Best practices of funding possibilities for energy efficiency measures in buildings

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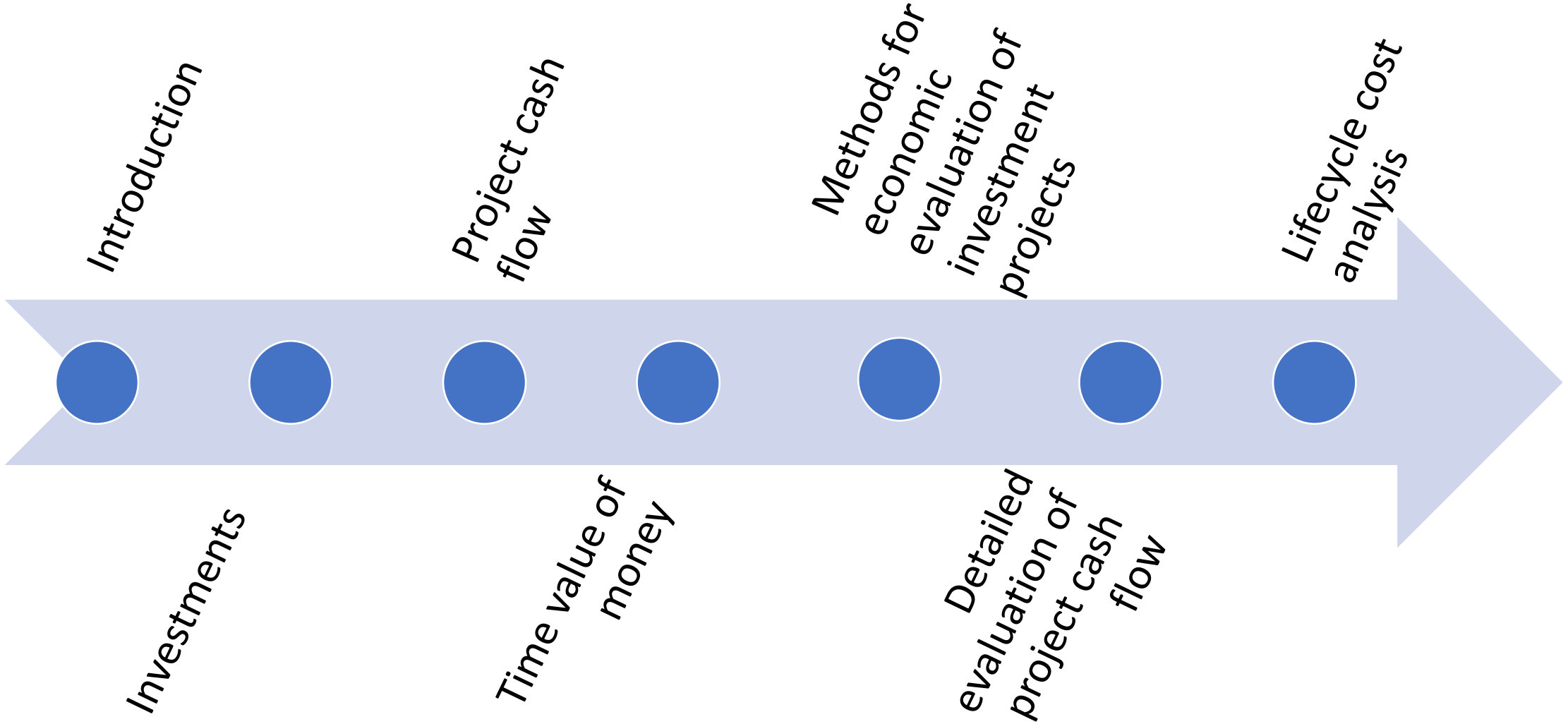


Introduction

- The retrofit measures aimed at enhancing the energy efficiency and the environmental impact of buildings do largely pay for themselves on the basis of energy savings, and consequent savings in expense, obtained thanks to the effects of their implementation.
- A proper economic evaluation of the EE actions is of great importance as one of the key elements of the decision-making process among various possible scenarios.
- Basic concepts of economic evaluation of investments in energy efficiency and in the use of renewable energy sources for building supply will be presented in this session.

