EVALUATION OF INVESTMENTS BASED ON RENEWABLE ENERGY SOURCES – FOCUSING ON ECONOMIC ASPECTS

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We can expect more and more investments in renewable energy industry sector. The analyses used in practice focus mainly on the technical aspects. From the point of sustainable development it is very important that studies and investigation concerning implementation should be more diverse. The aim of this study is briefly summarise the economic (mainly financial and accounting) aspects that should be taken into consideration in different analyses and feasibility studies to ensure that the best and most useful solutions should be chosen.

**Keywords:** renewable energy, Net Present Value method, Capital expenditure, Book-cost

**Introduction**

The demand for electricity has increased recently in a nearly unimaginable way. In modern societies households, institutions and factories depend heavily on electricity. This huge increase in demand is only limited by the facts which show a constant and rapid decrease in the amount of non-renewable energy resources.

Meeting the increasing demand is especially difficult since the majority of power plants in Hungary are outdated. It has become more and more important to enhance the present capacity and replace the items that cease to operate. On the other hand, this situation creates an excellent opportunity for Hungary to fulfil the proposals made by the European Commission at the beginning of 2008. Our country took on the obligation to combat climate change through the application of renewable energy sources. The proposals aim at reducing the emission of greenhouse gases by 20% in the European Union, at the same time increasing the proportion of renewable energy sources up to 20% in the whole energy sector by 2020.

As part of the proposals Hungary has to increase the proportion of renewable energy sources up to 13% of its whole energy consumption. Although our proportion is only the third lowest among the EU nations, and under the European average of 20% (Sweden, though, undertook 49%), we have to implement significant structural changes to achieve this aim. Although the
The application of renewable energy sources is only in its initial phase in Hungary and is supported mainly by EU funding, it is encouraging that there is increasing interest in these type of energy sources from the government, companies and individuals.

Based on the above-mentioned reasons we can expect increasing investment in the renewable energy industry sector. The analyses used in practice have mainly focused on the technical aspects. From the point of view of sustainable development it is very important that studies and investigations concerning implementation should be more diverse.

The aim of this study is briefly summarise the economic (mainly financial and accounting) aspects that should be taken into consideration in different analyses and feasibility studies to ensure that the best and most useful solutions are chosen.

1. Financial evaluation of investments based on renewable energy sources

In terms of finance we can define projects as investments in real assets for a period of more than one year. As investments based on renewable energy sources are long term, they should be handled as strategic decisions and special attention should be paid to their returns.

When we investigate return and profitability, 3 analyses should be made:
1. Absolute change in the owners’ assets
2. The calculation of the discounted rate of return
3. The revenue of an investment.

1.1. Absolute change in the assets during implementation

Due to its advantageous features Net Present Value method (NPV) seems to be the most suitable to show these changes. (In some approaches it is also known as Discounted Cash Flows method). The net present value is the sum of the present value of future money and present money. In equation:

\[
NPV = -P_0 + \sum_{t=1}^{n} \frac{C_t}{(1 + r)^t}
\]

where is a rate suitable to discount future cash flow, that is the alternative cost of the capital, “P_0” is present capital expenditure, “C_t” is the value of future cash flow due at a given time (t).
When we evaluate an investment economically it is not the calculations that mean the trouble but the identification of their parameters. Collecting the necessary information is the result of coordinated work done by several experts, but the main principles should be clear to all participants. As the model shows an increase in assets, for cash flow we should consider only the extra revenue and expenditure arising during the term of the investment.

After completing a project it can occur that certain earnings are not gained yet; these are considered as opportunity costs among the expenditures. But it also might happen that certain costs are not paid after completion of the project; these should be listed among sources of revenue.

In practice there can be several expenses that might or might not be listed in the cost-efficiency balance. There are expenses – called sunk cost – which come up regardless of the investment decision, which should be paid even if we decide or reject the project. Examples of this type can be research and development costs, pre-paid licence fees, expenses of market research and planning of the investment. In practice it can sometimes be demanding to separate these costs from the cash flow.

We would like to illustrate the possible difficulties in assessment through the examples of two companies.

Let us suppose that Company A is considering a brown field investment based on the above-mentioned economic and environmental reasons. It wants to replace its existing coal-fired traditional power plant with a new one that uses biomass and low-sulphur coal. After installing the new blocks the old ones will be shut down, but the service blocks will remain in operation after the resurrection. There are EU funds available to realise the project, and the application instructions contain the details of the support and the list of accountable costs. Among the latter there are the costs of the feasibility study, marketing research and impact study. The company has already chosen the optimal technical solution and wants to make the decision based on economic considerations.

