and Dorosenka boiler house regions

- Installation of Gas Turbine Combined Cycle (GTCC) and Heat Recovery Steam Generator (HRSG) with thermal capacity 45 MW and electrical capacity of 58.7 MW. This Option assumes utilization of five existing boilers with total capacity of 221 MW. Existing boilers will be equipped with modern controls. The equipment was sized for medium, shoulder season thermal load, and some cooling was assumed during the summer operation for extension of operating hours for electricity production.

- Retrofit of six existing boilers with total thermal capacity of 255.9 MW by installation of modern control system and minor upgrades. This option assumes only heat production with minimum investment.

All options were compared to the present situation. The current situation without investment was used as a baseline for all other options. Existing boilers and other equipment were assumed to continue operation with increased operation and maintenance costs.

The summary of installed thermal capacity and the installed electrical capacity in all options is shown in the following tables:

		PS	GT	GTCC	NGB
Existing Hot Water Boilers	[MW]	255.9	221.0	221.0	255.9
GT/GTCC	[MW]	0.0	30.0	45.0	0.0
Total	**[MW]**	**255.9**	**251.0**	**266.0**	**255.9**

		PS	GT	GTCC	NGB
GT	[MW]	0.0	13.5	51.2	0.0
0,0	[MW]	0.0	0.0	7.5	
Total	**[MW]**	**0.0**	**13.5**	**58.7**	**0.0**

The options were evaluated according to standard methodology based on specific equipment performance and based on incremental costs and benefits as compared to the present situation. The results are summarized in Exhibit 4-31 and shown in the table below.

Parameter	Unit	Option		
		GT	GTCC	NGB
Investment Cost Total	th.USD	10,433	36,872	1,919
NPV (DR = 0%)	th.USD	12,173	54,644	-1,464
NPV (DR = 5%)	th.USD	4,093	22,069	-1,710
NPV (DR = 10%)	th.USD	-159	4,881	-1,821
NPV (DR = 15%)	th.USD	-2,619	-5,075	-1,880
PBP (DR = 0%)	years	10.6	9.4	-
PBP (DR = 5%)	years	13.1	11.1	-
PBP (DR = 10%)	years	-	15.2	-
PBP (DR = 15%)	years	-	-	-
IRR	[%]	9.75%	12.14%	-

Options GT and GTCC considered repowering the Industrialna 34 plant and introducing the production of electricity. Option NGB considered upgrade of existing equipment and production of heat only.

The best economic performance and the largest investment cost would result from alternative GTCC. This alternative has positive Net Present Value (NPV) with discount rate lower than about 12%, and has IRR slightly above 12%, which is in reasonable range. The NPV remains positive even if investment cost increases by 10%, or when the gas price increases by 10%. However, should the price of electricity sold to the grid be decreased by more than 7% (to $26 per MWh), the NPV of this Option would become negative.

The lowest economic results, and the lowest required investment, would result from alternative NGB. This Option's NPV is negative

even at 0% discount rate, and would not become positive even by improving some parameters within a reasonable range.

The Option with Gas Turbine displays relatively modest results and the NPV is positive for low discount rate, higher price of sold electricity and lower cost of natural gas. The IRR of this alternative is 9.75%, which is not very attractive.

The largest influences on the investment are from the cost of electricity sold to the grid, the heat tariff, and the cost of natural gas. These parameters, especially the price of electricity sold, must be accurately defined prior to any investment's being made.

Assuming the implementation of the GTCC alternative, which produced the best economic results, the benefit of the project is also reflected in lowering Green House Emissions.

Projected annual emissions reduction and the total reduction of emissions over the period until the year 2012 are presented in tables below.

Summary Table: Projected Emission Reductions				
	GHG	***Unit***	***Emission per year***	***Total emission over project life***
A) Baseline scenario	CO_2	t	428 849	8 576 979
	CH_4	t		
	N_2O	t		
	other	t		
	total	t CO_2 eq.	428 849	8 576 979
B) JI project scenario	CO_2	t	267 519	5 350 372
	CH_4	t		
	N_2O	t		
	other	t		
	total	t CO_2 eq.	267 519	5 350 372
C) Effect (B-A)	CO_2	t	- 161 330	- 3 226 608
	CH_4	t		
	N_2O	t		
	other	t		
	total	t CO_2 eq.	- 161 330	- 3 226 608

Projected Emission Reductions during 2008 – 2012 years					
	2008	***2009***	***2010***	***2011***	***2012***
CO_2 emission reductions, t	228,304	219,203	210,102	201,001	191,907
Cumulative effect CO_2 emission reductions, t	**228,304**	**447,508**	**657,610**	**858,611**	**1,050,518**

The implementation of the repowering project will require substantial financial resources, depending on the selected alternative. The

creditworthiness of the city of Ivano-Frankivsk was briefly reviewed for possible loan guaranties by the city. Although the financial standing of the city is satisfactory, there are uncertainties in budget predictions for the future years due to shifting tax rules, and some difficulties to control the budget allocations.

The recommendations include:

?? Defining and documenting the current efficiency of operation for more accurate determination of the impact of investment.
?? Need to determine the cost of electricity sold to the grid, negotiate an agreement, and obtain the highest possible price for electricity sold. This should have the highest priority.
?? Solicit funding institutions for soft, or low-interest loans and grants. (for example Joint Implementation (JI) mechanism)
?? Concentrate on the GTCC alternative, as it has the best results.

2. Introduction

2.1 Objective

This project was funded by the US Department of Energy as part of the U.S. Initiative on Joint Implementation with the Ukraine Inter-Ministerial Commission on Climate Change. The objective of the effort was to assist the Ivano-Frankivsk Teplocomunenergo, the District Heating Company, to resolve their problems with heat and power production. The Industrialna 34 plant, originally designed and operated as a Combined Heat and Power Plant, is now used only for heat production. The distribution system is interconnected with two other boiler houses, and summer heat supply for domestic water heating is provided from Industrialna 34 plant. This project's objective is to assess CHP upgrades in three available Options, including heat-only production, use of gas turbine, and use of combined cycle system. The investment size, economic performance and practicality was be evaluated and compared to the existing situation. This information will help the management decide about plant repowering.

2.2 Approach

The assessment approach is based on standard evaluation methods used for heat and power production and for District Heating Systems. The existing condition and operating characteristics of the system are documented, and assessment is made of the equipment's useful life and need for upgrade. The heat load forecast used for system capacity sizing and the potential for electricity sales are determined based on historical data, current and future local development. A list of available options is reviewed and, based on their practicality, applicability, expected performance and investment costs, several best candidates are selected for further evaluation. For this project, the three options involving Natural Gas Boilers, Gas Turbine, and Combine Cycle based on gas turbine were selected for detailed evaluation.

The sizing is an iterative process that considers the heat load, desired annual operating hours, investment size, and other parameters. The objective is to size the equipment for the most economical performance. For the analysis, parameters of specific equipment (turbines, e.g.) characteristics were used. Results may change slightly if other equipment is selected, but the relative comparison of the alternatives will not change.

The economic analysis is performed iteratively with the technical assessment. For this project, the method of incremental cost and benefits was used. All three evaluated options were compared to the present situation, and only differences in investment, operating costs and benefits were considered. This method was used because the existing equipment has substantial remaining life and it is currently in operation.

2.3 Region

The Ivano-Frankivsk Region is situated in the southern west part of Ukraine on the division of large natural geographic territories - East-European plain and Ukrainian Carpathian Mountains. It borders such regions of Lviv, Ternopil, Chernivtsy, Zacarpatska and also the Republic of Romania. The total area of the region is 13.9 thousand square km (2.3 % of Ukraine's territory). An important natural resource of the Ivano-Frankivsk Region is its forests; 606.5 thousand hectares are covered by forests. Woodlands make up 43.5% of the Region, in comparison with the average forested area of Ukraine of 14%. The Ivano-Frankivsk Region are also has oil and gas resources of the Carpathian oil province.

The Ivano-Frankivsk region is an area with beautiful nature and rich resources. There are 160 deposits of 24 kinds of useful minerals. Non-ore mineral resources are represented by considerable deposits of potassium salts, and also there are beds of magnesium salts. The deposits of kitchen salt in Bolehiv and Dolyna are of considerable importance for the whole country. But the main industry is the fuel and energy complex, which produces more than a half of the Region's economic output.

The Region's administrative system consists of 14 districts, 15 towns (5 under regional and 10 under district jurisdiction), 24 townships of urban type and 765 villages. Regional population is 1460.6 thousand inhabitants (2.9 % of Ukraine's population), including 43.4 % in urban areas and 56,6 % villages. The average population density is 105 inhabitants per 1 square km. The administrative center – the City of Ivano-Frankivsk – is located about 600 km west of Ukraine's capital Kiev and covers 38.9 sq. km (0.3 % of region's territory). With 237 thousand inhabitants (17.2 % of regional population), Ivano-Frankivsk has a high intellectual potential and a high level of professional background of the labor force.

Compared with the beginning of 1990's, the economic situation of the city is improving after the great recession that hit all Eastern European countries in 1989-91. Output of light industry has increased more than twice compared to 1995. Basic machine-building industries also started to enlarge their production. The food retail industry, the largest component of city industry, is also

planning substantial production expansion. Significant growth is beginning in the sphere of small business and tourism.

2.4 Participants

Ivano-Frankivsk Teplocomunenergo, the recipient of the study, provided all data and information and was instrumental in supporting the effort and reviewing assumptions and interim results. Esco-West, an Ivano-Frankivsk Engineering and consulting firm, provided assistance with data collection, logistical support, and performed the majority of the economic assessment. SenTech, Inc. provided overall guidance and performed part of the technical and economic assessment. The participants of the project, including contacts, are listed in Exhibit 2-1.

Exhibit 2-1 Project Participants

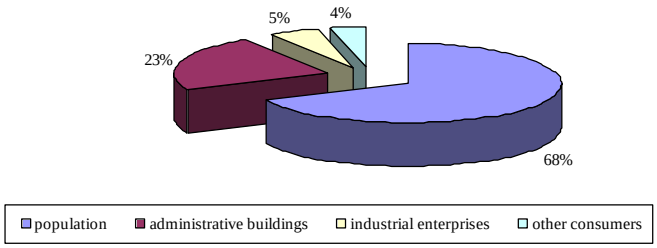
Description	Participant	Participant	Participant
Name of	Ivano-Frankivsk Teplokomunenerg	SENTECH,	Energy Service "ESCo
Function within	Project	Project	Project
Street	59a Bogdana Khmelnickogo	4733 Bethesda Ave, #608	67 Galytska str. Of.
Zip Code	76006	MD 20814	76019
City	Ivano-	Bethesda	Ivano-
Country	Ukraine	USA	Ukraine
Contact	Chukhniy, Bogdan Mikhalovic	Markel, Lawrence & Popelka, Andrew	Korzhik, Mykola,
Job title	Director	Vice-Pres. & Proj. Mgr.	President
Direct tel	+38 03422	+301 654-7224	(+380 3422) 7-60-
Direct fax	+38 03422	+301 654-7832	(+380 3422) 4-81-
Direct E-		LMarkel@sentech.org	info@escowest.co

3. System Description

Ivano-Frankivsk Teplocomunenergo is a municipal communal enterprise that was founded in 1966. It is the only supplier of heat for most of the heat consumers in the city, with almost 80% of the city population provided with the thermal energy by the Ivano-Frankivsk DH system. The rest of the population (mostly private sector) is provided with heat by individual heating systems or by stoves. The DH system provides a limited amount of steam and hot water to industrial enterprises. Teplocomunenergo also provides services such as repair of boilers and other heating equipment, works associated with connections of new customers, accounting and payment collection. The company has 1,107 employees, which represents 4.3 people per 1000 of population. 60 % of the 167 engineering and administrative personnel have higher education, and 40% have vocational education.

The District Heating system in Ivano-Frankivsk is comprised of five Heating Districts with 34 boiler houses and a total of 142 natural gas-fired boilers with a total capacity of 677 Gcal. Annual heat delivery from all boiler houses was 562 Tcal in year 2000. Consumers of heat energy are comprised of residential population (68.44%), administrative, communal and other buildings (22.73%), industrial enterprises (5.23%), and other consumers (3.6%). The distribution of heat energy consumption among consumer classes is shown in Exhibit 3-1

Exhibit 3-1 Heat Consumption Users



The age and condition of the boilers and equipment represents a mixture of older boilers built in the late 60's and early 70's, as well as boilers built recently. Most of the boiler houses work autonomously, in their own distribution network. The total length of distribution 4-pipe system in all districts is 133,3 km. The list of boilers by capacity is presented in Exhibit 3-2.

Exhibit 3-2 List of boilers according to capacity

Capacity, Gcal/hr	No. of Boiler Houses	Total capacity, Gcal/hr
Less than 3	13	24.94
From 3 to 20	16	132.45
From 20 to 100	6	224.9
More than 100	1	308
Total	**36**	**690.29**

The DH system produces only heat and purchases all electricity needed for the plant, substations and distribution pumps' operation from the grid. On average, the three locations considered in this project need about 8.7 GWh annually, out of which about half, or 4.3 GWh, is consumed by the Industrialna 34 plant. The electricity consumption intensity is about 5 kWh per GJ of heat produced, and represents about 5% of the cost of heat. The electricity consumption during the last three years in all three locations is presented in Exhibit 3-3.

Exhibit 3-3: Electricity consumption in all three locations

Year	Doroshenka 28			Symonenka 3			Industialna 34			Total		
	[MWh]	[GJ]	[kWh/GJ]	[MWh]	[GJ]	[kWh/GJ]	[MWh]	[GJ]	[kWh/GJ]	[MWh]	[GJ]	[kWh/GJ]
1998	1,739	353,410	5	5,324	1,086,965	5		0		7,063	1,440,375	5
1999	1,646	310,554	5	4,736	935,559	5	4,493	819,753	5	10,875	2,065,865	5
2000	1,109	198,765	6	3,326	563,697	6	4,304	1,209,295	4	8,739	1,971,757	4
Avg.			**5**			**5**			**4**			**5**

The alternatives investigated by this project were in these three locations. The boilers in these plants are presented in Exhibit 3-4.

Exhibit 3-4: List of Existing Boilers in all three locations

Existing Boilers										
	Unit	Total	Boiler Number							
Doroshenka 28			1	2	3	4				
Type			TVG-8.3	TVG-8.3	TVG-8.3	TVG-8.3				
Year of installation			1975	1975	1980	1985				
Capacity	[Gcal/hour]	33.2	8.3	8.3	8.3	8.3				
Capacity	[MW]	38.6	9.7	9.7	9.7	9.7				
Efficiency	[%]		87.8	87.8	87.8	87.8				
Medium			HW	HW	HW	HW				
Symonenka 3			1	2	3					
Type			PTVM-30	PTVM-30	PTVM-30					
Year of installation			1973	1985	1986					
Capacity	[Gcal/hour]	90.0	30.0	30.0	30.0					
Capacity	[MW]	104.7	34.9	34.9	34.9					
Efficiency	[%]		87.4	87.4	87.4					
Medium			HW	HW	HW					
Industrialna 34			1	2	3	4	5	6	7	8
Type			PTVM-30	PTVM-30	PTVM-30	PTVM-30	KVGM-100	UKEP-5	UKEP-5	TP-35U
Year of installation			1975	1975	1976	1976	1990	1951	1952	1961
Capacity	[Gcal/hour]	308.0	30.0	30.0	30.0	30.0	100.0	25.0	25.0	38.0
Capacity	[MW]	358.2	34.9	34.9	34.9	34.9	116.3	29.1	29.1	44.2
Efficiency	[%]		87.4	87.4	87.4	87.4	87.2	87.2	87.2	87.2
Medium			HW	HW	HW	HW	HW	Steam 3.4 MPa, 410 °C		

3.1 Plant Industrialna

The heat distribution network for plant Industrialna34 has a total length of 38.058 km, including 34.901 km of heat distribution system and 3.157 km of hot water distribution system. The chemical treatment used in this plant is Na-cation type. The temperature of exhaust gases from the existing boilers is in the range of 130-160 ?C. The plant is also equipped with three steam boilers with total capacity of 165 t/hr of steam. These boilers are not considered for further use in any of the assessed alternatives. The turbine generator set equipment was dismantled and the facility has sufficient space to accept equipment for all assessed alternatives. The interior of the plant is depicted in Exhibit 3-5

Exhibit 3-5 Inside view of Industrialna 34 Plant control room

3.2 Heat Load Projection

The heat load projections used to size the system for all alternatives were based on monthly heat load recorded during the past three years, 1998 through 2000, in each location. The total monthly heat delivery to consumers by the entire DH system in Ivano-Frankivsk during the 1998-2000 period, classified by residential, municipal and other consumers, is presented in Exhibit 3-6, and the complete historical data on fuel consumption, heat delivery and heat loses are in Appendix A.

Exhibit 3-6: Heat Delivered to Consumers 1998-2000

Realization of heat to consumers in Ivano-Frankivsk, Gcal												
Month	1998				1999				2000			
	Total	including groups			Total	including groups			Total	including groups		
		household	town budget	other		household	town budget	other		household	town budget	other
January	***97,928***	63,572	9,684	24,672	***98,043***	67,674	6,836	23,533	***149,651***	90,531	9,619	49,501
February	***81,252***	53,676	6,933	20,643	***84,383***	58,228	7,003	19,152	***106,249***	57,814	6,973	41,462
March	***87,894***	59,070	7,552	21,272	***76,501***	54,739	4,981	16,781	***95,163***	51,013	6,044	38,106
April	***41,800***	29,402	3,145	9,253	***46,994***	31,983	1,917	13,094	***45,566***	20,856	2,742	21,968
May	***26,884***	19,519	2,388	4,977	***31,891***	24,580	583	6,728	***5,613***		11	5,602
June	***6,571***	3,928	410	2,233	***6,537***	4,672	125	1,740	***513***			513
July	***17,633***	13,358	558	3,717	***959***	254	67	638	***436***			436
August	***7,930***	4,403	384	3,143	***15,132***	12,241	141	2,750	***529***			529
September	***19,318***	15,483	594	3,241	***22,878***	17,727	291	4,860	***487***		5	482
October	***42,786***	30,377	3,687	8,722	***58,978***	42,144	3,073	13,761	***5,712***	3,857	568	1,288
November	***87,250***	59,058	6,328	21,864	***116,877***	75,235	7,103	34,539	***59,112***	37,523	4,248	17,342
December	***131,394***	87,541	7,792	36,061	***139,868***	89,118	8,307	42,443	***93,017***	61,423	6,022	25,572
Total	**648,638**	**439,386**	**49,455**	**159,797**	**699,040**	**478,594**	**40,427**	**180,019**	**562,049**	**323,017**	**36,231**	**202,802**

This project evaluated the re-powering options only for a selected part of the DH system consisting of three locations – Symonenka, Doroshenka and Industrialna. These three locations can be interconnected for the summer DHW delivery from only one location. Industrialna 34 facility is the optimal location, offering infrastructure and space. The summary of past heat deliveries from these three locations for the period 1998-2000 is presented in Exhibit 3-7.

Exhibit 3-7: Heat Supply Summary from the evaluated locations

Heat Supply Summary For All Locations									
Year	Amb. temp. [°C]	Fuel [m3]	Heat production [Gcal]	Heat realization [Gcal]	Heat delivery [Gcal]	Fuel [GJ]	Heat production [GJ]	Heat realization [GJ]	Heat delivery [GJ]
Doroshenka 28									
1998		11,767,818	84,410.7	82,755.7	75,239.6	401,546	353,410	346,481	315,013
1999		10,493,760	74,174.6	72,507.9	65,474.6	358,072	310,554	303,576	274,129
2000	7.4	6,801,267	47,474.3	46,091.5	37,070.3	232,075	198,765	192,976	155,206
Avg. efficiency:							**87.0%**		
Avg. losses:								**2.3%**	**11.7%**
Symonenka 3									
1998		35,672,426	259,617.4	251,889.9	221,237.4	1,217,228	1,086,965	1,054,611	926,276
1999		30,549,333	223,454.6	215,454.9	194,834.5	1,042,416	935,559	902,065	815,732
2000	7.4	19,428,005	134,636.9	130,715.4	108,185.8	662,930	563,697	547,279	452,952
Avg. efficiency:							**88.5%**		
Avg. losses:								**3.2%**	**12.3%**
Industialna 34									
1998		0	0.0	0.0	0.0	0	0	0	0
1999		27,500,054	195,794.9	193,189.6	161,450.4	938,367	819,753	808,845	675,960
2000	7.4	40,440,853	288,835.4	284,786.9	231,212.4	1,379,938	1,209,295	1,192,344	968,039
Avg. efficiency:							**87.5%**		
Avg. losses:								**1.4%**	**17.8%**
Total									
1998		47,440,244	344,028.1	334,645.6	296,477.0	1,618,774	1,440,375	1,401,092	1,241,288
1999		68,543,147	493,424.1	481,152.4	421,759.4	2,338,855	2,065,865	2,014,486	1,765,820
2000	7.4	66,670,125	470,946.5	461,593.8	376,468.5	2,274,943	1,971,757	1,932,599	1,576,196
Avg. efficiency:							**87.9%**		
Avg. losses:								**2.4%**	**14.3%**

The total heat supplied (at the exit from the plant) from all three sources (Doroshenka 28, Symonenka 3, Industrialna 34) is expected to be 2,157 TJ/year, approximately at the same level as it was in year 2000, adjusted for irregularities in space and domestic hot water (DHW) heat supply. This heat load includes the domestic water heating during the summer months. During the summer, DHW is assumed to be provided from Plant Industrialna 34 through the existing network interconnection. The predicted heat delivery at each location for the first year of operation is shown in Exhibit 3-8.

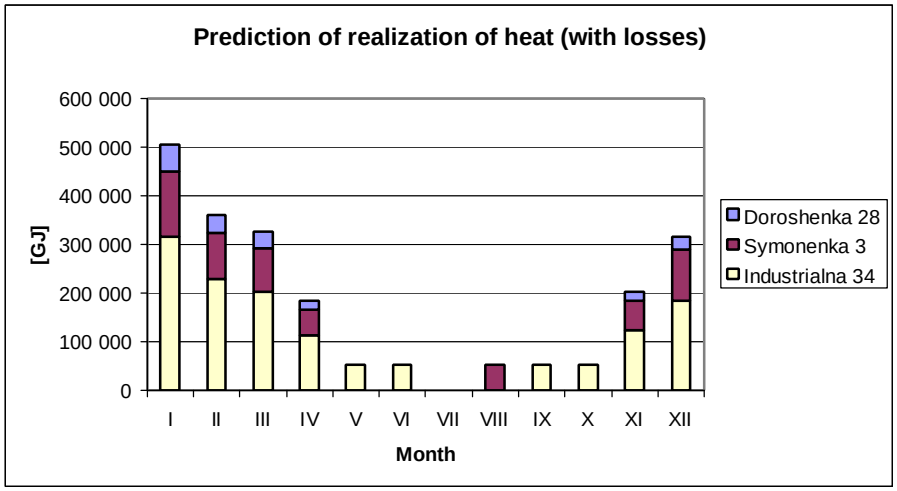
Exhibit 3-8: Heat and Capacity Demand Forecast

Estimated Heat and Capacity Demand								
Location	Heat					Predicted		
	Max. [MW]	1998 [GJ]	1999 [GJ]	2000 [GJ]	[hr/year]	Heat [GJ]	Operation [hr/year]	Capacity [MW]
Doroshenka 28	38.6	346,481	303,576	192,976	1,388	187,167	1500	34.7
Symonenka 3	104.7	1,054,611	902,065	547,279	1,452	587,839	1500	108.9
Industialna 34	279.1	0	808,845	1,192,344	1,187	1,381,991	1500	255.9
Total	**422.4**	**1,401,092**	**2,014,486**	**1,932,599**	1,271	**2,156,997**		399.4

Annual heat supply forecast is shown for all three locations on a monthly basis in Exhibit 3-9. It is assumed that during July, the system will have a maintenance shutoff and heat will not be supplied.

