CE51 TOGETHER

D.T1.3.2 Master train the trainers – financial material

Version 1
03 2017

Cracow 21.02.2017 _ Train-the-Trainer Workshop

Development of the together training material
Financial training material

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Three steps to get things done

Step n.1: finding the money

- **Module N.1**
  - EU, national & regional financing schemes

- **Module N.2**
  - Alternative financing methods

Step n.2: checking figures and indicators of the business case

- **Module N.3**
  - Economic & financial assessment of the investment/action

- **Module N.4**
  - Development of the project financial documentation (budget, business plan…..)

Every business plan starts from the energy usage baseline ….which leads to an ICP (Investor Confidence Protocol) →

Step n.3: making things happen

- **Module N.5**
  - Ensuring project's bankability, viability and profitability → ICP introduction and structure

- **Module N.6**
  - Attracting & cooperation with potential investors → what ICP was built for

- **Module N.7**
  - Choosing optimal funding for EE projects

- **Module N.8**
  - Tendering procedures and green public procurement

FINANCING ENERGY EFFICIENCY IN PUBLIC BUILDINGS

FINANCIAL AND ECONOMIC ANALYSIS

Krakow, February 22nd 2017

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Aims of the session

- Learning objectives:
  - To understand how to assess energy efficiency projects from the financial and economic perspective
  - To understand how to assess the projects having multiple needs
  - To understand how to select the best alternative
- Expected outcomes:
  - Better knowledge of methods for the financial and economic as well as multi-criteria analysis
  - Better skills how to use these methods
  - Higher awareness of existing self-learning resources, e.g. online platforms, guides, software tools, case studies

Financial analysis

Background

- For each projects, several types of retrofit packages are possible
  - Which of these alternatives is the best?
  - When is the project attractive in economic/financial terms?
- The rational behind the financial analysis is that most activities lead to costs and benefits.
- From this perspective, it is assumed that an activity is undertaken if the total benefits exceed the costs.

Project-related costs and benefits

Costs

Costs of investment and Operation & maintenance costs

- Costs of investment are those incurred in getting the equipment installed and running: equipment purchase; installation costs: wiring and builders' work; checking and adjusting controls, etc.
- Operation and maintenance costs include the energy costs, water costs, regular cleaning, replacement of failed components, etc.

Benefits

Avoided costs

- These are usually the reductions in energy costs and in some cases reductions in maintenance costs.

The financial analysis of an energy efficiency project considers extra costs and benefits incurred vs the "business-as-usual" or "no action" scenario

Notes: The cost of collecting the information about the alternatives and making the decision are not usually considered as the costs of investments , these are referred as transaction costs.

Cost-benefit analysis (CBA)

- The CBA method aims to quantify and compare the costs and benefits of a project over the project lifetime.

Debt-financing 2

- Your municipality would like to replace a conventional incandescent bulb with a compact fluorescent lamp. The lighting is required for 500 hours per year. Electricity price is € 0.1/kWh. The characteristics of the lamps are below. Does the project worth it?

Business-as-Usual:	**Energy Efficiency:**
Incandescent lamp	**Compact fluorescent lamp (CFL)**
60 W	14 W
1 €	15 €
1 year	10 year

Example: better lighting

Year	Capital costs, €		Operation costs, €		Cash Flow	
	BAU	EE	BAU	EE	BAU-EE	
1	1.0	15.0	3.0	0.7	+ 1.0 - 15.0 + 3.0 - 0.7 =	-11.7
2	1.0		3.0	0.7	+ 1.0 + 3.0 - 0.7 =	3.3
3	1.0		3.0	0.7	+ 1.0 + 3.0 - 0.7 =	3.3
4	1.0		3.0	0.7	+ 1.0 + 3.0 - 0.7 =	3.3
5	1.0		3.0	0.7	+ 1.0 + 3.0 - 0.7 =	3.3
6	1.0		3.0	0.7	+ 1.0 + 3.0 - 0.7 =	3.3
7	1.0		3.0	0.7	+ 1.0 + 3.0 - 0.7 =	3.3
8	1.0		3.0	0.7	+ 1.0 + 3.0 - 0.7 =	3.3
9	1.0		3.0	0.7	+ 1.0 + 3.0 - 0.7 =	3.3
10	1.0		3.0	0.7	+ 1.0 + 3.0 - 0.7 =	3.3

60W x 500 h / 1000 x 0.1€/kWh = 3.0 €

124 x 500 h / 1000 x 0.1€/kWh = 0.6 €

1st method: simple payback period (SPB)

- Simple payback period is the amount of time required for an investment to generate cash flows sufficient to recover its cost.

$$SPB = \frac{Investment}{Benefit} \times 100\%$$

- An investment is worth undertaking if the simple payback period < some specified number of years
- The cut-off value should be shorter than the project lifetime

- Example: better lighting
  - 4 + 1.8/3.3 = 4.5 years is a short payback period - > accept

Year	Project Cash-Flow, €	Cumulated Cash-Flow, €	Payback, years
1	-11.7	-11.7	
2	3.3	-8.4	
3	3.3	-5.1	
4	3.3	-1.8	>4
5	3.3	1.5	<5
6	3.3	4.8	
7	3.3	8.1	
8	3.3	11.4	
9	3.3	14.7	
10	3.3	18.0	

SPB: pros and contras

- Advantage:
  - Easy to understand and communicate
  - It uses readily available accounting data
  - It reduces the project's exposure to risk and uncertainty by selecting the project that has the shortest payback period
- Disadvantages:
  - Ignores the time value of money
  - It does not consider the profitability of the projects
  - Fail to consider other risks
  - Requires an arbitrary cut-off point i.e. the acceptable SPB
    - Usually < 5 years
  - Ignores cash flows beyond the cut-off point

2nd method: simple rate of return

- The initial (simple) rate of return or the simple return on investment is the inverse of the simple payback period
- It calculates the ratio of the average annual profit to the original investment

$$\text{ROI} = \frac{(Benefits)/n}{Investment} \times 100\%$$

- Example: better lighting

  2.3/5.0 x 100% = 46% - > accept

Year	Costs, €	Benefits, €
1	14.0	2.3
2	-1.0	2.3
3	-1.0	2.3
4	-1.0	2.3
5	-1.0	2.3
6	-1.0	2.3
7	-1.0	2.3
8	-1.0	2.3
9	-1.0	2.3
10	-1.0	2.3
	Total: 5.0	Average: 2.3

ROI: pros and contras

- Advantages
  - Easy to understand and communicate
  - It uses readily available accounting data.
  - It considers the cash-flow over the whole project.
- Disadvantages
  - It does not consider the time value of money
  - An investment with high initial profits would be ranked equally with a project with high profits later if the average profit was the same.

3rd method: Net Present Value (NPV)

- If someone does not care where they receive 100€ now or 110 € a year from now, they have a time preference that can be expressed by a discount rate of 10%.
  - Assuming an interest rate of 10%, the PV of $100 three years from now is approximately $133.
- If someone has a time preference that can be expressed in a discount rate r, they are indifferent about receiving an amount of X now or an amount $X \times (1+r)^n$ in n year from now.
- Using this indifference, we can convert all current and future expenditures and receivables to the present situation and count them together:

$$\text{NPV} = \sum_{i=0}^{n} \frac{Benefits_i - Costs_i}{(1+r)^n}$$

where NPV is net present value of the project in year 0

$Benefits_i$ are the benefits and $Costs_i$ are the costs of the projects in year i, r is the discount rate and n is the lifetime of the project

Table of discount factors

Discount factor = $\frac{1}{(1+r)^n}$

j	i in %									
	1,0	2,0	3,0	4,0	5,0	6,0	7,0	8,0	9,0	10,0
1	.99010	.98039	.97087	.96154	.95238	.94340	.93593		.91743	.90909
2	.98030	.96117	.94260	.92546	.90703	.89000	.87344	.85734	.84168	.82645
3	.97059	.94232	.91514	.88900	.86384	.83962	.81630	.79383	.77218	.75131
4	.96098	.92385	.88849	.85480	.82270	.79209	.76290	.73583	.70843	.68301
5	.95147	.90573	.86261	.82183	.78353	.74726	.71299	.68058	.64993	.62092
6	.94205	.88797	.83748	.79031	.74622	.70496	.66634	.63017	.59627	.56447
7	.93272	.87056	.81309	.75992	.71068	.66506	.62275	.58349	.51703	.51316
8	.92348	.85349	.78941	.73069	.67684	.62741	.59201	.54027	.50187	.46651
9	.91434	.83676	.76642	.70259	.64461	.59190	.54393	.50025	.46043	.42410
10	.90529	.82035	.74409	.67556	.61391	.55839	.50835	.46319	.42241	.38554
11	.89632	.80426	.72242	.64958	.58468	.52679	.47509	.42888	.38753	.35049
12	.88745	.78849	.70138	.62460	.55684	.49687	.44401	.39711	.35553	.31863
13	.87866	.77303	.60095	.60057	.53032	.46884	.41496	.36770	.32618	.28966
14	.86966	.75788	.66112	.57748	.50507	.44230	.36782	.34046	.29925	.26333
15	.86135	.74301	.64186	.55526	.48102	.41727	.36245	.31524	.27454	.23939
16	.85282	.72845	.62317	.53391	.45811	.39365	.33873	.29189	.25187	.21763
17	.84438	.71416	.60502	.51337	.43630	.37136	.31657	.27027	.23107	.19784
18	.83602	.70016	.58739	.49363	.41552	.35034	.28586	.25025	.21199	.17986
19	.82774	.68643	.57029	.47464	.39573	.33051	.27651	.23171	.18449	.16351
20	.81954	.67297	.55368	.45639	.37689	.31180	.25842	.21455	.17843	.14864

Discount rate

$$\text{NPV} = \sum_{i=0}^{n} \frac{Benefits_i - Costs_i}{(1+r)^n}$$

- A 'discount rate' represents the 'preference for the present'
  - At lower the discount rates, the higher is present value
  - The higher the discount rate, the smaller the present value
    - At high discount rates, every project with an initial investment will have a negative net present value

- A factor that complicates the analysis is that value of money changes over time , generally decreasing through inflation. This could be corrected by taking the real discount rate instead of the actual (market) discount rate

$$r = R - i$$

NPV: decision-making rule

- An investment is worth undertaking if it creates value for its owners:
  - If NPV > = 0, accept
  - If NPV < 0, reject
- Example: better lighting
  - Assume the discount rate is 4%
  - NPV > 0 - > accept

Year	Project Cash-Flow, €	Discount Factor	Present Value, €
1	-11.7	0.96154	-11.3
2	3.3	0.92456	3.1
3	3.3	0.88900	2.9
4	3.3	0.85480	2.8
5	3.3	0.82193	2.7
6	3.3	0.79031	2.6
7	3.3	0.75992	2.5
8	3.3	0.73069	2.4
9	3.3	0.70259	2.3
10	3.3	0.67556	2.2
NPV			**12.3**

NPV: pros and contras

- The advantages:
- The NPV expresses all future cash-flows in today's values, which enables their direct comparisons.
- The NPV method allows for inflation and escalation.
- It looks at the whole project from start to finish.
- It can simulate project what-if analysis using different values.
- The disadvantages are:
- It uses a fixed interest rate over the duration of the project.
- Its accuracy is limited by the accuracy of the predicted future cash-flows and discount rates.
- It is biased towards short run projects.

4th method: Discounted payback period

- The discounted payback period is the amount of time required for an investment to generate discounted cash flows sufficient to recover its discounted cost.
- An investment is accepted, if discounted payback period is < some specified number of years. This cutoff is arbitrarily chosen.
- Example: better lighting
  - 4 + 2.4/2.7 = 4.9 years is a short payback period - > accept

Year	Present value, €	Cumulated present value, €	Discounted payback, years
1	-11.3	-11.3	
2	3.1	-8.2	
3	2.9	-5.3	
4	2.8	-2.4	> 4
5	2.7	0.3	< 5
6	2.6	2.9	
7	2.5	5.4	
8	2.4	7.8	
9	2.3	10.1	
10	2.2	12.3	

DPB: pros and contras

- Advantage:
  - Still fairly easy to understand and communicate.
  - Takes the time value of money into consideration.
- Disadvantages:
  - Requires an arbitrary cut-off point.
  - Ignores cash flows beyond the cut-off.
  - Biased against long-term projects.

5th method: Internal Rate of Return (IRR)

- The internal rate of return (IRR) is the discounted rate that makes the NPV of an investment zero.
  - The IRR method allows finding the interest rate that is equivalent to the financial returns expected from the project.
  - Once you know the IRR, one can compare it to the rates you could earn by investing this money in other projects.
    - If the IRR is less than the cost of borrowing used to fund the project, the project will clearly be a money-loser.
    - Therefore, the IRR should be at least several percentage points higher than the cost of borrowing, to compensate for its risk, time, and efforts associated with the project.
- The higher a project's internal rate of return, the more desirable it is to undertake the project.

IRR: procedure

1. Compute a discount factor called internal rate of return factor

$$Internal\ rate\ of\ return\ factor = \frac{Investment\ required}{Net\ annual\ cash\ flow}$$

2. Locate this discount factor in “present value of an 1€ annuity” table, the factor could be located in the line with the project lifetime
3. See the rate of return written at the top of the column in which the factor is written
4. Compare it with the minimum required rate of return

