Guideline for financial calculation methods

EFFECT4buildings Toolbox:
Financial calculations; Annex 2

The project "Effective Financing Tools for implementing Energy Efficiency in Buildings" (EFFECT4buildings) develops in collaboration with public building managers a comprehensive decision-making support toolbox with a set of financial instruments: **Financial calculation tools**; **Bundling**; **Funding**; **Convincing decision makers**; **Energy Performance Contract**; **Multi Service Contract**; **Green Lease Contract**; **Prosumerism**. The tools and instruments chosen by the project has the biggest potential to help building managers to overcome financial barriers, based on nearly 40 interviews with the target group. The project improves these tools through different real cases.

To make sure building managers invest in the best available solutions, more knowledge on different possibilities is needed as well as confirmation from colleagues that the solutions performs well. EFFECT4buildings mapped **technological solutions** for energy efficiency in buildings with the aim to share knowledge and experiences of energy efficiency solutions among building managers in the Baltic Sea Region.

This document includes a comprehensive guideline for financial calculation methods and example how to use them. Material provides easy presentations of several optional methods with clear numerical samples. Furthermore, the guideline can be used as an additional supporting material, when studying and sharing information regarding calculation methods for stakeholders. It can be used also individually as material for educational purposes to all possible interested parties.

Partners

EFFECT4buildings project is implemented with the support from the EU funding Programme Interreg Baltic Sea Region (European Regional Development Fund) and Norwegian national funding. The aim of the project is to improve the capacity of public building managers in the Baltic Sea Region by providing them a comprehensive decision-making support toolbox with a set of financial instruments to unlock the investments and lower the risks of implementing energy efficiency measures in buildings owned by public stakeholders. More information: http://www.effect4buildings.se/

Financial calculation methods

The primary purpose of the guideline is to assist building managers and other relevant stakeholders, who are operating with energy savings investments to understand the functionality of different financial calculation methods.

This guideline deals with calculation methods of payback period, cash flow, net present value and internal rate of return.

The net present value and the internal rate of return give a better picture of profitability of energy saving investment comparing to the direct payback period.

Payback period

Direct Payback period is a good and simple measure to evaluate energy efficiency investment profitability. However, it does not take in the account e.g. energy price or value of money, and it does not take in to account future profits. The method does not really show the profitability of the investment.

Payback period can be calculated by dividing the Investment with yearly (net)profits.
In case of EE investment, the investment shall be divided by yearly energy savings

More detailed study of following examples:

1) Heat recovery unit

- 30 000 eur initial investment gives yearly energy savings of 3 000 eur
- Payback period is 30 000 / 3 000 = 10 years

2) Geothermal heat pump

- 55 000 eur initial investment gives yearly energy savings of 5 000 eur
- Payback period is 55 000 / 5000 = 11 years

Cash flow analysis

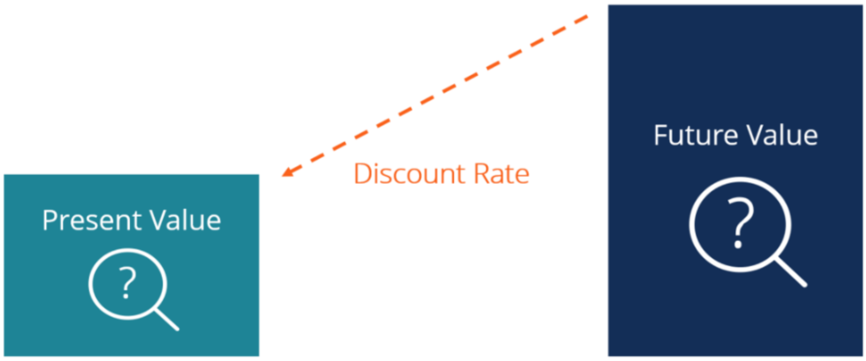
Cash flow estimation is the most difficult part of financial analysis. Investment costs are relatively easy to estimate, but instead of that energy savings and operation and maintenance costs are based on more extensive variables.