In the second example, Company B has a site near a landfill, which was recultivated last year using support from EU funds. At the same time a new method was introduced there: the released landfill gas is eliminated by flaring. Instead of flaring the landfill gas it seems possible technically to use it in the company’s boilers, where energy is currently generated by burning natural gas. In order to use landfill gas to generate heat in boilers a gas engine is to be installed and the burners should be replaced. Due to this innovation heat generation is favourable from both an energetics and an economic point of view. The company would like to investigate this matter further from an economic point of view, as well.
To solve the problems both companies have to apply the above described NPV model. The companies should collect the necessary capital expenditure and compare them to the present value of cash flows at the given time.

To evaluate investment alternatives we have to make several economic calculations. To calculate capital expenditures we need the costs of new capital goods (among others: turbines, turbine electrical control, boiler room, CFB boilers, generators, cooling towers, soot isolator, wagon unloading building, soot silo, limestone silo, clinker silo, coal crushing equipment, coal supplier belts, coal pickup instrument, boiler start up, electrical clearance, transformers, slurry casset, office blocks, workshops, storage buildings, control equipment) and that of the old tools which need resurrection.

After that the costs of dismantling and transport of productive devices which will not be used any more (e.g. old boilers, boiler room, old turbines, cooling tower, cooling water system, electrical control, electrical equipment, generators, fuel transport system etc.) should be added to the expenditures. If any of these assets can be sold, then the income should be listed as reducing the expenditure item in our calculations.

Besides these obvious items, there are some others that should be taken into consideration when making economic calculations. There is no need for Company A to buy a new place of business, as they can use their own current site, so there is no purchase cost. But they should consider the opportunity cost (the price for which the site could be sold) as an expenditure. Although the costs of feasibility and other studies are usually eligible costs in the case of EU applications, if we use NPV calculation we should consider them as sunk costs, as they are pre-paid and proceed the investment.

The table relating to the previous example shows that the capital expenditure category can be different depending on the aspect from which we investigate the investment: accounting, investment economics or project-financing. (The straight line means direct, the dot line means indirect connection.)
While in our return on investment (ROI) calculations there is only one line for capital expenditure, from an accounting point of view each tangible asset should have a cost. It will be especially important to define depreciation in the
current year, which also should be listed in ROI calculations. To find the exact costs it is essential to calculate the overall costs and overhead, which are necessary for appropriate pricing of the energy service.

After calculating capital expenditure the next step is the definition of the *price revenue and the costs*. The revenues - in case of such investments – derive from below costs, availability and energy sales. These values can be set by technical and economic calculations.

The price of fuel accounts for the majority of *variable costs*, but costs such as the disposal of slurry, maintenance, downtime and re-start, and the purchase of chemicals also should be listed here. As the company is to replace its former plant, which would probably have had higher emissions, it is quite possible that savings can be achieved in this field, which should be listed as revenue. In the project of Company B savings in natural gas are likely to appear, which should be counted as revenue.

Among the *fixed costs* we should list the warranty costs of producers and other costs of maintenance.

An important step in NPV model is to make the cash flows comparable, by using the technique of discounting. We need to define a discount rate, which is the weighted average of the ratio of sources and the expected yield:

\[
WACC = r_e \times \frac{E}{D+E} + r_d \times \frac{D}{D+E} \times (1-T_c),
\]

where "\(r_e\)" is the expected yield of own capital, "\(r_d\)" is the expected yield of debts, "\(E\)" is the value of own capital after taxation, "\(D\)" is the value of debts after taxation, "\(T_c\)" is corporate tax rates. As figure 1 shows, the financial resources and their proportion influence the value of discounting.

It is also very important to define the *duration time of investigation*. The following factors should be taken into consideration among others: useful life time (physically and economically) of the investment, product market forecasts, availability of financial sources, reliability of supplier relations, unchanged state regulations etc. In our investigation the duration time is defined by availability of resources (landfill gas) and technically useful lifecycle.

