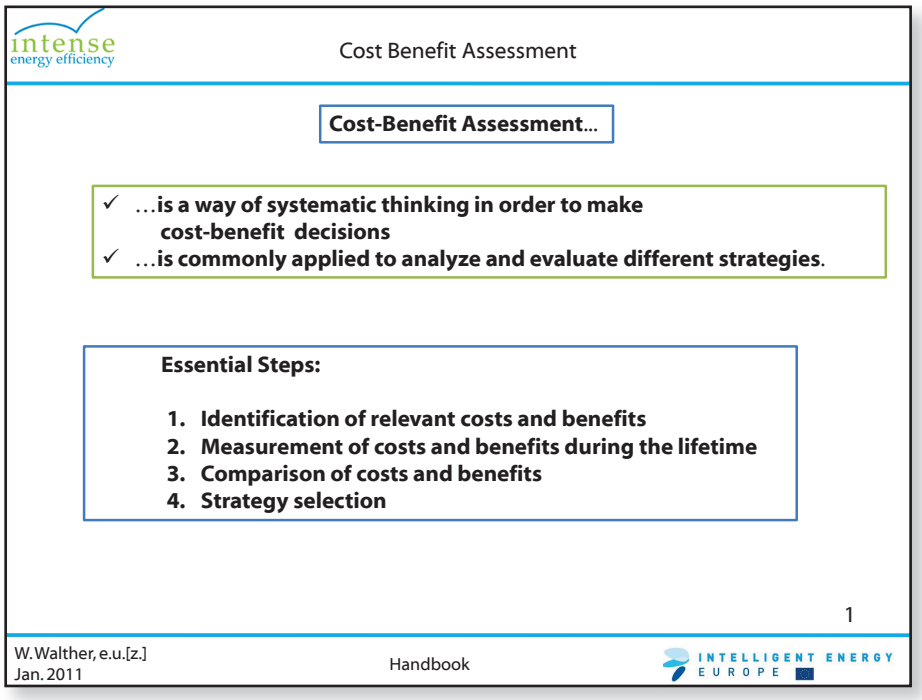


Often there are different designs (standard building or low-energy building), strategies (roof insulation or wall insulation), or products (which kind of material) available with which to achieve a specific goal or service. Choices are often made based on whether the method meets the current minimum standard or whether it is the least costly. With this kind of simple approach, however, modern, sustainable designs, strategies, or products have no chance at all to assert themselves on the market. To counter this, the cost of a strategy and its cost benefits must be added up before making a decision. Only after comparing the costs and cost benefits for the lifetime of a given strategy, a well-founded result can be achieved.

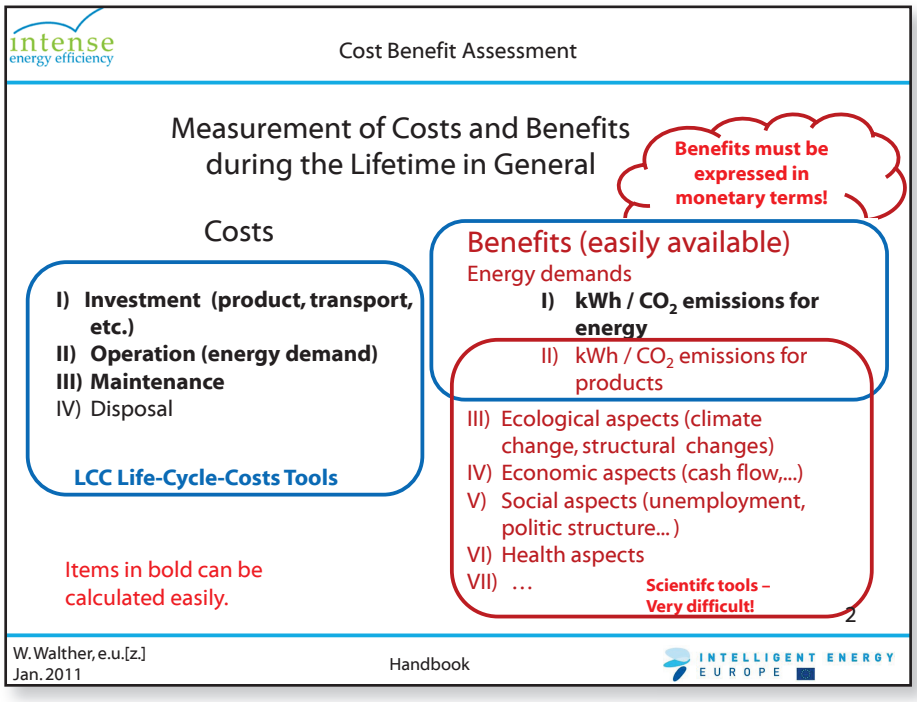
This "Cost-Benefit Assessment" module lists all costs and cost benefits in bullet point form and shows a pragmatic solution for the INTENSE themes of energy efficiency. Not all costs and cost benefits have to be determined—there is no need for it. We can carefully consider which costs have an impact and which ones less so, thus making it possible to carry out an assessment without any great effort.