The present value of an 1€ annuity

Period	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	20%	24%	25%	30%
1	0.9901	0.9804	0.9709	0.9615	0.9524	0.9434	0.9346	0.9259	0.9174	0.9091	0.9009	0.8929	0.8850	0.8772	0.8696	0.8621	0.8333	0.8065	0.8000	0.7692
2	1.9704	1.9416	1.9135	1.8861	1.8594	1.8334	1.8080	1.7833	1.7591	1.7355	1.7125	1.6901	1.6681	1.6467	1.6257	1.6052	1.5278	1.4568	1.4400	1.3609
3	2.9410	2.8839	2.8286	2.7751	2.7232	2.6730	2.6243	2.5771	2.5313	2.4869	2.4437	2.4018	2.3612	2.3216	2.2832	2.2459	2.1065	1.9813	1.9520	1.8161
4	3.9020	3.8077	3.7171	3.6299	3.5460	3.4651	3.3872	3.3121	3.2397	3.1699	3.1024	3.0373	2.9745	2.9137	2.8550	2.7982	2.5887	2.4043	2.3616	2.1662
5	4.8534	4.7135	4.5797	4.4518	4.3295	4.2124	4.1002	3.9927	3.8897	3.7908	3.6959	3.6048	3.5172	3.4331	3.3522	3.2743	2.9906	2.7454	2.6893	2.4356
6	5.7955	5.6014	5.4172	5.2421	5.0757	4.9173	4.7665	4.6229	4.4859	4.3553	4.2305	4.1114	3.9975	3.8887	3.7845	3.6847	3.3255	3.0205	2.9514	2.6427
7	6.7282	6.4720	6.2303	6.0021	5.7864	5.5824	5.3893	5.2064	5.0330	4.8684	4.7122	4.5638	4.4226	4.2883	4.1604	4.0386	3.6046	3.2423	3.1611	2.8021
8	7.6517	7.3255	7.0197	6.7327	6.4632	6.2098	5.9713	5.7466	5.5348	5.3349	5.1461	4.9676	4.7988	4.6389	4.4873	4.3436	3.8372	3.4212	3.3289	2.9247
9	8.5660	8.1622	7.7861	7.4353	7.1078	6.8017	6.5152	6.2469	5.9952	5.7590	5.5370	5.3282	5.1317	4.9464	4.7716	4.6065	4.0310	3.5655	3.4631	3.0190
10	9.4713	8.9826	8.5302	8.1109	7.7217	7.3601	7.0236	6.7101	6.4177	6.1446	5.8892	5.6502	5.4262	5.2161	5.0188	4.8332	4.1925	3.6819	3.5705	3.0915
11	10.368	9.7868	9.2526	8.7605	8.3064	7.8869	7.4987	7.1390	6.8052	6.4951	6.2065	5.9377	5.6869	5.4527	5.2337	5.0286	4.3271	3.7757	3.6564	3.1473
12	11.255	10.575	9.9540	9.3851	8.8633	8.3838	7.9427	7.5361	7.1607	6.8137	6.4924	6.1944	5.9176	5.6603	5.4206	5.1971	4.4392	3.8514	3.7251	3.1903
13	12.134	11.348	10.635	9.9856	9.3936	8.8527	8.3577	7.9038	7.4869	7.1034	6.7499	6.4235	6.1218	5.8424	5.5831	5.3423	4.5327	3.9124	3.7801	3.2233
14	13.004	12.106	11.296	10.563	9.8986	9.2950	8.7455	8.2442	7.7862	7.3667	6.9819	6.6282	6.3025	6.0021	5.7245	5.4675	4.6106	3.9616	3.8241	3.2487
15	13.865	12.849	11.938	11.118	10.380	9.7122	9.1079	8.5595	8.0607	7.6061	7.1909	6.8109	6.4624	6.1422	5.8474	5.5755	4.6755	4.0013	3.8593	3.2682
16	14.718	13.578	12.561	11.652	10.838	10.106	9.4466	8.8514	8.3126	7.8237	7.3792	6.9740	6.6039	6.2651	5.9542	5.6685	4.7296	4.0333	3.8874	3.2832
17	15.562	14.292	13.166	12.166	11.274	10.477	9.7632	9.1216	8.5436	8.0216	7.5488	7.1196	6.7291	6.3729	6.0472	5.7487	4.7746	4.0591	3.9099	3.2948
18	16.398	14.992	13.754	12.659	11.690	10.828	10.059	9.3719	8.7556	8.2014	7.7016	7.2497	6.8399	6.4674	6.1280	5.8178	4.8122	4.0799	3.9279	3.3037
19	17.226	15.678	14.324	13.134	12.085	11.158	10.336	9.6036	8.9501	8.3649	7.8393	7.3658	6.9380	6.5504	6.1982	5.8775	4.8435	4.0967	3.9424	3.3105
20	18.046	16.351	14.877	13.590	12.462	11.470	10.594	9.8181	9.1285	8.5136	7.9633	7.4694	7.0248	6.6231	6.2593	5.9288	4.8696	4.1103	3.9539	3.3158
21	18.857	17.011	15.415	14.029	12.821	11.764	10.836	10.017	9.2922	8.6487	8.0751	7.5620	7.1016	6.6870	6.3125	5.9731	4.8913	4.1212	3.9631	3.3198
22	19.660	17.658	15.937	14.451	13.163	12.042	11.061	10.201	9.4424	8.7715	8.1757	7.6446	7.1695	6.7429	6.3587	6.0113	4.9094	4.1300	3.9705	3.3230
23	20.456	18.292	16.444	14.857	13.489	12.303	11.272	10.371	9.5802	8.8832	8.2664	7.7184	7.2297	6.7921	6.3988	6.0442	4.9245	4.1371	3.9764	3.3254
24	21.243	18.914	16.936	15.247	13.799	12.550	11.469	10.529	9.7066	8.9847	8.3481	7.7843	7.2829	6.8351	6.4338	6.0726	4.9371	4.1428	3.9811	3.3272
25	22.023	19.523	17.413	15.622	14.094	12.783	11.654	10.675	9.8226	9.0770	8.4217	7.8431	7.3300	6.8729	6.4641	6.0971	4.9476	4.1474	3.9849	3.3286
30	25.808	22.396	19.600	17.292	15.372	13.765	12.409	11.258	10.274	9.4269	8.6938	8.0552	7.4957	7.0027	6.5660	6.1772	4.9789	4.1601	3.9950	3.3321
35	29.409	24.999	21.487	18.665	16.374	14.498	12.948	11.655	10.567	9.6442	8.8552	8.1755	7.5856	7.0700	6.6166	6.2153	4.9915	4.1644	3.9984	3.3330
36	30.108	25.489	21.832	18.908	16.547	14.621	13.035	11.717	10.612	9.6765	8.8786	8.1924	7.5979	7.0790	6.6231	6.2201	4.9929	4.1649	3.9987	3.3331
40	32.835	27.355	23.115	19.793	17.159	15.046	13.332	11.925	10.757	9.7791	8.9511	8.2438	7.6344	7.1050	6.6418	6.2335	4.9966	4.1659	3.9995	3.3332
50	39.196	31.424	25.730	21.482	18.256	15.762	13.801	12.233	10.962	9.9148	9.0417	8.3045	7.6752	7.1327	6.6605	6.2463	4.9995	4.1666	3.9999	3.3333

IRR: example

Example: better lighting

$$\frac{Investment\ required}{Net\ annual\ cash\ flow} = \frac{11.7}{3.3} = 3.54$$

- Based on the PV of €1-annuity factor, the IRR is 24%
- The minimum requirement is country and client specific, but 24% bits all records

Year	Project Cash-Flow, €
1	-11.7
2	3.3
3	3.3
4	3.3
5	3.3
6	3.3
7	3.3
8	3.3
9	3.3
10	3.3

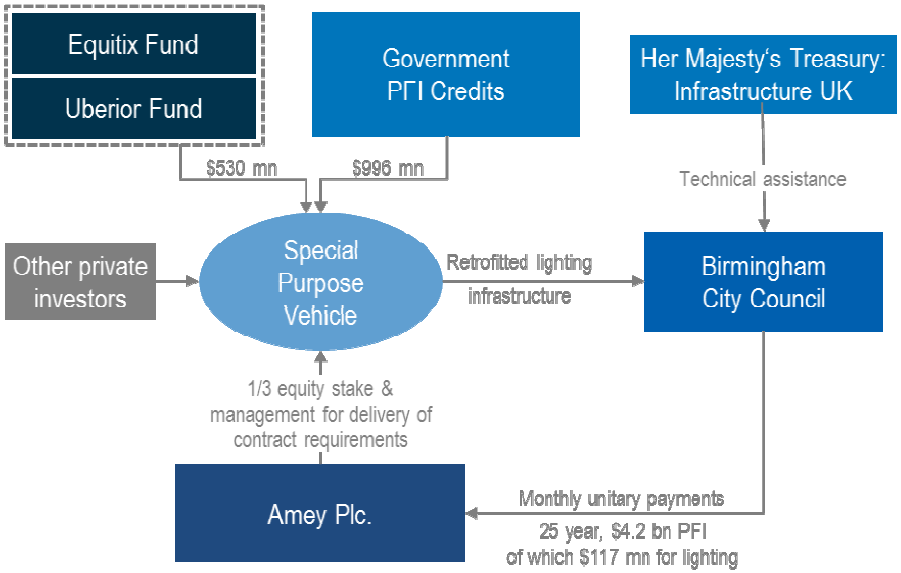
IRR: cut-off value

- The typical cut-off values for IRR are 10-15% that is much higher than the market interest rate
  - An investment with zero net benefit is not enough to be profitable
  - An investment is always associated with business risks i.e. changes in market conditions, but once started the investment is not reversible
  - Better equipment may become available in the future but investing now lowers the likelihood that the new equipment will be purchased later.
  - Many firms have limited access to capital and they need to select the investments with the best revenues.

IRR: pros and contras

- Advantages
  - The IRR rule accounts for time value because it is finding the rate of return that equates all of the cash flows on a time value basis.
  - The IRR rule accounts for the risk of the cash flows because you compare it to the required return, which is determined by the risk of the project.
  - The IRR rule provides an indication of value because we will always increase value if we can earn a return greater than our required return.
- Disadvantages
  - If the cash flow is non-conventional, it may have multiple IRR, depending on the number of changes in cash flow direction.

Project finance: Bimingham, UK



PFI - Private financing initiative
Source: ESMAP 2016

- Over the contract life time, the city pays to Amey Plc. monthly unitary payments .
- For the first 5 years of the contract, an independent certifier approves increases of monthly unitary charges by ca 4%.
- The contract foresees cases for deductions in payments by the city

Contracting

- The core investment - in the first 5 years.
- The rest - in the following twenty years.
- All assets are operated and maintained over the contract period of 25 years.
- Through the SPV, Amey Plc. is responsible for purchase, installation, and maintenance.
- The city can audit the performance of

Additional element

- Funding
  - Grants from the UK government
  - Credits from two investment fund as well as other investors and debt providers
- Key drivers of the project success are
  - availability of national framework
  - availability of technical assistance.

Project bundling

Case study: the province of Huelva, Spain

- The province of Huelva in Andalusia comprises a large number of small municipalities.
- In the IEE-funded project MLEI Accelerate, the Province and the provincial energy agency put together bundles of municipal investment projects which will be tendered to ESCOs. Some bundles target buildings (although the focus is not on deep renovation), and some target street lighting.
- A similar project is taking place on street lighting in the Province of Teramo (Italy)
- More information: accelerate project at www.diphuelva.es/

Project bundling: options

Option 1: DIPH as a procurement body

Municipality 1
Municipality 2
Municipality 3

DIPH — ESCO

Option 2: Groups of municipalities as a procurement body

DIPH → Procurement body Municipality 1 Municipality 2 → ESCO

Option 3: a local consortium as a procurement body

Municipality 1
Municipality 2
Municipality 3

Mancommunity local consortium procurement body

DIPH

ESCO

Option 4: groups of municipalities acting individually as procurement body

DIPH → Procurement body 1 Municipality 2 Municipality 3 …. → ESCO

Project bundling

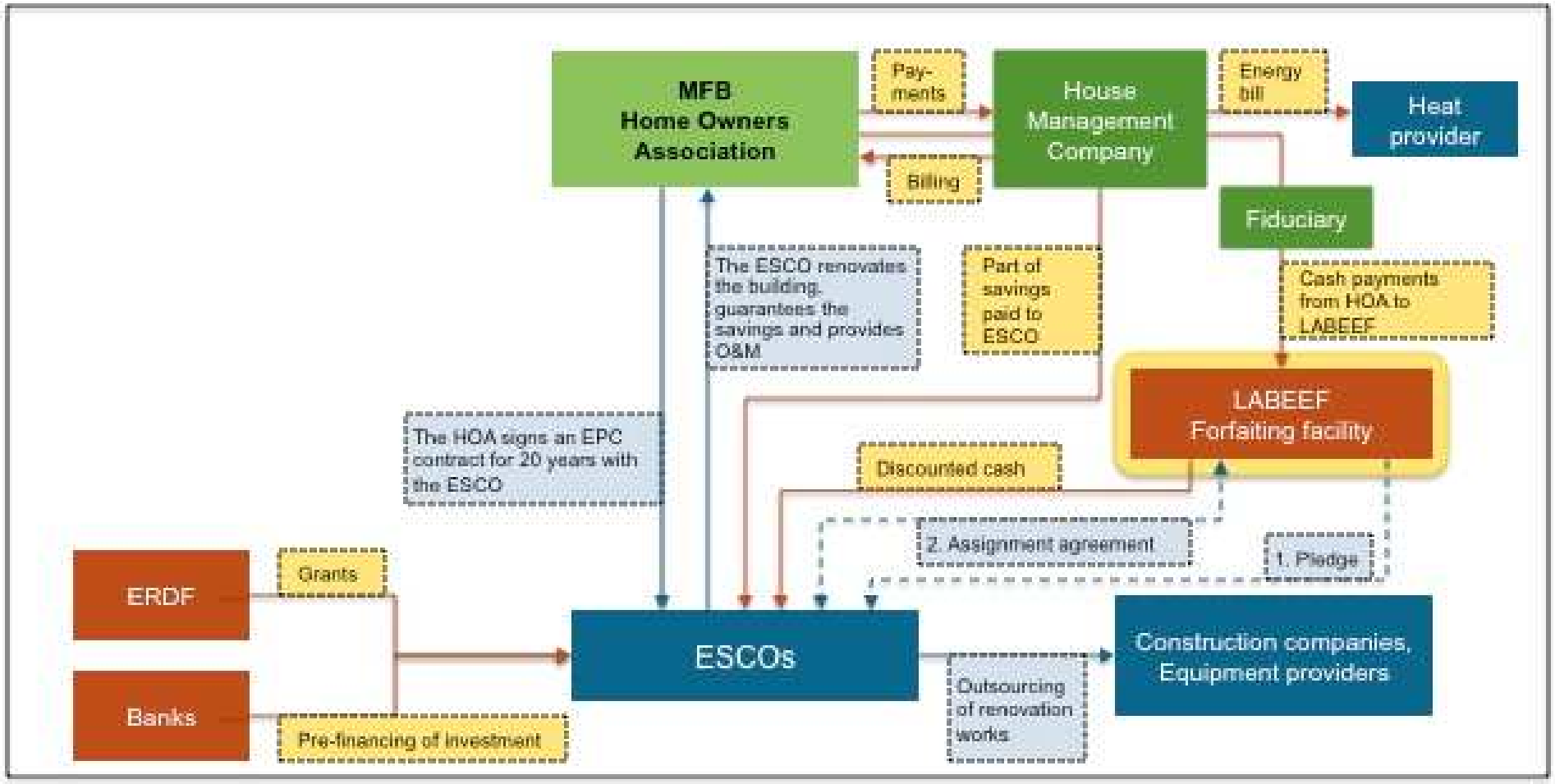
Basic data for financial viability per municipality
Investments in energy efficiency Annual energy consumption Annual preventative and corrective maintenance costs (equipment and staff)
Common conditions for financial liability
IRR 6% 5% of energy savings for municipalities with annual fee Retail Price Index 4% 12 year contract No substitution of maintenance personal
Costs chargeable to ESCO
First year investments Monitoring / telemanagement Annual electricity costs Annual maintenance costs Data collection costs
Costs chargeable to municipality
Annual fee for energy management Annual fee for maintenance

On-bill financing

On-bill financing

- On-bill financing - the homeowner continues to pay the same amount, while the investor recovers the amount saved through the house maintenance company.
- Using these money, energy suppliers are able to upgrade clean energy, where the house owner pays for it by himself.
- Such funds can be facilitated either by utility, the state or even third parties. Next to on-bill loans, there are on-bill tariffs.
- Example: The RenEsco's business model uses EPC as a tool for renovating the buildings, in combination with on-bill financing (i.e. the homeowner continues to pay the same amount, while the ESCO recovers the amount saved through the House Maintenance Company).
  - The ESCO signs a 20 year EPC contract with the Home Owner Association (HOA)
  - The ESCO takes on a loan from a Financial Institution (FI)
  - The ESCO renovates the building to reach typically 45% – 65% savings,
  - The House Maintenance Company (HMC) bills the same amount as before the renovation works, and pays the ESCO a percentage of those bills, based on the realized savings.
  - The HMC pays the lowered energy bill to the heat provider

On-bill financing



Conclusion

- The most straightforward model is to pay from the own funds of municipalities.
  - The revolving scheme help raise the funds to the budget.
- If own resources are limited, the municipalities could obtain debt.
  - The options are a low interest loan from a public lending program, a commercial loan from a commercial bank, or it could issue municipal bonds.
- The alternative is to reallocate the burden of financing on third parties.
  - In a simple contracting model, the contractor directly receives a contracting fee, which covers the costs of planning, financing and execution of the retrofit, plus its margin.
  - In a model with forfeiting and waiver of defence, but the bank enters into agreements both with the contractor and with the city.
  - In energy performance contracting models, the energy cost savings achieved via a reduction of energy consumption are used to finance the retrofit.
    - Typically, the contracted ESCO guarantees an energy saving level to be achieved.
    - Additional savings could be shared between the municipality and the contractor.
- Each of the models has its advantages and disadvantages as well as constraints to do with the economic, market, and legal conditions in which it could be applied.

Thanks

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Krakow, February 22nd 2017

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Aims of the session

- Learning objectives:
  - To understand the difference between different types of capital
  - To understand the main sources of funding for the projects on energy efficiency in public buildings
- Expected outcomes:
  - Better skills in identifying alternatives for funding
  - Be aware where to request additional information and how to apply
  - Be aware of the sources of case studies
  - Be aware of self-learning resources such as guides, platforms, studies, tools, etc.

Outline

- Type of capital
- Type of capital provides
- Capital providers for energy efficiency in public buildings
  - Objectives
  - Instruments
  - Activities covered
  - Beneficiaries
  - Timeline

Types of capital

- Grant
  - Non-repayable funds disbursed by grant-makers (government, foundation, etc).
- Equity (risk)
  - The funds provided by the owners and is the lowest-ranking capital of all in terms of its claims on the assets of a project.
  - Normally, any distributions that can be made to equity investors is done after all other project obligations are satisfied.
- Debt
  - Senior debt has first claim over all the assets of a project and must be repaid first, according to a predetermined schedule. The claims of others can be considered only after the claims of senior debt are satisfied.
- Mezzanine capital
  - Has both debt and equity features and, correspondingly, it has a risk profile that is somewhere between debt and equity capital (e.g. subordinated loans and preference shares)
- The return on each type of capital is determined largely by its risk characteristics.

European Structural and Investment Funds

European Structural and Investment Funds

- The European Structural and Investment (ESI) funds
  - The European Regional Development Fund (ERDF)
  - The Cohesion Fund (CF)
- The delivery is through Operational Programmes (OP), which are negotiated by the MS & regional authorities with the EC. OPs set strategic goals and investment priorities by country or region.
- The OPs are managed by authorities at national or regional level in the partnership with the EC.