Introduction

- To make a choice between the different scenarios of retrofit measures, and to assess what is actually convenient from the economic point of view, it is necessary to make a detailed COST vs. BENEFIT analysis for each of the measures considered.
- Various economic parameters must be considered: life cycle of the investment, the financing costs, the fluctuations of the costs related to energy, risks, taxes, etc.
- Expectations may differ:
  - for the end-users, the cost reduction whilst obtaining the same service level is utmost important and
  - For utilities/ESCOs the objective is the profit maximisation achieved through the more profitable business of providing as much energy as possible

Economic parameters

- **Initial investment (I_0)** – sum of all the costs to be sustained for the complete realisation of a given action, up to the final delivery (e.g., design, purchase of energy efficient systems/components, etc.)
- **Costs (C_t)** – costs of action at a time t (months/years) – initial investment costs and annual costs, including running costs, replacement costs for repair/change of components of systems:
  - Running costs
  - Maintenance costs
  - Administration and general costs
  - Energy costs
- **Benefits (B_t)** – benefits achieved as a result of action in time t – cost savings achieved thanks to a reduction of energy bills to be paid
- **Net savings (S_t)** – benefits obtained as a result of action to improve energy efficiency net of any maintenance cost or scheduled repair

  $S_t = B_t - C_t$

- **Calculation period (T)** – span considered for the calculation and it could be:
  - The lifespan of the retrofit measure (in years)
  - Lifespan of the complex of the retrofit measures (retrofit scenario)
  - Maximum time for which one is willing to support the investment
- **Discount rate (r)** – indicates the value of money at different times. It is used to determine the present value of money that will occur in the future, generated by an investment.

  $r = i + f - f'$

  i – inflation rate (annual depreciation of the currency expressed in %

  f – real cost of money (capital) gross of the direct taxes

  f' – the annual rate of change in the energy price

Investment

Investment – using (spending) money in order to gain economic benefits (profits)

Division:

- Financial – stocks, bonds, shares,… high liquidity!
- Real – transferring money in other forms of property – lowering liquidity of the company
  - Projects in energy sector
  - Energy efficiency projects

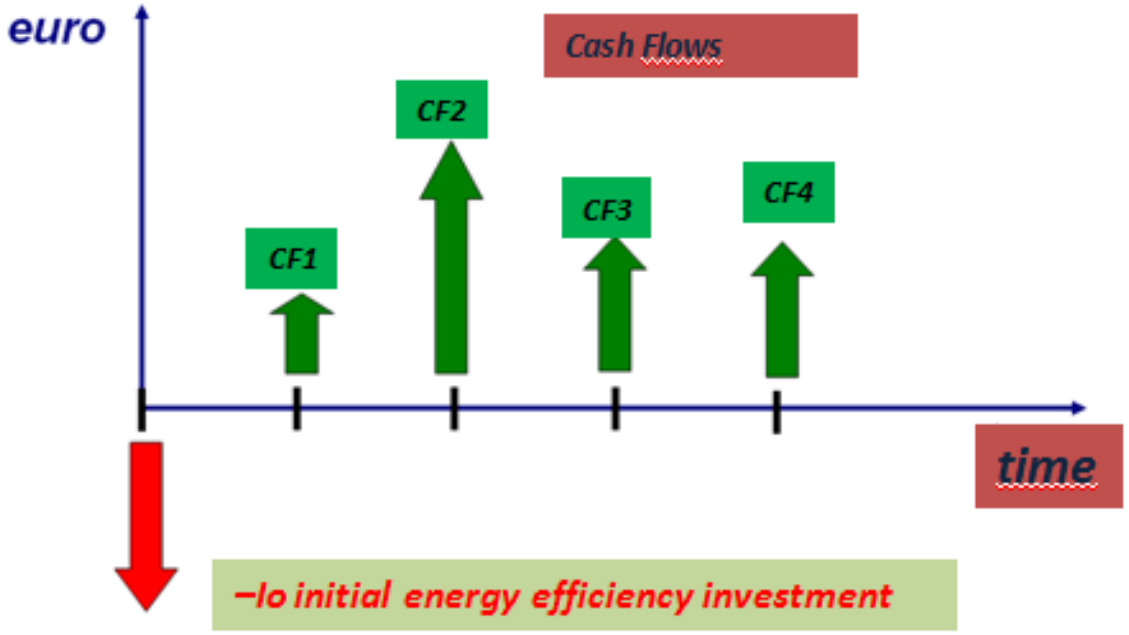
Cash Flow Analysis

- In energy audits it is important to account for the total cash receipts (REVENUES) and disbursements (EXPENDITURES) associated with an implementation of retrofit measures for each period during the calculation period