- As simplify Cash flow is the sum of costs and profits for each time period:
  In case of EE investment:
  Costs are sum of investment cost and other costs
  Profits are yearly energy savings

- can be also discounted with given discount rate.

Discount rate and discount factor

Discount rates are used to discount future cash flows back to the present.



Discount rates are a crucial factor in energy efficiency measures impact assessments.

Energy efficiency measures (e.g. in buildings) typically have relatively high upfront costs, which need to be recovered by savings over longer periods. Discount rates are thus used to attribute a value to future cash flows. The higher the discount rate, the lower the value we assign to future savings in today's decisions. Consequently, high discount rates make energy efficiency measures look less attractive.

Let's consider following example:

- We always prefer getting money today over getting it later in the future
- If we have a choise to get 100 eur now, or 100 + x eur next year, the rate 100/(100+x) is called discount factor
- Let's assume discount rate of 5 %. Following table shows present value of 100 eur cash flow in a 20 years timeline.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
discount factor	1	0,95	0,91	0,86	0,82	0,78	0,75	0,71	0,68	0,64	0,61	0,58	0,56	0,53	0,51	0,48	0,46	0,44	0,42	0,40
discounted cash flow	100	95,24	90,70	86,38	82,27	78,35	74,62	71,07	67,68	64,46	61,39	58,47	55,68	53,03	50,51	48,10	45,81	43,63	41,55	39,57

- With 5 % discount rate, 100 eur today is worth same as 39,57 eur in 20 years

Net present value

The sum of all discounted present and future cash flows is called net present value

In terms of net present value is significantly influenced by both the investment`s lenght of life cycle and discount rate and that is why them must be defined properly.

Previous two examples, Investment 1 and 2

Initial investment´s of 55 000 eur and 30 000 eur and savings of 5 000 eur and 3 000 eur in a year.

Following table shows the present values of those savings in 20 years with a discount rate of 5 %.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Investment 1	3000	2857	2721	2592	2468	2351	2239	2132	2031	1934	1842	1754	1671	1591	1515	1443	1374	1309	1247	1187
Investment 2	5000	4762	4535	4319	4114	3918	3731	3553	3384	3223	3070	2923	2784	2652	2525	2405	2291	2181	2078	1979

- Total discounted savings for the investment 1 are 39 256 eur

and for the investment 2 discounted savings are 65 427 eur in 20 years.

Net present values are then:

Investment 1: -30 000 + 39 256 = 9 256 eur

Investment 2: -55 000 + 65427 = 10 427 eur

Internal rate of return

Internal rate of return (IRR) for an investment is the discount rate at which the net present value of the investment is zero. An investment is profitable if it has a high internal rate of return. Usually a company sets itself a criterion that requires investment projects to exceed a certain value internal rate of return.

As regards the internal rate of return, the profitability of an investment is significantly influenced by the investment review period used in the calculation, so it needs to be properly defined.

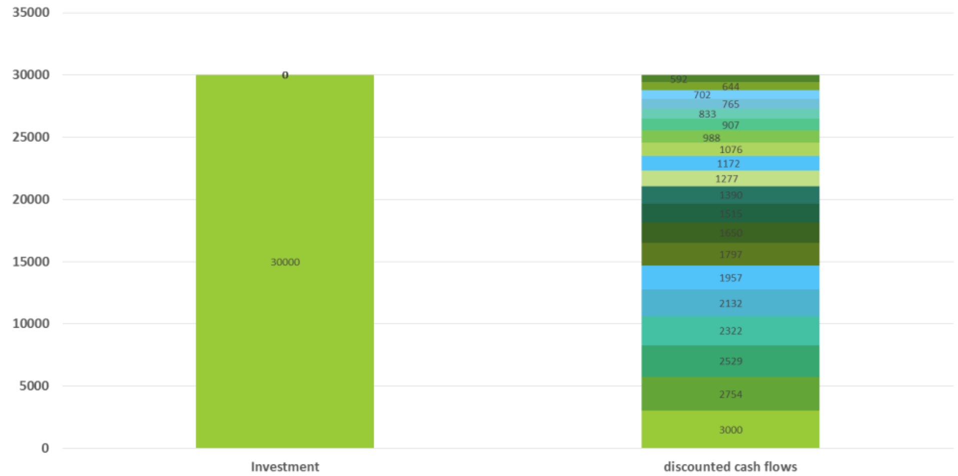
Internal rate of return is the discount rate that makes investments net present value to 0.

