ANALYSIS OF COSTS OF OPERATION AND MAINTENANCE OF HOT-WATER TRANSFER STATIONS

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Abstract

The article analyses the economic efficiency of investments with a view to future costs of operation and maintenance of two hot-water transfer stations to determine which one is optimal for the company. It contains an analysis of the maintenance costs of transfer stations, controllable in terms of reconstruction. In conclusion, the article presents the process of evaluating the effectiveness of investments using standard evaluation methods aimed at reducing maintenance costs, heat losses in the technology of thermal energy transformation and electricity consumption.

Keywords: Analysis, costs, maintenance, investment decision making

1. INTRODUCTION

One of the most severe activities for business management is determination of future investments. Investing is a bridge between the current state and future development of the company. Investment decision making is therefore one of the most important as well as most difficult activities which the owners and corporate management of the company must pursue because the main and basic criterion for the success of each activity in the market economy is its economic efficiency. Right investment decisions ensure future prosperity and profitability of the company. Conversely, wrong decisions can disrupt business activities of the company in the long term or, in some cases, even cause its demise. Since most of the investment decisions are accompanied by a various degree of uncertainty, it is very important that the corporate management addresses investment decisions with a certain seriousness to ensure the success of the company in its competitive environment. This article aims to assess whether the implementation of the investment project is economically efficient for the company.

2. INVESTMENT PROJECT

2.1. Description of the investment project

The company is engaged in the production and supply of heat, cold, electricity and other energy commodities and the essence of its investment project consists in the reconstruction of two hot-water transfer stations (HPSs). The proposed reconstruction mainly aims at reducing maintenance costs and heat losses in the technology of thermal energy transformation, failures in deliveries of thermal energy to end customers and electricity consumption. The proposed reconstruction involves the use of modern technologies in the field of heat transfer as well as the use of new mobile technologies for data transfer and their visualization in the control room. Economics of the reconstructions constitute an effort to reduce the total costs of HPS operation and thus potentially increase operating results of each performance-different HPS.

2.2. Characteristics of hot-water transfer stations

Hot-water transfer stations (HPSs) are used to prepare heating water and hot water to ensure central heating and HVAC parameters. Supply heat energy from the primary heating network does not have suitable

temperature and pressure parameters to be used directly for heating residential or business premises; this energy is therefore transferred in heat exchangers to a secondary circuit which is operated at parameters that comply with the relevant regulations and standards for heating buildings and hot water deliveries. The secondary circuit, usually a four-tube system, consists of hot-water channels with different profiles (from unascendable up to passage) leading to the objects supplied. The method of thermal energy transfer between the primary and secondary heat circuit is always pressure-independent. Investment decisions relate only to two HPSs which have a different installed thermal capacity (see **Table 1**).

Table 1 Hot-water transfer station (HPS)

HPS designation	Installed capacity (MW)	Type of technology
HPS 672	2.33	ÚT + TV
HPS 675	1.83	ÚT + TV

2.3. Costs of HPS operation and maintenance

Costs arising from the operation of HPS consist of technological costs and costs of operation and maintenance. Technological costs are immediately induced by the installed and operated technology or purposefully related to this technology in a certain way. Costs of operation and maintenance serve to ensure accompanying activities of the technological process that leads to a continuous trouble-free operation of HPSs.

In addition to these incurred costs, which can be identified using a software tool, there are other technological costs related to the operation and maintenance which will be tracked in the analysis of the overall costs because their effect on the total amount of the costs for each HPS is different before and after the reconstruction. For example, these costs relate to the consumption of purchased electricity, electricity distribution, legal revisions, communications, depreciation of tangible fixed assets, technical appreciation up to CZK 40,000.00, drinking water consumption. **Table 2** gives a general overview of the monitored costs that can be affected by the proposed reconstruction.