Table 1: Budget allocation among countries from the ERDF and Cohesion Fund in 2014 – 2020, billion EUR

Country	ERDF			Cohesion Fund		
	EU	Nat	Total	EU	Nat	Total
Austria	0,5	1,5	2	–	–	–
Croatia	4,3	0,7	5	2,6	0,4	3
Czech Republic	11,9	5,2	17,1	6,2	1,1	7,3
Germany	10,8	6,9	17,7	–	–	–
Hungary	10,7	1,8	12,6	6	1	7
Italy	20,6	11,9	32,6	–	–	–
Poland	40,2	7,2	47,5	23,2	4	27,3
Slovakia	7,3	2,9	10,2	4,1	0,8	5
Slovenia	1,4	0,4	1,8	0,8	0,2	1

European Regional Dvelopment Funds (ERDF)

Objectives:	To promote stronger economic and social cohesion by reducing the disparities between regions
Instruments:	•Grants (co-financing up to 75% of project cost). There is no minimum size for projects. •Non-grant funding: loans, guarantees, equity participation, other risk management instruments with possible technical assistance •Grants through the European Territorial Cooperation Programmes (INTERREG) Specific funding instruments and amounts are listed in OPs of each Member Stat.
Activities:	•Among listed activities: support for small and medium-sized enterprises (SMEs) and the low-carbon economy •Specific activities are listed in OPs of each Member State
Beneficiaries:	EU-28: Public bodies, local, regional, and national authorities, social, cultural and educational institutions, companies, small and medium-sized enterprises, associations, non-governmental organizations. Foreign firms with a base in the region covered by the relevant operational programme can also apply, provided they meet European public procurement rules.
Timeline:	2014-2020
More info:	http://ec.europa.eu/regional_policy/en/funding/erdf/

Cohesion Fund

Objectives:	To alleviate social and economic disparities in countries with lower GNI (Bulgaria, Croatia, Cyprus, the Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia and Slovenia)
Instruments:	•Grants •Non-grant funding (loans, guarantees, equity participation, other risk management instruments, possible with technical assistance) The level of financing for a project can amount to up to 85% of its cost.
Activities:	•Trans-European transport networks, infrastructure projects under the Connecting Europe Facility; •Environment: projects related to energy or transport, which clearly benefit the environment in terms of energy efficiency, use of renewable energy, developing rail transport, supporting intermodality, strengthening public transport, etc.
Beneficiaries:	Local and regional authorities
Timeline:	2014-2020
More info:	http://ec.europa.eu/regional_policy/en/funding/cohesion-fund/

Reference information: ERDF + Cohesion Fund

•Ongoing projects:

•http://ec.europa.eu/regional_policy/en/projects/

•Past projects:

•http://ec.europa.eu/regional_policy/en/projects/major/

•How to apply

•Please search for the OPs financed by ERDF and the Cohesion Fund which are available in your country: http://ec.europa.eu/regional_policy/en/atlas/programmes/

•Please find responsible managing authority in your country, which evaluates your proposal:

- http://ec.europa.eu/regional_policy/en/atlas/managing-authorities/

•If you are a small business, you could turn to the Enterprise Europe Network (een.ec.europa.eu) which provides expert advice on how to access EU public funds.

•Further readings

•EU Regulation - Common Provision Regulation (CPR): https://ec.europa.eu/digital-single-market/news/eu-regulation-common-provision-regulation-cpr

Interreg Central Europe

Objectives:	To improve capacities in regional development
Instruments:	Grants (co-financing)
Activities :	Transnational partnerships in innovation, CO2 reduction, transport & mobility, protection of natural and cultural resources
Beneficiaries:	Public authorities and real entities, regional development and innovation agencies, enterprises, chambers of commerce and associations, financial institutions, energy supplies and management institutions, education and training organisations, NGOs from Austria, Croatia, Czech Republic, Germany, Hungary, Italy, Poland, Slovakia, Slovenia
Timeline:	2014-2020. Current call: September 2017
More info:	http://www.interreg-central.eu/Content.Node/apply/home.html

- Past projects
  - http://www.interreg-central.eu/Content.Node/apply/projects-2007-2020.html
- How to apply
  - Please submit all the necessary documents listed here: http://www.interreg-central.eu/Content.Node/apply/documents.html
  - Please register and apply on the online platform here: https://ems.interreg-central.eu/app/main?execution=e1s1

EU finanacing instruments

European fund for strategic investments (EFSI)

Objectives:	Facilitate investment from the private sector for strategic investment projects for small and medium-sized companies
Instruments:	Grants, project loans, guarantees, debt financing, equity, venture capital
Activities:	Among other, in such areas as infrastructure and research and innovation strategic investments will be supported by the Fund.
Beneficiaries:	SMEs, public entities, national promotional banks, bespoke investment platforms, NGOs, funds, associations
More info:	http://www.eib.org/attachments/press/investment_plan_for_europe_qa_en.pdf

- Past projects: http://www.eib.org/efsi/efsi-projects/index.htm
- How to apply
  - Please submit your request for financing either to EIB or EIF partner institution in each country: http://www.eib.org/projects/cycle/applying_loan/index.htm
  - Each project will be assessed via EIB due diligence as well as the EFSI Investment Committee

Private Financing for Energy Efficiency (PF4EE)

Objectives:	To facilitate affordable private investment in the energy efficiency area and at the same time help involved countries pursue their targets within NEEAP
Instruments:	EIB Loans for Energy Efficiency , expert support
Activities:	The energy efficiency loans under this instrument will be provided for max. 20 years and at competitive rates, covering up to 75% of the capital costs.
Beneficiaries:	Public sector and private sector financial institutions. Financial institutions may submit an application as a group under a single legal entity.
Timeline:	2014-2017 (next deadline is the 30th of June)
More info:	http://www.eib.org/attachments/documents/pf4ee_request_for_proposals_en.pdf

- How to apply
  - Express your preliminary interest and ask questions, and eventually apply: PF4EE_Instrument@eib.org
  - Please find the information regarding financial intermediaries and participating countries on this webpage: http://www.eib.org/products/blending/pf4ee/index.htm

EIB Municipal framework loans

Objectives:	To provide framework financial support to multiple projects, but within one investment programme.
Instruments:	Loans: maximum volume of €50 million for 3-5 years
Activities	Municipal infrastructure, including energy efficiency
Beneficiaries	Local/regional authorities
More info:	http://www.eib.org/attachments/documents/mooc_factsheet_eib_framework_loans_en.pdf

- Past projects: http://www.eib.org/projects/loan/list/index
- How to apply
  - Please exchange information with the EIB to confirm mutual interest
  - After internal first stage approval, an appraisal phase will be carried out by a loan officer (accompanied by urban specialists)
  - Loan decision takes from 6 months to 1 year, depending on how specific framework loan aspects are

European Energy Efficiency Fund (EEEF)

Objectives:	To foster 20-20-20 goals, promoting a sustainable energy market and climate protection
Instruments:	Senior debt, subordinated, guarantees, mezzanine instruments, leasing structures, forfeiting loans
Activities:	Energy efficiency and renewable energy projects
Beneficiaries:	Municipal, local and regional authorities; public and private entities
More info:	Further information: http://www.eib.org/products/elena/index.htm

- Current investments:
  - http://www.eeef.eu/current-investments.html
- How to apply
  - Please find out whether your project is eligible: http://www.eeef.lu/eligibility-check.html
  - Please contact investments@eeef.eu or technical_assistance@eeef.eu for technical assistance (next deadline is 1st March 2017)

EU technical assistance in project development

European Local Energy Assistance (ELENA)

Objectives:	To overcome the lack of technical expertise and organisational capacity
Instruments:	Grants for up to 90% of technical support cost
Activities:	Among others, the facility provides the funding for technical assistance in developing, implementing an investment programme in the following areas: •energy efficiency improvements in public and private buildings, including social housing and street and traffic lighting, •integration of renewable energy sources (RES) into the built environment •investments into renovating, extending or building new district heating/cooling networks •local infrastructure, incl. smart grids, ICT infrastructure for energy efficiency, etc. The facility focuses on big-sized investment project of at least €30 million.
Beneficiaries:	Public authorities for the mobilisation of investments and implementation of their sustainable energy action plans (SEAPs). Public and private project promoters, including municipalities, regions, public/private infrastructure or transport operators, energy service companies, retail chains, estate managers, small and medium enterprises, as well as industry for the development and launch of substantial, investible (bankable) investment projects and programmes which will contribute to achieving and going beyond the objectives of the EU energy policy.
Timeline:	As of January 2017, the funds have been available. When funds will be exhausted, a notice will be posted on the ELENA webpage.
More info:	Further information: http://www.eib.org/products/elena/index.htm

ELENA cont.

- Ongoing and completed projects:
  - http://www.eib.org/products/advising/elena/projects/index.htm
- How to apply
  - Please contact the ELENA staff directly by e-mail at elena@eib.org
  - Please attach to your email:
    - A brief description of the applicant and the planned investment programme/project, e.g. the project/programme type, its schedule, investment costs, the implementation approach, etc.
    - A brief description of the need for technical assistance and the amount requested for it.
    - The ELENA team will follow up with further guidance how a formal application can then be submitted.

Horizon 2020 (Call EE-22-2016-2017 Project Development Assistance)

Objectives:	Build technical, economic and legal expertise needed for project development and leading to the launch of concrete investments.
Funding instruments:	Grants for 100% of eligible costs
Activities:	The call grants the funding for project development assistance in the range of €0.5 – 1.5 million. Submission of proposals requesting other amounts in allowed. The call focuses on small and medium-sized investment project of EUR 7.5 - 50 million.
Beneficiaries:	Public authorities or their groupings, public/private infrastructure operators and bodies, energy service companies, retail chains, estate managers and services/industry
Timeline:	A few deadlines per year The next application deadline is June 2017.
More info:	http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/ee-22-2016-2017.html

Horizon cont.

Ongoing projects:

http://ec.europa.eu/programmes/horizon2020/en/h2020-sections-projects

How to apply

- Online guide on the procedures from proposal submission to managing your grant:

http://ec.europa.eu/research/participants/portal4/desktop/en/funding/guide.html

Additional readings

- European Commission. Horizon 2020 Work Programme 2016 – 2017. 10. 'Secure, Clean and Efficient Energy'. (European Commission Decision C(2016)4614 of 25 July 2016).

http://ec.europa.eu/research/participants/data/ref/h2020/wp/2016_2017/main/h2020-wp1617-energy_en.pdf

European Investment Advisory Hub (EIAH)

Objectives:	To mobilise investments in the real economy by building an investment friendly environment
Instruments:	Free of charge project development assistance: technical project support, project structuring, financial advice, capacity building, policy advice
Activities :	Municipal projects, including energy efficiency
Beneficiaries:	Public and private sector; managing, procuring authorities; national promotional banks and institutions
More info:	Further information: http://www.eib.org/eiah/support/faq.htm

- Past projects:
  - http://www.eib.org/eiah/support/success-stories.htm
- How to apply
  - Please fill in the contact form here: http://www.eib.org/eiah/contact/index.htm

Joint Assistance to Support Projects in European Regions (JASPER)

Objectives:	Better allocation of EU Structural and Investment Funds
Instruments:	Technical assistance: project preparation, capacity building and strategic support, independent quality review, horizontal tasks
Activities :	Municipal projects, including energy efficiency
Beneficiaries	Public authorities
Timeline	Since 2006
More info:	http://www.jaspers-europa-info.org/content/eligible-countries https://ec.europa.eu/info/funding-tenders/european-structural-and-investment-funds_en#investmentareas

- JASPERS assignments so far: http://www.jaspers-europa-info.org/content/jaspers-assignments
- Current statistics: http://jaspers.eib.org/StatReport/201612/index.html
- How to apply
- Please consult the list of National Authorities: http://ec.europa.eu/regional_policy/en/atlas/managing-authorities/
- Managing Authorities should contact the JASPERS staff directly by e-mail at jaspers@eib.org

ESIF financial instruments (former JESSICA)

Objectives:	To enhance the efficient use of the EU funds
Instruments:	Grant funding for technical assistance to cover up to 90% of eligible costs. The latter include support the necessary preparation of an investment project. The project average size of the investment project is at least €30 million.
Activities covered:	Municipal projects, including energy efficiency
Beneficiaries:	Public authorities
Timeline:	2014-2020
More info:	http://www.eib.europa.eu/products/blending/esif/index.htm

Past projects:

http://www.eib.org/products/blending/esif/fis-in-practice/index.htm

Financial Instruments Advisory (fi-compass)

Objectives:	To provide practical knowhow and learning tools on financial instruments
Instruments:	Technical assistance
Activities:	Practical tools, learning opportunities, trainings, institutional assessments
Beneficiaries:	ESIF managing authorities, EaSI microfinance providers, other stakeholders
More info:	https://www.fi-compass.eu/

Financial intermediaries

European Investment Bank (EIB)

- The EIB is the Bank of the European Union, representing the interests of the Member States and implementing EU policies.
- EIB borrows, lends multilaterally and provides consulting for questions of combination of different financing sources, administrative and project management with the overriding goal to achieve EU´s targets.
- EIB defined four priority areas, where only projects with sustainable contribution will be supported.
  - One of the priority fields is environment and climate, where the Bank finances up to 50% of eligible costs for projects which fulfilled all strict requirements.
- http://www.eib.org/

European Bank for Reconstruction and Development (EBRD)

- ERBD represents a multilateral organisation, providing policy reform dialogue & advisory services, investments for promotion of modern market economy in more than 30 countries from Central Europe to Central Asia.
  - Although the Bank focuses more on private sector funding, municipal infrastructure builds an important pillar in the EBRD´s portfolio.
  - EBRD puts special emphasis on sustainable environmental improvement in a municipal infrastructure through market-based approaches and instruments.
- More information:
- http://www.ebrd.com/what-we-do/sectors-and-topics/municipal-and-environmental-infrastructure/mei-overview.html

KfW outside Germany

- The German bank KfW carries out some commercial activities abroad as well.
  - The KfW Energy Efficiency Programme – Production Facilities and Processes supports not also German enterprises and their subsidiaries and joint ventures, but also non-German companies as well as those under an energy contracting which would like to invest in and outside Germany.
  - The main prerequisite is to manifest considerable energy saving effects.
  - 20% end-energy should be saved in the last 3 year, and through new investment somewhat 15% must be reached compared with the industry average.
  - It is possible to receive up to 3 repayment-free years with favourable interest rates for small and medium-sized companies.
- The KfW also provides loans to partner banks in Europe which in turn provide financial support either form SMEs and municipalities focused on environmental and climate friendly development.
- More information
- https://www.kfw.de/inlandsfoerderung/Unternehmen/Auslandsvorhaben/index-2.html#
- https://www.kfw.de/KfW-Group/About-KfW/Auftrag/Sonderaufgaben/F%C3%B6rderkredite-EU/

Commercial Banks

- The most traditional source of debt financing are commercial banks.
- To a lesser extent, they are also providers of mezzanine capital.
- Their operations essentially revolve around the creditworthiness of their borrowers and the security of their loans.
- Much stress is put on actions aimed at ensuring loan repayment.
- Some of the considerations made by commercial banks during the appraisal of a project are:
  - The level of commitment of the sponsors and other major participants, in terms of investment and personnel
  - The completion and technical targets of the project's budget, as any slippage will have an adverse effect on the economic viability of the project
  - The experience and capabilities of project management in implementing this type of project
  - The degree of confidence in the project's cost and revenue targets will be determined by the reliability of the assumptions on which the inputs supplies and demand projections are based
  - The strength of government support

National public financing sources

Austria

- Climate and Energy Funds
  - Grants and subsidies.
- Federal programmes "Klimaschutz in Gemeinden" and "Energiesparen in Betrieben"
  - Provide low-cost loans to municipalities for a number of measures
- State funding
  - For small-scale urgent energy-saving measures in municipalities that are not covered by the federal programmes
- “Energie-Contracting-Programme”
  - Provides grants to municipalities to support implementation of energy performance contracting.
  - For local municipalities there is an advisory set of services in order to help local bodies develop and promote energy-efficient concepts.

Croatia

- The Fund for the Environmental Protection and Energy Efficiency
  - Provides co-financing to support the deployment of energy efficiency
  - Loans, subsidies, financial assistance, and donations based on a public contest.
- The Regional Energy Efficiency Programme for the Western Balkans (REEPWB) funded by the EU and implemented by EBRD
  - Credit lines and technical assistance to support investment by businesses and municipalities in energy efficiency and small-scale renewable energy projects.
  - The Programme encourages primarily public sector to participate in the Energy Community process, doing the projects contribution to the NEEAP.
- Green for Growth Fund Southeast Europe (GGF)
  - The other credit line and technical assistance available for energy efficiency and renewable energy investments by the municipalities and businesses in Croatia.