Sum of the discounted cash flows (energy savings) equals the initial investment.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	sum
discount factor	1,00	0,92	0,84	0,77	0,71	0,65	0,60	0,55	0,50	0,46	0,43	0,39	0,36	0,33	0,30	0,28	0,25	0,23	0,21	0,20	
discounted cash flow	3000	2754	2529	2322	2132	1957	1797	1650	1515	1390	1277	1172	1076	988	907	833	765	702	644	592	30000

Example Investment 1

- Internal rate of return for the investment 1 is 8,9 %
- Internal rate of return for the investment 2 is 7,4 %



Example investment 1

Length of life cycle

Lenght of life cycle of an investment is the time at which the investment is used and fulfills its intended purpose, and this is called technical lifetime.
The economic life of the investment can also be selected as the lenght of life cycle. There is a clear difference between the two and the period of consideration used in the calculation plays a major role in the profitability of the investment.

Length of life cycle can be:

• Technical lifetime: The period over which the investment object is usable in its intended use. The technical life can be extended or at least maintained by regular maintenance and servicing of the system or device

or

• Economical age: At what point does a new machine / building begin to be more efficient or energy efficient than the old one, and the device or system is worth replacing due to economic terms

or

• Life cycle, that is based on Experience from previous investments

Summary

Investment 1

- initial investment of 30 000 eur
- yearly savings of 3000
- payback period of 10 years
- IRR 8,9 %
- net present value 9256 eur

Investment 2

- initial investment of 55 000 eur
- yearly savings of 5000
- payback period of 11 years
- IRR 7,4 %
- net present value 10 427 eur

Example cases:

We have picked two different cases of renovation (one successful and another unsuccessful) and with these cases we present different financial calculation methods.

Simple pay back time

Case 1:

Tampere Hall: Heat recovery adding to ventilation machines

- Energy efficiency investment : **180000€**
- Decrease costs of Heating **520 000 kWh/year** (31200€/year)
- Price of heat energy : **0,06€/kWh**
- Specific emissions of CO2 (heating) : **0,16 (kgCO2/kWh)**
- Length of life cycle : **20 years**
- Discount rate : **2 %**

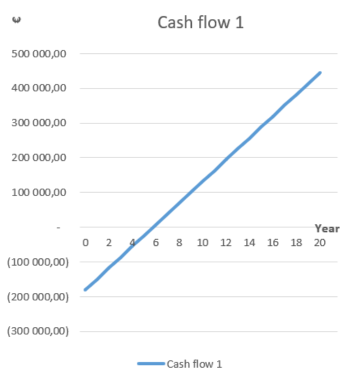
Case 2:

Tampere Hall:
Current lighting replacement for more powerful LED lighting in concert halls

- Energy efficiency investment : **176000€**
- Decrease cost of electricity: **105 000kWh/year** (9450 €/year)
- Price of electricity: **0,09 €/kWh**
- Specific emissions of CO2 (electricity) : **0,20 (kgCO2/kWh)**
- Decrease cost of Heating: **-91 000kWh/year** (-5460 €/year)
- Price of heat energy: **0,06 €/kWh**
- Specific emissions of CO2 (heating) : **0,16 (kgCO2/kWh)**
- Decrease cost of Cooling: **28 000kWh/year** (840 €/year)
- Price of cooling energy: **0,03 €/kWh**
- Specific emissions of CO2 (cooling) : **0,015 (kgCO2/kWh)**
- Length of life cycle: **15 years**
- Discount rate: **2%**