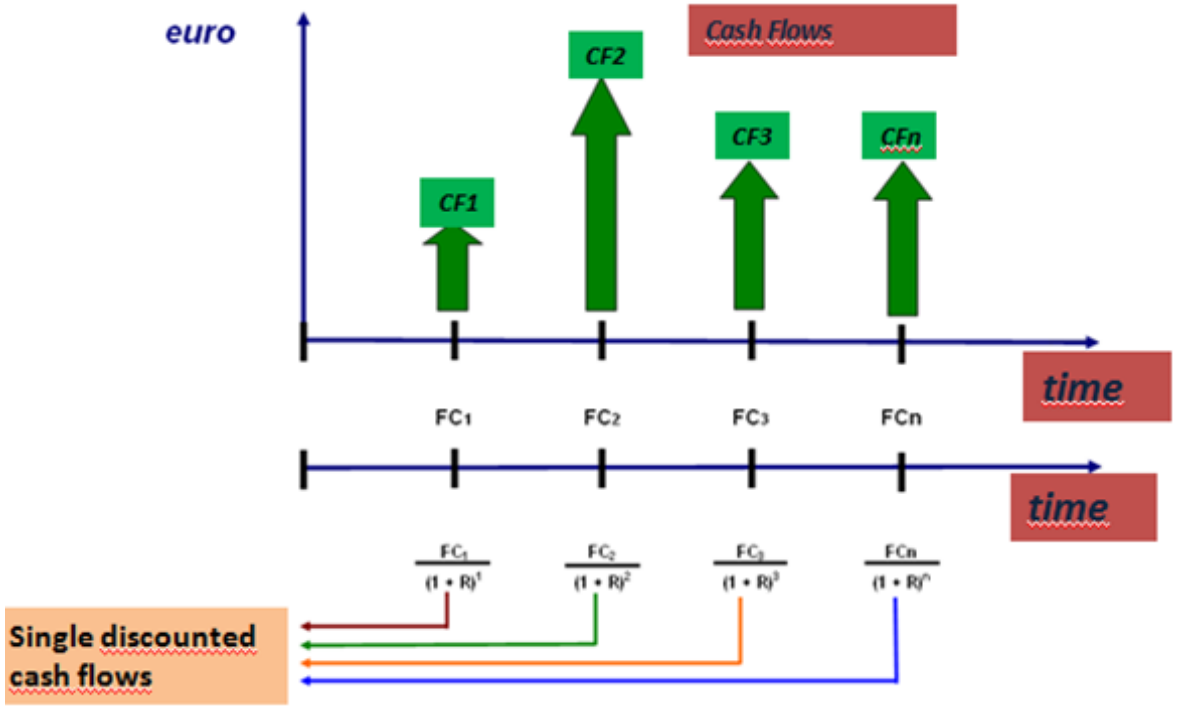
  net CASH FLOW (CF) = revenues - expenditures

- An accurate accounting of all the CFs should be performed over the lifetime of project
- Cash flow may be evaluated in real terms or in discounted terms

