# Assessment of Supply-Side Alternatives for the Handlova Heating System

October 1995


Pacific Northwest Laboratory

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Washington, DC 20024

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## 17 FEBRUARY 1994


**Prepared by:**
EGU Bratislava

**Under Contract With:**
Battelle, Pacific Northwest Laboratory

**Assisted by:**
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Thermo Power Corporation

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF FIGURES (Continued)

## ACKNOWLEDGEMENTS

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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 Paramters | | | | |
| 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/$m^3$

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 % |

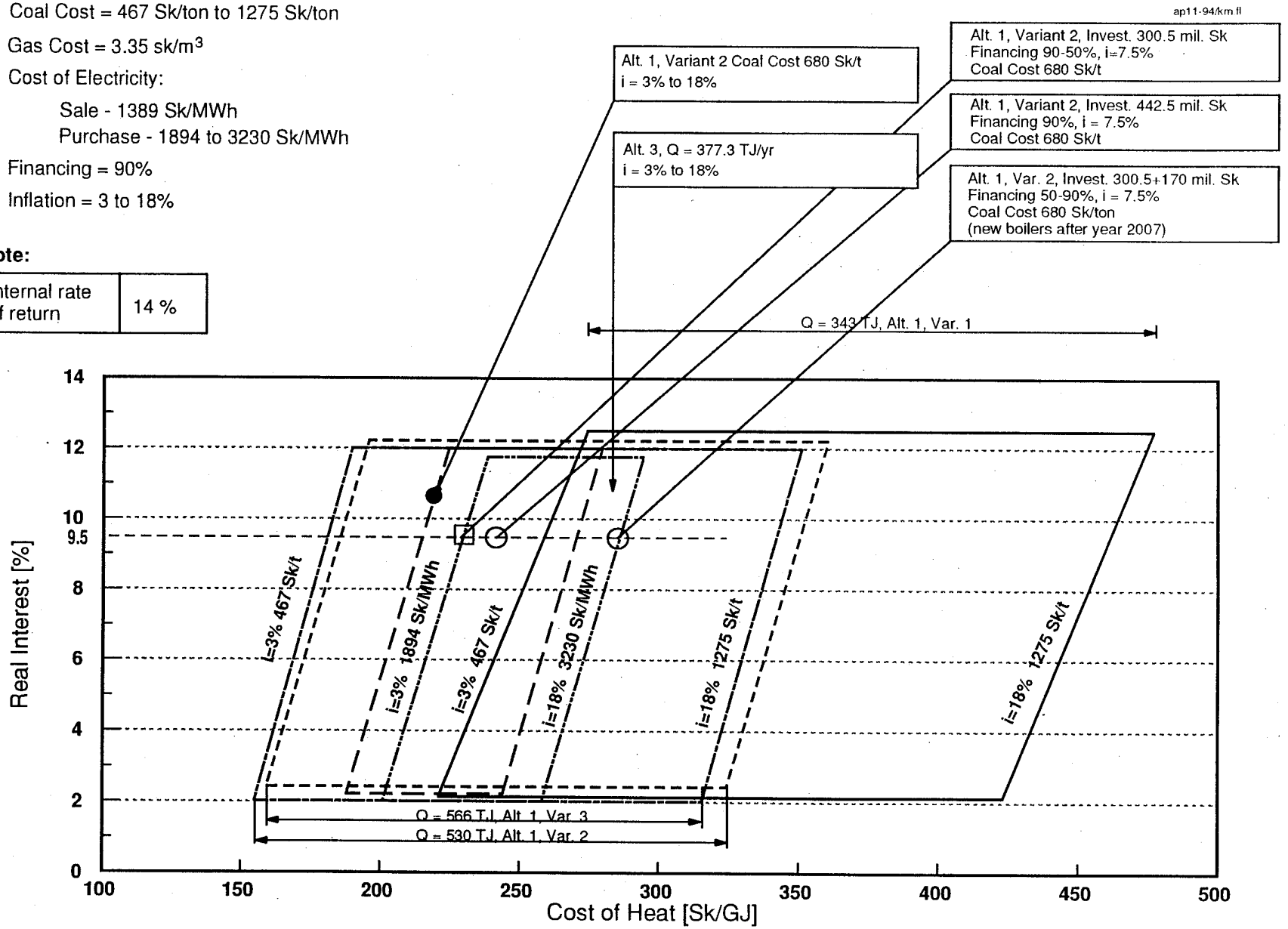


**Figure 1 - Economic Analysis and Sensitivity of Results for Decentralized (Alt. 3) and Central (Alt. 1) Production of Thermal Energy for Space and Water Heating in the Town of Handlova, Slovakia**

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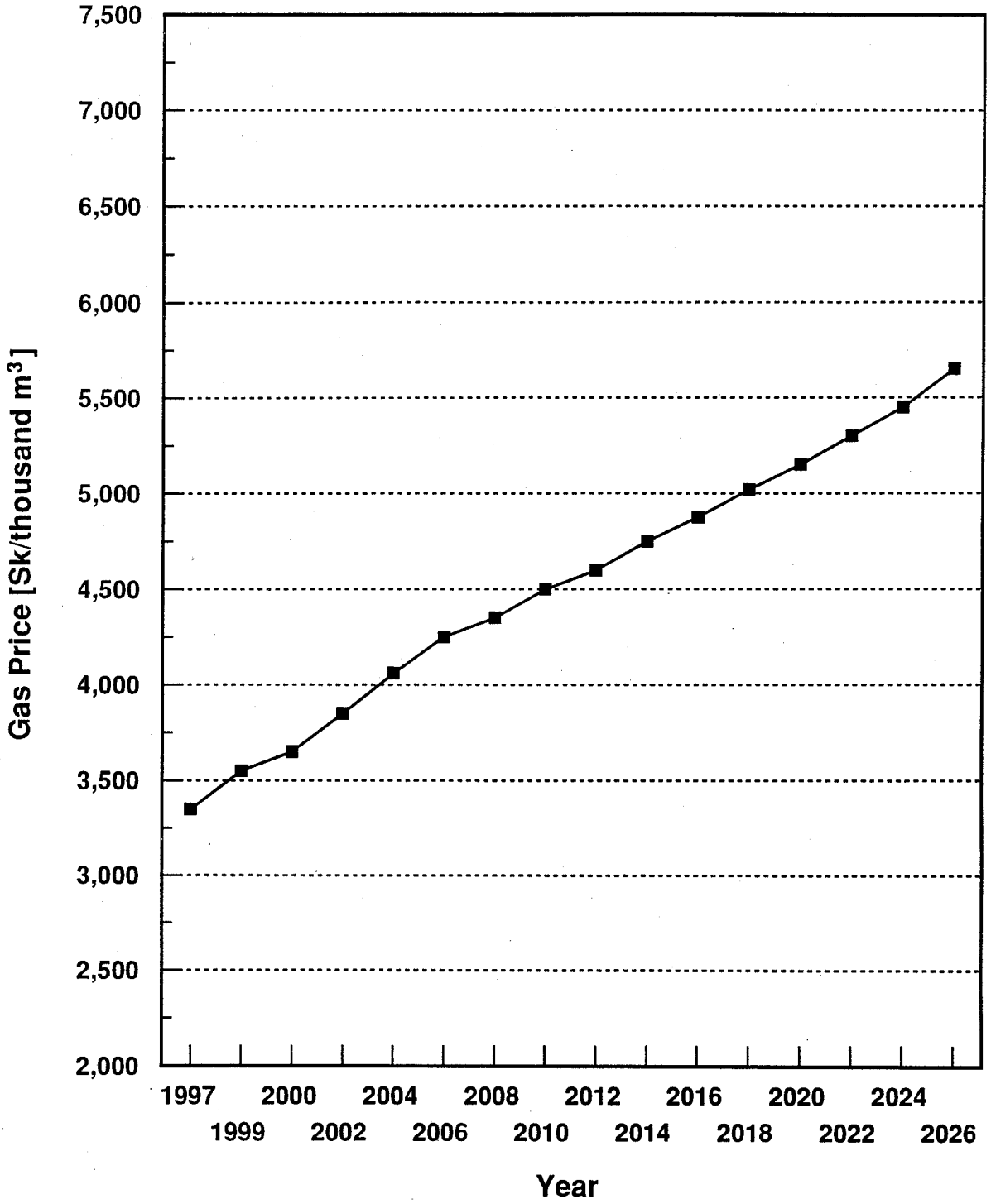


Figure 2 - Natural Gas Prices Development

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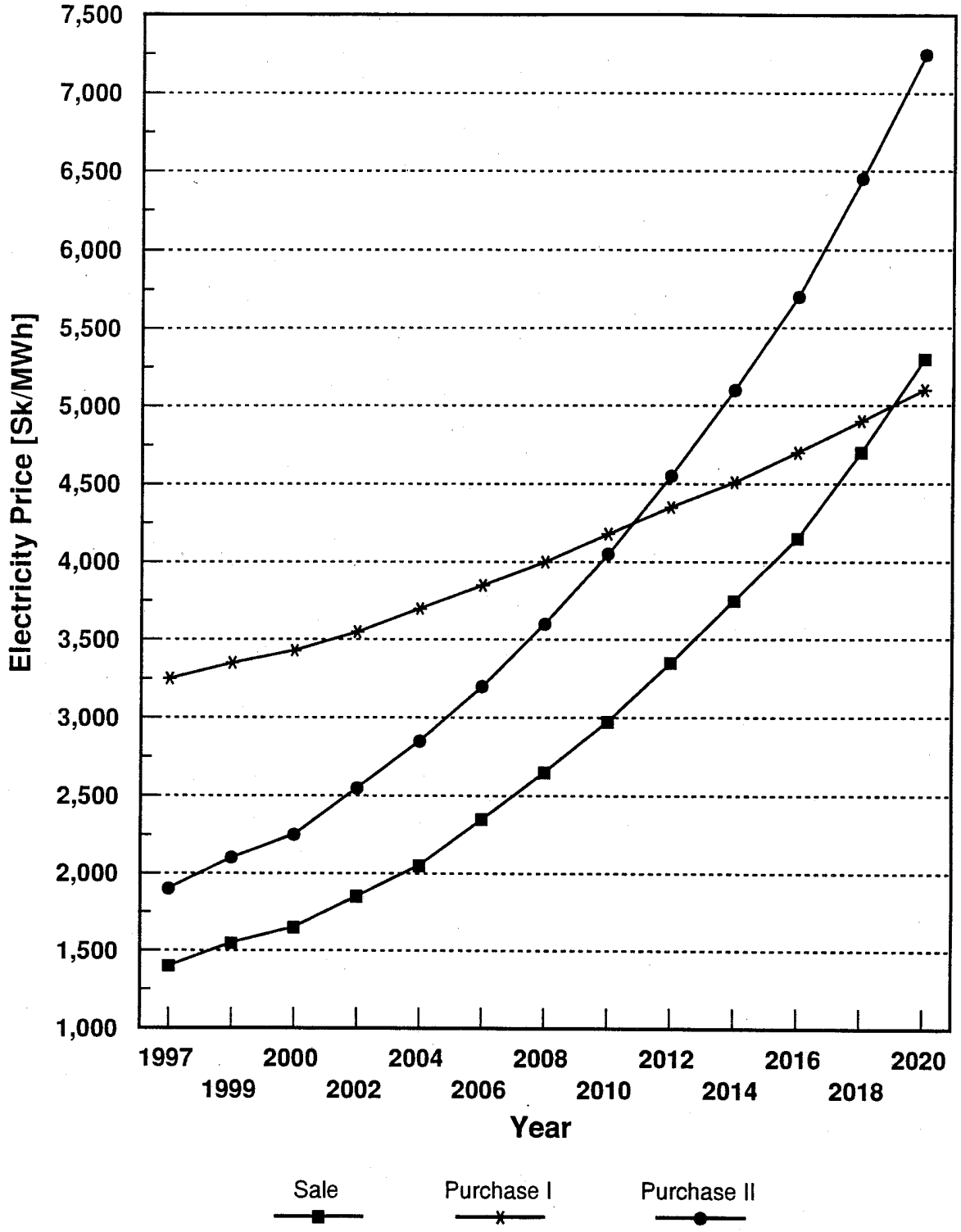


**Figure 3 - Electricity Prices Development**

# 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 (Bytovy 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 |
| | Compensator [pcs] | 50 | 50 |
| DN 250 | 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 |
| | Compensator [pcs] | 30 | 30 |