If this period will be shorter or will not be required, the economics of the investment will improve slightly.

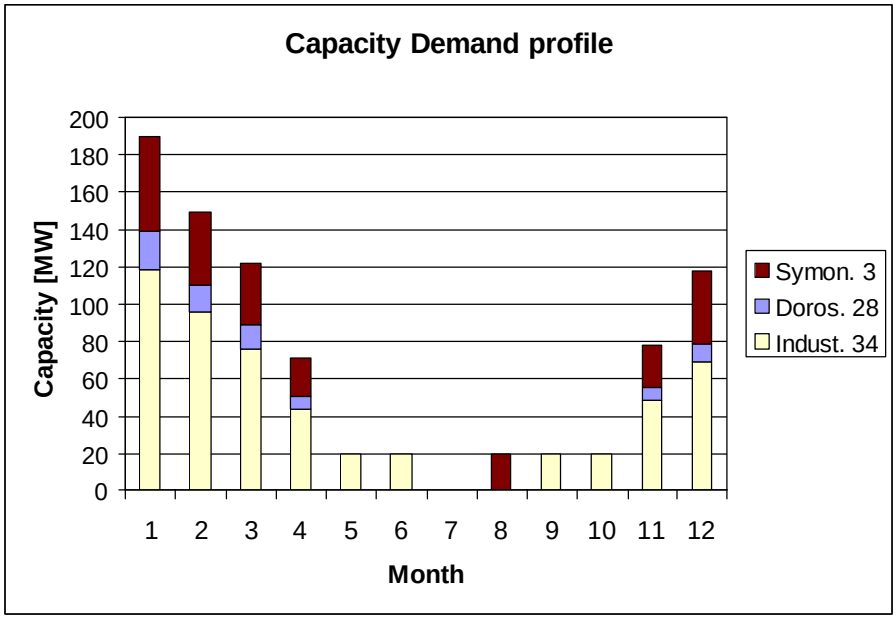
Exhibit 3-9: Annual Heat load forecast for DH system



Doroshenka 28	187 167 GJ
Symonenka 3	587 839 GJ
Industrialna 34	1 381 991 GJ
Total	**2 156 997 GJ**

Based on heat load forecast, average heating capacity requirements were assessed and are presented in Exhibit 3-10. The size of the installed equipment for the alternatives was based on this profile.

Exhibit 3-10: Capacity demand profile



3.3 Tariffs and Billing

The process of establishing tariffs

In Ukraine a process of price establishment for heat-supply services begins with determining the cost of 1Gcal of realized heat. The cost of a Gcal includes normative expenses on salary, depreciation and taxes, as well as forecasted expenses for other items such as fuel, electricity, materials, credits, etc. The sum of given expenses is then divided by expected heat production, thus arriving at cost per Gcal. Tariffs also include profit, which is calculated based on a given profitability level. The profit is calculated on the basis of the sum of expenses (but not on the basis of the enterprise's income). Marginal profitability levels are determined for each consumer category. For Teplocomunenergo, starting from March of 1999, town authorities set profitability levels for all consumer categories. Typical profit levels for residential consumers are 10%, for budget organizations - 5%, and for commercial enterprises - 20%. The profit is determined by multiplying cost of a Gcal by the corresponding profitability level (for each consumer category).

A value added tax (VAT) of 20% is added to the sum of the cost and profit for each consumer category. Thus, the calculated tariff for each consumer category is the sum of one Gcal's cost, profit and VAT.

Consumption Norms

Charges for heat and hot water supply for those consumers who do not have meters are set based on consumption norms, calculated according fixed formulas. Norms on heating are based on the size of the heating area in square meters, while norms on hot water are based on the number of people living in the apartment. For residences, the heating payment is calculated as the product of multiplying the tariff rate by the amount of the heated area's square meters by the corresponding heat consumption norm. The payment for hot-water supply is calculated by multiplying the consumption norm per person by the number of people in apartment. Those users who have installed meters pay in accordance with the meter reading. But most people have no meters to measure heating and hot water consumption. At the same time other consumer categories, such as commercial enterprises and administrative establishments, pay in accordance to the meter's rates.

Social Issues

To provide acceptable conditions for comfortable work and living environments, it is necessary to increase the reliability of the heat supply and simultaneously provide for necessary temperature

modes in space heating and domestic hot water systems. Decreasing the number of emergency situations by correcting existing defects in heating systems will increase the labor productivity of the heat supply enterprise. The proposed project will have a positive and tangible effect on the population living in a building that is supplied by heat from the centralized heating system.

4. Evaluation of Options

This chapter provides information on selection of options, summarizes technical assumptions used for the evaluation, describes options evaluated, and provides results of the technical and economical assessment.

4.1 Selection of Options

A range of options has been reviewed and three were selected for assessment and comparison to the current situation (referred to as Option "PS" – Present Situation) in order to accomplish the following objectives:

Investigate commercially viable technologies applicable to Ivano-Frankivsk District Heating system, the section comprising plants Industrialna 34, Symonenka 3, and Dorosenka 28.

Investigate improvements in efficiency and economy of operation, and Investigate environmental impact improvements in the plant by the considered options.

The selected options are also intended to satisfy the demands of Ivano-Frankivsk DH System management, potential investors and lending institutions regarding the depth of investigation. The repowering options for the DH section were selected and agreed upon with the DH company management, with emphasis on expected economic and environmental impact and with respect to:

?? Practicality of the implementation, considering the real situation in heat demand and electricity sales potential
?? Utilization of existing equipment, the distribution network and its interconnection capabilities
?? Minimizing the investment costs

4.2 Technical Assumptions

Location

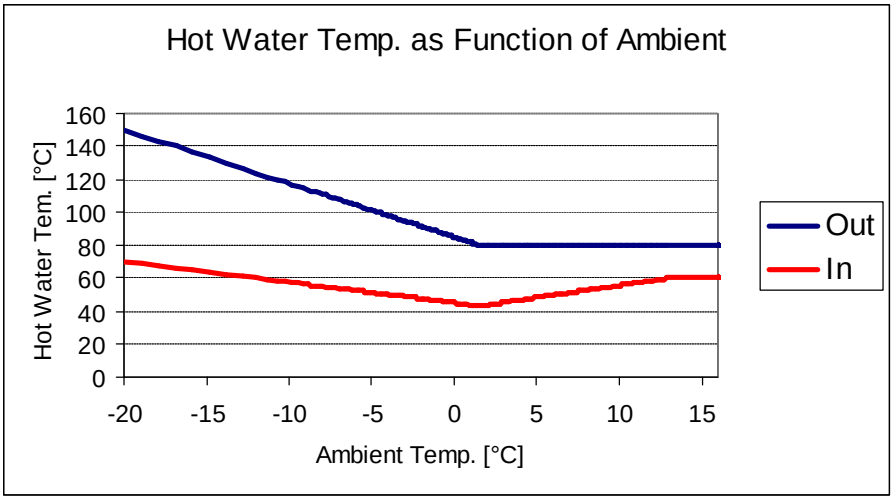
The assessment of options was applied only for the three locations that are already interconnected to the distribution system – locations Industrialna 34, Dorosenka 28 and Symonenka 3. Due to practical reasons, such as different operational characteristics (pressure, temperatures, pump capacities, etc), these areas are interconnected only for the summer operation, at which time the heat for Domestic Water Heating is supplied only from one location – Industrialna 34 – and the other two location are shut down. During the winter months, each location operates independently.

The location Industrialna 34 is by far the largest source, having facilities, including buildings, with sufficient space available for GT or GTCC installation, location for heat recovery steam boiler or heat recovery hot water boiler (HRSG, HRHWB), substations and heat exchangers, and other appropriate equipment and controls. The facility also has the capability to export electricity to the distribution grid, and has an external space for the electrical switch yard location. It was assumed that buildings and infrastructure for options constructed at this location will not require substantial investment.

Heating Water Temperature and Duration Curve

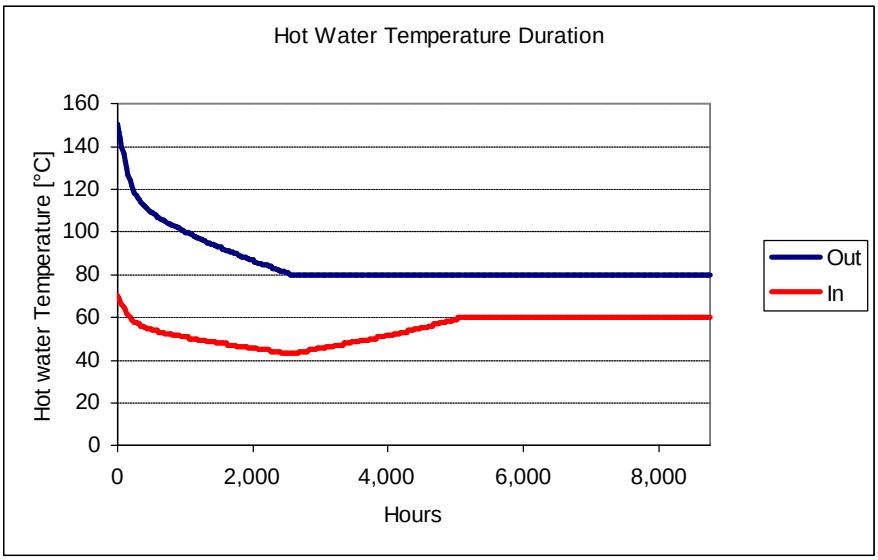
The heat supply to the District Heating system will remain as a hot water system. The "equithermic" characteristics of the media will be based on local weather data and load characteristics set by the historical data. The water temperature provided by the source as a function of the ambient temperature is shown in Exhibit 4-1.

Exhibit 4-1: Hot water temperature as function of ambient temperature



The heat duration curves for the water temperature are presented in Exhibit 4-2. For the summer operation, supply water temperature remains constant at 80 C and return temperature is at 60 C.

Exhibit 4-2: Temperature duration Curve



Optimization of Installed Capacity

In general, optimization of equipment size for each Option is an effort to balance the size of equipment with lowest relative investment cost ($/kW), highest efficiency (lowest relative fuel consumption) and longest operating hours (highest energy production). The size of cogeneration equipment is driven mainly by the required/expected winter heat load profile and the DHW heat load during the summer season. Assuming the summer heat supply for domestic water heating for the three locations (Symonenka, Dorosenka and Industrialna) is combined at one plant, the required heat capacity is 20 MWt.

In both cogeneration alternatives (GT and GTCC), the resulting efficiency and operating hours were sufficiently high and reasonable, thus positively influencing the economic results.

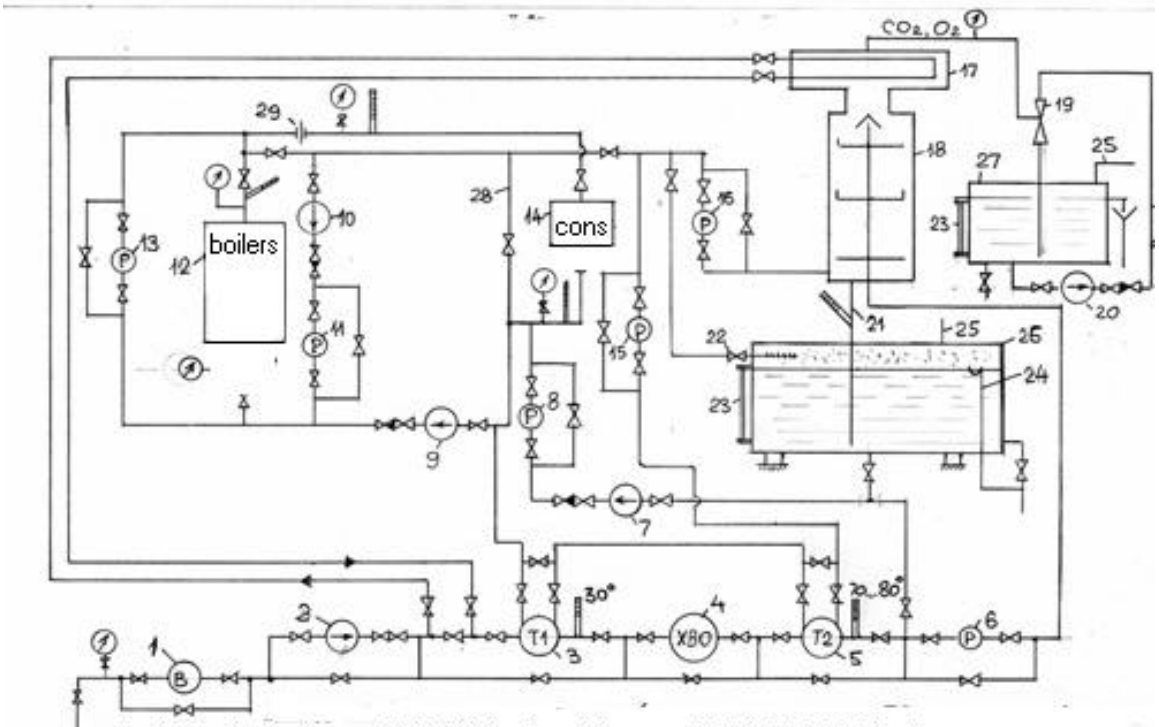
4.3 Description of Options

The repowering of the Industrialna 34 Plant was evaluated in three alternatives that were compared to the existing situation (Present Situation Option “PS”). Following is a description of all alternatives and parameters of equipment:

4.3.1 Option 1: Present Situation "PS":

The Option “Present Situation” represents the existing status and condition of equipment without any investment. This alternative serves as a basis for comparison of alternatives. It is assumed that the existing equipment will be operated “as is” and the repair and maintenance costs in Industrialna 34 will increase gradually, doubling over the evaluated period. The technological scheme of Industrialna 34 is shown in Exhibit 4-3.

Exhibit 4-3: Technological scheme of existing plant Industrialna 34



Technological scheme of BH with boilers of the type ТВГ, КВГ, ПТВМ with parameters 150-170 C & vacuum deaeration (BHs Industrianla,34; Symonenka, 3)

4.3.2 Option 2: Gas Turbine "GT"

This Option assumes installation of a gas turbine (GT) with electrical capacity of 13.5 MW and 20 MWt exhaust gas heat recovery hot water heat exchanger with 10 MWt after-heating burner for peak handling. This alternative assumes upgrade of selected existing boilers. The Gas Turbine Generator capacity of 13.5 MWe resulted in the highest overall efficiency, 7000-7,500 hours/year of operation time, optimal nominal fuel consumption and high electricity production. However, all parameters are functions of final selection of turbine type and manufacturer and will change somewhat depending

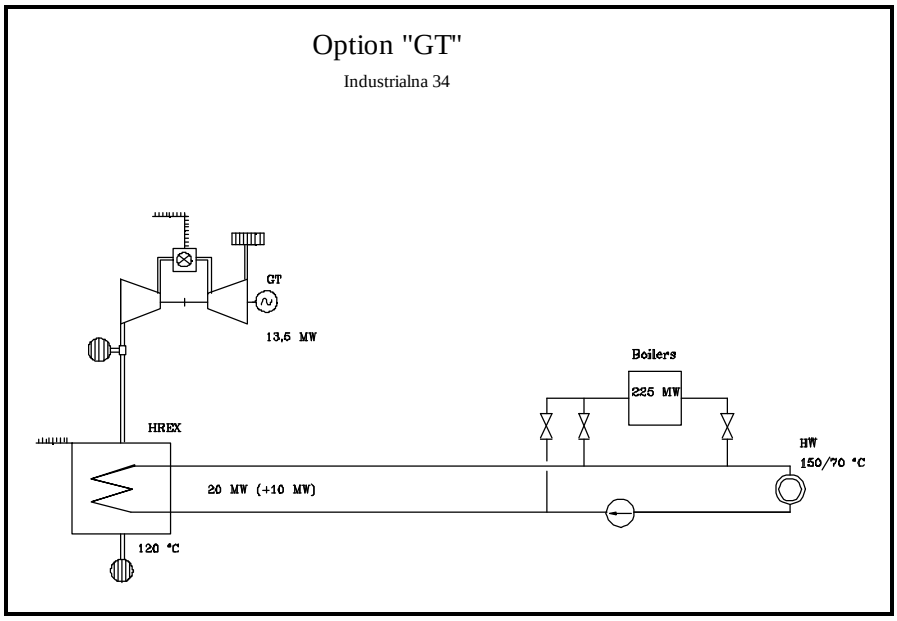
on this selection. The parameters presented in Exhibit 4- 4 were achieved by this option.

Exhibit 4-4: Parameters of GT Option:

Fuel consumption:	1 055 863 GJ
Net electricity supplied:	93 166 MWh
Net heat supply:	533 761 GJ
Net electric efficiency:	31.8 %
Net total efficiency:	82.3 %

Smaller GT would result in comparable efficiency but lower production of electricity and therefore higher relative investment cost. Larger GT with higher thermal capacity than is required for the summer load (20 MW) would have to operate with reduced capacity, with exhaust of hot gases through by-pass, or by employing the cooling system. Such arrangements would reduce the overall efficiency during the summer. Another possibility would be to reduce the operating hours when the load is insufficient, and thus reduce the electricity production. The scheme of this Option is presented in Exhibit 4-5 below.

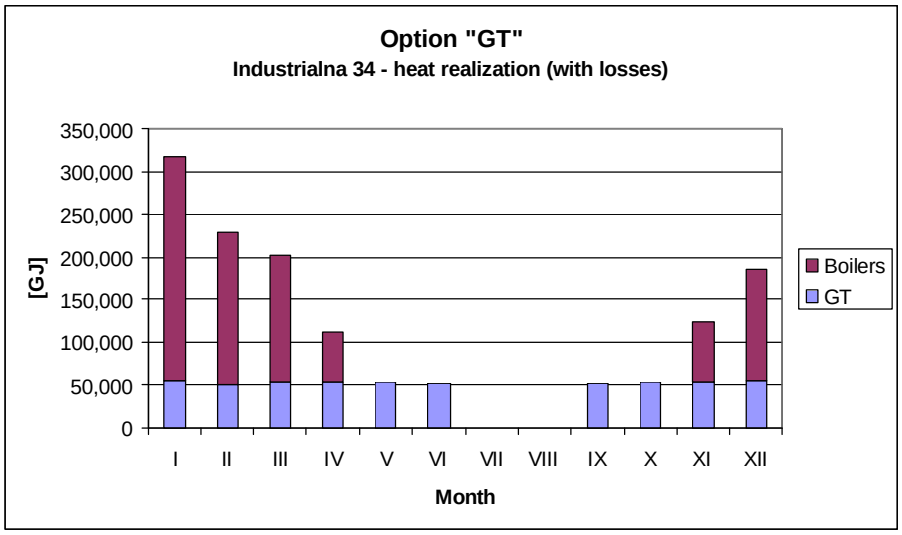
Exhibit 4-5: Option GT Scheme.



With the intent to maximize the annual operating hours of the new equipment, the Gas Turbine size was based on a cumulative average heat capacity requirement from three interconnected locations – Dorosenka 28, Symonenka 3 and Industrialna 34 for DHW supply during the summer. During the year 2001, all three

locations were already interconnected and DHW was supplied from Industrialna 34. Since the DHW was not supplied regularly over the last three years, it was assumed that the DHW will be supplied regularly in all three areas during the summer, except for one month of summer maintenance, probably during the month of July. The exhaust gas heat recovery hot water heat exchanger of about 20 MW was sized to cover the base load heat supply for all three locations, representing summer heat delivery of about 51,000-53,000 GJ/month. The summer peak demand of about 30 MWt will be covered by an additional 10 MW after-heater gas burner. The nominal after-heater burner capacity (fuel) will be 13 MWt. In this arrangement, the corresponding electrical capacity of the gas turbine is 13.5 MWe and annual operating hours of the system will be 7,000 to 8,000 hours. The heat production in Industrialna 34 plant in this option is shown in Exhibit 4-6.

Exhibit 4-6: Heat Production in Industrialna 34:



The parameters of equipment selected for this Option are summarized in Exhibits 4-7 through Exhibit 4-11 below. Exhibit 4-7 shows the main parameters of the Gas Turbine Titan 130 selected for the evaluation. For comparison, other similar GT and their parameters are shown in Exhibit 4-8.

Exhibit 4-7: Parameters of Gas Turbine (ISO):

Type:	Titan 130
Manufacturer:	Solar Turbines
Installed Capacity:	13.5 MW
Efficiency:	33.297 %
Flue Gas Qty:	49.9 kg/s
Flue Gas Temperature:	490.6 °C

Exhibit 4-8: Alternative Types of Gas Turbines

Manufacturer	Type	El. Capacity	Efficiency	Flue Gas Qty.	Flue Gas
		[MW]	[%]	[kg/s]	[°C]
Alstom	Cyclone	12.9	34.77	39.4	555.0
Solar Turbines	Titan 130	13.5	33.30	49.9	490.6
GE	LM1600	14.8	31.67	49.9	489.4
Rolls-Royce	Avon	14.6	28.21	78.5	441.7
Alstom	GT 35	17.0	32.20	92.1	374.0

Although the exact conditions of installation can be determined only by a detailed design of associated equipment and piping, for this assessment the pressure drops shown in Exhibit 4-9 were estimated.

Exhibit 4-9: Installation Site Assumption:

Suction Pressure Drop:	1 kPa
Exhaust Pressure Drop:	3 kPa
Elevation:	244 a.s.l.

Exhibit 4-10: Parameters of Flue Gas Heat Recovery Hot Water Boiler (at 15 °C):

Thermal Capacity	20 MW
Flue Gas Qty	49 kg/s
Flue Gas temperature, entering	500 C
Flue Gas Temperature, leaving	120 C
Hot Water Temperature Gradient	80/60 C
After Heat Burner Capacity	13 MW
Total heat Capacity (with afterheat)	30 MW

This option assumes that four out of the total of eight existing boilers PTVM-30 (1975-1976) and one boiler KVGM-100 (1990), with total capacity of 221 MW, will be upgraded by the new control system and will remain in operation. Other boilers will not be upgraded, and the cost of removal is not included in the economic assessment. The list of boilers and their parameters is presented in Exhibit 4-11.