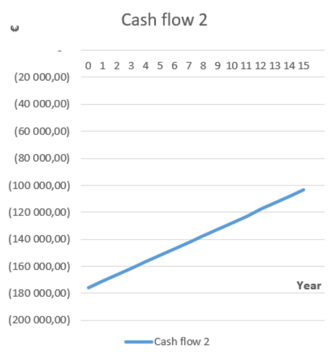
Cash flow

Heat recovery adding to ventilation machines



Year	€
0	- 180 000
1	- 148 800
2	- 117 600
3	- 86 400
4	- 55 200
5	- 24 000
6	7 200
7	38 400
8	69 600
9	100 800
10	132 000
11	163 200
12	194 400
13	225 600
14	256 800
15	288 000
16	319 200
17	350 400
18	381 600
19	412 800
20	444 000

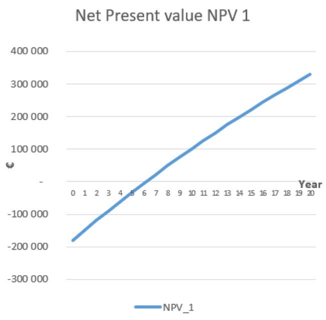
Current lighting replacement for more powerful LED lighting in concert halls



Year	€
0	- 176 000
1	- 171 170
2	- 166 340
3	- 161 510
4	- 156 680
5	- 151 850
6	- 147 020
7	- 142 190
8	- 137 360
9	- 132 530
10	- 127 700
11	- 122 870
12	- 118 040
13	- 113 210
14	- 108 380
15	- 103 550

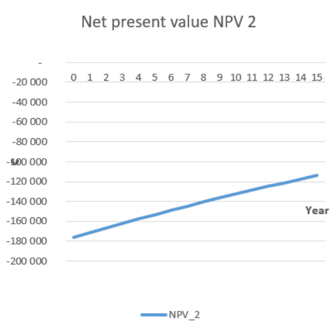
Net present value

Heat recovery adding to ventilation machines



Year	
0 -	180 000
1 -	149 412
2 -	119 423
3 -	90 023
4 -	61 199
5 -	32 940
6 -	5 235
7	21 926
8	48 555
9	74 662
10	100 257
11	125 350
12	149 951
13	174 069
14	197 715
15	220 897
16	243 625
17	265 906
18	287 751
19	309 168
20	330 165

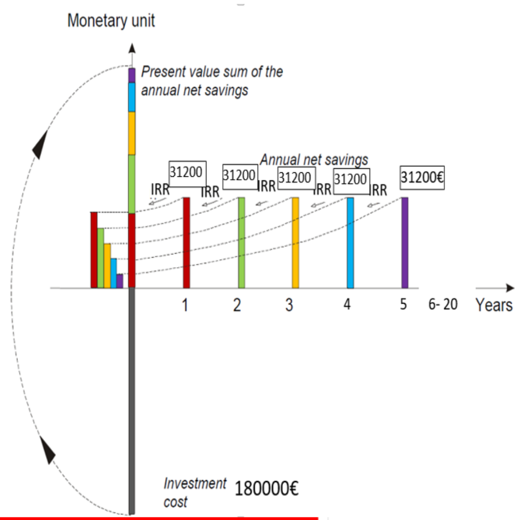
Current lighting replacement for more powerful LED lighting in concert halls



Year	
0 -	176 000
1 -	171 265
2 -	166 622
3 -	162 071
4 -	157 609
5 -	153 234
6 -	148 945
7 -	144 740
8 -	140 618
9 -	136 576
10 -	132 614
11 -	128 730
12 -	124 921
13 -	121 187
14 -	117 527
15 -	113 938

Internal rate of return

Heat recovery adding to ventilation machines



Internal rate of return, IRR (%)	16,52 %

Training: use of Financial calculation tool

Background information:

- Tampere Hall participated in the Total Concept project to get more knowledge on which energy-efficient measures are profitable to_implement at the same time as the house extension 2015.
- This calculation training is focused on presenting individual parts of Tampere Hall`s energy renovation.
- We have picked two different cases of renovation (one successful and another unsuccessful).

