Economic Comparison of Waste Water Cleaning for Central Waste Water Treatment Plant and Decentralised System with Smaller Waste Water Treatment Plants

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Abstract: In presented paper two economic analysis of investments for integrated waste water collection and treatment in selected area are presented. The methods of Net present value (NPV) and Capitalised costs (CC) have been used to compare economic efficiency of construction central waste water treatment plant with collecting system and construction of decentralised waste water treatment plants with belonging collecting system for each settlement separately. Two possible solutions have been selected to cover the extraordinary maintenance costs in the life time of each construction solution.

Key-Words: Waste water, catchment area, collecting system, cost price, net present value, capitalised cost

1 Introduction

Urban waste water represents a large share at pollution of water environment, which also influences the quality of drinking water sources.

The key to arrange matters on department of discharge and treatment of waste water and to the achievements of objectives under the National Environmental Protection Programme is the implementing act entitled Operational Programme for the discharge and treatment of Urban Waste water (Government of the Republic of Slovenia Decision No 352-08/2001-2 of 14 October 2004), which contains cost's schedule for the construction of collecting systems and urban waste water treatment plants [1,8].

The Operational Programme for specific agglomerations are down the deadlines by which the urban waste water collecting and treatment system must be in place in compliance with the provisions of Directive 91/271/EEC.

In accordance with Operational Programme Municipal shall ensure that agglomerations are provided with collecting system for urban waste water at least by the year 2017. The main criterias for discharge and treatment of waste water depends on:

1. total load arise from urban waste water in PE,
2. concentration of residents arise from urban waste water in PE/hectare,
3. determination of sensitive areas of eutrophication or sources of drinking water [2,8]. Agglomerations means an area where the population and/or economic activities are sufficiently concentrated for urban waste water to be collected or conducted to an urban waste water treatment plant or to a final discharge point [3,8].

2 Determination of catchment area

The basic of feasibility study for discharge and urban waste water treatment in municipal Slovenska Bistrica are also agglomerations.

In municipal we selected areas around settlement Pragersko as a priority, where a municipal waste land-fill and the settlements without regulated sewage system is located. The agglomerations of this areas are represented in Figure 1.

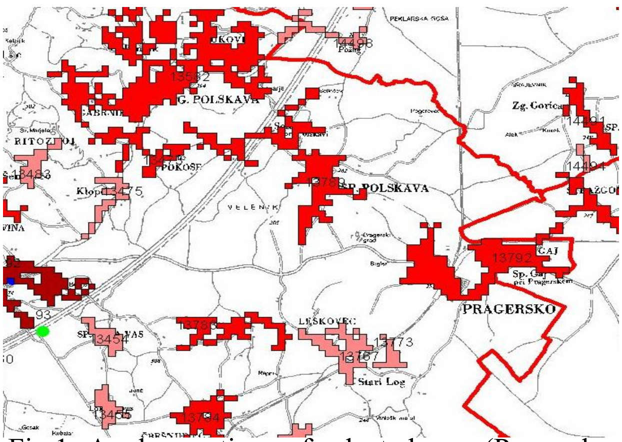

Fig.1: Agglomerations of selected area (Pragersko, Zgornja Polskava, Spodnja Polskava, Črešnjevec, Vrhloga) [2].

The design of the collecting system depends on topographical conditions, the type of building development, the existing and future runoff from the catchment area as well as on the suitability of the water or sewage treatment facilities and on the hydraulic capacity of the existing system [4].

For the selected area we have made analyses of two possible investments for:

1. Project 1: Construction of central waste water treatment plant in Pragersko and collecting system for all selected area.
2. Project 2: Construction of decentralised waste water treatment plants with belonging collecting system for each settlement separately.

In our analyses we compare economical parameters of investment and operation costs in a selected period. Feasibility study of Project 1 and Project 2 is presented in Table 1.

Table 1: Compare of infrastructure for Project 1 and Project 2

Infrastructure	PROJECT 1	PROJECT 2
Waste water treatment plant	1 pcs (8200 PE)	5 pcs (3500 PE, 2500 PE; 1500 PE, 500 PE, 200 PE)
Length of gravity line	40.070 m	38.040 m
Length of pressure line	6.977 m	4.102 m
Length of vacuum line	25.620 m	25.620 m
Pumping station	4 pcs	3 pcs
Vacuum station	2 pcs	2 pcs

2.1 Financial plan

The following grants are foreseen for financing the investments:

- EU funds; Cohesion fund and Structural fund,
- Environmental protection taxes,
- Ministry of the Environment,
- Municipal budget.

We have prepared for both investments investment's schedule which assumes financing of the projects from year 2008 to 2017 presented in Fig 2.