Table 2 Costs before the reconstruction (CZK)

HPS type	HPS 672		HPS 675	
Year	**2013**	**2014**	**2013**	**2014**
Communications	914	1 114	1 307	1 024
Technical appreciation up to CZK 40,000.00	10 219	0	10 290	0
Depreciation of tangible fixed assets	6 803	6 803	4 936	4 936
Drinking water consumption	1 501	1 126	1 853	2 961
Legal revisions	5 427	5 427	4 886	4 320
Consumption of purchased electricity	52 798	43 661	33 017	30 320
Electricity distribution	68 399	55 965	46 998	44 625
In-house maintenance	120 397	153 929	116 857	126 102
TOTAL	**266 458**	**268 025**	**220 144**	**214 288**

2.4. Capital expenditures

For evaluating the effectiveness of investment and for the purposes of investment decision making, it is necessary to know capital expenditures for the made reconstructions. Determination of capital expenditures

for HPS reconstructions is done using a simple technical calculation of each HPS with different capacity. Price calculations are derived from budgets of already completed reconstructions of a similar type, considering performance differences between HPSs. The total capital expenditures are given by the total price for the work, which is the amount determined by the difference between the price for the investment part of the work and revenue from dismantling the original technology. For completeness, it should be noted that the amount of the total price for the work means the final amount for executing the work on a turnkey basis. In HPS 672 and HPS 675, the total price for the work amounts to CZK 1,324,000.00 and CZK 1,224,000.00, respectively.

3. COSTS ANALYSIS

3.1. Costs analysis before the reconstruction

The current operating costs are specified for each HPS and their respective volume of deliveries of GJ produced using existing technologies. In the future, we cannot consider that HPSs with the existing technology would produce a similar amount of thermal energy with the same financial impact on operation and maintenance. To determine the costs of HPS operation and maintenance in the future, these costs will be predicted based on the achievement of their actual values during the current operation, including obsolescence of the existing technology. Using this method, it is possible to predict the course of future costs (see **Table 3**).

Table 3 Estimated future costs before the reconstruction (CZK)

HPS type	HPS 672			HPS 675		
Year	**2016**	**2017**	**2018…**	**2016**	**2017**	**2018…**
Communications	930	994	1 098	1 424	1 567	1 732
Technical appreciation up to CZK 40,000.00	0	0	0	0	0	0
Depreciation of tangible fixed assets	6 803	6 803	6 803	4 936	4 936	4 936
Drinking water consumption	1 670	1 706	1 842	2 986	3 207	3 320
Legal revisions	5 706	5 788	6 033	5 466	5 768	5 988
Consumption of purchased electricity	47 122	50 008	53 497	36 785	38 976	41 983
Electricity distribution	58 876	64 564	69 121	49 876	57 688	63 871
In-house maintenance	136 283	197 554	243 187	158 769	249 408	229 667
TOTAL	**257 390**	**327 417**	**381 581**	**260 242**	**361 550**	**351 497**

This analysis showed an annual increase in all cost items at the current HPS operation. A significant increase of the costs in the prediction period is caused by changing some of the primary components of existing technology (pump, emergency valve, control valve, repair or replacement of the tube plate in the countercurrent heater).

3.2. Costs analysis after the reconstruction

The reconstruction should primarily lead to savings in the consumption of purchased electricity, communications and drinking water consumption (see **Table 4**). This reduction will be due to the change of HPS technology.

Table 4 Estimated future costs after the reconstruction (CZK)

HPS type	HPS 672			HPS 675		
Year	**2016**	**2017**	**2018…**	**2016**	**2017**	**2018…**
Communications	312	323	364	354	358	381
Technical appreciation up to CZK 40,000.00	0	0	0	0	0	0
Depreciation of tangible fixed assets	66 200	66 200	66 200	61 200	61 200	61 200
Drinking water consumption	48	52	57	48	51	54
Legal revisions	2 207	2 234	2 342	1 998	2 063	2 109
Consumption of purchased electricity	17 209	19 765	20 435	14 432	15 790	17 651
Electricity distribution	22 345	24 651	26 912	13 420	14 675	16 942
In-house maintenance	43 567	44 981	46 231	37 675	38 995	40 532
TOTAL	**151 888**	**158 206**	**162 541**	**129 127**	**133 132**	**138 869**

Regarding the development of maintenance costs after reconstructions: we can see a significant cost reduction on individual cost accounts compared to the current situation.