The Czech Republic

- The EFEKT program implemented by the Ministry of Industry and Trade is the key program
- The country relies strongly on the OPs of ERDF
- Starting with 2014, a few low-interest loans for the building sector have been provided under the JESSICA Programme in order to support the development in urban areas.
  - By now, there are 41 cities in the Czech Republic, where the programme with the overall volume of €19,6 million is available in cooperation with the Commercial Bank (KB).

Germany

- The KFW programmes for municipalities : IKK – Investitionskredit Kommunen (208) and IKU – Investitionskredit Kommunale und Soziale Unternehmen (148).
  - Investitionskredit Kommunen (208)
    - Can cover up to 100% of all eligible investments per project of over €2 million and up to 50% of the costs for projects under €2 million at 0,05%
    - The maximum funding amount per applicant is up to €150 million.
- Bayerische Landesbank offers more favourable financing conditions for those who satisfy the bank's sustainability criteria.
    - A service called LBImmoWert helps establish the value and risk effects of the sustainability of their clients' properties, and provides advice concerning building improvements. Furthermore, the bank is offering PPP municipal special financing model providing project financing with other additional services.

Germany

- National Climate Initiative (NKI) implemented by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety since 2008 also offers significant support to the municipalities under the NKI programme “Förderprogramm Kommunalrichtlinien”
  - The amount of funding depends on the energy savings achieved.
  - Ex.: for street lighting, the programme covers up to 20% of eligible costs for projects achieving emission reductions of at least 70%, and up to 25% of eligible costs for projects with at least 80% of emission reductions. If a project is using high efficient LED technologies and achieves at least 70% emission reductions, the amount of support can cover up to 30% of eligible project cost.
  - Municipalities with limited financial possibilities will be subsidised with a maximum funding rate.

Hungary

- Two programmes facilitated by the EU Structural and Cohesion Funds
  - The Environment and Energy Operative Programme (Környezet és Energia Operatív program - KEOP)
  - The Environment and Energy Efficiency Operative Programme (KEHOP)
- The alternative is debt-capital from the EBRD in cooperation with the Erste Bank

Italy

- Within the 2014-2020 programme period, the EU Structural funds have allocated overall €22 billion for increasing regional energy efficiency, mainly focusing on public buildings with application of energy performance contracting.

Slovenia

- There are a few programmes facilitated by the EU Structural and Cohesion Funds which promote energy efficiency in public buildings
  - OP “Sustainable energy consumption and production, and smart grids” facilitated by the Cohesion Fund managed by the Ministry of Infrastructure
  - ERDF Ops where increasing of energy efficiency in the public sector is a funding priority.

Other sources

Financing by a contractor (ESCOs)

- An energy service company (ESCO) is a company that provides energy solutions, including
  - auditing, designing, and implementing energy efficiency projects
  - sometimes they also provided energy supply, financing and risk management.
- ESCOs are fundamentally different from consulting engineers and equipment contractors because they bear the project risks
  - consulting engineers provide a piece of advice
  - equipment contractors are paid for the equipment
- ESCOs may be privately-owned companies, state-owned, non-profits, joint ventures, manufacturers or manufacturers' subsidiaries.
- Financing capabilities vary with the financial situation of the ESCO. Some have large parent companies, which allows them to self-finance projects. However, all ESCOs rely to some extent on third-party financing.

Financing through utility obligation schemes

•Example: Italy

•All distributors of electricity and natural gas with more than 50,000 clients are obliged to reach specific quantitative goals of primary energy savings,

•The Ministry of Economic Development, together with the Ministry of the Environment and Protection of Land and Sea, sets the annual energy saving obligations and the rules of the White Certificate scheme.

•Electricity and gas distributors have two choices:

- They can fulfil the specific targets (obligations) by implementing energy efficiency projects or they can buy certified energy savings (White Certificates) from other parties in the certificate market.
- ESCOs can also participate in trading

•Savings achieved must be additional to measures that would be normally implemented, including those implemented to meet new legal requirements.

•Eligible measures are e.g. the replacement of inefficient equipment, boiler and lighting systems, solar thermal and cogeneration.

Institutional investors

- Institutional investors as a source of debt, equity and mezzanine financing are non-bank financial institutions such as insurance companies, pension funds and investment funds.
- Institutional investors distinguish themselves from commercial banks in that they mobilize long-term contractual savings as opposed to short-term deposits.
- By virtue of the long-term nature of the funds, many institutional investors are able to provide long-term debt, mezzanine and pure equity financing.
- Institutional investors are therefore an important source of long-term funds for large projects.

Crowd financing

- Crowd investment platforms allow people jointly invest in energy efficiency projects of established enterprises, NGOs and local authorities.
- Case study: Bettervest, Germany
  - is a platform that brings together project owners with investors.
  - is a platform for manufacturers and the companies which install their technologies.
  - it selects projects with high energy /cost savings assessed by certified consultants
  - it helps the project owners get the investment capital with the help of the crowd.
  - it ensures the investors receive a part of their investment plus a fixed interest rate annually throughout the contract period.
  - ensures that participants fulfil legal requirements
  - supports project owners with individual marketing campaigns.
  - charges a commission based on the initial investment and an annual handling fee.
  - both are already taken into consideration when calculating the interest rate so that the project owner does not face a large initial outlay.

Case study: Wilhelmstadt Gymnasium, GE

- Project (energy savings 27%, implementation time 8 years)
  - The replacement of an oil-based heating system with two combined heat and power (CHP) units, modernized condensing boilers, a local heat distribution network, transfer stations and modern control technology
- Start Date - Close Date : 2016/09/22 - 2016/12/22
- Participation Type: Loan, expected ROI: 6%
- Total Investment required : € 810,000
- Crowd Investment Target: € 600,350
- Received through crowd investment: 418,150€ from 472 investors

Summary: Capital providers for energy efficiency in public buildings: EU funds

- European Structural and Investment Funds
  - European Regional Development Fund (ERDF), including INTERREG CE
  - Cohesion Fund
- Financing institutions instruments
  - European Fund for Strategic Investments (EFSI)
  - EIB Municipal framework loans (EIB)
  - Private Finance for Energy Efficiency (PF4EE)
  - European Energy Efficiency Fund (EEE)

Summary: Technical assistance provided by EU

- Technical assistance in project development
  - European Local Energy Assistance (ELENA)
  - Horizon 2020 (Call EE-22-2016-2017 Project Development Assistance)
  - Joint Assistance to Support Projects in European Regions (JASPERS)
  - European Investment Advisory Hub (EIAH)
  - ESIF financial instruments (former JESSICA)
  - Financial instruments advisory (fi-compass)

Summary: Capital providers for energy efficiency in public buildings: others

- National public financing sources
  - Austria, Croatia, the Czech Republic, Germany, Hungary, Italy, Poland, Slovakia, and Slovenia
- Financial intermediaries / bi and multi-lateral agencies
  - European Investment Bank (EIB)
  - European Bank for Reconstruction and Development (EBRD)
  - KfW (outside of Germany)Alternative public financing mechanisms/instruments
- Financial intermediaries / Commercial banks
- Institutional investors
- Contractor
- Citizens
- Utilities (e.g. under utility obligation schemes/ white certificates)

Thank you

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FINANCING ENERGY EFFICIENCY IN PUBLIC BUILDINGS BUSINESS MODELS

Krakow, February 22nd 2017

Aleksandra Novikova

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Aims of the session

- Learning objectives:
  - Understand different models to finance the projects on energy efficiency improvement in public building
- Expected outcomes:
  - Be able to choose a relevant financing model depending on local conditions
  - Be aware of resources for further self-learning, e.g. guides, comparative studies, case studies, online platforms, etc.

Content

- Self-financing
- Debt-financing
- Financing by a private contractor
- Financing by private partner through energy savings
- Project finance
- Case studies
  - Revolving fund
  - On-bill financing
  - Project bundling

SELF-FINANCING

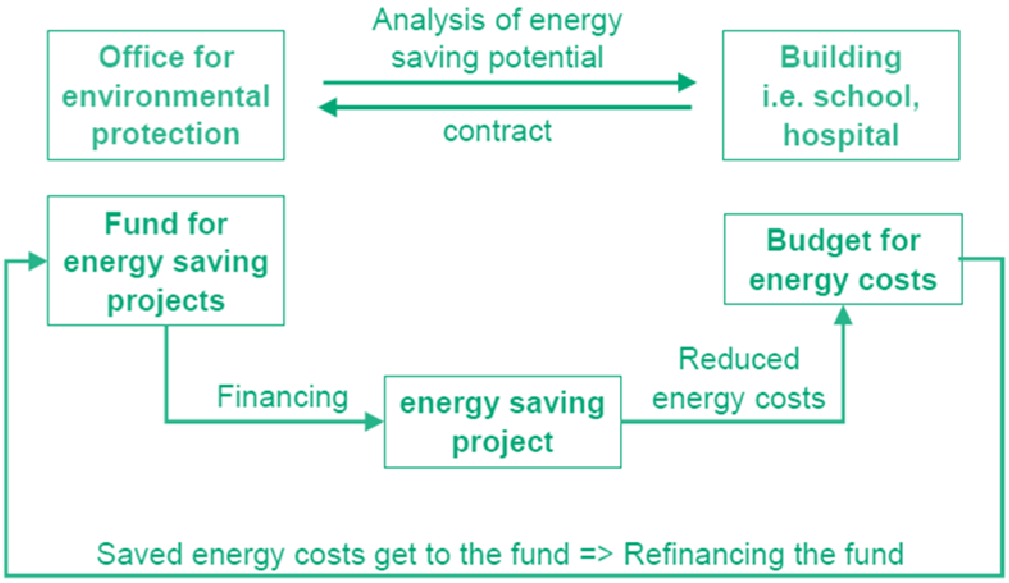
Self-financing

- Historically, the municipal budget and dedicated national or federal funding sources used to be very common for funding the projects on energy efficiency retrofits of public buildings.
- The financing model of such retrofit project is rather simple, e.g. a municipality identifies the investment need, prepares a request for financing, obtains its approval, and issues a tender to select a contractor, who conducts the retrofit.
- To minimize the burden on tax payers, the public sector could design and implement additional schemes to help raise the funds for the budget.
  - For instance, a municipality could invest in retrofits and once it accrues saved energy costs, it could re-invest them in new retrofit projects.
  - The example includes for instance the municipality of the Hague .

Internal Contracting (intracting)

- The municipal internal performance contracting scheme is based on the “contracting” concept but is entirely financed from municipal budget funds.
- One department finances cost-efficient energy and water saving measures.
- The savings made by the other department or an municipally-owned companion
- Their energy bills are used to repay the 1st department until full recovery of the investment capital.

Example: City of Stuttgart



Source: Energy cities project
http://energy-cities.eu/IMG/pdf/dossier_intracting_en.pdf

DEBT-FINANCING

Debt-financing 1

- The financing model of such projects would include obtaining the debt, e.g. taking the loan or issuing bonds, and issuing a tender to select a contractor, i.e. an energy service company, who conducts the retrofit.
- A low-interest (concessionary) loans from the public (national or EU) budget
  - In Germany, a dedicated programme of KfW bank for municipalities offers loans for energy efficiency in public buildings at interest rates close to 0%.
  - In Croatia and Lithuania, the revolving funds are set up from the federal budget that provides loans and guarantees to municipal governments for energy efficiency investments.
- A commercial loan at a market rate from commercial banks.
  - In case of commercial loans, the interest rate under which the loan is awarded does not depend on saved energy costs but on the credit record of borrower.
  - In Hungary, the Erste bank provides tailored commercial loans to municipalities to finance energy efficiency infrastructure.

Debt-financing 2

- The issue of municipal bonds.
- A municipal bond is a bond issued by a local government, or their agencies.
  - Potential issuers: states, cities, counties, redevelopment agencies, special-purpose districts, school districts, public utility districts, etc.
- A bond is a debt in which the authorized issuer (i.e. debtor – municipality) owes the holders (creditors) a debt and is obliged to pay interest (coupon) and/or to repay the principal at a later date, termed maturity.
- If bonds are issued on a large scale, a dedicated municipal bonds agency is required. It aggregates the borrowings from a number of local governments, raise capital on the financial markets through the sale of bonds and on lend the proceeds at a lower rate than if the debtors were to issue their own bonds.

Example: municipal bonds

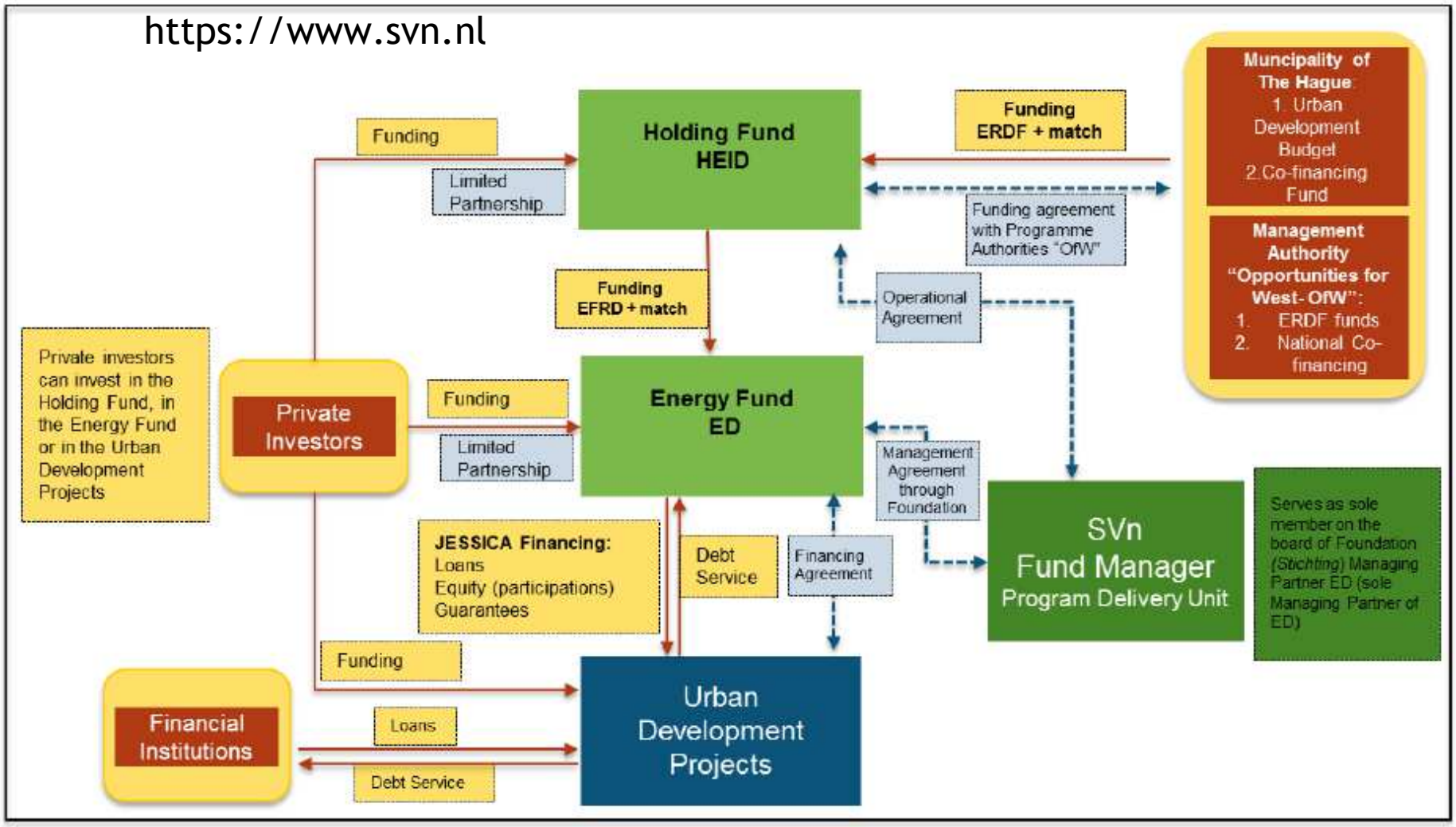
- Kommuninvest in Sweden
  - Set up in 1986, Kommuninvest is triple A-rated and borrows using bonds.
  - It lends the funds to 260 local authorities to fund projects such as roads and renewable energy. In 2012 its target was to lend more than EUR 20 billion.
- In Europe national municipal bond agencies exist in Finland, Sweden, Denmark, Holland, Switzerland, and Italy.
- The Green Bond Program of the Swedish city of Gothenburg
  - Issued a 6 year 'green' bond to fund public transport, water management, energy and waste management projects.
  - This raised EUR 50 million and was oversubscribed.
- Three French provinces have also raised money via bond issuance to fund green social housing, renewable energy and energy efficiency projects.