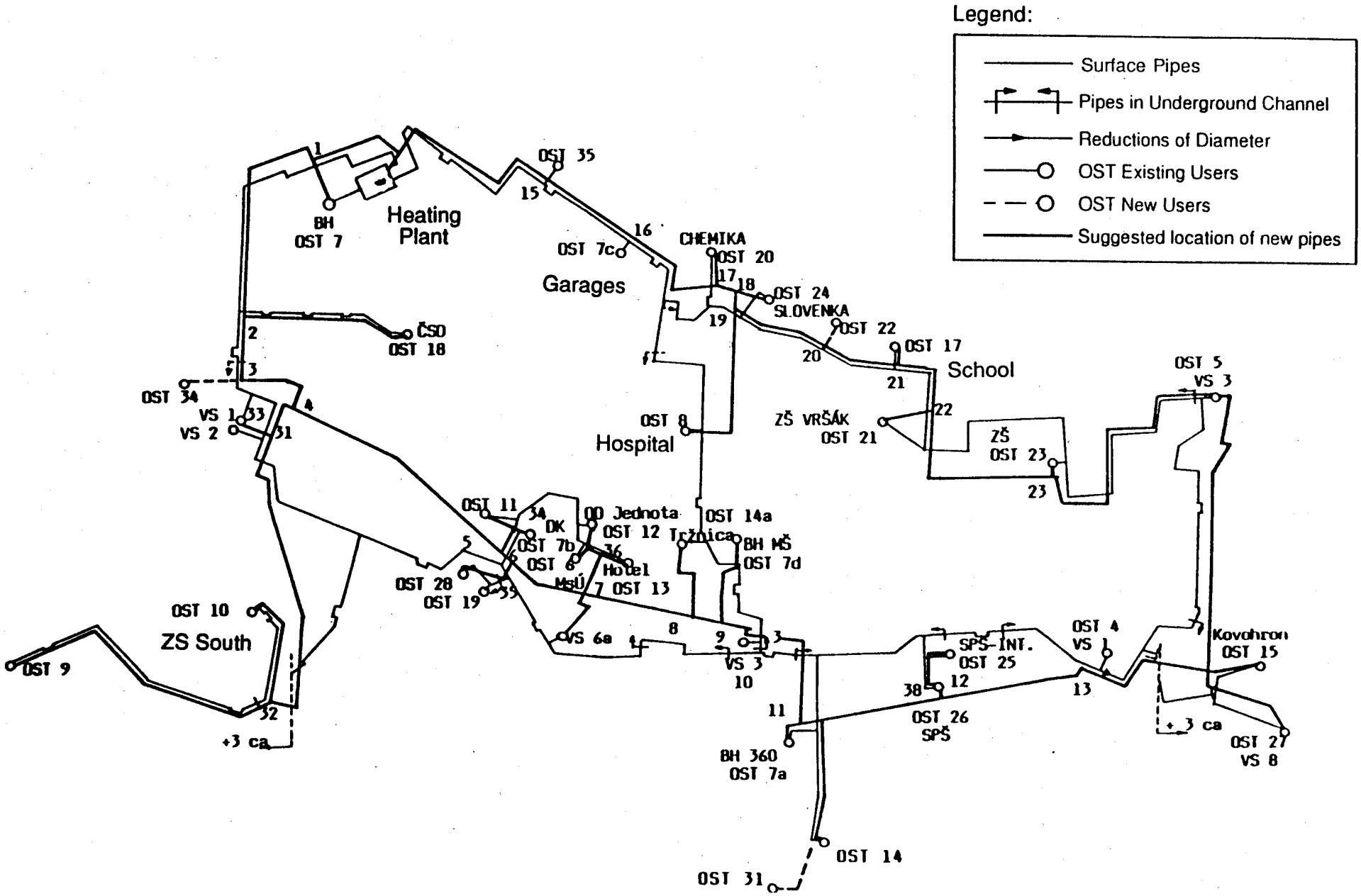


**Figure 3.1 - Layout of Central Heating System in Town of Handlova**

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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 |
| 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 |
| 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.

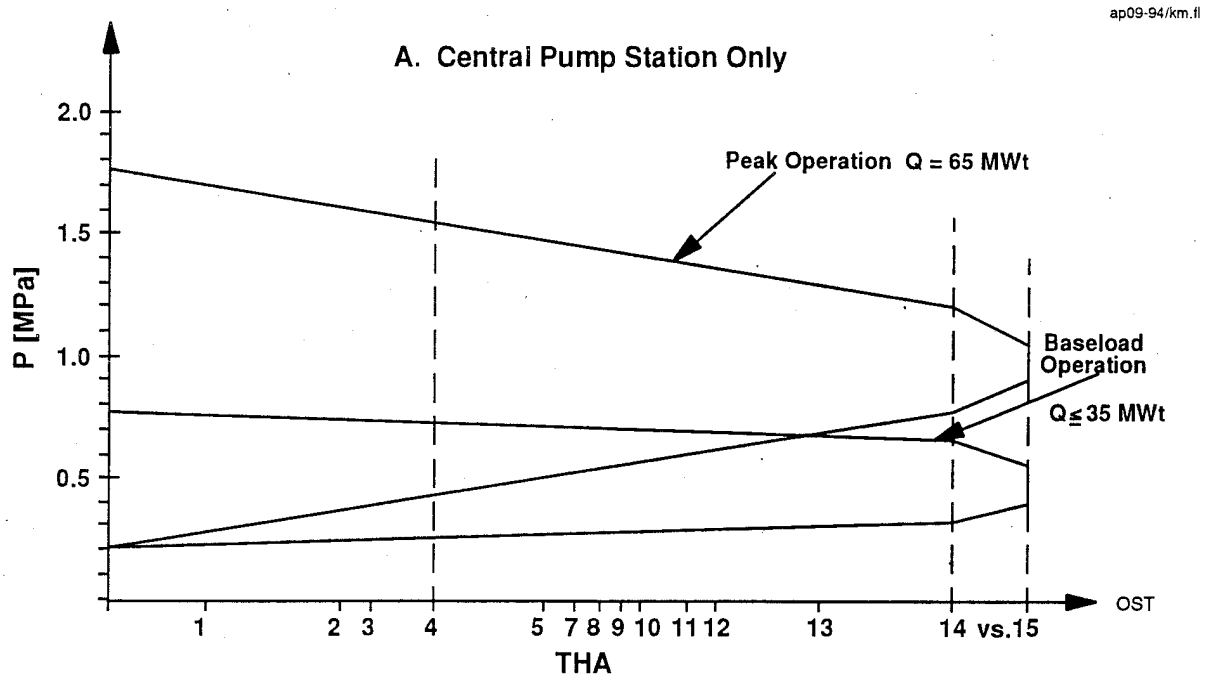



Figure 3.2 - Pressure Diagram of Main Distribution System

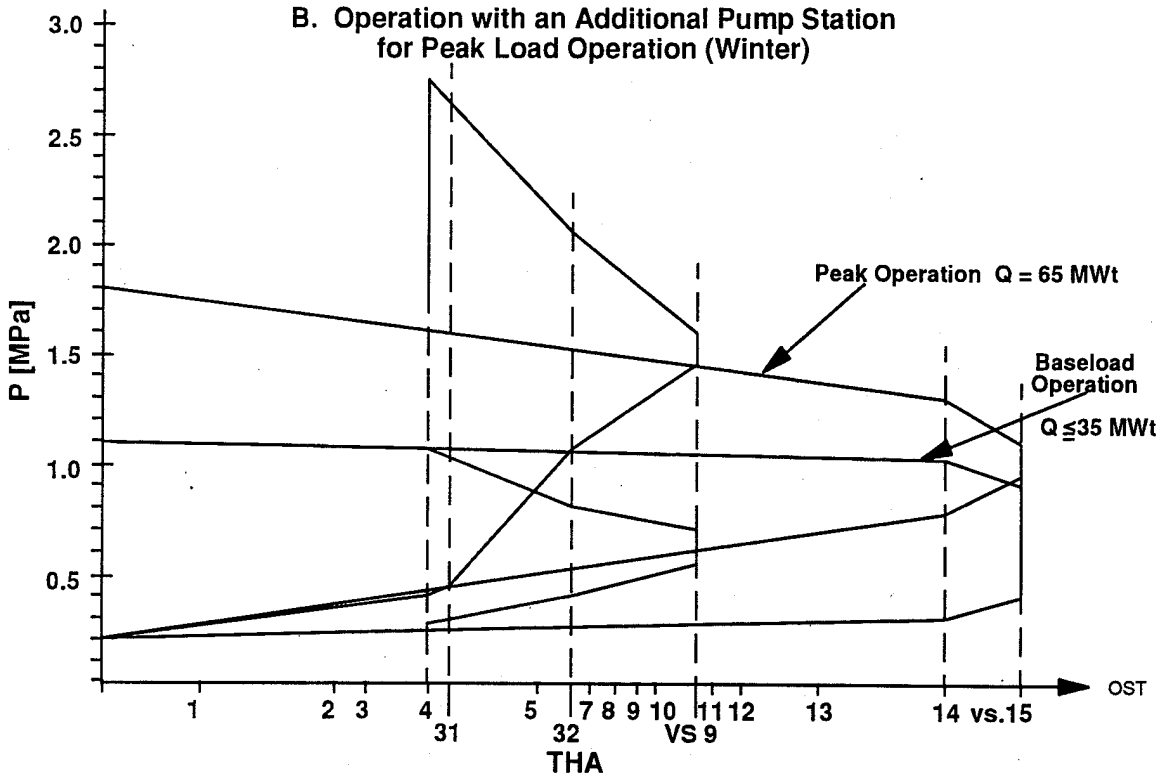



Figure 3.3 - Pressure Diagram of Main Distribution System

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 form 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 "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*