4. INVESTMENT EFFICIENCY EVALUATION METHODS

There are several methods for assessing the effectiveness of investment projects and their selection. These methods can be divided according to two aspects - whether they respect (dynamic methods) or ignore (static methods) the time factor. Static methods are used in the case of less significant projects, in projects with short lifetime and when the discount factor is low. Dynamic methods are used in other cases. [1]

4.1. Net present value

The concept of net present value is based on the principle of time value of money; it converts the future revenues and expenditures of the project to their present value using the so-called discount factor i.e. discount rate. The net present value (NPV) has the following form. [2]

$$NPV = \sum_{i=1}^{n}\left[\frac{CF_i}{(1+k)^i}\right] - II \qquad (1)$$

where:

NPV net present value,

II initial investment (internal investment),

i individual investment years.

4.2. Profitability index

Profitability index (PI) is a method of representing a ratio of benefits expressed as the present value of the predicted future cash flows and initial capital expenditures. The PI method is based on discounting, showing a particular investment option, i.e. the present value of its benefits in relative terms. [3]

$$PI = \frac{\sum_{i=1}^{n} \frac{CF_i}{(1+k)^i}}{K} \quad (2)$$

where:

PI profitability index,

CF_i cash income from the investment in individual years of its lifetime,

k required return,

K initial capital expenditures,

i individual years of the investment.

4.3. Payback period

Generally, the payback period of the investment project is a period in which the project will be repaid from cash revenues ensured by the project, simply said, from its after-tax profits and depreciations. In this case, therefore, the effect of the project means not only after-tax profits but also depreciations. The shorter is the payback period, the better evaluation of the investment project. [4]

$$K = \sum_{i=1}^{a} (z_i + o_i) \quad (3)$$

where:

K acquisition costs (capital expenditures),

z_i annual after-tax profit from the investment in individual years of its lifetime,

o_i annual depreciations of the investment in individual years of its lifetime,

i individual years of the investment,

a payback period.

5. EVALUATION OF THE INVESTMENT PROJECT

Data relating to the cash flow of the project plan are based on the company's data. If wanting to express the benefits of the investment, we need to compare them with the situation prior to its implementation. In the case of investments in HPS reconstructions, it is a saving calculated as the difference between the existing controllable costs of operation and maintenance and the future annual costs for HPS operation and maintenance, affected by this investment. The discount rate is set at 5% which is a percentage amount normally used by Czech companies.

5.1. Net present value

The net present value is the difference between discounted cash revenues and capital expenditures. Consequently, the net present value for HPS 672 and HPS 675 is CZK 331,185.00 and CZK 770,532.00, respectively. Using the method of net present value, it was calculated that the highest savings would be achieved when investing in the reconstruction of HPS 675. The company will gain this amount from the investment project considering the time factor.

5.2. Profitability index

Profitability index calculation showed the value of 1.25 for HPS 672 and the value of 1.63 for HPS 675, indicating that the investment project is acceptable in both cases because the resulting profitability index

should be higher than 1. This means, for example, that one crown invested into the reconstruction of HPS 675 will yield CZK 1.63 of the future revenue in the present money value.

5.3. Payback period

The payback period method was used to express the HPS operation time in which the investment in reconstructions would be repaid by the effect from the operation. The shorter the payback period, the more favourable is the investment. Payback period for HPS 672 and HPS 675 will be 5 years and 1 month, and 4 years and 8 months, respectively. Therefore, in terms of payback period, the investment in HS 675 will be repaid faster (sooner).

6. CONCLUSION

In companies, the investment decision making does not take place every day, it is a planned activity; yet it is one of the greatest responsibilities of management. Only the right investment decisions can lead to achieving strategic objectives and financial growth of the company. Evaluation of all relevant data on the respective investment along with understanding the nature of the investment decision making is essential for the successful management and future of the company. [5]

We conducted an analysis of the costs for maintaining transfer stations, influenceable from the perspective of possible reconstructions. Upon subsequent predictions of costs at different HPS outputs after reconstructions, we specified savings represented by the difference between the actual costs before the reconstruction and predicted costs after the reconstruction. Then we assessed the efficiency of investment projects using standard evaluation methods. It was proposed to evaluate the investment in accordance with NPV methods, payback period and profitability index. Based on the results of these evaluation methods, the reconstruction should be performed in HPSs providing the best effects from the perspective of investment decision making. The results of the used evaluation methods show that both investment projects are cost-effective for the company.

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