Cash Flow Analysis – CF diagram



real terms

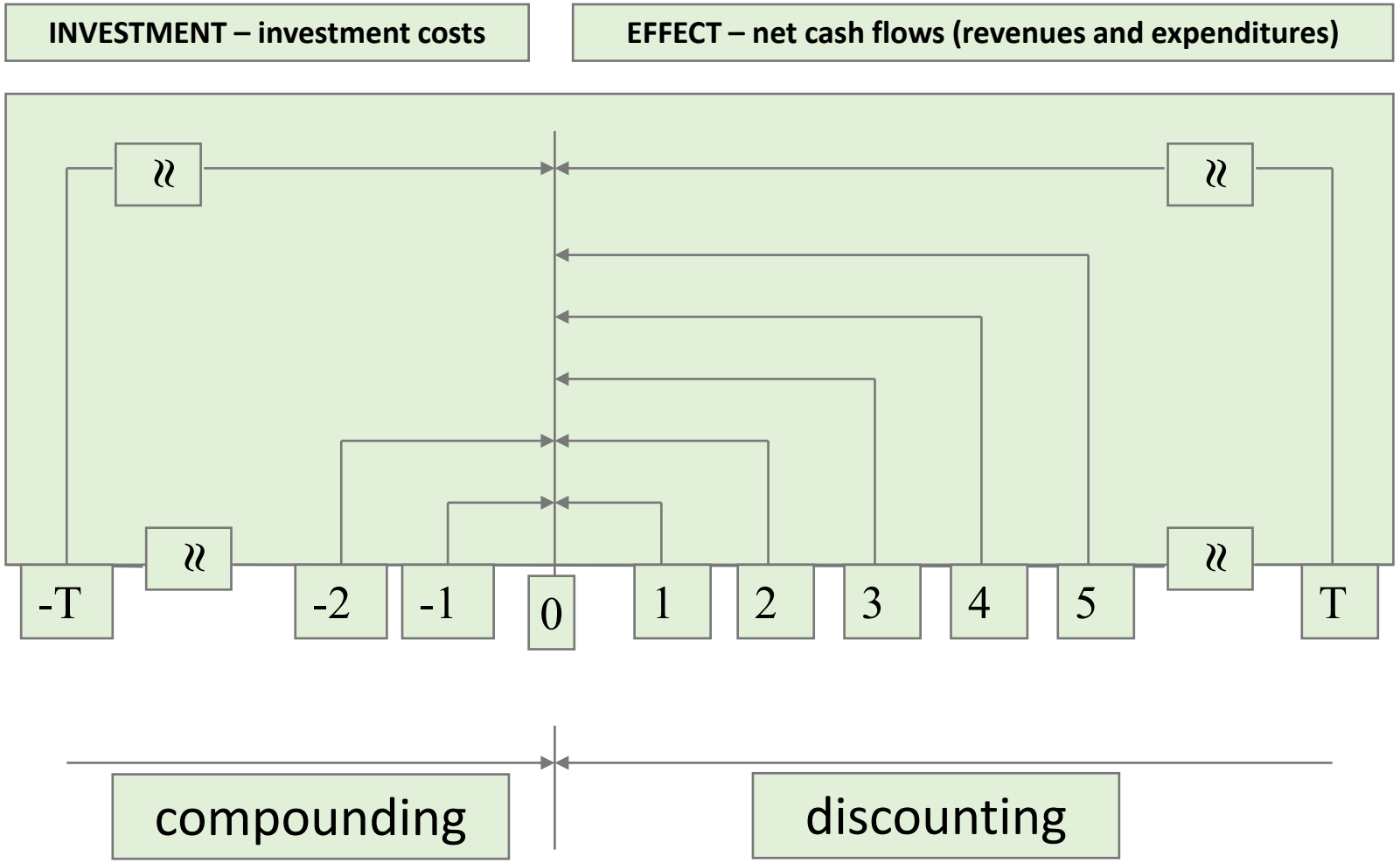


discounted terms

Time value of money

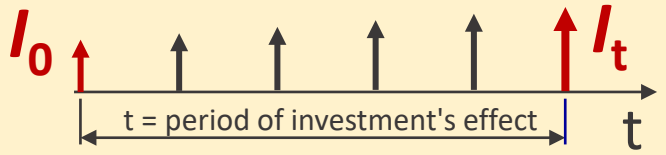
- Is 2,000 $ worth today more than 2,000 $ in a year?
- Inflation indicates a general rise in price levels (almost always positive – price increases)
  - The inflation rate tells how much percentages has the value of a currency decreased in the past year in relation to a particular “consumer basket”
- Other reason why 1 $ tomorrow is work less than 1 $ today are:
  - Advantage is given to possibility to spend money today rather than tomorrow
  - Future brings risks and risks diminish the value of money
- Time value of money is measured with the DISCOUNT RATE
- **Discounted cash flow is the basis for all financial analysis!**