Exhibit 4-11: Parameters of Gas Boilers:

Industrialna 34						
Boiler Number			**1**	**3**	**4**	**5**
Type			PTVM-30	PTVM-30	PTVM-30	KVGM-100
Year of installation			1975	1976	1976	1990
Capacity	[Gcal/hour]	190.0	30.0	30.0	30.0	100.0
Capacity	[MW]	221.0	34.9	34.9	34.9	116.3
Efficiency	[%]		87.4	87.4	87.4	87.2
HW parameters	C		150/70	150/70	150/70	150/70

4.3.3 Option 3: Gas Turbine Combined Cycle "GTCC"

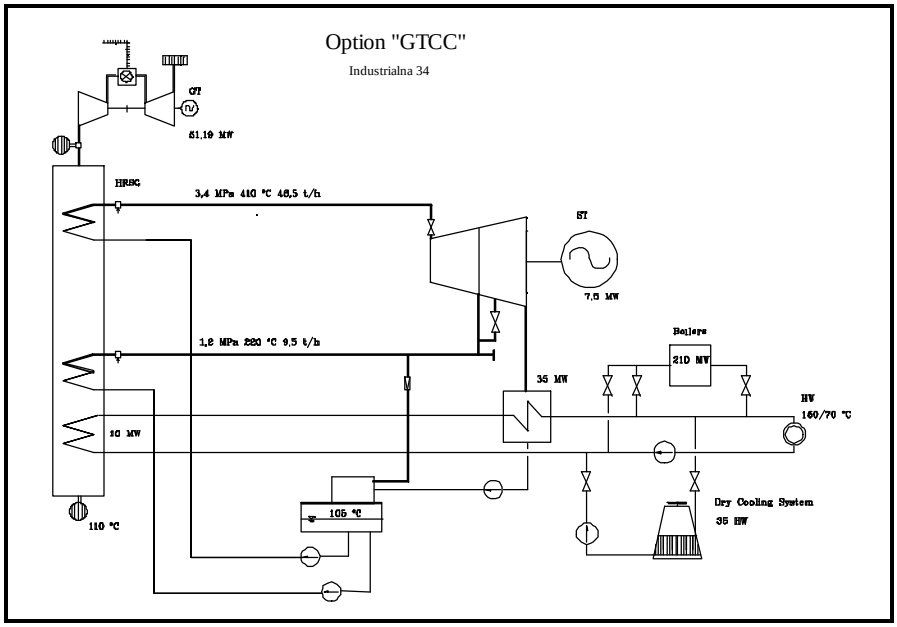
This alternative assumes installation of a Gas Turbine with electric generator capacity of 51.2 MWe, double pressure Heat Recovery Steam Generator (HRSG) without afterheat, backpressure steam turbine with two pressure levels with electric generator capacity of 7.5 MWe, heat exchanger station, and dry cooling system for operation in condensing mode. This option also assumes upgrade of selected existing boilers. The equipment size in this option was selected with the same philosophy as in “GT” option, except that this option assumes use of a cooling system for a period of time during the shoulder season. GTCC with backpressure steam turbine was selected for its simple arrangement. The parameters resulting from this option are summarized in table in Exhibit 4-12.

Exhibit 4-12: Main Parameters of GTCC Option

Fuel consumption:	3 886 234 GJ
Net electricity supplied:	416 627 MWh
Net heat supply:	895 222 GJ
Net electric efficiency:	45.8 %
Net total efficiency:	72.6 %

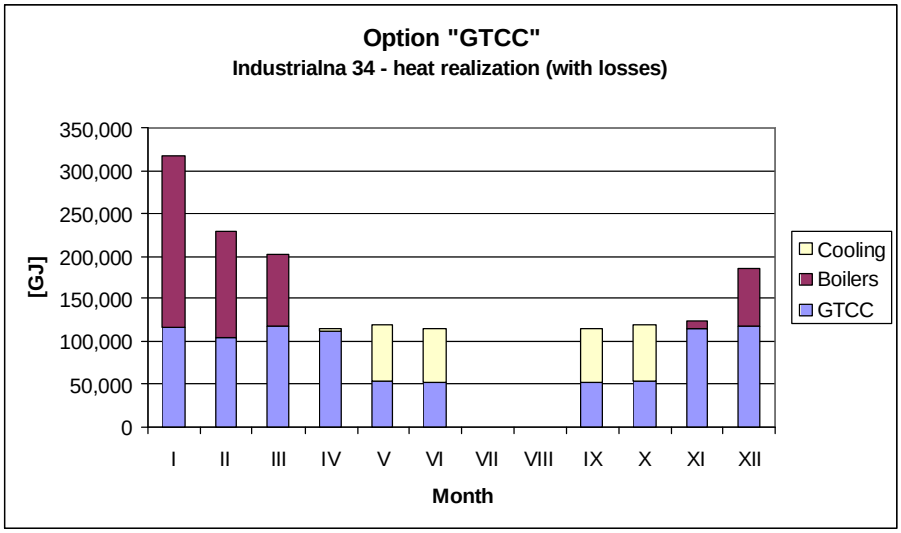
The system Scheme for the GTCC Option depicting the main components is shown in Exhibition 4-13

Exhibit 4-13: Option CCGT scheme



The thermal capacity of the GTCC was specified based on average capacity demand in the Industrialna 34 plant at the shoulder season (beginning and the end of the heating season) of year 2000. The thermal capacity is distributed between the heat exchanger (35 MW) in backpressure of Steam Turbine and the hot water heat exchanger in HRSG (10 MW) that cools the exhaust gases down to 110 C. The corresponding gas turbine has an electrical capacity of 51.2 MWe and the steam turbine has an electrical capacity of 7.5 MW. In order to operate the system during the lower summer demand, the GTCC is equipped with a dry cooling system with cooling capacity of 35 MW. This will allow the system to operate about 7,000 to 8,000 hour annually. The heat production in Industrialna 34 plant in this option is shown in Exhibit 4-14.

Exhibit 4-14: Heat Production in Industrialna 34



The main parameters of equipment for this Option are presented in Exhibits 4-15 through Exhibit 4-22 as follows.

Exhibit 4-15: Parameters of Gas Turbine (ISO):

Type:	Trent
Manufacturer:	Rolls-Royce
Installed Capacity:	51.19 MW
Efficiency:	41.571 %
Flue Gas Quantity:	159.2 kg/s
Flue Gas Temperature:	427.7 °C

Exhibit 4-16: Installation Site Assumptions:

Suction Pressure Drop:	1 kPa
Exhaust Pressure Drop:	3 kPa
Elevation:	244 a.s.l.

Exhibit 4-17: Alternative Types of Gas Turbines

Manufacturer	Type	El. Capacity [MW]	Efficiency [%]	Flue Gas QTY [kg/s]	Flue Gas [°C]
GE	PG6581(B)	42.1	32.07	141.1	548.3
Alstom	GTX100	43.0	37.00	122.5	546.0
GE	LM6000	43.1	41.37	131.0	450.0
Siemens	W251B11/12	49.5	32.66	175.1	513.9
Westinghouse					
Rolls-Royce	Trent	51.2	41.57	159.2	426.7
Alstom	GT 8 C	52.8	34.41	179.2	517.0

Exhibit 4-18: Parameters of Heat Recovery Steam Generator (HRSG) at 15 C:

Total Thermal Capacity	53 MW
Flue Gas Qty	153 kg/s
Flue Gas Entering Temperature	431 C
Flue Gas leaving temperature	110 C
H-P Steam pressure	3.4 MP
H-P Steam Temperature	410 C
H-P Steam Qty	46.5 t/hr
L-P Steam Pressure	1.2 Mpa
L-P Steam temperature	220 C
L-P Steam Qty	9.5 t/hr
Feed Water Temperature	105 C
Hot Water Heater Capacity	10 MW

Exhibit 4-19: Parameters of Steam Turbine at 15 C:

Installed Electric Capacity	7.5 MWe
H-P Steam Pressure	3.4 Mpa
H-P Steam Temperature	410 C
H-P Steam Qty	46.5 t/hr
L-P Steam Pressure	1.2 Mpa
L-P Steam Temperature	220 C
L-P Steam Qty	8.5 t/hr
Backpressure	0.054 Mpa
Thermal gradient of Hot Water	80/60 C

Exhibit 4-20: Parameters of Heat Exchanger Station

Installed capacity	35 MW
Steam Pressure	0.12 Mpa
Nominal Water temperature	100/60 C

Exhibit 4-21: Parameters of Dry Cooling System

Installed Capacity	35 MW
Nominal Water Temperature	80/60 C

This option assumes that four out of the total of eight existing boilers PTVM-30 (1975-1976) and one boiler KVGM-100 (1990), with total capacity of 221 MW, will be upgraded by a new control system and will remain in operation. Other boilers will not be upgraded, and the cost of removal is not included in the economic assessment. The list of boilers is presented in Exhibit 4-22

Exhibit 4-22: Parameters of Gas Boilers:

Industrialna 34						
Boiler Number			**1**	**3**	**4**	**5**
Type			PTVM-30	PTVM-30	PTVM-30	KVGM-100
Year of installation			1975	1976	1976	1990
Capacity	[Gcal/hour]	190.0	30.0	30.0	30.0	100.0
Capacity	[MW]	221.0	34.9	34.9	34.9	116.3
Efficiency	[%]		87.4	87.4	87.4	87.2
HW parameters	C		150/70	150/70	150/70	150/70

4.3.4 Option 4: Natural Gas Boilers "NGB"

This Option assumes production of heat in existing gas-fired boilers without electricity production. Since the existing boilers PMVT-30 with 34.9 MW capacity, and the boiler KVGM-100 with capacity of 116.3 MW, are in reasonably good technical condition and have substantial remaining life, their continuous use was assumed and only minor repairs are assumed. Installation of control systems on all five boilers was assumed. The total boiler capacity of 255.9 MW would then be available. No other investment is included. The boilers in this option are listed in Exhibit 4-23.

Exhibit 4-23: Parameters of Gas Boilers

Industrialna 34							
Boiler Number			**1**	**2**	**3**	**4**	**5**
Type			PTVM-30	PTVM-30	PTVM-30	PTVM-30	KVGM-100
Year of installation			1975	1975	1976	1976	1990
Capacity	[Gcal/hour]	220.0	30.0	30.0	30.0	30.0	100.0
Capacity	[MW]	255.9	34.9	34.9	34.9	34.9	116.3
Efficiency	[%]		87.4	87.4	87.4	87.4	87.2
HW parameters	C		150/70	150/70	150/70	150/70	150/70

4.3.5 Comparison of the Characteristics of Options Evaluated

A summary of installed thermal capacity in Industrialna 34 for all options is presented in Exhibit 4-24. The total thermal capacity in all

options was approximately the same; the variation in total heat capacity is mostly due to sizes of existing and available equipment.

Exhibit 4-24: Installed thermal capacity for all Options (without steam boilers)

		PS	GT	GTCC	NGB
Existing Hot Water Boilers	[MW]	255.9	221.0	221.0	255.9
GT/GTCC	[MW]	0.0	30.0	45.0	0.0
Total	**[MW]**	**255.9**	**251.0**	**266.0**	**255.9**

Note: In Options GT and GTCC, one more existing hot water boiler with capacity of 34.9 MW is available, but this boiler will not be upgraded with a new control system.

The summary of installed electric capacity in the options evaluated is presented in Exhibit 4-25. The size of electric generating capacity is determined by the heat output in each option and by the specific equipment selected; it will be slightly different for different selected turbines, depending on their specifications and characteristics.

Exhibit 4-25: Installed Electric Capacity in all Options:

		PS	GT	GTCC	NGB
GT	[MW]	0.0	13.5	51.2	0.0
ST	[MW]	0.0	0.0	7.5	0.0
Total	**[MW]**	**0.0**	**13.5**	**58.7**	**0.0**

The absolute values and incremental values of operating parameters in each option in Industrialna 34 plant are presented in Exhibit 4-26. Total values for all three locations are given in Exhibit 4-27.

Exhibit 4-26: Operating Parameters in Industrialna 34

Industrialna 34		Absolute Values				Incremental Values		
		PS	GT	GTCC	NGB	GT	GTCC	NGB
Fuel consumption - total	[GJ]	1,594,244	2,011,461	3,886,234	1,556,921	+417,217	+2,291,991	-37,322
Fuel consumption - GT	[GJ]		1,055,863	3,337,852		+1,055,863	+3,337,852	±0
Fuel consumption - boilers	[GJ]	1,594,244	955,598	548,383	1,556,921	-638,646	-1,045,861	-37,322
Heat production - total	[GJ]	1,401,229	1,401,229	1,866,268	1,401,229	±0	+465,039	±0
Heat production - HRSG/HREx	[GJ]		541,191	1,372,724		+541,191	+1,372,724	±0
Heat production - boilers	[GJ]	1,401,229	860,038	493,544	1,401,229	-541,191	-907,685	±0
Heat own consumption	[GJ]	19,238	19,238	25,620	19,238	±0	+6,382	±0
Heat for Steam Turbine	[GJ]			198,807		±0	+198,807	±0
Heat dry cooling	[GJ]			259,850		±0	+259,850	±0
Heat realization	[GJ]	1,381,991	1,381,991	1,381,991	1,381,991	±0	±0	±0
Electricity production - total	[MWh]	0	95,067	433,386	0	+95,067	+433,386	±0
Electricity production - GT	[MWh]		95,067	384,199		+95,067	+384,199	±0
Electricity production - ST	[MWh]			49,187		±0	+49,187	±0
Electricity own - electricity	[MWh]		1,901	8,668		+1,901	+8,668	±0
Electricity own - heat	[MWh]	6,075	6,075	8,091	6,075	±0	+2,016	±0
Electricity balace	[MWh]	-6,075	87,091	416,627	-6,075	+93,166	+422,702	±0
Electricity delivery	[MWh]	0	87,091	416,627	0	+87,091	+416,627	±0
Electricity demand	[MWh]	6,075	0	0	6,075	-6,075	-6,075	±0

Exhibit 4-27: Operating Parameters, Total for all three plants

Total		Absolute Values				Incremental Values		
		PS	GT	GTCC	NGB	GT	GTCC	NGB
Fuel consumption - total	[GJ]	2,500,532	2,917,749	4,792,522	2,463,209	+417,217	+2,291,991	-37,322
Fuel consumption - GT	[GJ]		1,055,863	3,337,852		+1,055,863	+3,337,852	±0
Fuel consumption - boilers	[GJ]	2,500,532	1,861,886	1,454,671	2,463,209	-638,646	-1,045,861	-37,322
Heat production - total	[GJ]	2,199,921	2,199,921	2,664,960	2,199,921	±0	+465,039	±0
Heat production - HRSG/HREx	[GJ]		541,191	1,372,724		+541,191	+1,372,724	±0
Heat production - boilers	[GJ]	2,199,921	1,658,730	1,292,236	2,199,921	-541,191	-907,685	±0
Heat own consumption	[GJ]	42,924	42,924	49,306	42,924	±0	+6,382	±0
Heat for ST	[GJ]			198,807		±0	+198,807	±0
Heat dry cooling	[GJ]			259,850		±0	+259,850	±0
Heat realization	[GJ]	2,156,997	2,156,997	2,156,997	2,156,997	±0	±0	±0
Electricity production - total	[MWh]		95,067	433,386		+95,067	+433,386	±0
Electricity production - GT	[MWh]		95,067	384,199		+95,067	+384,199	±0
Electricity production - ST	[MWh]			49,187		±0	+49,187	±0
Electricity own - electricity	[MWh]		1,901	8,668		+1,901	+8,668	±0
Electricity own - heat	[MWh]	10,215	10,215	12,232	10,215	±0	+2,016	±0
Electricity balance	[MWh]	-10,215	82,950	412,487	-10,215	+93,166	+422,702	±0
Electricity delivery	[MWh]	0	82,950	412,487	0	+82,950	+412,487	±0
Electricity demand	[MWh]	10,215	0	0	10,215	-10,215	-10,215	±0

4.4 Capital and Operating Cost Development

Capital and operating costs were estimated for each option.

4.4.1 Capital Cost Development

The capital costs for each option were estimated on the basis of individual technology or plant modifications and standard investment values used in industry in Eastern Europe. These estimates, on an individual unit basis, were then applied to each of the options and each of the units that were modified as part of the respective option.

Estimates for the options that included combined cycle plants were developed by applying the cost estimating model that is part of the combined cycle design software. The results were modified to reflect the specific scope and location of the units, with adjustments for local labor and materials and partial costs for the repowering cases. The costs of the Gas Turbine option were based on manufacturer's price information and assessment of the cost of modifications necessary for the installation. Capital cost results in 2004 US$ are presented in Exhibit 4-28.

Exhibit 4-28: Capital Costs of Ivano-Frankivsk DH Repowering Options

Option	Description	Capital Cost, 1,000 US$ (year 2004)
1	Present Situation	None
2	Option Gas Turbine "GT"	10,433
3	Option Gas Turbine Combined Cycle "GTCC"	36,872
4	Option Natural Gas Boilers "NGB"	1,919

4.4.2 Operating and Maintenance Cost Development

Operating & maintenance costs were based on input from Ivano-Frankivsk DH plant for existing facilities. Estimates for new facilities were developed by SenTech project staff. For this comparative analysis it was assumed that the costs will remain constant during the life of the project. For actual operating cost analysis, it would be necessary to develop reasonable escalation ratios for each cost, but for the purpose of comparing available options, escalation of costs would not significantly affect the relative advantage of each alternative.

4.5 Economic Analysis of Options

4.5.1. Fundamental Approach

The economic assessment of the investment was performed based on discounted cash flow over the 20 year analysis period. The project was assessed costs with respect to the origin and cost of the capital, tax consequences (investor's view), and use of constant prices based on year 2002. It was assumed that the location "Industrialna 34" is an independent economic subject consisting of

existing equipment supplemented by new equipment for each option evaluated (GT, GTCC, NGB).

The incremental costs and benefits of each alternative (GT, GTCC and NGB) were compared to the existing situation "Option PS" (Present Situation). Therefore only the differences between the existing situation and each alternative were considered in each category for investment and operating costs. This incremental cost and benefit approach was considered to be the most appropriate, as it considers not only the performance of a new investment, but also its influence on economic performance of existing equipment. The evaluated alternatives are then compared to the total performance of Industrialna 34 location.

For the incremental cost and benefit assessment, the following cash flow parameters were included:

(–) share of own investment
(–) construction period interest capitalization
(+) depreciation
(+) net profit
(–) loan payments

The evaluated economic metrics included Net Present Value (NPV), Discounted Cash Flow (DCF) based on applicable discount rate, Payback period (PBP), and Internal Rate of Return (IRR).

4.5.2 Economic Analysis Inputs and Assumptions

Most inputs for the economic assessment were provided by the DH plant management and municipal staff. Some information was collected by the project team. Assumptions related to economic parameters used, such as discount rate, project life, etc., were consistent with typical values used and accepted on other similar projects.

Escalations of parameters were assumed only between the present time and the startup year (2004). After commissioning, all the prices and values were considered as constant. The model is reflecting cost differences in individual costs (maintenance, salaries, etc.) between each alternative and alternative "PS".

The economic analysis assumes that the project will be implemented in Industrialna 34 Plant and that the Symonenka and Dorosenka locations will be supplied with heat during the summer through existing interconnections of the distribution piping system. Exhibit 4-29 presents a complete list of inputs and assumptions used for the calculations.

Exhibit 4-29: Economic Inputs and Assumptions

Construction period:	2 years
1st. year of construction:	2004
1st. Year of operation:	2006
Evaluation period:	20 years of operation
Currency used for economic analysis:	USD
Currency Exchange ratio UAH/USD:	5.6 (today is 5.3)
Currency Exchange ratio SKK/USD	48
Type of Depreciation of Investment:	linear
Depreciation period:	20 years
Discount Rate:	Perform for 5%, 10% 15%
Percent of OWN investment:	35 % of total
Percent of LOAN in investment:	65 % of total
Loan life (repayment period of loan):	5 yrs (least) and 8 yr (highest) cost
Grace period (delay of payments)	same as construction time = 2year
Interest (bank):	12 %
Tax on Profit:	30 %
Average price of Natural Gas (34,1 MJ/m^3):	55.00 USD/th.m^3
Average heat price – at :	3.29 USD/GJ (in 12/2001)
Average price for electricity:	37.18 USD/MWh
Average SALE price of electricity (to grid):	28.0 USD/MWh market
	21.7 USD/MWh from Burshtinskaya
Average cost of de-mineralized water:	1.19 USD/m3 (in 2001)
Current cost of water:	0.1028 USD/GJ (in 2001)
Current maintenance cost:	0.235 USD/GJ (in 2001)
Current cost of emission fees:	0.0001 USD/GJ (in 2001)
Current Other costs :	221724 USD (in 2001)
Current Salary cost:	736547 USD (in 2001)
Current number of employees (in all categories:	1107
Cost of Maintenance of GT/ GTCC:	4 /2 USD/MWh
Cost of maintenance for new gas boilers:	0.1 USD/GJ
Emissions Fees for GT and new gas boilers:	0.005 USD/GJ, fuel
Investment cost for GT (13,5 MW) + HREx:	700 000 USD/MW
Investment cost for GTCC (51,2 + 7,5 MW):	650 000 USD/MW
Investment cost for gas boilers:	55 000 USD/MW
Number of new employees for GT + HREx:	25
Number of new employees for GTCC:	35
2001 Cost of natural gas	4,010,414 USD w/o VAT
	4,812,497 USD with VAT
2001 Cost of Water	299,840.61 USD w/o VAT
	359,808 USD with VAT
2001 Cost of Maintenance	852523 USD
2001Cost of Emissions	2,289 USD
2001 Salary	736,547 USD
2001 Other Costs	221,724 USD w/o VAT
	300,144 With VAT
2001 total expenses of Teplocomunenergo	7,558,920 USD

4.5.3 Financial Analysis Results

The analysis and results provide a relative comparison between the three options and the present situation. The preliminary results for Options 1 through 3, in Ivano-Frankivsk, in Industrialna 34 plant, involving the summer load from Symonenka and Dorosenka plants, are shown in Exhibit 4- 30.

Exhibit 4-30: Economic Analysis Results

Parameter	Unit	Option		
		GT	GTCC	NGB
Investment Cost Total	th.USD	10,433	36,872	1,919
NPV (DR = 0%)	th.USD	12,173	54,644	-1,464
NPV (DR = 5%)	th.USD	4,093	22,069	-1,710
NPV (DR = 10%)	th.USD	-159	4,881	-1,821
NPV (DR = 15%)	th.USD	-2,619	-5,075	-1,880
PBP (DR = 0%)	years	10.6	9.4	-
PBP (DR = 5%)	years	13.1	11.1	-
PBP (DR = 10%)	years	-	15.2	-
PBP (DR = 15%)	years	-	-	-
IRR	[%]	9.75%	12.14%	-

Option GTCC appears to have the highest investment cost and also the best Net Present Value and IRR. Option GT rates second with its investment cost, NPV and IRR. It is apparent that the option's economic performance with discount rates greater than 10% is not satisfactory, and the NPV is negative. The possible solutions for performance improvement are discussed in Chapter 6 – Conclusions and Recommendations – of this report. The diagrams presenting the cumulative cash flow and cumulative discounted cash flows for all alternatives for discount rates of 0% (real analysis), 5%, 10% and 15% are presented in Exhibits 4-31 through 4-33.

