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Peter Klatecki

The prices for energy are exploding and therefore encumbering the outlay of energy-intensive companies. The price for oil has doubled during the last year and the prices for gas and electricity are adapted continuously, next time in autumn. Direct influence on the advertised price is limited, signing more favourable contracts only. Saving of energy is a central point of discussion, not in private scope only but even more in industrial applications. Naturally the potential of energy savings are much larger in the industry because of the consumption of a single application is significantly bigger. The capabilities to increase the efficiency of using energy are manifold ([1], [2]). As the public discussion focuses to the reduction of CO_2 output primarily, even more interesting for a company is the renumeration of the investment.

If an investment in energy saving techniques renumerates can be analyzed using the methods of business management. Below it will be evinced that environmental protection by decrease of consumption and increasing the corporate profit are not expelling each other.

This article directs to the corporate technicians mainly. These should be aware of costs and profit as well. The merchants will do similar, maybe more detailed calculations. These commercial calculations may appear tediously but the results give underlying knowledge in the profitability of modernizations. The results are surprising regularly. The results are illustrating too, which parameters have important, respectively minimal effects to the profitability of an investment.

For instance it will be obvious, that the investment price is not arbitrative for the return and, in consequence the decision, but the costs and the profit operating the system.

Modernizing a furnace installation, or the acquisition of a new furnace replacing an old system, imply a significant amount of money. The most important criterion for the decision, beside technical criteria like optimizing the way of production or increasing the occupational safety, where no direct profit is generated out of the system, are the payments and costs as well as the expected receipts in direct contiguity with the projected system.

The asset costs, the regular costs and profit are aligned inseparably because they are all originated by the investment. A decision following budgets, while one cost centre has to cover the acquisition and a different cost centre achieves the profit (savings), leads to opposition of the responsible officer for the debited budget invariably. Therefore the acquisition remains undone regularly. Overall this is inimically for the entire company, because the improvement of profit (by decreasing the costs) is waived in the following years. The job of the company management and the controlling is to assess the profitability of the investment and to take measures for an adequate internal compensation.

Determination of savings

The conventional, broadly business case is done by calculating the expected fuel savings only. The expected fuel consumption after modernizing (or new installation) is compared to the actual, known consumption. Each priced in EURO and therefore depending on the fuel price. An alteration of fuel, for instance oil to gas, can be factored in the price also.

The necessary basic data are:

C_f consumption, previous:

For example 1,077 kWh per ton molten aluminium, operating cold air burners (no preheating of air).

C_a consumption, after:

For example 700 kWh per ton molten aluminium, operating regenerator burners (with preheating of air). This is the guarantee value from the supplier written in the offer.

M_r melting rate:

The melting rate of the system per hour

A_h annual operating hours:

The hours, the system is operating (per year)

$$S_a = (C_f - C_a) \cdot M_r \cdot A_h \cdot F_p$$

or

$$Savings_{annual} = (Consumption_{previous} - Cosumption_{after}) \cdot MeltingRate \cdot AnnualHours \cdot Fuelprice$$

The product out of MeltingRate and AnnualHours represents the annual metal production.

The result is the annual (at least) expected saving in EURO. With this, a broadly comparison between different offers can be performed.

Certainly, it must be verified that the data are really comparable. Especially meant is the guaranteed value of consumption. The conditions for the validity of the guaranteed value of consumption (supplier) are strictly to prove, respectively questioned. Severally stated is the consumption for melting mode only, without considering the times for charging, dedrossing and depleting the furnace, or as an average value of the complete melting cycle with consideration of the above times. The average value is significantly more realistic.

The capital value

From the point of view of business economics the solely calculation of the annual savings is inexact and less expressive. Effects by interest are unconsidered completely. That's why a procedure is used to make the investment comparable to an alternative invest (mainly the investment of money at a credit institute) for a given period of time, the "capital value method". An investment is deemed to be profitable if the capital value is positive (>0). The availability of real financial resources is irrelevant for comparability.

The method for calculating the capital value is an instrument of the "dynamic investment calculation". All payments (costs) and all receipts (savings or other profits) are assigned to the particular year inside the considered period of time and are correlated to the day (!) of investment with consideration of interest. The objective is not to calculate the "real" profit but an overview for this is achieved also.

The capital value is calculated as follows:

$$Cap_0 = -I + \sum_{t=1}^{T} (R_t - S_t) \cdot (1-i)^{-t} + L \cdot (1-i)^{-T}$$

Whereas:

Cap_0	Capital Value
I	Investment
t	actual year
T	period of time / Years
R_t	Receipts
S_t	Spendings
i	interest
L	Liquidation

Which data are necessary?

I – The value of the investment, this means the price of the system. It is written in the offer of the supplier.