In order to be able to make a decision regarding the different options, strategies, or designs (standard building, low-energy building, Passivehouse), all costs and cost benefits have to be determined and added up. Only then can a decision be made. If costs are hidden or not considered, the decision being made is certainly not sustainable.

It is the goal to develop a simple method.

The life span is often underestimated. For a wall or roof insulation, 50 years can be estimated. We have learnt from the past that, only after a complete change of use or sale of the object, changes are made. The cost comparison of different strategies can be carried out or the costs and cost benefits can be compared. It is possible to rank the strategies according to the comparison results or to determine the strategy with the best benefit-cost ratio.

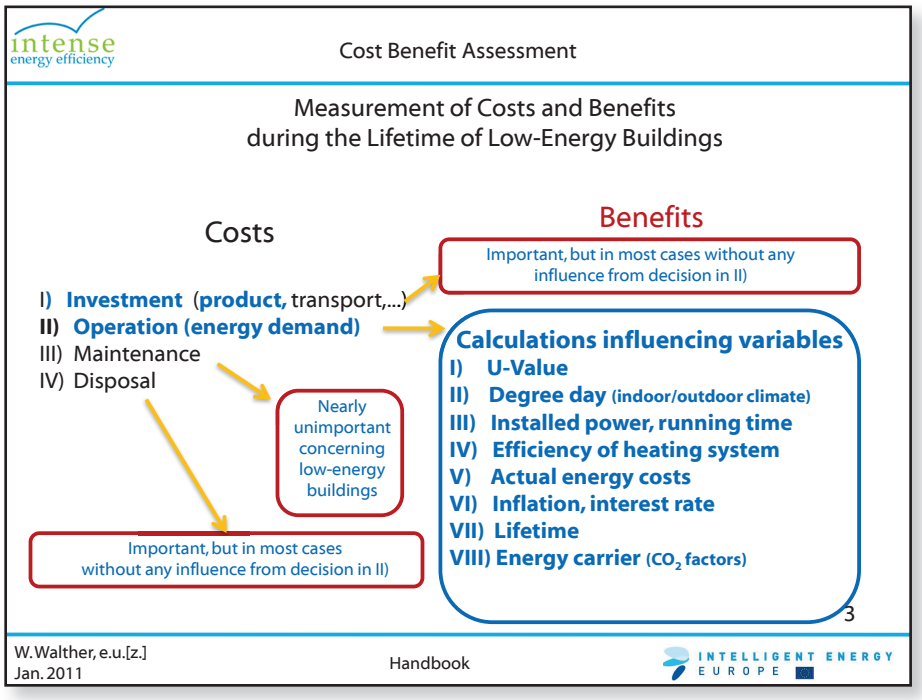
There are a lot of "science" lectures on this topic available. Keywords on the Web: cost-benefit analysis



The costs of a strategy must be added up for its life cycle. If the life span is chosen too short, the cost benefits arising during the operation phase would not be considered properly and wrong decisions will be made.

Since it is very difficult to establish a monetary value for the cost benefits, we will not carry out this step for the INTENSE project and introduce a simplification as has already been suggested in the LCC Life-Cycle-Costs Tools of the project "intelligent energy." Only the data printed in bold are used and CO_2 emissions are not converted into monetary values. The benefits are not given as a monetary value but as a much more easily calculated value called "energy content of the product" (kWh) and the energy consumption during its use (kWh). Provided that data are available, the energy consumption in kWh are converted into CO_2 emissions so that options with different energy sources can be taken into account.

The more factors of influence are reduced, the easier the calculation will be. In the slide after the next, we will choose the factors of influence that simplify the calculation, but without significantly affecting the result.