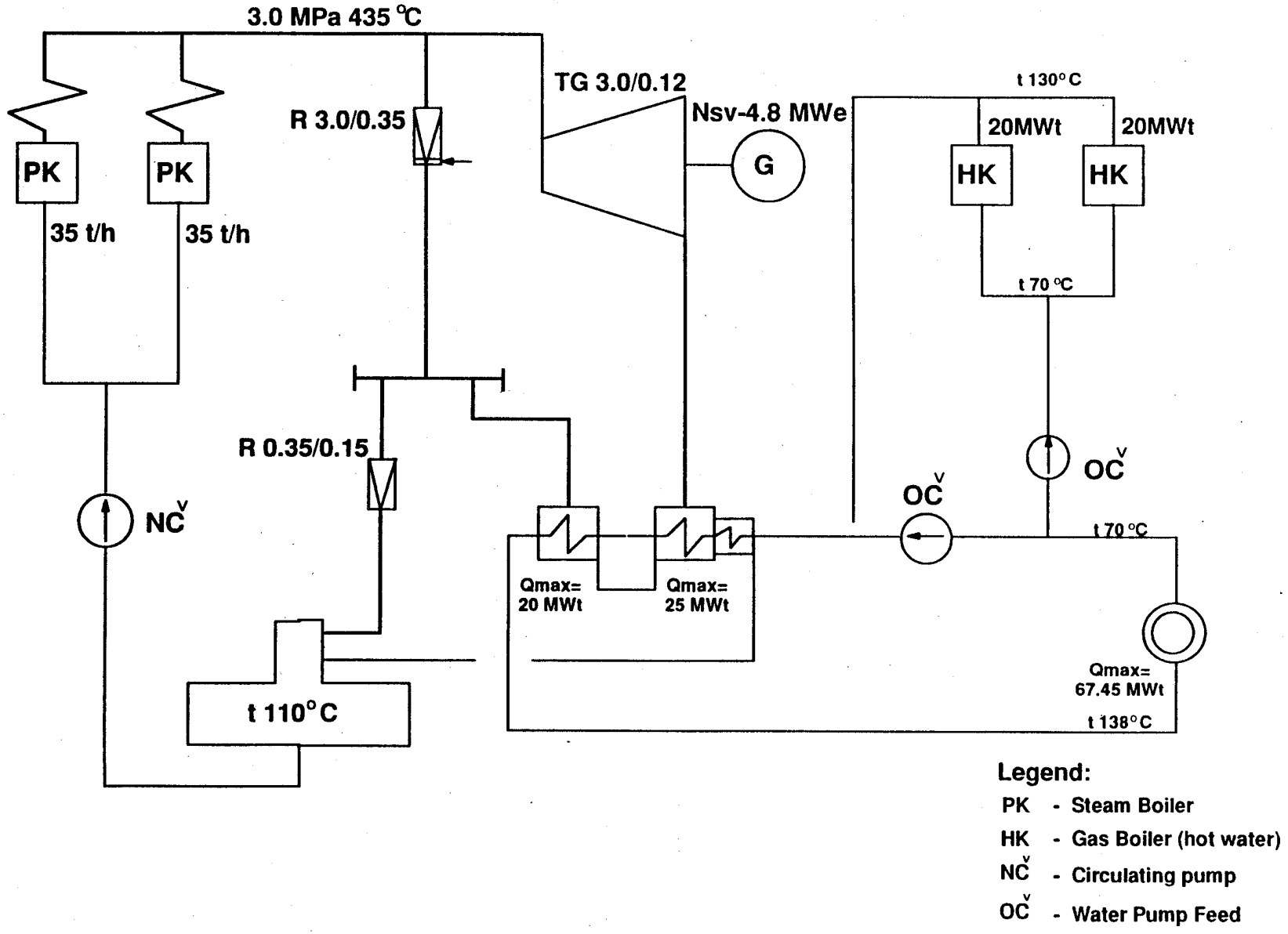



Figure 3.4 - Basic Equipment Diagram for Alternative 1

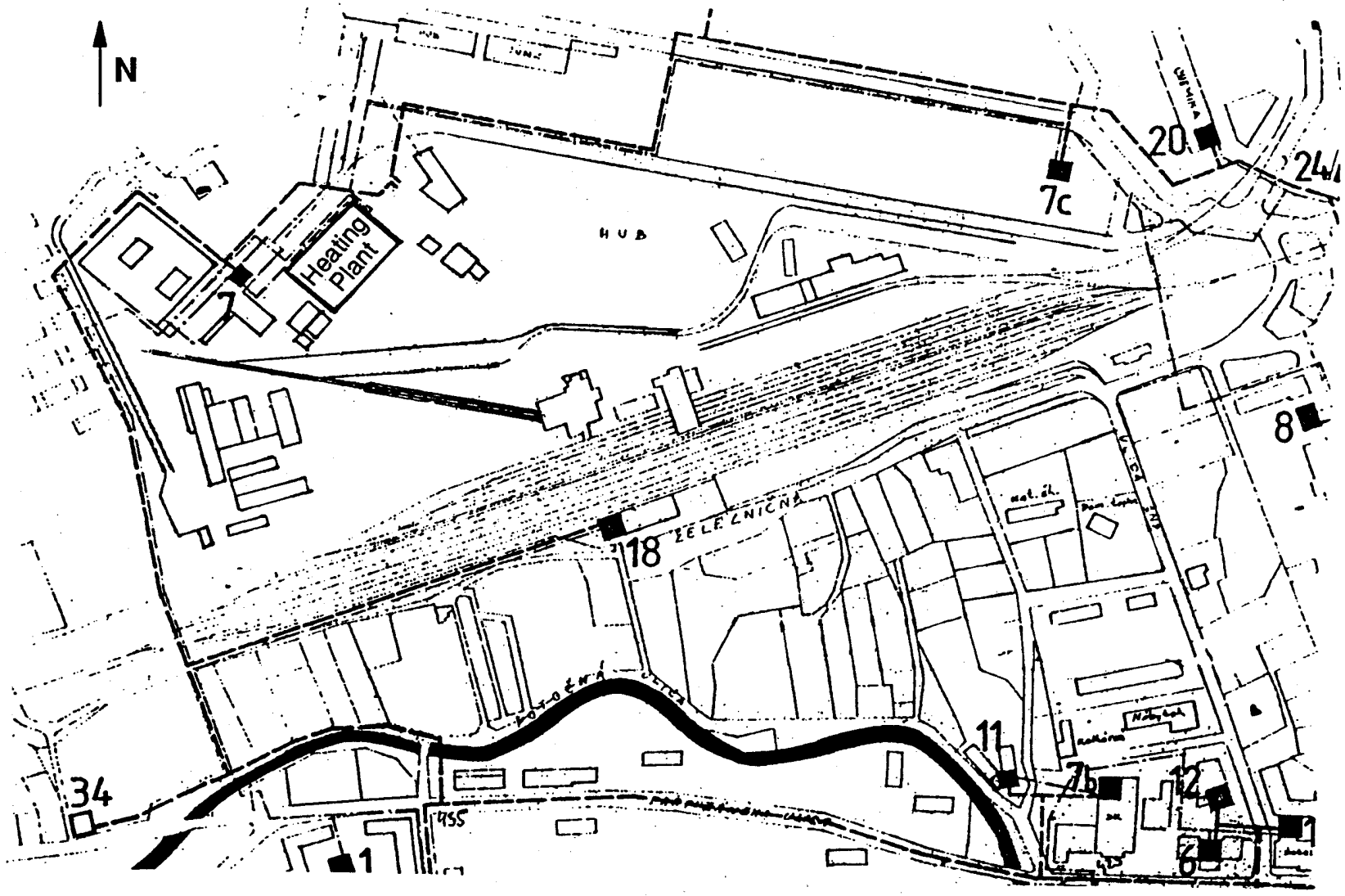



**Figure 3.5 - Heating Plant Location**

**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/m3 |

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/m3 |

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.

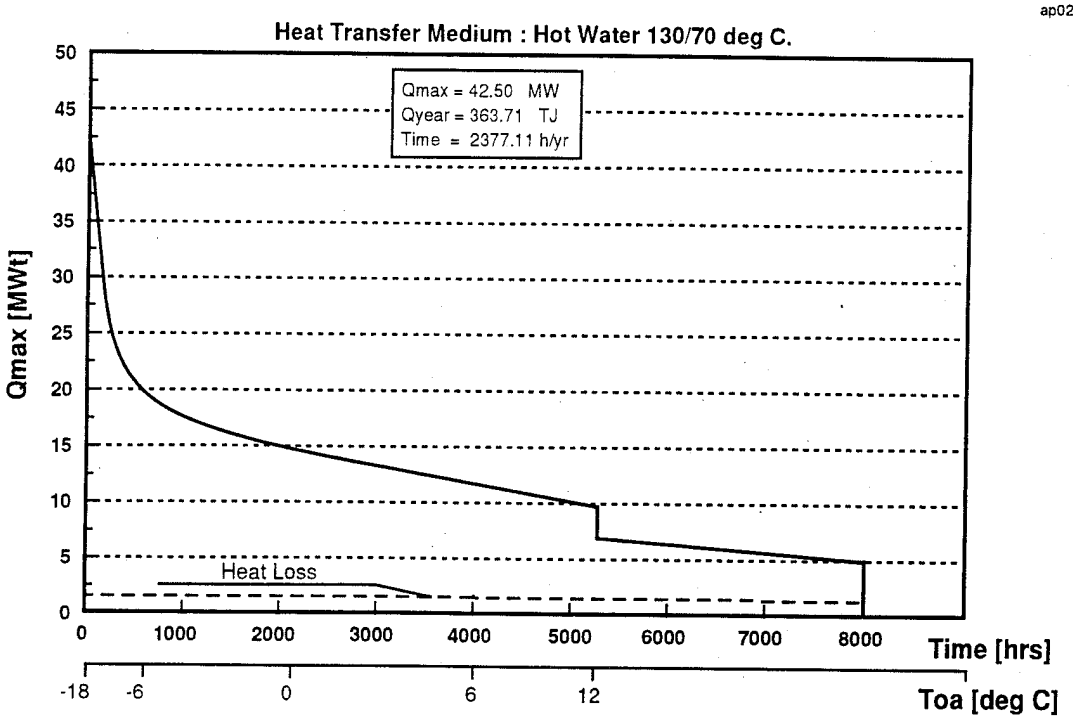
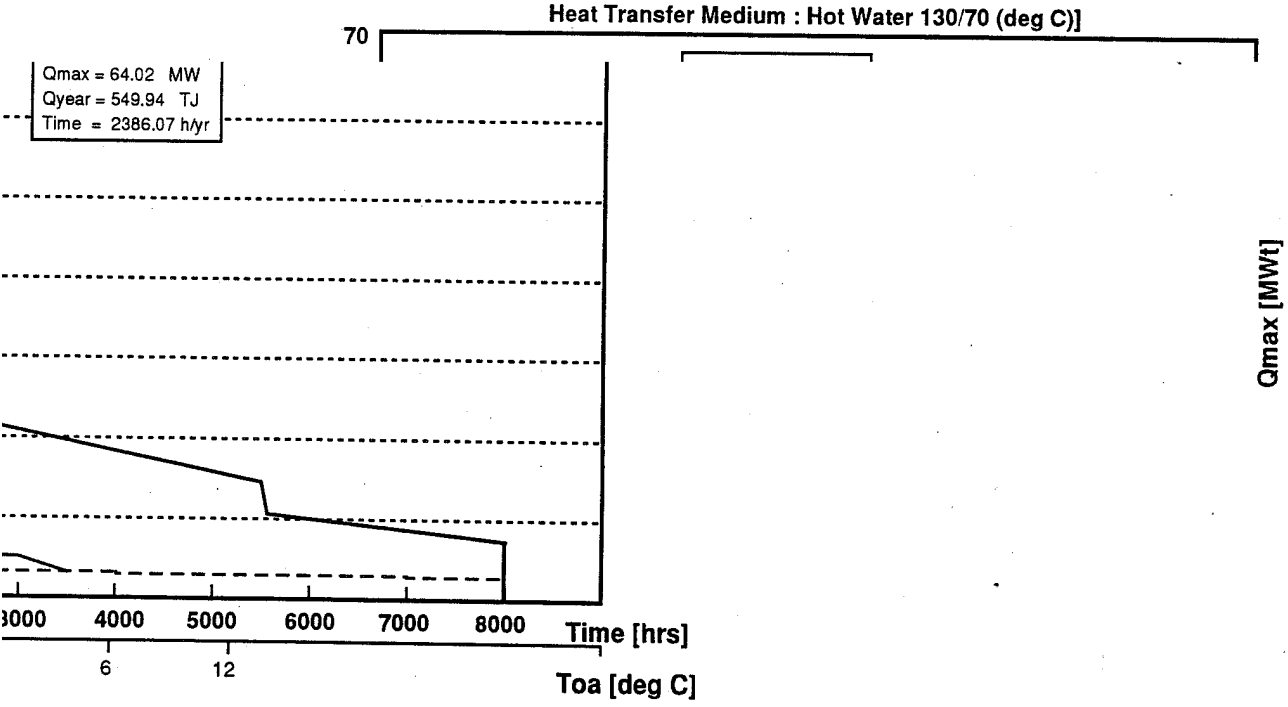
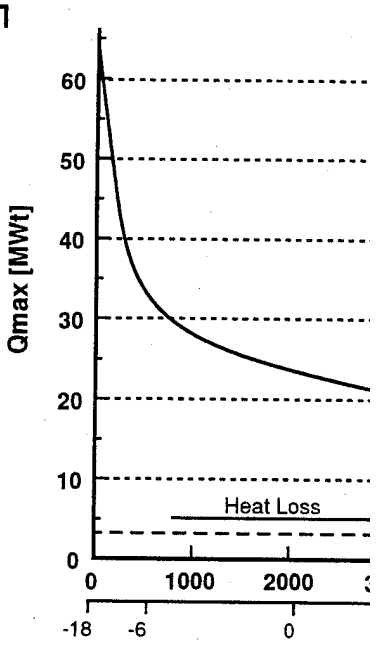



Figure 3.6 - Load Duration Curve, Heat Supply Including Distribution Losses, Variant 1