- Basic informations

Name of building: **Tampere Hall**

Heating system: **District heating**

Cooling: **District cooling**

Ventilation system: **Exhaust ventilation**

- Energy amount before the renovation:

Heating energy demand = **3050 MWh**

Electricity demand = **2050 MWh**

Cooling energy demand = **290 MWh**

- Renovations:

Measure 1: **Adding HRU to a Small Concert Hall IV**

Measure 2: **Better Windows to the Expansion Part**

District heating costs = **0.06 (€/kWh)**

Specific emissions of CO2 (heating) = **0,16 (kgCO2/kWh)**

Option 1. Estimation for electricity price change **2,6 (%/year)**

Option 2. Estimation for electricity price change **6,0 (%/year)**

Energy Subsidies = **0 %**

Non- energy benefits = **0 €**

Finance interest rate = **0 %**

Discount rate= **2 %**

1. Adding HRU to a Small Concert Hall IV

- Change of purchased amount of heating energy **161 MWh / a**
- The investment **69 000 €**
- Length of life cycle **20 years**
- Maintenance cost = **2 (% of the investment cost/year)**

2. Replacing the North Glass Wall with Better Windows at the Expansion Part

- Change of purchased amount of heating energy **15,4 MWh / a**
- The investment **128 000 €**
- Length of life cycle **30 years**
- Maintenance cost = **0,5 (% of the investment cost/year)**

Answers

DECREASE ENERGY/ WATER COSTS	Adding HRU to a Small Concert Hall IV	Better Windows to the Expansion Part
Decrease of heating cost(€/year)	10 465	1 001
Decrease of electricity cost (€/year)	0	0
Decrease of cooling cost (€/year)	0	0
Total decrease of energy costs/year (€/year)	10 465	1 001
Decrease of water cost (€/year)	0	0
Total decrease of costs during Life-cycle (€)	209 300	30 030

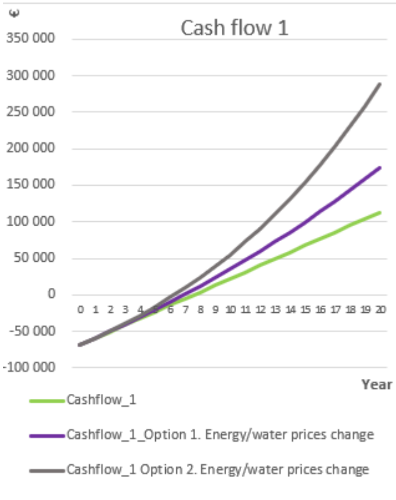
INCREASE COSTS	Adding HRU to a Small Concert Hall IV	Better Windows to the Expansion Part
Investment cost of measures - energy subsidies (€)	69000	128000
Maintenance costs/year (€/year)	1 380	640
Increase of costs during Life-cycle (€)	96 600	147 200

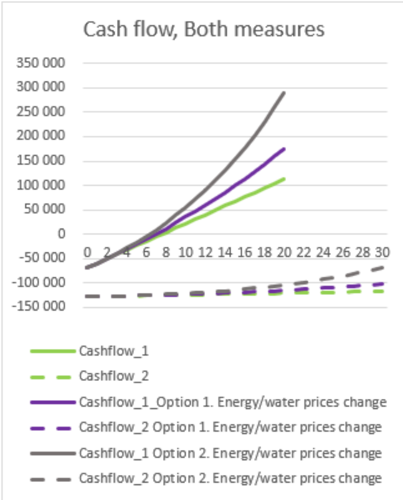
COSTS OF LIFE CYCLE	Adding HRU to a Small Concert Hall IV	Better Windows to the Expansion Part
Life cycle result (€)	112 700	-117 170