When we proceed with the argument that we should only calculate costs that are easily available, then we come to the following decision:

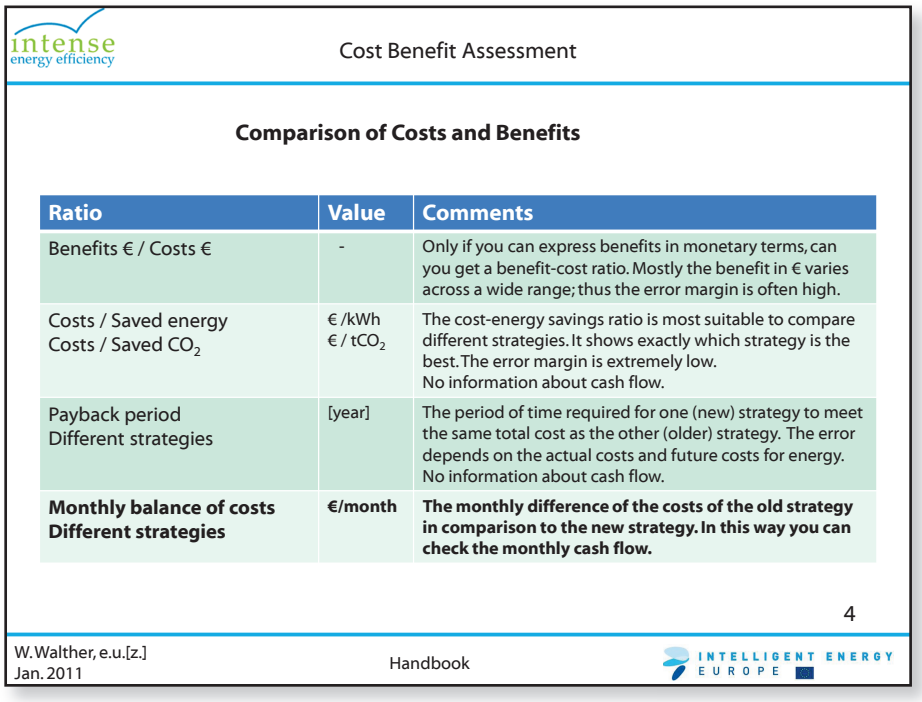
We calculate the costs of investment, operation, and maintenance and calculate the benefits either with the kWh of energy savings or with the total amount of savings. The benefits can be easily gathered from standard consulting software or calculation programs such as "Passivhaus Projektierung (PHPP) and CO_2 emission values in GEMIS.

In practice it has been found that additional criteria have no impact to speak of on the decision-making process (red frame). In the end we will also have a look at the following important criteria: manufacturing costs of the product and the energy costs over its lifetime (blue frame).

For example, if we set the INTENSE theme "low-energy building" and "Passive House", it will be sufficient to only consider and calculate the criteria highlighted in blue, without distorting the decision. Transport costs apply to all products and—in comparison to the energy consumption costs of II)—are rather minimal. Thus we can relegate the transport analysis to the back. The same applies to the maintenance costs. Disposal costs also apply to all products and—in comparison to the operation costs over many decades—have very little impact on the decision.

At this point it must be weighed as to whether the product costs must be inserted into the calculation at 100%. For the purpose of the assessment, it is quite legitimate to only use those costs that arise for a specific strategy in addition to the initial cost. The unavoidable costs may be subtracted.

The variables in the field highlighted in blue are values that play a role in the following example of the Payback Trainer.



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Cost Benefit Assessment

Comparison of Costs and Benefits

Ratio	Value	Comments
Benefits € / Costs €	-	Only if you can express benefits in monetary terms, can you get a benefit-cost ratio. Mostly the benefit in € varies across a wide range; thus the error margin is often high.
Costs / Saved energy Costs / Saved CO_2	€ /kWh € / tCO_2	The cost-energy savings ratio is most suitable to compare different strategies. It shows exactly which strategy is the best. The error margin is extremely low. No information about cash flow.
Payback period Different strategies	[year]	The period of time required for one (new) strategy to meet the same total cost as the other (older) strategy. The error depends on the actual costs and future costs for energy. No information about cash flow.
Monthly balance of costs Different strategies	**€/month**	**The monthly difference of the costs of the old strategy in comparison to the new strategy. In this way you can check the monthly cash flow.**

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This table shows various options how to determine key figures. All of the above-listed key figures have their advantages and disadvantages.