ation Curve, Heat Supply Including Distribution
Variant 2 and 3

Figure 3.7 - Load Dur
Losses, V

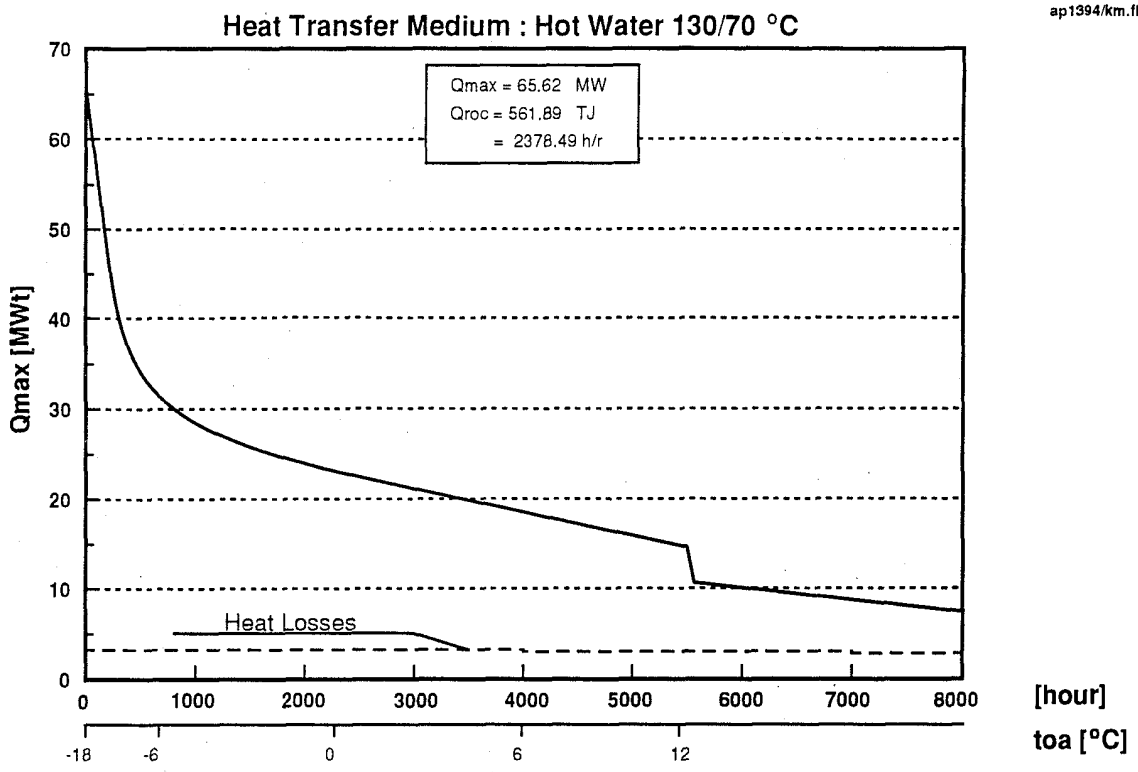



**Figure 3.8 - Load Duration Curve, Heat Supply Including Distribution Heat Losses - Variant 2**

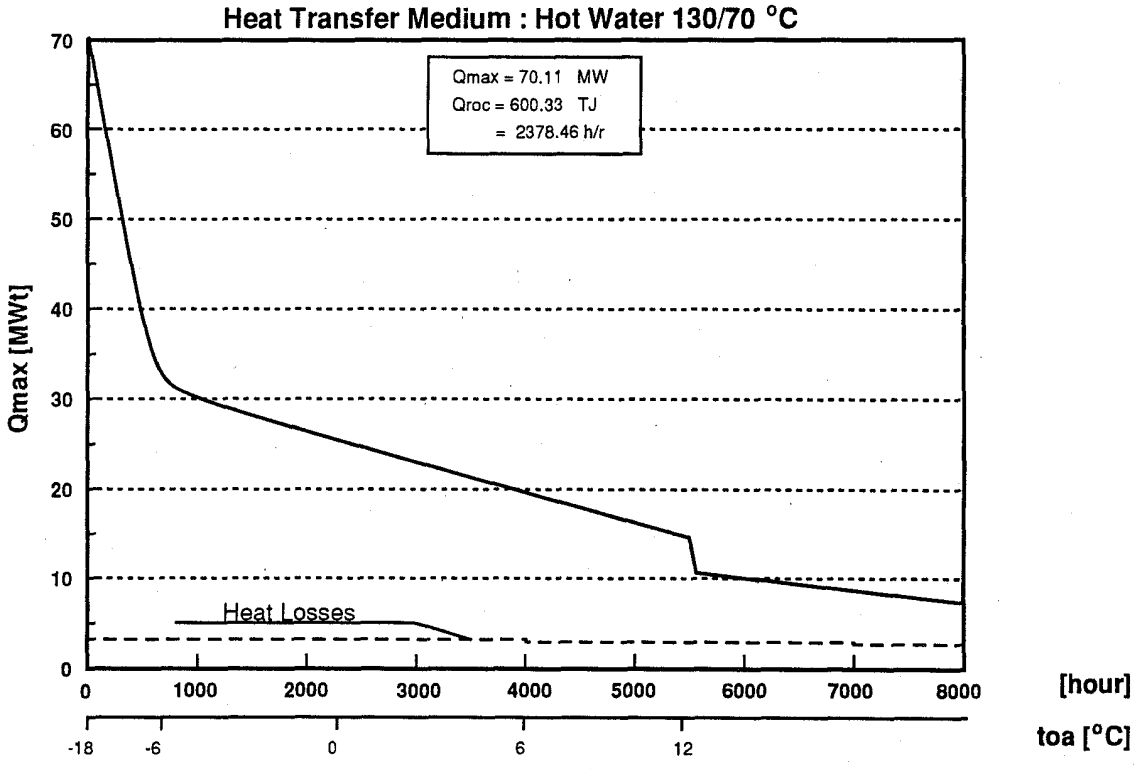



**Figure 3.9 - Load Duration Curve, Heat Supply Including Distribution Heat Losses - Variant 2**

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** | | | | | | | |
| Boiler Loads in MWt | | | | | | | |
| K1 | 21.25 | -- | 20.10 | 11.75 | 9.30 | -- | -- |
| K5 | 21.25 | -- | -- | -- | -- | -- | -- |
| HK1 | -- | -- | -- | -- | -- | 7.20 | 5.21 |
| HK2 | -- | -- | -- | -- | -- | -- | -- |
| Steam Production in kg/s | | | | | | | |
| K1 | 8.185 | --- | 8.730 | 4.820 | 3.903 | -- | -- |
| K2 | 8.185 | --- | -- | -- | -- | -- | -- |
| Turbine Load in MWe | | | | | | | |
| TG1 | 4.042 | --- | 4.288 | 2.217 | 1.704 | -- | -- |
| Turbine throughput in kg/s | | | | | | | |
| TG1 | 7.313 | --- | 7.677 | 4.502 | 3.662 | -- | -- |
| **Load Variant 2** | | | | | | | |
| Boiler Loads in MWt | | | | | | | |
| 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 | --- | --- | --- | --- | --- | --- |
| Steam Production in kg/s | | | | | | | |
| K1 | 7.072 | 8.696 | 6.332 | 8.007 | 6.138 | --- | --- |
| K2 | 7.072 | --- | 6.332 | --- | --- | --- | --- |
| Turbine Load in MWe | | | | | | | |
| TG1 | 3.207 | 4.735 | 4.735 | 4.154 | 3.015 | --- | --- |
| Turbine throughout in kg/s | | | | | | | |
| TG1 | 6.054 | 8.722 | 8.733 | 7.479 | 5.759 | --- | --- |
| **Load Variant 3** | | | | | | | |
| Boiler Loads in MWt | | | | | | | |
| 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 | --- | --- | --- | --- | --- | --- |
| Steam Production in kg/s | | | | | | | |
| K1 | 8.198 | 9.535 | 6.717 | 8.59 | 6.585 | --- | --- |
| K5 | 8.198 | --- | 6.717 | --- | --- | --- | --- |
| Turbine Load in MWe | | | | | | | |
| TG1 | 3.87 | 4.735 | 4.735 | 4.524 | 3.288 | --- | --- |
| Turbine throughput in kg/s | | | | | | | |
| 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.

