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Assessment of Supply-Side Alternatives for the Handlova Heating System

October 1995

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Pacific Northwest Laboratory
Washington, DC 20024

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ASSESSMENT OF SUPPLY-SIDE ALTERNATIVES FOR THE HANDLOVA HEATING SYSTEM

17 FEBRUARY 1994

Prepared by:
EGU Bratislava

Under Contract With:
Battelle, Pacific Northwest Laboratory

Assisted by:
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Thermo Power Corporation

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SUMMARY

GOALS OF THE STUDY

The goals of this study were to:

- perform technical and economical analyses for three alternatives for the production and distribution of thermal energy in the town of Handlova, Slovakia,
- perform an economic evaluation for the main parameters for each alternative at the given required rate of return,
- evaluate the sensitivity of the cost of delivered energy to several parameters, such as the thermal energy demand, cost of fuels and real interest rate, and
- provide this information to the town officials for their decisions about the future development of the heat supply for space heating and water heating in the residential and non-residential sectors.

APPROACH

The study consisted of several major activities with a specific approach to each activity. The demand side energy consumption data were acquired through a statistical collection and subsequent energy use intensity evaluation of the consumption of the individual energy users. The technical evaluation of the energy source was performed in accordance with the standard thermodynamic and hydraulic calculation methods. The information on the required investment was obtained by averaging the quotes from manufacturers of the equipment. Operation and maintenance costs were estimated based on data available from other similar operations. The evaluation of the economics was performed according to a discounted cash flow method.

RESULTS

Three alternative heat supply systems and three load variants were analyzed. Alternative 1, which would use both coal and natural gas, and Alternative 2, which would use only coal, are both centralized district heating systems. Alternative 3, which would use only natural gas, is a decentralized heating system.

The comparison of the decentralized and centralized heat supply system alternatives evaluated in this study is presented in Table 1. For this comparison, the demand variant No. 2, from the demand side study of the centralized heat supply system, and a coal price of 680 SK were used. The coal price of 680 Sk is a real 1993 coal price, escalated to year 1997.

Table 1 - Technical and Economical Evaluation of Alternatives

Parameter	Unit	Alt. 1	Alt. 2	Alt. 3
Technical Parameters				
Boiler Output Installed				
Steam	MWt	60	90	1.5
Hot Water	MWt	40	--	55.5
Source Installed Output	MWe	4.8	4.8	(.2 - .3)
System Peak Thermal Output Requirements	MWt	70	70	42.5
Operational Parameters				
Fuel Consumption				
Coal	t/yr	69,307	93,013	---
Gas	mil.m3/yr	3,947	---	11,074
Internal Consumption				
Electricity	MWh/yr	1,790	2,180	500
Thermal Energy	GJ/yr	110,234	94,209	---
Delivered Energy				
Thermal Energy	GJ/yr	530,050	530,050	377,280
Electricity	MWh/yr	20,610	25,020	---
Emissions Produced				
SO ₂	ton/yr	1,073	1,518	---
NO _x	ton/yr	266	344	14.58
Particulate	ton/yr	25,212	47,334	---
Economic Parameters				
Total Investment (IN)	thous. SK	300,500	261,500	229,554
Average Annual Net Profit	thous. SK	23,366	20,448	18,787
Discounted Total Profit	thous. SK	220,522	192,975	172,232
Discounted Total Cash Flow	thous. SK	96,245	85,954	70,662
Simple Payback	years	16	16	15
Cost of Delivered Energy	SK/GJ	228.35	205.80	245.30
Number of Jobs	--	55	55	7

The comparison shows that Alternative 2 (coal and gas fueled central heat supply system) offers the lowest delivered thermal energy cost of 205.80 SK/GJ. It also offers approximately 55 jobs in the central heating system operation and can help to maintain 1,000 to 1,400 jobs in the coal mine. Coal mine jobs do not solely depend on the town's heat supply system; another market can be found for all coal grades produced by the coal mine.

Figure 1 shows the comparison of the cost of delivered thermal energy for the centralized and decentralized systems under the selected economic parameters. Each alternative produces a range of delivered energy costs depending on economic parameters, such as inflation, real interest rate and cost, and the sale price of electricity. A required rate of return of 14% was used for all compared alternatives.

The comparison of the results presented in Figure 1 and Table 1 suggests that the gas and coal prices along with the size of the thermal energy demand will have a major impact on the cost of the delivered energy for each of the evaluated alternatives. If, for example, the gas price development follows the trends shown in Figure 2, purchase price of electricity follows the trends shown in Figure 3, and the coal price goes higher than 800 SK/ton, the decentralized heat supply system would be more attractive for a thermal demand less than 350 GJ/year. Higher thermal energy demand and lower coal cost (680 SK) increases the attractiveness of the central heating system. Under the assumed economic parameters, the centralized thermal energy supply system delivers energy at lower cost when the coal price is below 700 SK/ton and the demand exceeds 500 TJ/year.

Under the assumed economic environment, the ranges of delivered energy cost for the three alternatives are overlapping and depend on many variables. Higher real interest rate, coal price, and inflation will result in higher thermal energy cost. The thermal energy cost from the central system with cogeneration will benefit from the purchase price of electricity higher than 1,389 SK/MWh.

Timing and the size of the required investment in the central system alternative will also influence the cost of delivered energy. The total investment of 442.5 million SK assumes that boilers K1 and K5 will be replaced in 1997. If the new boiler K1 is installed in the year 2007 and boiler K5 is installed in the year 2011, the total required investment in 1997 will increase from 442.5 to 470.5 million SK, thus reducing the cost of the delivered thermal energy.

The economic calculations were performed with the following assumptions: 90% financing, real interest rate 9.5%, nominal interest rate 17%, coal price 680 SK/ton, gas price 3,350 SK/m³, electricity purchase price (selling to distribution) 1,389 SK/MWh, electricity cost (buy from distribution) 2,160 SK/MWh, and required return on investment 14%.

Economic Assumptions

Coal Cost = 467 Sk/ton to 1275 Sk/ton

Gas Cost = 3.35 sk/m³

Cost of Electricity:

Sale - 1389 Sk/MWh

Purchase - 1894 to 3230 Sk/MWh

Financing = 90%

Inflation = 3 to 18%

Note:

Internal rate of return	14 %
-------------------------	------

Figure 1 - Economic Analysis and Sensitivity of Results for Decentralized (Alt. 3) and Central (Alt. 1) Production of Thermal Energy for Space and Water Heating in the Town of Handlova, Slovakia

Figure 2 - Natural Gas Prices Development

Figure 3 - Electricity Prices Development

1. INTRODUCTION

1.1 SCOPE AND APPROACH

The purpose of this study is to support the town officials in Handlova, Slovakia in their effort to provide a thermal energy source for space heating and water heating for all the demand sectors of the town by providing necessary technical and economical information about available alternative solutions.

The study performs analyses of alternative solutions of heat supply available for the Town of Handlova and evaluates their technical, economical and environmental merits. It analyzes the alternatives with the respect to the cost of delivered thermal energy to the user. This study utilizes results of previous studies and other projects performed in 1992 and 1993, and all available measurements performed by the Heating Plant and by the users.

1.2 REPORT ORGANIZATION

This report is organized into five chapters. Chapter 1 is an introduction and provides information on the subject of the project, methodology used, report organization and study participants. Chapter 2 provides information on the current state of the energy supply and demand in Handlova and the physical condition of the existing district heating system. It also describes the current thermal energy demand for space heating and water heating purposes and presents three possible development scenarios. Chapter 3 contains an economic analysis of the central heating system, which also cogenerates electricity, and provides an analysis of the sensitivity of the delivered energy cost to the input parameters. The analysis of the decentralized natural gas distributed boiler-based energy system are presented in the Chapter 4. Chapters 3 and 4 are significant chapters of this report. Chapter 5 provides a statistical summary of the results of the evaluation of the three energy supply alternatives that were analyzed.

1.3 STUDY PARTICIPANTS

This project was made possible by the US Agency for International Development (US AID). US AID provided funding through the Department of Energy, Office of Energy Efficiency and Renewable Energy, which contracted Battelle, Pacific Northwest Laboratories (PNL) to manage and technically direct the project. The analyses of the demand side and the supply side were performed by the Energy Research Institute (EGU), Bratislava and by the US based company Tecogen. The role of the US partners was to participate in an advisory role, to perform an analysis related to the demand side and to manage the project activities:

EGU Bratislava contracted with the Slovak company Stavimex, with the Building Administration Company (Bytový Podnik Mesta Handlova - BPMH) and with the Town Administration Office. Stavimex was responsible for providing analysis of the decentralized heating system, and BPMH and the Town were responsible for providing information on residential and non-residential building stock and thermal energy consumption for space and water heating.

2. THE SUPPLY AND DEMAND SIDE ANALYSES

This chapter develops and evaluates the supply side alternatives for production and distribution of thermal energy for space heating and water heating. The investment effectiveness and the sensitivity analysis are performed for each of the three developed alternatives. Variables in the sensitivity study are demand side energy consumption levels, real interest on borrowed money and cost of fuels.

The purpose of the work presented in this chapter is to provide information on technical, economic and environmental parameters for each of the thermal energy supply alternatives. Section 2.1 describes the history and current state of the thermal energy supply. Section 2.2 summarizes the existing energy demand for space and water heating by sector, fuel and type of equipment. It also provides information on availability of fuels. Section 2.3 develops scenarios of expected future energy demand.

2.1 HISTORY AND CURRENT STATE OF THE THERMAL ENERGY SUPPLY AND DEMAND

The central heating system covers 80% of the current energy demand for space heating and water heating in the town of Handlova. The Heating Plant was built from 1937 to 1940 and was originally designed as a cogeneration plant with a condensing steam turbine, which supplied the electricity for the coal mine Handlova. Operation of the plant began in 1938. The last major investment to the plant was in 1954, when the boiler K6 (45 t/h, 432°C, 3.8 MPa) was built.

The fuel used by the Heating Plant is a brown coal dust with a heating value of 12.54 MJ/kg. The Heating Plant is equipped with a closed loop condenser cooling system, natural circulation boilers, a closed loop coal preparation and delivery system and mechanical ash collectors. The plant had the following parameters:

Total installed boiler output	195 ton/hr
Total output of turbo-generators	30 MWe
Number of boilers	4
Number of turbo-generators	3

The steam distribution system was built in 1965 and the central heating system was started in 1968. Steam was supplied through the non-regulated heat transfer station TG2 at 3.0/0.9 MPa and 250°C. Currently, the distribution network consists of 29 heat exchanger stations, 5,300 meters of pipes installed in non-accessible channels and 2,735 meters of pipes on the surface. Maximum pipe dimension is DN 400 for the steam distribution lines and DN 150 for the condensate return lines.

Due to equipment age and economically ineffective production of electricity, the cogeneration plant was converted to heat production only. Boiler K1 was retrofitted in 1982 and boiler K5 was retrofitted and equipped with a pre-combustion reactor in 1990. Boiler K6, which was installed in 1954 was upgraded in 1989 and was converted to gas operation.

The heat generating plant uses industrial grade coal (brown coal dust) with a heating value of 8.5-12.54 MJ/kg and natural gas with a heating value of 33.4 MJ/m³. Boilers with natural circulation are equipped with closed-loop coal feed and electrostatic filters. Boiler K1 is equipped with a pre-combustion reactor, boilers K5 and K6 are equipped with gas burners with capacity equal to 50% of the boiler total output. Total output of all boilers is 100 ton/hr (60 MWt). The plant employs 120 workers and 24 administration staff members.

The new, 115 meter concrete stack was built in 1983; in 1984 and 1985 the flue exhaust was equipped with electrostatic filters. The old generators were removed from the building. Ash produced by the heating plant is either used by the coal mine to fill old coal mine cavities or partially deposited to ash and coal mine refuse depository outside of town.

In general, the central heating system, including the heat generating plant, distribution and the heat exchanging stations is old and inefficient.

2.2 BASELINE PARAMETERS

2.2.1 Energy use baseline and demand forecast

Energy consumption in Handlova for space heating, water heating and for industrial processes in 1992 is summarized in Table 2.1.

Nearly 62% of the net delivered energy (fuel input less losses in conversion and transit) is consumed by the residential sector. More detailed energy consumption data are presented in the Demand Side Analysis Report, which is part of this study. Industrial consumption represents about 19% and the non-residential sector also represents about 19%. District heat is the major energy source for space and water heating, representing 79.6% of the total energy consumption.

The Industrial Sector in Handlova uses the District Heating System exclusively as a source of thermal energy for space and water heating. Table 2.2 below shows the industrial energy users and the amount of energy they consume. The thermal energy use for industrial processes is negligible.