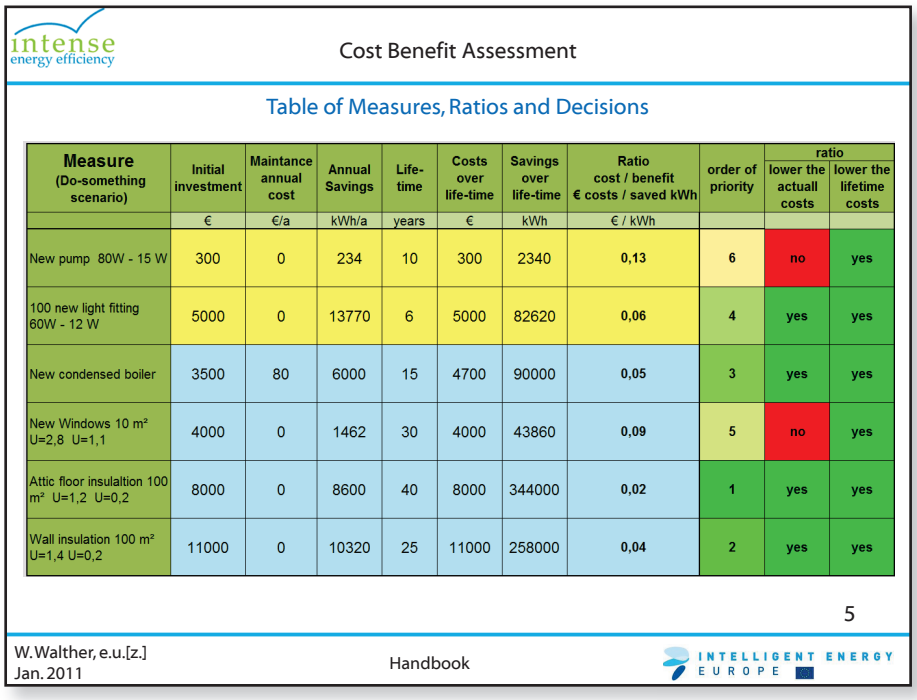
In order to determine a ranking for different strategies, the cost-energy savings ratio has proven to be most suitable. Decisions in the financial area are often based on the payback period. Is the payback period longer than the life span of the strategy/method, then it is obviously a pointless project. But it can also happen that the costs for the construction were set too high or too few cost benefits were calculated. In the example of the "Payback Calculater", the balance of the sum total of the costs of two projects are analyzed in such a way that an additional monthly financial charge is shown.

Benefits € / Costs €: If the value is > 1 the strategy is acceptable. A ratio >1 plus inflation rate à the strategy is more than positive

Costs / Saved energy: If the ratio € /kWh is lower than the actual price of energy, the strategy is very favorable and should be selected. If the ratio €/kWh is lower than the mean value of the price of energy during the lifetime, the strategy should be selected.

Payback period: If the payback period is shorter than the lifetime of the new strategy, then the strategy should be chosen.

Monthly balance of costs / Different strategies: In addition to the payback period, the strategies with the lowest monthly costs should be chosen.



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Cost Benefit Assessment

Table of Measures, Ratios and Decisions

Measure (Do-something scenario)	Initial investment	Maintance annual cost	Annual Savings	Life-time	Costs over life-time	Savings over life-time	Ratio cost / benefit € costs / saved kWh	order of priority	ratio	
									lower the actuall costs	lower the lifetime costs
	€	€/a	kWh/a	years	€	kWh	€ / kWh			
New pump 80W - 15 W	300	0	234	10	300	2340	0,13	6	no	yes
100 new light fitting 60W - 12 W	5000	0	13770	6	5000	82620	0,06	4	yes	yes
New condensed boiler	3500	80	6000	15	4700	90000	0,05	3	yes	yes
New Windows 10 m² U=2,8 U=1,1	4000	0	1462	30	4000	43860	0,09	5	no	yes
Attic floor insulaltion 100 m² U=1,2 U=0,2	8000	0	8600	40	8000	344000	0,02	1	yes	yes
Wall insulation 100 m² U=1,4 U=0,2	11000	0	10320	25	11000	258000	0,04	2	yes	yes

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The table shows various methods including their savings potential, cost-energy savings ratio, and the resulting ranking of the various strategies:

An old 80 W heat pump is replaced with a new 15 W pump. The cost is EUR 300.00, and over the next 10 years 2.340 kWh electricity are saved. This strategy is listed at place six and only becomes an economic choice when the electricity costs €/kWh rise within the pump's lifetime to above 0.13 €/kWh.