Exhibit 4-31: Cash Flow, Option GT

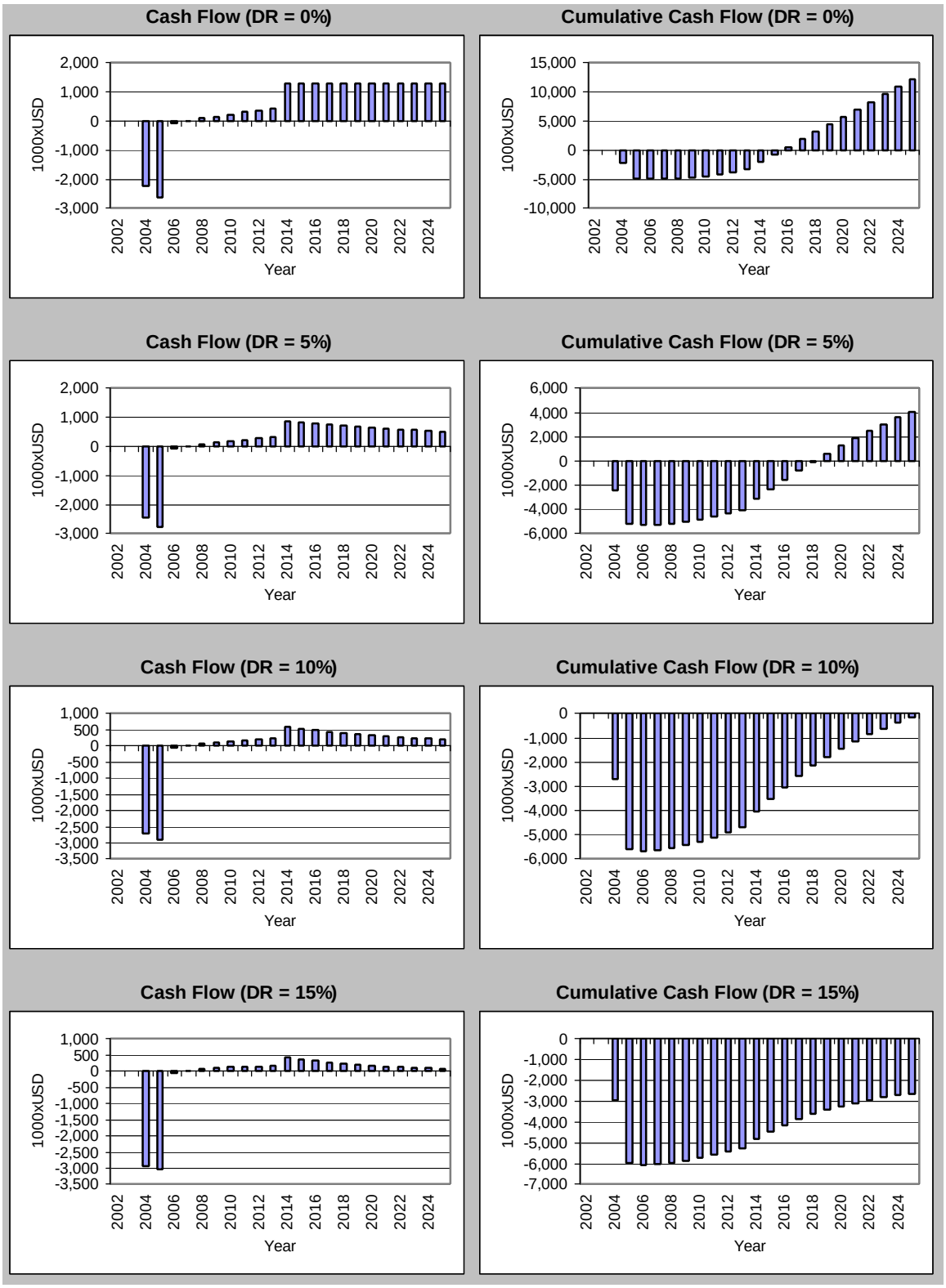


Exhibit 4-32: Cash Flow, Option GTCC

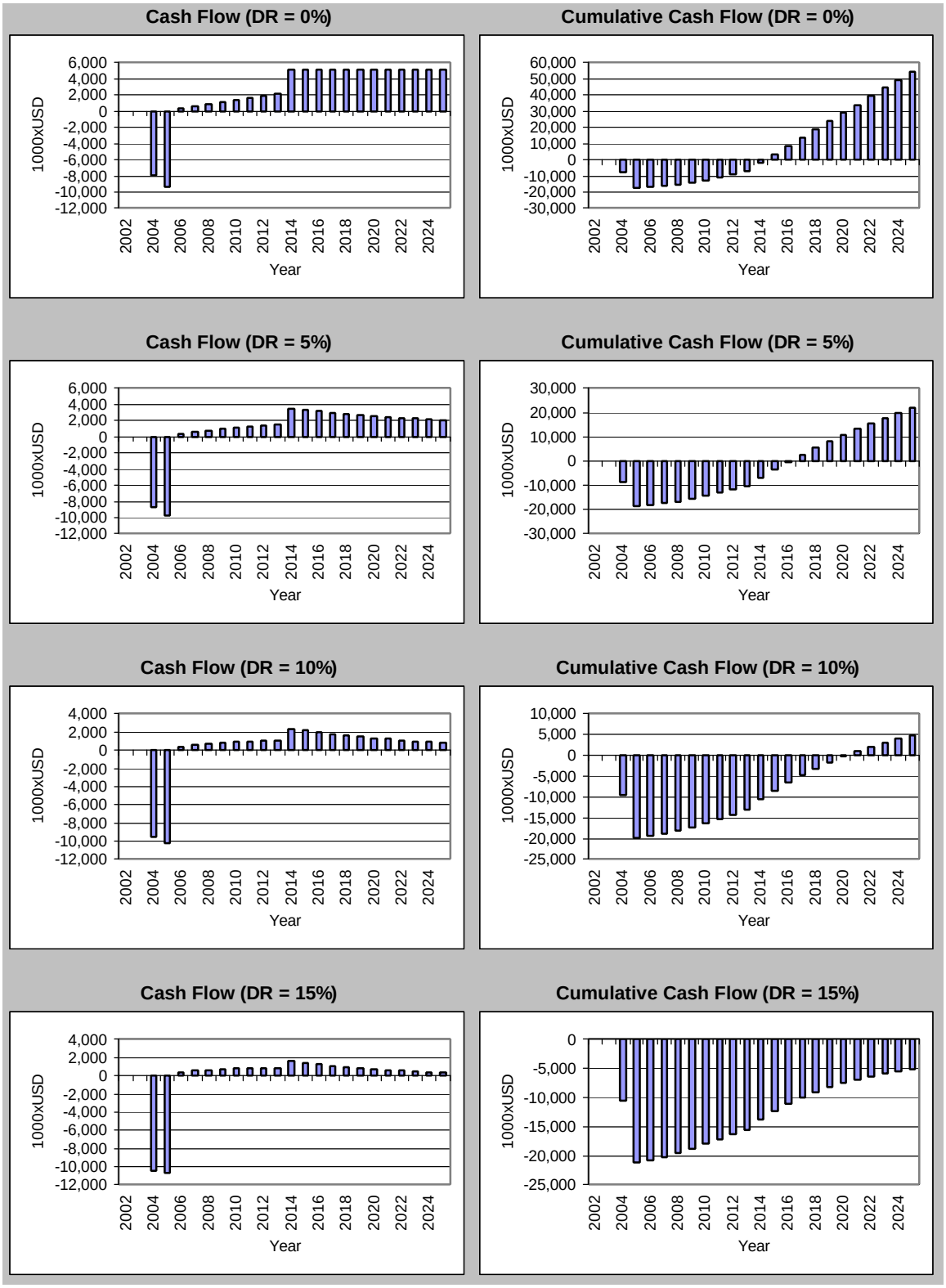
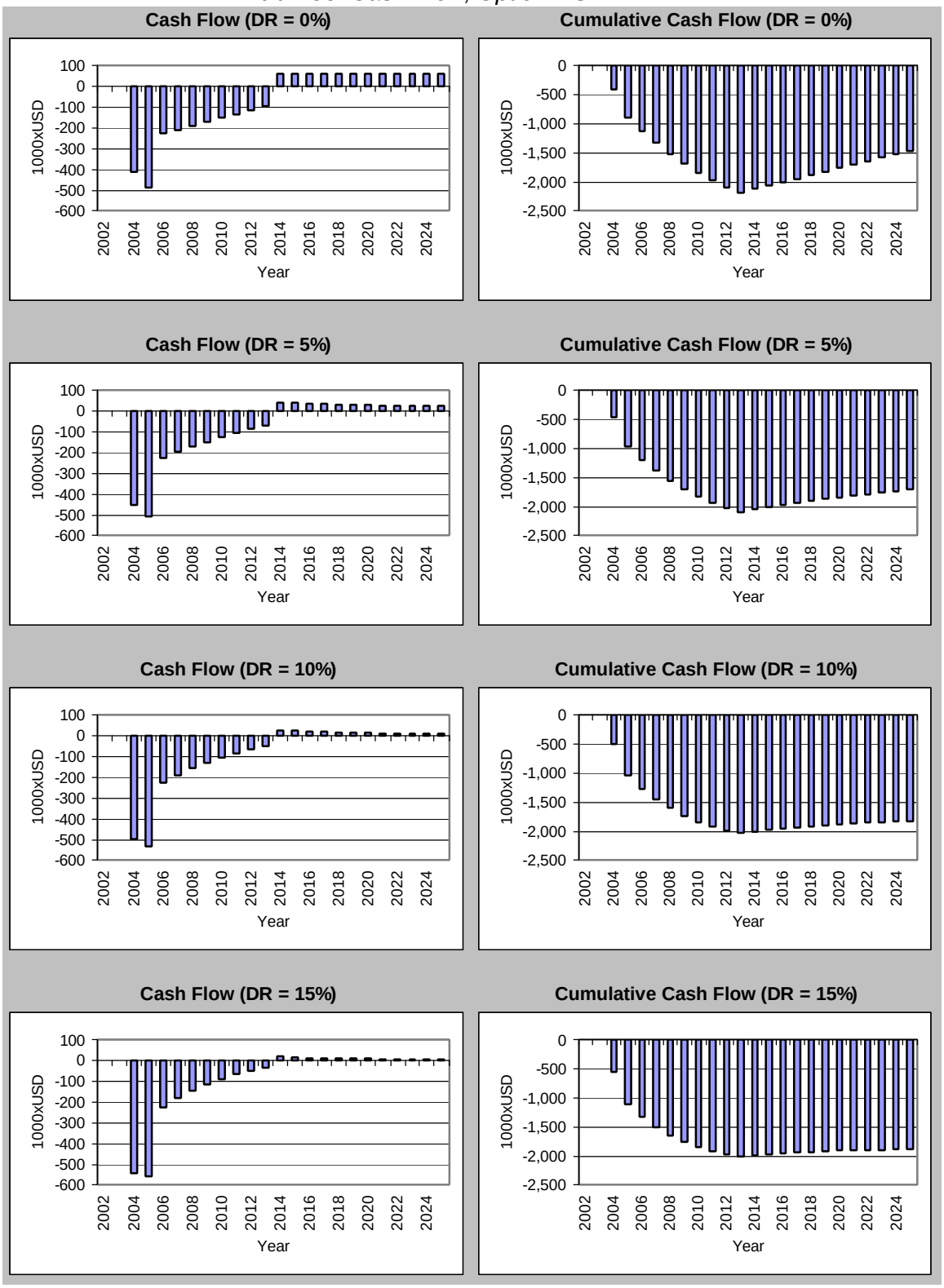


Exhibit 4-33: Cash Flow, Option NGB



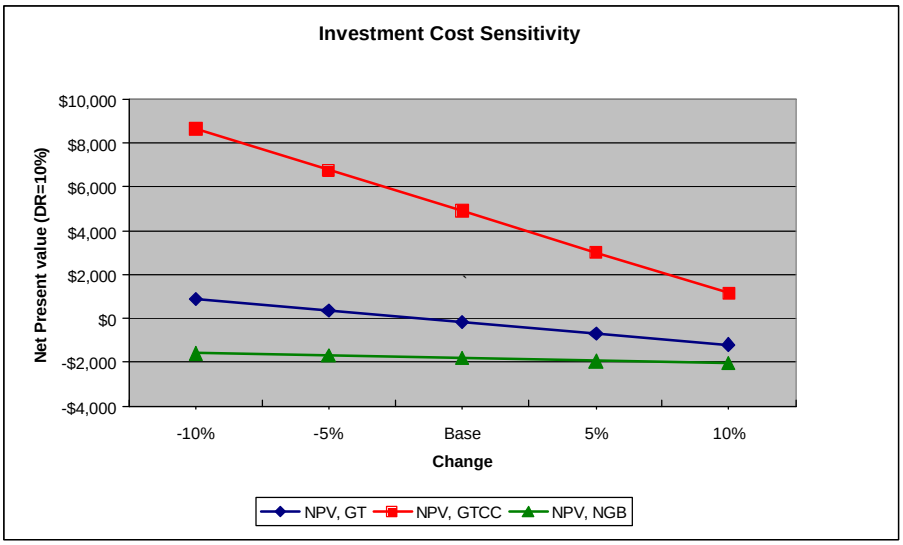
4.5.4 Sensitivity Analysis

The results and ranking of options represent the set of assumptions presented in Exhibit 4-30, including some uncertain values that may be subject to change based on market conditions, such as fuel prices and cost of electricity sold. To explore the impact of a change in these assumptions, a sensitivity analysis was performed. This provides an indication whether the economic ranking of options will change within a reasonable range of variation in the assumptions. The sensitivity of the Net Present Value (NPV) of costs is evaluated for changes to capital costs, the price of natural gas and coal, discount rate, and plant capacity factor. Economic sensitivity results for a range of variables are presented in the sections that follow.

Capital Investment Change

For pre-investment studies, estimates of capital costs are generic capital costs based on installed electric or thermal capacity of the equipment, modified for specific conditions. Manufacturers' quotations for similar equipment and cost data from previous actual projects are also used. Although such an estimating process is usually sufficiently accurate, the sensitivity of changes in investment cost on overall economic performance is presented in Exhibit 4-34.

Exhibit 4-34: Investment Cost Sensitivity



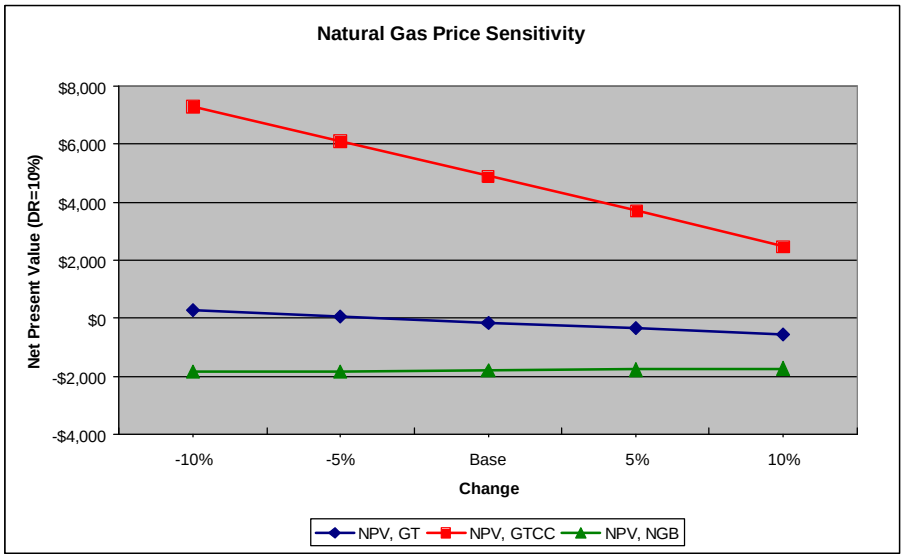
It is apparent that the Option GTCC is the most sensitive to investment cost changes, but the NPV stays positive even with a 10% increase in the base investment cost. The Option GT had very low NPV, and increased cost puts it in the negative area. Option

NGB stays negative even if the investment cost decreases substantially.

Natural Gas Price

Natural gas prices for the base case were based on current pricing generally accepted by major financing institutions for the Central European area. However, gas prices have proven to be quite volatile recently and difficult to predict. Therefore, a variation in projected average gas pricing has been studied from -10% to +10% of the based assumed cost. The sensitivity of NPV to variations in gas price is presented in Exhibit 4-35

Exhibit 4-35: Natural Gas Price Sensitivity

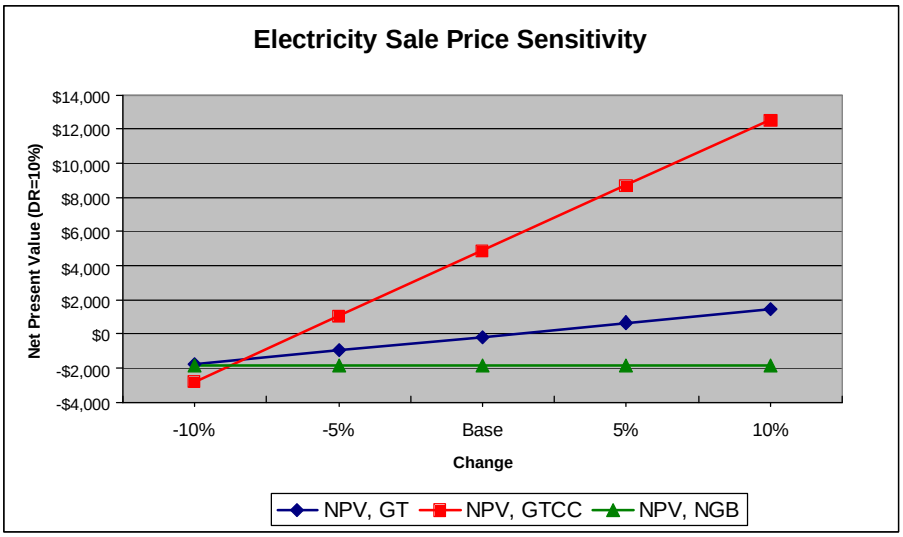


The sensitivity of NPV to natural gas price is again more visible in Option GTCC, but even for a 10% increase of NG price that doesn't reflect a corresponding increase in cost of heat and electricity, the NPV remains positive. The other alternatives are in negative territory.

Electricity Sale Price

The sensitivity of NPV to price of electricity generated the two alternatives, GTCC and GT, is presented in Exhibit 4-36. Option NGB remains unchanged. It is apparent that the price of electricity sold to the distribution system is very important and affects the economic performance of both the GT and GTCC Options. The assumed electricity price of $28 per MWh is at the "border" and if lowered, none of the Options would be feasible. On the other hand, its increase by 10%, would increase the NPV 2.5 times the value of base case.

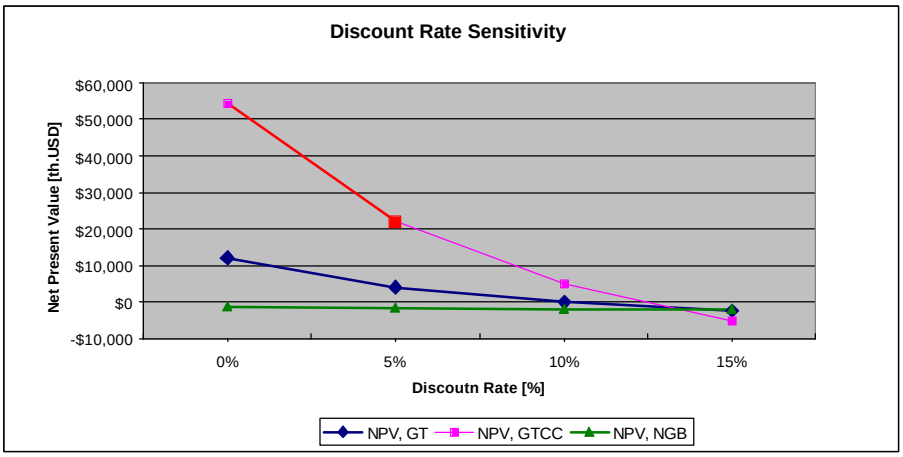
Exhibit 4-36: Electricity (Sold) price Sensitivity



Discount rate Sensitivity

Discount rate represents the real cost of capital and, in the analysis, serves to reduce the relative impact of future years. A lower discount rate makes future years more important, and tends to favor high capital cost, fuel-efficient plants. A real discount rate of 10% was used in the analysis. To explore the impact of a change in discount rate, the sensitivity analyses depicted in Exhibits 4-37 were prepared.

Exhibit 4-37: Discount Rate Sensitivity



The results of sensitivity analysis of the discount rate clearly shows that the NPV will become negative for all Options for discount rates

higher that about 12%. In the region where the NPV is positive for GT and GTCC Options, their relative ranking is not changed.

5. Financial Analysis of Creditworthiness of the Municipality

This section provides information on the financial standing of the city of Ivano-Frankivsk. It is very likely that for any investment in the District Heating System, the city will participate as the main borrower or at least as one of the principal parties. Therefore, its creditworthiness will play a key role in obtaining the required funds.

5.1 Analysis of Budget Revenues

The estimate of municipal income is based on consideration of fiscal trends in 1999-2001. This estimate is required to determine the capacity of the municipality to guarantee or participate in repayment of future credit if the district heating company ("Ivano-Frankivsk Teplocomunenergo") does not collect sufficient funds to repay a loan. As a last resort, the municipality can contribute direct financial support to "Ivano-Frankivsk Teplocomunenergo" as its own municipal company. A possible option is also the undertaking of obligations by the municipality to repay a certain part of the loan, while the rest will be paid by the utility from its income from heat and (potentially) electricity sales.

In general, the analysis shows that in the last years there was a continuing reduction in income for the municipal budget in constant dollars. Some increase in incomes of the municipal budget took place only in 2000 (by 3% without allowance for inflation factor) against the background of the general recovery of economic activity in Ukraine, as shown in Exhibit 5-1. In 2001, the revenues were lower again by 21% compared to the previous year, but this reduction was mostly caused by drastic reductions in subsidies from the State budget. Local tax revenues increased by 4.3% despite the fact that the companies' income taxes were transferred to the State budget practically in full. The principal factor for the increase in tax revenues was an increase in employment in the city. A small part of this increase was the increase in the amount of citizens' income tax by 64% in 2000 as compared with 1999, and in 2001 it increased by additional 9%. One result of the expected increase in the level of employment in the city is that the incomes will increase subsequently. This is of particular importance since the share of incomes from the income tax imposed on citizens makes about half of all budget revenues, without accounting for subsidies from the State budget. There are also some increases in proceeds from land charges and from single business tax (more than 2 times), as well as from other less significant tax and non-tax revenues.