Table 2.1 - Energy End Use by Sectors and Fuels (GJ), 1992

FUEL	SECTORS			TOTAL	
	Residential	Non-Residential	Industrial	[GJ/Year]	[%]
LOCAL:					
Coal	29,599	0	0	29,599	5.2
Gas	66,950	50	0	67,000	11.9
Electr.	1,200	1,684	0	2,884	0.5
BOILER HOUSES:					
Coal	0	11,080	0	11,080	2.0
Gas	0	4,737	0	4,737	0.8
DISTRICT HEAT	251,033	92,054	107,671	450,758	79.6
TOTAL	348,782	109,605	107,671	566,058	100
[%]	61.6	19.4	19.0	100	100

Table 2.2 - Industrial User Energy Consumption (GJ), 1992

USER	DISTRICT HEAT	
	[GJ/Year]	[%]
Coal Mine	76,736	71.3
Chemika	5,684	5.2
Lahke Konstrukcie	19,177	17.8
Slovenka	2,114	2.0
AMK	188	0.2
CSD Station	2,079	1.9
State Farm	1,693	1.6
TOTAL	107,671	100

2.2.2 Demand Forecast

This section develops the three variants for energy demand growth used for the study. Assuming a 25 year life for the heat supply equipment to be built by 1997, the energy demand was projected to the year 2022.

Load Variant 1:

This variant assumes no change in the thermal energy demand in the Residential and Non-Residential Sectors and assumes detachment of the industrial sector from the District Heating System.

Under this variant, energy demand will remain on the 1992 level of 458,387 GJ/Year for space heating and water heating in Residential and in Non-Residential sectors. The Industrial Sector will be served by its own sources, but the annual consumption would remain the same - 107,671 GJ/Year. This variant represents the lowest possible energy demand, when only the buildings owned by the town would be served by the central heating system.

Load Variant 2:

This variant based on the Urban Development Plan for the Town of Handlova performed by AGS Atelier for the Town Hall in 1993. This study predicted the town population would increase from 18,332 in 1992 to 19,500 in the year 2010. By extrapolating the growth curve at a somewhat cautious rate, the town population was predicted to be 19,750 in 2022. This is a population increase of approximately 1400 persons, or 5.22%. Industrial activity in this variant was assumed to stay at the 1992 level with no increase in thermal energy demand.

Under these assumptions, energy demand for space heating and water heating would increase by 18,206 [GJ], or 3.22% of the town energy demand in 1992. Increase in District Heating Demand is assumed 11,268 GJ, or 4.5%.

Load Variant 3:

This variant assumed greater population growth and increased industrial activity. Population growth was assumed 6% greater than predicted in Scenario 1, for a total increase of 11.22% or 2057 persons. Industrial thermal energy demand was assumed to grow by 20% from the 1992 level.

For this variant, energy demand for residential space heating and water heating would increase by 39,133 GJ, or 6.91%, and industrial thermal energy demand would increase by 21,534 GJ, or 3.80%. Total energy demand would increase by 60,667 GJ, or 10.71% of the total demand in 1992. The district heating demand would increase by 24,247 GJ (4.28%) due to population growth, and 23,287 GJ (4.11%) due to industrial growth.

The summary of parameters in each variant is presented in Table 2.3.

Table 2.3 Demand Forecast Scenarios, Year 2022

GJ/yr	Load Variant 1		Load Variant 2		Load Variant 3	
	MWt	GJ/yr	MWt	GJ/yr	MWt	GJ/yr
Residential Sector	30.32	251,033	30.32	251,033	30.32	251,033
Population Growth	---	---	1.58	11,268	3.40	24,247
Non-Residential Sector	11.12	92,054	11.12	92,054	11.12	92,054
New Customers (Residential and Non-Residential)	---	---	8.2	68,024	8.20	68,024
Industry	---	---	12.80	107,671	12.8	107,671
Industrial Growth	---	---	---	---	2.56	23,287
TOTAL	41.44	343,087	64.02	530,050	68.40	566,316

2.2.3 Fuel Availability

The State Upper Nitra Coal Mines (Hornonitrianske Bane) with headquarters in Prievidza, Slovakia have, in their letter from August 14, 1993 to SEP Bratislava, guaranteed supply of standard quality coal up to year 2020.

The following coal quality was guaranteed:

Heating value	Qa = 10.5 MJ/kg
Ash content	A = 36.38%
Water	W = 21.46%
Sulfur	S = 1.55%
Carbon	C = 66.51%
Hydrogen	H = 5.4%
Nitrogen	N = 1.28%
Oxygen	O = 25.49%

The Slovak Gas Company (Slovensky Plynarensky Podnik), the local gas utility, with headquarters in Prievidza, Slovakia is capable and willing to provide a sufficient gas supply to satisfy the needs of the Town of Handlova. Currently, the low pressure gas distribution network in Handlova is in use and serves only small users (residences). The decentralized heating system would require installation of new pipes with a gas pressure of 0.3 MPa to serve new, distributed boilers.

3. CENTRAL DISTRICT HEATING SYSTEM

This chapter presents a technical and economic evaluation of the central district heating system alternatives considered for the thermal energy supply for the town of Handlova. Section 3.1 presents the analysis of a hot water based distribution system. The investments required for buried, pre-insulated pipes and for pipes installed in a channel are also shown. Section 3.2 presents the analysis of Alternative 1 for the central heating system with cogeneration and with a coal/gas combined fuel base. Section 3.3 presents the analysis of Alternative 2 for the central heating system with cogeneration based on coal only.

3.1 DISTRIBUTION SYSTEM ANALYSIS

The replacement of the old steam distribution system with a new, hot water distribution system must be performed without service interruption. Therefore, the new system will be installed parallel to existing one, as recommended by the study "Transition from Steam to Hot Water Distribution System in Town of Handlova", which was performed by Energoprojekt Kosice in March 1992. The replacement of heat exchangers in all stations is assumed to be performed in the summer season.

The analysis of the distribution system was based on the system layout shown in Figure 3.1. It includes hydraulic calculations of the system and estimates of required investment for two scenarios. One assumes use of buried pre-insulated pipes, the other assumes use of pre-insulated pipes installed in utility channels. The hydraulic calculation of the hot water distribution system was performed for two scenarios. One assumed a central pumping station only; the other assumed the use of an additional pumping station for winter peak operation in critical locations, as determined by the system pressure diagram.

3.1.1 Distribution System with Central Pumping Station Only

The analyses were performed with the assumptions that the distribution system will be designed as a two-pipe system with pressure independent heat exchanger stations, with a central pumping station located in the central heating plant building and with a system temperature gradient of 130/70°C.

The pressure diagram of such system is shown in Figure 3.2. The specification of the pipes required for this system follow.

Pipe Dimension	Item	Alternative A	Alternative B
DN 50	Total length [m]	3,530	4,230
	T fittings [pcs]	6	4
	Elbows [pcs]	54	70
	Compensators [pcs]	68	60
DN 65	Total length [m]	160	160
	Elbow [pcs]	6	6
	Compensator [pcs]	4	4
DN 80	Total length [m]	1,140	2,670
	T fitting 80/80 [pcs]	---	4
	T fitting 80/50 [pcs]	2	4
	Reduction 80/50 [pcs]	---	2
	Elbow [pcs]	26	30
	Compensator [pcs]	28	52
DN 100	Total length [m]	590	590
	Elbow [pcs]	8	12
	Compensator [pcs]	12	12
DN 150	Total length [m]	7,530	5,690
	T fitting 150/150 [pcs]	4	2
	T fitting 150/100 [pcs]	2	4
	T fitting 150/80 [pcs]	6	4
	T fitting 150/50 [pcs]	6	8
	Reduction 150/100 [pcs]	2	-
	Reduction 150/80 [pcs]	6	4
	Reduction 150/50 [pcs]	6	-
	Elbow [pcs]	82	64
	Compensator [pcs]	100	80
DN 200	Total length [m]	3,700	3,580
	T fitting 200/200 [pcs]	2	-
	T fitting 200/150 [pcs]	2	-
	T fitting 200/100 [pcs]	2	4
	T fitting 200/50 [pcs]	14	16
	Reduction 200/150 [pcs]	2	4
	Reduction 200/100 [pcs]	2	-
	Elbow [pcs]	72	38
DN 250	Compensator [pcs]	50	50
	Total length [m]	1,720	1,720
	T fitting 250/200 [pcs]	2	2
	T fitting 250/150 [pcs]	-	2
	T fitting 250/80 [pcs]	2	2
	T fitting 250/50 [pcs]	4	2
	Reduction 250/200 [pcs]	2	2
	Elbow [pcs]	16	16
DN 250	Compensator [pcs]	30	30

Figure 3.1 - Layout of Central Heating System in Town of Handlova

Quotes for delivery of the materials listed were requested and received from PIPECO, Ltd. Podbrezova and the ASEA Brown Boveri Bratislava. Pricing information from BTV STAV-ISOLAR Bratislava was also used for comparison. This company is offering pre-insulated pipes type Fotav-Isoplus and also type KE Rohrsystem und Umwelttechnik GmbH. For the purpose of this study, an average price was calculated for each component from all received quotes.

The cost of installation was calculated based on information provided by the company ALDY, s.r.o. and on information included in the previously mentioned study "Transition from Steam to Hot Water Distribution System in Town of Handlova", which was performed by Energoprojekt Kosice in March 1992.

- *The cost of material and installation of pre-insulated pipes buried in-ground.*

Material	45,000,000 SK
Installation	21,000,000 SK
<hr/>	
Total	66,000,000 SK

- *The cost of material and installation of standard pipes installed in prefabricated utility channels*

Material	25,000,000 SK
Installation	91,000,000 SK
<hr/>	
Total	116,000,000 SK

Based on this comparison, the economic analysis of the central district system was performed assuming the hot water distribution system with pre-insulated, directly buried pipes (Alternative A).

The system arrangement with the central pumping station will require only 550 MWh of electric energy consumption to operate the pumps.

3.1.2 Distribution System with Central Pumping Station and an Additional Pumping Station for Peak Operation

In this alternative, the central pumping station is located in the heating plant and an additional pumping station is located on distribution branch 4-31 (see Figure 3.1) Distribution is designed with a two-pipe arrangement with pressure independent heat exchanger stations. Temperature gradient is 130/70°C. The pressure diagram is shown in Figure 3.3.

Figure 3.2 - Pressure Diagram of Main Distribution System

Figure 3.3 - Pressure Diagram of Main Distribution System

The specification of pipes and other components is shown as Alternative B in Section 3.1.1. The cost of material and installation is approximately 5% lower for this alternative. The cost of additional peak pumps, the cost of a remote control system for the station and an additional electricity consumption cost - approximately 750 MWh - will eliminate this cost advantage and will bring the total cost to the same level as for Alternative A.

3.1.3 Heat Exchanger Stations

The new heat exchangers and other required equipment will be installed in existing buildings. The domestic water heating equipment is assumed to be installed at the consumption sites - in the building basements. A secondary side distribution will be utilized for providing the heat source for water heating purposes.

The installed cost of compact water-to-water heat exchangers from company Tlakove Nadoby, Zilina, should be expected to be 80,000 thousand SK. The installed cost of plate heat exchangers from company ALFA LAVAL can be expected to be 54,000 thousand SK. This lower price was used for the economic evaluation calculations.

3.2 ALTERNATIVE 1 : CENTRAL DISTRICT HEATING SYSTEM WITH COGENERATION AND COAL/GAS FUELS

This alternative assumes reconstruction of existing boilers K5 and K6, fuel supply equipment, ash removal equipment and hot water manifolds; completion of a new chemical plant for water treatment; installation of new gas fired hot water boilers including gas piping, new 6.2 kW electrical distribution center, new mechanical room, new hot water heat exchanger station, and limestone preparation equipment; and a new ash dump site. General schematic of the system is shown in Figure 3.4. The plant location is shown in Figure 3.5.

3.2.1 Equipment Specification:

Boiler K1 - steam boiler made by "První Brněnská Strojárna", retrofitted in 1982 (up-stream combustion reactor addition)

Max. boiler output	30 MWt
Max. mass flow	35 t/hr
Nominal steam pressure	3.6 MPa
Nominal steam temperature	425°C
Nominal water temperature	110°C
Thermal efficiency	77%
Fuel	brown coal

Note: Reconstruction of this boiler - installation of the up-stream reactor - was already performed

Figure 3.4 - Basic Equipment Diagram for Alternative 1

Figure 3.5 - Heating Plant Location

Boiler K5 - steam boiler made by "Prvni Brnenska Strojirna". Recommended reconstruction and installation of up-stream combustion reactor in 1995.

Max. boiler output	30 MWt
Max. mass flow	35 t/hr
Nominal steam pressure	3.6 MPa
Nominal steam temperature	425°C
Nominal water temperature	110°C
Thermal efficiency	77%
Fuel	brown coal

Note : this boiler will be retrofitted and equipped with up-stream combustion reactor.

Boiler HK1 - gas fired hot water boiler to be built in 1996, manufacturer SES Tlmace or DjDj- Wanson.

Max. boiler output	20 MWt
Nominal water pressure	3.2 MPa
Nominal inlet water temperature	70°C
Nominal outlet water temperature	130°C
Thermal efficiency	94%
Fuel	Natural gas, 33.4 MJ/m ³

The gas burner for inlet gas pressure of 0.1-0.3 MPa, recirculation pump, M&R system, EGA analyzer and all electrical equipment will be included with the boiler.

Boiler HK2 - gas fired hot water boiler to be built in 1997, manufacturer SES Tlmace or DjDj- Wanson.