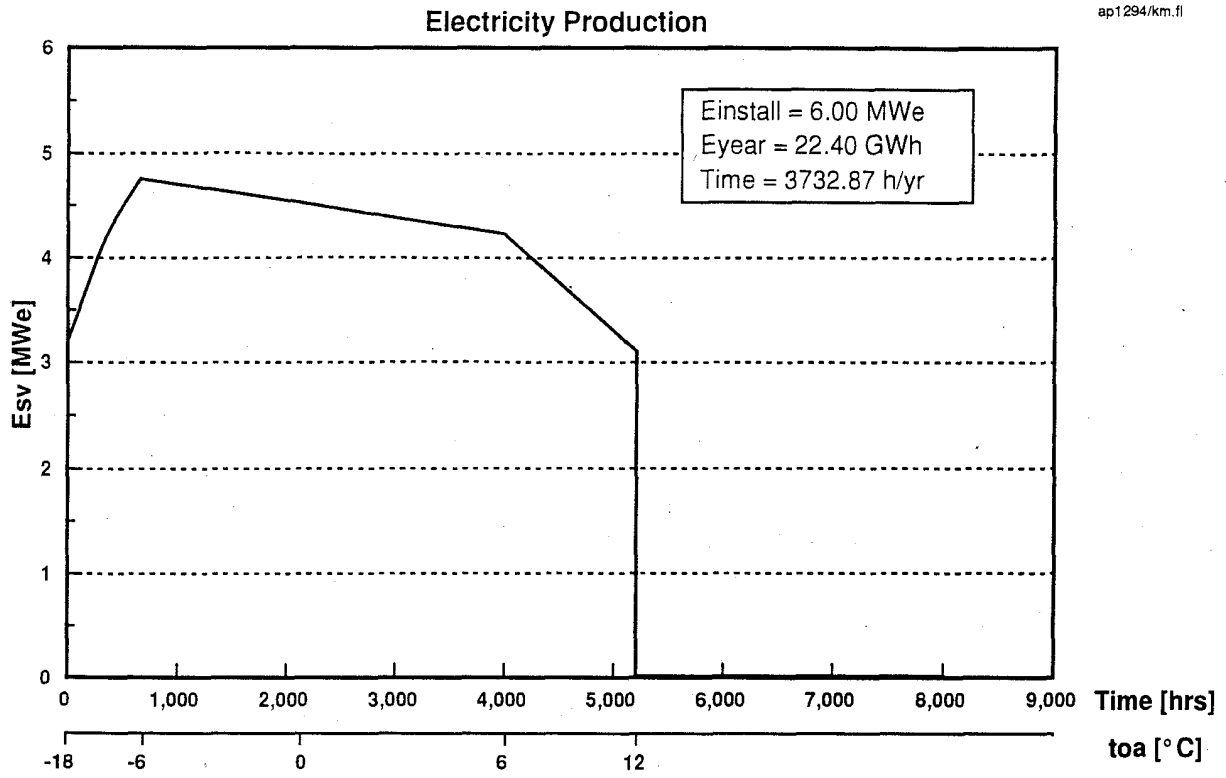



**Figure 3.10 - Load Duration Curve, Output Electricity Production, Alternative 1, Load Variant 2**

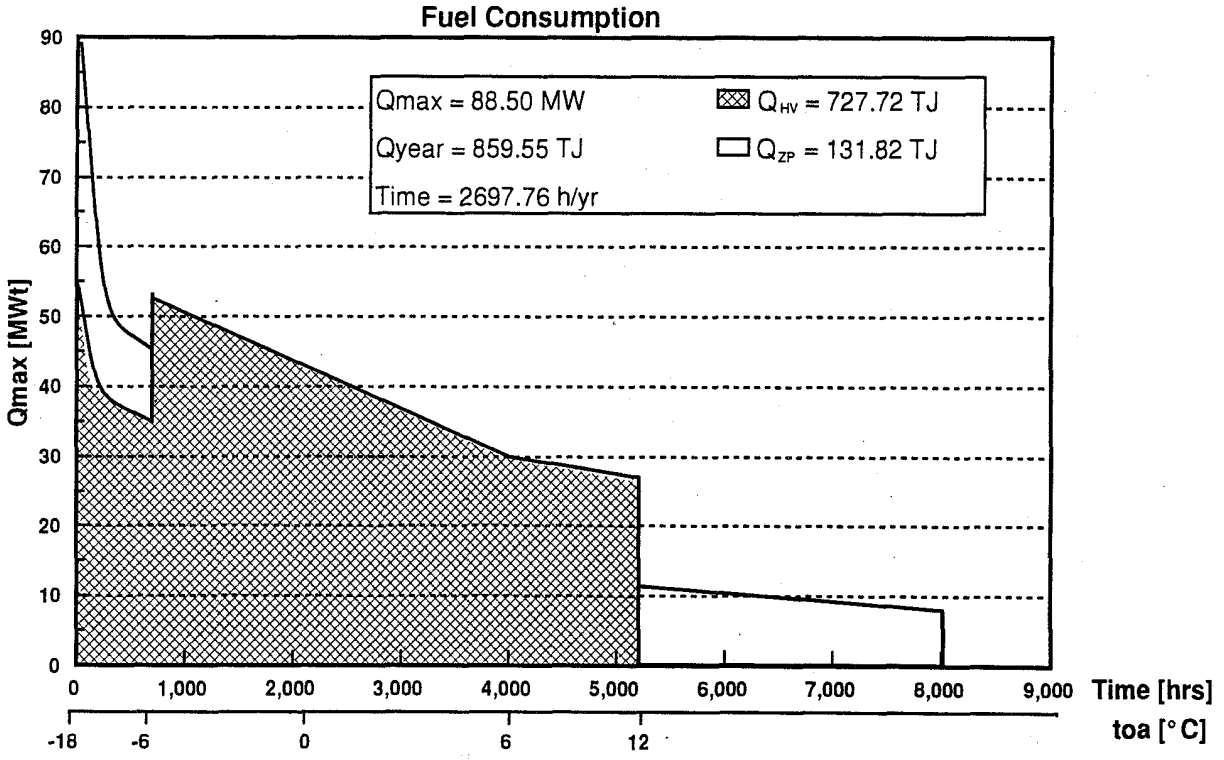



**Figure 3.11 - Load Duration Curve, Output Electricity Production, Alternative 1 Load Variant 2**

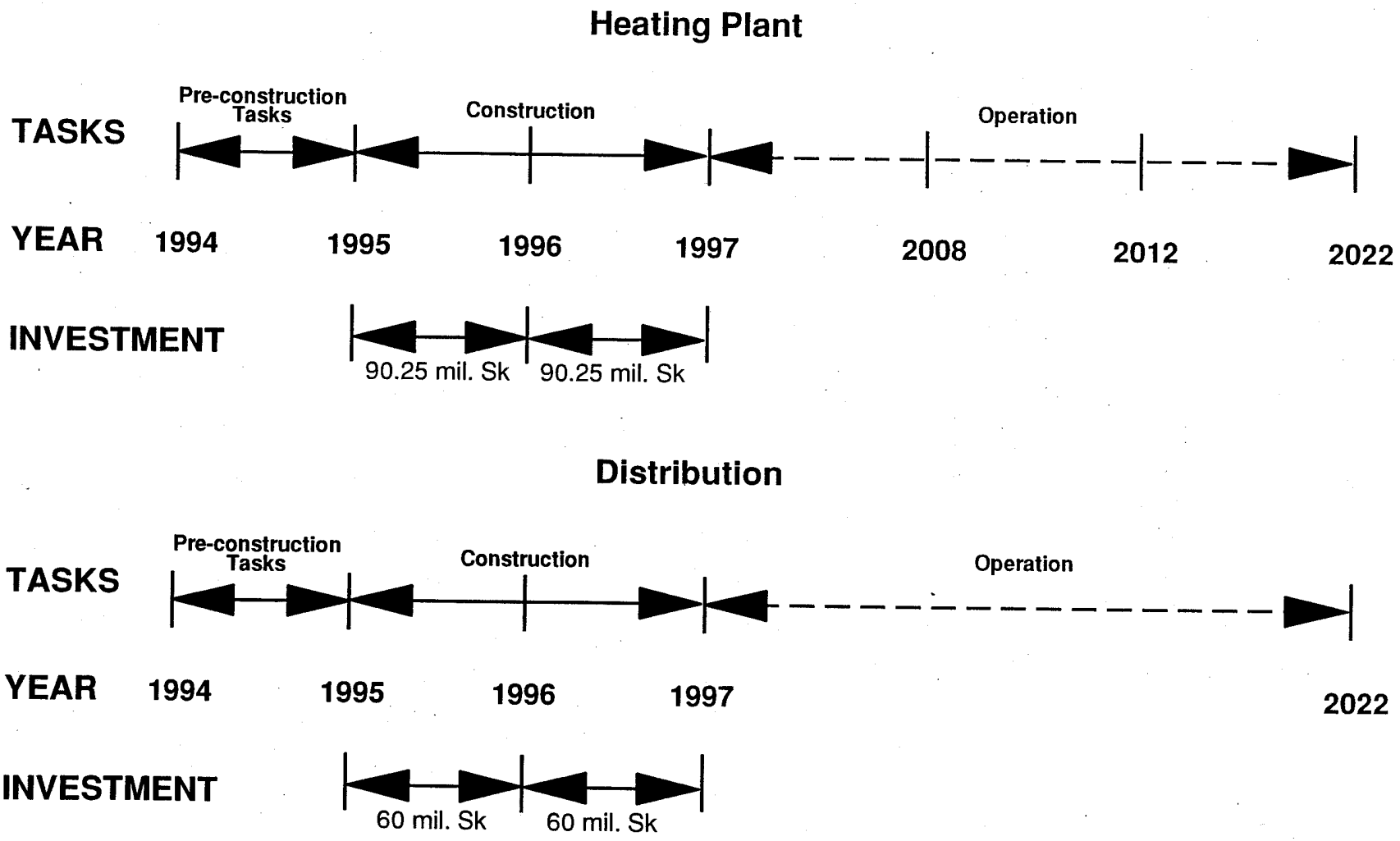



**Figure 3.12 - Construction Schedule - Alternative 1**

#### *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*

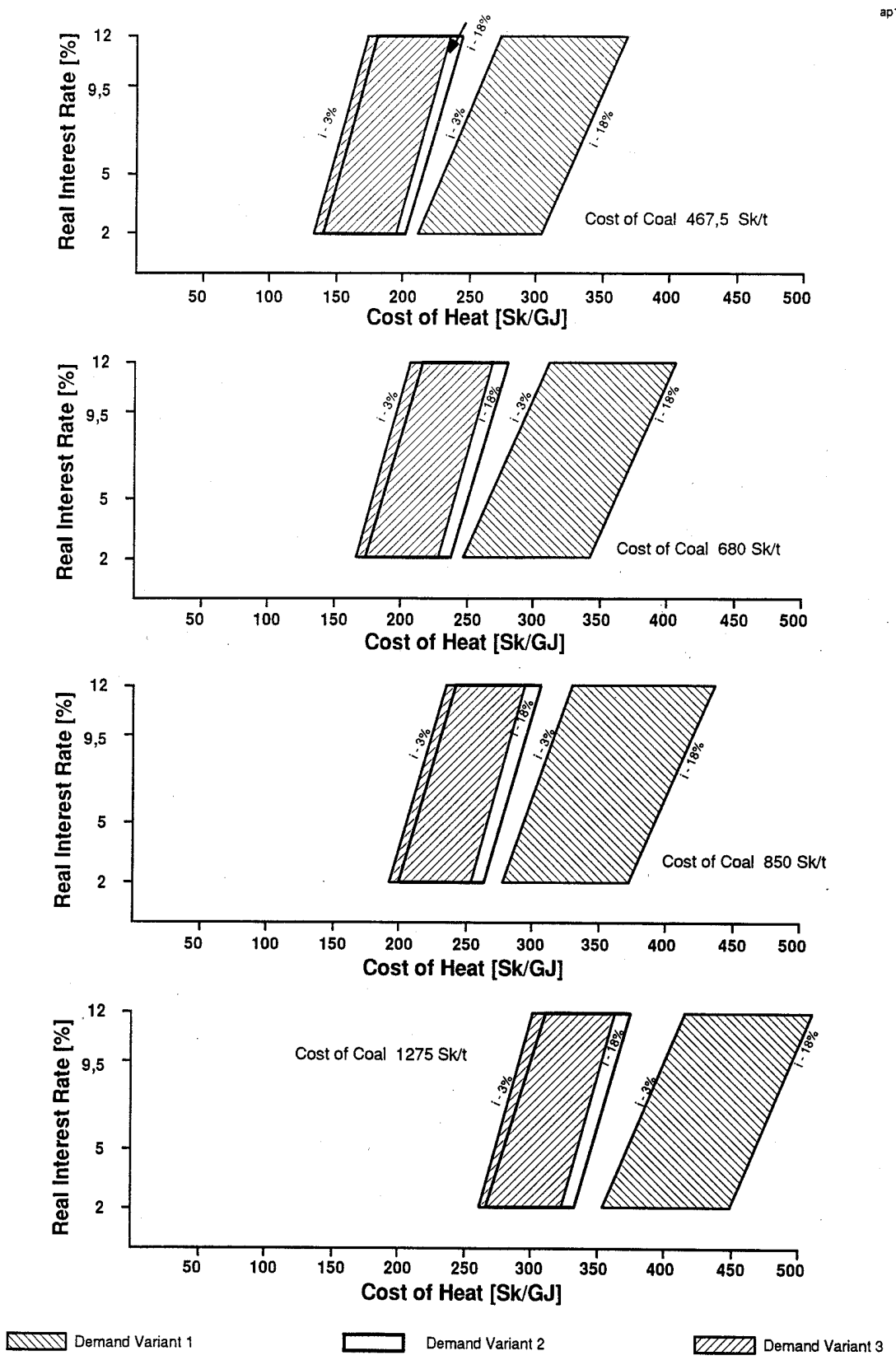



**Figure 3.13 - Cost of Heat as Function of Real Interest Rate and Inflation**

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

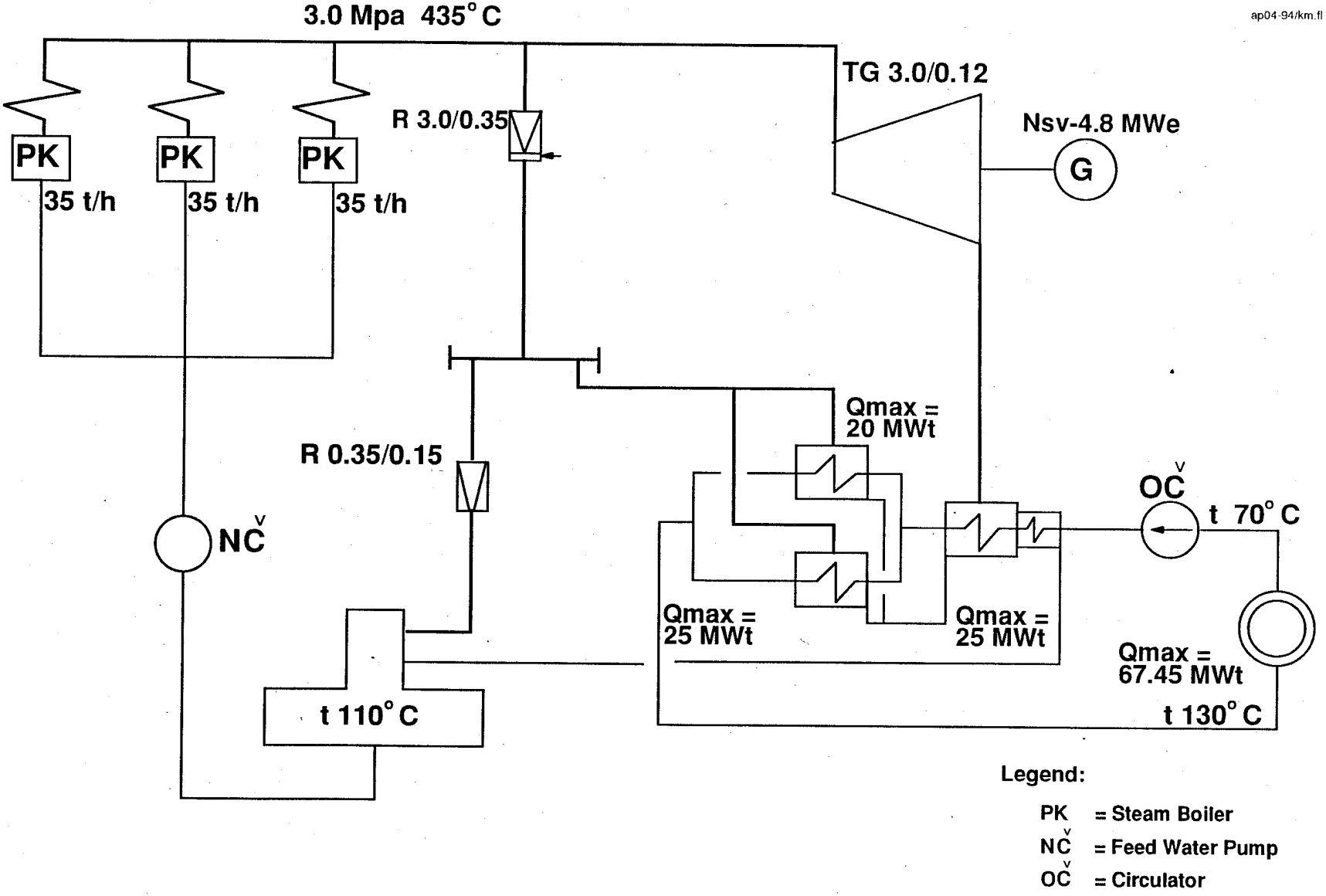



Figure 3.14 - Equipment Diagram, Alternative 2

**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

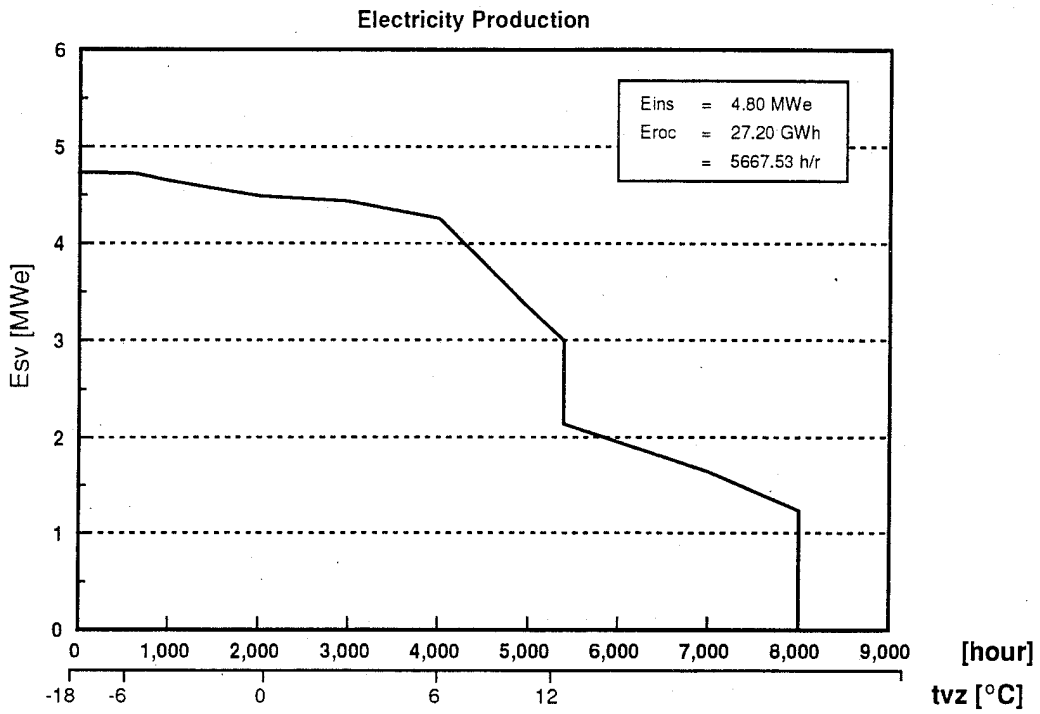



**Figure 3.15 - Load Duration Curve, Output Electricity Production, Alternative 2, Load Variant 2**

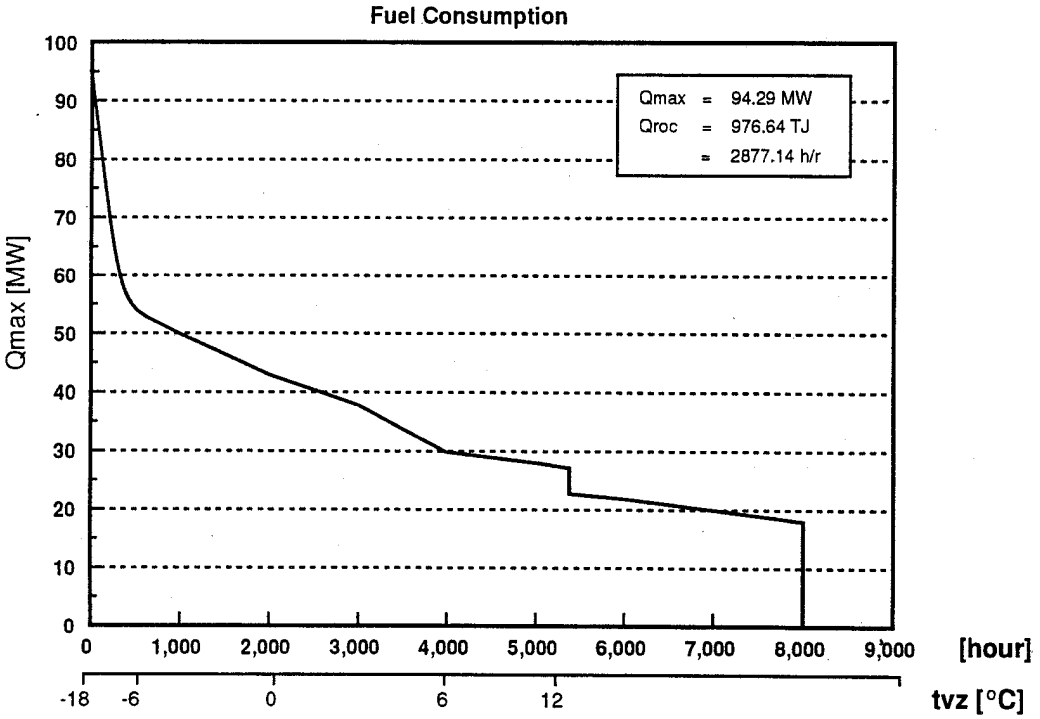



**Figure 3.16 - Load Duration Curve, Fuel Consumption, Alternative 2 Load Variant 2**

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

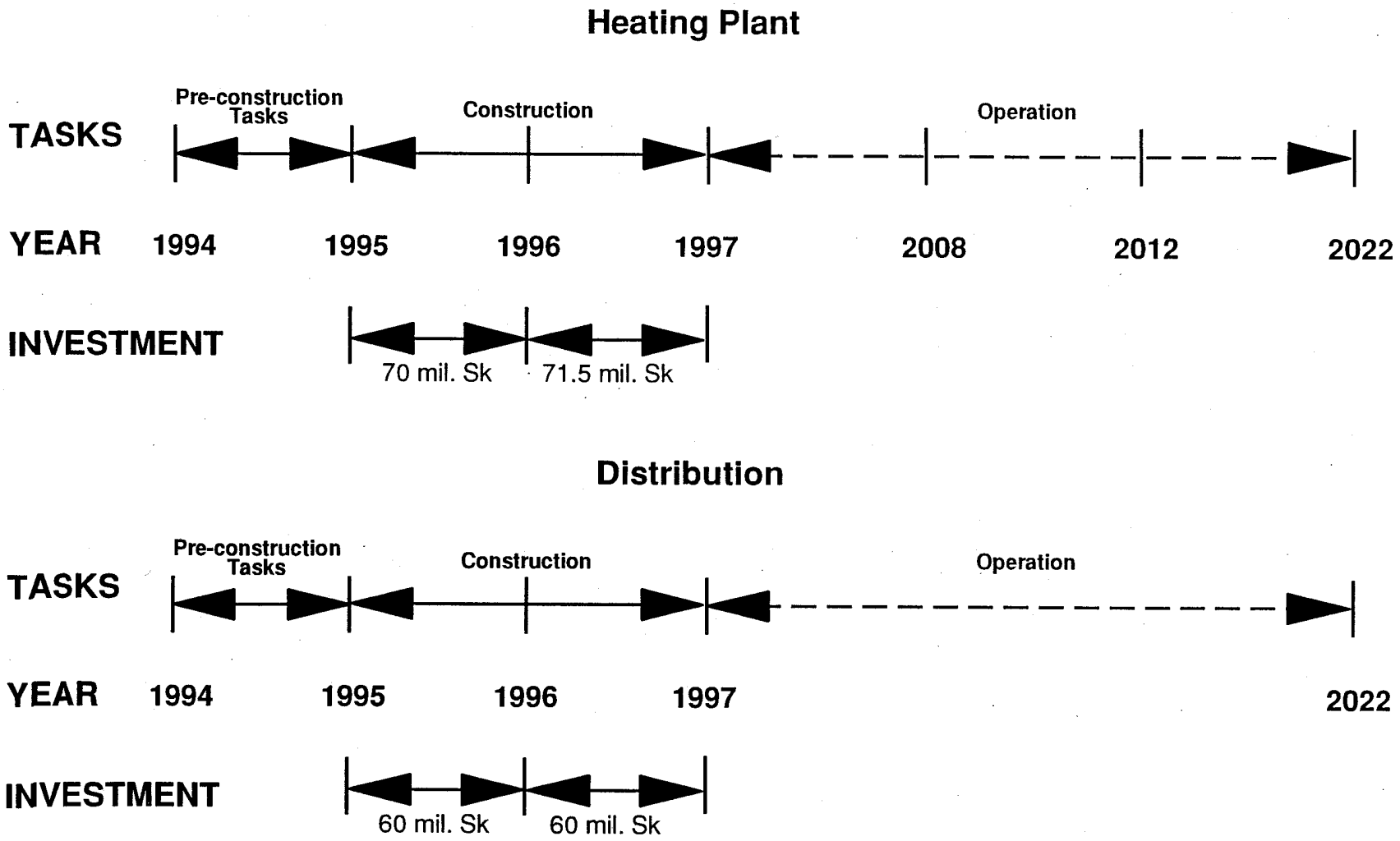



Figure 3.17 - Construction Schedule, Alternative 2

### 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 | 12.4% annually |
| | after 2005 | 6% 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 |
| 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).

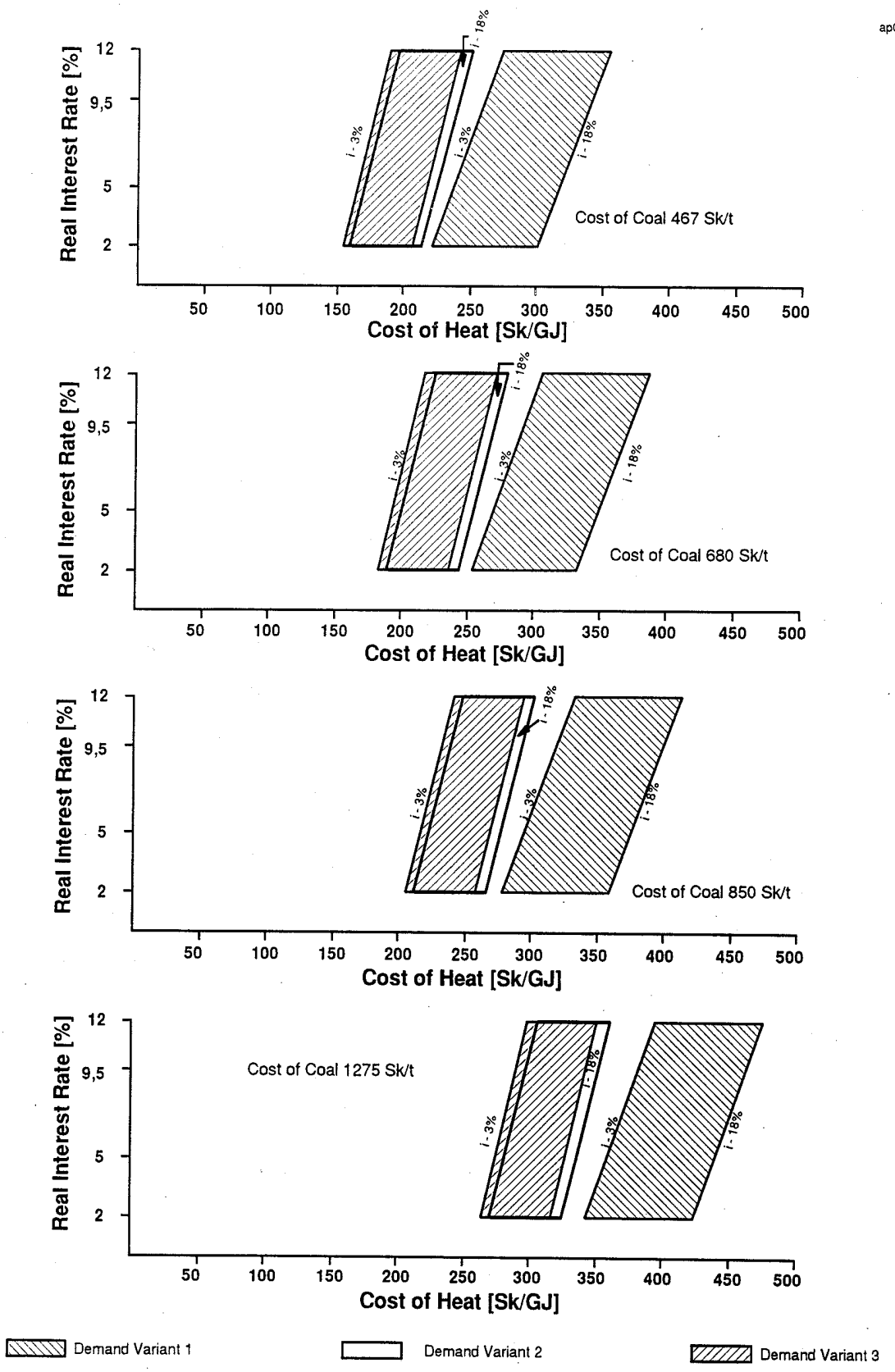



**Figure 3.18 - Cost of Heat as Function of Real Interest and Inflation**

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 | 195,75 | 130,48 | 128,75 |