Exhibit 5-1 Income of municipal budget in 1999-2002 (in1999 prices)

Sources	*Actual indicators*			*Target*
	1999	*2000*	*2001*	*2002*
Tax revenues:	53 368	47 372	49 419	49 843
Including				
Citizen income tax	19 842	32 578	35 611	35 076
Enterprise income tax	19 372	1 574	2	1 333
Vehicle owner tax	2 136	309	41	1 323
Land charge	4 159	5 371	5 997	5 141
Charge for special use of water and natural resources	55	55	-1	
Excise	569			
Business tax	68	61	25	27
Other taxes (to be indicated):	0	0	0	
Penalties, financial sanctions and fines for violation of tax legislation	202	166	159	
Single tax	438	952	2 413	2 154
Fee for trade patent for some types of entrepreneurial activity	1 958	1 450	1 438	1 383
Fee for licenses and certificates	1 196	1 054	-27	0
Fee for the state registration of entities of entrepreneurial activity	97	75	107	94
Stamp duty	43	0	0	0
Local taxes and duties	3 232	3 726	3 654	3 310
Other proceeds	0	0	1	1
Non-tax proceeds	7 193	5 234	6 411	6 399
Proceeds from bank interests for the use of budget funds	83	81	61	67
Receipts from privatization of communal property	686	1 269	2 286	1 817
Charge for leasing integral property complexes of the communal property	1 127	1 633	2 249	1 959
State tax	275	220	1 118	1 061
Proceeds from penalties and financial sanctions	131	317	139	266
other non-tax proceeds	4 892	1 713	557	1 228
Transfers(subsidies, funds received)	3 307	5 052	1 223	0
Subsidies	31 916	36 465	16 374	17 084
Including for education	2 606	946	0	409
Pollution charge	48	45	18	66
Other items (own funds of budgetary institutions)		4 090	3 329	3 277
Deductions				-2 655
Balance of funds as of the beginning of the year	226	248	616	234
Total incomes, thou. UAH	**96 058**	**98 505**	**77 390**	**74 248**

Income for the municipal budget (without accounting for subsidies) was reduced by 1.7% in 2001 from the level of 2000. (The 2002 budget without subsidies was about 62 million hryvnas.) For 2002, the budget revenues are expected to decrease by 6.3%. Obviously, it is impossible to ignore completely the possibility of deterioration of the financial situation of the city in the future, since the city cannot rely on taxes. Tax rates are established at the government level.

At the same time, the last trends in the state economy show that the budget proceeds are likely to have a stable increase in the long run. Supporting evidence for this is the sufficiently good financial activity of the municipality under severe conditions of recession in the local economy during 1990's.

During the last several years the structure of municipal incomes has changed significantly. Instability of rates of basic taxes, the shares of which were retained in the municipal budget, were the main reason for changes in taxes revenues. For example, the rates of deductions from proceeds from income tax paid by citizens in the last 5 years have varied from 25% to 100%, while proceeds from enterprises' income tax have varied from 0% to 100%. This complicates both financial planning for the city and forecasting the future financial situation of the city in the context of estimating its solvency and reliability as a guarantor for repayment of the loan.

5.2 Shortage of Local Budget in Taxes and Duties

A certain amount of obligations to the municipal budget from previous years has remained unpaid. This includes both the tax revenues from taxes whose rates are established by the state as well as from local taxes and duties. Exhibit 5-2 shows that this shortage for the last two years in real values decreased in 2001. Recently, non-receipts of land charges have increased steeply. During 2001 there was improvement in funds transfer to the municipal budget. In 1999 such shortages (delinquent and non-payments) were 7.3% of the total municipal income. In 2001 these were only 3.4%. Thus, delinquent tax revenues in Ivano-Frankivsk are not a large problem, and they probably will not adversely affect the financial program of the city.

Exhibit 5-2: Shortage of payments in 1999-2001 (in 1999 fixed prices)

Sources of proceeds	1999		2000		2001	
	Th. UAH	% of annual value	Th. UAH	% of annual value	Th. UAH	% of annual value
Citizen income tax	219	3.1	317	4.7	182	6.9
Enterprise income tax	3311	47.3	2553	37.8	17	0.7
Vehicle owner tax	97	1.4	66	1	47	1.8
Land charge	2309	33	2559	37.9	1381	52.4
Fee for licenses and certificates			4	0.1	10	0.4
Fee for trade patent for some types of entrepreneurial activity	87	1.2	49	0.7	19	0.7
Local taxes and duties	371	5.3	409	6.1	42	1.6
Proceeds from penalties and financial sanctions	64	0.9			133	5
Single tax			6	0.1	15	0.6
Charge for leasing integral property complexes of the communal property	333	4.8	735	10.9	764	29
Other proceeds (including excise)	205	2.9	26	0.4	0	
Pollution charge			26	0.4	23	0.9
Total shortage, thou. UAH	6995	100	6753	100	2634	100
Total shortage in percents of the total budget incomes	7.3	-	6.9	-	3.4	-

5.3 Analysis of Expenses of Municipal Budget

During 1999-2001period, the expenses of the municipal budget of the city followed the pattern of proceeds – they also decreased in fixed dollars. In 2000 they decreased by 3.2% as compared with 1999. In 2001 expenses decreased by 21.7%. Further reductions in expenses are expected for 2002 (by 4.4%).

Data given in Exhibit 5-3 show a constant reduction in funds for social support and reduction in subsidies for housing and communal services, especially in the excessive share of expenditures for repayment of debts for energy used. This is possible primarily because people must now pay the full cost of heat supply services. At the same time, expenditures for support to humanitarian causes (education, culture, art, mass media) have increased somewhat. Expenses for construction in 2000 increased by 17% and then dropped in the 2001 budget by 20%. Further reduction by 15% is also envisaged in the budget for 2002.

It should be emphasized that the Ivano-Frankivsk city management understands the necessity to adhere to a pragmatic approach to budget planning which is essential for future financial stability. First of all, it is expressed in the development and approval of deficit-free budget. Moreover, in 2000 and 2001 receipts exceeded expenditures by 6.3 and 6.7%, respectively. For the 2002 budget, a surplus of 5 million hryvnas (in

1999 prices) or 7.1% is planned. Potentially, these funds can be transferred for repayment of debts incurred by the proposed project. The city management can also reallocate a part of funds intended for the development of the city infrastructure. However, all these actions will require some efforts from the city in reallocation of expenditures within the existing budget process (both from the City's and delegated authorities' budgets).

Exhibit 5-3:. Expenditures of the municipal budget in 1999-2002 (in 1999 prices)

Type	***Actual indicators***			***Target***
	1999	***2000***	***2001***	***2002***
Expenditures (by the function, including capital investments)				
State administration	1 488	2110	1959	2118
Activity in protection of rights	145	391	410	572
Education	15 698	13331	17333	17966
Health protection	13 256	12211	12834	11595
Social support	33 361	26217	2707	769
Housing and communal services	23 379	28837	12906	11595
Culture and art	1 430	1353	1486	1335
Mass media	221	391	445	485
Physical culture and sport	770	642	551	584
Construction	4 150	4869	3879	3295
Agriculture	59	60	0	0
Transport, roads, communication	718	652	340	1872
Prevention and liquidation of extraordinary situations and consequences of natural disasters	52	48	63	67
Reserve fund	464	476	550	471
Other expenses	281	313	626	616
Other items				
Subsidies given to subordinated budgets				
Subsidies to rural councils	273	238	75	491
Repayment of debt to oblast budget		499		
Total expenditures, thou. UAH	95 746	92637	56164	53831
Subvention from the state budget for privileges and subsidies			15150	13758
Difference in the price for heat to the account of privileges and subsidies			1224	309
Other subventions				1454
Total expenditures	**95 746**	**92637**	**72538**	**69352**

5.4 Financing of City's Own and Delegated Authority

Expenditures for the City's budget authority are financed from local taxes and duties, land charge and other incomes, as shown in Exhibit 5-4. The collection of these fees depends to a great extent on the local administration. Delegated authority budgets include functions performed by the local administration but that the state is responsible for financing.

According to data in Exhibit 5-4, income for the budget of “own authority” of the city increased by 4% in fixed prices in 2001, and such incomes for 2002 are expected to further increase by 11%. At the same time, expenses within this budget are rather unstable. For 2002, the City expects a deficit of 2.2 million hryvnas, which represents 13.6% of the total budget. The city could eliminate or reduce this deficit by increasing collections for property leases and for land fees (decreasing unpaid receivables).

There are limitations on the city’s ability to redistribute the available funds for loan repayment purposes, especially when considering the need to pay for housing and municipal services. Realistic possibilities for fund redistribution are only about 2.4 –3.2 million hryvnas per year, which is not more than 4% of the city’s income in 2001. This is not a large amount; however preliminary calculations show that the city has the possibility to receive additional income from local taxes and duties, which can be used for repayment of the loan.

The city has no experience in obtaining long-term loans. In the recent past, the local administration has attracted only short term budget loans for time periods of up to ten days to settle cash flow problems of current payments. At the same time, “Ivano-Frankivsk Teplocomunenergo” independently has a reasonable credit history.

Exhibit 5-4: Incomes and expenditures by budget of “own authority” of the city in 1999-2002 (in prices of 1999)

Sources	*Actual indicators*			*Target*
	1999	*2000*	*2001*	*2002*
Incomes	14250.8	13762	14324	15898
Including				
Local taxes and duties	3232.3	3726	3654	4430
Land charge	4159.2	5371	5997	6880
Excise from vehicle owners				
Other proceeds	6859.3	4665	4674	4587
Expenditures	12676.9	13983	13911	18084
Including				
Housing and communal services	11882.1	12962	12906	15931
Youth construction	83.9	57	25	315
Program "Native Home"		12	15	72
Right-protecting bodies	145.4	391	410	766
Including				
Fire safety				108
Local programs of development of physical culture and sport	278.9	239	245	374
Expenditures for elaboration of concept and strategy of the economic development of the city	5	8	4	41
Other expenditures	286.6	322	312	626
Difference between incomes and expenditures	1573.9	-221	413	-2187

6. Conclusions and Recommendations

The purpose of the study was to provide the Invano-Frankivsk Teplocomunenergo District Heating Company with information for their investment decision process related to repowering the location Industrialna 34. This location was selected due to a possibility to include summer heat load from other two locations – Symonenka and Dorosenka boiler houses – by interconnecting their distribution systems. The plant Industrialna 34 was originally designed as CHP, but the turbine and generators were dismantled and steam boilers are not being used. The electricity needed for its operation is now being purchased. This study provides information on positive and negative aspects of available options.

6.1 Options Evaluated

Present Situation, "PS"
This Option represents the current situation without investment and was used as a baseline for all other options. Existing boilers and other equipment are assumed to continue operation with increased operation and maintenance costs.

Gas Turbine, "GT"
This Option assumed installation of Gas Turbine, Heat Recovery Heat Exchanger and upgrade and utilization of existing boilers. For analysis, the parameters of gas turbine TITAN 130 made by Solar Turbine were used, as its capacity matched the needs and its efficiency is high. The system capacity of 20 MWt was designed to match the summer load and allow operation for up to 8000 hours annually, thus maximizing the production of electricity and eliminating need for dumping heat or shutting down the system for a prolonged time.

Gas Turbine Combined Cycle "GTCC
This option assumes installation of a combined cycle unit comprising a gas turbine Trend made by Rolls-Royce with thermal output of 53 MWt and efficiency 41.57%. This system would provide thermal capacity of 35 MW and was designed for shoulder season load. In order to extend the operating hours, a dry cooling system with 35 MW capacity was assumed. Depending on electricity needs and on utilization of the cooling system, this system can also be operated up to 8000 hours annually, and electricity production can be maximized.

Natural Gas Boilers
This option assumes only heat production with minimum investment. Use of the existing boilers was assumed after installation of modern control systems on selected boilers.

The summary of installed thermal capacity for all options is shown in Exhibit 4-25 and also shown below.

OPTION		PS	GT	GTCC	NGB
Existing Hot Water Boilers	[MW]	255.9	221.0	2210	255.9
GT/GTCC	[MW]	0.0	30.0	45.0	0.0
Total	**[MW]**	**255.9**	**251.0**	**266.0**	**255.9**

The electrical installed capacity is presented in Exhibit 4-25 and repeated in the following table.

		PS	GT	GTCC	NGB
GT	[MW]	0.0	13.5	51.2	0.0
ST	[MW]	0.0	0.0	7.5	0.0
Total	**[MW]**	**0.0**	**13.5**	**58.7**	**0.0**

The options were evaluated for the same heat load by the district heating system, using the same economic inputs and assumptions, such as price of natural gas, electricity, etc. The results are summarized in Exhibit 4-31 and shown below.

Parameter	Unit	Option		
		GT	GTCC	NGB
Investment Cost Total	th.USD	10,433	36,872	1,919
NPV (DR = 0%)	th.USD	12,173	54,644	-1,464
NPV (DR = 5%)	th.USD	4,093	22,069	-1,710
NPV (DR = 10%)	th.USD	-159	4,881	-1,821
NPV (DR = 15%)	th.USD	-2,619	-5,075	-1,880
PBP (DR = 0%)	years	10.6	9.4	-
PBP (DR = 5%)	years	13.1	11.1	-
PBP (DR = 10%)	years	-	15.2	-
PBP (DR = 15%)	years	-	-	-
IRR	[%]	9.75%	12.14%	-

6.2 Emission Reduction

The CTCC alternative produced the best economic results. Assuming that option is implemented, the benefit of the project is also reflected in lowering Green House Gas Emissions. Estimates of GHG emission reductions in this project were developed using the IPCC methodology and based on IPCC emission factors for natural gas combustion in Ukraine of 55.82 t CO_2/TJ. Ukraine baseline

electricity grid CO_2 emissions for JI projects generating electricity are based on the factors used in the "ERUPT" program of Ministry of Housing, Spatial Planning and the Environment of the Netherlands (Volume 2a: "Baseline Studies, Monitoring and Reporting", version 2.0, October 2001). This document gives the standardized baseline GHG emissions figures for grid-connected electricity generation for 14 JI host countries in Central and Eastern Europe to be used in the second tender of ERUPT. The ERUPT standardized baseline methodology for grid-connected electricity generation combines several features:

- Emission factors that take the current power system of country as a starting point.
- Prevailing rules for dispatching of power plants.
- Correction of emission figures for the combined production of heat and power.
- Possible future development of the power system to contain more efficient and less carbon-intensive power generation technologies.

Projected emissions reductions are summarized in Exhibit 6-1, and cumulative emissions reductions through year 2012 are presented in Exhibit 6-2.

Exhibit 6-1 Projected Emission Reductions by the Project

Summary Table: Projected Emission Reductions				
	GHG	***Unit***	***Emission per year***	***Total emission over project life***
A) Baseline scenario	CO_2	t	428 849	8 576 979
	CH_4	t		
	N_2O	t		
	other	t		
	total	t CO_2 eq.	428 849	8 576 979
B) JI project scenario	CO_2	t	267 519	5 350 372
	CH_4	t		
	N_2O	t		
	other	t		
	total	t CO_2 eq.	267 519	5 350 372
C) Effect (B-A)	CO_2	t	- 161 330	- 3 226 608
	CH_4	t		
	N_2O	t		
	other	t		
	total	t CO_2 eq.	- 161 330	- 3 226 608

Exhibit 6-2 Projected Emission Reduction till year 2012

Projected Emission Reductions during 2008 – 2012 years					
	2008	*2009*	*2010*	*2011*	*2012*
CO_2 emission reductions, t	228,304	219,203	210,102	201,001	191,907
Cumulative effect CO_2 emission reductions, t	**228,304**	**447,508**	**657,610**	**858,611**	**1,050,518**

6.3 Creditworthiness of the City of Ivano Frankivsk

Funds designated for capital expenses can potentially be used for loan service for the proposed project if the income of "Ivano-Frankivsk Teplocomunenergo" will be insufficient for this purpose. At the same time, it is necessary to note that the city cannot be completely confident of the level of incomes from taxes, the rates of which are established by central State bodies every year. Also, it is difficult to predict with certainty the future demands for financing individual expenses. The city also has no significant control over the tax base, tax rates and right to dispose of about 90% of its incomes. It is possible to roughly estimate the amount of funds that the city could allocate to guarantee or directly repay the future loan. But as with any city in Ukraine, there are many uncertainties in medium-term and long-term planning of capital expenses, so there is significant potential for inaccuracy of the budget indicators.

6.4 Conclusions

Two Options evaluated repowering the Industrialna 34 plant and producing electricity on-site. One option considered upgrade of existing equipment and production of heat only. The results of the assessments of the three options can be summarized as follows:

The best economic performance, and the largest investment cost will result from alternative GTCC. This alternative has positive Net Present Value (NPV) with discount rates lower than about 12%, and has IRR slightly above 14%, which is in reasonable range. The NPV remains positive even if investment cost increase by 10%, or if the gas price increases by 10%. However, should the price of electricity sold to the grid be decreased by more than 7% (to $26 per MWh), the NPV of this Option would become negative.

The lowest economic benefit, and the lowest required investment, will result from alternative NGB. This Option's NPV is negative even at 0% discount rate, and it would not become positive even by making more optimistic (but still reasonable) improvements in the basic economic assumptions. It is difficult to accurately estimate the current efficiency of the city's boilers. They are assumed to have efficiencies of about 87%, and therefore the proposed investment

theoretically would not result in efficiency improvements of more than 1.5 to 2%. This may not be correct, as the actual efficiencies of current boilers are likely much less than 87%. Even assuming greater efficiency improvements, this alternative will likely still offer the lowest cost, but will remain economically least attractive.

The Option with Gas Turbine displays relatively modest results and the NPV is positive for low discount rate, higher price of sold electricity and lower cost of natural gas. The IRR of this alternative is 9.75%, which is not very attractive. In order to consider this alternative, more accurate and very detailed analysis would have to be performed, as the results are very close to the "break-even point" and, with a little change, the investment may result in loss.

There is a need for more accurate data. The current boiler efficiency does not seem to be accurate, appearing to be too high. Upgrade of the equipment may make more sense if the efficiency improvement considers more realistic current conditions.

The largest influences on the investment are from

- the cost of electricity sold to the grid
- the heat tariff and
- the cost of natural gas.

These parameters, especially the price of electricity sold, must be accurately defined prior to any investment's being made.

6.5 Recommendations:

The project team makes the following recommendations:

- Define and document the current efficiency of operation. The feasibility of investment is being determined based on potential improvements. If the current efficiency of operation is overstated (too optimistic), the investment will be less attractive and the system will operate in a lower than expected efficiency range.

- Need to determine the cost of electricity sold to grid, and negotiate an agreement that will yield the highest possible price for electricity. This should be the first order of priority.

- Solicit funding institutions for soft, or low interest loans and grants (for example Joint Implementation (JI) mechanism)

- Concentrate on the GTCC alternative, as it has the best results.

- Consider soliciting investments through the sales of emission reduction units (ERUs) - Joint Implementation (JI) mechanism.

The GTCC option evaluated in this study meets the main JI criteria established by the "Berlin decision" [first Conference of Parties of UN FCCC, Berlin in 1995, Decision # 5 on "Activities implemented jointly under the pilot phase"] and:

- The project is compatible with and supportive of Ukrainian environment and development priorities and strategies, contributes to cost-effectiveness in achieving global benefits, and would be conducted in a comprehensive manner covering all relevant sources, sinks and reservoirs of greenhouse gases.
- The project brings about real, measurable and long-term environmental benefits related to the mitigation of climate change that would not have occurred in the absence of such activities.
- The financing of this project will be additional to the financial obligations of Parties included in Annex II of the agreement.

?? The eligibility of this financially feasible project under JI guidelines can be supported by the numerous financial barriers to its implementation. The most important is lack of access to investment capital due to lack if willingness of Ukrainian commercial banks to engage in project financing, high cost of debt financing, difficulties in obtaining guarantees/insurance and shortage of the city's own financial resources.

?? Description of project already is included in the Ukrainian Joint Implementation Project Database developed by the Institute of Energy of the National Academy of Sciences of Ukraine under the Canada-Ukraine Environmental Cooperation Program.

?? Propose that the project be included in the pilot project pipeline of the National Joint Implementation Strategy Study (NSS) for Ukraine.