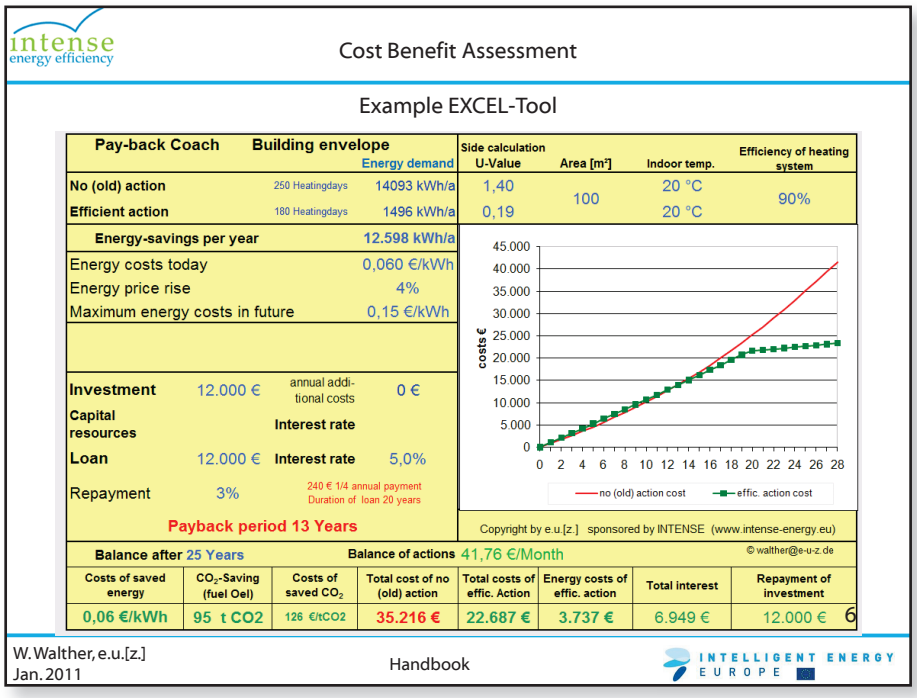
100 incandescent lamps are replaced with compact fluorescent lamps. This strategy is already economical today because the electricity costs per kWh saved are lower than the actual price of electricity.

A new furnace is installed. Again, the costs per kWh saved are lower than the actual heating costs per kWh.

New windows are only economical when considered over a longer period of time and include the total costs.

Insulating the ceiling of the uppermost floor is the most economical strategy.

Insulating an old masonry wall is also very economical, considering the current energy costs.



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Cost Benefit Assessment

Example EXCEL-Tool

Pay-back Coach	Building envelope	Energy demand	Side calculation U-Value	Area [m²]	Indoor temp.	Efficiency of heating system
No (old) action	250 Heatingdays	14093 kWh/a	1,40	100	20 °C	90%
Efficient action	180 Heatingdays	1496 kWh/a	0,19		20 °C	
Energy-savings per year		12.598 kWh/a				
Energy costs today		0,060 €/kWh				
Energy price rise		4%				
Maximum energy costs in future		0,15 €/kWh				

Investment	12.000 €	annual additional costs	0 €
Capital resources		Interest rate	
Loan	12.000 €	Interest rate	5,0%
Repayment	3%	240 € 1/4 annual payment Duration of loan 20 years	

Payback period 13 Years

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Balance after 25 Years — Balance of actions 41,76 €/Month

Costs of saved energy	CO_2-Saving (fuel Oel)	Costs of saved CO_2	Total cost of no (old) action	Total costs of effic. Action	Energy costs of effic. action	Total interest	Repayment of investment
0,06 €/kWh	95 t CO2	126 €/tCO2	35.216 €	22.687 €	3.737 €	6.949 €	12.000 €

