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COST-EFFECTIVENESS ANALYSIS OF LONG-LIFE INVESTMENTS ON EXAMPLE OF POLISH WIND POWER PLANTS

Abstract
The authors present criteria availed in taking investment decisions in wind energy investments. Macroeconomic aspects of Poland wind energy sector/industry have also been described. The article is based on numerous press and scientific articles, as well as reports. Due to the fact that investments related to construction of a wind farm are characterized by a long payback period, the authors recommend discount methods as the best method of profitability assessment. The authors suggest using the concept of weighted average cost of capital to determine the discount rate. They recommend a sensitivity analysis and value at risk to assess the impact of changes in prices of certificates of origin prices on productivity of wind farms.

Key words
wind energy, investment profitability, discount methods, criterion of profitability

Introduction

Poland energy sector/industry including wind energy segment seems to be particularly interesting for foreign investors. Depreciated infrastructure, steady growth in electricity demand for households and the economy as a whole create many investment opportunities to be exploited in Poland over the next years. An investment in wind energy segment is not only a chance for foreign entities, but primarily for Polish economy. Owing to development of this segment in subsequent years production of zero emissive energy will be possible and Polish energy security will improve. Multimillion investments will be a significant source of income for state budget, and have a positive impact on a creation of new jobs.

Literature Review and Hypotheses

The wind energy sector/industry in Europe

During past 12 years in Europe, an increase from a level of 3.2 GW to almost 12 GW of installed capacity in wind power plants was recorded annually [1]. This trend is shown in Fig. 1.

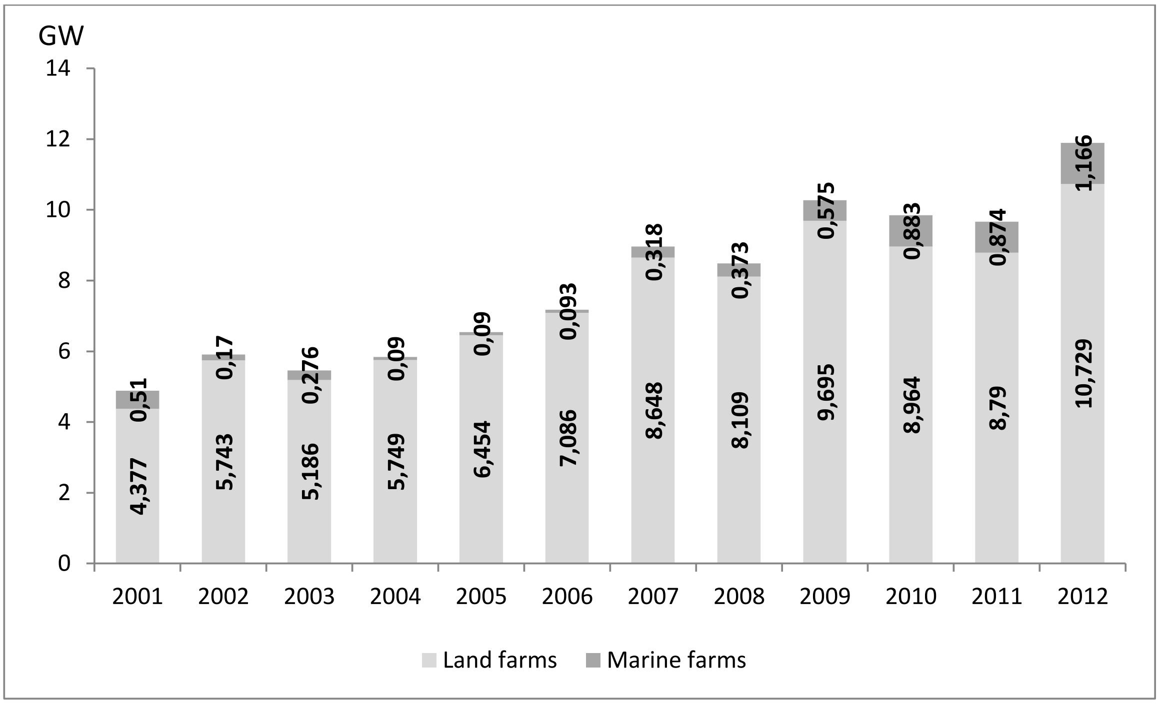

Fig. 1. Investments in wind power in the years 2001-2012 in Europe
Source: own study based on [1].

Currently a total capacity of about 106 GW of wind power is installed in Europe (Fig. 2). The regular leader on energy market is Germany whose share in the European wind energy equals 30%.

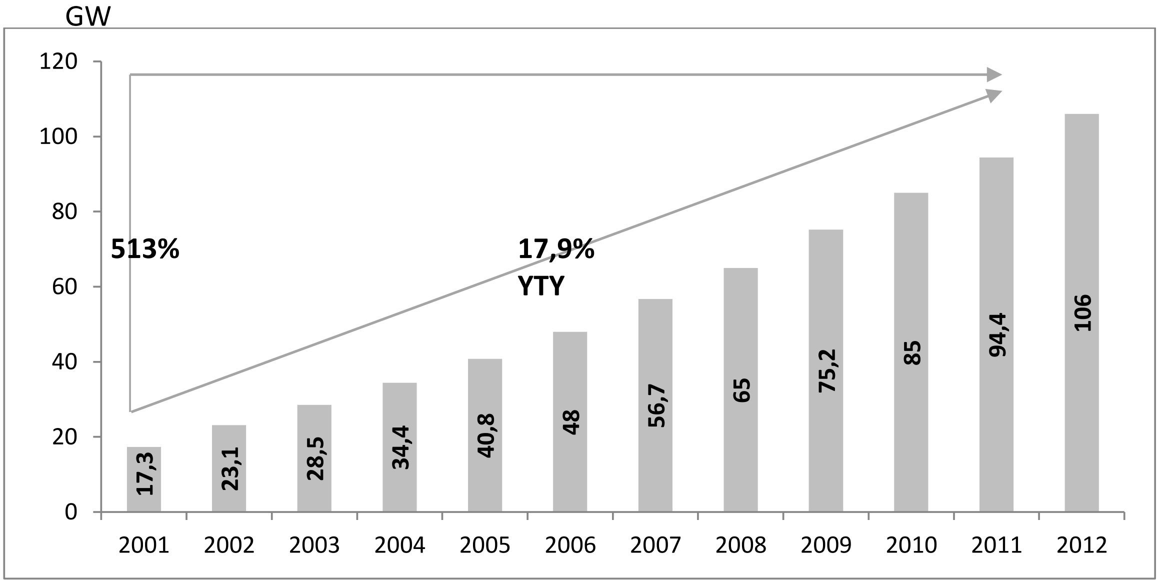

Fig. 2. Total wind power in the European Union
Source: own study based on [1].