Max. boiler output	20 MWt
Nominal water pressure	3.2 MPa
Nominal inlet water temperature	70°C
Nominal outlet water temperature	130°C
Thermal efficiency	94%
Fuel	Natural gas, 33.4 MJ/m ³

The gas burner for inlet gas pressure 0.1-0.3 MPa, recirculation pump, M&R system, EGA analyzer and all electrical equipment will be included with the boiler.

TG1 - 4.8 MWe back-pressure steam turbine made by "Prvni Brnenska Strojirna"

Nominal electrical output	4.8 MWe
Nominal steam throughput	40 t/hr
Nominal steam parameters:	
• pressure	3.2 MPa
• temperature	420°C
Back-pressure turndown	.035 - .35 MPa
Generator:	
• Nominal RPM	3,000 1/min
• Nominal Power Output	6,000 kVA
• Voltage	6.3 kV
• Frequency	50 Hz

The turbine package includes control and safety equipment, lubrication package, leakage steam condensation package and piping.

Heat Transfer Station including circulation pumps

1 piece of tube and shell steam-to-water heat exchanger

Nominal thermal output	25,0 MWt
Nominal water parameters	60/94°C
Nominal steam parameters	
• pressure	.12 MPa
• temperature	105°C
Design pressure	PN 25

1 piece of tube and shell steam-to-water heat exchanger

Nominal thermal output	20,0 MWt
Nominal water parameters	60/130°C
Nominal steam parameters	
• pressure	.35 MPa
• temperature	140°C
Design pressure	PN 25

The Heat Transfer Station includes circulating pumps, piping, a supporting steel structure and electrical installation package.

Installation of Central Management System (CMS)

The installation of CMS has been initiated. It is assumed, that the CMS will be expanded to the distribution system and to all heat exchanger stations.

Reconstruction of a 6.2 kV electrical distribution system.

The installation of this system was initiated.

Replacement of steam line inside the heating plant.

Limestone and coal preparation equipment

Ash dump site construction.

3.2.2 Investment for Heating Plant Reconstruction

The required investment for reconstruction of the heating plant in this alternative, based on quoted prices is:

	Thousand SK
Combustion reactor for steam boiler K5 and K6, material and installation	8,000
Hot water boilers HK1 and HK2, material and installation	50,000
Turbine TG1, material and installation	30,000
Heat transfer station including circulating pumps	20,000
Central management system, material and installation	16,000
6.2 kV electrical distribution system	9,500
Steam piping, material and installation	6,000
Coal and limestone preparation equipment	25,000
Ash deposition site	16,000
Total Investment Required	180,500

3.2.3 Analysis of Operation

Thermodynamic calculations were performed for several alternative loads. The internal and distribution losses in the primary and secondary circuits were included.

	Year 1997		Year 2022	
Load Variant 1	42.5 MWt	363,710 GJ/yr	42.5 MWt	363,710 GJ/yr
Load Variant 2	64.02 MWt	549,947 GJ/yr	65.02 MWt	561,853 GJ/yr
Load Variant 3	64.02 MWt	549,947 GJ/yr	70.11 MWt	600,295 GJ/yr

The load duration curves for the above load variants are shown in Figures 3.6, 3.7, 3.8, and 3.9.

Figure 3.6 - Load Duration Curve, Heat Supply Including Distribution Losses, Variant 1

Figure 3.7 - Load Duration Curve, Heat Supply Including Distribution Losses, Variant 2 and 3

Figure 3.8 - Load Duration Curve, Heat Supply Including Distribution Heat Losses - Variant 2

Figure 3.9 - Load Duration Curve, Heat Supply Including Distribution Heat Losses - Variant 2

The turbine TG1, with nominal output of 4.8 MWe, is in operation only during the heating season, when average ambient air temperature drops below 12°C. During the peak loads, the hot water boilers are operated with the baseload steam boilers. Summer load is covered only by hot water boilers. The characteristics of electricity production in load Variant 2 are shown in Figure 3.10. Table 3.1 summarizes the electricity production curve for all load variants. Table 3.2 shows turbine loads characteristics, heat production and boiler loads.

Fuel consumption for load Variant 2 expressed in thermal units is shown in Figure 3.11. Table 3.1 summarizes fuel consumption and emission production for all load variants. (Emission production limits set by Law 309/91 Zb).

The construction schedule diagram is shown in Figure 3.12.

Table 3.1 - Analyses of Operation
Alternative 1

	Unit	Var. 1	Var. 2	Var. 3
Heat Production by the plant	[GJ/year]	363,710	561,856	600,295
Fuel Consumption				
Coal (10.5 MJ/kg)	t/yr	50,297	69,307	71,908
Gas (33.4 MJ/m3)	10 ⁶ m3	1.947	3.947	4.254
Limestone Consumption	t/yr	5,029	6,931	7,191
Internal Consumption				
Thermal Energy	GJ/yr	75,597	110,234	114,188
Electricity	MWh/yr	1,280	1,790	1,890
Production of Thermal Energy	GJ/yr	418,720	640,320	680,540
Production of Electricity	MWh/yr	16,030	22,400	23,620
Heat Losses in Distribution	GJ/yr	20,623	31,806	33,979
Thermal Energy Delivered	GJ/yr	343,087	530,050	566,316
Electricity Delivered	MWh/yr	14,750	20,610	21,730
Ash Production	t/yr	18,298	25,218	26,160

Table 3.2 - Production of Thermal Energy and Electricity. Load Characteristic of the Boilers and the Turbine.

Ambient Air Temperature						Summer	
	-18	-6	-6	+6	+12	Max	Min
Load Variant 1							
<u>Boiler Loads in MWt</u>							
K1	21.25	--	20.10	11.75	9.30	--	--
K5	21.25	--	--	--	--	--	--
HK1	--	--	--	--	--	7.20	5.21
HK2	--	--	--	--	--	--	--
<u>Steam Production in kg/s</u>							
K1	8.185	---	8.730	4.820	3.903	--	--
K2	8.185	---	--	--	--	--	--
<u>Turbine Load in MWe</u>							
TG1	4.042	---	4.288	2.217	1.704	--	--
<u>Turbine throughput in kg/s</u>							
TG1	7.313	---	7.677	4.502	3.662	--	--
Load Variant 2							
<u>Boiler Loads in MWt</u>							
K1	17.81	22.29	15.15	18.27	14.27	---	---
K5	17.81	---	15.15	---	---	---	---
HK1	15.0	8.0	---	---	---	11.18	7.13
HK2	15.0	---	---	---	---	---	---
<u>Steam Production in kg/s</u>							
K1	7.072	8.696	6.332	8.007	6.138	---	---
K2	7.072	---	6.332	---	---	---	---
<u>Turbine Load in MWe</u>							
TG1	3.207	4.735	4.735	4.154	3.015	---	---
<u>Turbine throughput in kg/s</u>							
TG1	6.054	8.722	8.733	7.479	5.759	---	---
Load Variant 3							
<u>Boiler Loads in MWt</u>							
K1	20.55	21.86	16.18	19.51	15.2	---	---
K5	20.55	---	16.18	---	---	---	---
HK1	14.5	10.5	---	---	---	11.95	7.72
HK2	14.5	---	---	---	---	---	---
<u>Steam Production in kg/s</u>							
K1	8.198	9.535	6.717	8.59	6.585	---	---
K5	8.198	---	6.717	---	---	---	---
<u>Turbine Load in MWe</u>							
TG1	3.87	4.735	4.735	4.524	3.288	---	---
<u>Turbine throughput in kg/s</u>							
TG1	7.057	8.333	8.333	8.024	6.179	---	---

3.2.4 Economic Analysis

The discounted cash flow method of analysis was used to evaluated the economic effectiveness of the project. Sensitivity analyses were performed for the delivered energy price as a function of a cost of coal, energy sales by the central district heating system, inflation and real interest.

Figure 3.10 - Load Duration Curve, Output Electricity Production, Alternative 1, Load Variant 2

Figure 3.11 - Load Duration Curve, Output Electricity Production, Alternative 1 Load Variant 2

Figure 3.12 - Construction Schedule - Alternative 1

3.2.4.1 Method Used

The discounted cash flow method analyzes the investment economics over the life of the investment. It takes into account the time the investment was executed and the time when the income is realized. The evaluation is based on the time value of money.

The evaluation can be performed to assess the complete project or to assess the attractiveness of the investment. The assessment of the project does not consider the tax consequences and the origin of the investment. Such analysis evaluate the project (system) macro-economics. The results of such analysis are not influenced by tax system inefficiencies thus providing comparable results for all compared alternatives.

The assessment of the investment from the investors point of view takes into account tax liability and the origin of the capital. The investment analysis will provide information on the size of the required investment, investment timing and its rate of return.

3.2.4.2 Analysis Metrics

Following is a description of several metrics used in this analysis.

Discounted total profit is the sum of annual profits from the operation of the investment subject over its entire life, discounted to the year in which the investment is evaluated. It is a function of annual profits, discount rate and number of years in which the profit was realized.

Average Annual profit is annual profit, which in its constant value over the life of the investment results in identical discounted total profit. It is also called annualized profit.

Discounted cash flow, also called Net Present Value, is the sum of discounted cash flow over the life of the investment. In this project, the first year of operation of the new system was used as the basis of the calculation.

Internal Rate of Return is the discount rate which results in zero Net Present Value of the investment.

Simple Payback Period is the number of years required for the income resulting from an investment to offset the cost of the investment. Thus the lower the payback period, the more attractive the investment.

3.2.4.3 Project Economic Analysis

Key Financial Assumptions

Construction duration		2 years
Time of start up/base year		1997
Term of Projected Sales (Life)		25 years
Cost of Natural Gas in 1997		3,350 SK/m3
Cost of Coal in 1997 (four alternatives)		467.5 SK/ton
		680.0 SK/ton
		850.0 SK/ton
		1,275 SK/ton
Fuel Cost Escalation		
Natural Gas	from year 1997 to 2005	2.85%
	after year 2005	1.4%
Coal		2.7%
Rate of Return Investment		14%
Nominal Interest Rate		5% to 30%
Real Interest Rate		2%, 5%, 9.5% and 12%
Investment Repayment Term		10 years
Investment Financed		90%
Net Effective Tax Rate		45%
Labor Rate		8,750 mil. SK/yr
Labor Rate Escalation	to year 2005	12.4% annually
	after 2005	6.0% annually
Overhead		3,000 mil. SK/yr
Overhead Escalation	to year 2005	6.0% annually
	after 2005	3.0% annually
Repairs and Maintenance		5,000 mil. SK/yr
R&M Escalation	to year 2005	7.5% annually
	after 2005	3.5% annually
Material Supplies		3,500 mil. SK/yr
Materials Escalation	to year 2005	7.5% annually
	after 2005	3.5% annually
Other Expenses, Escalation		1.0% annually
Depreciation of Existing Equipment (steam distr., electrostatic filters)		
	In Year 1997	1,566 mil. SK/yr
	In Year 2000	.690 mil. SK/yr
	In Year 2003	.690 mil. SK/yr
Price of electricity sold		1,389 Sk/Mwh
Escalation		6% annually
TOTAL PROJECT COST		300.5 mil. SK

Fuel cost in the first year of operation is assumed to be covered from in-house funds. The cost of obtaining the loan is not accounted for and will have to be added to the total cost at the time of detailed financial analyses.

The details of the calculations of the the economics for load Variant 2 is presented in computer printout form in Appendix A. Figure 3.13 and Table 3.3 present the results of this analysis as function of inflation, delivered energy and the fuel cost.

The presented results shows that the delivered energy cost

- is a direct function of the cost of fuel, inflation rate and real interest
- is an inversed function of the energy sales - delivered energy
- is substantially influenced by investment approach, pricing policy and by quantity of delivered energy (sales). For example, 50% financing (compared to 90%) will reduce the cost of delivered energy by 15 SK/GJ; a 200 SK/MWh increase in the price of electricity sold will reduce the cost of delivered heat by approximately 10 SK/GJ.

3.3 ALTERNATIVE 2 : CENTRAL DISTRICT HEATING SYSTEM WITH COGENERATION, COAL FIRED

This alternative assumes reconstruction of existing boilers K5 and K6, coal supply equipment, ash removal equipment and hot water manifolds, completion of a new chemical plant for water treatment, installation of a new 6.2 kW electrical distribution center, new mechanical room, new hot water heat exchanger station, and a new ash dump site. A general schematic of the system is shown in Figure 3.14.