?? Include the project in the JI Projects Data Base prepared by the Climate Change Initiative Center

Exhibit A-1: Heat Supply from Doroshenka 28

Heat Supply from Doroshenka 28 Plant, 1998-2000									
Month	Amb. temp. [°C]	Fuel [m³]	Heat production [Gcal]	Heat realization [Gcal]	Heat delivery [Gcal]	Fuel [GJ]	Heat production [GJ]	Heat realization [GJ]	Heat delivery [GJ]
Year 2000									
Jan	-5.1	1,910,793	13,618	13,222	10,179	65,201	57,017	55,357	42,617
Feb	-3.7	1,266,657	8,893	8,634	6,910	43,221	37,234	36,149	28,931
March	1.3	1,215,193	8,571	8,322	7,044	41,465	35,886	34,840	29,491
April	7.6	642,252	4,452	4,322	3,393	21,915	18,638	18,095	14,207
May	13.5	152,126	1,054	1,024	655	5,191	4,415	4,286	2,742
June	16.6					0	0	0	0
July	18.5					0	0	0	0
Aug.	17.8					0	0	0	0
Sept.	13.5					0	0	0	0
Oct	8.2	49,483	375	364	323	1,688	1,568	1,522	1,353
Nov.	2.2	613,544	4,296	4,170	3,611	20,936	17,984	17,461	15,120
Dec	-2.4	951,219	6,216	6,035	4,955	32,458	26,023	25,265	20,743
Year	**7.4**	**6,801,267**	**47,474**	**46,092**	**37,070**	**232,075**	**198,765**	**192,976**	**155,206**
Efficiency:							85.6%		
Losses:								2.9%	19.6%
Year 1999									
Jan	-5.1	1,874,419	13,072.9	12,816.6	11,560.6	15,933	54,734	53,660	48,402
Feb	-3.7	1,574,788	11,101.2	10,883.5	9,751.6	13,386	46,478	45,567	40,828
March	1.3	1,441,781	10,333.8	10,131.2	9,097.8	12,255	43,266	42,417	38,091
April	7.6	464,322	3,300.4	3,235.7	2,954.2	3,947	13,818	13,547	12,369
May	13.5	436,474	3,102.5	3,041.6	2,850.0	3,710	12,990	12,735	11,932
June	16.6	209,748	1,490.9	1,461.7	1,365.2	1,783	6,242	6,120	5,716
July	18.5	37,016	263.1	258.0	230.4	315	1,102	1,080	965
Aug.	17.8	190,138	1,351.5	1,325.0	1,232.2	1,616	5,658	5,548	5,159
Sept.	13.5	355,982	2,530.3	2,480.7	2,331.9	3,026	10,594	10,386	9,763
Oct	8.2	747,177	5,310.9	5,206.8	4,665.3	6,351	22,236	21,800	19,533
Nov.	2.2	1,441,375	10,154.8	9,859.0	8,843.5	12,252	42,516	41,278	37,026
Dec	-2.4	1,720,540	12,162.3	11,808.1	10,591.9	14,625	50,921	49,438	44,346
Year	**7.4**	**10,493,760**	**74,174.6**	**72,507.9**	**65,474.6**	**89,197**	**310,554**	**303,576**	**274,129**
Efficiency:							348.2%		
Losses:								2.2%	9.7%
Year 1998									
Jan	-5.1	1,747,020	12,531.4	12,285.7	11,081.7	14,850	52,466	51,438	46,397
Feb	-3.7	1,494,140	10,717.5	10,507.3	9,477.6	12,700	44,872	43,992	39,681
March	1.3	1,662,970	11,928.5	11,694.6	10,548.5	14,135	49,942	48,963	44,164
April	7.6	743,148	5,330.8	5,226.3	4,719.3	6,317	22,319	21,881	19,759
May	13.5	418,805	3,004.1	2,945.2	2,768.5	3,560	12,578	12,331	11,591
June	16.6	337,268	2,419.2	2,371.8	2,229.5	2,867	10,129	9,930	9,334
July	18.5	284,039	2,037.4	1,997.5	1,877.6	2,414	8,530	8,363	7,861
Aug.	17.8	136,727	980.7	961.5	903.8	1,162	4,106	4,026	3,784
Sept.	13.5	436,192	3,128.8	3,067.5	2,883.4	3,708	13,100	12,843	12,072
Oct	8.2	769,349	5,518.5	5,410.3	4,896.3	6,539	23,105	22,652	20,500
Nov.	2.2	1,603,197	11,499.7	11,274.2	10,203.2	13,627	48,147	47,203	42,719
Dec	-2.4	2,134,963	15,314.1	15,013.8	13,650.2	18,147	64,117	62,860	57,151
Year	**7.4**	**11,767,818**	**84,410.7**	**82,755.7**	**75,239.6**	**100,026**	**353,410**	**346,481**	**315,013**
Efficiency:							353.3%		
Losses:								2.0%	9.1%

Exhibit A-2 Heat Supply from Symonenka 3

Heat Supply from Symonenka 3 Plant, 1998-2000									
Month	Amb. temp. [°C]	Fuel [m³]	Heat production [Gcal]	Heat realization [Gcal]	Heat delivery [Gcal]	Fuel [GJ]	Heat production [GJ]	Heat realization [GJ]	Heat delivery [GJ]
Year 2000									
Jan	-5.1	4,933,876	33,017.3	32,055.6	25,926.8	168,356	138,237	134,210	108,550
Feb	-3.7	3,321,476	22,917.3	22,249.8	18,063.3	113,337	95,950	93,155	75,627
March	1.3	3,211,626	21,834.9	21,198.9	17,572.0	109,588	91,418	88,755	73,570
April	7.6	1,942,435	13,206.0	12,821.4	10,163.4	66,281	55,291	53,681	42,552
May	13.5	297,042	2,019.5	1,960.7	1,384.3	10,136	8,455	8,209	5,796
June	16.6					0	0	0	0
July	18.5					0	0	0	0
Aug.	17.8					0	0	0	0
Sept.	13.5					0	0	0	0
Oct	8.2	161,084	1,199.6	1,164.7	1,020.3	5,497	5,022	4,876	4,272
Nov.	2.2	1,998,464	14,614.3	14,188.6	12,451.9	68,192	61,187	59,405	52,134
Dec	-2.4	3,562,002	25,828.0	25,075.7	21,603.8	121,544	108,137	104,987	90,451
Year	**7.4**	**19,428,005**	**134,636.9**	**130,715.4**	**108,185.8**	**662,930**	**563,697**	**547,279**	**452,952**
Efficiency:							85.0%		
Losses:								2.9%	17.2%
1999									
Jan	-5.1	5,187,425	39,476.2	37,957.9	34,314.0	184,609	165,279	158,922	143,666
Feb	-3.7	4,343,325	33,376.4	32,092.7	29,076.0	154,569	139,740	134,366	121,735
March	1.3	4,270,726	32,312.6	31,069.9	28,118.3	151,986	135,286	130,083	117,726
April	7.6	1,842,788	13,224.6	12,716.0	11,546.1	65,581	55,369	53,239	48,341
May	13.5	1,567,603	11,249.2	10,816.5	10,070.2	55,787	47,098	45,286	42,162
June	16.6	257,571	1,848.7	1,777.6	1,628.3	9,166	7,740	7,442	6,817
July	18.5					0	0	0	0
Aug.	17.8	849,033	6,093.8	5,859.4	5,449.2	30,215	25,513	24,532	22,815
Sept.	13.5	842,192	6,044.7	5,812.2	5,370.5	29,972	25,308	24,334	22,485
Oct	8.2	2,248,742	16,140.0	15,519.3	13,827.7	80,028	67,575	64,976	57,894
Nov.	2.2	4,552,968	32,364.0	31,421.4	28,185.0	162,030	135,501	131,555	118,005
Dec	-2.4	4,586,960	31,324.4	30,412.0	27,249.2	163,240	131,149	127,329	114,087
Year	**7.4**	**30,549,333**	**223,454.6**	**215,454.9**	**194,834.5**	**1,087,182**	**935,559**	**902,065**	**815,732**
Efficiency:							86.1%		
Losses:								3.6%	9.6%
1998									
I	-5.1	5,584,394	40,642.2	39,079.0	35,327.4	198,736	170,161	163,616	147,909
II	-3.7	4,602,682	33,497.5	32,209.1	29,117.0	163,799	140,247	134,853	121,907
III	1.3	4,879,307	35,510.7	34,144.9	30,867.0	173,644	148,676	142,958	129,234
IV	7.6	2,533,115	18,435.5	17,726.5	16,166.6	90,148	77,186	74,217	67,686
V	13.5	1,798,239	13,087.3	12,583.9	11,828.9	63,995	54,794	52,686	49,525
VI	16.6					0	0	0	0
VII	18.5	1,017,379	7,404.3	7,119.5	6,692.3	36,206	31,000	29,808	28,019
VIII	17.8	1,047,998	7,627.1	7,627.1	440.0	37,296	31,933	31,933	1,842
IX	13.5	1,322,166	9,622.5	9,622.3	8,697.3	47,053	40,287	40,287	36,414
X	8.2	2,459,419	17,899.2	17,210.8	15,696.2	87,525	74,940	72,058	65,717
XI	2.2	4,732,004	34,438.7	33,114.1	30,133.8	168,401	144,188	138,642	126,164
XII	-2.4	5,695,723	41,452.4	41,452.7	36,270.9	202,698	173,553	173,554	151,859
Year	**7.4**	**35,672,426**	**259,617.4**	**251,889.9**	**221,237.4**	**1,269,502**	**1,086,965**	**1,054,611**	**926,276**
Efficiency:							85.6%		
Losses:								3.0%	12.2%

Exhibit A-3: Heat Supply From Industrialna 34

Heat Supply from Industrialna Plant 34, 1998-2000									
Month	Amb. temp. [°C]	Fuel [m³]	Heat production [Gcal]	Heat realization [Gcal]	Heat delivery [Gcal]	Fuel [GJ]	Heat production [GJ]	Heat realization [GJ]	Heat delivery [GJ]
Year 2000									
Jan	-5.1	10,895,064	76,395.1	75,653.7	64,868.5	371,765	319,851	316,747	271,591
Feb	-3.7	7,759,753	55,672.1	54,957.6	47,105.0	264,781	233,088	230,096	197,219
March	1.3	7,062,080	48,912.7	48,285.0	39,122.0	240,975	204,787	202,159	163,796
April	7.6	3,844,808	27,082.9	26,735.3	18,587.6	131,194	113,391	111,935	77,822
May	13.5	469,790	3,368.0	3,267.0	1,500.1	16,030	14,101	13,678	6,281
June	16.6					0	0	0	0
July	18.5					0	0	0	0
Aug.	17.8					0	0	0	0
Sept.	13.5					0	0	0	0
Oct	8.2	242,562	1,922.1	1,862.5	1,009.5	8,277	8,047	7,798	4,227
Nov.	2.2	4,021,388	30,602.2	29,885.8	23,409.4	137,219	128,125	125,126	98,010
Dec	-2.4	6,145,408	44,880.3	44,140.0	35,610.3	209,696	187,905	184,805	149,093
Year	**7.4**	**40,440,853**	**288,835.4**	**284,786.9**	**231,212.4**	**1,379,938**	**1,209,295**	**1,192,344**	**968,039**
Efficiency:							87.6%		
Losses:								1.4%	18.8%
1999									
Jan	-5.1					0	0	0	0
Feb	-3.7					0	0	0	0
March	1.3					0	0	0	0
April	7.6	3,372,301	24,554.0	24,320.0	19,830.0	115,071	102,803	101,823	83,024
May	13.5	1,852,109	12,757.0	12,592.6	8,896.6	63,198	53,411	52,723	37,248
June	16.6					0	0	0	0
July	18.5					0	0	0	0
Aug.	17.8	807,784	5,612.5	5,527.0	4,368.5	27,564	23,498	23,140	18,290
Sept.	13.5	1,618,414	11,353.3	11,156.0	7,315.9	55,224	47,534	46,708	30,630
Oct	8.2	3,785,811	27,502.8	27,074.0	21,398.7	129,181	115,149	113,353	89,592
Nov.	2.2	6,818,655	49,079.3	48,354.0	42,019.6	232,669	205,485	202,448	175,928
Dec	-2.4	9,244,980	64,936.0	64,166.0	57,621.1	315,461	271,874	268,650	241,248
Year	**7.4**	**27,500,054**	**195,794.9**	**193,189.6**	**161,450.4**	**938,367**	**819,753**	**808,845**	**675,960**
Efficiency:							87.4%		
Losses:								1.3%	16.4%
1998									
I	-5.1					0	0	0	0
II	-3.7					0	0	0	0
III	1.3					0	0	0	0
IV	7.6					0	0	0	0
V	13.5					0	0	0	0
VI	16.6					0	0	0	0
VII	18.5					0	0	0	0
VIII	17.8					0	0	0	0
IX	13.5					0	0	0	0
X	8.2					0	0	0	0
XI	2.2					0	0	0	0
XII	-2.4					0	0	0	0
Year	**7.4**	**0**	**0.0**	**0.0**	**0.0**	**0**	**0**	**0**	**0**
Efficiency:									
Losses:									

Exhibit B-1: Gas Consumption by Boilers, year 2000

		Gas consumption by boilers in year 2000, ?:										
		Month										
?	Address	1	2	3	4	5	6	7	8	9	10	
1	Pn.bulvar Pushkina 2a	377,483	229,534	213,942	48,125	28,155	32,271	34,355	30,187	19,879	49,752	
2	Internationalistiv 8a	525,796	369,994	309,976	116,925	16,193					22,235	
3	Naberezhna 8a	424,760	267,879	255,890	69,183						13,746	
4	Ugorska 6	167,144	127,911	109,250	56,798	11,684					3,383	
5	Troleybusna 40	1,946,675	1,477,793	1,519,843	1,027,896	385,720					125,126	
6	Poljuja 1	87,132	62,117	52,412	14,321						4,363	
7	Fedkovycha 91	885,527	673,377	432,187	184,490	9,369	9,196	11,588	12,086	10,798	55,876	
8	***Doroshenka 28***	***1,910,793***	***1,266,657***	***1,215,193***	***642,252***	***152,126***					***49,483***	
9	Krehivtsi 22 sichnja 141	24,835	17,473	16,168	4,825						1,464	
10	G.Mazepy 142	126,360	92,192	89,208	18,493						6,986	
11	Belvederska 46	111,002	68,871	59,564	14,165						7,513	
12	Belvederska 49	75,423	47,792	43,050	10,258						4,316	
13	Belvederska 61	95,174	69,744	64,503	16,557						6,477	
14	Vovchynetska 103	45,884	33,738	29,191	7,185						2,626	
15	Garbarska 22	31,980	23,580	23,500	6,634						1,014	
16	Maksymovycha 5	11,855	7,997	12,818	5,034						2,936	
17	Sorochteja 16	100,114	58,405	55,493	15,111						4,156	
18	Shevchenka 34	140,845	92,298	82,028	18,031						3,723	
19	Nezalezhnosti 95	103,251	66,050	54,497	14,413						4,913	
20	Chubynskogo 14	13,012	11,075	11,626	3,736						963	
21	Donzova 4	6,013	4,242	4,690	1,565							
22	Medychna 1	143,102	92,043	86,277	28,202	4,630	2,418	3,817	4,938	5,690	11,729	
23	Medychna 4	50,713	34,570	32,971	17,607	4,664	5,406	2,495	5,306	5,058	10,638	
24	Konovaltsa 132	89,573	64,572	59,676	27,925	6,372	3,784	7,116	9,364	10,126	19,880	
25	G.Mazepy 114a	195,612	143,507	136,966	61,095	5,477					24,865	
26	Matejka 34	97,341	67,030	62,007	24,967	5,919	7,646	1,755	8,341	8,382	19,524	
27	Chornovola 47a	166,424	126,981	125,383	77,726	25,883	22,457	7,093	13,204	17,406	41,876	
28	Dovga 68	693,051	487,805	481,639	175,258						27,415	
29	Karpatska 15	679,895	471,266	445,501	264,305	83,053					21,612	
30	Junosti 11	217,141	149,077	126,428	26,258							
31	Nezalezhnosti 36	70,582	49,948	45,606	21,241	6,497					2,420	
32	Byha 3a	574,678	391,598	365,460	154,412	22,670					21,598	
33	***Symonenka 3***	***4,933,876***	***3,321,476***	***3,211,626***	***1,942,435***	***297,042***					***161,084***	***1***
34	***Industrialna 34***	***10,895,064***	***7,759,753***	***7,062,080***	***3,844,808***	***469,790***					***242,562***	***4***
	Total	**26,018,110**	**18,228,345**	**16,896,649**	**8,962,236**	**1,535,244**	**83,178**	**68,219**	**83,426**	**77,339**	**976,254**	**10**

Exhibit B-2: Gas Consumption by Boilers, year 1999

		Gas consumption by boilers in year 1999, ?:										
		Month										
?	Address	1	2	3	4	5	6	7	8	9	10	
1	Pn.bulvar Pushkina 2	348,000	303,476	249,434	30,902	24,279	31,738	32,827	30,793	17,880	66,872	
2	Internationalistiv 8a	482,774	450,014	404,450	88,029	59,921	36,240	5,200	21,783	46,950	185,336	
3	Naberezhna 8a	413,004	346,023	273,845	18,325						105,336	
4	Ugorska 6	163,431	157,083	138,362	52,297	36,754	19,361	2,248	7,743	33,835	66,827	
5	Troleybusna 40	2,027,903	1,780,954	1,565,739	1,031,597	1,135,461	384,122		421,153	869,592	1,229,136	1
6	Poljuja 1										15,110	
7	Fedkovycha 91	899,547	776,151	774,682	257,597	12,312	9,383	13,125	12,055	12,393	320,495	
8	***Doroshenka 28***	***1,874,419***	***1,574,788***	***1,441,781***	***464,322***	***436,474***	***209,748***	***37,016***	***190,138***	***355,982***	***747,177***	***1,***
9	Krehivtsi 22 sichnja 1	24,247	22,240	17,553	1,420						6,943	
10	G.Mazepy 142	135,210	120,198	107,804	2,588						26,540	
11	Belvederska 46	107,073	93,202	70,875	5,474						21,044	
12	Belvederska 49	70,967	63,267	47,740	4,516						14,817	
13	Belvederska 61	98,111	83,209	68,657	6,434						21,095	
14	Vovchynetska 103	45,232	38,678	31,452	3,213						13,149	
15	Garbarska 22	29,172	26,601	19,361	1,760						7,885	
16	Maksymovycha 5	22,931	23,323	17,254	1,586						8,838	
17	Sorochteja 16	93,985	77,529	65,276	5,669						21,308	
18	Shevchenka 34	113,554	103,850	73,628	5,213						28,964	
19	Nezalezhnosti 95	111,343	89,183	61,909	6,016						19,915	
20	Chubynskogo 14	12,047	10,689	9,167	1,401						4,396	
21	Donzova 4	5,916	5,580	4,892	652						1,827	
22	Medychna 1	124,238	112,025	92,373	27,633	20,863	8,021	8,284	14,943	17,823	37,354	
23	Medychna 4	51,590	45,574	36,526	15,994	9,502	7,577	2,547	7,594	7,815	21,606	
24	Konovaltsa 132	97,679	79,316	65,865	29,789	17,854	5,460	11,673	12,923	15,641	35,482	
25	G.Mazepy 114a	168,076	156,613	125,963	41,423	21,350	4,975	14,771	15,276	17,247	58,911	
26	Matejka 34	84,608	76,140	64,195	18,025	13,019	9,170	4,817	9,825	10,087	29,634	
27	Chornovola 47a	179,320	154,822	145,969	90,510	51,392	21,787	12,209	24,380	31,299	66,671	
28	Dovga 68	728,336	607,982	528,977	335,752	297,852	80,402		112,042	245,411	367,205	
29	Karpatska 15	677,646	578,463	506,162	35,248						163,272	
30	Junosti 11	244,049	204,726	174,325	2,413						49,860	
31	Nezalezhnosti 36	73,858	63,528	57,480	23,422	21,757	6,020	3,661	9,359	19,331	33,363	
32	Byha 3a	521,274	493,548	415,227	125,417	93,330	14,742	6,897	34,844	74,412	229,368	
33	***Symonenka 3***	***5,187,425***	***4,343,325***	***4,270,726***	***1,842,788***	***1,567,603***	***257,571***		***849,033***	***842,192***	***2,248,742***	***4,***
34	***Industrialna 34***				***3,372,301***	***1,852,109***			***807,784***	***1,618,414***	***3,785,811***	***6,***
35	Lypova	327,681	297,610	204,013	11,314							
	Total	**15,544,646**	**13,359,710**	**12,131,662**	**7,961,040**	**5,671,832**	**1,106,317**	**155,275**	**2,581,668**	**4,236,304**	**10,060,289**	**19**

Exhibit B-3: Gas Consumption by Boilers, year 1998

		Gas consumption by boilers in year 1998, ?3									
		Month									
?	Address	1	2	3	4	5	6	7	8	9	10
1	Pn.bulvar Pushkina 2a	337,154	264,108	317,265	73,555	34,612	35,287	31,890	27,354	17,905	96,19
2	Internationalistiv 8a	473,834	412,343	415,673	145,954	12,453	19,273	42,752	38,717	44,061	200,55
3	Naberezhna 8a	399,058	301,055	360,574	70,093						100,67
4	Ugorska 6	155,796	140,668	158,449	65,658	44,848	31,608	11,445	14,484	15,032	65,67
5	Troleybusna 40	1,970,569	1,646,294	1,816,702	1,193,422	1,126,314		927,486	803,953	870,328	1,287,65
6	Poljuja 1										
7	Fedkovycha 91	800,917	676,849	760,520	253,917		9,020	13,989	10,528	13,797	187,98
8	***Doroshenka 28***	***1,747,020***	***1,494,140***	***1,662,970***	***743,148***	***418,805***	***337,268***	***284,039***	***136,727***	***436,192***	***769,34***
9	Krehivtsi 22 sichnja 141	24,664	20,069	19,964	3,404						7,91
10	G.Mazepy 142	124,686	109,905	125,330	50,021						25,97
11	Belvederska 46	96,646	66,123	80,461	14,233						32,40
12	Belvederska 49	66,779	51,776	56,771	11,255						15,70
13	Belvederska 61	98,945	67,244	83,287	15,635						27,10
14	Vovchynetska 103	43,716	30,809	34,014	7,802						10,81
15	Garbarska 22	28,827	22,753	22,019	5,937						8,72
16	Maksymovycha 5	24,369	19,938	24,784	12,992						6,55
17	Sorochteja 16	91,964	70,364	77,250	17,112		`				20,27
18	Shevchenka 34	103,903	76,666	97,695	19,621						28,13
19	Nezalezhnosti 95	97,955	79,442	84,858	17,798						19,31
20	Chubynskogo 14	11,264	8,866	9,809	3,326						3,55
21	Donzova 4	6,523	5,395	5,677	2,068						1,29
22	Medychna 1	120,766	100,721	120,946	52,455	20,082	1,983	1,878	17,102	20,807	31,66
23	Medychna 4	49,587	40,492	46,268	24,509	10,520	7,589	3,923	8,451	9,619	23,91
24	Konovaltsa 132	98,315	78,068	94,087	97,102	16,616	7,414	19,033	18,354	18,702	47,24
25	G.Mazepy 114a	172,177	142,049	162,535	68,697	25,365	21,947	21,132	13,350	9,647	52,12
26	Matejka 34	86,393	58,746	66,817	28,752	11,890	8,067	11,484	10,091	10,978	31,78
27	Chornovola 47a	181,032	171,132	174,830	125,926	45,232	47,085	20,925	35,070	44,890	105,20
28	Dovga 68	738,448	606,131	648,045	415,101	335,239	444,420	237,153	232,448	124,343	369,15
29	Karpatska 15	673,106	579,737	607,592	174,673						203,78
30	Junosti 11	247,940	216,541	229,999	41,604						68,87
31	Nezalezhnosti 36	68,014	54,077	62,724	26,909	19,265	14,595	8,299	13,309	14,965	31,51
32	Byha 3a	463,085	392,425	447,934	183,341	80,869	14,141	36,014	48,792	83,646	237,23
33	***Symonenka 3***	***5,584,394***	***4,602,682***	***4,879,307***	***2,533,115***	***1,798,239***		***1,017,379***	***1,047,998***	***1,322,166***	***2,459,41***
34	***Industrialna 34***										
35	Lypova	270,798	273,295	327,700	84,757	45,827	8,633				131,88
	Total	**15,458,644**	**12,880,903**	**14,082,856**	**6,583,892**	**4,046,176**	**1,008,330**	**2,688,821**	**2,476,728**	**3,057,078**	**6,709,65**