Compounding Factors



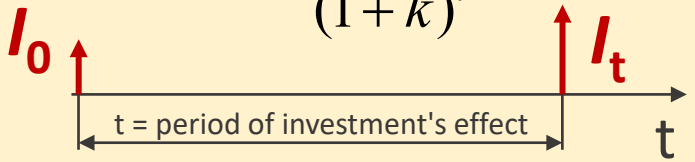
Compounding - Bringing the value of cash flows down to the future value

$$I_t = I_0 \cdot (1+k)^t$$



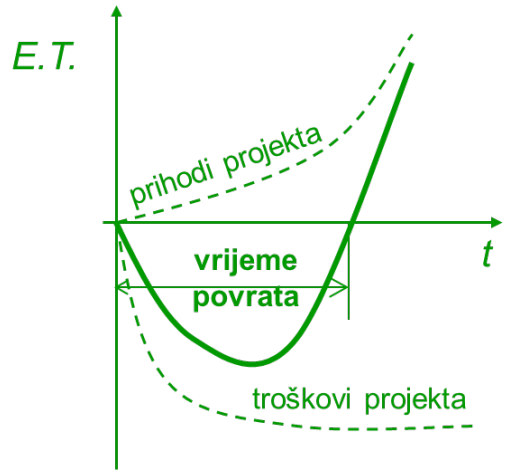
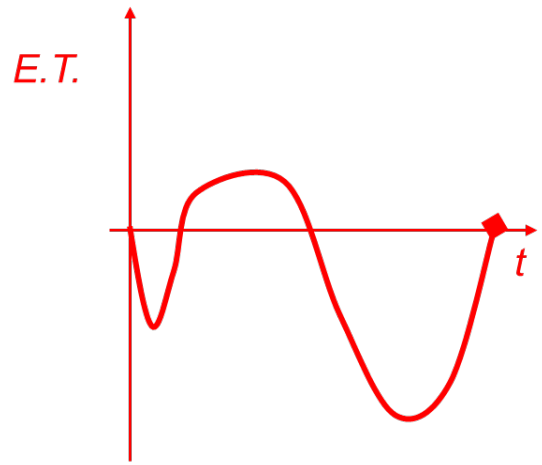
Discounting - Bringing the value of future cash flows to the present value

$$I_0 = \frac{I_t}{(1+k)^t}$$



I_0 = present value; I_t = value after t years;
k = interest rate
(1+k) = interest factor; 1/(1+k) = discount factor

Cash Flow Analysis – types

Projects with standard cash flow:	Projects with non standard cash flow:
	
• initial negative expenditure, followed by a series of positive revenues • one change of the sign of cash flow function	• initial negative expenditure, followed by series of positive revenues, with project closure expenditures at the end • two or more changes of the sign of cash flow function

Time and money – interest account

- Assume you have deposited 1,000 $ at your savings account at the beginning of the year, with annual interest rate i = 0.1 = 10%

- After a year, you will have

  $1{,}000\ (1 + i) = 1{,}100\ \$$

- after one more year, you will have

  $1{,}100\ (1 + i) = 1{,}000\ (1 + i)^2 = 1{,}210\ \$$

- and so on…, after N years you will have

  $1{,}000\ (1 + i)^N\ \$$

- where expression **(1 + i)** is called **INTEREST FACTOR**

Time and money – present value

- The same is valid contrariwise to the interest account!
- Ask yourself how much K $ that you will receive in N years is worth today with interest factor (1 + i)? Obviously:

$$K_0 = \frac{K}{(1+i)^N}.$$

- K0 is **PRESENT VALUE** of amount K that you will receive in N years with discount rate i
- Factor 1/(1 + i) is called **DISCOUNT FACTOR**
- Interest rate i applied for discounting depends on what is being discounted

Economic Indicators and Methods

- Payback period
- Discounted payback period
- Net present value (NPV)
- Internal rate of return
- Profitability index
- Annuity
- Life-Cycle Cost Method

Payback period

- The most popular economic indicator, being easier to understand for non-experts
- The information returned is the time in which the investment can be paid off, corresponding to the number of years in which the benefits equal the costs of its implementation
- The time value of money is neglected (treats the cash flows made in different time equally)
- Does not analyse period after the investment is repaid
- Acceptable values for simple payback periods are typically significantly shorter than the lifetime of the project
- Payback period is not a measure of profitability!