3.3.1 Equipment specification:

Boiler K1 - steam boiler made by "Prvni Brnenska Strojirna", retrofitted in 1982 (up-stream combustion reactor addition)

Max. boiler output	30 MWt
Max. mass flow	35 t/hr
Nominal steam pressure	3.6 MPa
Nominal steam temperature	425°C
Nominal water temperature	110°C
Thermal efficiency	77%

Fuel	brown coal
------	------------

Note : Reconstruction of this boiler - installation of the up-stream reactor -was already performed

Figure 3.13 - Cost of Heat as Function of Real Interest Rate and Inflation

Table 3.3 - Cost of Heat, Alternative 1

Coal Cost [Sk/t]	Discount Rate [%]	Inflation [%]	Cost of Heat		
			Load Var. 1 [Sk/GJ]	Load Var. 2 [Sk/GJ]	Load Var. 3 [Sk/GJ]
467	5	3 18	221,00 317,30	159,95 225,30	155,33 217,50
	9,5	3 18	261,10 341,40	187,15 242,05	181,20 233,60
	12	3 18	274,50 355,00	196,25 251,40	189,80 242,50
680	2	3 18	253,10 333,30	188,75 243,20	183,90 235,60
	5	3 18	269,15 349,40	199,65 254,10	194,25 246,05
	9,5	3 18	293,20 373,50	216,00 270,80	209,75 262,10
	12	3 18	306,60 387,00	225,05 280,20	218,40 271,05
850	2	3 18	278,70 359,00	211,75 266,20	206,73 258,45
	5	3 18	294,80 375,00	222,65 277,10	217,05 268,80
	9,5	3 18	318,80 399,10	239,00 293,75	232,60 284,90
	12	3 18	332,20 412,60	248,05 303,15	241,20 293,80
1275	2	3 18	342,75 423,00	269,25 323,70	263,75 315,45
	5	3 18	358,80 439,00	280,15 34,60	274,10 325,80
	9,5	3 18	382,90 463,10	296,50 351,10	289,60 431,85
	12	3 18	396,25 476,50	305,55 360,50	298,20 350,80

Figure 3.14 - Equipment Diagram, Alternative 2

Boiler K5 - steam boiler made by "Prvni Brnenska Strojirna". Recommended reconstruction and installation of up-stream combustion reactor in 1995.

Max. boiler output	30 MWt
Max. mass flow	35 t/hr
Nominal steam pressure	3.6 MPa
Nominal steam temperature	425°C
Nominal water temperature	110°C
Thermal efficiency	77%
Fuel	brown coal

Note: This boiler will be retrofitted and equipped with up-stream combustion reactor.

Boiler K6 steam boiler made by "Prvni Brnenska Strojirna". Recommended reconstruction and installation of up-stream combustion reactor in 1995.

Max. boiler output	30 MWt
Max. mass flow	35 t/hr
Nominal steam pressure	3.6 MPa
Nominal steam temperature	425°C
Nominal water temperature	110°C
Thermal efficiency	77%
Fuel	brown coal

Note: this boiler will be retrofitted and equipped with up-stream combustion reactor.

TG1 - 4.8 MWe back-pressure steam turbine made by "Prvni Brnenska Strojirna"

Nominal electrical output	4.8 MWe
Steam throughput at nominal parameters	40 t/hr
Nominal steam parameters:	
• pressure	3.2 MPa
• temperature	420°C
Back-pressure turndown	.035 - .35 MPa
Generator:	
• Nominal RPM	3,000 1/min
• Nominal Power Output	6,000 kVA
• Voltage	6.3 kV
• Frequency	50 Hz

The turbine package includes control and safety equipment, lubrication package, leakage steam condensation package and piping.

Heat Transfer Station including circulation pumps

2 pieces of tube and shell steam-to-water heat exchanger

Nominal thermal output	25,0 MWt
Nominal water parameters	60/94°C
Nominal steam parameters	
• pressure	.12 MPa
• temperature	105°C
Design pressure	PN 25

1 piece of tube and shell steam-to-water heat exchanger

Nominal thermal output	20,0 MWt
Nominal water parameters	60/130°C
Nominal steam parameters	
• pressure	.35 MPa
• temperature	140°C
Design pressure	PN 25

The Heat Transfer Station includes circulating pumps, piping, supporting steel structure and electrical installation package.

Installation of Central Management System (CMS)

The installation of the CMS has been initiated. It is assumed, that the CMS will be expanded to the distribution system and to all heat exchanger stations.

Reconstruction of a 6.2 kV electrical distribution system.

The installation of this system was initiated.

Replacement of steam line inside the heating plant.

Limestone and coal preparation equipment

Ash dump site construction.

3.3.2 Investment for Heating Plant Reconstruction

The required investment for reconstruction of the heating plant in this alternative, based on quoted prices, is:

	Thousand SK
Combustion reactor for steam boiler K5 and K6, material and installation	16,000
Turbine TG1, material and installation	30,000
Heat transfer station including circulating pumps	23,000
Central management system, material and installation	16,000
6.2 kV electrical distribution system	9,500
Steam piping, material and installation	6,000
Coal and limestone preparation equipment	25,000
Ash deposition site	16,000
Total Investment Required	141,500

3.3.3 Analysis of Operation

Thermodynamic calculations were performed for several alternative loads. The internal and distribution losses in the primary and secondary circuits were included. The same method was used as for Alternative 1. The load duration curves are shown in Figures 3.6, 3.7, 3.8 and 3.9. The turbine TG 1 (4.8 MWe) is operated all year round.

The characteristics of electricity production in load Variant 2 are shown in Figure 3.15. Table 3.4 summarizes the electricity production curve for fuel consumption and emission production for all load variants. (Emission production limits are set by Law 309/91 Zb.) Table 3.5 shows the turbine loads characteristics. The heat production, turbine loads characteristics and boiler loads are shown in Table 3.5.

Fuel consumption for load Variant 2 expressed in thermal units is shown in Figure 3.16.

The construction schedule diagram is shown in Figure 3.17

Figure 3.15 - Load Duration Curve, Output Electricity Production, Alternative 2, Load Variant 2

Figure 3.16 - Load Duration Curve, Fuel Consumption, Alternative 2 Load Variant 2

**Table 3.4 - Analyses of Operation
Alternative 2**

	Unit	Var. 1	Var. 2	Var. 3
Heat Production by the plant	[GJ/year]	363,710	561,865	600,295
Fuel Consumption				
Coal (10.5 MJ/kg)	t/yr	64,059	93,013	106,327
Limestone Consumption	t/yr	5,030	9,301	10,633
Internal Consumption				
Thermal Energy	GJ/yr	64,070	94,209	100,406
Electricity	MWh/yr	1,490	2,180	2,300
Production of Thermal Energy	GJ/yr	427,780	656,100	700,740
Production of Electricity	MWh/yr	18,610	27,200	28,740
Heat Losses in Distribution	GJ/yr	20,623	31,806	33,979
Thermal Energy Delivered	GJ/yr	343,087	530,050	566,316
Electricity Delivered	MWh/yr	17,210	25,020	26,440
Ash Production	t/yr	32,599	47,334	38,681

Table 3.5 - Production of Thermal Energy and Electricity. Load Characteristic of the Boilers and the Turbine.

	Ambient Air Temperature				Summer	
	-18	-6	+6	+12	Max	Min
Load Variant 1						
<u>Boiler Loads in MWt</u>						
K1	21.25	20.10	11.35	9.30	7.2	5.21
K5	21.25	---	---	---	---	---
K6	---	---	---	---	---	---
<u>Steam Production in kg/s</u>						
K1	8.485	8.730	4.820	3.903	2.972	2.104
K5	8.485	---	---	---	---	---
K6	---	---	---	---	---	---
<u>Turbine Load in MWe</u>						
TG1	4.042	4.288	2.217	1.704	1.190	.737
<u>Turbine throughput in kg/s</u>						
TG1	7.313	7.667	4.502	3.662	2.788	1.974
Load Variant 2						
<u>Boiler Loads in MWt</u>						
K1	21.33	17.05	15.45	13.78	11.10	7.12
K5	21.33	15.05	---	---	---	---
K6	21.34	---	---	---	---	---
<u>Steam Production in kg/s</u>						
K1	8.395	6.297	7.600	5.931	4.711	2.936
K5	8.395	6.297	---	---	---	---
K5	8.395	---	---	---	---	---
<u>Turbine Load in MWe</u>						
TG1	4.735	4.735	3.888	2.889	2.166	1.171
<u>Turbine throughput in kg/s</u>						
TG1	8.333	8.333	7.099	5.565	4.420	2.755
Load Variant 3						
<u>Boiler Loads in MWt</u>						
K1	23.37	16.18	19.51	15.20	11.95	7.72
K5	23.37	16.18	---	---	---	---
K6	23.37	---	---	---	---	---
<u>Steam Production in kg/s</u>						
K1	9.151	6.717	8.590	6.585	5.096	3.201
K5	9.151	6.717	---	---	---	---
K6	9.151	---	---	---	---	---
<u>Turbine Load in MWe</u>						
TG1	4.735	4.735	4.524	3.288	2.391	1.314
<u>Turbine throughput in kg/s</u>						
TG1	8.333	8.333	8.024	6.179	4.782	3.003

Heating Plant

Distribution

Figure 3.17 - Construction Schedule, Alternative 2

3.3.4 Project Economic Analysis

Key Financial Assumptions

Construction duration	2 years
Time of start up/base year	1997
Term of Projected Sales (Life)	25 years
Cost of Natural Gas in 1997	3,350 SK/m3
Cost of Coal in 1997 (four alternatives)	467.2 SK/ton 680.0 SK/ton 850.0 SK/ton 1,275 SK/ton
Fuel Cost Escalation	2.7%
Coal	
Rate of Return Investment	14%
Nominal Interest Rate	5% to 30%
Real Interest Rate	2%, 5%, 9.5% and 12%
Investment Repayment Term	10 years
Investment Financed	90%
Net Effective Tax Rate	45%
Labor Rate	8,750 mil. SK/yr
Labor Rate Escalation	to year 2005 after 2005
	12.4% annually 6% annually
Overhead	3,000 mil. SK/yr
Overhead Escalation	to year 2005 after 2005
	6.0% annually 3.0% annually
Repairs and Maintenance	5,000 mil. SK/yr
R&M Escalation	to year 2005 after 2005
	7.5% annually 3.5% annually
Material Supplies	3,500 mil. SK/yr
Materials Escalation	to year 2005 after 2005
	7.5% annually 3.5% annually
Other Expenses, Escalation	1.0% annually
Amortization of Existing Equipment (steam distr., electro-installation)	
In Year 1997	1,566 mil. SK/yr
In Year 2000	.690 mil. SK/yr
In Year 2003	.690 mil. SK/yr
Price of Electricity Sold	1,389 SK/Mwh
Escalation	6% annually
TOTAL PROJECT COST	261.5 mil. SK

Fuel cost in first year of operation is assumed to be covered from in-house funds. The cost of obtaining the loan is not accounted for and will have to be added to the total cost at the time of detailed financial analyses.

Figure 3.18 and Table 3.6 present the results of this analysis as a function of inflation, delivered energy and fuel cost.

The comparison with Alternative 1 shows that cogeneration in the summer as well as the winter improves the economics. The positive impact of electricity sales is greater than the negative impact of greater emission production and its cost. The cost of delivered thermal energy is lower in this alternative (compared to Alternative 1).

Figure 3.18 - Cost of Heat as Function of Real Interest and Inflation

Table 3.6 - Cost of Heat, Alternative 2

Coal Cost [Sk/t]	Discount Rate [%]	Inflation [%]	Cost of Heat		
			Load Var. 1 [Sk/GJ]	Load Var. 2 [Sk/GJ]	Load Var. 3 [Sk/GJ]
467	2	3 18	195,75 265,55	130,48 176,35	128,75 173,75
	5	3 18	209,70 279,50	139,65 185,70	137,75 183,00
	9,5	3 18	230,65 300,50	153,40 199,95	151,25 197,00
	12	3 18	242,20 312,50	161,05 207,80	158,75 204,75
680	2	3 18	236,60 306,40	169,08 214,95	168,15 213,15
	5	3 18	250,60 320,40	178,25 224,20	190,65 222,15
	9,5	3 18	271,50 341,30	192,00 238,40	205,25 251,25
	12	3 18	283,15 253,30	199,65 246,35	198,15 244,00
850	2	3 18	269,25 339,05	199,88 245,75	199,63 244,60
	5	3 18	283,20 353,00	209,05 254,95	208,63 253,60
	9,5	3 18	304,15 373,90	222,80 269,20	222,10 267,60
	12	3 18	315,80 385,80	230,45 277,10	229,60 275,40
1275	2	3 18	350,80 420,60	276,90 322,80	278,25 323,25
	5	3 18	364,75 434,60	286,05 331,95	287,25 332,25
	9,5	3 18	385,70 455,50	299,85 346,00	300,75 345,95
	12	3 18	397,30 467,20/	307,50 353,95/	308,25 353,70

4. DECENTRALIZED HEAT SUPPLY SYSTEM

The analysis presented in this chapter was performed by Stavimex, the Slovak contractor. Presented here are the main highlights of their report. The economic calculations in the Stavimex report were performed without accounting for the time value of money. The cost of servicing the loan was also not considered. In order to compare all analyzed alternatives on an equivalent basis, the economic calculations were performed according to the same model. Therefore, the results presented here are different from those presented in the Stavimex report.

The analysis of the decentralized heat supply were performed for gas fuel only, since previous studies have shown that coal fired environmentally friendly small heat sources (small boilers) cannot compete with gas fired boilers due to the high cost of flue cleaning equipment. Electric boilers were also not considered due to high cost of electric energy. It is expected that the cost of electricity will increase from 1.67 SK/kWh to approximately 3.0 SK/kWh in 1997, and up to 3.4 SK/kWh in 2000.