Source: http://www.managenergy.net/

Case study: a revolving fund

Case study: Energy Fund Den Haag

https://www.svn.nl



Case study: Energy Fund Den Haag 2

Ownership	Public
Program authority	Municipality of The Hague
Program delivery unit	Energiefonds Den Haag (ED) C.V.
Operating services	Marketer, assessor, financier
Ambition/targets	Create a multiplier effect in investments in renewable energy in the territory of The Hague by the provision of 4million € revolving finance to urban development projects by 31.12.2015 and by attracting complementary private financing
Beneficiaries	Project developers, housing corporations, businesses, foundations and NGO's and public entities e.g. municipalities, local authorities
Funding Vehicle	Investment fund, financial institutions, private investors, project owners
Financial Instruments	Loans, equity, guarantees

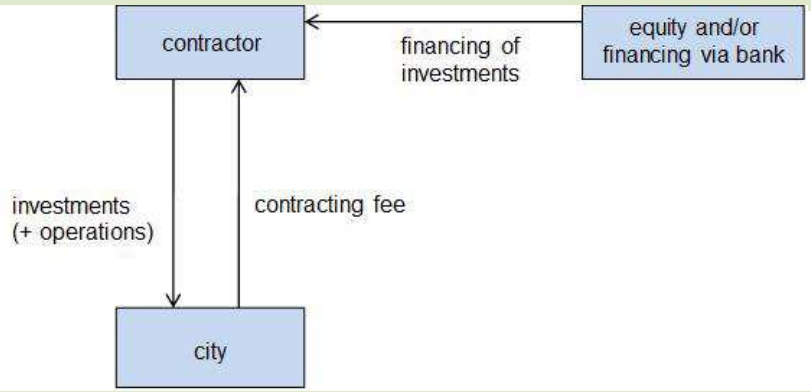
Case study: Energy Fund Den Haag 3

- Beneficiaries requesting aid from ED have to meet eligibility criteria set ERDF OPs
- Projects are appraised on the basis of:
  - sound business model and business plan,
  - cash flow able to reimburse the investments increased by the inflation or interest rate,
  - a financial viability gap to justify the need for sub-commercial investments by ED,
  - prior to applying for sub-commercial conditions, beneficiaries need to demonstrate that efforts were taken to secure the max level of private finance under market conditions.
- SVn and applicants follow an application process with standard documents
  - Negotiation phase
  - Credit analysis, preparation and submit advice request to Advisory Committee
  - Issue offer and offer accepted by beneficiary
  - Credit application refused of withdrawn
  - Credit application approved
- Amounts reimbursed by the beneficiaries will be used by ED to fund other urban projects.

Financing by a private contractor

Simple contracting model

Architecture



Advantages

- For cities: the model usually is off-balance sheet.
  - However, do clarify this issue with the responsible authority, which the city has to report to.
- Specialised companies can be selected via the tendering process.

Projects financed with this model

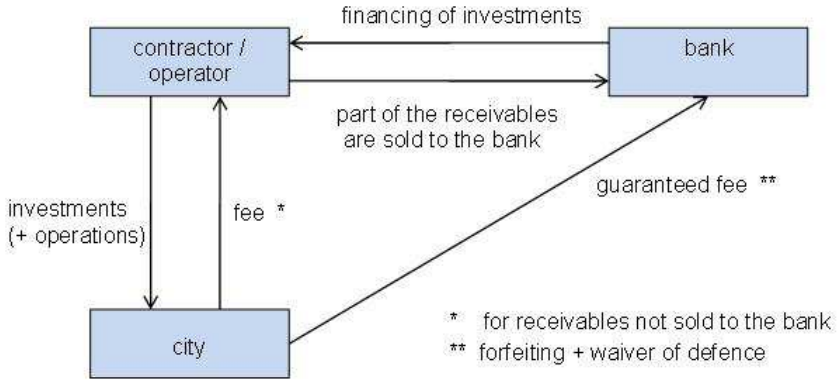
- Projects need to have a sensible minimum size, to justify the set-up of the model by the contractor.
  - EUR 0.5 - 1 million may be the minimum project volume.

Disadvantages

- For cities: high costs.
  - The contractor's capital is expensive vs cities' budget or low % loans.
- Restrictions in the availability of grants.
  - Sometimes, federal budget grants cannot be used for contracting models.
- For contractors: it's on-balance sheet.

Contracting model with forfeiting and waiver of defence

Architecture



Advantages

For cities:

- The model usually is off-balance sheet.
- Contracting with forfeiting and waiver of defence will have a lower interest rate, included in the contracting fee (because municipal money is low-risk).

Projects financed with this model

- Projects need to have a sensible minimum size.
  - EUR 0.5 - 1 million may be the minimum project volume.
- But due to the higher complexity of the model, it might be a more difficult to find a bank financing projects below EUR 1 million.

Disadvantages

- Although the % rate is lower than in the simple contracting model, it is still higher than in low % rate lending programmes.
- The high complexity of this model
- A large part of the city's payments, e.g. the payments to the bank, have to be guaranteed, regardless of the project performance.

Contracting model with forfeiting and waiver of defence: Dillenburg, Germany

Challenge

- To find a specialist for the modernisation of street lighting , while the responsibility for operations would remain with the utility of Dillenburg.
- To spread the costs over a 12-year period

Financing details

- Some 70 % of receivables were sold by the contractor to a bank, which then became a third partner to the contract in order to enable forfeiting and the waiver of defence.

Contracting

- The contract was tendered in multiple steps:
  - an indicative analysis and concept,
  - a detailed analysis and concept.
- The final decision was based on the maximum reduction of annual costs for the city, consisting of the contracting fee and energy costs of the street lighting

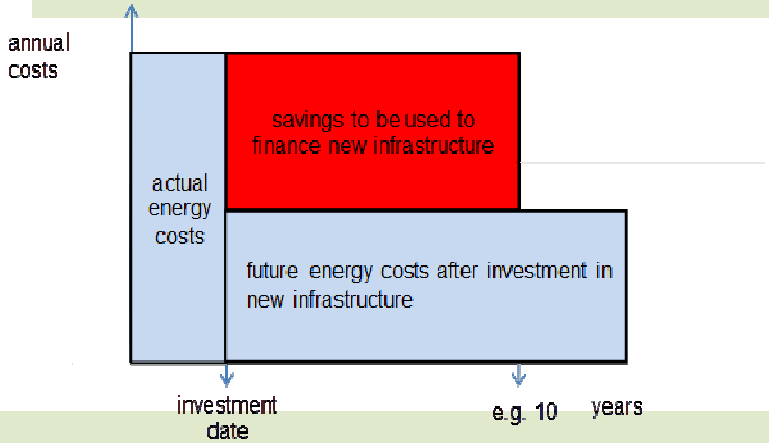
Additional element

- The successful bidder guaranteed a certain level of energy savings (minimum 52 %).
- If the contractor achieves higher savings, the additional savings are split between the city of Dillenburg and the contractor.
- The exact split was part of the successful offer.

Financing by a contractor through energy saving

EPC-guaranteed savings model

Architecture (time-optimized)



Advantages

- For the city
  - New, energy efficient infrastructure, without any peaks in public spending.
  - After expiry of the contract, the city benefits from the low operating costs.

Projects financed with this model

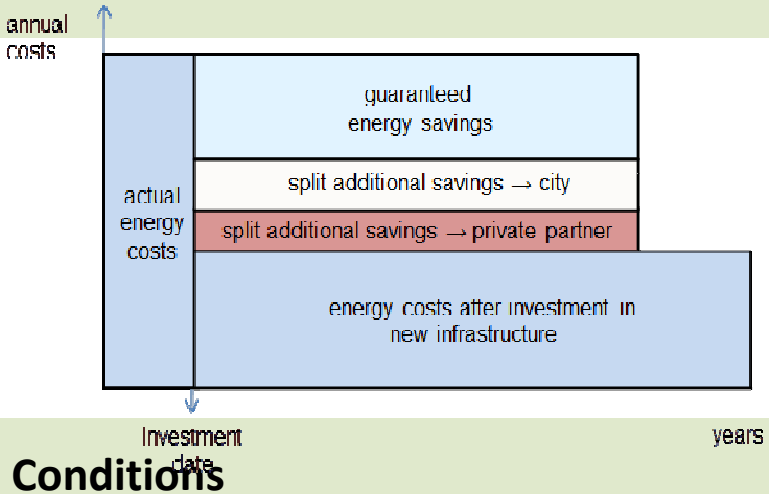
- Projects with high energy cost savings because private partners do not favour long contacts.
- Municipalities should have sufficient funds to pay the same – or a slightly reduced - amount of money in total over the contract length
  - split between energy costs and payments to the private partner.

Disadvantages

- The model is difficult to use in CEE, where energy prices are low.
- A missing incentive for the private partner to reduce energy demand more than guaranteed in the contract.

EPC-shared savings model

Architecture



Conditions

- Projects with high energy cost savings because private partners do not favour long contacts.
- Municipalities should have sufficient funds to pay the same – or a slightly reduced - amount of money in total over the contract length
  - split between energy costs and payments to the private partner.

Advantages

- There is an incentive on both sides to consider and realise additional energy savings.
- This allows utilising additional financing resources becoming available during the running time of the contract, or realise new ideas for savings, potentially arising from new technological developments.

Disadvantages

- The model is difficult to use in CEE, where energy prices are low.

EPC-shared savings model: Neuen, Germany

Challenge

- 45% HPM lamps / 55% HPS lamps
- A complete replacement of HPM based luminaires by more efficient technology
- Energy savings of at least 40 %
- A limitation of investment needs due to budgetary constraints

Contracting

- The contract was tendered a 5-year contract for the operation of the infrastructure
- Several bids were received and evaluated based on the total operating and investment costs.

Financing details

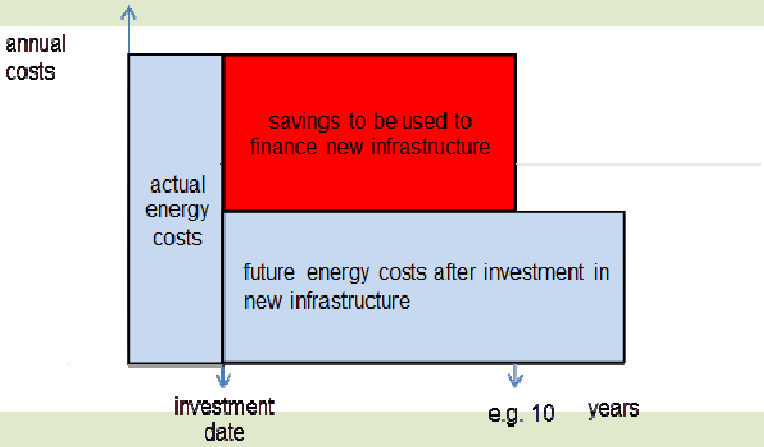
- Additional energy savings, on top of the 43 % being guaranteed, should be split 50% /50 % between the city and the private partner.
- Based on an electricity price per kWh fixed at the beginning of the contract, any additional energy savings were measured once a year.

Additional element

- As a result of this agreement, some additional investments in energy efficient technology were carried out in later years given higher energy cost savings achieved, proving the “win-win” character of the model.

EPC: modernisation with immediate savings of energy costs

Architecture



Advantages

- The key advantage of this model is the maximisation of energy savings.
- As new technologies often require less maintenance needs, corresponding costs are lower too, which should be reflected in the price offered by the private partner.

Conditions

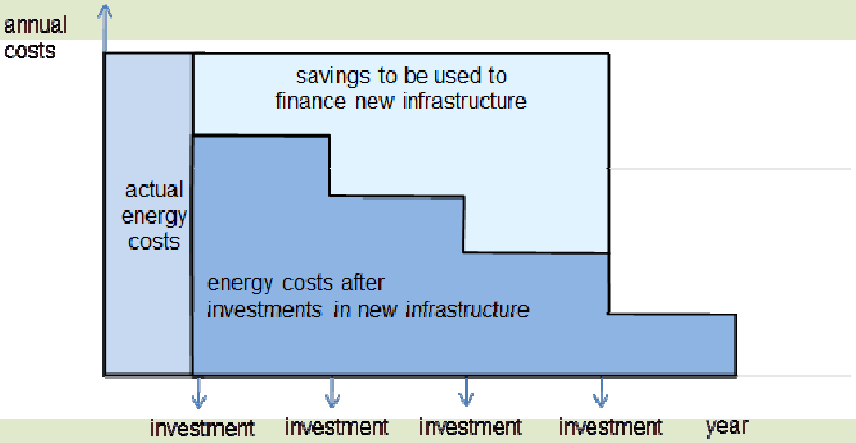
- The investment period is as short as possible, in order to benefit from the energy savings as soon as possible.

Disadvantages

- High investment costs in the initial phase .
- There will be a lot of modernisation activity in the city at the same time that may result in traffic congestion and public protests.
- The early realisation of the investment means that the entire infrastructure at the end of measure lifetime is “old” again.

EPC: model with staggered modernisation

Architecture



Conditions

- The investment period is stretched over time.

Advantages

- The city always has a reasonably modern infrastructure
- The peaks in investment needs and building activity are avoided.
- It is possible to focus on those projects with the worst energy efficiency first.

Disadvantages

- The major disadvantage is that energy savings, as well as the benefit of lower maintenance costs, will be achieved at a later stage than in the previous model.

EPC - shared savings model: Hilden Germany

Challenge

- A key condition of this contract was a definition of a maximum average age, as well as a maximum age of any single luminaire and pole at fixed times (after 5, 10, 15 and 20 years).

Contracting

- The contract was tendered for all operations, including energy supply, and the modernisation of more than 5,000 luminaires, which is the vast majority of all existing luminaires, as well as the modernisation of some 2,400 poles.

Financing details

- The costs of electricity were split between the private partner (direct costs) and the city (indirect costs such as taxes, dues and grid access costs).

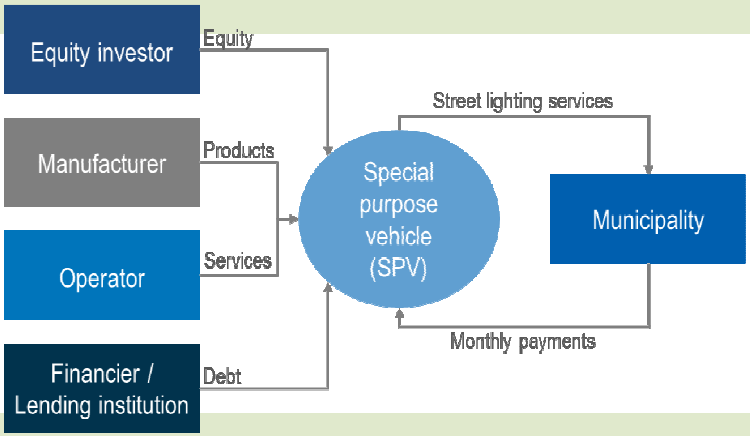
The winner

- The task of the winner was to select the right luminaires to be modernised at the right time, while taking the age restrictions into account.

Project finance

Project finance

Architecture



Advantages

- For cities:
  - the model is off-balance sheet
  - if private sector partners fail to deliver the services, there could be deductions , withholding of payments or penalties
- For both public and private sectors:
  - isolating the project risks within SPV.

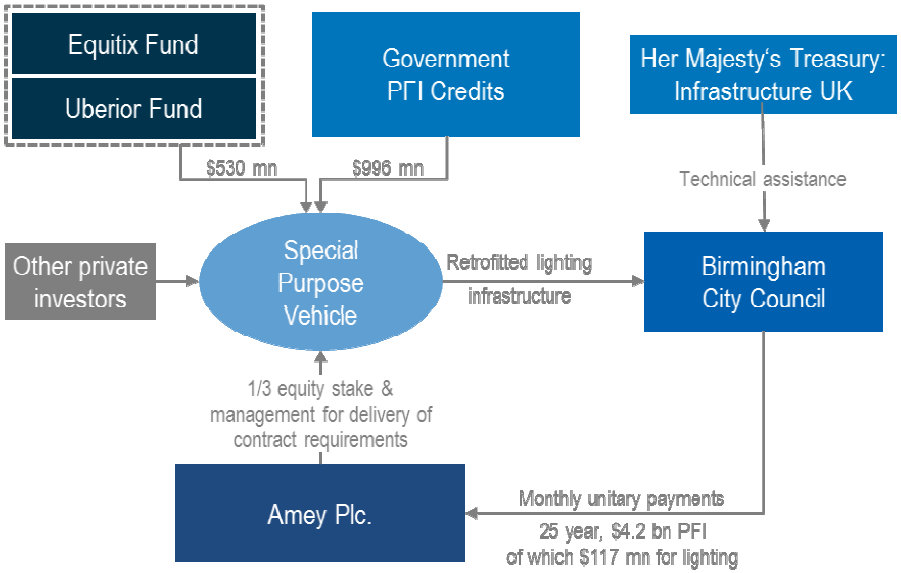
Projects financed with this model

- Projects with capital costs over EUR 20 million.
- Financially sustainable projects i.e.
  - Municipalities with good credit profile
  - Supported by grants, tax exemptions, tax-free bonds, or credits.
- This model implies long term contracting of private actors for operation and maintenance.