Payback period

$$I = \sum_{t=1}^{t_p} V_t = \sum_{t=1}^{t_p} (P_t - Z_t)$$

- P_t – annual revenues
- Z_t – annual expenditures
- V_t – net annual cash flow
- I – investment
- T_p – payback period – period needed to repay the investment (ration investment/savings in case of equal annual net cash flows)

criteria: min t_p, $t_p < t_z$

(project with the lowest payback period should be chosen)

Discounted payback period

$$I = \sum_{t=1}^{t_p} \frac{V_t}{(1+k)^t} = \sum_{t=1}^{t_p} \frac{(P_t - Z_t)}{(1+k)^t}$$

- P_t – annual revenues
- Z_t – annual expenditures
- V_t – net annual cash flow
- I – investment
- T_p – payback period
- k – discount rate

criteria: min t_p, $t_p < t_z$

(project with the lowest payback period should be chosen)

Example

You have installed a new boiler for your heating system, which costed 20.000 €. Your estimated annual energy cost savings are 5.000 €. What is the payback period of this investment?

1	40 years
2	3 months
3	4 years
4	Not possible to determine.
5	Possible to determine, but I don’t know.

Net present value

- The net present value (NPV) or net present worth (NPW) of a time series of the cash flows (CFs), both incoming and outgoing, is defined as the sum of the present values of the individual CFs.
- NPV is one of the most often used economic indicators for the evaluation of energy retrofit projects.
- If NPV > 0, the investment would add value and the project may be accepted whereas if NPV < 0, the investment would subtract value and the project should be rejected. If NPV = 0, the investment would neither gain nor lose value so the decision should be based on other criteria.
- The higher is the NPV, the more economically sound is the project.

Net present value

- Bringing all cash flows down to the present value

General	$S_0 = \sum_{t=1}^{T} \frac{V_t}{(1+k)^t} - I_0$
Equal cash flows (e.g. equal annual energy cost savings)	$S_0 = V_t \frac{(1+k)^t - 1}{(1+k)^t \cdot k} - I_0$

Net present value

- NPV takes time value of money into account
- NPV takes into account the whole lifetime of the project, not only up to the point of investment return
- Realistically evaluates the values of different projects
- Positive net present value means increase of the value of the company
- Sensitive to the choice of discount rate

If the project has negative NPV, it needs co-financing in order to come to the borderline profitability in the lifetime (NPV = 0)

$$co - financing\ rate = \frac{NPV\ (i, N)}{R_0}$$

Internal rate of return

- The internal rate of return (IRR), also called discounted CF rate of return (DCFROR) or rate of return (ROR) is a ROR used in capital budgeting to measure and compare the profitability of investment.
- The term *internal* refers to the fact that its calculation does not incorporate environmental factors (e.g., the interest rate or inflation).
- IRR, as the index of profit, has the advantage of being very useful when comparing different projects.
- If the IRR is greater than the cost of capital, the project could be accepted, if the IRR is less than the cost of capital then the project should be rejected.

Internal rate of return

- Discount rate that makes net present value equal to zero

$$S_0 = 0 \rightarrow \sum_{t=1}^{T} \frac{V_t}{(1+R)^t} - I_0 = 0$$

$$I_0 = \sum_{t=1}^{T} \frac{V_t}{(1+R)^t}$$

Internal rate of return

- IRR takes time value of money into account
- IRR takes into account the whole lifetime of the project
- Objectively determined the discount rate
- Iterative calculation (use of calculation tools)

Profitability index

- The profitability index (PI), also known as profit investment ration (PIR) and value investment ration (VIR), is equal to the ration between the discounted benefits and costs discounted.
- If PI is greater than 1, the project could be accepted.
- The PI is a very useful indicator for comparison between multiple projects.
- If there is a need to choose between multiple projects, the most economically advantageous, it would not be sufficient to identify it from having a greater NPV. One must assess which of the different indices expresses the higher profit.