After estimating and/or defining the necessary technical and economic data the calculations can be made. Usually an investment is proposed to be approved if NPV>0, if there are more investments, we choose the one which has higher NPV values.
1.2. The calculation of the discounted payback

In the evaluation of investments based on renewable energy sources it can be especially important, from what time on will the investment make revenues, that is, what is its rate of return. By the calculation of this the time value of money is not taken into consideration and currencies from different dates are compared directly, which results in a deceptive – shorter – payback. A better solution is the application of Discounted Payback model, with the help of which the results will be comparable discounted with the expected revenue.

\[ n \rightarrow P_0 = \sum_{i=1}^{n} \frac{CF_i}{(1+r)^i}, \text{ where} \]

\( P_0 \) is the cost of the investment, \( CF_i \) is the cash flow due in the \( i^{th} \) time, \( r \) is the rate of return of the investment, \( n \) is the expected revenue. The investment is acceptable, if the discounted rate of return is shorter than the expected rate.

1.3. The revenue of an investment

There are more opportunities to define the revenue of an investment. The easiest way is the Profitability Index, in which the Gross Present Value (Net Present Value + capital expenses) of the investment has to be divided with the initial capital expense. This shows, how many times our invested money will increase by accepting the investment. It should be applied, if the company would like to choose from more technologically similar programs with different NVPs and can only choose one because of the limited sources. On financial grounds, it has to choose the one with the highest PI value.

2. The risk analysis of investments

The NPV method assigns specific money flows to certain times of the project’s duration. Then, it determines the project’s neat present value by discounting these money flows on the basis of their distance from present. In a world like this, certain yearly money flows can take up only one determinated value. But, since we can not be sure about the future, events can have several possible outcomes in practice. Therefore, the NPV model can also be interpreted as a kind of estimation of the future. It is possible that our estimation will be wrong. It is also possible that our estimation is correct, but due to changes in the nature of economy, something different will happen in reality instead of the correctly estimated value.
During the evaluation of investments based on renewable energy sources possible risks have to be taken into consideration.

![Diagram showing types of risks to be considered when making investments]

Break-even analysis follows the inverse logics as the sensitivity analysis; in this case we are looking for the value of parameters—also with ceteris paribus analysis—at which the value of NPV will be 0. With the help of this method break-even points of different factors can be determined, and intervention thresholds can be set.

Besides the aforementioned analyses, we have the opportunity for scenario analysis, with the help of which not only the change of one, but also the collective change of more factors can be numerically defined.

With the help of these simple methods it is possible to define the risks numerically, and the disadvantage is that the creators of the models and the
decision-makers can become aware of the critical points of an investment and can react to them in a well-prepared way.

3. The application of real option models in the evaluation of investments

In some cases it is possible that a company executes further investments based on renewable energy sources (e.g. construction of new power plants) in case of the success of previous projects. As the later investment depends on the current realization decision, the realization of the future cash flows is uncertain and the later execution is not an obligation, but only an option, so the problem can be solved with the help of real options, with the Black-Scholes model. The primary application field of this model is the pricing, but can also be used to analyse investments.

The equations of the model are the following:

\[
c = S \cdot N(d_1) - X \cdot e^{-r_f \cdot t} \cdot N(d_2)
\]

\[
d_1 = \frac{\ln \left( \frac{S}{X} \right) + r_f \cdot t + \sigma \cdot \sqrt{t}}{\sigma \cdot \sqrt{t}} + \frac{\sigma \cdot \sqrt{t}}{2}
\]

where in case of the evaluation of an investment „c“ is the value of the investment, „S“ is the Gross Present Value of the investment, „X“ is the expenses in current price, „r_f“ is the safe rate of interest, „t“ is the duration of the opening of the investment opportunity, „\sigma“ is the volatility of the Gross Present Value, „N(d1)” is the value of the standard normal distribution at d1 place, „N(d2)” is the value of the standard normal distribution at d2 place. Similarly to the previous equations it is not the calculation that causes trouble, but the identification of parameters, which should happens as mentioned before.

4. Summary

However the evaluation of investments based on renewable energy sources is primarily a technical problem, economic, and especially financial and accountancy questions and connection points have to be taken into consideration. The analyses of projects based on these aspects have more difficulties, but after the clarification of the problems in question it is possible to analyse them properly. By the economic calculations it is not the calculations themselves that cause difficulties, but the identification of the parameters within.

As we have shown, there are some very similar concepts, but they are just similar, not the same. And after our right analysis we can calculate the real value of our investments to ensure that the best and most useful solutions are chosen.
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