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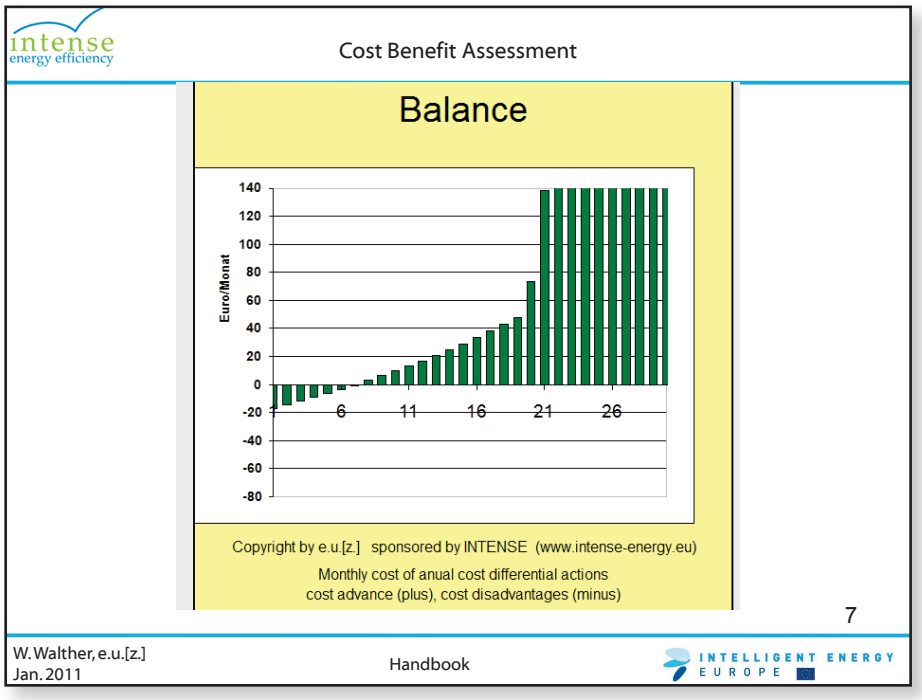
This slide shows the cost performance result of two strategies regarding the building envelope. In the graph the cost performance (energy costs) of an existing wall (red) is shown and the cost performance of an external wall with an efficient wall insulation, including an investment (12.000€) made through a line of credit with an interest rate of 5%. For the first 13 years, the cost performance of the energy-efficient strategy is slightly above the old strategy. Thus we have a payback period of 13 years. In the 14th year, the cost performance falls below the red curve (break-even line). After 20 years the credit is repaid (kink in the green curve) and only the lower energy costs are left to be paid.

The values in the side calculation show input values that describe the status of the building envelope and the heating system.

The three lines at the bottom are the resulting numbers. A balance and assessment are performed for after 25 years (lifetime). On average 41.76€ per month are saved over 25 years.

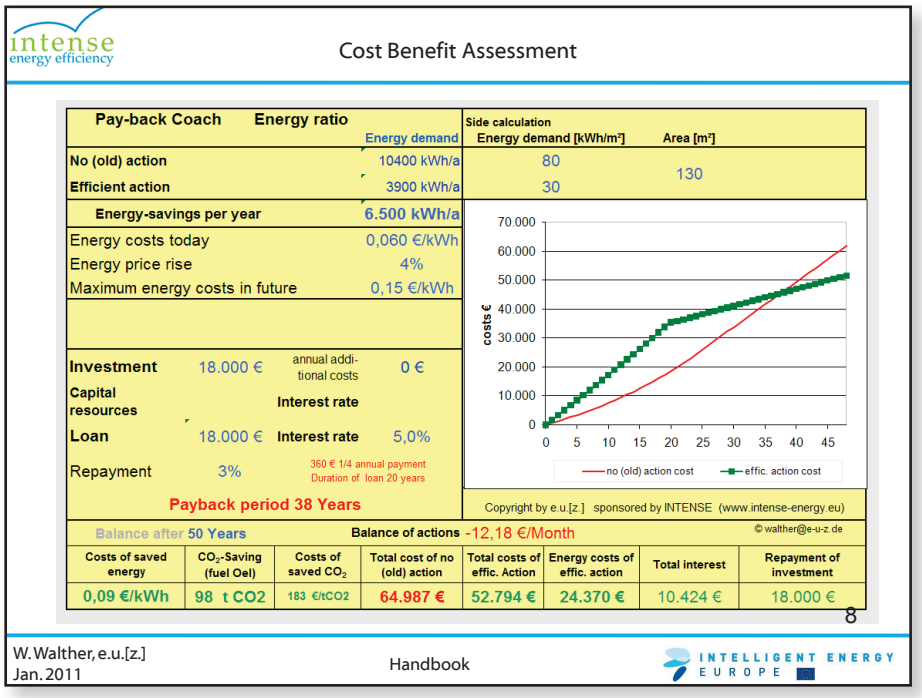
In the EXCEL chart, the calculations are made transparent. It is worthwhile taking a closer look at the individual columns and rows. The EXCEL-charts are available from e-mail: Walther@e-u-z.de



This graph shows an analysis and balance of the monthly financial situation for every year.