According to estimates, owing to currently existing installations about 231 TWh of electricity can be generated, which covers 7% of total energy demand in Europe. In 2011, the figure was less than 6.3%. Denmark with its (27%) of energy produced by wind power is the country with the highest ratio of meeting a demand for electricity. The subsequent places are taken by Portugal and Spain, where value of this ratio is 18% and 17% respectively.

Currently in Poland there are 890 installations that produce electricity by wind power with a total capacity of 3727.03 MW (as of 31.08.2014) [2]. This means that in the first six months of 2013 Poland already reached the level envisaged by the Ministry of Economy, which was to be reached at the end of 2013 [3]. Undoubtedly, over the last few years a steady and stable growth in the number of wind farms has been observed (Fig. 3).

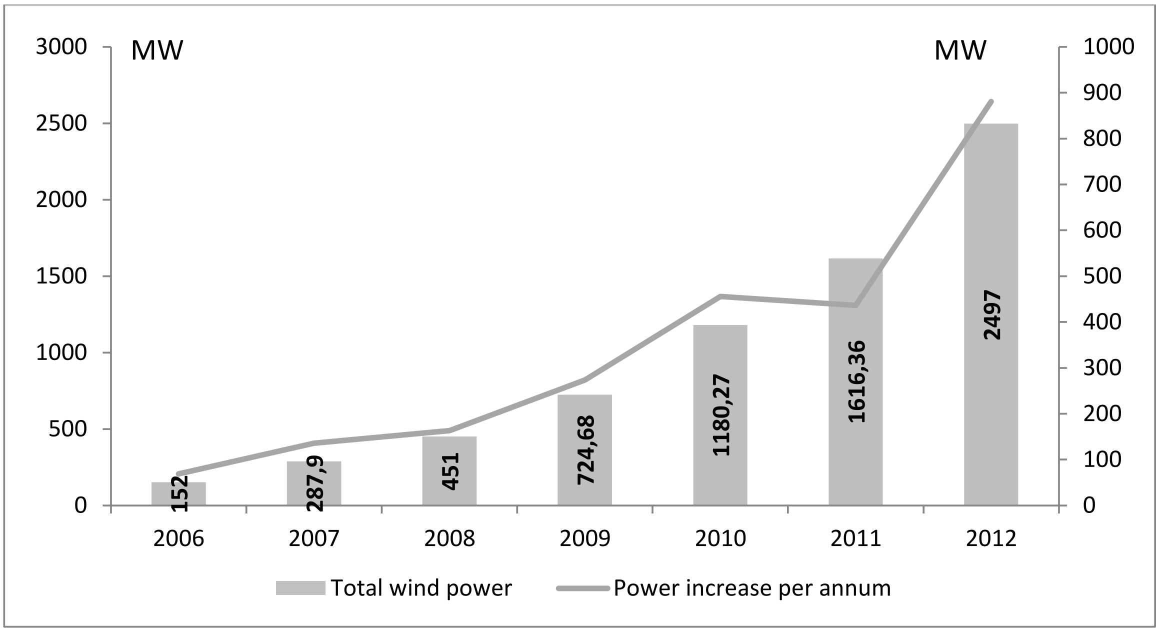

Fig. 3. Installed capacity of wind farms and growth rate of installed capacity in Poland
Source: own study based on [4].

Particularly rapid growth of installed capacity occurred in 2012 and amounted to 880 MW compared to 436 MW in 2011, which may be due to the fact that investors wanted to complete their projects before the end of 2012 in order to benefit from old support systems.

Wind energy is the fastest growing segment of renewable energy in Poland. Owing to stable growth of capacity, wind power represents nearly 60% of all green energy market in Poland in terms of installed capacity. Currently operating wind farms produced 3 126 GWh of electricity in 2011, which allowed to meet a demand of almost 2% of the total demand for electricity (in 2012 4 026 GWh (3%), in 2013 5 895 GWh (4%)). In 2004, this figure was only 0,1% [4].

Poland is a country with favorable climatic conditions for conducting activities related to production of electricity using wind. Currently, owing to development of technologies to manufacture wind turbines having an impact on lowering minimum wind speed at which it is possible to produce electricity, nearly two thirds of Poland territory is characterized by appropriate wind conditions. The most attractive areas are located in the north-western part of Poland, where wind speed can fluctuate within 10 m/s [1]. Favorable conditions are also along the coast of the Baltic Sea, and in Warmia and Mazury province. Marine areas are excellent investment zones. It is estimated that about 3600 km^2 area of the Baltic Sea may be used for a construction of offshore wind farms [5]. In 2012, off the coast of Europe, new wind parks with a total power of almost 1.2 GW came into existence. However, no project of the type has been implemented by now on Polish territorial waters [1].

Macroeconomic aspects of wind energy sector development in Poland

In 2018 it is planned to add first offshore wind farms with a power of 500 MW. In subsequent years there will be a steady growth in power of offshore wind farms at a level of 500 MW a year so that total capacity is to amount to 1.5 GW in 2020. The amount of incurred expenses associated with a construction of wind farms off the coast of the Baltic Sea is estimated to be 20.5 billion PLN (5,03 billion Euro). The total value of investments in the wind energy sector in the period of 2013-2020 will amount to over 80 billion PLN

(19,62 billion Euro). Almost 21.6 billion PLN (5,2 billion Euro) will be invested in Poland. These are the connection costs, financial services, installation of turbines or internal construction of infrastructure [6].

Capital expenditures in the wind energy sector are a significant part of all expenses allocated for investments. In order to illustrate the above-described trend a value of investments in 2011 in various sectors of Polish economy was listed (Fig. 4).