| | | 18 | 265,55 | 176,35 | 173,75 |
| | 5 | 3 | 209,70 | 139,65 | 137,75 |
| | | 18 | 279,50 | 185,70 | 183,00 |
| | 9,5 | 3 | 230,65 | 153,40 | 151,25 |
| | | 18 | 300,50 | 199,95 | 197,00 |
| | 12 | 3 | 242,20 | 161,05 | 158,75 |
| | | 18 | 312,50 | 207,80 | 204,75 |
| 680 | 2 | 3 | 236,60 | 169,08 | 168,15 |
| | | 18 | 306,40 | 214,95 | 213,15 |
| | 5 | 3 | 250,60 | 178,25 | 190,65 |
| | | 18 | 320,40 | 224,20 | 222,15 |
| | 9,5 | 3 | 271,50 | 192,00 | 205,25 |
| | | 18 | 341,30 | 238,40 | 251,25 |
| | 12 | 3 | 283,15 | 199,65 | 198,15 |
| | | 18 | 253,30 | 246,35 | 244,00 |
| 850 | 2 | 3 | 269,25 | 199,88 | 199,63 |
| | | 18 | 339,05 | 245,75 | 244,60 |
| | 5 | 3 | 283,20 | 209,05 | 208,63 |
| | | 18 | 353,00 | 254,95 | 253,60 |
| | 9,5 | 3 | 304,15 | 222,80 | 222,10 |
| | | 18 | 373,90 | 269,20 | 267,60 |
| | 12 | 3 | 315,80 | 230,45 | 229,60 |
| | | 18 | 385,80 | 277,10 | 275,40 |
| 1275 | 2 | 3 | 350,80 | 276,90 | 278,25 |
| | | 18 | 420,60 | 322,80 | 323,25 |
| | 5 | 3 | 364,75 | 286,05 | 287,25 |
| | | 18 | 434,60 | 331,95 | 332,25 |
| | 9,5 | 3 | 385,70 | 299,85 | 300,75 |
| | | 18 | 455,50 | 346,00 | 345,95 |
| | 12 | 3 | 397,30 | 307,50 | 308,25 |
| | | 18 | 467,20/ | 353,95/ | 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 that 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/m3) | $10^6$ m3 | 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.

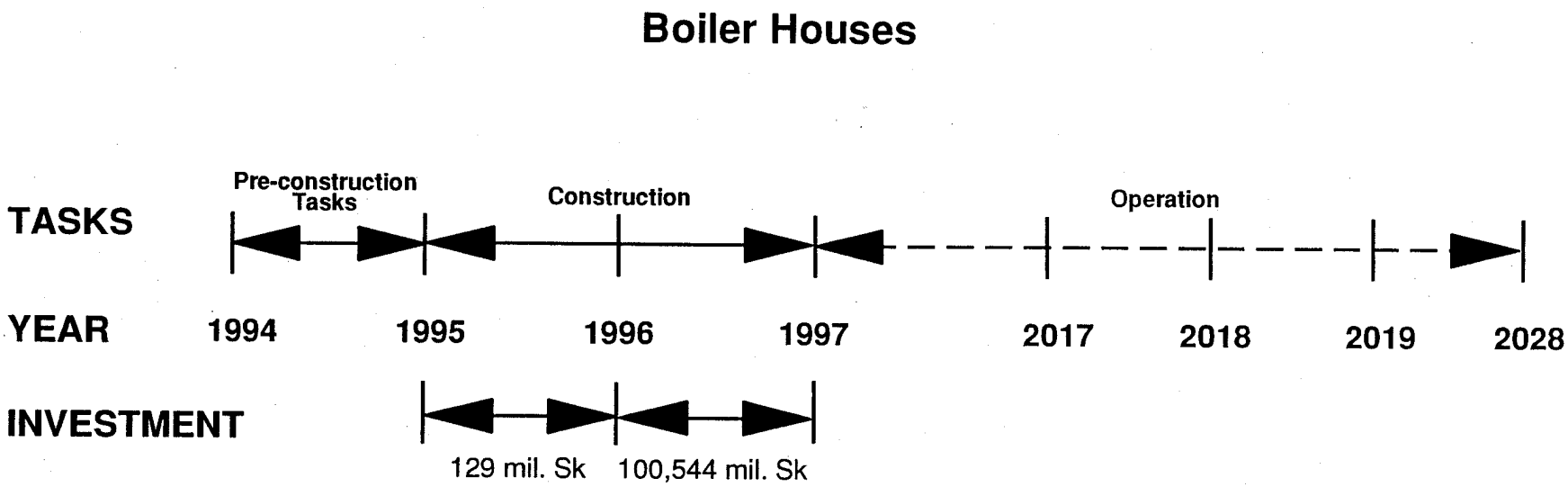



Figure 4.1 - Construction Schedule, Alternative 3 (Decentralized)

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 |
| Investement 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.