The analysis assumes that the decentralized heat supply system will provide heat only to residential and non-residential sectors, and will not provide heat to industrial customers. The total installed capacity of all boilers amounts to 42.2 MWt with annual delivery of 377.28 TJ. The assumed total delivered thermal energy is smaller than in previous alternatives, however this should not have any impact on cost of delivered energy. In the case of this system, an increase in the required capacity will equally increase the investment.

4.1 EQUIPMENT SPECIFICATION

The specifications for each boiler and other boiler room equipment were based on the required heat delivery in a given location with respect to code CSN 06 0310, Section 58b. A duplication of equipment in as many location as possible was also a consideration to simplify maintenance and reduce spare parts inventory. The installation of boilers was assumed (where possible) to be in existing heat exchanger station buildings and existing old boiler houses to minimize the installation cost. The boiler rooms were designed to comply with the code CSN 07 0703.

4.1.1 Boiler Rooms

Following is a description of the proposed equipment in each boiler room and its parameters:

1. Boiler room consisting of:

boiler	2x SR plus 602
condensing units	2x TCR 800
Total installed output	0.7 to 1.24 MWt
Number of boiler rooms	23

2.	Boiler room consisting of:	
	boiler	2x UnoLyt UL 279
	condensing unit	2x TCR 280
	Total installed output	0.56 MWt
	Number of boiler rooms	18
3.	Boiler room consisting of:	
	boiler	2x AtmoGas 66
	Total installed output	0.132 MWt
	Number of boiler rooms	1
4.	Boiler room consisting of:	
	boiler	2x ST plus 800
	condensing unit	2x TCR 800
	Total installed output	1.86 MWt
	Number of boiler rooms	3
5.	Boiler room consisting of:	
	boiler	3x ST plus 800
	condensing unit	3x TCR 800
	Total installed output	2.79 MWt
	Number of boiler rooms	3
6.	Boiler room consisting of: (hospital boiler room)	
	boiler	3x ST plus 800
	condensing unit	3x TCR 800
	Installed output of Hot Water boilers	2.79 MWt
	Steam mini-boiler	2xTDH PU 400
	Steam output	800 kg/hr
	Cogeneration unit	
	Broadkrown-Dorman	BCHP 6.1 N
	Electric output	200-300 kW
	Number of boiler rooms	1

The total number of Hoval boilers to be installed in all boiler rooms:

Hoval SR plus 620	46 pcs
Hoval ST plus 800	18 pcs
Hoval UnoLyt UL 279	36 pcs
Hoval AtmoGas 66	2 pcs
Hoval THD PU 400	2 pcs

Cogeneration unit

Broadkrown BCHP 280	1 pc
---------------------	------

Condensing unit

Hoval TRC 280	36 pcs
Hoval TRC 800	60 pcs

4.1.2 Distribution System

The distribution system external to the boiler rooms will utilize the existing secondary distribution system. Hot water will be distributed at 110/70°C in the winter and at 70/40°C during the summer. Domestic hot water heating and space heating water temperature control will be done in individual residential buildings based on outside air temperature. Buildings will be equipped with GJ meters and water flow meters.

4.1.3 Water Heating

The domestic water heating system (DWHS) will be designed in two alternatives, depending on the building:

1. Buildings with the boiler room inside (basement), will have a DWHS with the storage tank installed in the boiler room. The water heating system will utilize the boiler flue gas condensing heat for preheating the cold water.
2. Buildings supplied with heat from an external boiler room (old heat exchanger station) will have the DWHS installed in the external boiler room.

4.2 Required Investment

Total installed cost of all listed equipment, including gas piping, and new building structures as required by specification	203,014 thous. SK
Total installed cost for Energy Management System EY 2 400, from Sauter, Switzerland (662,303 SF)	14,570 thous. SK
Installation of gas distribution system for all boiler rooms	11,970 thous. SK
Total Installed Cost of this Alternative	229,554 thous.SK

4.3. ANALYSIS OF OPERATION

Table 4.1 summarizes heat production, consumption of the fuel and electric energy. The construction schedule diagram is shown in Figure 4.1.

Table 4.1 - Operation Data, Alternative 3

Total Production of Heat by all Boiler Rooms	GJ/year	377,280
Gas Consumption (33.4 MJ/m ³)	10 ⁶ m ³	11,074.3
Internal Consumption		
Thermal Energy	GJ/year	---
Electricity	MWh/year	500
Thermal Energy Production	GJ/year	386,712
Delivered Thermal Energy	GJ/year	377,280

4.4 PROJECT ECONOMIC ANALYSIS

The economic analysis were performed using the discounted cash flow method, the same as in the previous alternatives.

Boiler Houses

Figure 4.1 - Construction Schedule, Alternative 3 (Decentralized)

Key Financial Assumptions

Construction duration		2 years
Time of Start up/base year		1997
Term of Projected Sales (life)		25 years
Cost of Natural Gas in 1997		3,350 SK/m ³
Gas Cost Escalation		
Natural Gas	from year 1997 to 2005	2.85% annually
	after year 2005	1.4% annually
Rate of Return of Investment		14%
Nominal Interest Rate		5% to 30%
Real Interest Rate		2%, 5%, 9.5% and 12%
Investment Repayment Term		10 years
Investment financed		90%
Net Effective Tax Rate		45%
Labor Rate		1.8 mil. SK/yr
Labor Rate Escalation	to year 2005	12.4% annually
	after year 2005	6% annually
Overhead		2.3 mil. SK/yr
Overhead Escalation	to year 2005	7.5% annually
	after year 2005	3.5% annually
Repairs and Maintenance		2.3 mil. SK/yr
R&M Escalation	to year 2005	7.5% annually
	after year 2005	3.5% annually
Material, energy		
Water		10.0 SK/m ³
Water cost escalation	to year 2005	2.85% annually
	after year 2005	1.4% annually
Electricity	a)	3,230.0 SK/MWh
	b)	1894.0 SK/MWh
Electricity cost escalation	a)	2.0%
	b)	6.0%
Other expenses, emissions		.0346 mil SK/yr
Other expenses escalation		1.0% annually
TOTAL PROJECT COST		229.554 mil. SK

Fuel cost in first year of operation is assumed to be covered from in-house funds. The cost of obtaining the loan is not accounted for and will have to be added to the total cost at the time of detailed financial analyses.

Figure 4.2, Table 4.2 and Table 4.3 present the results of this analysis as function of inflation, delivered energy and the fuel cost.

Heat Supply = 377,280 GJ/yr
Cost of Gas = 3.35 SK/m³

Cost of Electricity
1,894 Sk/MWh
3,230 Sk/MWh

Figure 4.2 - Cost of Heat as Function of Electricity Cost

Table 4.2 - Results Summary, Alternative 3

Electricity Cost	Discount Rate	Inflation	Delivered Energy Cost
[\$/MWh]	[%]	[%]	[\$/GJ]
1894	2	3	200.75
		18	256.50
	5	3	211.90
		18	267.60
	9.5	3	228.60
		18	284.30
	12	3	239.90
		18	293.65
3230	2	3	201.65
		18	257.40
	5	3	212.80
		18	268.50
	9.5	3	229.50
		18	285.20
	12	3	238.80
		18	294.60

5. COMPARISON OF ALTERNATIVES

This chapter summarizes the results and offers a comparison of the results obtained for all three alternatives. The results are shown in Table 5.1. The economic parameters for the central district heat system shown in this table were, for the purpose of comparison, calculated for load Variant 2 and a coal cost of 680 SK/ton, which is the most likely cost of coal in year 1997.

As it can be seen from the presented results, that lowest delivered energy cost (205.80 SK/GJ) is for Alternative 2. Alternative 2 also creates approximately 55 job opportunities and helps to maintain 1,000 to 1,400 jobs in the Handlova Coal Mine. (Note that the central heating system may not be the only user of the industrial grade coal produced by the coal mine, and the coal mine can maintain employment by finding other customers, should the heating system be converted to natural gas.) The delivered energy cost for Alternative 1 is slightly higher - 228.35 SK/GJ, however, this Alternative offers more reliable operations, lower emissions and less solid waste production due to bi-fuel (coal/gas) base.

In order to compare the town's central and decentralized energy supply system options on an equal platform, the economic calculations were performed for selected technical and economic assumptions which were the same for both systems. Internal Rate of Return on investment was set at 14%, financing of the project was assumed to be 90%, electricity price sold to distribution was assumed to be 1,389 SK/MWh and cost of electricity purchased was assumed at 1,894 SK/MWh. The central system is represented by Alternative 1. The delivered thermal energy cost was selected as the comparison parameter. The results are graphically presented in Figure 5.1. The five fields shown in the Figure 5.1 represent delivered energy cost ranges calculated for Alternative 1 and 3.

Each field is defined by the minimum assumed fuel price (467 SK/ton for coal) and minimum inflation (3%) on the left side and the maximum assumed fuel price (1,275 SK/ton for coal) and maximum inflation (18%) on the right side. The price of natural gas is assumed to be 3,350 SK/m³. The real interest rate of 2% and 12% defined the low and high of the range, respectively.

The following conclusions can be drawn from the presented results of comparison of the central and the decentralized heating systems, providing that the fuel prices and the prices of electricity purchased and sold will be developing as assumed in the calculation:

- The delivered energy cost will be lower for the decentralized system when the coal price is higher than 800 SK/ton and the thermal energy demand is lower than 350 TJ/year. Increased demand and lower coal price will make the centralized system more attractive.
- The delivered energy cost will be lower for the central heating system when the coal price is less than 700 SK/ton and the thermal energy demand is over 500 TJ/year.

Economic Assumptions

Coal Cost = 467 Sk/ton to 1275 Sk/ton

Gas Cost = 3.35 sk/m³

Cost of Electricity:

Sale - 1389 Sk/MWh

Purchase - 1894 to 3230 Sk/MWh

Financing = 90%

Inflation = 3 to 18%

Note:

Internal rate of return	14 %
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ap19-94/km fl

Figure 5.1 - Economic Analysis and Sensitivity of Results for Decentralized (Alt. 3) and Central (Alt. 1) Production of Thermal Energy for Space and Water Heating in the Town of Handlova, Slovakia

The absolute delivered energy cost will depend on the actual economic parameters, such as general inflation, real interest rate, purchasing and selling prices of electricity, and on actual thermal energy demand. The thermal delivered energy cost fields shown in Figure 5.1 are overlapping and suggest the thermal delivered energy price could fall in broad range from approximately 150 to 430 SK/GJ. A more realistic range is more likely to be between 200 and 250 SK/GJ.

In the US it is common practice to perform the economic analysis on a real basis, thus excluding general inflation. Such analysis can be performed under the assumption that the inflation has the same impact on general prices and income of citizens. This is currently not the case in Slovakia, where prices are inflating at a substantially higher rate than income. For this reason, the general inflation impact was considered in this analysis. The effect of the general inflation can be removed by setting the inflation rate equal to zero. In this case, the delivered energy cost would in general be lower.

The decision on whether to implement the decentralized or the central heat supply system will depend on actual negotiated prices of coal from the Handlova Coal Mine, the latest development in world gas prices and the latest estimates for the purchase and selling price of electricity.

The economic calculations were performed with the following assumptions: 90% financing, real interest rate 9.5%, nominal interest rate 17%, coal price (1st year of operation) 680 SK/ton, gas price 3.25 SK/m³, electricity purchase price (selling to distribution) 1,894 SK/MWh, electricity cost (buy from distribution) 1,389 SK/MWh, and required return on investment 14%.