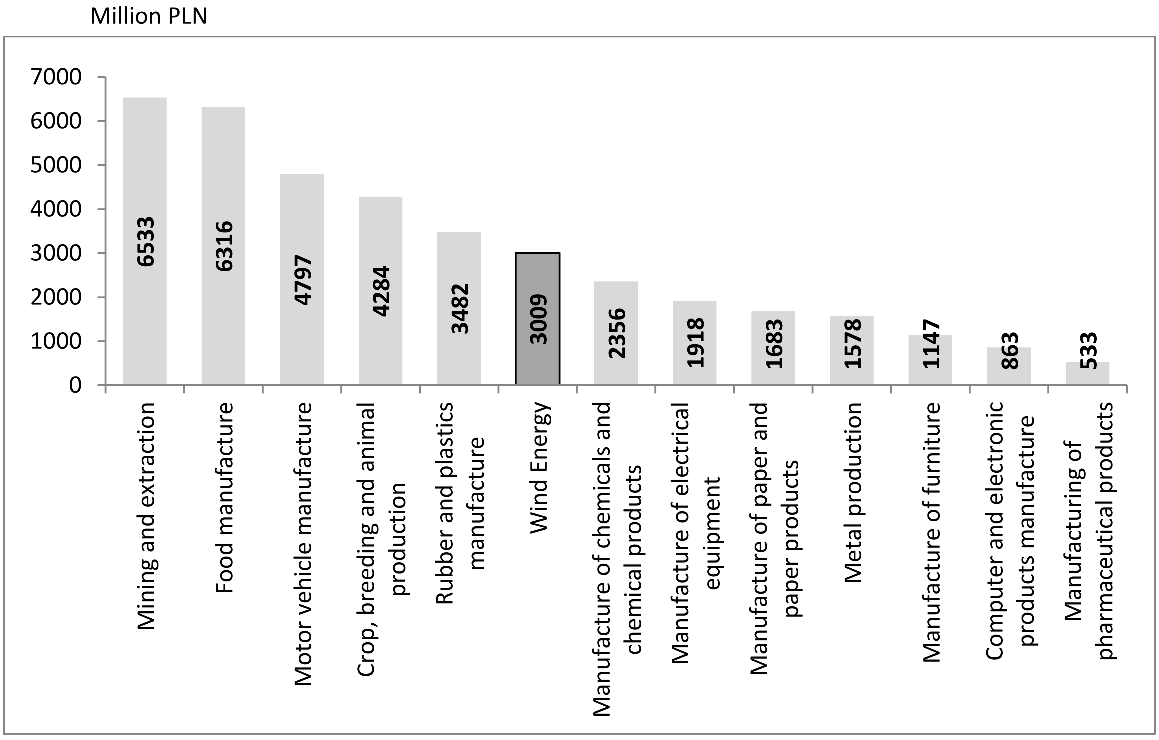

Fig. 4. Investment expenditure in the various sectors of the economy in 2011
Source: own study based on [7].

Corporate income tax from businesses operating in the wind energy sector, in addition to capital investment is an important stream of payments that contributes to Polish economy. The authors conducted the analysis on an amount of state budget revenues from income tax of entities operating in production of electricity from wind in 2012-2020. The following assumption for the needs of this analysis was made: an average value of income tax paid by companies in 2011 amounted to about 98 200 PLN (24 089 Euro) per 1 MW of power. It was also assumed that by 2020 an average value of CIT per 1 MW of installed capacity will not change [8]. In order to estimate future revenues from CIT, energy development scenario was used. The estimated results developed by the Institute for Renewable Energy are shown in Fig. 5.

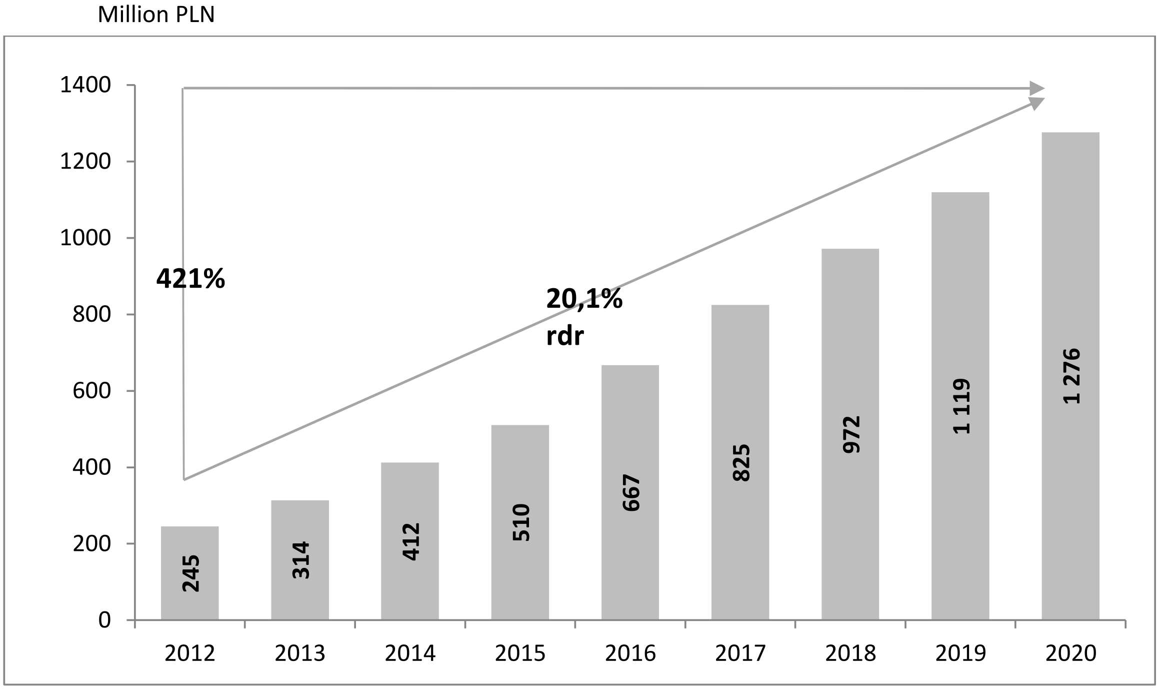

Fig. 5. The projection of revenues from CIT to state budget in 2012-2020 in million PLN (constant prices of 2011)
Source: own study.

Owing to wind farms activity, state budget revenues increased by approximately 245 million PLN (60 million Euro) in the previous year. In subsequent years, there shall be a steady increase in revenues from income tax at a level of about 20.1% per year. In 2019, payments due to corporate income tax will exceed one billion PLN (245 million Euro) and amount to 1 119 million PLN (275 million Euro), while next year they will amount to about 1 276 million PLN (313 million Euro). It should be noted that these values are in constant prices as of 2011.

Method and results

The criteria used in making investment decisions

An investment is a process of allocating funds for reconstruction or increase of property resources [9]. This definition, however, does not fully reflect the essence of an investment and elements that influence on it. Jack Hirshleifer in one of his articles described the concept of investment as "...a current renouncement for future benefits. The present, however, is well known, but the future is a mystery. Therefore, an investment is a renouncement of something certain for an unknown, uncertain benefit." [10]. According to Jack Hirshleifer's definition the following components of an investment can be defined: distribution of cash, time, and risk.