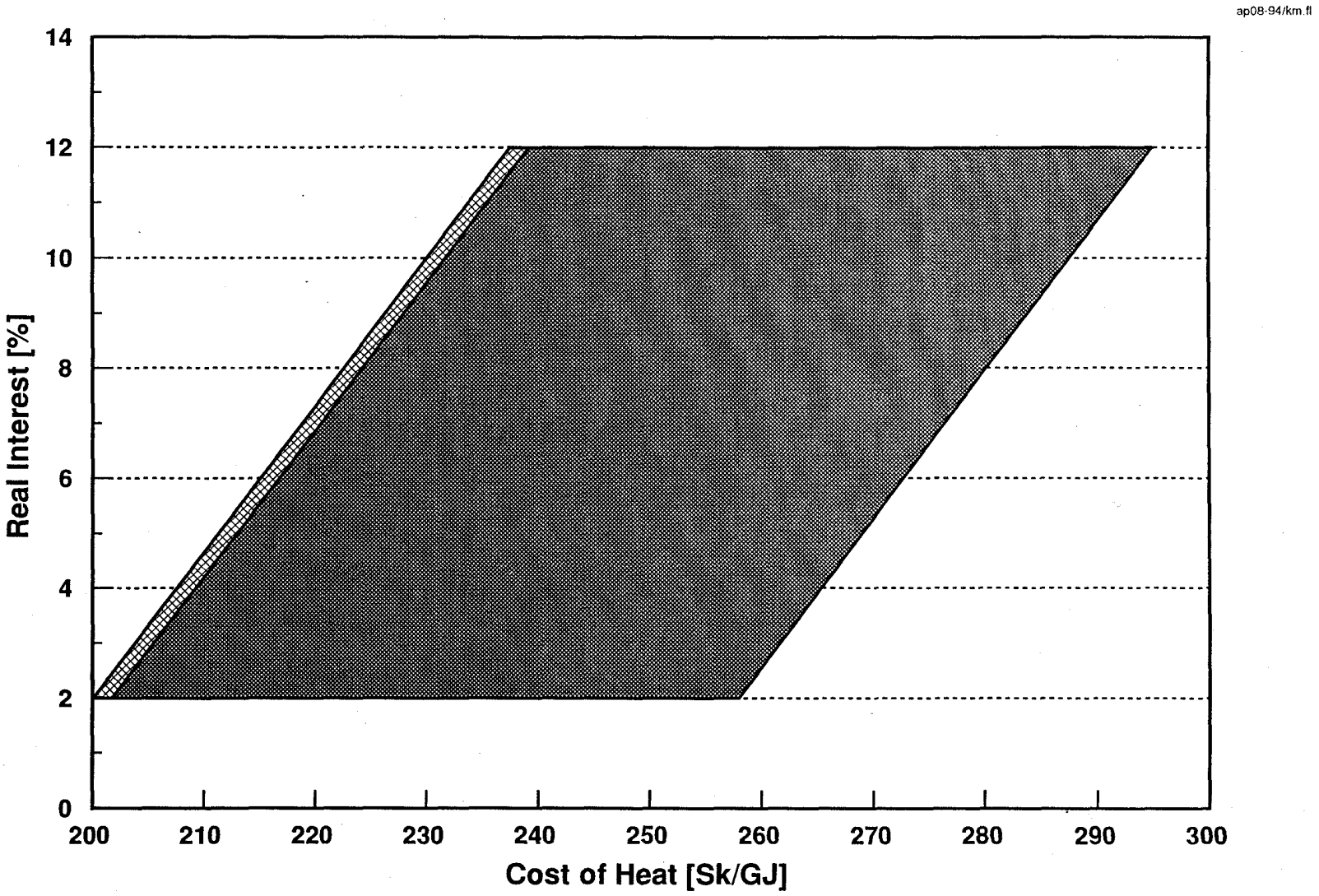



Figure 4.2 - Cost of Heat as Function of Electricity Cost

Table 4.2 - Results Summary, Alternative 3

| Electricity Cost [SK/MWh] | Discount Rate [%] | Inflation [%] | Delivered Energy Cost [SK/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/$m^3$. 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**

ap19-94/km.fl

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

Gas Cost = 3.35 sk/m$^3$

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 % |

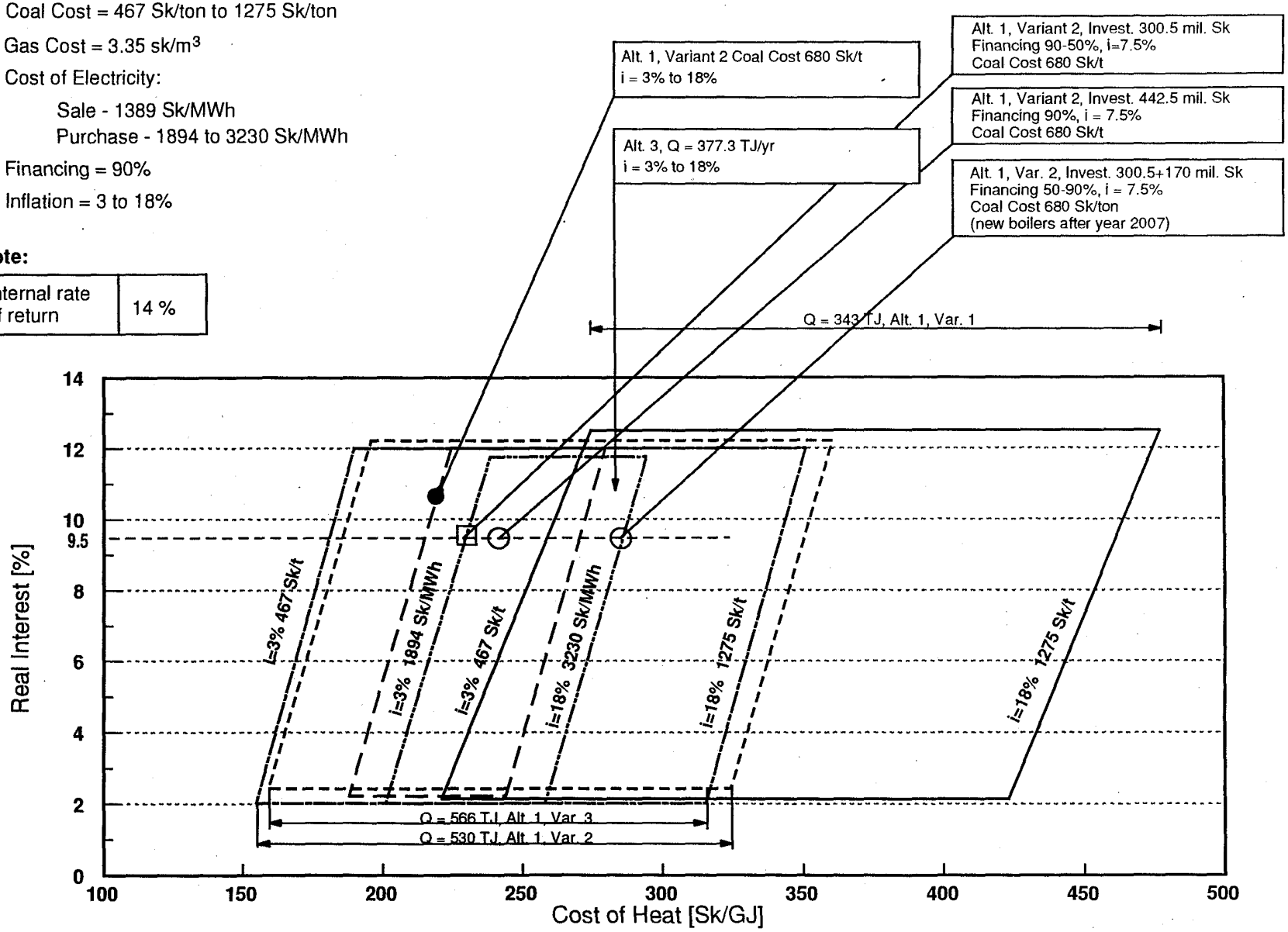



**Figure 5.1 - Economic Analysis and Sensitivity of Results for Decentralized (Alt. 3) and Central (Alt. 1) Production of Thermal Energy for Space and Water Heating in the Town of Handlova, Slovakia**

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/$m^3$, 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 Paramters | | | | |
| 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 Summary, Alternative 1, Load Variant 2

| | Year | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| Heat [TJ] | | | 518.9 | 519.3 | 519.8 | 520.3 | 520.8 | 521.2 | 521.7 | 522.2 | 522.7 | 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 |
| Escalated price [SK/GJ] | | | 228.4 | 233.7 | 239.0 | 244.5 | 250.1 | 255.9 | 261.8 | 267.8 | 274.0 | 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 |
| Electricity supply [GWh] | | | 19.9 | 19.9 | 19.9 | 20 | 20 | 20 | 20.1 | 20.1 | 20.1 | 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 |
| Escalated price [SK/MWh] | | | 1389.0 | 1472.3 | 1560.7 | 1654.3 | 1753.6 | 1858.8 | 1970.3 | 2088.5 | 2213.9 | 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 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 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 | 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 |
| Escalated cost of coal [SK/ton] | | | 680 | 698.4 | 717.2 | 736.6 | 756.5 | 776.9 | 797.9 | 819.4 | 841.5 | 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 |
| Gas consumption [ths.m3] | | | 3945.5 | 3945.5 | 3945.5 | 3945.6 | 3945.6 | 3945.7 | 3945.7 | 3945.8 | 3945.8 | 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 |
| Escalated price [Sk/th.m3] | | | 3350.0 | 3445.5 | 3543.7 | 3644.7 | 3748.5 | 3855.4 | 3965.3 | 4078.3 | 4194.5 | 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 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Labor and overhead [thous. SK] | | | 8750.0 | 9835.0 | 11054.5 | 12425.3 | 13966.0 | 15697.8 | 17644.4 | 19832.3 | 22291.5 | 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 |
| Repair and Maint. [thous. SK] | | | 5000 | 5375.0 | 5778.1 | 6211.5 | 6677.3 | 7178.1 | 7716.5 | 8295.2 | 8917.4 | 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 |
| Emissions [thous. SK] | | | 2359.7 | 2384.4 | 2409.4 | 2434.7 | 2460.2 | 2486.0 | 2512.0 | 2538.3 | 2564.9 | 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 |
| Materials, fuels [thous. SK] | | | 3500 | 3762.5 | 4044.7 | 4348.0 | 4674.1 | 5024.7 | 5401.6 | 5806.7 | 6242.2 | 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 |
| Overhead [thous. SK] | | | 3000 | 3180.0 | 3370.8 | 3573.0 | 3787.4 | 4014.7 | 4255.6 | 4510.9 | 4781.5 | 4925.0 | 5072.7 | 5224.9 | 5381.7 | 5543.1 | 5709.4 | 5880.7 | 6057.1 | 6238.8 | 6426.0 | 6618.8 | 6817.3 | 7021.9 | 7232.5 | 7449.5 | 7673.0 |
| Depreciat. exist. asssets [th. SK] | | | 1556 | 1556 | 1556 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Project Summary | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Depreciation | 0 | 0 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 | 13787 |
| Annual Interest | 0 | 0 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 | 22735 |
| Investment Total | 150250 | 150250 | 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 |
| Fines | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Profit | 0 | 0 | 27176 | 28130 | 29017 | 29822 | 30531 | 31125 | 31583 | 31880 | 31992 | 34302 | 36713 | 39230 | 41860 | 44607 | 47479 | 50483 | 53626 | 56916 | 60362 | 63973 | 67757 | 71725 | 75888 | 80256 | 84842 |
| Cash Flow Project | -150250 | -150250 | 63698 | 64652 | 65538 | 66344 | 67053 | 67647 | 68104 | 68402 | 68513 | 70824 | 73235 | 75752 | 78381 | 81128 | 84001 | 87005 | 90148 | 93438 | 96884 | 100494 | 104279 | 108247 | 112410 | 116778 | 121364 |
| Cash Flow, r^-t | -164524 | -150250 | 58172 | 53920 | 49918 | 46147 | 42594 | 39243 | 36081 | 33095 | 30273 | 28578 | 26988 | 25493 | 24090 | 22771 | 21531 | 20366 | 19272 | 18242 | 17274 | 16363 | 15506 | 14700 | 13941 | 13226 | 12553 |
| Discounted Cash Flow, Project | -164524 | -314774 | -256602 | -202682 | -152764 | -106617 | -64023 | -24780 | 11301 | 44395 | 74668 | 103246 | 130234 | 155727 | 179817 | 202587 | 224119 | 244485 | 263757 | 281999 | 229272 | 315635 | 331141 | 345841 | 359781 | 373007 | 385560 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Investors Summary | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Depreciation | 0 | 0 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 | 14779 |
| Depreciation of Existing Equip. | 0 | 0 | 1556 | 1556 | 1556 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 |
| Interest | 22988 | 45977 | 41379 | 36781 | 32184 | 27586 | 22988 | 18391 | 13793 | 9195 | 4598 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest During Construction | 22988 | 45977 | 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 |
| Pre-Tax Profit | 0 | 0 | 5985 | 11536 | 17020 | 23290 | 28596 | 33787 | 38843 | 43738 | 48447 | 55355 | 57766 | 60283 | 62913 | 65660 | 68532 | 71536 | 74679 | 77970 | 81416 | 85026 | 88810 | 92778 | 96941 | 101309 | 105896 |
| Taxes | 0 | 0 | 2693 | 5191 | 7659 | 10480 | 12868 | 15204 | 17479 | 19682 | 21801 | 24910 | 25995 | 27128 | 28311 | 29547 | 30840 | 32191 | 33606 | 35085 | 36637 | 38262 | 39965 | 41750 | 43623 | 45589 | 47653 |
| Usable Profit | 0 | 0 | 3292 | 6345 | 9361 | 12809 | 15728 | 18583 | 21364 | 24056 | 26646 | 30445 | 31772 | 33156 | 34602 | 36113 | 37693 | 39345 | 41074 | 42883 | 44779 | 46764 | 48846 | 51028 | 53318 | 55720 | 58243 |
| Own Investment | 15025 | 15025 | 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 |
| Loan Draw-Down | 135225 | 135225 | 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 |
| Subsidies | 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 |
| Loan Payment | 0 | 0 | 27045 | 27045 | 27045 | 27045 | 27045 | 27045 | 27045 | 27045 | 27045 | 27045 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cash Flow (after tax) | -38013 | -61002 | -7419 | -4366 | -1349 | 1233 | 4152 | 7007 | 9787 | 12480 | 15070 | 18869 | 47240 | 48624 | 50071 | 51582 | 53161 | 54813 | 56542 | 58352 | 60247 | 62233 | 64314 | 66496 | 68786 | 71189 | 73711 |
| Cash Flow, r^-t | -41625 | -61002 | -6775 | -3641 | -1028 | 858 | 2637 | 4065 | 5185 | 6038 | 6658 | 7614 | 17408 | 16364 | 15389 | 14478 | 13626 | 12831 | 12087 | 11392 | 10742 | 10133 | 9563 | 9030 | 8531 | 8063 | 7624 |
| Discounted Cash Flow, Investor | -41625 | -102626 | -109401 | -113042 | -114070 | -113212 | -110575 | -106510 | -101325 | -95287 | -88629 | -81015 | -63607 | -47243 | -31854 | -17377 | -3750 | 9081 | 21168 | 32560 | 43302 | 53345 | 62998 | 72028 | 80559 | 88621 | 96245 |