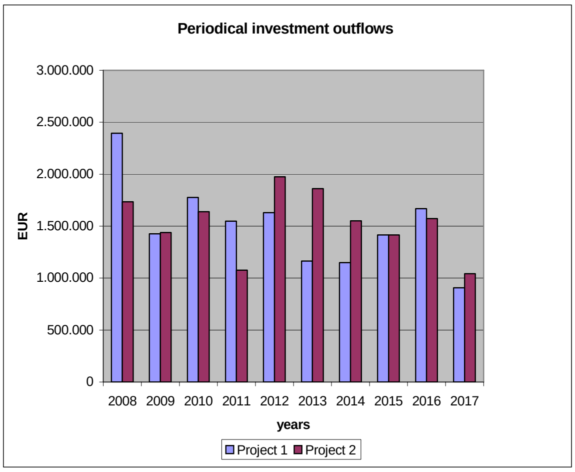

Fig.2:Financial schedule for Project 1 and Project 2

3. Economic analysis of Project 1 and Project 2 in selected time

For comparison of named projects the methods of Net present value (NPV) and Capitalised costs (CC) methods have been chosen in accordance of the lasting period.

3.1 Net present value (NPV)

Net present value (NPV) is one of the best financial tools to establish the value of a project or investment. NPV is used for capital budgeting, and widely throughout economics, it measures the excess or shortfall of cash flows in present value (PV) terms, once financing charges are met. All projects with a positive NPV are profitable, however this does not necessarily mean that they should be undertaken since NPV does not account for opportunity costs. Assuming a firm aims to maximise profit, projects should only be undertaken if their NPV is greater than the opportunity cost [5].

$$NPV = \sum_{t=0}^{n} \frac{c_t}{(1+r)^t} = \sum_{t=1}^{n} \frac{c_t}{(1+r)^t} - c_0 \qquad (1)$$

3.2 Capitalised costs (CC)

Capitalised costs represent present worth of a project which is assumed to last a period of infinite duration. Certain assets, such as dums and other public works, have lives of such great extent that for all practical purposes their lives may be regarded as infinite. The capitalised costs of an asset may be interpreted as the sum of money that must be deposited in a fund at the date of purchase at the stipulated interest rate to provide all payments for perpetual service [6].

$$CC = B_0 + \frac{(B_0 - L)(A/F_{u,n})}{r} + \frac{C}{r} \qquad (2)$$

$$(A/F_{u,n,r}) = \frac{r}{(1+r)^n - 1} \qquad (3)$$

3.3 Presumptions of economic analysis

The presumptions of economic analysis are:

- presumed economic parameters of investment are the same for both investments,
- investment is financed with non- returnable sources from EU funds;
- the depreciation costs are not included in the operative costs,
- life span of asset n = 50 years,
- discount rate r = 8 %,
- planned revenues are based on calculation of Price of public utility service which include only cost price of service (operating costs) and does not include cost of investment. Investment is treatment like a national assets and as such should be non profitable. Price of public utility service and cost price are calculated on the base of Regulations on pricing of Municipal Utility Service (Official Gazette of RS No. 45/2005, No. 45/2006) [7,8].

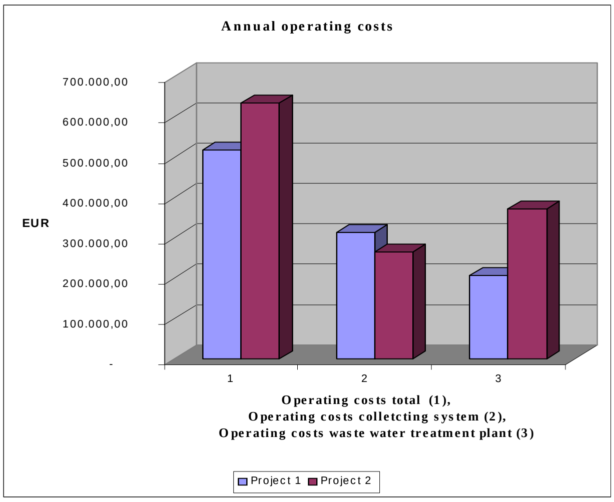

Fig.3: Annual operating costs (cost price) for Project 1 and Project 2

- sources for extraordinary maintenance in expected period could be grants or regular business sources. In case of financing project from regular business the revenue should be higher over a cost price. In our simulation we were increasing the cost price for both projects until the first project reached NPV value zero,
- we planned extraordinary maintenance each ten years.

4 Conclusion

The results leads Project 1 to be more optimal from economical point of view. Project 1 is showing higher investment costs and annual operating costs for construction of collecting system over Project 2, while the total investment costs and related annual operating costs for selected period for Project 1 are lower as for Project 2.

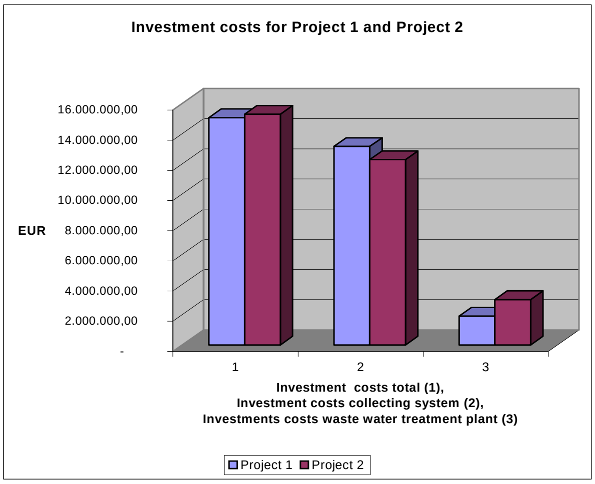

Fig.4: Investment costs for project 1 and Project 2

Cumulative costs of investment and related operative costs for Project 2 (assuming several waste water treatment plants) are much higher than for Project 1 (Figure 3 and Figure 4).