Disadvantages

- High transaction costs.
  - Creating a consortium of several municipalities could reduce these costs but will bring in new ones related to the consortium governance and structure.
- The model might also imply long time frames from project start to actual development.

Project finance: Bimingham, UK



PFI - Private financing initiative
Source: ESMAP 2016

- Over the contract life time, the city pays to Amey Plc. monthly unitary payments .
- For the first 5 years of the contract, an independent certifier approves increases of monthly unitary charges by ca 4%.
- The contract foresees cases for deductions in payments by the city

Contracting

- The core investment - in the first 5 years.
- The rest - in the following twenty years.
- All assets are operated and maintained over the contract period of 25 years.
- Through the SPV, Amey Plc. is responsible for purchase, installation, and maintenance.
- The city can audit the performance of Amey

Additional element

- Funding
  - Grants from the UK government
  - Credits from two investment fund as well as other investors and debt providers
- Key drivers of the project success are
  - availability of national framework
  - availability of technical assistance.

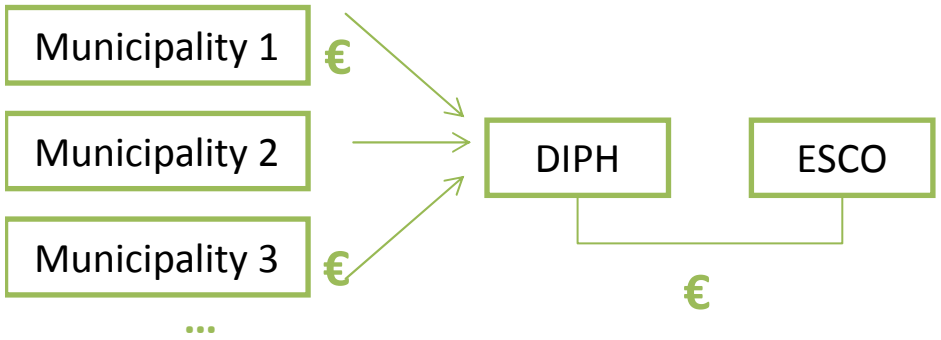
Project bundling

Case study: the province of Huelva, Spain

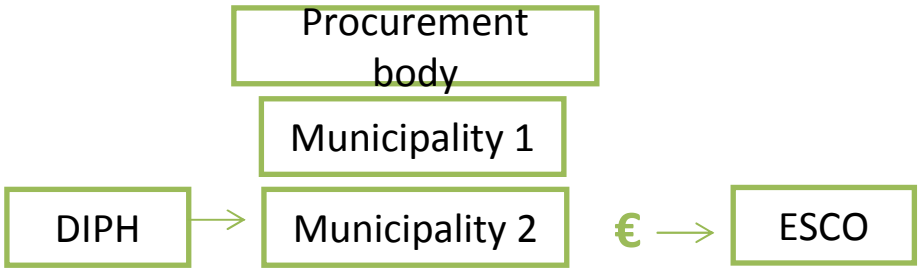
- The province of Huelva in Andalusia comprises a large number of small municipalities.
- In the IEE-funded project MLEI Accelerate, the Province and the provincial energy agency put together bundles of municipal investment projects which will be tendered to ESCOs. Some bundles target buildings (although the focus is not on deep renovation), and some target street lighting.
- A similar project is taking place on street lighting in the Province of Teramo (Italy)
- More information: accelerate project at www.diphuelva.es/

Project bundling: options

Option 1: DIPH as a procurement body



Option 2: Groups of municipalities as a procurement body



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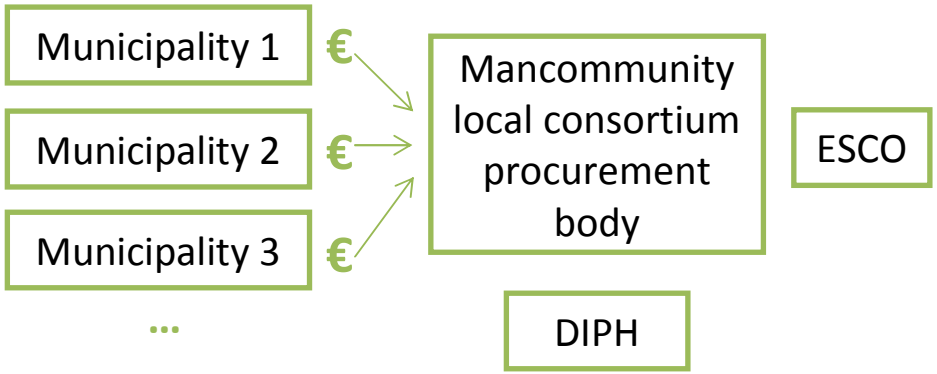
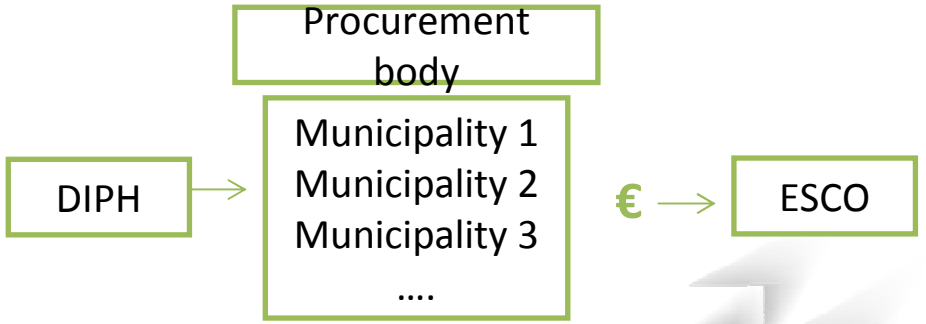
Option 3: a local consortium as a procurement body



Option 4: groups of municipalities acting individually as procurement body



Project bundling

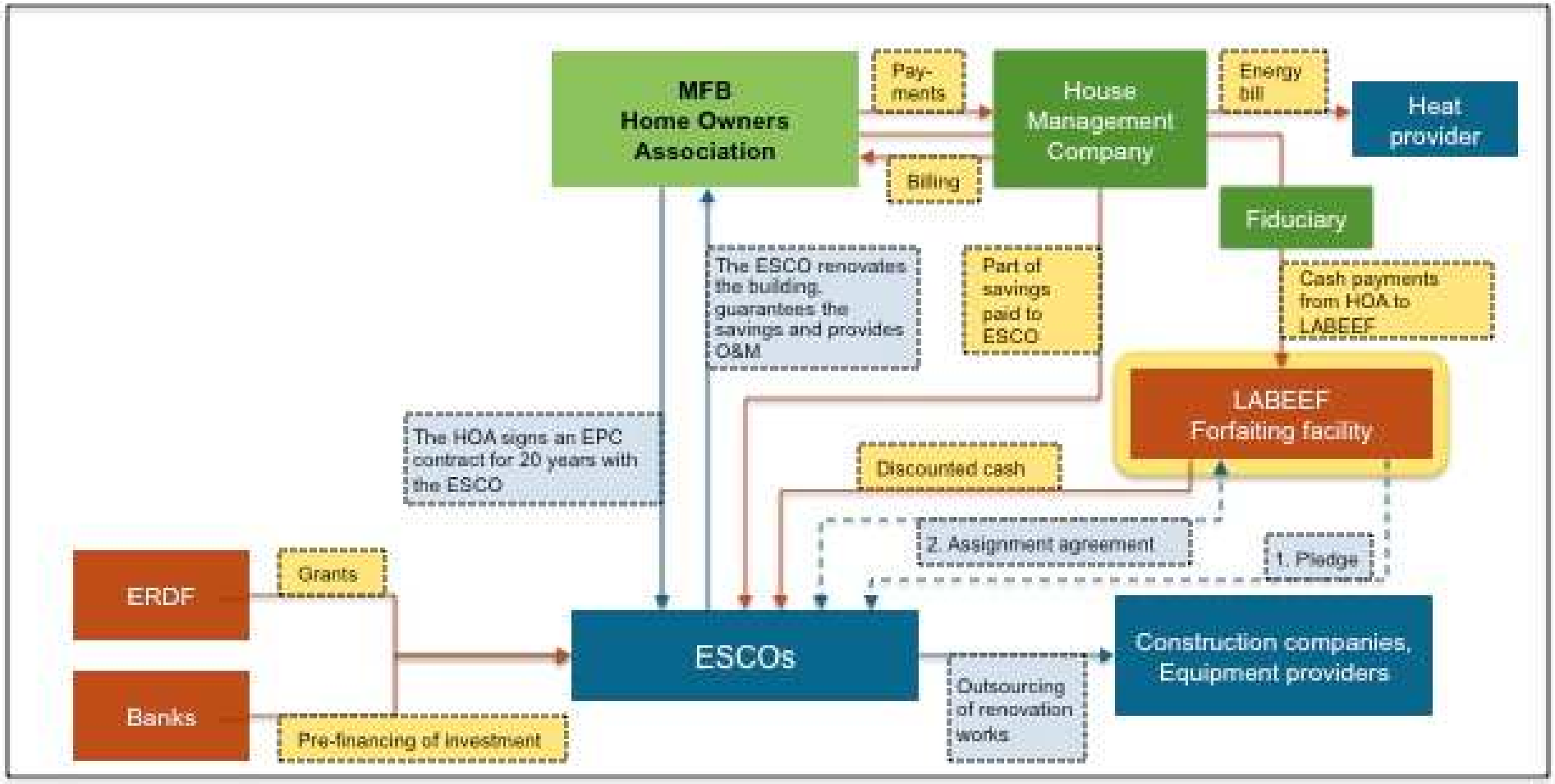
Basic data for financial viability per municipality
Investments in energy efficiency Annual energy consumption Annual preventative and corrective maintenance costs (equipment and staff)
Common conditions for financial liability
IRR 6% 5% of energy savings for municipalities with annual fee Retail Price Index 4% 12 year contract No substitution of maintenance personal
Costs chargeable to ESCO
First year investments Monitoring / telemanagement Annual electricity costs Annual maintenance costs Data collection costs
Costs chargeable to municipality
Annual fee for energy management Annual fee for maintenance

On-bill financing

On-bill financing

- On-bill financing - the homeowner continues to pay the same amount, while the investor recovers the amount saved through the house maintenance company.
- Using these money, energy suppliers are able to upgrade clean energy, where the house owner pays for it by himself.
- Such funds can be facilitated either by utility, the state or even third parties. Next to on-bill loans, there are on-bill tariffs.
- Example: The RenEsco's business model uses EPC as a tool for renovating the buildings, in combination with on-bill financing (i.e. the homeowner continues to pay the same amount, while the ESCO recovers the amount saved through the House Maintenance Company).
  - The ESCO signs a 20 year EPC contract with the Home Owner Association (HOA)
  - The ESCO takes on a loan from a Financial Institution (FI)
  - The ESCO renovates the building to reach typically 45% – 65% savings,
  - The House Maintenance Company (HMC) bills the same amount as before the renovation works, and pays the ESCO a percentage of those bills, based on the realized savings.
  - The HMC pays the lowered energy bill to the heat provider

On-bill financing



Conclusion

- The most straightforward model is to pay from the own funds of municipalities.
  - The revolving scheme help raise the funds to the budget.
- If own resources are limited, the municipalities could obtain debt.
  - The options are a low interest loan from a public lending program, a commercial loan from a commercial bank, or it could issue municipal bonds.
- The alternative is to reallocate the burden of financing on third parties.
  - In a simple contracting model, the contractor directly receives a contracting fee, which covers the costs of planning, financing and execution of the retrofit, plus its margin.
  - In a model with forfeiting and waiver of defence, but the bank enters into agreements both with the contractor and with the city.
  - In energy performance contracting models, the energy cost savings achieved via a reduction of energy consumption are used to finance the retrofit.
    - Typically, the contracted ESCO guarantees an energy saving level to be achieved.
    - Additional savings could be shared between the municipality and the contractor.
- Each of the models has its advantages and disadvantages as well as constraints to do with the economic, market, and legal conditions in which it could be applied.

Thanks

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Kraków, 21.02.2017

EPIC: DSM applied to Contractual Models

Antonio Zonta – Provincia di Treviso

STRUCTURE OF THE PRESENTATION

Energy Performance Contracts

The first part of the presentation, reports an overview on most frequently used EPC models, and the subsequent evolution to Energy Performance Integrated Contract

Analysis of the results of the EPIC model at Treviso

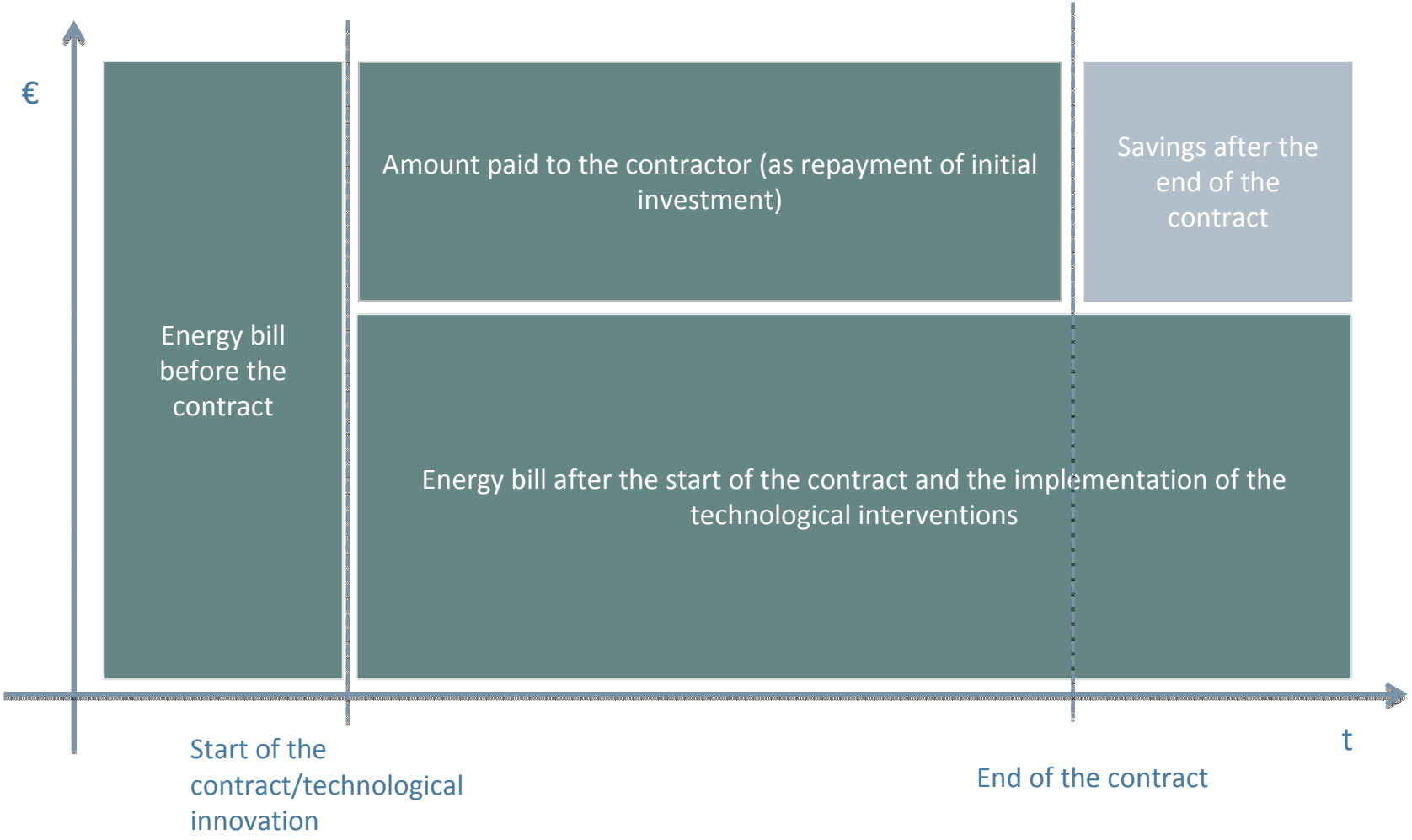
The second part concerns a first analysis of the results of the EPIC model applied at the Province of Treviso, and some considerations on how the experience might be influenced by DSM

Ideas for an improvement of the EPIC model

On the basis of a successful EPC model and implementation process, in the third part a suggestion for the improvement of the EPIC model is presented