Discount Rate - 9 5

Inflation - 3%

## 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) | % | 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 | 20 702 | 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) % / 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 | 20 461 | 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 Summary, Alternative 2, Load Variant 2

| | Year | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| Heat [TJ] | | | 518.8 | 519.3 | 519.7 | 520.2 | 520.7 | 521.1 | 521.6 | 522.1 | 522.5 | 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 |
| Escalated heat price [SK/GJ] | | | 192 | 196.4 | 200.9 | 205.6 | 210.3 | 215.1 | 220.1 | 225.1 | 230.3 | 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 |
| Electricity supplied [GWh] | | | 24.3 | 24.3 | 24.4 | 24.4 | 24.4 | 24.4 | 24.5 | 24.5 | 24.5 | 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 |
| Escalated electricity price [SK/MWh] | | | 1389 | 1472.3 | 1560.7 | 1654.3 | 1753.6 | 1858.8 | 1970.3 | 2088.5 | 2213.9 | 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 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cost of fuel and energy | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Coal [tons] | | | 91628 | 91685.2 | 91742.6 | 91799.9 | 91857.3 | 91914.8 | 91972.3 | 92029.8 | 92087.3 | 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 |
| Escalated cost of coal [SK/ton] | | | 680 | 698.4 | 717.2 | 736.6 | 756.5 | 776.9 | 797.9 | 819.4 | 841.5 | 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 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Direct labor and overhead [thous.SK] | | | 8750 | 9835 | 11054.5 | 12425.3 | 13966 | 15697.8 | 17644.4 | 19832.3 | 22291.5 | 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 |
| Repair and maintenance [thous.SK] | | | 5000 | 5375 | 5778.1 | 6211.5 | 6677.3 | 7178.1 | 7716.5 | 8295.2 | 8917.4 | 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 |
| Emissions [thous. SK] | | | 3804.4 | 3844.7 | 3885.4 | 3926.6 | 3968.2 | 4010.3 | 4052.8 | 4095.8 | 4139.2 | 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 |
| Materials and other fuels [thous SK] | | | 3500 | 3762.5 | 4044.7 | 4348 | 4674.1 | 5024.7 | 5401.6 | 5806.7 | 6242.2 | 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 |
| Overhead [thous.SK] | | | 3000 | 3180 | 3370.8 | 3573 | 3787.4 | 4014.7 | 4255.6 | 4510.9 | 4781.5 | 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 |
| Depreciation [thous. SK] | | | 1556 | 1556 | 1556 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Project Summay | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Depreciation | 0 | 0 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 | 11998 |
| Annual interest | 0 | 0 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 | 19784 |
| Investment total | 130750 | 130750 | 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 |
| Profit | 0 | 0 | 15221 | 16006 | 16734 | 17392 | 17964 | 18433 | 18779 | 18981 | 19013 | 21023 | 23142 | 25379 | 27739 | 30232 | 32866 | 35649 | 38590 | 41701 | 44991 | 48472 | 52157 | 56057 | 60187 | 64561 | 69195 |
| Cash flow, project | -130750 | -130750 | 47003 | 47788 | 48516 | 49174 | 49745 | 50214 | 50561 | 50763 | 50795 | 52805 | 54924 | 57161 | 59521 | 62014 | 64648 | 67431 | 70372 | 73483 | 76773 | 80254 | 83938 | 87839 | 91969 | 96343 | 100977 |
| Cash flow r-T | -143171 | -130750 | 42925 | 39856 | 36952 | 34204 | 31600 | 29130 | 26787 | 24560 | 22444 | 21307 | 20240 | 19237 | 18293 | 17406 | 16571 | 15785 | 15044 | 14346 | 13688 | 13067 | 12481 | 11928 | 11406 | 10911 | 10444 |
| discounted cash flow, project | -143171 | -273921 | -230996 | -191140 | -154188 | -119984 | -88384 | -59254 | -32467 | -7907 | 14537 | 35844 | 56084 | 75321 | 93614 | 111020 | 127590 | 143375 | 158419 | 172765 | 186453 | 199520 | 212002 | 223930 | 235335 | 246247 | 256691 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Investors Summary | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Depreciation | 0 | 0 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 | 12225 |
| Depreciation of Existing Equipment | 0 | 0 | 1556 | 1556 | 1556 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 | 690 |
| Loan interest | 14709 | 29419 | 26477 | 23535 | 20593 | 17651 | 14709 | 11768 | 8826 | 5884 | 2942 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest during construction | 14709 | 29419 | 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 |
| Pre-tax profit | 0 | 0 | 6745 | 10472 | 14142 | 18607 | 22121 | 25532 | 28820 | 31964 | 34938 | 39890 | 42009 | 44245 | 46606 | 49099 | 51733 | 54515 | 57457 | 60568 | 63858 | 67339 | 71023 | 74924 | 79054 | 83428 | 88062 |
| Taxes | 0 | 0 | 3035 | 4712 | 6364 | 8373 | 9954 | 11489 | 12969 | 14384 | 15722 | 17950 | 18904 | 19910 | 20973 | 22095 | 23280 | 24532 | 25856 | 27256 | 28736 | 30303 | 31960 | 33716 | 35574 | 37542 | 39628 |
| Net Porfit | 0 | 0 | 3710 | 5760 | 7778 | 10234 | 12166 | 14042 | 15851 | 17580 | 19216 | 21939 | 23105 | 24335 | 25633 | 27005 | 28453 | 29984 | 31601 | 33312 | 35122 | 37036 | 39063 | 41208 | 43479 | 45885 | 48434 |
| Own investment | 13075 | 13075 | 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 |
| Loan draw-down | 117675 | 117675 | 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 |
| subsidies | 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 |
| Loan payment | 0 | 0 | 23535 | 23535 | 23535 | 23535 | 23535 | 23535 | 23535 | 23535 | 23535 | 23535 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cash Flow | -27784 | -42494 | -6044 | -3994 | -1976 | -386 | 1547 | 3423 | 5231 | 6961 | 8596 | 11319 | 36020 | 37250 | 38548 | 39920 | 41368 | 42899 | 44517 | 46227 | 48037 | 49952 | 51978 | 54123 | 56395 | 58800 | 61349 |
| Cash Flow r-T | -30424 | -42494 | -5520 | -3331 | -1505 | -268 | 982 | 1986 | 2772 | 3368 | 3798 | 4568 | 13274 | 12536 | 11847 | 11204 | 10604 | 10042 | 9517 | 9025 | 8565 | 8133 | 7729 | 7350 | 6994 | 6659 | 6345 |
| discounted cash flow, | -30424 | -72918 | -78437 | -81769 | -83274 | -83542 | -82560 | -80574 | -77803 | -74435 | -70637 | -66069 | -52795 | -40260 | -28442 | -17208 | -6604 | 3438 | 12954 | 21979 | 30544 | 38677 | 46406 | 53756 | 60755 | 67409 | 73755 |

Discount Rate - 9 5
Inflation - 3*.

## PARAMETERS OF ECONOMIC EFFECTIVENESS
## ALTERNATIVE 2

### Table B.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 | 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) | % | 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 | 18 229 | 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 Summary, Alternative 3, Load Variant 3

| | Year | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| Heat [TJ] | | | 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 | 377.3 | 377.3 | 377.3 | 377.3 | 377.3 | 377.3 | 377.3 | 377.3 | 377.3 |
| Escalated price [SK/GJ] | | | 246.2 | 251.9 | 257.7 | 263.6 | 269.6 | 275.8 | 282.2 | 288.7 | 295.3 | 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 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cost of Fuel and Energy | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Electricity [MWh] | | | 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 | 500.0 | 500.0 | 500.0 | 500.0 | 500.0 | 500.0 | 500.0 | 500.0 | 500.0 |
| Escalated Cost of El. [Sk/MWh] | | | 1894.0 | 2007.6 | 2128.1 | 2255.8 | 2391.1 | 2534.6 | 2686.7 | 2847.9 | 3018.7 | 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 |
| Gas consumption [ths.m3] | | | 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 | 11074.3 | 11074.3 | 11074.3 | 11074.3 | 11074.3 | 11074.3 | 11074.3 | 11074.3 | 11074.3 |
| Escalated price [Sk/th.m3] | | | 3350.0 | 3445.5 | 3543.7 | 3644.7 | 3748.5 | 3855.4 | 3965.3 | 4078.3 | 4194.5 | 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 |
| Water [th.m3] | | | 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 | 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 | 12520.9 | 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 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Labor and overhead [thous. SK] | | | 1800.0 | 2023.2 | 2274.1 | 2556.1 | 2873.0 | 3229.3 | 3629.7 | 4079.8 | 4585.7 | 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 |
| Repair and Maint. [thous. SK] | | | 2300.0 | 2472.5 | 2657.9 | 2857.3 | 3071.6 | 3301.9 | 3549.6 | 3815.8 | 4102.0 | 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 |
| Emissions [thous. SK] | | | 34.6 | 34.9 | 35.3 | 35.6 | 36.0 | 36.4 | 36.7 | 37.1 | 37.5 | 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 |
| Materials, fuels [thous. SK] | | | 3500 | 3762.5 | 4044.7 | 4348.0 | 4674.1 | 5024.7 | 5401.6 | 5806.7 | 6242.2 | 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 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Project Summary** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Depreciation | 0 | 0 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 | 10532 |
| Annual Interest | 0 | 0 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 | 17367 |
| Investment Total | 114777 | 114777 | 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 |
| Fines | 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 |
| Profit | 0 | 0 | 22461 | 23079 | 23672 | 24235 | 24764 | 25253 | 25697 | 26087 | 26418 | 27811 | 29227 | 30665 | 32126 | 33608 | 35111 | 36636 | 38180 | 39743 | 41326 | 42926 | 44543 | 46176 | 47823 | 49484 | 51157 |
| Cash Flow Project | -114777 | -114777 | 50360 | 50978 | 51571 | 52135 | 52663 | 53153 | 53596 | 53986 | 54317 | 55710 | 57126 | 58565 | 60025 | 61507 | 63011 | 64535 | 66079 | 64643 | 69225 | 70825 | 72442 | 74075 | 75722 | 77383 | 79056 |
| Cash Flow, r^-t | -125681 | -114777 | 45991 | 50360 | 51571 | 52135 | 52663 | 30835 | 28394 | 26210 | 24000 | 22480 | 21051 | 19709 | 18448 | 17264 | 16151 | 15107 | 14126 | 13206 | 12342 | 11532 | 10772 | 10059 | 9391 | 8764 | 8177 |
| Discounted Cash Flow, Project | -125681 | -240458 | -194467 | -151950 | -112671 | -76408 | -42954 | -12120 | 16275 | 42395 | 66394 | 88874 | 109926 | 129635 | 148083 | 165346 | 181497 | 196604 | 210730 | 223936 | 236278 | 247810 | 331141 | 268641 | 278032 | 286796 | 294973 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Investors Summary** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Depreciation | 0 | 0 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 | 11289 |
| Depreciation of Existing Equip. | 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 |
| Interest | 17561 | 35122 | 31610 | 28097 | 24585 | 21073 | 17561 | 14049 | 10537 | 7024 | 3512 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest During Construction | 17561 | 35122 | 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 |
| Pre-Tax Profit | 0 | 0 | 7461 | 11591 | 15696 | 19772 | 28813 | 27814 | 31770 | 35673 | 39515 | 44421 | 45837 | 47275 | 48736 | 50218 | 51721 | 53245 | 54790 | 56353 | 57936 | 59536 | 61153 | 62786 | 64433 | 66094 | 67767 |
| Taxes | 0 | 0 | 3357 | 5216 | 7063 | 8897 | 10716 | 12516 | 14296 | 16053 | 17782 | 19989 | 20627 | 21274 | 21931 | 22598 | 23275 | 23960 | 24655 | 25359 | 26071 | 26791 | 27519 | 28253 | 28995 | 29742 | 30495 |
| Usable Profit | 0 | 0 | 4104 | 6375 | 8633 | 10875 | 13097 | 15298 | 17473 | 19620 | 21733 | 24431 | 25210 | 26001 | 26805 | 27620 | 28447 | 29285 | 30134 | 30994 | 31865 | 32745 | 33634 | 34532 | 35438 | 36352 | 37272 |
| Own Investment | 11478 | 11478 | 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 |
| Loan Draw-Down | 103299 | 103299 | 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 |
| Subsidies | 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 |
| Loan Payment | 0 | 0 | 20660 | 20660 | 20660 | 20660 | 20660 | 20660 | 20660 | 20660 | 20660 | 20660 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cash Flow (after tax) | -29039 | -46599 | -5267 | -2995 | -737 | 1504 | 3727 | 5928 | 8103 | 10250 | 12363 | 15061 | 36500 | 37291 | 38094 | 38909 | 39736 | 40574 | 41424 | 42284 | 43154 | 44034 | 44923 | 45822 | 46728 | 47641 | 48561 |
| Cash Flow, r^-t | -31797 | -46599 | -4810 | -2498 | -562 | 1046 | 2367 | 3439 | 4293 | 4959 | 5463 | 6077 | 13450 | 12550 | 11708 | 10921 | 10185 | 9498 | 8855 | 8255 | 7694 | 7170 | 6680 | 6222 | 5795 | 5396 | 5023 |
| Discounted Cash Flow, Investor | -31797 | -78397 | -83207 | -85705 | -86266 | -85220 | -82852 | -79414 | -75121 | -70162 | -64699 | -58622 | -45172 | -32622 | -20914 | -9993 | 192 | 9690 | 18545 | 26800 | 34494 | 41664 | 48344 | 54566 | 60361 | 65757 | 70780 |

Discount Rate - 9 5
Inflation - 3%

## 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) % / Inflation % | | 2,0 | | 5,0 | | 9,5 | | 12,0 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 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 |