In most cases, property investments cannot be implemented using small funds and this causes mistakes to be very costly. Furthermore, the process of investing capital is better described by a company than a structure of equity or liabilities, which in case of many companies are unclear and seem to be very similar. Bearing the above statements in mind, it is assessed that investments play one of the key roles in operation of an organization. The investments determine a company's position on the market, and decide on its future. First of all, they enable an increase in value for shareholders over a long period of time being the primary objective for operation of any enterprise [11].

Jack Hirshleifer regarded aspect of time and risk as the most important features of an investment. On the basis of his words it can be concluded that simple methods are not the best measures that enable to estimate profitability of a project. This is due to the fact that simple methods do not take into account the concept of time value of money. This concept includes categories of risk and time. In some cases, simple methods are used in the initial phase of the investment projects' selection. This is due to the fact that on the basis of simple calculations, simple methods allow projects that carry the highest risk to be rejected [12]. Due to the fact that investments related to construction of a wind farm are characterized with a long payback period, only discount methods are described in this paper.

In order to make an investment decision using discount methods it is necessary to ensure comparability of measured economic values. For this purpose, a discount rate of the following formula is used:

$$d = \frac{1}{(1+r)^n}$$

where:
r - discount rate,
n - number of periods.

Owing to the concept of time value of money used in the above formula, it is possible to ensure consistency between incurred expenditures and revenues achieved in subsequent years. Estimation of discount rate value is one of the key elements of investment profitability assessment. A discount rate can be determined on the basis of the following concepts:

- A minimum rate of return at which a project implementation will cause an increase in market value of the company,
- Rate of return on risk-free instruments (e.g. government bonds) increased by a risk premium specific to the country,
- A rate of return that can be achieved by investing in similar projects with a similar level of risk to the analyzed project (the so-called alternative rate of return),
- A rate of inflation increased by a risk premium specific to the country,
- Cost of company's capital [12].

It is accepted that a value of a discount rate depends on the policies adopted by the company.

The cost of company's capital

In order to finance projects, companies use a variety of funding sources. A company's management determines how capital structure will look like, while capital owners decide about its cost. The capital owners expect risk and time premiums. If a company uses both forms of recourses: own and foreign, cost of capital is determined as follows:

$$WACC = w_w k_w + w_d k_d (1-T)$$

where:
WACC – Weighted Average Cost of Capital,
w_w – share of equity,
k_w – cost of equity,
w_d – share of foreign capital,
k_d – cost of foreign capital,
T – corporate income tax rate.

As it appears from the above formula, it is necessary to take into account income tax rate while calculating WACC. This is due to the fact that a company being financed by a bank loan is forced to pay interests on its liabilities to the bank [12]. This results in a decreased income, which is taxable. In addition, a company that finances itself with equity might be at risk of loss of own resources. In case of using foreign capital a risk of capital loss is transferred to a lender. The biggest advantage of equity is its lower cost in comparison with foreign capital [13].

Cash flows

Another key element of profitability assessment is valuation of cash flows for subsequent years. They cover both construction and operation periods of a facility that resulted from an investment. Amount of cash flows for a single period is calculated as follows:

Table 1. Scheme of cash flows determination

	Net profit
+	Amortization
=	Operating cash
+/-	Change in liabilities
+/-	Investment in assets
+/-	Investments in fixed assets
=	Net cash (Cash Flow)

Source: own study.

The starting point for cash flows estimation for each period is the net profit achieved by the implementation of the investment project. This point is to be corrected by an amount of amortization. This is due to the fact that amortization is a reporting period cost but the company does not bear expenses (non-cash expenses) in this respect.

Change in liabilities balance should be understood as revenues that a company obtained as a result of incurring credit or these expenses that are associated with repayment of liabilities to the lender. It should be noted that only capital part of a credit installment decreases cash flow. An interest part is taken into account in determining net profit.

During operation of a facility, expenses related to modernization or replacement of machinery are incurred. These expenses are classified as investments in current assets and reduce value of cash flows during the period. The mentioned assets components can be liquidized. Then such a transaction constitutes additional income. Investments in current assets should be understood as expenses associated with an increase in inventories or receivables. As in the case of fixed assets, sale of current assets results in additional revenue [14].

The Net Present Value

Net Present Value, NPV is a sum of discounted positive cash flows generated in subsequent years reduced by discounted expenditures related to a project implementation. NPV is calculated by the following formula:

$$NPV = I_0 + CF_1 \times d_1 + CF_2 \times d_2 + \cdots + CF_n d_n$$

$$NPV = I_0 + \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \cdots + \frac{CF_n}{(1+r)^n}$$

where:
I_o – capital expenditures,
CF_n – cash flow,
d_n – a discount rate.

The above equation assumes that the expenditures are incurred only in year 0. However, many projects are characterized by a negative cash flow in subsequent periods. Thus, more universal is the following formula, which assumes that negative cash flows can occur not only during 0 period.

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+r)^t}, \qquad where$$

CF_t – Cash flow (cash flow in the year t, positive or negative).

Since the NPV is an amount by which a value of a company will increase as a result of an adoption of project implementation, thus interpretation of the NPV is as follows:

- NPV > 0, a project should be implemented,
- NPV < 0, a project should be rejected,
- NPV = 0, a decision on a project implementation should be based on other factors not included in the analysis [11].

In addition, the NPV is a criterion particularly useful in projects analysis of unconventional cash flows.

Profitability Index

Profitability Index is a quotient of discounted positive cash flows and capital expenditures. PI is determined by the following formula:

$$PI = \frac{\sum_{t=0}^{n} \frac{CIF_t}{(1+r)^t}}{\sum_{t=0}^{n} \frac{COF_t}{(1+r)^t}} = \frac{NPV + I_0}{I_0}$$

where:
CIF_t – positive cash flow in a period t,
COF_t – negative cash flow in a period t.

It may be noted that PI criterion is highly correlated with NPV criterion. Thus, when NPV > 0, a profitability index will take values greater than 1, while NPV < 0, a profitability index will be lower than 1. Interpretation of PI index is as follows:

- PI > 1, a project should be implemented,
- PI < 1, a project should be rejected,
- PI = 1, a decision on implementation of a project should be based on other factors, not included in the analysis.

A profitability index criterion is relative and indicates how much revenue one unit of expenditure will generate [11].

