DOCTORAL (PhD) THESIS

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ECONOMIC STUDY OF WIND AND HYDRO POWER AS RENEWABLE ENERGY SOURCES

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KAPOSVÁR
2007

1 PRECEDENTS OF THE RESEARCH, SETTING UP THE OBJECTIVES

The intensifying and more and more frequent global catastrophe due to the destruction of natural sources clearly indicate that the present industrial behaviour and consumer habits can not be kept in the future or only with the help of dissimilar technologies and methods.

Not only the negative effects of environmental pollution can be avoided by the appearance and spread of renewable energy sources, but they open an opportunity to reduce or avoid the importation of more and more uncertain and expensive energy sources – which mean an increasing problem both in Europe and Hungary.

Thus, it is to be achieved that the individual, the company and the society could consider the environmentally sound or destructive possibilities and, with the help of market stimulants, fundamentally exclude the implementations that can have a negative effect on the nature. Public education can play an important role in this attitude formation.

The aim of this thesis is to prove the profitability of concrete renewable projects in different scenarios through a financial-mathematical calculation model.

In my opinion, the success of the long term energy policy depends on how much time it is necessary to cut down the market advantages of conventional energy sources caused by negative externalities. The statement of these non-internalized expenses and the calculation of their rate are not small tasks for financial planners.

A detailed valuation of two investments – which have the same goals but built on different, fossil and renewable sources – with similar methods, can throw a light on the differences appearing on the sides of the returns and the expenses. With the equalization of these the investments built on renewable energy sources can gain a more advantageous market position.

2 MATERIAL AND METHOD

Steps of calculation of the profitability analysis of the projects:

1. Collecting technical data
2. Classifying technical data
3. Transforming the classified data into financial/accounting data
4. Demonstration of the appropriate ratios and profitability statement with the help of financial-mathematical methods
5. Comparison of results at different scenarios of the projects

2.1 Collecting and classifying technical data

Due to the novelty of the topic in Hungary there are no comprehensive profitability analyses among the Hungarian technical literatures about the use of the renewable sources. A reliable valuation of the investment can always be made by considering the local endowments. According to these, in chapter ”Results” economy studies of some home projects, realized during the research, will be presented.

Each of the producing enterprises that gave data about the investment, the production, their expenses and the circumstances of business, made a condition of giving data without publishing the exact place and name of the project as the given data make it possible to inspect the profitability of the enterprise. At the same time, these pieces of information are essential to reach the aims of an economy study of the home application of the renewable sources, outlined in the introduction chapter. The primary data were collected on lectures, conferences, and discussions that dealt with this topic.

2.2 Transforming the classified data into financial/accounting data

For carrying out the economy study it is essential to know the applied technology. Mainly, the engineers of the given plants gave help in it. During processing the technical information the necessary pieces for constructing the model should be selected. They are transformed into economic data by elaboration groups of expenses and returns.

Calculation of Cash Flow

Revenues (nominal)
- Operating expenses
- Interest costs
- Principal repayment
- Corporate tax

FREE CASH FLOW

Tax Calculation

Revenues (nominal)
- Operating expenses
- Other expenses
- Interest cost
- Amortization

Tax base

Tax (16%)

2.3 Comparison of the results

Valuation of the investments based on renewable energy sources demands high accuracy, as, considering every energy source and the investments connected to them, different conditions, technologies and – according to them – different cashflows are characteristic.

Hence, from the demonstrated financial-mathematical ratios the profit-annuity, the dynamic payback period and the internal rate of return can be used as bases of the comparison. For the sake of a better transparency, the results can be illustrated graphically, where the development of the net present value plotted against time can be demonstrated with the help of diagrams.

3 RESULTS

3.1 Utilization of wind power

The base of the modelled project is an Enercon E-70 device with 2 MW capacity.

The expected generated annual electricity can be calculated by the capacity curve of the machine.

The expected duration of the velocities of wind given in hours and the capacity according to the velocities of wind defines the expected amount of the generated annual electricity in the different velocities of wind in kWh. With their summation, presumably with 6,34 m/s average velocity of wind a year, 4 million kWh electricity can be generated.

Scenario 1. Valuation of the investment without considering the negative taxes

If the investing company works only on this project, and it does not have the opportunity to reduce its other obligations to pay taxes with the negative taxes in the first years of the investment, only 0 tax payment can be considered in the calculation.
The results show that the value of the yearly returns of the constant cashflows (annuity) is the highest in the case of choosing an optimal, 20-year investment period. In the case of a 20-year investment, the project is returned in the 15th year, and the present value of the investment is 383 thousand Euros.
Besides, the internal rate of return of the investment is 21%, which means that the investment will have a positive present value until the profitability rate of other similar investments on the market exceeds this value.