T – Period of time. For investments in machine-building a period of 10 years is legislated in Germany for depreciation (capital allowance). Only needed is the maximum depreciation period, the kind of depreciation (straight-line or degressive) is not important because the depreciation value is not considered. This is inherent in depreciation. (See below)

R_t – Receipts. These are all annual returns (profit) in connection with the projected system. At first these are the savings of energy input, priced in EURO. (See above: Determination of Savings)

S_t – Spendings. At first these are the expected maintenance costs and additionally all costs arising out of the modernization on a regular basis. Furthermore the corporate taxes should be considered. The savings improve the pre-tax results; therefore there is an influence on the taxes to pay.

i – Interest. In any company there is a specified "calculation interest". It can be found out in the commercial department. Normally it is estimated slightly (to) high. But this is a business decision, respecting other influences as additional risks or any. For the evaluation of invest-

Valuation of Investment (Capital Value)

Revamping / Comparision

			Data Input	
Price of System	500.000 €	+	50.000 €	Additional nec. Investment (customer)
Annual Costs (Maintenance, etc.)	2,00%	-	0 €	Actual necess. Replacement Investment
Annual tons	27.000	to		
Initial Value of Interest (see below)	8,00%			
Liquidation Receipts	15.000 €			
Price of Fuel (per kWh)	0,045 €		0,00%	Expected Increase of Price/a
Price of Fuel (prior, per kWh)	0,045 €			
Guarantee Value per to (Fuel)	700	kWh		
Expected Savings (Fuel, in %)	35,00%			
Consumption (Cold Air)	1077	kWh		
Decrease of Metal-Losses (in % absolut)	0,00%			
Price per kg	2,00 €		0,00%	Expected Increase of Price/a
Company-Taxes (in %)	29,83%			

	Start 0	Year 1	Year 2	Year 3	...	Year 10	Total
Amount to be invested (purchase)	-550.000 €						-550.000 €
Annual Costs (Maintenance, etc.)		-10.000 €	-10.000 €	-10.000 €	...	-10.000 €	-100.000 €
Surplusses (Fuel)		457.962 €	457.962 €	457.962 €	...	457.962 €	4.579.615 €
Surplusses (Losses)		-	-	-	...	-	
Liquidation Receipts					...	15.000 €	15.000 €
Taxes (variance)		30.433 €	-133.605 €	-133.605 €	...	-138.078 €	-1.176.482 €
Surplusses per Period	-550.000 €	478.395 €	314.357 €	314.357 €	...	324.883 €	2.768.134 €
Surplusses (cumulated)	-550.000 €	-71.605 €	242.752 €	557.109 €		2.768.134 €	
Amortization (static,Years)		-	1,23	-		-	

Initial Value of Interest (money)	Capital Value	Annuity	
8,00%	1.716.123 €	255.753 €	(10 Years)

(Overvalue compared to investment of Money at date of Investment)

Final Value (inv. of Money)	1.187.409 €	8,00%	
Final Value (if investment)	4.892.390 €	24,43%	corresponding Interest from Bank Institut

(|Surplusses (Start)| + Capital Value), payed with Initial Value of Interest for 10 Years

Capital Value (Method)

$$Cap_0 = -I + \sum_{t=1}^{T} (R_t - S_t) \times (1-i)^{-t} + L \times (1-i)^{-T}$$

Fig. 1: Exemplary Calculation of Modernization (Source: Jasper GmbH)

ments in modernizing thermal processing plants an interest, a bank institute will afford for the „period of time", is more realistic.

L – Liquidation. Considered here is the amount, which can be obtained selling the system at the end of the „period of time". This is the salvage value of the system in this contemplation, no matter the installation can still be used for production or not. This is the usual way in business economics. Operating the system longer than the „period of time" will surely improve the value of the investment, but this is without meaning for the decision to find.

It makes good economic sense to do this calculation in spread sheet software. The programs I know are offering a special function. In Microsoft Excel this function is named "NPV = Net Present Value" respectively "NBW = Netto Barwert" in versions with German language. It is to heed to subtract the investment value here to get the capital value as result.

The formula to insert in a spread sheet program should be like this:

=NPV(interest;profit-Year1:profit-Year10) – investment value

The necessary data are to be inserted as an address (cell), respectively reference inside the spreadsheet.

Is depreciation (capital allowance) considered?

The depreciation is used for the valuation of capital assets. The corporate accounting should represent a nearly realistic value of the company assets. Up to very less exceptions the "accounted costs" are NO (!) effective spending in the particular year, they should be assessed as an apportionment of the investment value according the lifetime of the system.

Calculating the capital value, the price of the system is considered directly. Additional consideration of the depreciation would lead to a falsified result, because the system would quasi be paid double in the calculation. But to make the capital expenditure comparable to an investment of money at the day of investment is achieved.