Internal rate of return

Internal Rate of Return (IRR) is one of the most frequently used methods in an analysis of both investment projects, as well as securities. For investments characterized by conventional cash flows (capital expenditures are incurred in initial stages, however, in subsequent years only positive cash flows are achieved), IRR is a value of discount rate, where current value of positive cash flows equals capital expenditures. This relation is described by the formula presented below:

$$\sum_{t=1}^{n} \frac{CF_t}{(1+IRR)^t} = I_0$$

This formula can be transformed as follows:

$$\sum_{t=1}^{n} \frac{CF_t}{(1+IRR)^t} = 0$$

This form of the above formula resembles equation that allows for calculating a value of NPV. Thus, IRR determines maximum value of a discount rate for which the project's NPV equals 0. The investment decisions based on NPV criterion are taken as follows:

- IRR > r, means that an investment project should be adopted for implementation because at a given cost of capital it will generate positive NPV,

- IRR = r, means that a project has no impact on increase of company's value, therefore whether the project should be implemented or not other factors not included in the analysis decide,
- IRR < 0, a project should be rejected.

It is assumed that in calculating IRR all received income will be reinvested at the same rate of interest as in discounting. This is an assumption virtually unheard of in a market economy. This is due to the fact that many entities on the market offer a lot of different possibilities, both in acquisition and investment of capital. In addition, there are some limitations when using the IRR method for assessment of investment profitability. There are two cases when the IRR does not answer the question of whether an implementation of a project is justified.

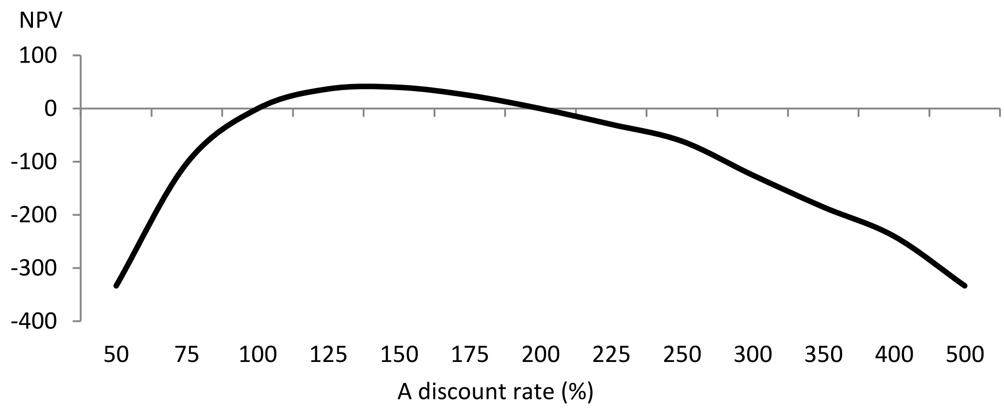

Fig. 6. NPV curve for a project with multiple IRR
Source: own study based on [11].

In conventional projects where positive cash flows occur in later periods than capital expenditures a problem of multiple IRR does not exist. In the example presented above (Fig. 6) such a situation can occur because capital expenditures are also in subsequent years. This is the case when IRR equation is a polynomial. Thus, it is possible that as much value of IRR can be achieved as many times cash flows will change their sign. In addition, it is possible that an analyzed project will not have an internal rate of return (Fig. 7).

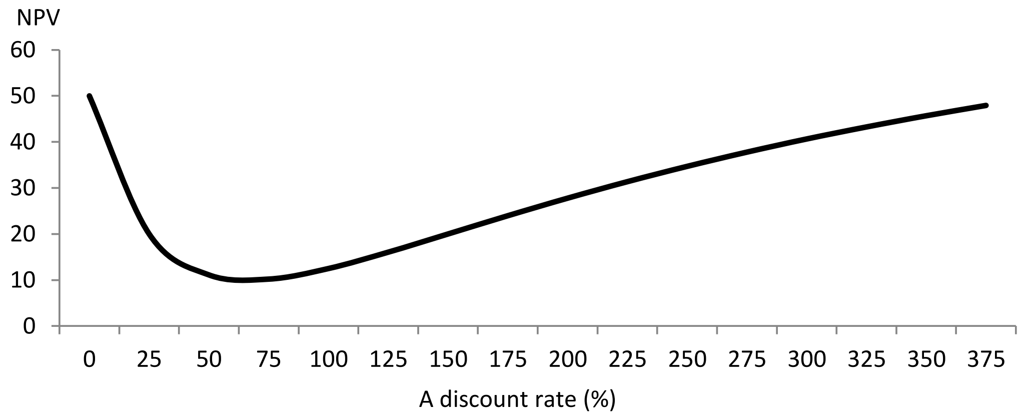

Fig. 7. NPV curve for a project without IRR
Source: own study based on [11].

These considerations relate to problems with determination of IRR. Fortunately, most of investments has only one value of IRR [11].

The selection of mutually exclusive projects

For an individual project with conventional cash flows NPV and IRR indications are identical. If NPV indicates profitability of a project, so does IRR [11]. Some problems arise when two projects are analyzed but only one of which may be adopted for implementation (the so-called projects mutually exclusive). However, there is a possibility where two criteria (NPV and IRR) are incompatible. At that point a conflict of selection arises and it means that NPV criterion indicates another project as more cost-effective than IRR method (Fig. 8). This situation can occur when:

- Projects differ in the amount of capital expenditure (i.e. project scale),
- Projects differ in distribution of cash flows over time [15].

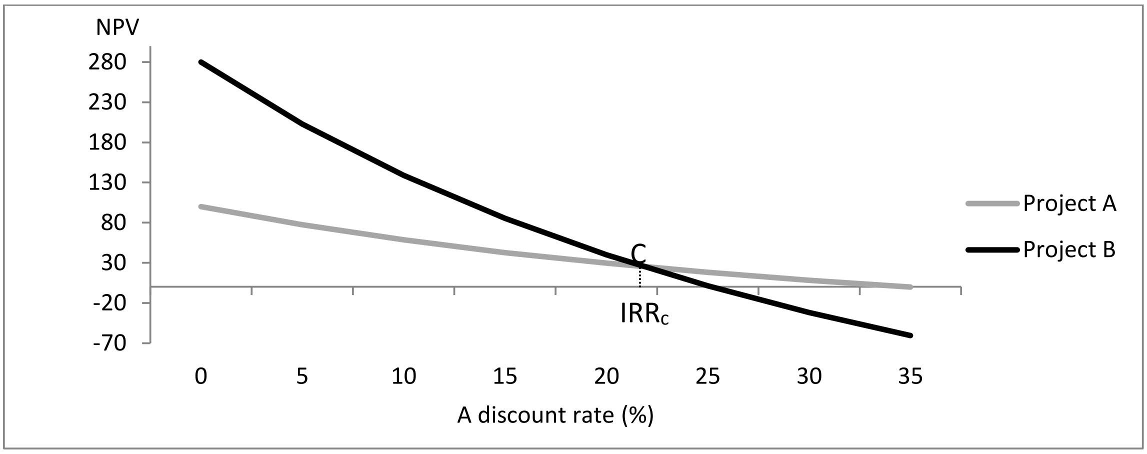

Fig. 8. Conflict of choice of investment projects
Source: own study based on [11].