Exhibit B-4: Boiler Houses Heat Output During 2000, Gcal

		Boiler houses heat output during 2000, Gca									
		Month									
?	Address of boiler house	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
1	Pn.bulvar Pushkina 2a	2,782.7	1,626.0	1,515.5	340.9	199.4	228.6	243.4	213.8	140.8	367
2	Internationalistiv 8a	3,704.8	2,668.9	2,236.0	843.4	116.8					167
3	Naberezhna 8a	3,000.8	1,922.8	1,863.6	708.5						102
4	Ugorska 6	1,134.3	868.0	741.4	385.5	79.3					24
5	Troleybusna 40	14,119.6	10,718.7	11,023.7	7,455.6	2,797.7					946
6	Poljuja 1	638.1	442.4	391.5	104.2						33
7	Fedkovycha 91	6,414.1	4,794.3	3,104.3	1,325.1	67.3	66.6	83.9	87.6	78.2	421
8	***Doroshenka 28***	***13,618.4***	***8,893.1***	***8,571.2***	***4,451.7***	***1,054.4***					***374.***
9	Krehivtsi 22 sichnja 141	174.0	122.5	113.3	33.8						10
10	G.Mazepy 142	925.2	692.9	978.2	137.3						53
11	Belvederska 46	722.4	448.2	387.6	92.2						51
12	Belvederska 49	490.9	311.0	280.2	66.8						30
13	Belvederska 61	619.3	453.9	419.8	107.8						43
14	Vovchynetska 103	300.8	221.1	191.3	47.1						17
15	Garbarska 22	207.4	152.8	152.3	43.0						6
16	Maksymovycha 5	76.4	51.6	82.6	32.3						20
17	Sorochteja 16	649.0	378.7	359.8	98.0						28
18	Shevchenka 34	909.5	596.0	529.8	116.5						25
19	Nezalezhnosti 95	685.2	438.3	361.7	95.6						34
20	Chubynskogo 14	82.0	69.9	73.3	23.5						6
21	Donzova 4	24.8	17.5	19.4	6.5						
22	Medychna 1	947.3	609.3	571.1	186.6	30.7	16.0	25.2	32.7	37.7	81
23	Medychna 4	329.0	224.2	213.8	114.2	30.3	35.0	16.2	34.4	32.9	72
24	Konovaltsa 132	596.0	429.6	397.1	185.8	42.4	25.1	47.4	62.3	67.4	138
25	G.Mazepy 114a	1,002.5	735.5	729.4	396.5	35.6					172
26	Matejka 34	652.3	449.2	415.5	167.3	39.7	51.2	11.7	55.9	56.1	136
27	Chornovola 47a	1,107.4	844.9	834.3	517.2	172.2	149.5	47.2	87.9	115.8	290
28	Dovga 68	5,263.1	3,333.8	3,278.9	1,274.2						206
29	Karpatska 15	4,853.0	3,363.9	3,180.0	1,886.6	592.8					161
30	Junosti 11	1,573.0	1,080.0	915.9	190.2						
31	Nezalezhnosti 36	458.1	324.2	296.0	137.9	42.2					16
32	Byha 3a	4,347.6	2,853.7	2,676.1	1,086.9	159.6					166
33	***Symonenka 3***	***33,017.3***	***22,917.3***	***21,834.9***	***13,206.0***	***2,019.5***					***1,199.***
34	***Industrialna 34***	***76,395.1***	***55,672.1***	***48,912.7***	***27,082.9***	***3,368.0***					***1,922.***
	Total	**181,821.3**	**128,726.3**	**117,652.2**	**62,947.6**	**10,847.9**	**572.0**	**475.0**	**574.6**	**528.9**	**7,328**

Exhibit B-5: Boiler Houses Heat Output During 1999, Gcal

		Boiler houses heat output during 1999, Gcal										
		Month										
?	ddress of boiler hous	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	
1	Pn.bulvar Pushkina 2a	2,461.8	2,146.8	1,764.5	218.6	171.8	224.5	232.2	217.8	126.5	473.1	
2	Internationalistiv 8a	3,332.3	2,987.8	2,916.7	672.8	492.0	285.2	40.9	171.4	369.5	1,458.7	
3	Naberezhna 8a	3,113.6	2,579.1	2,100.7	138.4						769.1	
4	Ugorska 6	1,022.1	982.4	865.3	327.1	229.9	121.1	14.1	48.4	211.6	417.9	
5	Troleybusna 40	14,600.9	12,822.8	10,895.6	5,926.7	6,522.9	2,238.8	0.0	2,454.6	5,068.3	7,163.9	
6	Poljuja 1				24,554.0	12,757.0	7,333.8		5,612.5	11,353.3	103.6	
7	Fedkovycha 91	6,566.5	5,665.7	5,383.1	1,827.4	89.9	68.5	95.8	88.0	90.5	2,339.5	
8	***Doroshenka 28***	***13,072.9***	***11,101.2***	***10,333.8***	***3,300.4***	***3,102.5***	***1,490.9***	***263.1***	***1,351.5***	***2,530.3***	***5,310.9***	***1***
9	Krehivtsi 22 sichnja 14	165.7	152.0	119.9	9.7						47.4	
10	G.Mazepy 142	899.1	799.3	716.8	17.2						195.8	
11	Belvederska 46	662.6	576.8	438.6	33.9						130.2	
12	Belvederska 49	439.2	391.5	295.4	27.9						91.7	
13	Belvederska 61	609.4	516.9	426.5	40.0						131.0	
14	Vovchynetska 103	281.5	239.5	195.7	20.0						81.4	
15	Garbarska 22	181.0	165.0	120.1	10.9						48.9	
16	Maksymovycha 5	146.6	148.4	110.3	10.1						56.2	
17	Sorochteja 16	615.2	507.5	427.3	37.1						139.5	
18	Shevchenka 34	715.9	654.7	464.2	32.9						182.6	
19	Nezalezhnosti 95	731.7	586.0	406.8	39.5						130.9	
20	Chubynskogo 14	75.2	66.4	56.9	8.7						27.3	
21	Donzova 4	24.4	23.0	20.2	2.7						7.5	
22	Medychna 1	782.2	705.3	581.6	174.0	131.3	50.5	52.2	94.1	112.2	235.2	
23	Medychna 4	352.6	311.5	249.6	109.3	64.9	51.8	17.4	51.9	53.4	147.7	
24	Konovaltsa 132	613.5	498.1	413.7	187.1	112.1	34.3	73.3	81.2	98.2	222.8	
25	G.Mazepy 114a	1,066.3	993.6	799.1	262.8	135.4	31.6	93.7	96.9	109.4	373.7	
26	Matejka 34	540.9	486.8	410.4	115.2	83.2	58.2	30.8	62.8	64.5	189.5	
27	Chornovola 47a	1,180.9	1,019.6	961.3	596.1	338.5	143.5	80.4	160.6	206.1	439.1	
28	Dovga 68	5,014.1	3,907.1	3,608.0	2,219.5	2,121.4	543.5		757.3	1,658.8	2,482.1	
29	Karpatska 15	4,864.2	4,352.6	3,843.0	268.4						1,172.0	
30	Junosti 11	1,379.4	1,249.0	1,174.6	15.5						362.7	
31	Nezalezhnosti 36	459.4	395.1	357.5	145.7	135.3	37.4	22.8	58.2	120.2	207.5	
32	Byha 3a	3,797.9	3,475.1	2,961.7	888.1	691.9	104.9	49.1	248.0	529.7	1,632.6	
33	***Symonenka 3***	***39,476.2***	***33,376.4***	***32,312.6***	***13,224.6***	***11,249.2***	***1,848.7***		***6,093.8***	***6,044.7***	***16,140.0***	***3***
34	***Industrialna 34***				***24,554.0***	***12,757.0***			***5,612.5***	***11,353.3***	***27,502.8***	***4***
35	Lypova	2,342.2	2,127.3	1,458.3	80.9							
	Total	**111,587.4**	**96,010.3**	**87,189.8**	**80,097.2**	**51,186.2**	**14,667.2**	**1,065.8**	**23,261.5**	**40,100.5**	**70,414.8**	**13**

Exhibit B-6: Boiler Houses Heat Output During 1998, Gcal

		Boiler houses heat output during 1998, Gcal									
		Month									
?	Address	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.
1	Pn.bulvar Pushkina 2a	2,385.1	1,868.3	2,244.4	520.3	244.9	249.6	225.6	193.5	126.7	68
2	Internationalistiv 8a	3,420.5	2,976.6	3,000.6	1,053.6	442.4	139.1	308.6	279.5	318.1	1,44
3	Naberezhna 8a	2,913.7	2,198.1	2,632.7	511.8						73
4	Ugorska 6	974.3	879.7	990.9	410.6	280.5	197.7	71.6	90.6	94.0	41
5	Troleybusna 40	14,154.0	11,824.8	13,048.8	8,572.0	8,090.0		6,661.9	5,774.6	6,251.3	9,24
6	Poljuja 1	461.1									
7	Fedkovycha 91	5,846.5	4,940.9	5,551.6	1,853.5	90.9	65.8	102.1	76.9	100.7	1,37
8	***Doroshenka 28***	***12,531.4***	***10,717.5***	***11,928.5***	***5,330.8***	***3,004.1***	***2,419.2***	***2,037.4***	***980.7***	***3,128.8***	***5,51***
9	Krehivtsi 22 sichnja 141	168.5	137.1	136.4	23.3						5
10	G.Mazepy 142	829.1	730.8	833.4	332.6						17
11	Belvederska 46	598.1	409.2	498.0	88.1						20
12	Belvederska 49	413.3	320.4	351.3	69.7						9
13	Belvederska 61	614.6	417.7	517.3	97.1						16
14	Vovchynetska 103	270.7	190.8	210.6	48.3						6
15	Garbarska 22	178.8	141.2	136.6	36.8						5
16	Maksymovycha 5	155.0	126.8	157.7	82.6						4
17	Sorochteja 16	602.0	460.6	505.7	112.0						13
18	Shevchenka 34	655.1	483.4	615.9	123.7						17
19	Nezalezhnosti 95	643.7	522.0	557.6	117.0						12
20	Chubynskogo 14	69.9	55.0	60.9	20.6						2
21	Donzova 4	26.9	22.3	23.4	8.5						
22	Medychna 1	760.3	634.1	761.5	330.2	126.4	12.5	11.8	107.7	131.0	19
23	Medychna 4	338.9	276.8	316.2	167.5	71.9	51.9	26.8	57.8	65.7	16
24	Konovaltsa 132	617.5	490.3	590.9	295.8	104.4	46.6	119.5	115.3	117.5	29
25	G.Mazepy 114a	1,092.3	901.2	1,031.2	435.8	160.9	139.2	134.1	84.7	61.2	33
26	Matejka 34	552.4	375.6	427.2	183.8	76.0	51.6	73.4	64.5	70.2	20
27	Chornovola 47a	1,192.2	1,127.0	1,151.4	829.3	297.9	310.1	137.8	231.0	295.6	69
28	Dovga 68	5,308.1	4,357.0	4,658.3	2,983.8	2,409.8	3,194.6	1,704.7	1,670.9	893.8	2,65
29	Karpatska 15	4,831.6	4,161.4	4,361.3	1,253.8						1,46
30	Junosti 11	1,803.8	1,575.4	1,673.3	302.7						50
31	Nezalezhnosti 36	423.0	336.3	390.1	167.4	119.8	90.8	51.6	82.8	93.1	19
32	Byha 3a	3,373.9	2,859.1	3,263.5	1,335.8	589.2	103.0	262.4	355.5	609.4	1,72
33	***Symonenka 3***	***40,642.2***	***33,497.5***	***35,510.7***	***18,435.5***	***13,087.3***	***0.0***	***7,404.3***	***7,627.1***	***9,622.5***	***17,89***
34	***Industrialna 34***										
35	Lypova	1,935.6	1,953.5	2,342.4	605.8	289.8	54.6				94
	Total	**110,784.1**	**91,968.4**	**100,480.3**	**46,740.1**	**29,486.2**	**7,126.3**	**19,333.6**	**17,793.1**	**21,979.6**	**48,00**

Exhibit B-7: Initial Heat Realization (with losses) During 2000, Gcal

		Initial heat realization (with losses) during 2000, Gcal									
		Month									
?	Address of boiler house	1	2	3	4	5	6	7	8	9	10
1	Pn.bulvar Pushkina 2a	2,701.6	1,578.6	1,471.4	331.0	193.6	221.9	236.3	207.6	136.7	356.9
2	Internationalistiv 8a	3,632.2	2,616.6	2,192.2	826.9	114.5					164.0
3	Naberezhna 8a	2,942.0	1,885.1	1,827.1	694.6						100.9
4	Ugorska 6	112.1	851.0	726.9	377.9	77.7					23.7
5	Troleybusna 40	13,073.7	9,924.7	10,207.1	6,903.3	2,590.5					876.8
6	Poljuja 1	628.7	435.9	385.7	102.7						32.8
7	Fedkovycha 91	6,227.3	4,654.7	3,013.9	1,286.5	65.3	64.7	81.5	85.0	75.9	409.6
8	***Doroshenka 28***	***13,221.7***	***8,634.1***	***8,321.5***	***4,322.0***	***1,023.7***					***363.6***
9	Krehivtsi 22 sichnja 141	172.3	121.3	112.2	33.5						10.6
10	G.Mazepy 142	907.1	679.3	664.9	134.6						52.3
11	Belvederska 46	715.2	443.8	383.8	91.3						50.5
12	Belvederska 49	486.0	307.9	277.4	66.1						29.9
13	Belvederska 61	613.2	449.4	415.6	106.7						43.5
14	Vovchynetska 103	297.8	218.9	189.4	46.6						17.7
15	Garbarska 22	205.3	151.3	150.8	42.6						6.7
16	Maksymovycha 5	76.0	51.3	82.2	32.3						20.1
17	Sorochteja 16	642.6	374.9	356.2	97.0						27.8
18	Shevchenka 34	900.5	590.1	524.5	115.3						24.8
19	Nezalezhnosti 95	678.4	434.0	358.1	94.7						33.7
20	Chubynskogo 14	81.6	69.5	72.9	23.4						6.3
21	Donzova 4	24.8	17.5	19.4	6.5						
22	Medychna 1	919.7	591.5	554.5	181.2	29.8	15.5	24.5	31.7	36.6	78.6
23	Medychna 4	319.4	217.7	207.6	110.9	29.4	34.0	15.7	33.4	31.9	69.9
24	Konovaltsa 132	578.6	417.1	385.5	180.4	41.2	24.4	46.0	60.5	65.4	134.0
25	G.Mazepy 114a	992.6	728.2	722.2	392.6	35.2					170.9
26	Matejka 34	933.3	436.1	403.4	162.4	38.5	49.7	11.4	54.3	54.5	132.5
27	Chornovola 47a	1,075.1	820.3	810.0	502.1	167.2	145.1	45.8	85.3	112.4	282.2
28	Dovga 68	5,159.9	3,268.4	3,214.6	1,249.3						202.0
29	Karpatska 15	4,757.8	3,297.9	3,117.6	1,849.6	581.2					157.8
30	Junosti 11	1,542.2	1,058.8	897.9	186.5						
31	Nezalezhnosti 36	453.6	321.0	293.1	166.5	47.8					16.2
32	Byha 3a	4,262.3	2,797.7	2,623.6	1,065.6	156.5					163.1
33	***Symonenka 3***	***32,055.6***	***22,249.8***	***21,198.9***	***12,821.4***	***1,960.7***					***1,164.7***
34	***Industrialna 34***	***75,653.7***	***54,957.6***	***48,285.0***	***26,735.3***	***3,267.0***					***1,862.5***
	Total	**177,043.9**	**125,652.0**	**114,467.1**	**61,339.3**	**10,419.8**	**555.3**	**461.2**	**557.8**	**513.4**	**7,086.0**

Exhibit B-8: Initial Heat Realization (with losses) During 1999, Gcal

		Initial heat realization (with losses) during 1999, Gcal									
		Month									
?	Address of boiler house	1	2	3	4	5	6	7	8	9	10
1	Pn.bulvar Pushkina 2a	2,390.1	2,084.3	1,713.1	212.2	166.8	218.0	225.5	211.5	122.8	459.3
2	Internationalistiv 8a	3,267.0	2,929.2	2,859.5	659.6	482.4	279.6	40.1	168.1	362.3	1,430.1
3	Naberezhna 8a	3,052.6	2,528.5	2,059.5	135.6						754.0
4	Ugorska 6	1,012.0	972.7	856.7	323.8	227.6	119.9	13.9	47.9	209.5	413.8
5	Troleybusna 40	13,519.4	11,873.0	10,088.5	5,487.7	6,039.7	2,073.0		2,272.8	4,692.9	6,633.2
6	Poljuja 1										101.5
7	Fedkovycha 91	6,375.2	5,500.7	5,226.3	1,774.2	87.3	66.5	93.0	85.4	87.8	2,271.4
8	***Doroshenka 28***	***12,816.6***	***10,883.5***	***10,131.2***	***3,235.7***	***3,041.6***	***1,461.7***	***258.0***	***1,325.0***	***2,480.7***	***5,206.8***
9	Krehivtsi 22 sichnja 141	164.1	150.5	118.8	9.6						47.0
10	G.Mazepy 142	872.9	776.0	696.0	16.7						190.1
11	Belvederska 46	656.1	571.1	434.3	33.5						128.9
12	Belvederska 49	434.8	387.7	292.5	27.7						90.8
13	Belvederska 61	603.4	511.7	422.2	39.6						129.7
14	Vovchynetska 103	280.1	239.5	194.7	19.9						81.4
15	Garbarska 22	179.2	163.4	118.9	10.8						48.4
16	Maksymovycha 5	145.9	148.4	109.8	10.1						56.2
17	Sorochteja 16	609.1	502.5	423.0	36.7						138.1
18	Shevchenka 34	708.8	648.3	459.6	32.5						180.8
19	Nezalezhnosti 95	724.4	580.2	402.8	39.1						129.6
20	Chubynskogo 14	74.8	66.4	56.9	8.7						27.3
21	Donzova 4	24.4	23.0	20.2	2.7						7.5
22	Medychna 1	759.4	684.7	564.6	168.9	127.5	49.0	50.6	91.3	108.9	228.3
23	Medychna 4	342.3	302.4	242.4	106.1	63.1	50.3	16.9	50.4	51.9	143.4
24	Konovaltsa 132	595.6	483.6	401.6	181.6	108.9	33.3	71.2	78.8	95.4	216.4
25	G.Mazepy 114a	1,055.8	983.8	791.2	260.2	134.1	31.3	92.8	96.0	108.3	370.0
26	Matejka 34	525.2	472.6	398.5	111.9	80.8	56.9	29.9	61.0	62.6	183.9
27	Chornovola 47a	1,146.5	989.9	933.3	578.7	328.6	139.3	78.1	155.9	200.1	426.3
28	Dovga 68	4,915.8	3,830.5	3,537.3	2,176.0	2,079.8	532.8		742.5	1,626.3	2,433.4
29	Karpatska 15	4,768.8	4,267.3	3,767.7	263.1						1,149.0
30	Junosti 11	1,352.4	1,224.5	1,151.6	15.2						355.6
31	Nezalezhnosti 36	446.0	383.6	347.1	141.4	131.4	36.4	22.1	56.5	116.7	201.5
32	Byha 3a	3,723.4	3,407.0	2,903.7	871.0	678.3	102.9	48.1	243.2	519.3	1,600.6
33	***Symonenka 3***	***37,957.9***	***32,092.7***	***31,069.9***	***12,716.0***	***10,816.5***	***1,777.6***		***5,859.4***	***5,812.2***	***15,519.3***
34	***Industrialna 34***				***24,320.0***	***12,592.6***			***5,527.0***	***11,156.0***	***27,074.0***
35	Lypova	2,296.3	2,085.6	1,429.7	79.3						
	Total	**107,796.3**	**92,748.8**	**84,223.1**	**54,105.8**	**37,187.0**	**7,028.5**	**1,040.2**	**17,072.7**	**27,813.7**	**68,427.6**

Exhibit B-9: Initial Heat Realization (with losses) During 1998, Gcal

		??????? ????? ?? 1998 ??, ???? / Initial heat realization (with losses) during 1998, Gcal									
		? ?????/ Month									
?	Address of boiler house	1	2	3	4	5	6	7	8	9	10
1	Pn.bulvar Pushkina 2a	2,315.8	1,813.9	2,179.0	505.2	237.7	242.4	219.0	187.9	123.0	660.7
2	Internationalistiv 8a	3,353.4	2,918.2	2,941.8	1,032.9	433.7	136.4	302.6	274.0	311.8	1,419.3
3	Naberezhna 8a	2,856.5	2,155.0	2,581.1	501.7						720.6
4	Ugorska 6	1,964.7	871.0	981.1	406.6	277.7	195.7	70.9	89.7	93.1	406.7
5	Troleybusna 40	13,741.8	11,480.4	12,668.8	8,322.3	7,854.7		6,467.8	5,606.4	6,069.2	8,979.5
6	Poljuja 1	456.5									
7	Fedkovycha 91	5,676.2	4,796.9	5,389.9	1,799.6	88.3	63.9	99.1	74.6	97.8	1,332.3
8	***Doroshenka 28***	***12,285.7***	***10,507.3***	***11,694.6***	***5,226.3***	***2,945.2***	***2,371.8***	***1,997.5***	***961.5***	***3,067.5***	***5,410.3***
9	Krehivtsi 22 sichnja 141	166.9	135.8	135.1	23.0						53.5
10	G.Mazepy 142	804.9	709.5	809.1	322.9						167.7
11	Belvederska 46	592.2	405.2	493.0	87.2						198.6
12	Belvederska 49	409.2	317.3	347.9	69.0						96.3
13	Belvederska 61	608.5	413.6	512.2	96.2						166.7
14	Vovchynetska 103	270.7	190.8	210.6	48.3						66.9
15	Garbarska 22	177.1	139.8	135.3	36.5						53.6
16	Maksymovycha 5	155.0	126.8	157.7	82.6						41.7
17	Sorochteja 16	596.0	456.0	500.6	110.9						131.4
18	Shevchenka 34	648.6	478.6	609.8	122.5						175.6
19	Nezalezhnosti 95	637.3	516.9	552.1	115.8						125.7
20	Chubynskogo 14	69.9	55.0	60.9	20.6						22.1
21	Donzova 4	26.9	22.3	23.4	8.5						5.3
22	Medychna 1	738.2	615.7	739.3	320.6	122.8	12.1	11.5	104.5	127.2	193.5
23	Medychna 4	329.0	268.7	307.0	162.6	69.8	50.4	26.0	56.1	63.8	158.7
24	Konovaltsa 132	599.5	476.0	573.7	287.2	101.3	45.2	116.1	111.9	114.0	288.1
25	G.Mazepy 114a	1,081.5	892.3	1,020.9	431.5	159.3	137.9	132.7	83.9	60.6	327.4
26	Matejka 34	536.3	364.7	414.8	178.5	73.8	50.1	71.3	62.6	68.1	197.3
27	Chornovola 47a	1,157.5	1,094.2	1,117.8	805.2	289.2	301.1	133.8	224.2	287.0	672.6
28	Dovga 68	5,204.0	4,271.5	4,566.9	2,925.3	2,362.5	3,131.9	1,671.3	1,670.9	893.8	2,601.5
29	Karpatska 15	4,736.8	4,079.8	4,275.8	1,229.2						1,434.1
30	Junosti 11	1,768.5	1,544.5	1,640.5	296.7						491.2
31	Nezalezhnosti 36	410.7	326.6	378.8	162.5	116.3	88.1	50.1	82.8	93.1	190.3
32	Byha 3a	3,307.8	2,803.0	3,199.5	1,309.6	577.6	101.0	257.2	355.5	609.4	1,694.5
33	***Symonenka 3***	***39,079.0***	***32,209.1***	***34,144.9***	***17,726.5***	***12,583.9***	***?***	***7,119.5***	***7,627.1***	***9,622.3***	***17,210.8***
34	***Industrialna 34***										
35	Lypova	142.7	1,915.2	2,296.4	594.0	284.1	53.6				924.2
	Total	**106,905.3**	**89,371.6**	**97,660.3**	**45,368.0**	**28,577.9**	**6,981.6**	**18,746.4**	**17,573.6**	**21,701.7**	**46,618.7**