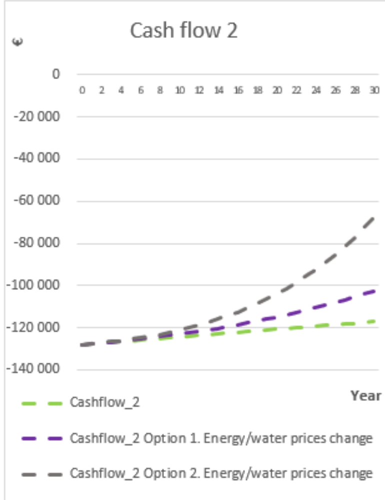
REDUCTION OF CO2-EMISSIONS	Adding HRU to a Small Concert Hall IV	Better Windows to the Expansion Part
Reduction of CO2- emissions (kgCO2/year)	25 760	2 464
Reduction of CO2-emissions / CO2-emissions before measures (%)	5 %	1 %
Reduction of CO2- emissions during the Life cycle (kgCO2)	515 200	73 920

FINANCIAL RESULTS	Adding HRU to a Small Concert Hall IV	Better Windows to the Expansion Part
Pay back time (year)	6,59	127,87
Internal rate of return, IRR (%)	11,74 %	-11,76 %
Internal rate of return, IRR (%), Option 1. Energy/water prices change	14,56 %	-7,37 %
Internal rate of return, IRR (%), Option 2. Energy/water prices change	18,14 %	-3,41 %
Net Present Value, NPV (€)	79 553	-119 915
Net Present Value, NPV (€), Option 1. Energy/water prices change	125 513	-110 238
Net Present Value, NPV (€), Option 2. Energy/water prices change	211 478	-88 009
Cash flow (€)	112 700	-117 170
Cash flow (€), Option 1. Energy/water prices change	173 432	-102 546
Cash flow (€), Option 2. Energy/water prices change	288 361	-68 063

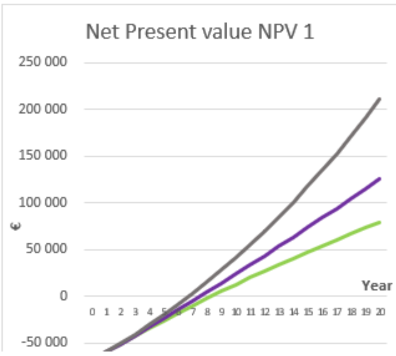
Adding HRU to a Small Concert Hall IV **Better Windows to the Expansion Part**

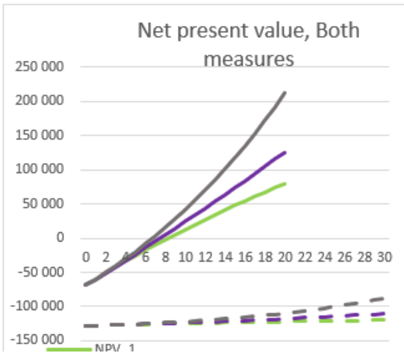


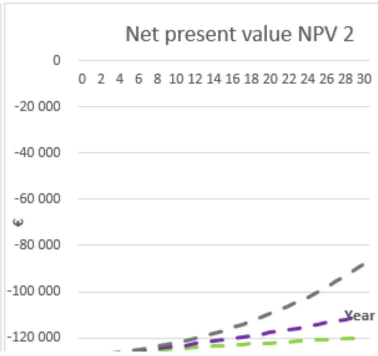




Adding HRU to a Small Concert Hall IV **Better Windows to the Expansion Part**







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