NPV curves of both analyzed projects intersect at point C, which corresponds to value of IRR_c. IRR_c is an internal rate of hypothetical return of a project, called „incremental" project whose cash flows constitute a difference between project A and B cash flows. Thus, the IRR_c is a discount rate for which NPV of two analyzed projects are equal. If there is IRR_c value, a choice of optimal investment project shall be as follows:

- If a capital cost of both projects is lower than predetermined value of IRR_c then a project whose NPV is greater should be adopted for an implementation;
- If, however, a cost of capital is higher than a predetermined value IRR_c a project whose internal rate of return is higher should be implemented.

Problems also arise during analysis of two mutually exclusive projects with different lifetime. NPV indications in case of two mutually exclusive projects may prove to be incorrect. There are two methods to make optimal investment decision:

- Replacement Chain Method - consists of leveling lifetimes of analyzed projects (when lifetime of a project has ended, it is assumed that this project will be implemented again),
- Equivalent Annual Annuity (EAA) - consists of determination of equivalent annual value (so-called an-nuity in arrears) NPV.

In both cases mentioned above a project characterized by higher calculated values will be adopted for the implementation [12].

The safety margin

The safety margin is a positive deviation between maximum discount rate value (IRR), at which an investment project will not generate losses, and a value of discount rate adopted for calculation.

$$Safety\ margin = IRR - r$$

Safety margin signifies financial security of a project. It is a very useful tool in case of financing investments by foreign capital whose interest rate is variable over time (i.e. it depends on WIBOR), because it allows to estimate to what maximum extend an interest rate of incurred liability can increase not to cause a simultaneous decrease in value of a project [14].

Modified internal rate of return

Modified Internal Rate of Return (MIRR) is a modification of IRR method described above. The assumption on the level of reinvestment of income has changed. MIRR criterion assumes that positive cash flows can be reinvested according to offered market opportunities. MIRR is calculated by the following formula:

$$MIRR = \sqrt[n]{\frac{\sum_{t=0}^{n} CIF_t (1+k)^{n-t}}{\sum_{t=0}^{n} \frac{COF_t}{(1+k)^t}}} - 1$$

where:
CIF_t - positive cash flow in period t reinvested by any interest rate,
COF_t - negative cash flow in period t.

MIRR is a limit value of a discount rate. At that value equalization of incurred capital expenditures with positive discounted cash flows occurs. They are reinvested according to opportunities offered by the market. MIRR criterion cannot be used to assess profitability of investments of non-conventional cash flows (similarly to IRR) [14].

Discounted payback period

Discounted payback period determines a period after which there will be a balance of capital expenditures value with a sum of discounted cash flows achieved in subsequent years. DPP is a criterion that uses discounted cash flows just like NPV criterion. This means that if NPV of a project is negative it is probable that DPP does not exist because expenses will never be covered by revenues from operation of investment. It should be noted that the DPP method does not take into account cash flows that occur after achievement of a balance between income and expenditure. This approach makes the DPP not to be a good method of evaluation effectiveness of the whole project. In addition, there is a possibility that an investment project is characterized by a negative NPV, however during life of an investment it generates positive discounted cash flows, which cause calculation of DPP value possible [11].

Analysis of net cash flows in subsequent years

In order to estimate profitability of wind farm construction in Poland calculated cash flows for period 2013-2039 were used. The analysis was carried out for a case of wind farm that consist of 15 Vestas V-90 wind turbines located over an area of about 345 acres.

The years 2013-2015 is a period when significant capital expenditures are incurred. First revenues from electricity sales appear in January 2015. The analysis has been prepared for the years up to 2039 due to the fact that the lifetime of a wind turbine is 25 years. At the end of this period a thorough modernization of the wind park will be necessary.

Table 2. Cash flows in 2013-2018

		2013	2014	2015	2016	2017	2018
1	**Revenues**	**-**	**-**	**39 486 838,26**	**39 950 358,44**	**40 425 466,63**	**40 912 452,53**
2	**Operating costs**	**-**	**-**	**16 130 409,25**	**16 328 669,58**	**16 531 886,42**	**16 740 183,68**
2a	Ground rent	-	-	951 649,59	975 440,83	999 826,85	1 024 822,52
2b	Property tax	-	-	1 110 257,86	1 138 014,30	1 166 464,66	1 195 626,28
2c	Service fees	-	-	3 568 685,96	3 657 903,11	3 749 350,69	3 843 084,46
2d	Energy balancing	-	-	396 520,66	406 433,68	416 594,52	427 009,38
2e	Supervision and management	-	-	713 737,19	731 580,62	749 870,14	768 616,89
2f	Energy use for own needs	-	-	79 304,13	81 286,74	83 318,90	85 401,88
2g	Insurance	-	-	475 824,80	487 720,42	499 913,43	512 411,26
2h	Other	-	-	634 433,06	650 293,89	666 551,23	683 215,01
2i	Amortization	-	-	8 199 996,00	8 199 996,00	8 199 996,00	8 199 996,00
3	**EBIT**	**-**	**-**	**15 156 433,00**	**15 421 692,86**	**15 693 584,21**	**15 972 272,85**
4	Interests	-	-	14 098 543,23	13 129 015,90	12 159 488,57	11 189 961,24
5	**EBIT**	**-**	**-**	**1 057 889,77**	**2 292 676,96**	**3 534 095,64**	**4 782 311,60**
6	Tax	-	-	200 999,06	435 608,62	671 478,17	908 639,20
7	**Net profit (loss)**	**-**	**-**	**856 890,72**	**1 857 068,34**	**2 862 617,47**	**3 873 672,40**
8	Change of liabilities	75 768 000,00	75 768 000,00	10 102 400,00	10 102 400,00	10 102 400,00	10 102 400,00
9	Investments in fixed/current assets	-96 135 000,00	-96 135 000,00	-	-	-	-
10	**Cash flow (1+2i+7+8+9)**	**-**	**-20 367 000,00**	**-1 045 513,28**	**-45 335,66**	**960 213,47**	**1 971 268,40**