Table 5.1 - Technical and Economical Comparison of Alternatives

Parameter	Unit	Alt. 1	Alt. 2	Alt. 3
Technical Parameters				
Boiler Output Installed				
Steam	MWt	60	90	1.5
Hot Water	MWt	40	--	55.5
Source Installed Output	MWe	4.8	4.8	(.2 - .3)
System Peak Thermal Output Requirements	MWt	70	70	42.5
Operational Parameters				
Fuel Consumption				
Coal	t/yr	69,307	93,013	---
Gas	mil.m3/yr	3,947	---	11,074
Internal Consumption				
Electricity	MWh/yr	1,790	2,180	500
Thermal Energy	GJ/yr	110,234	94,209	---
Delivered Energy				
Thermal Energy	GJ/yr	530,050	530,050	377,280
Electricity	MWh/yr	20,610	25,020	---
Emissions Produced				
SO ₂	ton/yr	1,073	1,518	---
NO _x	ton/yr	266	344	14.58
Particulate	ton/yr	25,212	47,334	---
Economic Parameters				
Total Investment (IN)	thous.	300,500	261,500	229,554
Average Annual Net Profit	SK	23,366	20,448	18,787
Discounted Total Profit	thous.	220,522	192,975	172,232
Discounted Total Cash Flow	SK	96,245	85,954	70,662
Simple Payback	thous.	16	16	15
Cost of Delivered Energy	SK	228.35	205.80	245.30
Number of Jobs	thous.	55	55	7
	SK			
	years			
	SK/GJ			
	--			

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APPENDIX A

Table A1 - Cash Flow S.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Heat [TJ]			518.9	519.3	519.8	520.3	520.8	521.2	521.7	522.2	522.7
Escalated price [SK/GJ]			228.4	233.7	239.0	244.5	250.1	255.9	261.8	267.8	274.0
Electricity supply [GWh]			19.9	19.9	19.9	20	20	20	20.1	20.1	20.1
Escalated price [SK/MWh]			1389.0	1472.3	1560.7	1654.3	1753.6	1858.8	1970.3	2088.5	2213.9
Cost of Fuel and Energy											
Coal consumption [tons]			68491.4	68525.1	68588.9	68592.7	68626.5	68660.4	68694.2	68728.1	68762
Escalated cost of coal [SK/ton]			680	698.4	717.2	736.6	756.5	776.9	797.9	819.4	841.5
Gas consumption [th.m3]			3945.5	3945.5	3945.5	3945.6	3945.6	3945.7	3945.7	3945.8	3945.8
Escalated price [SK/th.m3]			3350.0	3445.5	3543.7	3644.7	3748.5	3855.4	3965.3	4078.3	4194.5
Labor and overhead [thous. SK]			8750.0	9835.0	11054.5	12425.3	13966.0	15697.8	17644.4	19832.3	22291.5
Repair and Maint. [thous. SK]			5000	5375.0	5778.1	6211.5	6677.3	7178.1	7716.5	8295.2	8917.4
Emissions [thous. SK]			2359.7	2384.4	2409.4	2434.7	2460.2	2486.0	2512.0	2538.3	2564.9
Materials, fuels [thous. SK]			3500	3762.5	4044.7	4348.0	4674.1	5024.7	5401.6	5806.7	6242.2
Overhead [thous. SK]			3000	3180.0	3370.8	3573.0	3787.4	4014.7	4255.6	4510.9	4781.5
Depreciat. exist. assets [th. SK]			1556	1556	1556	690	690	690	690	690	690
Project Summary											
Depreciation	0	0	13787	13787	13787	13787	13787	13787	13787	13787	13787
Annual Interest	0	0	22735	22735	22735	22735	22735	22735	22735	22735	22735
Investment Total	150250	150250	0	0	0	0	0	0	0	0	0
Fines											
Profit	0	0	27176	28130	29017	29822	30531	31125	31583	31880	31992
Cash Flow Project	-150250	-150250	63698	64652	65538	66344	67053	67647	68104	68402	68513
Cash Flow, r ⁿ -t	-164524	-150250	58172	53920	49918	46147	42594	39243	36081	33095	30273
Discounted Cash Flow, Project	-164524	-314774	-256602	-202682	-152764	-106617	-64023	-24780	11301	44395	74668
Investors Summary											
Depreciation	0	0	14779	14779	14779	14779	14779	14779	14779	14779	14779
Depreciation of Existing Equip.	0	0	1556	1556	1556	690	690	690	690	690	690
Interest	22988	45977	41379	36781	32184	27586	22988	18391	13793	9195	4598
Interest During Construction	22988	45977	0	0	0	0	0	0	0	0	0
Pre-Tax Profit	0	0	5985	11536	17020	23290	28596	33787	38843	43738	48447
Taxes	0	0	2693	5191	7659	10480	12868	15204	17479	19682	21801
Usable Profit	0	0	3292	6345	9361	12809	15728	18583	21364	24056	26646
Own Investment	15025	15025	0	0	0	0	0	0	0	0	0
Loan Draw-Down	135225	135225	0	0	0	0	0	0	0	0	0
Subsidies	0	0	0	0	0	0	0	0	0	0	0
Loan Payment	0	0	27045	27045	27045	27045	27045	27045	27045	27045	27045
Cash Flow (after tax)	-38013	-61002	-7419	-4366	-1349	1233	4152	7007	9787	12480	15070
Cash Flow, r ⁿ -t	-41625	-61002	-6775	-3641	-1028	858	2637	4065	5185	6038	6658
Discounted Cash Flow, Investor	-41625	-102626	-109401	-113042	-114070	-113212	-110575	-106510	-101325	-95287	-88629

Discount Rate - 9.5
Inflation - 3%

Summary, Alternative 1, Load Variant 2

Year															
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
523.2	523.7	524.2	524.6	525.1	525.6	526.1	526.6	527.1	527.6	528.1	528.6	529	529.5	530	530.5
280.3	286.7	293.3	300.1	307.0	314.0	321.2	328.6	336.2	343.9	351.8	359.9	368.2	376.7	385.3	394.2
20.2	20.2	20.2	20.2	20.3	20.3	20.3	20.4	20.4	20.4	20.5	20.5	20.5	20.5	20.6	20.6
2346.7	2487.5	2636.7	2794.9	2962.6	3140.4	3328.8	3528.5	3740.3	3964.7	4202.6	4454.7	4722.0	5005.3	5305.6	5624.0
68795.9	68829.8	68863.8	68897.7	68931.7	68965.7	68999.7	69033.7	69067.3	69101.8	69135.9	69170	69204.1	69238.2	69272.4	69306.8
864.3	887.6	911.6	936.2	961.4	987.4	1014.1	1041.4	1069.6	1098.4	1128.1	1158.6	1189.8	1222.0	1255.0	1288.8
3945.9	3945.9	3946	3946	3946.1	3946.1	3946.2	3946.2	3946.3	3946.3	3946.4	3946.4	3946.5	3946.5	3946.6	3946.7
4253.2	4312.8	4373.1	4434.4	4496.4	4559.4	4623.2	4687.9	4753.6	4820.1	4887.6	4956.0	5025.4	5095.8	5167.1	5239.5
23628.9	25046.7	26549.5	28142.5	29831.0	31620.9	33518.1	35529.2	37661.0	39920.6	42315.8	44854.8	47546.1	50398.9	53422.8	56628.2
9229.5	9552.5	9886.9	10232.9	10591.1	10961.7	11345.4	11742.5	12153.5	12578.9	13019.1	13474.8	13946.4	14434.5	14939.7	15462.6
2591.8	2619.0	2646.4	2674.2	2702.2	2730.5	2759.1	2788.0	2817.3	2846.8	2876.6	2906.8	2937.2	2968.0	2999.1	3030.6
6460.6	6686.8	6920.8	7163.0	7413.7	7673.2	7941.8	8219.7	8507.4	8805.2	9113.4	9432.4	9762.5	10104.2	10457.8	10823.8
4925.0	5072.7	5224.9	5381.7	5543.1	5709.4	5880.7	6057.1	6238.3	6426.0	6618.8	6817.3	7021.9	7232.5	7449.5	7673.0
690	690	690	690	690	690	690	690	690	690	690	690	690	690	690	690
13787	13787	13787	13787	13787	13787	13787	13787	13787	13787	13787	13787	13787	13787	13787	13787
22735	22735	22735	22735	22735	22735	22735	22735	22735	22735	22735	22735	22735	22735	22735	22735
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34302	36713	39230	41860	44607	47479	50483	53626	56916	60362	63973	67757	71725	75888	80256	84842
70824	73235	75752	78381	81128	84001	87005	90148	93438	96884	100494	104279	108247	112410	116778	121364
28578	26988	25493	24090	22771	21531	20366	19272	18242	17274	16363	15506	14700	13941	13226	12553
103246	130234	155727	179817	202587	224119	244485	263757	281959	229272	315635	331141	345841	359781	373007	385560
14779	14779	14779	14779	14779	14779	14779	14779	14779	14779	14779	14779	14779	14779	14779	14779
690	690	690	690	690	690	690	690	690	690	690	690	690	690	690	690
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55355	57766	60283	62913	65660	68532	71536	74679	77970	81416	85026	88810	92778	96941	101309	105896
24910	25995	27128	28311	29547	30840	32191	33606	35086	36637	38262	39965	41750	43623	45589	47653
30445	31772	33156	34602	36113	37693	39345	41074	42883	44779	46764	48846	51028	53318	55720	58243
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27045	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18869	47240	48624	50071	51582	53161	54813	56542	58352	60247	62233	64314	66496	68786	71189	73711
7614	17408	16364	15389	14478	13626	12831	12087	11392	10742	10133	9563	9030	8531	8063	7624
-81015	-63607	-47243	-31854	-17377	-3750	9081	21168	32560	43302	53345	62998	72028	80559	88621	96245

**PARAMETERS OF ECONOMIC EFFECTIVENESS
ALTERNATIVE 1**

Table A.2 - Heat Supply According to Variant 1

Cost of Coal SK/ton	Real Interest (discount)		2,0		5,0		9,5		12,0	
	Inflation	%	3	18	3	18	3	18	3	18
467 Sk/ton	Average Annual Profit	thous. Sk	18 054	31 613	19 306	31 022	20 109	29 221	20 119	27 908
	Discounted Profit (life)	thous. Sk	352 479	617 193	272 096	437 223	189 760	275 776	157 795	218 889
	Discounted Cash Flow (life)	thous. Sk	325 256	576 235	199 254	336 821	77 444	132 634	30 703	47 602
	Payback Period	Years	13	12	13	13	16	15	19	19
	Return on Investment	%	60,08	105,20	64,25	103,23	66,92	97,24	66,95	92,87
680 Sk/ton	Average Annual Profit	thous. Sk	17 893	31 452	19 196	30 912	20 062	29 174	20 101	27 881
	Discounted Profit (life)	thous. Sk	349 337	614 051	270 542	435 669	189 339	275 335	157 651	218 677
	Discounted Cash Flow (life)	thous. Sk	322 114	573 093	197 700	335 267	77 003	123 193	30 560	47 391
	Payback Period	Years	13	12	13	13	16	15	19	19
	Return on Investment	%	59,54	104,67	63,88	102,87	66,76	97,09	66,89	92,78
850 Sk/ton	Average Annual Profit	thous. Sk	17 760	31 452	19 196	30 912	20 062	29 174	20 101	27 881
	Discounted Profit (life)	thous. Sk	349 337	614 051	270 542	435 669	189 339	275 335	157 651	218 677
	Discounted Cash Flow (life)	thous. Sk	322 114	573 093	197 700	335 267	77 003	123 193	30 560	47 391
	Payback Period	Years	13	12	13	13	16	15	19	19
	Return on Investment	%	59,54	106,67	63,88	102,87	66,76	97,09	66,89	92,78
1 275 Sk/ton	Average Annual Profit	thous. Sk	17 439	31 010	18 883	30 587	19 939	29 028	20 045	27 833
	Discounted Profit (life)	thous. Sk	340 469	605 423	266 138	431 098	188 172	18 172	157 217	218 295
	Discounted Cash Flow (life)	thous. Sk	313 246	564 464	193 296	330 696	75 837	75 837	30 125	47 008
	Payback Period	Years	13	12	13	12	16	16	19	18
	Return on Investment	%	58,03	103,19	62,84	101,79	66,35	66,35	66,71	92,62

**PARAMETERS OF ECONOMIC EFFECTIVENESS
ALTERNATIVE 1**

Table A.2 - Heat Supply According to Variant 2

Cost of Coal SK/ton	Real Interest (discount) Inflation	%	2,0		5,0		9,5		12,0	
			3	18	3	18	3	18	3	18
467 Sk/ton	Average Annual Profit	thous. Sk	20 702	34 812	21 367	33 530	21 401	30 877	21 062	29 139
	Discounted Profit (life)	thous. Sk	404 176	696 654	301 140	427 567	201 976	291 403	165 194	228 538
	Discounted Cash Flow (life)	thous. Sk	375 514	636 801	225 472	368 421	85 613	133 909	33 624	51 302
	Payback Period	Years	13	12	14	13	16	15	19	19
	Return on Investment	%	66,67	112,12	68,81	107,99	68,93	99,49	99,44	93,84
680 Sk/ton	Average Annual Profit	thous. Sk	20 498	34 602	21 225	33 388	21 355	30 810	21 033	29 128
	Discounted Profit (life)	thous. Sk	400 198	675 677	299 145	470 571	201 537	290 772	164 967	228 453
	Discounted Cash Flow (life)	thous. Sk	371 538	632 824	223 477	366 426	85 175	133 276	33 397	51 217
	Payback Period	Years	13	12	14	16	16	15	19	19
	Return on Investment	%	66,02	111,46	68,36	105,53	68,78	99,23	67,74	93,81
850 Sk/ton	Average Annual Profit	thous. Sk	20 341	34 451	21 117	33 280	21 309	30 758	21 015	29 106
	Discounted Profit (life)	thous. Sk	397 127	672 605	297 624	469 051	201 103	290 283	164 824	228 283
	Discounted Cash Flow (life)	thous. Sk	368 467	629 752	221 956	364 906	84 741	132 789	33 253	51 047
	Payback Period	Years	13	12	14	16	16	15	19	19
	Return on Investment	%	65,51	110,95	68,01	107,18	68,63	99,06	67,68	93,74
1 275 Sk/ton	Average Annual Profit	thous. Sk	19 948	34 058	20 847	33 011	21 194	30 619	20 969	29 043
	Discounted Profit (life)	thous. Sk	389 448	664 926	293 823	465 249	200 018	288 973	164 465	227 785
	Discounted Cash Flow (life)	thous. Sk	360 788	622 073	218 155	361 104	83 655	131 479	32 894	50 549
	Payback Period	Years	13	12	13	13	16	15	19	19
	Return on Investment	%	64,24	109,69	67,14	106,31	68,26	98,61	67,53	93,53