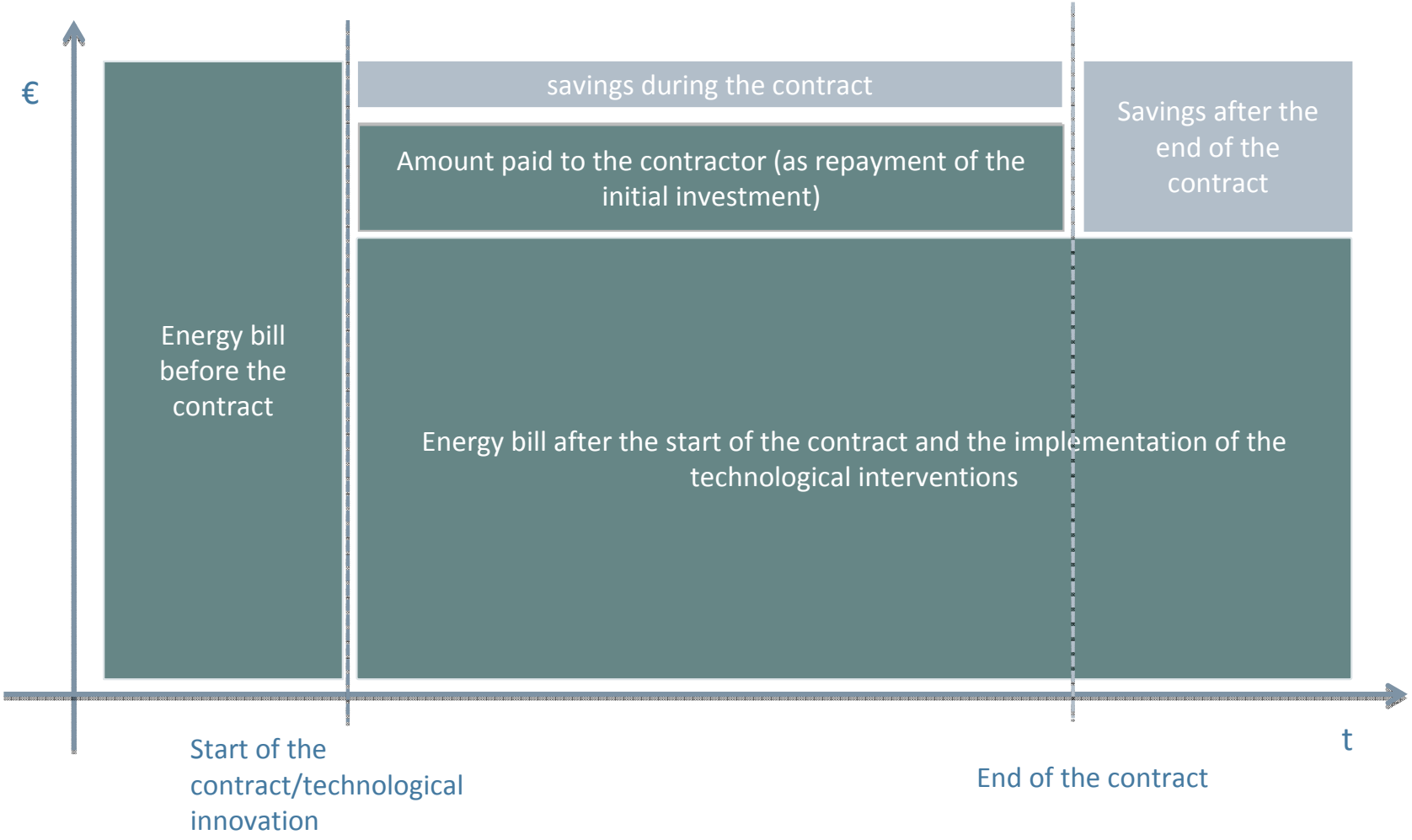
CLASSIC EPC MODEL

Energy Efficiency measures adopted for energy reduction in public buildings at the province of Treviso : the Energy Performance Integrated Contract



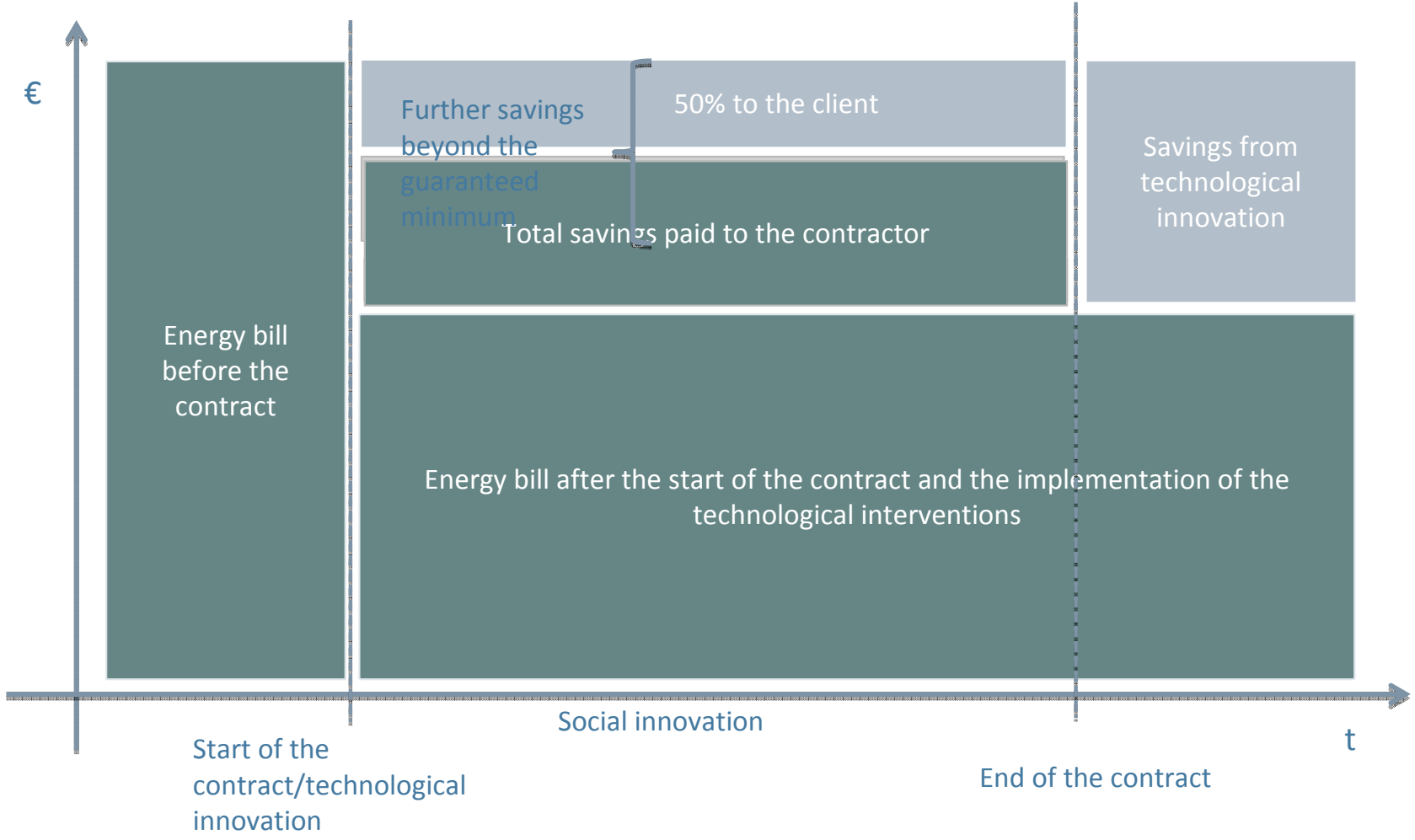
SHARED SAVINGS EPC MODEL

Energy Efficiency measures adopted for energy reduction in public buildings at the province of Treviso : the Energy Performance Integrated Contract



SHARED SAVINGS WITH MINIMUM GUARANTEED EPC MODEL

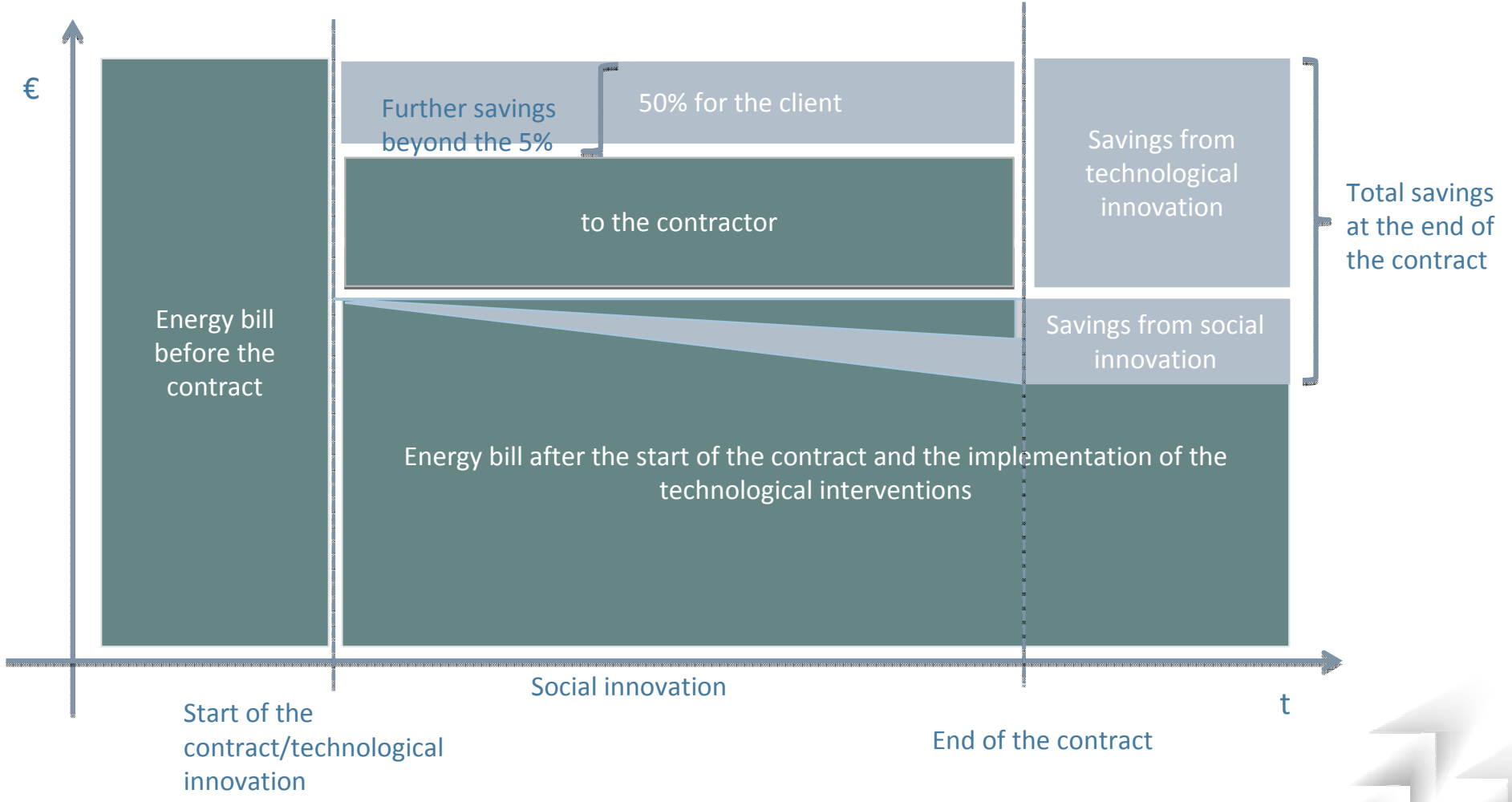
Energy Efficiency measures adopted for energy reduction in public buildings at the province of Treviso : the Energy Performance Integrated Contract



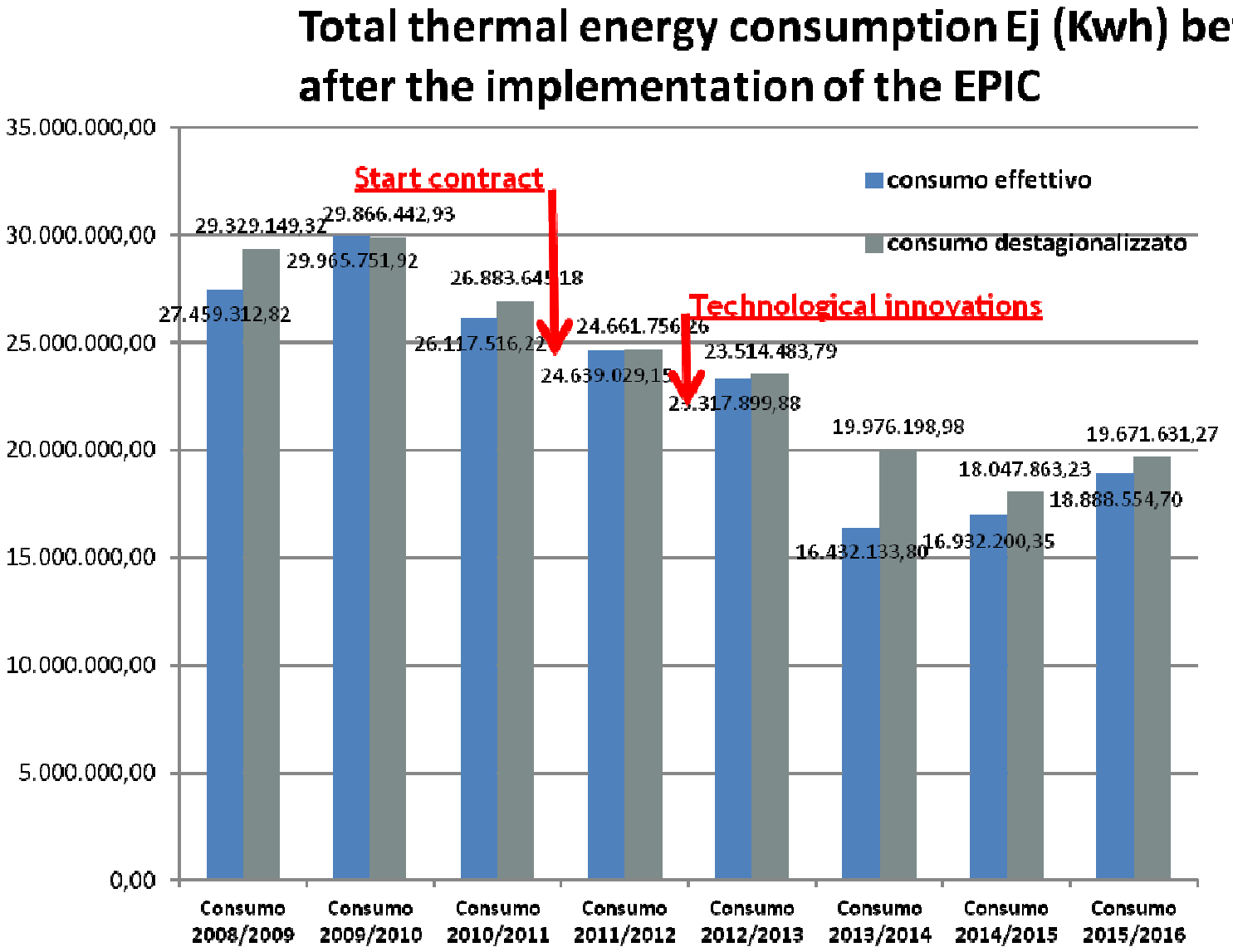
EPIC MODEL AT THE PROVINCE OF TREVISO : BEHAVIOURAL DSM

Interreg CENTRAL EUROPE TOGETHER

Energy Efficiency measures adopted for energy reduction in public buildings at the province of Treviso : the Energy Performance Integrated Contract