Source: own study

Table 3. Cash flows in 2019-2025

	2019	2020	2021	2022	2023	2024	2025
Revenues	**41 411 613,07**	**41 923 252,63**	**42 447 683,18**	**42 985 224,49**	**43 536 204,33**	**44 100 958,67**	**44 679 831,87**
Operating costs	**16 953 688,38**	**17 172 530,69**	**17 396 844,05**	**17 626 765,25**	**17 862 434,49**	**18 103 995,45**	**18 351 595,43**
Ground rent	1 050 443,09	1 076 704,16	1 103 621,77	1 131 212,31	1 159 492,62	1 188 479,93	1 218 191,93
Property tax	1 225 516,93	1 256 154,86	1 287 558,73	1 319 747,70	1 352 741,39	1 386 559,92	1 421 223,92
Service fees	3 939 161,57	4 037 640,61	4 138 581,62	4 242 046,16	4 348 097,32	4 456 799,75	4 568 219,75
Energy balancing	437 684,62	448 626,73	459 842,40	471 338,46	483 121,92	495 199,97	507 579,97
Supervision and management	787 832,31	807 528,12	827 716,32	848 409,23	869 619,46	891 359,95	913 643,95
Energy use for own needs	87 536,92	89 725,35	91 968,48	94 267,69	96 624,38	99 039,99	101 515,99
Insurance	525 221,54	538 352,08	551 810,88	565 606,16	579 746,31	594 239,97	609 095,97
Other	700 295,39	717 802,77	735 747,84	754 141,54	772 995,08	792 319,96	812 127,95
Amortization	8 199 996,00	8 199 996,00	8 199 996,00	8 199 996,00	8 199 996,00	8 199 996,00	8 199 996,00
EBIT	**16 257 928,70**	**16 550 725,95**	**16 850 843,12**	**17 158 463,23**	**17 473 773,84**	**17 796 967,22**	**18 128 240,43**
Interests	10 220 433,92	9 250 906,59	8 281 379,26	7 311 851,93	6 342 324,60	5 372 797,28	4 403 269,95
EBIT	**6 037 494,78**	**7 299 819,36**	**8 569 463,86**	**9 846 611,30**	**11 131 449,24**	**12 424 169,95**	**13 724 970,48**
Tax	1 147 124,01	1 386 965,68	1 628 198,13	1 870 856,15	2 114 975,36	2 360 592,29	2 607 744,39
Net profit (loss)	**4 890 370,77**	**5 912 853,68**	**6 941 265,73**	**7 975 755,15**	**9 016 473,89**	**10 063 577,66**	**11 117 226,09**
Change of liabilities	10 102 400,00	10 102 400,00	10 102 400,00	10 102 400,00	10 102 400,00	10 102 400,00	10 102 400,00
Investments in fixed/current assets	-	-	-	-	-	-	-
Cash flow	**2 987 966,77**	**4 010 449,68**	**5 038 861,73**	**6 073 351,15**	**7 114 069,89**	**8 161 173,66**	**9 214 822,09**

Source: own study

Table 4. Cash flows in 2026-2032

	2026	2027	2028	2029	2030	2031	2032
Revenues	**45 273 176,89**	**45 881 355,55**	**46 504 738,67**	**47 143 706,36**	**47 798 648,25**	**48 469 963,69**	**49 158 062,01**
Operating costs	**18 605 385,42**	**18 865 520,16**	**19 132 158,26**	**13 548 322,32**	**11 485 602,97**	**11 772 743,05**	**12 067 061,62**
Ground rent	1 248 646,73	1 279 862,90	1 311 859,47	1 344 655,96	1 378 272,36	1 412 729,17	1 448 047,39
Property tax	1 456 754,52	1 493 173,38	1 530 502,72	1 568 765,28	1 607 984,42	1 648 184,03	1 689 388,63
Service fees	4 682 425,24	4 799 485,87	4 919 473,02	5 042 459,84	5 168 521,34	5 297 734,37	5 430 177,73
Energy balancing	520 269,47	533 276,21	546 608,11	560 273,32	574 280,15	588 637,15	603 353,08
Supervision and management	936 485,05	959 897,17	983 894,60	1 008 491,97	1 033 704,27	1 059 546,87	1 086 035,55
Energy use for own needs	104 053,89	106 655,24	109 321,62	112 054,66	114 856,03	117 727,43	120 670,62
Insurance	624 323,37	639 931,45	655 929,74	672 327,98	689 136,18	706 364,58	724 023,70
Other	832 431,15	853 241,93	874 572,98	896 437,31	918 848,24	941 819,44	965 364,93
Amortization	8 199 996,00	8 199 996,00	8 199 996,00	2 342 856,00	0,00	0,00	0,00
EBIT	**18 467 795,47**	**18 815 839,39**	**19 172 584,41**	**31 252 528,05**	**36 313 045,28**	**36 697 220,64**	**37 091 000,39**
Interests	3 433 742,62	2 464 215,29	1 494 687,96	525 160,64	0,00	0,00	0,00
EBIT	**15 034 052,85**	**16 351 624,10**	**17 677 896,44**	**30 727 367,41**	**36 313 045,28**	**36 697 220,64**	**37 091 000,39**
Tax	2 856 470,04	3 106 808,58	3 358 800,32	5 838 199,81	6 899 478,60	6 972 471,92	7 047 290,07
Net profit (loss)	**12 177 582,81**	**13 244 815,52**	**14 319 096,12**	**24 889 167,60**	**29 413 566,68**	**29 724 748,72**	**30 043 710,31**
Change of liabilities	10 102 400,00	10 102 400,00	10 102 400,00	10 102 400,00	0,00	0,00	0,00
Investments in fixed/current assets	-	-	-	-	-	-	-
Cash flow	**10 275 178,81**	**11 342 411,52**	**12 416 692,12**	**17 129 623,60**	**29 413 566,68**	**29 724 748,72**	**30 043 710,31**