Capitalised costs calculation for both projects is presented in Figure 5.

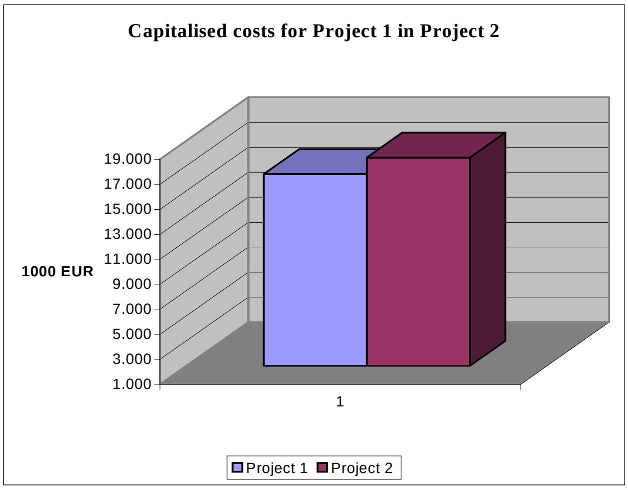

Fig.5: Capitalised costs for Project 1 and Project 2

Lower capitalised costs on present worth confirms Project 1 to be decided. In comparison with Project 2 the capitalised cost for Project 1 are lower for 7,5%.

Considering incomes to be equal to operating costs and with extraordinary maintenance assumed to be realized each ten years, NPV is negative for both projects. To achieve the required results for NPV to be at least zero or minimum positive value we have chosen following possibilities:

- extraordinary maintenance realized by repeated grants or by Environmental protection taxes, which is paid by all consumers and is based on the efficiency of cleaning waste water treatment plant. The income resulting from this tax will be notable lower after finishing the whole system.
- By increasing the cost price.

The Project 1 is reaching the positive NPV with the increase of the cost price for 21,1%, while Project 2 is still presenting the negative value. The comparison of net annual inflows for Project 1 and Project 2 for the increased incomes of 1,211 is shown in Fig.6. Pulse differences in negative direction present the extraordinary maintenance in periodical intervals.

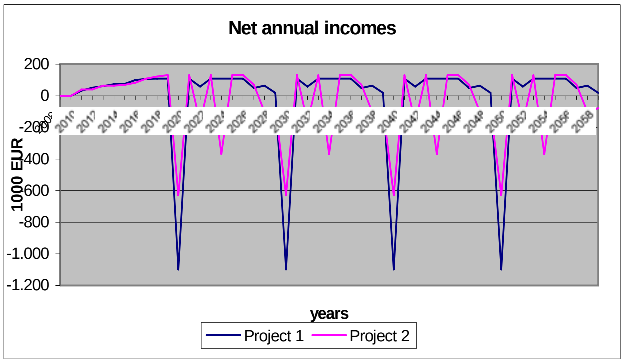

Fig.6: Net annual incomes for Project 1 and Project 2

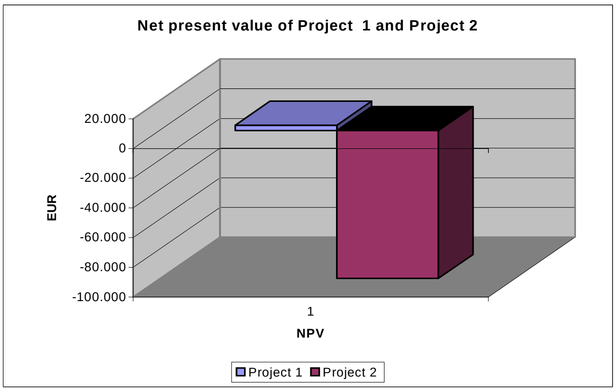

Fig.7: Comparison NPV for Project 1 and Project 2 for period 50 years and by increased incomes of 1,211

Including the extraordinary maintenance in Price of public utility service and increasing the cost price for 21,1% is proved to be an acceptable source of financing. By achieving the capacities of waste water treatment plant by 90% (7380 PE) and normative consumption of drinking water per inhabit (50 m^3/inhabit/year) the Price of public utility service for discharging and cleaning of waste water should reach the value of 1,7 EUR/m^3.

Symbols:

PE	population equivalent,
C_t	net cash flow (the amount of cash) at that point of time
C_0	the capital outlay at the beginning of the investment time (t=0)
r	discount rate
t	time of the cash flow
n	total time of the project
L	salvage value (in our case = 0)
B_0	first cost of asset
C	annual operating cost, including maintenance and normal repairs
$(A/F_{u,n})$	sinking fund factor.

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