**PARAMETERS OF ECONOMIC EFFECTIVENESS
ALTERNATIVE 1**

Table A.2 - Heat Supply According to Variant 3

Cost of Coal SK/ton	Real Interest (discount) %		2,0		5,0		9,5		12,0	
	Inflation %		3	18	3	18	3	18	3	18
467 Sk/ton	Average Annual Profit	thous. Sk	20 461	34 408	20 989	32 992	20 781	30 150	20 428	28 306
	Discounted Profit (life)	thous. Sk	399 461	671 772	295 812	464 994	196 974	284 547	160 221	222 005
	Discounted Cash Flow (life)	thous. Sk	372 239	630 813	222 970	364 592	84 638	132 405	33 129	50 718
	Payback Period	Years	13	12	14	13	16	16	19	19
	Return on Investment	%	68,09	114,50	114,50	109,79	69,45	100,33	67,98	94,19
680 Sk/ton	Average Annual Profit	thous. Sk	20 322	34 262	20 904	32 896	20 821	30 091	20 419	28 290
	Discounted Profit (life)	thous. Sk	396 761	668 920	294 616	463 631	196 498	283 985	160 147	221 885
	Discounted Cash Flow (life)	thous. Sk	369 539	627 962	221 774	363 229	84 163	131 843	33 055	50 599
	Payback Period	Years	13	12	14	13	16	16	19	19
	Return on Investment	%	67,63	114,02	69,56	109,47	69,29	100,14	67,95	94,14
850 Sk/ton	Average Annual Profit	thous. Sk	20 223	34 171	20 826	32 804	20 803	30 064	20 402	28 265
	Discounted Profit (life)	thous. Sk	394 816	667 126	293 523	462 344	196 331	283 728	160 017	221 684
	Discounted Cash Flow (life)	thous. Sk	367 593	626 168	220 681	361 942	83 996	131 585	32 925	50 397
	Payback Period	Years	13	12	14	13	16	16	19	19
	Return on Investment	%	67,30	113,71	69,31	109,17	69,23	100,05	67,89	94,06
1 275 Sk/ton	Average Annual Profit	thous. Sk	19 952	33 892	20 651	32 618	20 715	29 976	20 361	28 243
	Discounted Profit (life)	thous. Sk	389 536	661 695	291 055	459 719	195 496	282 905	159 691	221 544
	Discounted Cash Flow (life)	thous. Sk	362 313	620 736	218 213	359 317	83 160	130 763	32 599	50 258
	Payback Period	Years	13	12	14	13	16	15	19	19
	Return on Investment	%	66,40	112,79	68,72	108,55	68,93	99,76	67,76	94,00

APPENDIX B

Table B1 - Cash Flow S

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Heat [TJ]			518.8	519.3	519.7	520.2	520.7	521.1	521.6	522.1	522
Escalated heat price [SK/GJ]			192	196.4	200.9	205.6	210.3	215.1	220.1	225.1	230
Electricity supplied [GWh]			24.3	24.3	24.4	24.4	24.4	24.4	24.5	24.5	24
Escalated electricity price [SK/MWh]			1389	1472.3	1560.7	1654.3	1753.6	1858.8	1970.3	2088.5	2213
Cost of fuel and energy											
Coal (tons)			91628	91685.2	91742.6	91799.9	91857.3	91914.8	91972.3	92029.8	92087
Escalated cost of coal [SK/ton]			680	698.4	717.2	736.6	756.5	776.9	797.9	819.4	841
Direct labor and overhead (thous.SK)			8750	9835	11054.5	12425.3	13966	15697.8	17644.4	19832.3	22291
Repair and maintenance (thous.SK)			5000	5375	5778.1	6211.5	6677.3	7178.1	7716.5	8295.2	8917
Emissions (thous. SK)			3804.4	3844.7	3885.4	3926.6	3968.2	4010.3	4052.8	4095.8	4139
Materials and other fuels (thous SK)			3500	3762.5	4044.7	4348	4674.1	5024.7	5401.6	5806.7	6242
Overhead (thous.SK)			3000	3180	3370.8	3573	3787.4	4014.7	4255.6	4510.9	4781
Depreciation (thous. SK)			1556	1556	1556	690	690	690	690	690	69
Project Summary											
Depreciation	0	0	11998	11998	11998	11998	11998	11998	11998	11998	11998
Annual interest	0	0	19784	19784	19784	19784	19784	19784	19784	19784	19784
Investment total	130750	130750	0	0	0	0	0	0	0	0	0
Profit	0	0	15221	16006	16734	17392	17964	18433	18779	18981	19015
Cash flow, project	-130750	-130750	47003	47788	48516	49174	49745	50214	50561	50763	50794
Cash flow r-T	-143171	-130750	42925	39856	36952	34204	31600	29130	26787	24560	22444
discounted cash flow, project	-143171	-273921	-230996	-191140	-154188	-119984	-88384	-59254	-32467	-7907	14537
Investors Summary											
Depreciation	0	0	12225	12225	12225	12225	12225	12225	12225	12225	12225
Depreciation of Existing Equipment	0	0	1556	1556	1556	690	690	690	690	690	690
Loan interest	14709	29419	26477	23535	20593	17651	14709	11768	8826	5884	2942
Interest during construction	14709	29419	0	0	0	0	0	0	0	0	0
Pre-tax profit	0	0	6745	10472	14142	18607	22121	25532	28820	31964	34933
Taxes	0	0	3035	4712	6364	8373	9954	11489	12969	14384	15722
Net Profit	0	0	3710	5760	7778	10234	12166	14042	15851	17580	19216
Own investment	13075	13075	0	0	0	0	0	0	0	0	0
Loan draw-down	117675	117675	0	0	0	0	0	0	0	0	0
subsidies	0	0	0	0	0	0	0	0	0	0	0
Loan payment	0	0	23535	23535	23535	23535	23535	23535	23535	23535	23535
Cash Flow	-27784	-42494	-6044	-3994	-1976	-386	1547	3423	5231	6961	8596
Cash Flow r-T	-30424	-42494	-5520	-3331	-1505	-268	982	1986	2772	3368	3793
discounted cash flow,	-30424	-72918	-78437	-81769	-83274	-83542	-82560	-80574	-77803	-74435	-70637

Discount Rate - 9.5
Inflation - 3%

Summary, Alternative 2, Load Variant 2

Year															
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
523	523.4	523.9	524.4	524.8	525.5	525.8	526.2	526.7	527.2	527.7	528.1	528.6	529.1	529.5	530
235.6	241	246.6	252.2	258	264	270	276.3	282.6	289.1	295.8	302.6	309.9	316.6	323.9	331.4
24.6	24.6	24.6	24.7	24.7	24.7	24.7	24.8	24.8	24.8	24.9	24.9	24.9	25	25	25.02
2346.7	2487.5	2636.7	2794.9	2962.6	3140.4	3328.8	3528.5	3740.3	3964.7	4202.6	4454.7	4722	5005.3	5305.6	5624
92144.9	92202.5	92260.2	92317.9	92375.6	92433.3	92491.1	92549	92606.8	92664.7	92722.7	92780.7	92838.7	92896.7	92954.8	93013
864.3	887.6	911.6	936.2	961.4	987.4	1014.1	1041.4	1069.6	1098.4	1128.1	1158.6	1189.8	1222	1255	1288.8
23628.9	25046.7	26549.5	28142.5	29831	31620.9	33518.1	35529.2	37661	39920.6	42315.8	44854.8	47546.1	50398.9	53422.8	56628.2
9229.5	9552.5	9886.9	10232.9	10591.1	10961.7	11345.4	11742.5	12153.5	12578.9	13019.1	13474.8	13946.4	14434.5	14939.7	15462.6
4183.1	4227.4	4272.2	4317.5	4363.3	4409.5	4456.3	4503.5	5441.2	4599.5	4648.2	4697.5	4747.3	4797.6	4848.5	4899.9
6460.6	6686.8	6920.8	7163	7413.7	7673.2	7941.8	8219.7	8507.4	8805.2	9113.4	9432.4	9762.5	10104.2	10457.8	10823.8
4925	5072.7	5224.9	5381.7	5543.1	5709.4	5880.7	6057.1	6238.8	6426	6618.8	6817.3	7021.9	7232.5	7449.5	7673
690	690	690	690	690	690	690	690	690	690	690	690	690	690	690	690
11998	11998	11998	11998	11998	11998	11998	11998	11998	11998	11998	11998	11998	11998	11998	11998
19784	19784	19784	19784	19784	19784	19784	19784	19784	19784	19784	19784	19784	19784	19784	19784
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21023	23142	25379	27739	30232	32866	35649	38590	41701	44991	48472	52157	56057	60187	64561	69195
52805	54924	57161	59521	62014	64648	67431	70372	73483	76773	80254	83938	87839	91969	96343	100977
21307	20240	19237	18293	17406	16571	15785	15044	14346	13688	13067	12481	11928	11406	10911	10444
35844	56084	75321	93614	111020	127590	143375	158419	172765	186453	199520	212002	223930	235335	246247	256691
12225	12225	12225	12225	12225	12225	12225	12225	12225	12225	12225	12225	12225	12225	12225	12225
690	690	690	690	690	690	690	690	690	690	690	690	690	690	690	690
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39890	42009	44245	46606	49099	51733	54515	57457	60568	63858	67339	71023	74924	79054	83428	88062
17950	18904	19910	20973	22095	23280	24532	25856	27256	28736	30303	31960	33716	35574	37542	39628
21939	23105	24335	25633	27005	28453	29984	31601	33312	35122	37036	39063	41208	43479	45885	48434
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23535	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11319	36020	37250	38548	39920	41368	42899	44517	46227	48037	49952	51978	54123	56395	58800	61349
4568	13274	12536	11847	11204	10604	10042	9517	9025	8565	8133	7729	7350	6994	6659	6345
-66069	-52795	-40260	-28442	-17208	-6604	3438	12954	21979	30544	38677	46406	53756	60755	67409	73755

**PARAMETERS OF ECONOMIC EFFECTIVENESS
ALTERNATIVE 2**

Table B.2 - Heat Supply According to Variant 1

Cost of Coal SK/ton	Real Interest (discount) Inflation	%	2,0		5,0		9,5		12,0	
			3	18	3	18	3	18	3	18
467 Sk/ton	Average Annual Profit	thous. Sk	15 953	27 756	16 916	27 105	17 477	25 398	17 423	24 206
	Discounted Profit (life)	thous. Sk	311 463	541 898	238 411	382 016	164 937	239 695	136 653	189 852
	Discounted Cash Flow (life)	thous. Sk	289 846	508 328	176 591	296 213	68 308	108 425	27 028	41 768
	Payback Period	Years	13	12	13	13	16	15	19	19
	Return on Investment	%	61,01	106,14	64,69	103,65	66,83	97,12	66,63	92,57
680 Sk/ton	Average Annual Profit	thous. Sk	15 741	27 544	16 781	26 970	17 411	25 324	17 394	24 183
	Discounted Profit (life)	thous. Sk	307 324	537 759	236 504	380 108	164 314	238 997	136 420	189 674
	Discounted Cash Flow (life)	thous. Sk	285 707	504 189	174 684	294 305	67 685	107 727	26 795	41 590
	Payback Period	Years	13	12	13	13	16	15	19	19
	Return on Investment	%	60,20	105,33	64,17	103,13	66,58	96,84	66,51	92,48
850 Sk/ton	Average Annual Profit	thous. Sk	15 584	27 387	16 662	26 851	17 368	25 270	17 380	24 150
	Discounted Profit (life)	thous. Sk	304 244	534 679	234 837	378 441	163 916	238 492	136 316	189 413
	Discounted Cash Flow (life)	thous. Sk	282 627	501 109	173 017	292 638	67 287	107 223	26 691	41 329
	Payback Period	Years	13	12	13	13	15	15	19	19
	Return on Investment	%	59,59	104,73	63,72	102,68	66,42	96,64	66,46	92,35
1 275 Sk/ton	Average Annual Profit	thous. Sk	15 171	26 974	16 378	26 579	17 246	25 160	17 319	24 103
	Discounted Profit (life)	thous. Sk	296 186	526 621	230 837	374 608	162 762	237 445	135 837	189 043
	Discounted Cash Flow (life)	thous. Sk	274 569	493 051	169 016	288 805	66 133	106 176	26 212	40 959
	Payback Period	Years	13	12	13	13	16	15	19	19
	Return on Investment	%	58,01	103,15	62,63	101,64	65,95	96,21	66,23	92,17