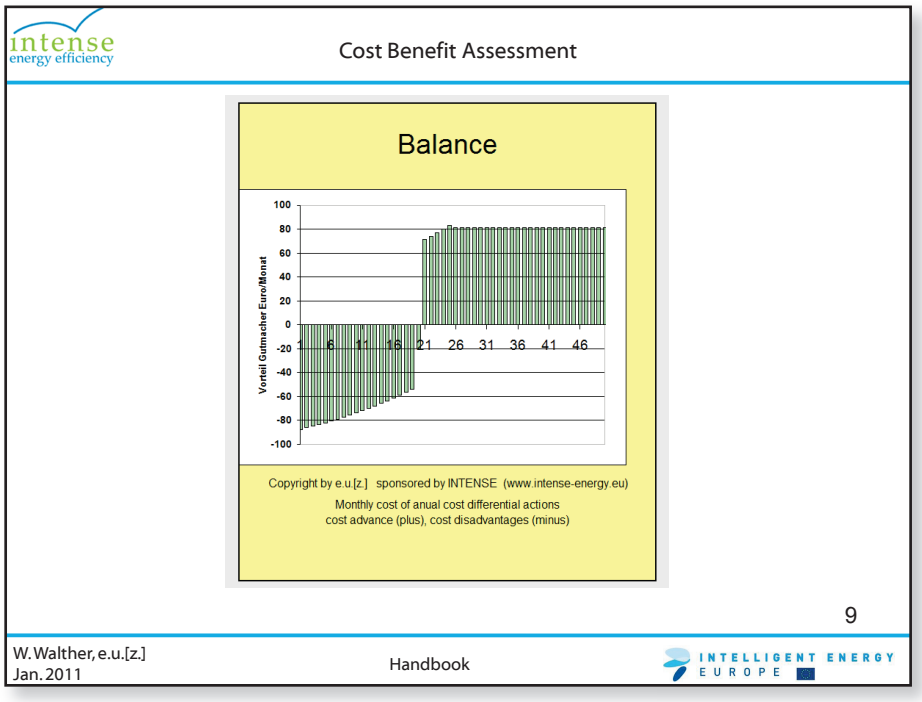
In the beginning the additional cost per month amounts to only 17 euro/month and decreases to 0 € in year 7.

After the 8th year, the additional cost turns into a positive value and continues to increase until year 21. After the 21st year, the financial cost amounts to more than 140 euro because there is no loan to repay.



This slide shows the cost performance result of two strategies regarding the whole building by using the energy ratio kwh/m^2. In the graph the cost performance (energy costs) of an "normal new house" (no action) is shown and the cost performance of an "passive house" (efficient action) including an investment (18.000€) made through a line of credit with an interest rate of 5%. For the first 38 years, the cost performance of the energy-efficient strategy is slightly above the old strategy. After 20 years the credit is repaid (kink in the green curve) and only the lower energy costs are left to be paid. Thus we have a payback period of 38 years. After the 39th year, the cost performance falls below the red curve (break-even line). The values in the side calculation show input values that describe the status of the energy-ratio and the heating area. A balance and assessment are performed for after 50 years (lifetime). On average 12.18 euro per month are saved over 38 years.

In the EXCEL chart, the calculations are made transparent. It is worthwhile taking a closer look at the individual columns and rows.



This graph shows an analysis and balance of the monthly financial situation for every year.

In the beginning the additional cost per month amounts to only 90 euro/month and decreases to 0 € in the next 21 years.

After the 22nd year, the additional cost turns into a positive value, that means that you save every month 80 euro with regard to the no-action curve.

In summary, we can say that

… the additional cost is low.
… after the payback period the financial benefit is much greater than the initial additional financial cost.
… energy-saving strategies are always economical when the period under consideration is chosen sufficiently long.
… taking action makes sense from a purely physical as well as mathematical perspective.