Source: own study

Table 4. Cash flows in 2033-2039

	2033	2034	2035	2036	2037	2038	2039
Revenues	**49 863 362,79**	**50 586 296,09**	**51 327 302,73**	**52 086 834,52**	**52 865 354,62**	**53 663 337,71**	**54 481 270,39**
Operating costs	**12 368 738,16**	**12 677 956,62**	**12 994 905,53**	**13 319 778,17**	**13 652 772,63**	**13 994 091,94**	**14 343 944,24**
Ground rent	1 484 248,58	1 521 354,79	1 559 388,66	1 598 373,38	1 638 332,72	1 679 291,03	1 721 273,31
Property tax	1 731 623,34	1 774 913,93	1 819 286,77	1 864 768,94	1 911 388,17	1 959 172,87	2 008 152,19
Service fees	5 565 932,17	5 705 080,48	5 847 707,49	5 993 900,18	6 143 747,68	6 297 341,37	6 454 774,91
Energy balancing	618 436,91	633 897,83	649 745,28	665 988,91	682 638,63	699 704,60	717 197,21
Supervision and management	1 113 186,43	1 141 016,10	1 169 541,50	1 198 780,04	1 228 749,54	1 259 468,27	1 290 954,98
Energy use for own needs	123 687,38	126 779,57	129 949,06	133 197,78	136 527,73	139 940,92	143 439,44
Insurance	742 124,29	760 677,40	779 694,33	799 186,69	819 166,36	839 645,52	860 636,65
Other	989 499,05	1 014 236,53	1 039 592,44	1 065 582,25	1 092 221,81	1 119 527,36	1 147 515,54
Amortization	0,00	0,00	0,00	0,00	0,00	0,00	0,00
EBIT	**37 494 624,63**	**37 908 339,47**	**38 332 397,19**	**38 767 056,35**	**39 212 581,99**	**39 669 245,77**	**40 137 326,15**
Interests	0,00	0,00	0,00	0,00	0,00	0,00	0,00
EBIT	**37 494 624,63**	**37 908 339,47**	**38 332 397,19**	**38 767 056,35**	**39 212 581,99**	**39 669 245,77**	**40 137 326,15**
Tax	7 123 978,68	7 202 584,50	7 283 155,47	7 365 740,71	7 450 390,58	7 537 156,70	7 626 091,97
Net profit (loss)	**30 370 645,95**	**30 705 754,97**	**31 049 241,73**	**31 401 315,65**	**31 762 191,41**	**32 132 089,07**	**32 511 234,18**
Change of liabilities	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Investments in fixed/current assets	-	-	-	-	-	-	-
Cash flow	**30 370 645,95**	**30 705 754,97**	**31 049 241,73**	**31 401 315,65**	**31 762 191,41**	**32 132 089,07**	**32 511 234,18**

Source: own study

The years 2013 and 2014 due to ongoing construction work were completed with a loss. First revenues appeared in January of 2015. Value of earned income in the first year of wind farms operation amounted to 39.5 million PLN (9.7 million Euro). In subsequent years, an increase of income due to the indexation of electricity prices appeared. Income from whole time operation of the wind park will be 1 157 million PLN (284 million Euro).

Operating costs including depreciation write off and offshore/external financing costs amounted to 30.23 million PLN (7.42 million Euro)) in the first year of use. Repayments of loan instalments and depreciation write off will end in 2029. Total costs associated with pursuit of business activity in the period of 2015-2039 will amount to 614.85 million PLN (150.82 million Euro). Temporary problems with financial liquidity may occur for the years 2015 and 2016. This may result in problems with repayment of liabilities. Conditions of "Good Energy Loan" authorize a possibility of suspension of liabilities repayment for a period of 18 months. During this period a recovery of liquidity and resumption of loan repayment will be possible. In addition, there are other tools such as working capital loans, which allow companies to regain financial liquidity. Thus, a temporary lack of liquidity will not adversely affect economic profitability of an investment. In the first year of wind farm operation net profit will reach 0,857 million PLN (0.21 million Euro). In subsequent years, net income will increase to reach 32.5 million PLN (8 million Euro) in 2039. Net profit developed in the years 2015-2039 will amount to 363.99 million PLN (89.3 million Euro).
A discounted rate estimated according to this method for the analyzed project (a wind farm construction located in the north-eastern part of Poland) equals 9.931%. This value includes interest rate amount of a loan (WIBOR 3M + Margin: 9.597%) and a value of Polish Energy Partners equity rate of return (18,56%). Net present value (NPV) of the analyzed project is 78.8 million, while the profitability index (PI) 3.06. The internal rate of return (IRR) and modified internal rate of return (MIRR) the authors estimated at the level of 22.439% and 11.836% respectively.

A detailed description of the research, basic risk factors, instruments used to eliminate or minimalize these risks and the methods of estimating the impact of risk on the profitability of the venture will be described by the authors in the monograph. This article presents merely the research objectives as well as basic information concerning the profitability of the venture analysed.

Summary and conclusions

Although there are many methods to estimate project cost-effectiveness, a decision making related to an investment implementation is a difficult task. The choice of a method to estimate the cost-effectiveness of a project depends on individual preferences of managers. However, bearing in mind a paramount importance of investment decisions for the future of a company a decision should be made based on more than one criterion. This is due to the fact that each and every method analyzes a project from a different perspective thus providing a fuller picture of an investment.

Theoretically, NPV is considered to be the best. This criterion should be applied especially when analyzing projects of non-conventional cash flows and mutually exclusive [12]. It should be noted that a condition for accurate estimates is an adequate determination of cash flows, a discount rate and duration of an investment [14].

Due to the fact that an investment in a wind farm construction is characterized with a long duration of profitability assessment, the authors recommend discount methods and concept of weighted average cost of capital to determine a discount rate. Thus, all of indicators used to assess profitability of an investment indicate that the studied project is viable.

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ANALIZA OPŁACALNOŚCI INWESTYCJI O DŁUGIM CYKLU ŻYCIA NA PRZYKŁADZIE POLSKICH ELEKTROWNI WIATROWYCH

Streszczenie
Autorzy przedstawili kryteria wykorzystywane przy podejmowaniu decyzji dotyczącej budowy farmy wiatrowej w Polsce. Opisano makroekonomiczne aspekty rozwoju sektora energetyki wiatrowej w Polsce. Artykuł powstał w oparciu o liczne artykuły prasowe, naukowe oraz raporty. Ze względu na fakt, iż inwestycje związane z budową farmy wiatrowej cechuje się długim okresem zwrotu do oceny opłacalności autorzy rekomendują metody dyskontowe. Do wyznaczenia stopy dyskontowej proponują wykorzystanie koncepcji średniego ważonego kosztu kapitału, do oszacowania wpływu cen świadectw pochodzenia oraz produktywności farmy wiatrowych analizę wrażliwości oraz wartość zagrożoną, do oszacowania wartości zagrożonej koncepcję Cash Flow at Risk.

Słowa kluczowe
energetyka wiatrowa, opłacalność inwestycji, metody dyskontowe, kryterium opłacalności