Profitability index

- Profitability index takes into account time value of money

$$P_I = \frac{\sum_{t=1}^{T} \frac{V_t}{(1+k)^t}}{I} \qquad P_I = \frac{V_t \cdot \frac{(1+k)^T - 1}{(1+k)^T \cdot k}}{I}$$

- Criteria: $P_I > 1$, max P_I
- Supplements net present value: between projects with equal or similar NPVs, it prefers those projects having lower investment costs

Profitability index

- Benefit-cost ratio:

$$B_C = \frac{\sum_{t=1}^{T} \frac{{}_cP_t}{(1+k)^t}}{\sum_{t=1}^{T} \frac{{}_cI_t}{(1+k)^t} + I}$$

- ${}_cP_t$ – annual revenues
- ${}_cI_t$ – annual expenditures
- Favours less capital intensive projects

Annuity

- Benefits and costs are not viewed in their total present value but in average annual amounts
- All cash amounts are reduced to the average annual size with annuity factor:

$$a = \frac{(1+k)^t \cdot k}{(1+k)^t - 1}$$

- Annuities are calculated by applying factor to the present value of all cash flows (investment and net cash flows)

$$A_i = I \cdot a$$

$$AV = a \cdot \sum_{t=1}^{T} \frac{V_t}{(1+k)^t}$$

$$A_v \geq A_i$$

Economic Indicators and Methods - remarks

- All methods have their pros and cons
- There is no best method
- It is good to use more than one method (especially when there are several investment options under consideration)
- For start – simple payback period
- For more detailed analysis – NPV and IRR
- Carefully determine the discount rate!

Discount rate

- Discount rate I different for every company
- It is determined as the Weighted Average Cost of Capital (WACC)
- WACC is the cost which company expects in financing its assets
- WACC is a discount rate to be used when calculating NPV
- How can a company ensure money for investment?
  - Shares, bonds, loan, own source (equity), etc.
- Every component of capital has its own cost
  - E – equity
  - D – debt
  - R_e – price of equity
  - R_d – price of loan
  - T_c – corporate tax

$$WACC = \frac{E}{E+D} * R_e + \frac{D}{E+D} * R_d * (1 - T_c)$$

Detailed evaluation of the project cash flow

- For energy efficiency projects, annual net cash flow is represented by energy cost savings (reduction in energy bill)
- Energy savings can be quite accurately calculated
- Future energy prices are unknown – must be forecasted
- Financing model of the project must also be taken into account:
  - It is not the same if the project is financed by own sources or by the bank loan
  - Loan has additional costs (interests)
- In detailed cash flow analysis profit tax, other taxes or tax relives should be taken into account

Project cash flow form

Cash flow		Year										
		0	1	2	3	4	5	6	7	8	9	10
A	**Investment**											
	Financing:											
B	Own financing											
C	Loan											
D	Principal											
E	Interest											
F	**Savings:**											
G	Total savings											
H	Operational costs											
I	**Net savings**											
J	Amortisation											
K	Savings before tax											
L	Tax											
M	Tax relieves											
N	**Net savings after tax**											
O	**Net cash flow**											
P	Accumulated cash flow											
Q	Discount factor											
R	Present value											
S	Accumulated present value											

Life-Cycle Cost Method

- The life-cycle cost (LCC) method is the most commonly accepted method to assess the economic benefits of energy efficiency projects over their lifetime.
- The method is used to evaluate at least two alternatives of a given projects (e.g., evaluate two alternatives for the installation of new HVAC systems).
- First step is to identify all costs associated with the action (e.g., initial installed cost, maintenance costs, operating costs including energy, fuel escalation rates, inflation, interest on the investment, salvage value and other lifetime expenses for the equipment).
- All costs are multiplied by their single payment present value factor over the life of the intervention: $P/F = (1 + r)^{n-1}$.
- The sum of all the present values is called the life cycle cost.

Sensitivity analysis

- Results of economic evaluation of investment projects are uncertain as they are based on future values of variables that are not exactly known in the present
- Typical examples of uncertain data are:
  - Life time of project
  - Investment costs
  - Energy cost saving potential
  - Energy price increase
  - Interest and discount rate
  - Exchange rate
- The aim of sensitivity analysis is to quantify economic consequences of alternative values of key input variables

Conclusion

- Always determine economic indicators for proposed energy efficiency measures
- Define and check:
  - Implementation costs (investment)
  - Estimated cost savings
  - Available incentives (potential reduction of investment costs)
  - Lifetime
  - Interest rates (for loan financing)
  - Discount rates (cost of capital)
  - Other input data

Q&As

Thank you for your attention!

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