An exemplary calculation for a modernization of a melting furnace appears like **Figure 1**:

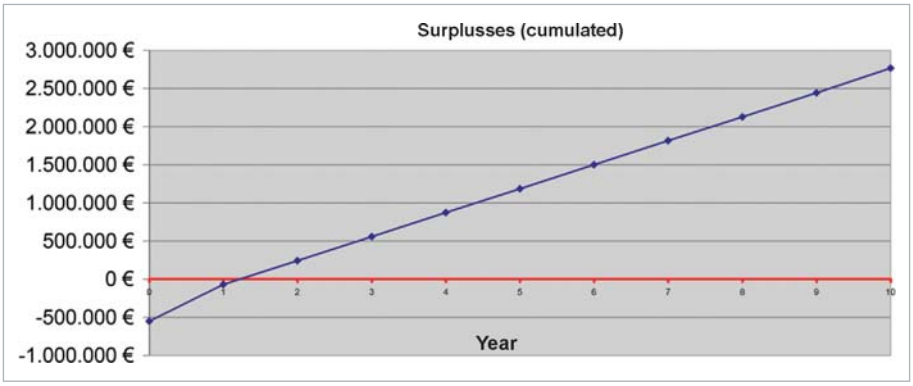

Fig. 2: Illustration of cumulated Profits (Source: Jasper GmbH)

The cumulated profit (year to year) appears as illustrated in **Fig. 2**.

This graph is illustrating the "Determination of Savings" (see above). Certainly, this graph does not factor any effects of interest!

Explanation

Calculated here is the revamping of a burner installation in addition with a regenerator system. The purchase price is 500,000 EURO. Additionally needed are financial resources of 50,000 EURO, for some ground work or any. The sum of investment is 550,000 EURO (Start, Year 0). The annual maintenance costs are anticipated as 2% of the purchase price. The operating costs (manpower, storage, logistics etc.) are not considered, because they would accrue regardless of the modernization. After the time period of 10 years, the system is „sold" for the price of 15,000 EURO (as scrap, regularly there are longer operating times!). The difference of previous fuel consumption (1,077 kWh per ton, operating with cold air burners) and the consumption afterwards (700 kWh per ton with Regenerator, warranty value) results in an annual saving of fuel costs with the amount of 457,962 EURO, calculated on the basis of 0.045 EURO pro kWh and an annual melting production of 27,000 tons. The consideration of company taxes (round about 30% for capital companies in Germany since 2008) leads to a decrease of tax with the amount of 30,433 EURO during the first year (because of the investment) and to an increase of tax with the amount of 133,605 EURO in every subsequent year (because of the energy savings). Considering the calculation basis of 8% interest, a capital value of 1,716,123 EURO is the result.

Interpreted from the point of view of business economics:

At the day of investment (!) the deployed 550,000 EURO represents a value of 550,000 EURO + 1,716,123 EURO = 2,266,123 EURO already.

If the amount is funded at a bank institute with an interest of 8%, after the period of 10 years (depreciation period) the balance would be 1,18,409 EURO.

Doing the investment instead, the calculated return is 4,892,390 EURO (2,266,123 EURO, 8% interest, 10 years). To achieve this amount the bank institute has to afford an interest of 24.43% for the real deployment of 550,000 EURO!

The static amortization fort his revamping is 1.23 years (cumulated profit equal to the investment costs).

The annuity

One step further in business economics is the determination of the annuity. This calculation is based on the method for calculating the capital value. For every particular year in the given period of time, the "net present value" is calculated and the associated average value is determined. The result is the amount of the average savings per year.

The net present value of a single year is the difference between profit and costs of a particular year applied to the day of investment, considering the calculation interest.

An investment is esteemed as profitable if the annuity is larger than zero, according to the capital value.

It can be gathered doing the calculation above that this investment is extremely profitable. The percentage interest is

