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The financial aspects of LCA in the Polish mining industry

Life Cycle Assessment (LCA) is a tool that can help producers make better decisions pertaining to environmental protection. LCA deals with the environmental impact of a process or product during its entire life, but it does not take account of the financial aspects. However, it can be a valuable additional factor in investment decisions when basic investment evaluation methods fail to give an unequivocal answer. This can occur when competing projects are found to be financially equivalent. Even so, for every project under consideration it is essential to perform a normal investment evaluation, since – as with all decisions that involve money – the financial aspects are crucial. If the project is unsatisfactory in financial terms it cannot be implemented even if this means rejecting solutions that are environmentally safer. One of the reasons for this is that the company's shareholders expect to earn a profit on the money they have invested. They will not accept a loss or break-even situation over the long term, and if such a situation should take place they will withdraw their funds from the company and invest them elsewhere. Therefore every environmental investment should be screened with the usual investment evaluation methods. There are several methods used to evaluate investments. The most popular are NPV (Net Present Value) and IRR (Internal Rate of Return). NPV is the value of the project expressed in the first year of project life. It is calculated by discounting all costs and incomes during project life using the following formula:

$$NPV = \sum_{i=0}^n \frac{CF_n}{(1+i)^n} \quad \text{where CF – cash flow, } i \text{ – interest rate, } n \text{ – number of years.}$$

A positive NPV indicates that, by this criterion, the project is profitable. Another criterion, the IRR, is a rate of return that would make the NPV equal to zero, which indicates the minimum rate of return that can be accepted in order to achieve a profit. One typical problem encountered in such estimates is to determine the annual cost of the equipment purchased. Example 1 illustrates how to make such calculations.

Example 1. Annual cost calculation¹

An underground mine intends to purchase a drill car for \$40,000, with a lifetime of 10 years and a salvage value of \$10,000. The minimum rate of return on this investment is set at 15% per year. The following equation can be used to determine annual costs for this drill car:

$$\text{Annual cost} = C \left[\frac{i(1+i)^n}{(1+i)^n - 1} \right] - L \left[\frac{i}{(1+i)^n - 1} \right]$$

where C – initial cost, L – salvage value, i – interest rate, n – number of years.

The first component of this equation is equal to a uniform series of end-of-period payments equivalent to a present lump sum of money. The second component indicates a uniform series of equal end-of-period payments equivalent to a future sum of money. In this example the annual cost for the drill car will be \$7,478 (\$40,000 x 0.1993 – \$10,000 x 0.0493).

The calculation of annual costs is very important, because project costs and revenues must be known in order to calculate the NPV and IRR. It is also important to include in the project plan the costs and savings that pertain to environmental protection. Apart from the initial investment, these costs should cover technology (usually more expensive, but better for the environment), pollution monitoring, rehabilitation costs, final disposal costs, and energy and maintenance costs, which are often neglected. The cost of performing LCA should also be taken into account. As for savings: these include not only financially measurable items, such as reduced (or even eliminated) fines for pollution, and lower operation and maintenance costs, but also non-measurable effects, such as improved company image and increased competitiveness. In LCA, particular functional units are analyzed in terms of their environmental input and output, but the financial implications are omitted. However, input and output can be measured for each functional unit in monetary terms. Even such output as contribution to the greenhouse effect can be monetised in terms of fines that will have to be paid for emissions. Cost analysis should be performed for each functional unit. Depending on the product or process under analysis, it is crucial to define the functional unit accordingly. The functional unit can be defined as one machine, for example an underground mine drill car with a 10-year life span and a purchase cost of \$40,000 (including freight and installation). The primary input and output of such a functional unit are presented in table 1, and selected costs associated with it are presented in table 2.

¹ F.J. Stermole, J.M. Stermole, Economic evaluation and investment decision methods, Investment Evaluation Corporation, Colorado 2000.