Scenario 2. Valuation of the investment considering the negative taxes

In this case the negative taxes, generated by the depreciation and the obligation of interest payment, can be considered as sources of returns, since they can be used for reducing other tax payments.
From the results it can be stated that the optimal investment period (annuity) is 20 years in this case as well. The increase of free cashflows, due to considering the negative taxes, reduces the payback period of the project to 14 years, and the present value of the project with these conditions exceeds 427 thousand Euros. The internal rate of return is 21%.

Scenario 3. Valuation of the investment considering the possible sales of the negative taxes and emmission quotas

The cashflows attainable by the trade of the carbon dioxide quota, started in January, 2005, can also be considered as sources of returns, “as the amount of CO_2 that was not discharged from the electricity generation from renewable sources is marketable on the international market”[1].

The market price of the quota, which gives the right to discharge 1 ton of carbon dioxide, is constantly changing under the demand and supply, and is now around 1-10 Euros. I based my calculations on 5 Euros/quota sales price and scaled the amount of quotas given by the utilization of biomass of the Bakony Thermal Power Station.

It is determinable by the values that with the 20-year investment period (annuity) the payback period continues to be 14 years, however, with the internalization of the externalities applied this way, the present value of the project is approximately 442 thousand Euros. The internal rate of return is 21%.

As this is the most probable scenario, it is worth carrying out the examination of sensitivity in case of an adverse change of the take-over price of electricity. According to the calculations, the net present value of the investment can tolerate the 16% decrease of the take-over price, in this case it takes a zero value by the end of the 20th year.

Scenario 4. Valuation of the investment in case of the change of a low capacity wind power plant

[1] Légáram Foundation (2004)

According to this scenario the investment of the 2 MW machine is started with the change of a 600 kW wind power machine working at the same place for 13 years. It means that the expenses and savings, arising due to the change of the existing 600 kW machine, are also taken into account. According to the results, in the case of the optimal 20-year investment period, the investment is returned in the 20th year and the present value of the investment is 9 thousand Euros. Being an additional investment, it means that after 14 years of using it is better to change the lower capacity machine to a higher capacity one. The internal rate of return is 13%.

Scenario 5. Valuation of the investment in case of a foreign project

Provided that the above project is realized outside Hungary, for instance in Austria, it has to be calculated with a different take-over price and a different production value. With the lower Austrian take-over price – 7.76 cent/kWh (Boltz, 2007) – the project is returned in the 12th year and its present value is almost 2,9 million Euros. The production of the wind power plant can be planned with 5 million kWh generation of electricity a year.

3.2 Utilization of water power

In the project of the River Rába there are 8 Francis turbines, each with a nominal capacity of 50 kW.

If the technical features and the meteorological facilities of the place of the water power plant are known, the expected amount of the generated annual electricity can be calculated. The expected period of the water outputs given in hours and the capacity belonging to them defines the expected amount of the generated electricity by the different water outputs in kWh. With their summation, presumably with 5,44 m3/s average water output a year, almost 1,5 million kWh electricity can be generated.

Scenario 1. Valuation of the investment without considering the negative taxes

If the investing company works only on this project, and it does not have the opportunity to reduce its other obligations to pay taxes with the negative taxes in the first years of the investment, only 0 tax payment can be considered in the calculation.

The results show that the value of the yearly returns of the constant cashflows (annuity) is the highest in the case of choosing an optimal, 20-year investment period. And in the case of a 20-year investment, the project is returned in the 15th year, and the present value of the investment is 129 thousand Euros.

Besides, the internal rate of return of the investment is 21%.

Scenario 2. Valuation of the investment considering the negative taxes

In this case the negative taxes, generated by the depreciation and the obligation of interest payment, can be considered as sources of returns, since they can be used for reducing other tax payments.

From the results it can be stated that the optimal investment period (annuity) is 20 years in this case as well. The increase of free cashflows, due to considering the negative taxes, reduces the payback period of the project to 14 years, and the present value of the project with these conditions is more than 153 thousand Euros. The internal rate of return is 22%.

Scenario 3. Valuation of the investment considering the possible sales of the negative taxes and emission quotas

The possibility of returns from trading the emission quota, mentioned already in chapter ”Wind power”, is also available in the case of water power.

It is determinable by the results that with the 20-year investment period (annuity) the payback period continues to be 14 years, however, with the internalization of the externalities applied this way, the present value of the project highly exceeds 158 thousand Euros. The internal rate of return is 22%.