Exhibit B- 10: Delivered Heat During 2000, Gcal

		?????????? ????? ?? ????????? ?? 2000 ???, ???? / Delivered heat during 2000, Gcal										
		? ?????/ Month										
?	**Address of boiler house**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
1	Pn.bulvar Pushkina 2a	2,490.9	1,455.5	1,352.2	301.9	182.0	208.6	222.1	195.1	128.5	328.0	
2	Internationalistiv 8a	3,342.1	2,412.5	2,019.0	761.6	46.2					151.5	1
3	Naberezhna 8a	2,697.8	1,728.6	1,671.8	635.6						89.2	1
4	Ugorska 6	1,032.3	790.3	678.2	341.5	58.3					21.2	
5	Troleybusna 40	10,261.4	7,628.0	7,625.0	4,308.9	914.5					787.4	3
6	Poljuja 1	587.8	407.6	360.2	96.2						30.3	
7	Fedkovycha 91	4,819.2	3,841.9	2,622.1	1,114.0	62.7	62.1	78.2	81.6	72.9	371.9	2
8	***Doroshenka 28***	***10,178.8***	***6,910.1***	***7,043.9***	***3,393.4***	***655.0***					***323.2***	***3***
9	Krehivtsi 22 sichnja 141	163.7	115.2	105.2	31.7						9.8	
10	G.Mazepy 142	842.7	631.1	617.0	125.2						39.2	
11	Belvederska 46	667.3	414.1	360.0	85.3						46.5	
12	Belvederska 49	459.8	291.3	262.1	62.5						27.9	
13	Belvederska 61	569.1	417.0	385.3	98.5						39.5	
14	Vovchynetska 103	284.7	209.3	181.3	44.5						16.7	
15	Garbarska 22	194.4	143.3	143.9	40.5						6.3	
16	Maksymovycha 5	71.8	48.5	78.1	30.8						19.0	
17	Sorochteja 16	589.3	343.8	325.6	89.0						24.9	
18	Shevchenka 34	835.7	547.6	484.6	106.0						22.8	
19	Nezalezhnosti 95	624.1	399.3	327.3	86.2						30.7	
20	Chubynskogo 14	78.3	66.7	69.9	22.4						6.0	
21	Donzova 4	24.8	17.5	19.4	6.5							
22	Medychna 1	853.5	548.9	414.4	167.2	28.0	14.6	23.0	29.8	34.4	70.1	
23	Medychna 4	302.5	206.2	196.4	105.1	28.1	32.5	15.0	31.9	30.5	65.8	
24	Konovaltsa 132	551.4	397.5	367.0	171.9	39.6	23.4	44.2	58.1	62.8	127.2	
25	G.Mazepy 114a	917.2	672.9	667.3	360.9	41.9					156.5	
26	Matejka 34	595.9	410.4	379.2	152.7	36.6	47.2	10.8	51.6	51.8	124.4	
27	Chornovola 47a	1,004.1	766.2	756.5	470.5	157.8	124.7	43.0	80.5	106.1	263.6	
28	Dovga 68	4,213.2	2,728.2	2,696.8	752.6						184.2	1
29	Karpatska 15	4,025.3	2,811.1	2,842.3	1,699.8	394.1					137.3	1
30	Junosti 11	1,412.7	969.9	818.9	167.5							
31	Nezalezhnosti 36	332.8	243.0	225.6	79.9	17.4					15.0	
32	Byha 3a	3,831.4	2,508.2	2,372.8	905.1	66.2					146.5	1
33	***Symonenka 3***	***25,926.8***	***18,063.3***	***17,572.0***	***10,163.4***	***1,384.3***					***1,020.3***	***12***
34	***Industrialna 34***	***64,868.5***	***47,105.0***	***39,122.0***	***18,587.6***	***1,500.1***					***1,009.5***	***23***
	Total	**149,650.9**	**106,250.0**	**95,163.3**	**45,566.4**	**5,612.8**	**513.1**	**436.3**	**528.6**	**487.0**	**5,712.4**	**59**

Exhibit B-11: Delivered Heat During 1999, Gcal

		Delivered heat during 1999, Gcal										
		Month										
?	Address of boiler house	1	2	3	4	5	6	7	8	9	10	
1	Pn.bulvar Pushkina 2a	2,175.0	1,880.0	1,564.1	196.1	156.8	204.9	212.0	198.8	115.4	419.8	
2	Internationalistiv 8a	2,969.7	2,703.7	2,636.5	610.1	451.1	260.0	35.1	155.3	340.6	1,321.4	
3	Naberezhna 8a	2,793.1	2,323.7	1,886.5	124.8						707.3	
4	Ugorska 6	941.2	908.5	797.6	303.1	213.3	112.1	12.5	44.4	196.9	386.9	
5	Troleybusna 40	12,181.0	10,662.0	9,079.6	4,960.9	5,665.2	1,938.3		2,127.3	4,411.3	6,115.8	
6	Poljuja 1										93.0	
7	Fedkovycha 91	5,833.3	5,027.6	4,776.8	1,625.2	83.8	63.8	89.3	82.0	84.3	2,144.2	
8	***Doroshenka 28***	***11,560.6***	***9,751.6***	***9,097.8***	***2,954.2***	***2,850.0***	***1,365.2***	***230.4***	***1,232.2***	***2,331.9***	***4,665.3***	
9	Krehivtsi 22 sichnja 141	155.6	142.7	110.6	9.1						44.6	
10	G.Mazepy 142	804.8	714.7	641.7	15.6						176.8	
11	Belvederska 46	614.8	534.5	406.9	31.3						120.1	
12	Belvederska 49	408.3	363.7	274.7	26.0						84.6	
13	Belvederska 61	563.6	475.9	391.0	36.9						120.8	
14	Vovchynetska 103	268.9	229.9	187.3	19.0						78.1	
15	Garbarska 22	169.9	154.9	112.2	10.3						45.3	
16	Maksymovycha 5	138.6	140.5	103.7	9.6						52.6	
17	Sorochteja 16	560.4	462.3	385.8	33.4						128.2	
18	Shevchenka 34	657.8	600.3	424.7	30.1						169.0	
19	Nezalezhnosti 95	667.2	534.4	368.6	35.9						119.6	
20	Chubynskogo 14	71.1	62.9	53.9	8.3						26.5	
21	Donzova 4	24.4	23.0	19.4	2.7						7.5	
22	Medychna 1	713.8	641.6	529.0	157.8	119.5	45.7	47.2	85.8	101.9	210.7	
23	Medychna 4	322.4	284.6	227.9	100.5	60.1	47.9	16.0	48.0	49.5	136.1	
24	Konovaltsa 132	565.8	463.3	384.7	173.8	104.3	31.8	68.1	75.4	91.4	207.5	
25	G.Mazepy 114a	980.8	909.0	727.1	241.7	126.3	29.4	87.4	90.4	102.0	344.8	
26	Matejka 34	490.5	448.0	366.6	105.7	76.8	54.1	28.4	57.9	59.5	173.2	
27	Chornovola 47a	1,067.4	919.6	866.1	544.6	309.5	130.9	73.1	146.5	188.3	397.3	
28	Dovga 68	4,512.7	3,508.8	3,176.5	1,995.4	1,940.5	493.9		691.3	1,520.6	2,226.6	
29	Karpatska 15	4,349.1	3,908.9	3,424.8	241.3						1,042.1	
30	Junosti 11	1,237.5	1,119.2	1,053.7	14.1						328.6	
31	Nezalezhnosti 36	413.9	354.4	321.4	131.2	124.0	34.2	20.7	53.2	110.2	192.4	
32	Byha 3a	3,414.4	3,127.6	2,656.9	794.4	643.0	96.6	38.6	225.4	488.1	1,464.5	
33	***Symonenka 3***	***34,314.0***	***29,076.0***	***28,118.3***	***11,546.1***	***10,070.2***	***1,628.3***		***5,449.2***	***5,370.5***	***13,827.7***	***2***
34	***Industrialna 34***				***19,830.0***	***8,896.6***			***4,368.5***	***7,315.9***	***21,398.7***	***4***
35	Lypova	2,101.1	1,925.0	1,328.2	74.1							
	Total	**98,042.7**	**84,382.8**	**76,500.6**	**46,993.3**	**31,891.0**	**6,537.1**	**958.8**	**15,131.6**	**22,878.3**	**58,977.6**	**11**

Exhibit B-12: Delivered Heat During 1998, Gcal

		Delivered heat during 1998, Gcal									
		Month									
?	Address of boiler house	1	2	3	4	5	6	7	8	9	10
1	Pn.bulvar Pushkina 2a	2,107.2	1,650.6	1,982.9	464.8	223.4	227.9	205.9	176.6	115.6	613.1
2	Internationalistiv 8a	3,048.2	2,652.6	2,674.1	951.3	407.7	128.2	284.4	257.6	293.1	1,334.1
3	Naberezhna 8a	2,613.7	1,971.8	2,361.7	462.6						684.6
4	Ugorska 6	897.2	810.0	912.4	378.5	261.0	184.0	66.6	84.3	87.5	382.3
5	Troleybusna 40	12,381.4	10,343.8	11,414.6	7,606.6	7,383.1		6,079.7	5,270.0	5,705.0	8,108.5
6	Poljuja 1	456.5									
7	Fedkovycha 91	5,193.7	4,389.2	4,931.8	1,646.6	84.8	61.3	95.1	71.6	93.9	1,265.7
8	***Doroshenka 28***	***11,081.7***	***9,477.6***	***10,548.5***	***4,719.3***	***2,768.5***	***2,229.5***	***1,877.6***	***903.8***	***2,883.4***	***4,896.3***
9	Krehivtsi 22 sichnja 141	158.2	128.7	128.1	21.8						51.9
10	G.Mazepy 142	742.1	654.2	746.0	300.9						157.6
11	Belvederska 46	554.9	379.7	461.9	81.8						187.1
12	Belvederska 49	384.2	297.9	326.7	64.8						90.7
13	Belvederska 61	568.3	386.3	478.4	89.9						157.0
14	Vovchynetska 103	257.2	181.3	200.1	46.4						64.9
15	Garbarska 22	167.4	132.1	127.9	34.9						51.2
16	Maksymovycha 5	147.2	120.5	149.8	79.3						40.0
17	Sorochteja 16	548.3	419.5	460.6	103.2						123.5
18	Shevchenka 34	601.9	444.1	656.9	114.5						165.8
19	Nezalezhnosti 95	587.0	476.1	508.5	108.0						120.7
20	Chubynskogo 14	66.4	52.2	57.9	19.7						21.4
21	Donzova 4	25.8	21.4	22.5	8.2						5.1
22	Medychna 1	690.2	575.7	691.2	299.8	115.4	11.4	10.8	98.2	119.6	181.9
23	Medychna 4	309.3	252.6	288.6	152.8	66.7	48.1	24.8	53.6	60.9	151.6
24	Konovaltsa 132	563.5	447.4	539.3	270.0	97.2	43.4	111.5	107.6	109.4	276.6
25	G.Mazepy 114a	1,004.7	828.9	948.4	400.9	150.4	130.2	125.3	79.2	57.2	307.4
26	Matejka 34	500.9	340.6	387.4	166.7	70.1	47.6	67.7	59.5	64.7	187.4
27	Chornovola 47a	1,077.6	1,018.7	1,040.7	749.6	273.0	284.2	126.3	211.6	270.9	634.9
28	Dovga 68	4,777.3	3,921.2	4,192.4	2,685.4	2,220.7	2,944.0	1,571.0	98.3		2,445.4
29	Karpatska 15	4,320.0	3,720.8	3,899.5	1,125.4						1,322.2
30	Junosti 11	1,618.2	1,413.2	1,501.1	273.0						461.7
31	Nezalezhnosti 36	381.1	303.1	351.5	151.4	109.9	83.3	47.5	4.4	85.4	182.7
32	Byha 3a	3,033.3	2,570.4	2,933.9	1,208.6	554.5	97.0	246.9	13.9	573.6	1,570.8
33	***Symonenka 3***	***35,327.4***	***29,117.0***	***30,867.0***	***16,166.6***	***11,828.9***		***6,692.3***	***440.0***	***8,697.3***	***15,696.2***
34	***Industrialna 34***										
35	Lypova	1,736.4	1,752.4	2,101.2	547.1	268.2	50.6				845.6
	Total	**97,928.4**	**81,251.6**	**88,893.5**	**41,500.4**	**26,883.5**	**6,570.7**	**17,633.4**	**7,930.2**	**19,217.5**	**42,785.9**

Exhibit C: Water Boilers and Their Main Characteristics

HD No.		Water boilers								Total hea capacity, Gcal/h
		?1	?2	?3	?4	?5	?6	?7	?8	
1	**Pn. bulvar Pushkina**									
1	Type	??-21	??-21	??-21	??-21	????-4/13	????-4/13			
1	Year of installation	1967	1976	1976	1968	1968	1984			
1	Capacity, Gcal / hour	1.72	1.72	1.72	1.72	2.66	2.66			12.3
1	Efficiency,%	89.2	89.2	89.2	89.2	85.7	85.7			
1	**Ugorska str. 6a**									
1	Type	??????-5	??????-5	??????-5	??????-5	??????-5	??????-5			
1	Year of installation	1971	1978	1978	1978	1981	1981			
1	Capacity, Gcal / hour	0.63	0.63	0.63	0.63	0.63	0.63			3.78
1	Efficiency,%	80	80	80	80	80	80			
1	**Puljuja str. 1a**									
1	Type	??-21	??-21	??-21	??-21					
1	Year of installation	1998	1998	1998	1998					
1	Capacity, Gcal / hour	1.72	1.72	1.72	1.72					6.88
1	Efficiency,%	89.2	89.2	89.2	89.2					
1	**Internatiohalistiv str. 8a**									
1	Type	???-8,3	???-6,5	???-4						
1	Year of installation	1978	1988	1987						
1	Capacity, Gcal / hour	8.3	6.5	4						18.8

1	Efficiency,%	87.8	87.8	87.8						
1	**Fedkovycha str. 91a**									
1	Type	???-6,5	???-6,5	???-6,5	??-800	??-800				
1	Year of installation	1996	1996	1996	1991	1991				
1	Capacity, Gcal / hour	6.5	6.5	6.5	0.5	0.5				20.5
1	Efficiency,%	87.8	87.8	87	83	83				
1	**Naberezhna str. 4a**									
1	Type	????-2,5	????-2,5	????-2,5	????-2,5	??-22	??-21	??-21		
1	Year of installation	1986	1986	1988	1988	1994	1993	1995		
1	Capacity, Gcal / hour	2.5	2.5	2.5	2.5	0.86	1.72	1.72		14.3
1	Efficiency,%	87.4	87.4	87.4	87.4	89.6	89.2	89.2		
1	**Trolejbusna str. 40a**									
1	Type	???-8,3	???-8,3	???-8,3	???-8,3					
1	Year of installation	1978	1980	1981	1984					
1	Capacity, Gcal / hour	8.3	8.3	8.3	8.3					33.2
1	Efficiency,%	87.8	87.8	87.8	87.8					
2	**Doroshenka str. 28**									
2	Type	???-8,3	???-8,3	???-8,3	???-8,3					
2	Year of installation	1975	1975	1980	1985					
2	Capacity, Gcal / hour	8.3	8.3	8.3	8.3					33.2
2	Efficiency,%	87.8	87.8	87.8	87.8					
2	**Mazepy str. 142a**									
2	Type	??-21	??-21	??-21						
2	Year of installation	1999	1999	1999						
2	Capacity, Gcal / hour	1.72	1.72	1.72						5.16
2	Efficiency,%	89.2	89.2	89.2						
2	**Krehivtsi 22 sichnja str.**									
2	Type	?????	?????	?????						

2	Year of installation	1992	1992	1992						
2	Capacity, Gcal / hour	0.86	0.86	0.86						2.58
2	Efficiency,%	86.1	86.1	86.1						
2	**Masepy str. 144a**									
2	Type	???-???	???-???	??????-5	??????-5	??????-5	??????-5	???? ??-5	???? ??-5	
2	Year of installation	1975	1975	1978	1978	1978	1978	1978	1978	
2	Capacity, Gcal / hour	0.65	0.65	0.63	0.63	0.63	0.63	0.63	0.63	5.08
2	Efficiency,%	83	83	80	80	80	80	80	80	
2	**Medychna str. 4**									
2	Type	??????-5	??????-5	??????-5	??????-5	??????-5				
2	Year of installation	1992	1992	1992	1978	1978				
2	Capacity, Gcal / hour	0.63	0.63	0.63	0.63	0.63				3.15
2	Efficiency,%	80	80	80	80	80				
2	**Medychna str.1**									
2	Type	???-???	???-???	???-???	??????-5	??????-5	??????-5	???? ??-5	???? ??-5	
2	Year of installation	1982	1982	1982	1980	1978	1978	1978	1978	
2	Capacity, Gcal / hour	0.65	0.65	0.65	0.63	0.63	0.63	0.63	0.63	5.1
2	Efficiency,%	83	83	83	80	80	80	80	80	
2	**Belvederska str. 46a**									
2	Type	??????-5	??????-5	??????-5	??????-5					
2	Year of installation	1980	1980	1980	1980					
2	Capacity, Gcal / hour	0.63	0.63	0.63	0.63					2.52
2	Efficiency,%	80	80	80	80					
2	**Belvederska str. 61**									
2	Type	??????-5	??????-5	??????-5	??-34					
2	Year of installation	1980	1980	1980	1995					
2	Capacity, Gcal / hour	0.63	0.63	0.63	0.5					2.39

2	Efficiency,%	80	80	80	89.2					
2	**Belvederska str. 49**									
2	Type	??????-5	??????-5	??????-5						
2	Year of installation	1978	1978	1978						
2	Capacity, Gcal / hour	0.63	0.63	0.63						1.89
2	Efficiency,%	80	80	80						
2	**Garbarska str. 22**									
2	Type	??????-5	??????-5							
2	Year of installation	1978	1978							
2	Capacity, Gcal / hour	0.63	0.63							1.26
2	Efficiency,%	80	80							
2	**Shevchnka str. 34**									
2	Type	??????-5	??????-5	??????-5	??????-5					
2	Year of installation	1978	1978	1978	1978					
2	Capacity, Gcal / hour	0.63	0.63	0.63	0.63					2.52
2	Efficiency,%	80	80	80	80					
2	**Nezalezhnosti str. 96**									
2	Type	??????-5	??????-5	??????-5	??????-5					
2	Year of installation	1978	1978	1978	1978					
2	Capacity, Gcal / hour	0.63	0.63	0.63	0.63					2.52
2	Efficiency,%	80	80	80	80					
2	**Chubynskogo str. 14**									
2	Type	??????-5								
2	Year of installation	1980								
2	Capacity, Gcal / hour	0.63								0.63
2	Efficiency,%	80								
2	**Vovchynetska str. 103**									

2	Type	??????-5	??????-5	??????-5						
2	Year of installation	1978	1978	1978						
2	Capacity, Gcal / hour	0.63	0.63	0.63						1.89
2	Efficiency,%	80	80	80						
2	**Sorohteja str.16**									
2	Type	??????-5	??????-5	??????-5	??????-5					
2	Year of installation	1986	1986	1986	1986					
2	Capacity, Gcal / hour	0.63	0.63	0.63	0.63					2.52
2	Efficiency,%	80	80	80	80					
2	**Dontsova str. 4**									
2	Type	?????????								
2	Year of installation	1900								
2	Capacity, Gcal / hour	0.18								0.18
2	Efficiency,%	51.3								
2	**Maksymovycha str. 5**									
2	Type	??????-5	??????-5							
2	Year of installation	1987	1987							
2	Capacity, Gcal / hour	0.63	0.63							1.26
2	Efficiency,%	80	80							
2										
3	**Dovga str. 68a**									
3	Type	???-8,3	???-8,3	???-6,5						
3	Year of installation	1970	1970	1983						
3	Capacity, Gcal / hour	8.3	8.3	6.5						23.1
3	Efficiency,%	87.8	87.8	87.8						
3	**Karpatska str. 15**									
3	Type	???-8	???-8	???-8						
3	Year of installation	1970	1970	1970						

3	Capacity, Gcal / hour	8.3	8.3	8.3						24.9
3	Efficiency,%	87.8	87.8	87.8						
3	**Junosti str. 11a**									
3	Type	???-4	???-4	???-6,5						
3	Year of installation	1977	1977	1987						
3	Capacity, Gcal / hour	4	4	6.5						14.5
3	Efficiency,%	88.2	88.2	87.8						
3	**Nezalezhnosta str. 36**									
3	Type	??????-5	??????-5	??????-5	??????-5					
3	Year of installation	1978	1978	1986	1999					
3	Capacity, Gcal / hour	0.63	0.63	0.63	0.63					2.52
3	Efficiency,%	80	80	80	80					
3	**Byha str. 3a**									
3	Type	???-6,5	???-6,5	???-6,5						
3	Year of installation	1987	1987	1987						
3	Capacity, Gcal / hour	6.5	6.5	6.5						19.5
3	Efficiency,%	87.8	87.8	87.8						
3	**Mateiky str.34**									
3	Type	???-7??	???-7??	??????-5	??????-5	??????-5				
3	Year of installation	1979	1980	1978	1978	1978				
3	Capacity, Gcal / hour	0.65	0.65	0.63	0.63	0.63				3.2
3	Efficiency,%	83	83	80	80	80				
3	**Chornovola str. 47**									
3	Type	???-7??	???-7??	??????-5	??????-5	??????-5	??????-5			
3	Year of installation	1990	1990	1988	1988	1988	1988			
3	Capacity, Gcal / hour	0.65	0.65	0.71	0.71	0.71	0.71			4.14
3	Efficiency,%	83	83	80	80	80	80			
3	**Konovaltsa str. 132**									

3	Type	???-???	???-???	??????-5	??????-5	??????-5	??????-5			
3	Year of installation	1982	1982	1989	1989	1989	1989			
3	Capacity, Gcal / hour	0.65	0.65	0.71	0.71	0.71	0.71			4.14
3	Efficiency,%	83	83	80	80	80	80			
4	**Symonenka str 3**									
4	Type	????-30	????-30	????-30						
4	Year of installation	1973	1985	1986						
4	Capacity, Gcal / hour	30	30	30						90
4	Efficiency,%	87.4	87.4	87.4						
5	**Industrialna 34**									
5	Type	????-30	????-30	????-30	????-30	????-100	????-5	????-5	??-35?	
5	Year of installation	1975	1975	1976	1976	1990	1951	1952	1961	
5	Capacity, Gcal / hour	30	30	30	30	100	25	25	38	308
5	Efficiency,%	87.4	87.4	87.4	87.4	87.2	87.2	87.2	87.2	