Table 1. Functional unit inventory

Input		Output	
Fuel [kg/h]	24.56	CO [g/h]	2.80
Electric power [kWh]	50	NO _x [g/h]	8.20
Lubricants [g/h]	0.30	Lubricants used [g/h]	0.30

Table 2. Functional unit cost estimation

Cost type	Amount
Purchase (incl. freight and installation) [\$]	40,000.00
Power (fuel and electric) [\$ /h]	15.00
Lubricants [\$ /h]	0.04
Operator wages [\$ /h]	5.00
Maintenance labor costs [\$ /h]	5.00
Fines for CO emission [\$ /10,000h]	0.63
Fines for NO _x emission [\$ /10,000h]	6.76
Fees for used lubricant disposal [\$ /10,000h]	0.0117

For companies already in business, the most common difficult decision involves the choice between existing and new technology. Example 2 shows how to deal with such a dilemma. It is quite difficult to assess the exact amount of income produced by a capital improvement that provides a service (such as a drill car, in this example). Incremental analysis is thus required in order to evaluate service-producing investment alternatives that involve initial costs. This analysis is based on subtracting the investment that would require less capital from the one that would place a larger demand on funds². As a result, a cash flow diagram is created with an initial investment that will produce savings and/or revenues in the future.

Example 2. The choice between existing equipment and its replacement

An underground mine is considering the alternative whether to purchase a new drill car or keeping the existing one. The installation of a new drill car would reduce operating costs (OC) from \$27,000 to \$20,000 in year one, from \$30,000 to \$22,000 in year two, from \$33,000 to \$24,000 in year three, and from \$37,000 to \$27,000 in year four. Because a new drill car is more environment-friendly, environmental fees (E) will be reduced from \$3,000 to \$2,000 each year. The purchase cost (C) of a new drill car is \$20,000 and the expected salvage value (L) after four years is \$5,000. The minimum acceptable rate of return is 20%.

² F.J. Stermole, J.M. Stermole, Economic evaluation and investment decision methods, Investment Evaluation Corporation, Colorado 2000.

New drill car

Costs	C = 20	OC = 20	OC = 22	OC = 24	OC = 27	
[\$ '000]		E = 2	E = 2	E = 2	E = 2	L = 5
Year	0	1	2	3	4	

Existing drill car

Costs	C = 0	OC = 27	OC = 30	OC = 33	OC = 37	
[\$ '000]		E = 3	E = 3	E = 3	E = 3	L = 0
Year	0	1	2	3	4	

New versus existing drill car

Costs	C = 20	OC = -8	OC = -9	OC = -10	OC = -11	
[\$ '000]						L = 5
Year	0	1	2	3	4	

The incremental analysis with calculation of the incremental NPV and IRR is based upon the comparison between the new and existing drill car.

$$NPV = \frac{-20}{(1+0.2)^0} + \frac{8}{(1+0.2)^1} + \frac{9}{(1+0.2)^2} + \frac{10}{(1+0.2)^3} + \frac{16}{(1+0.2)^4} = 6.4 > 0, \text{ therefore acceptable}$$

By interpolation the IRR = 34.6% > 20%, therefore acceptable.

The incremental NPV of the project is greater than 0, so revenues can be expected from the investment. In this example, the revenues consist in the savings that will be achieved as a result of purchasing a new drill car. The incremental IRR is greater than the 20% minimum rate of return, and is therefore acceptable. Both the NPV and the IRR of this project indicate that investing in a new drill car is a satisfactory alternative.

The same method of investment evaluation can be applied to clarify the decision whether to improve existing technology or introduce a new system. The choice between these two alternatives is constrained by limited funds, resources, and other factors, such as environmental issues. If the two investment opportunities are economically comparable, an LCA would be useful. It can also happen that during the whole life of a product the greatest environmental impact occurs beyond the producer's interest (this mainly pertains to the energy used by product). In such circumstances it is even harder to introduce an environmentally safer product, because it does not produce direct profits, and thus companies have no incentive to launch such a product. However, there is a trend among producers to minimize the environmental impact of energy production, so there may be some pressure on them to focus on less energy-consuming products. This undertaking can be supported by LCA, but LCA itself has to be supplemented by proper financial analysis. Common investment decision methods can be used in order to evaluate cost-effective alternatives regardless of the type of functional unit chosen (mining equipment, home appliance, hi-tech equipment, etc.). The preparation of such a broad analysis of an investment insures that the projects introduced will comply with both economic and ecological standards.