As this is the most probable scenario, it is worth carrying out the examination of sensitivity in case of an adverse change of the take-over price of electricity. According to the calculations, the net present value of the investment can tolerate the 17% decrease of the take-over price, in this case it takes a zero value by the end of the 20th year.

4 CONCLUSIONS

Due to the constant decrease of the reserves of fossil energy sources – according to the forecasts they will last for 40-50 years – and their extraction becoming more and more difficult, the market prices of the conventional energy sources and their products will increase, giving space to the already competitive green technologies and products.

Of course, the conventional technologies, because of their great influence on the world economy, as it was mentioned earlier, can be drawn out from the world economic processes only by gradual reduction and the parallel appearance of substituting technologies.

So, considering the energy sector, first we have to map the future needs, then, after defining the energy potential from the renewable energy sources, we can set up the energy program concerning the region, considering the local natural, economic and social endowments.

In the course of integration of the systems using renewable energy sources into the electricity network, we must not leave out of consideration that their production is highly dependent on meteorological factors. Therefore, the fluctuations of both the demand and the supply can cause problems in the area of system regulation.

The fluctuation of the supply side of the electric energy system can increase by the usage rate of the renewables depending on the weather, however, as the necessary energy can be produced on the whole, it is only this time-shift of the production that is to be solved. Pumped-storage hydro systems can mean a way out for storing electricity in Hungary, since beside its big capacity potential it can be installed quickly and its running expenses are relatively low.

5 NEW SCIENTIFIC RESULTS

- The expected profitability of the investments built on the use of wind and water power – the green projects outlined in the study – can be demonstrated with the help of financial mathematical devices, by the model presented in the thesis.

- The capacity of the renewables put in the Hungarian electricity network is dependent of the weather by their nature. The joint usage of the wind and water power can be applied as a suitable combination for their levelling, with building storage capacities. Through the standardization urged by the European Union, it is also worth considering to take part in building and using storage capacities outside the Hungarian borders.

- The urge of the reduction of discharging harmful materials, beside the decrease of the market prices of the products produced from renewable energy sources (e.g.: electicity), the external costs appearing due to the use of fossil energy sources can make it reasonable to consider them in their market prices.

- Utilization of the water power collaterally gives good chances for the development of the agricultural water utilization, which has been neglected so far, and also for the reduction of fluctuation in productivity because of drought.

6 PROPOSALS

The thesis emphasizes the importance of the consideration of the future in connection with the Hungarian power generation. The increase of the usage rate of the renewable energy sources, like the wind and water power, is inevitable for reaching a sustainable development for the sake of the next generations.

The main aim of the thesis is to prove – through the economy study of power plants built on renewable energies – that these investments are not only sustainable but also profitable.

Considering the externalities caused by the production, expenses accompany the use of the environmental essentials, thus the end product produced in a pollutant way costs at least the same but probably even more. Of course, it is not the only way to spread environmental friendly technologies but in the short run, this economic consideration can bring a complete solution.

For the valuation of a wind or water power plant project, the market based cost/profit analysis generally used in economic sciences is appropriate, as it is not necessary to make a financial distinction between a green and a normal project. To be more exact, as long as the economic policy aims at global internalization of external expenses and at the same time the calculations of the model take these expenses into consideration, the above statement is appropriate.

It was proved that the profitability of the examined projects is not inferior to the return of alternative possibilities on the market. In case of a favourable scenario, the wind power plant produces a 14-year payback period, while in case of an adverse scenario (10% decrease of the take-over price), its payback period is 17 years.

The payback periods of the water power plant project, in the same cases of scenarios are 13 and 17 years.

According to the results it can be acknowledged that, although the starting investments of the ”green” projects are high, considering the saved external expenses compared to the fossil energy generation, they reach an appropriate global profitability.

As with every other investment, in the case of renewable projects macro economic advantages appear as well, such as giving employment possibilities, rural development, rise in GDP and decrease of energy imports.

7 PUBLICATIONS OF THE TOPIC OF THE THESIS

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Varga Zoltán - Pálosi Dániel (2006): Nachhaltigkeit im Energiesektor am Beispel thermischer Biomasseverwertung in Kraftwerken. Acta Scientiarum Socialium, (21-22) 157-166

Varga Zoltán - Pálosi Dániel (2007): Allokationsstörung durch Externalitäten. Acta Scientiarum Socialium, (24) under publication

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Pálosi Dániel (2007): Érdemes-e korszerűbbre cserélni a szélerőművek berendezéseit? Acta Oeconomica Kaposváriensis, **1**, (1) under publication