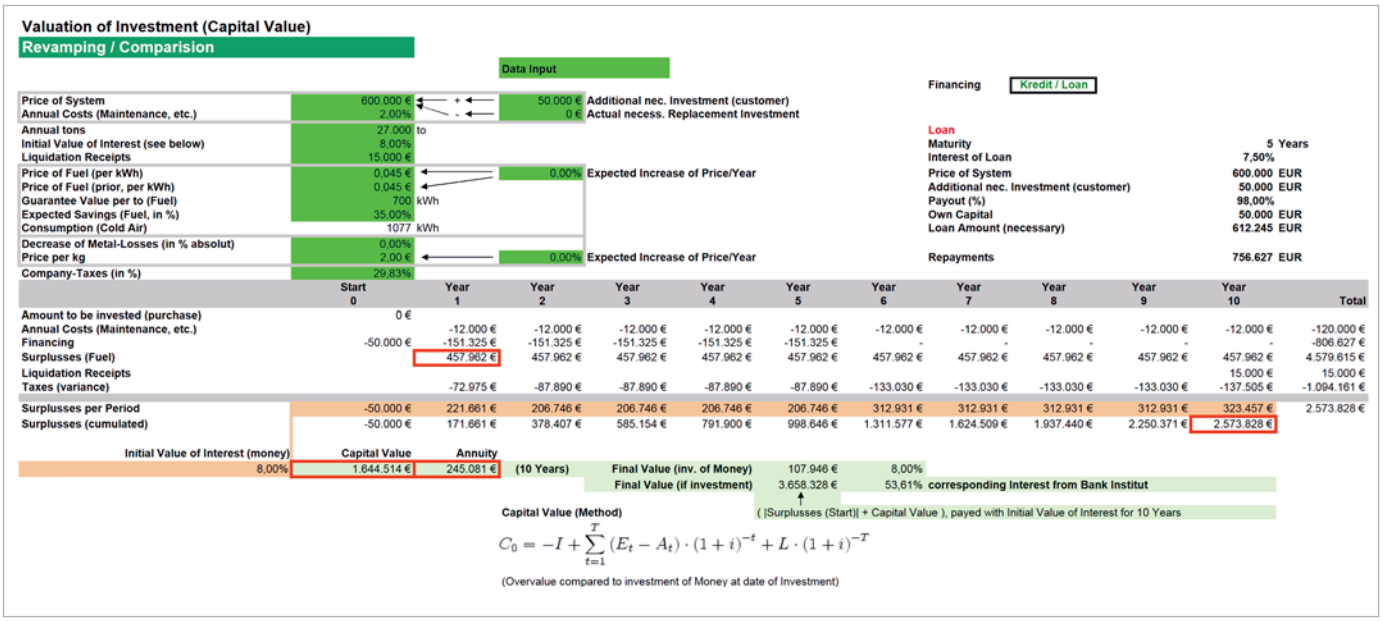

Fig. 3: Evaluation of an investment, respecting Loan (Source: Jasper GmbH)

three times of the interest if the capital is funded. Nevertheless taking advantage of improving the company appearance or image (decrease of CO_2 emissions, protecting the environment). This is the usual result for all comparable investments!

Additional influences

It makes sense to consider the increasing prices for energy additionally. It can be expected that the dramatic escalation of the energy costs will proceed. The profitability of the investment increases accordingly.

Technically the changeover from cold air combustion to a regenerative burner system has a collateral effect in most melting applications.

Simplified: Because of the decreased supply of fresh air for combustion due to the depletion of fuel, there is a lower level of „free" oxygen inside the furnace which is able to react with the molten metal, reasonable furnace operation presupposed. The consequence is a decrease of dross (metal loss). A reduction of one percent only (for example 5% down to 4%) will have a dramatic effect on this business case. Instead of disposing dross or transferring it to the after-treatment, this one percent will generate an additional output of 270,000 kg alloys (in this exemplary calculation, Fig. 1 and **Fig. 3**) and with this an additional profit multiplied with the respective sales price per kg of the product. Every year! Deposit or recycling costs not even considered. The amortization period would be clearly beyond one year. This has to be scrutinized for each installation separately.

Only a barely implication is done by changing the purchase price of the system. An exaltation of the price up to 600,000 EURO (in this exemplary calculation, Fig. 1) will reduce the interest rate from 24.43% to 22.46% only. The capital value will be 1,634,322 EURO instead of 1,716,123 EURO. With consideration of the rising fuel prices and the possible reduction of metal-losses the distinctions will get even minor. The cumulated surplusses will, in this example, only be reduced from 2,768,134 EURO to 2,683,924 EURO, the additional investment of 100,000 EURO is included in this calculation already.

Financing

By means of the hugely profit and the incidental interest financing, as leasing or loan, can be done without problems. The surplusses are covering the financing costs easily (Fig. 3). The revamping project will generate periodical, nameable profit which will be abdicated if the investment is not been done.

Conclusion

A modernization of thermal processing plants, energy saving techniques in combustion, is meaningful and profitable in nearly every application. Using the calculation methods above, it could be validated quick and easily for a selected system. Different offers and technologies can be compared considering the determined consumption and surpluses, too.

Which explanatory variables are considered has to be determined for every special application. For comparison, it must be verified that the data are ascertained on equal basis and only data are used which have direct influences on the installation to evaluate. Not more, but not even less then necessary. Otherwise an investment is spuriously stated as unprofitable or, on the other hand, overvalued.

Literature

[1] Dipl.-Ing. Robert Jasper, Potentials for energy-savings in thermal processing plants and systems, GWI 4/2007, www.gaswaerme-online.de

[2] Dr. Franz Beneke, Energy-Efficiency in thermal processing plants, GWI 3/2008, www.gaswaerme-online.de ■

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