**PARAMETERS OF ECONOMIC EFFECTIVENESS
ALTERNATIVE 2**

Table B.2 - Heat Supply According to Variant 2

Cost of Coal Sk/ton	Real Interest (discount) Inflation	%	2,0		5,0		9,5		12,0	
			3	18	3	18	3	18	3	18
467 Sk/ton	Average Annual Profit	thous. Sk	18 229	30 109	18 473	28 757	18 135	26 152	17 683	24 504
	Discounted Profit (life)	thous. Sk	355 895	587 824	260 358	405 300	171 148	246 809	138 691	192 188
	Discounted Cash Flow (life)	thous. Sk	334 278	554 254	198 538	319 497	74 520	115 539	29 066	44 104
	Payback Period	Years	13	12	14	13	16	16	19	19
	Return on Investment	%	69,71	115,14	70,64	109,97	69,35	100,01	67,62	93,71
680 Sk/ton	Average Annual Profit	thous. Sk	17 952	29 831	18 283	28 545	18 054	26 037	17 651	24 479
	Discounted Profit (life)	thous. Sk	350 482	582 412	257 679	402 306	170 384	245 731	138 437	191 996
	Discounted Cash Flow (life)	thous. Sk	328 865	548 842	195 859	316 502	73 755	114 461	28 812	43 912
	Payback Period	Years	13	12	14	13	16	16	19	19
	Return on Investment	%	68,65	114,08	69,92	109,16	69,04	99,57	67,50	93,61
850 Sk/ton	Average Annual Profit	thous. Sk	17 728	29 607	18 128	28 380	17 986	25 988	17 622	24453
	Discounted Profit (life)	thous. Sk	346 107	578 037	255 502	399 990	169 748	245 261	138 215	191792
	Discounted Cash Flow (life)	thous. Sk	324 490	544 467	193 682	314 187	73 119	113 991	28 590	43708
	Payback Period	Years	13	12	14	13	16	16	19	19
	Return on Investment	%	67,79	113,22	69,32	108,53	68,78	99,38	67,39	93,51
1 275 Sk/ton	Average Annual Profit	thous. Sk	17 175	29 066	17 742	27 994	17 835	25 789	17 568	24 379
	Discounted Profit (life)	thous. Sk	335 317	567 466	250 059	394 437	168 323	243 390	137 792	191 211
	Discounted Cash Flow (life)	thous. Sk	313 700	533 896	188 239	308 744	71 694	112 121	28 167	43 127
	Payback Period	Years	13	12	14	15	16	15	19	19
	Return on Investment	%	65,68	111,15	67,85	107,05	68,20	98,62	67,18	93,23

**PARAMETERS OF ECONOMIC EFFECTIVENESS
ALTERNATIVE 2**

Table B.2 - Heat Supply According to Variant 3

Cost of Coal SK/ton	Real Interest (discount) Inflation	%	2,0		5,0		9,5		12,0	
			3	18	3	18	3	18	3	18
467 Sk/ton	Average Annual Profit	thous. Sk	18 479	30 616	18 674	29 142	18 243	26 334	17 733	24 591
	Discounted Profit (life)	thous. Sk	360 781	597 722	263 187	410 723	172 174	248 525	139 079	192 871
	Discounted Cash Flow (life)	thous. Sk	339 171	564 161	201 381	324 939	75 565	117 283	29 477	44 817
	Payback Period	Years	13	12	14	13	16	16	19	19
	Return on Investment	%	70,68	117,10	71,42	111,46	69,78	100,72	67,82	94,06
680 Sk/ton	Average Annual Profit	thous. Sk	17 944	30 080	18 306	28 705	18 084	26 157	17 665	24 515
	Discounted Profit (life)	thous. Sk	350 328	587 269	257 999	404 561	170 665	246 863	138 553	192 277
	Discounted Cash Flow (life)	thous. Sk	328 718	553 708	196 193	318 776	74 057	115 620	28 950	44 223
	Payback Period	Years	13	12	14	13	16	16	19	19
	Return on Investment	%	68,63	115,05	70,02	109,79	69,17	100,05	67,57	93,77
850 Sk/ton	Average Annual Profit	thous. Sk	17 530	29 654	18 025	28 433	17 957	26 026	17 613	24 482
	Discounted Profit (life)	thous. Sk	342 243	578 956	254 038	400 728	169 475	245 621	138 143	192 019
	Discounted Cash Flow (life)	thous. Sk	320 633	545 396	192 232	314 943	72 886	114 378	28 541	43 965
	Payback Period	Years	13	12	14	13	16	16	19	19
	Return on Investment	%	67,05	113,42	68,94	108,75	68,68	99,54	67,37	93,64
1 275 Sk/ton	Average Annual Profit	thous. Sk	16 463	28 600	17 292	27 711	17 651	25 687	17 491	24 326
	Discounted Profit (life)	thous. Sk	321 424	558 364	243 713	390 561	166 582	242 426	137 187	190 789
	Discounted Cash Flow (life)	thous. Sk	299 814	524 804	181 907	304 776	69 973	111 183	27 585	42 735
	Payback Period	Years	13	12	13	13	16	15	19	19
	Return on Investment	%	62,97	109,39	66,14	105,99	67,51	98,25	66,90	93,04

APPENDIX C

Table C1 - Cash Flow

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	200
Heat [TJ]			377.3	377.3	377.3	377.3	377.3	377.3	377.3	377.3	377.
Escalated price [SK/GJ]			246.2	251.9	257.7	263.6	269.6	275.8	282.2	288.7	295.
Cost of Fuel and Energy											
Electricity [MWh]			500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.
Escalated Cost of El. (SK/MWh)			1894.0	2007.6	2128.1	2255.8	2391.1	2534.6	2686.7	2847.9	3018.
Gas consumption [ths.m3]			11074.3	11074.3	11074.3	11074.3	11074.3	11074.3	11074.3	11074.3	11074.
Escalated price [SK/ths.m3]			3350.0	3445.5	3543.7	3644.7	3748.5	3855.4	3965.3	4078.3	4194.
Water [th.m3]			2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Escalated Price [SK/th.m3]			10000.0	10285.0	10578.1	10879.6	11189.7	11508.6	11836.6	12173.9	12520.
Labor and overhead [thous. SK]			1800.0	2023.2	2274.1	2556.1	2873.0	3229.3	3629.7	4079.8	4585.
Repair and Maint. [thous. SK]			2300.0	2472.5	2657.9	2857.3	3071.6	3301.9	3549.6	3815.8	4102.
Emissions [thous. SK]			34.6	34.9	35.3	35.6	36.0	36.4	36.7	37.1	37.5
Materials, fuels [thous. SK]			3500	3762.5	4044.7	4348.0	4674.1	5024.7	5401.6	5806.7	6242.
Project Summary											
Depreciation	0	0	10532	10532	10532	10532	10532	10532	10532	10532	10532
Annual Interest	0	0	17367	17367	17367	17367	17367	17367	17367	17367	17367
Investment Total	114777	114777	0	0	0	0	0	0	0	0	0
Fines	0	0	0	0	0	0	0	0	0	0	0
Profit	0	0	22461	23079	23672	24235	24764	25253	25697	26087	26416
Cash Flow Project	-114777	-114777	50360	50978	51571	52135	52663	53153	53596	53986	54317
Cash Flow, r ⁿ -t	-125681	-114777	45991	50360	51571	52135	52663	53085	53394	53621	53800
Discounted Cash Flow, Project	-125681	-240458	-194467	-151950	-112671	-76408	-42954	-12120	16275	42395	66394
Investors Summary											
Depreciation	0	0	11289	11289	11289	11289	11289	11289	11289	11289	11289
Depreciation of Existing Equip.	0	0	0	0	0	0	0	0	0	0	0
Interest	17561	35122	31610	28097	24585	21073	17561	14049	10537	7024	3512
Interest During Construction	17561	35122	0	0	0	0	0	0	0	0	0
Pre-Tax Profit	0	0	7461	11591	15696	19772	28813	27814	31770	35673	39515
Taxes	0	0	3357	5216	7063	8897	10716	12516	14296	16053	17782
Usable Profit	0	0	4104	6375	8633	10875	13097	15298	17473	19620	21733
Own Investment	11478	11478	0	0	0	0	0	0	0	0	0
Loan Draw-Down	103299	103299	0	0	0	0	0	0	0	0	0
Subsidies	0	0	0	0	0	0	0	0	0	0	0
Loan Payment	0	0	20660	20660	20660	20660	20660	20660	20660	20660	20660
Cash Flow (after tax)	-29039	-46599	-5267	-2995	-737	1504	3727	5928	8103	10250	12363
Cash Flow, r ⁿ -t	-31797	-46599	-4810	-2498	-562	1046	2367	3439	4293	4959	5463
Discounted Cash Flow, Investor	-31797	-78397	-83207	-85705	-86266	-85220	-82852	-79414	-75121	-70162	-64699

Discount Rate - 9.5

Inflation - 3%

Summary, Alternative 3, Load Variant 3

Year															
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
377.3	377.3	377.3	377.3	377.3	377.3	377.3	377.3	377.3	377.3	377.3	377.3	377.3	377.3	377.3	377.3
302.1	309.1	316.2	323.4	330.9	338.5	346.3	354.2	362.4	370.7	379.2	388.0	396.9	406.0	415.4	424.9
500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0
3199.9	3391.9	3595.4	3811.1	4039.8	4282.2	4539.1	4811.4	5100.1	5406.1	5730.5	6074.3	6438.8	6825.1	7234.6	7668.7
11074.3	11074.3	11074.3	11074.3	11074.3	11074.3	11074.3	11074.3	11074.3	11074.3	11074.3	11074.3	11074.3	11074.3	11074.3	11074.3
4253.2	4312.8	4373.1	4434.4	4496.4	4559.4	4623.2	4687.9	4753.6	4820.1	4887.6	4956.0	5025.4	5095.8	5167.1	5239.5
2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
12696.2	12873.9	13054.1	13236.9	13422.2	13610.1	13800.7	13993.9	14189.8	14388.4	14589.9	14794.1	15001.3	15211.3	15424.2	15640.2
4860.8	5152.5	5461.6	5789.3	6136.7	6504.9	6895.2	7308.9	7747.4	8212.2	8705.0	9227.3	9780.9	10367.8	10989.8	11649.2
4245.6	4394.2	4548.0	4707.1	4871.9	5042.4	5218.9	5401.5	5590.6	5786.3	5988.8	6198.4	6415.3	6639.9	6872.3	7112.8
37.8	38.2	38.6	39.0	39.4	39.8	40.2	40.6	41.0	41.4	41.8	42.2	42.6	43.1	43.5	43.9
6460.6	6686.8	6920.8	7163.0	7413.7	7673.2	7941.8	8219.7	8507.4	8805.2	9113.4	9432.4	9762.5	10104.2	10457.8	10823.8
10532	10532	10532	10532	10532	10532	10532	10532	10532	10532	10532	10532	10532	10532	10532	10532
17367	17367	17367	17367	17367	17367	17367	17367	17367	17367	17367	17367	17367	17367	17367	17367
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27811	29227	30665	32126	33608	35111	36636	38180	39743	41326	42926	44543	46176	47823	49484	51157
55710	57126	58565	60025	61507	63011	64535	66079	67643	69225	70825	72442	74075	75722	77383	79056
22480	21051	19709	18448	17264	16151	15107	14126	13206	12342	11532	10772	10059	9391	8764	8177
88874	109926	129635	148083	165346	181497	196604	210730	223936	236278	247810	331141	268641	278032	286796	294973
11289	11289	11289	11289	11289	11289	11289	11289	11289	11289	11289	11289	11289	11289	11289	11289
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44421	45837	47275	48736	50218	51721	53245	54790	56353	57936	59536	61153	62786	64433	66094	67767
19989	20627	21274	21931	22598	23275	23960	24655	25359	26071	26791	27519	28253	28995	29742	30495
24431	25210	26001	26805	27620	28447	29285	30134	30994	31865	32745	33634	34532	35438	36352	37272
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20660	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15061	36500	37291	38094	38909	39736	40574	41424	42284	43154	44034	44923	45822	46728	47641	48561
6077	13450	12550	11708	10921	10185	9498	8855	8255	7694	7170	6680	6222	5795	5396	5023
-58622	-45172	-32622	-20914	-9993	192	9690	18545	26600	34494	41664	48344	54566	60361	65757	70780

PARAMETERS OF ECONOMIC EFFECTIVENESS

Table C.2 - Heat Supply, According to Alternative 3, 377 280 GJ/year (comparable with Variant 1)

Cost of Electricity SK/MWh	Real Interest (discount) %		2,0		5,0		9,5		12,0	
	Inflation %		3	18	3	18	3	18	3	18
1894 Sk/MWh	Average Annual Profit	thous. Sk	14 669	25 036	15 606	24 543	16 170	23 110	16 145	22 095
	Discounted Profit (life)	thous. Sk	286 384	488 796	219 940	345 907	152 606	218 105	126 630	173 292
	Discounted Cash Flow (life)	thous. Sk	253 390	445 309	155 066	259 979	60 158	95 249	23 821	36 722
	Payback Period	Years	13	12	13	13	16	15	19	19
	Return on Investment	%	63,90	109,07	67,98	106,92	70,44	100,67	70,33	96,25
3230 Sk/MWh	Average Annual Profit	thous. Sk	14 874	25 242	15 242	24 683	16 230	23 170	16 169	22 115
	Discounted Profit (life)	thous. Sk	290 398	492 811	492 811	347 882	153 168	218 667	126 819	173 452
	Discounted Cash Flow (life)	thous. Sk	257 404	449 324	449 324	261 953	60 720	95 811	24 010	36 882
	Payback Period	Years	13	12	12	13	16	15	19	19
	Return on Investment	%	64,80	109,96	68,59	107,53	70,70	100,93	70,44	96,34