HOW TOTAL THERMAL ENERGY CONSUMPTION DECREASED



ANALYSIS OF THE RESULTS

			RIDUZIONE PROGRESSIVA DEI CONSUMI						RIDUZIONE ANNUA DEI CONSUMI							INTERVENTI TECNOLOGICI						INTERVENTI SOCIALI (PUNTEGGIO GSC)			
N°	Cod. Imp.	Complesso Edificio-Impianto (Bene)	Risparmio/Perdita 2009/2010	Risparmio/Perdita 2010/2011	Risparmio/Perdita 2011/2012	Risparmio/Perdita 2012/2013	Risparmio/Perdita 2013/2014	Risparmio/Perdita 2014/2015	performance stagionale 1011/0910	performance stagionale 1112/1011	performance stagionale 1213/1112	performance stagionale 1314/1213	performance stagionale 1415/1314	volume riscaldato	emergia /m3	generatore a condenzazione	installazione valvole termostatiche	metanizzazione	rifacimento piping C.T.	adeguamento sistema di termo regolazione	altro	1 ed	2 ed	3 ed	
32	ML037_01	ISISS "Scarpa" Motta di Livenza	6,33%	24,91%	33,64%	39,83%	53,26%	58,21%	19,84%	11,63%	9,33%	22,32%	2,70%	9879,88	38,21	condensazione	termostatiche		piping	termoregolazione	FV	15,39		48,6	63,99
33	TV116_01	IPSC Besta	4,26%	14,96%	19,30%	18,65%	45,57%	51,03%	11,18%	5,09%	-0,80%	30,00%	6,03%	28959,69	16,46	condensazione	termostatiche	metano	piping	termoregolazione		0,00			0
34	CN028_01	ITAS Cerletti Aule/Direz.	-3,95%	13,15%	18,02%	46,78%	52,31%	50,74%	16,45%	5,61%	35,68%	10,40%	0,90%	15122,69	25,65		termostatiche		piping	termoregolazione		54,42		13	67,42
58	CN763_01	ITCS Fanno	0,00%	24,41%	25,35%	49,13%	58,14%	49,75%	24,41%	1,25%	23,81%	26,40%	-21,06%								FV	0			0
35	TV041_01	ITG Palladio	3,79%	16,36%	26,77%	37,69%	49,65%	49,05%	13,06%	12,45%	14,90%	11,19%	4,62%	51114,01	11,58	condensazione	termostatiche		piping	termoregolazione	cogenerazione +FV	66,39	86	59	211,39
36	VV150_01	Liceo Sc. Flaminio Vittorio V.to	4,35%	21,34%	12,47%	10,21%	34,94%	48,58%	17,77%	-11,28%	-2,59%	27,55%	17,71%	13201,17	14,88							7,89			7,89
37	TV043_01	ITT Mazzotti aule	1,71%	11,99%	32,25%	37,04%	48,71%	47,44%	10,46%	23,02%	7,07%	18,54%	-4,06%	20411,38	33,35	condensazione	termostatiche		piping	termoregolazione		0,00	62	62,4	124,4
38	VV039_01	ITIS Galilei Vittorio V.to	-0,04%	25,70%	27,01%	30,50%	51,16%	47,19%	25,73%	1,76%	4,77%	29,73%	-8,09%	16338,01	22,17							15,39			15,39
39	TV096_01	Liceo Canova - Succursale.	7,67%	13,94%	22,57%	25,04%	36,01%	45,57%	6,79%	10,03%	3,20%	14,64%	9,47%	21313,61	8,46							0,00			0
40	CN042_01	ISISS F. da Collo	-3,14%	19,81%	23,74%	38,30%	49,07%	43,99%	22,25%	4,91%	19,09%	18,91%	-6,08%	20562,06	46,17						rid flusso lum	0,00			0
41	CN130_01	LP.S.tA. "Pittoni" - Aule + Officine	3,43%	15,99%	6,14%	27,83%	46,68%	44,42%	13,01%	-11,73%	23,11%	26,01%	-5,50%	4740,54	119,08	condensazione	termostatiche	metano	piping	termoregolazione		28,17			28,17
36	CV747_01	IPSS NIGHTINGALE - Nuova sede	-10,34%	12,05%	29,16%	36,81%	49,27%	44,50%	20,29%	19,46%	10,80%	19,71%	-0,33%	5798,52	26,79							0,00		32	32
37	VV114_04	IPSSAR Beltrame	3,98%	8,07%	20,53%	26,07%	45,19%	44,37%	4,26%	13,55%	6,97%	25,87%	-4,72%	68692,93	5,33						solare termico + FV	9,00		22,4	31,4
38	VV127_01	IPSIA Vittorio V.to	-1,79%	17,08%	27,80%	32,13%	47,06%	44,20%	18,54%	12,93%	6,00%	22,00%	-3,91%	22104,78	19,93		termostatiche		piping	termoregolazione		15,39	65	7,2	87,59
39	VB049_01	ISIS VERDI (Ex-Liceo Valgimigli aule)	-1,10%	6,73%	8,09%	19,94%	43,60%	42,12%	7,75%	1,45%	12,89%	29,55%	-1,80%	12960,56	29,30	condensazione	termostatiche		piping	termoregolazione		53,58	63	33,4	149,98
40	CN048_03	Liceo "Marconi" Ampliamento	1,94%	3,60%	11,39%	35,17%	41,71%	41,79%	1,69%	8,09%	26,84%	13,16%	-4,85%	8022,42	10,55							45,12			45,12
36	OD029_01	ITG/ITCS Sansovino	-2,77%	3,20%	26,24%	33,62%	39,02%	41,76%	5,80%	25,87%	7,49%	6,64%	6,86%	11134,75	38,04	condensazione	termostatiche	metano	piping	termoregolazione		9,00			9
24	MB030_01	ITG Einaudi	4,08%	7,57%	19,93%	29,95%	30,95%	41,65%	3,64%	13,37%	12,51%	1,44%	12,20%	5764,01	20,82	condensazione	termostatiche		piping	termoregolazione	FV	15,39		33,4	48,79
25	TV137_02	Liceo Classico Canova - Succ. Ex Liceo	-3,55%	7,45%	6,97%	29,08%	43,60%	40,71%	10,62%	-0,52%	23,76%	20,55%	-2,64%	24971,73	9,13	condensazione	termostatiche	metano	piping	termoregolazione		0,00			0
4	CV046_01	Liceo Clas./Sc. Giorgione	0,26%	0,99%	9,17%	37,83%	39,53%	40,51%	0,73%	8,26%	34,25%	2,74%	1,44%	56790,90	3,34	condensazione	termostatiche		piping	termoregolazione		0,00			0
5	TV034_01	ITCS Riccati	0,00%	16,06%	23,86%	22,82%	31,59%	39,43%	16,06%	9,29%	-1,36%	11,37%	11,46%	16679,72	33,13							0,00			0
37	OD106_01	LP.S.A.A. "Corazzin"	8,32%	7,05%	18,55%	28,68%	31,15%	39,37%	-1,38%	12,38%	12,43%	3,47%	7,18%	16925,90	6,65							54,42			54,42
38	TV047_01	Liceo Da Vinci e palestra	7,44%	19,92%	28,80%	22,37%	35,07%	37,86%	13,48%	11,10%	-9,04%	16,36%	-0,04%	6224,57	143,04					termoregolazione		12,00			12
34	MV045_01	Liceo Berto	7,27%	3,62%	15,57%	19,51%	31,85%	37,17%	-3,94%	12,40%	4,67%	15,32%	3,84%	16402,07	12,44	condensazione	termostatiche		piping	termoregolazione		9,00			9
35	TV137_01	Liceo Classico Canova	0,94%	10,71%	26,28%	24,25%	37,43%	36,66%	9,87%	17,44%	-2,76%	17,40%	-1,78%	10537,39	18,00							0,00			0
36	TV032_02	ITIS Fermi + laboratori	4,09%	14,82%	13,33%	8,93%	34,04%	36,58%	11,19%	-1,75%	5,08%	20,57%	1,59%	26976,09	53,22	condensazione	termostatiche	metano	piping	termoregolazione	pompa geotermica	9,00			9
40	TV086_01	IPSIA Giorgi	10,89%	16,33%	32,46%	23,89%	34,95%	35,11%	6,11%	19,27%	-12,68%	14,53%	-5,63%	10507,46	45,36							57,00	82	47,8	186,8
41	CV119_01	IPSC Rosselli	-5,75%	27,46%	30,93%	18,69%	41,42%	34,75%	34,11%	4,79%	-17,72%	27,95%	-7,98%	5368,89	63,03		termostatiche	metano	piping	termoregolazione		0,00		22	22
42	CN048_01	Liceo "Marconi"	0,61%	11,70%	19,20%	25,76%	35,53%	34,74%	11,16%	8,50%	8,12%	13,16%	-1,56%	11377,70	55,38							45,12			45,12
44	VL005_04	ITIS Planck	1,74%	3,22%	11,71%	10,56%	26,67%	33,31%	1,50%	8,77%	-1,30%	18,02%	8,26%							termoregolazione		15,39			15,39
46	VV085_01	Liceo flaminio	13,47%	0,11%	2,91%	-1,13%	23,32%	31,69%	-15,45%	2,80%	-4,16%	24,18%	5,34%	11778,08	33,84							7,89			7,89
38	OD120_01	I.S.I.S.S. "Obici" - sede coordinata	-0,65%	12,91%	21,08%	23,52%	32,16%	30,71%	13,48%	9,38%	3,10%	11,30%	-1,85%	25919,08	11,19							33,39			33,39
3	CV035_01	ITIS Barsanti	1,87%	12,30%	16,15%	10,96%	25,45%	30,61%	10,63%	4,39%	-6,19%	16,28%	6,15%	13646,74	63,66		termostatiche	metano	piping	termoregolazione	FV	1,40	57		58,4020833
41	PS040_01	ITG/Liceo Casagrande	0,91%	6,06%	11,14%	18,70%	31,60%	29,57%	5,19%	5,41%	8,51%	15,93%	-3,43%	51331,76	10,08							29,55			29,55
42	VV135_01	Ist. St. d'Arte Vittorio V.to	-8,75%	-2,31%	-2,03%	1,85%	29,09%	28,94%	5,92%	0,27%	3,81%	27,75%	3,37%	10806,09	30,75		termostatiche		piping			0,00			0
5	CV087_01	IPSIA Galilei	6,12%	10,63%	13,41%	15,30%	17,72%	27,19%	4,80%	3,11%	2,18%	2,86%	9,49%	26791,42	26,51		termostatiche					46,11	70	34,8	150,91
1	CV031_01	ITCS Martini aule e Palestra	2,02%	11,05%	14,24%	23,18%	32,86%	27,13%	9,22%	3,58%	10,42%	12,60%	-9,34%	6316,06	68,81		termostatiche					9,00		23,6	32,6
7	CV091_01	Ist. Alberghiero Maffioli	4,21%	6,87%	17,96%	29,97%	33,83%	26,45%	2,78%	11,91%	14,64%	5,52%	-12,83%	38570,16	8,71		termostatiche				solare termico	0,00			0
8	MB030_02	ITCS Einaudi	-3,27%	4,64%	14,20%	3,12%	20,10%	25,74%	7,66%	10,03%	-12,91%	17,52%	8,12%	33548,14	9,70	condensazione	termostatiche		piping	termoregolazione		15,39		33,4	48,79
9	VL005_21	IPSSAR Alberini	-2,24%	-4,33%	18,63%	11,13%	24,31%	25,13%	-2,05%	22,00%	-9,21%	14,82%	1,83%	17012,49	29,26		termostatiche				solare termico	0,00			0
10	TV095_01	Ist. Magistrale Duca degli Abruzzi	0,78%	14,61%	24,71%	11,84%	25,73%	24,50%	13,94%	11,83%	-17,11%	15,76%	-1,92%	28697,57	18,82							33,90	65	47,8	146,7
8	CV104_01	IPSA Sartor + Palestra + convitto	6,27%	0,92%	15,72%	21,97%	19,62%	24,18%	-5,71%	14,94%	7,42%	-3,02%	3,79%	7277,84	65,99		termostatiche				solare termico	44,64	83	55,2	182,84
11	TV044_01	Liceo Artistico	1,69%	0,38%	4,16%	7,55%	15,86%	21,06%	-1,34%	3,80%	3,54%	8,98%	5,77%	30925,71	10,04		termostatiche		piping	termoregolazione		0,00			0
12	MB121_01	LP.S.tA. "Scarpa" aule	-4,17%	11,01%	8,96%	5,89%	17,28%	19,67%	14,57%	-2,30%	-3,38%	12,10%	3,88%	12134,48	19,64							9,00			9
13	MB083_02	LP.S.tA. succ.+ Ist. Mag."Veronese"	2,39%	8,11%	12,14%	1,36%	12,81%	12,21%	5,86%	4,38%	-12,27%	11,61%	-1,03%	11231,28	25,15							0,00			0
59	CN038_03	ITIS Galilei + officine	-24,16%	-46,00%	-45,90%	-12,52%	-1,82%	-7,92%	-17,59%	0,07%	9,17%	24,16%	-7,86%			condensazione	termostatiche		piping	termoregolazione		0,00			0
60	MB083_01	Ist. Mag. "Veronese"	3,55%	2,52%	1,16%	3,74%	6,47%	-21,92%	-1,07%	-1,39%	2,61%	2,84%	-29,53%	11790,82	10,86							0,00			0
	TOTALE		-1,32%	8,92%	16,31%	20,78%	34,63%	35,30%	10,10%	8,12%	5,34%	17,48%	1,74%												

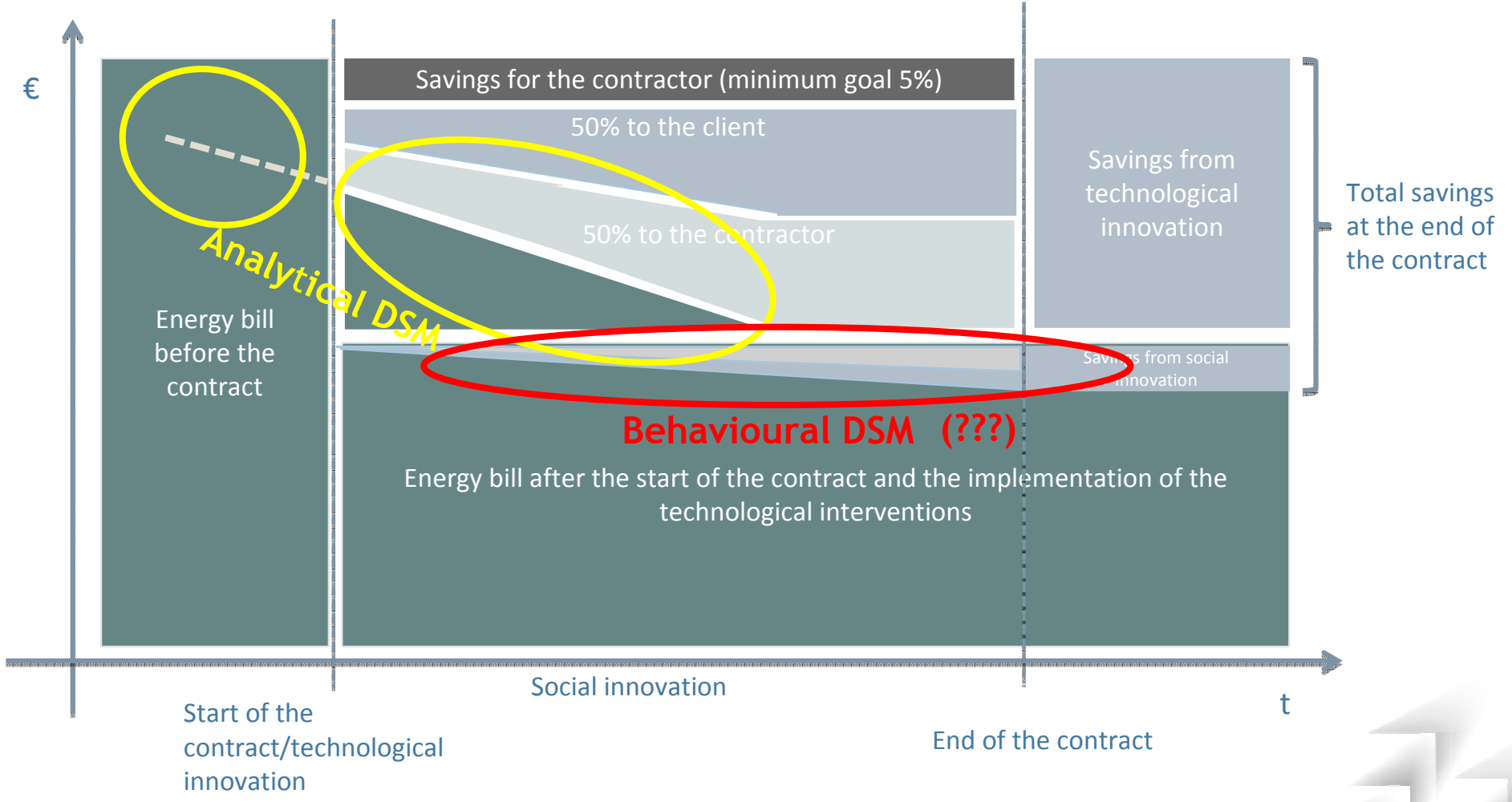
% di riduzione/aumento consumi

oltre - 20%	
tra -20% e -10%	
tra -10% e 0	
tra 0 e 10%	
tra 10% e 20%	
tra 20% e 30%	
tra 30% e 40%	
tra 40% e 50%	
oltre 50%	

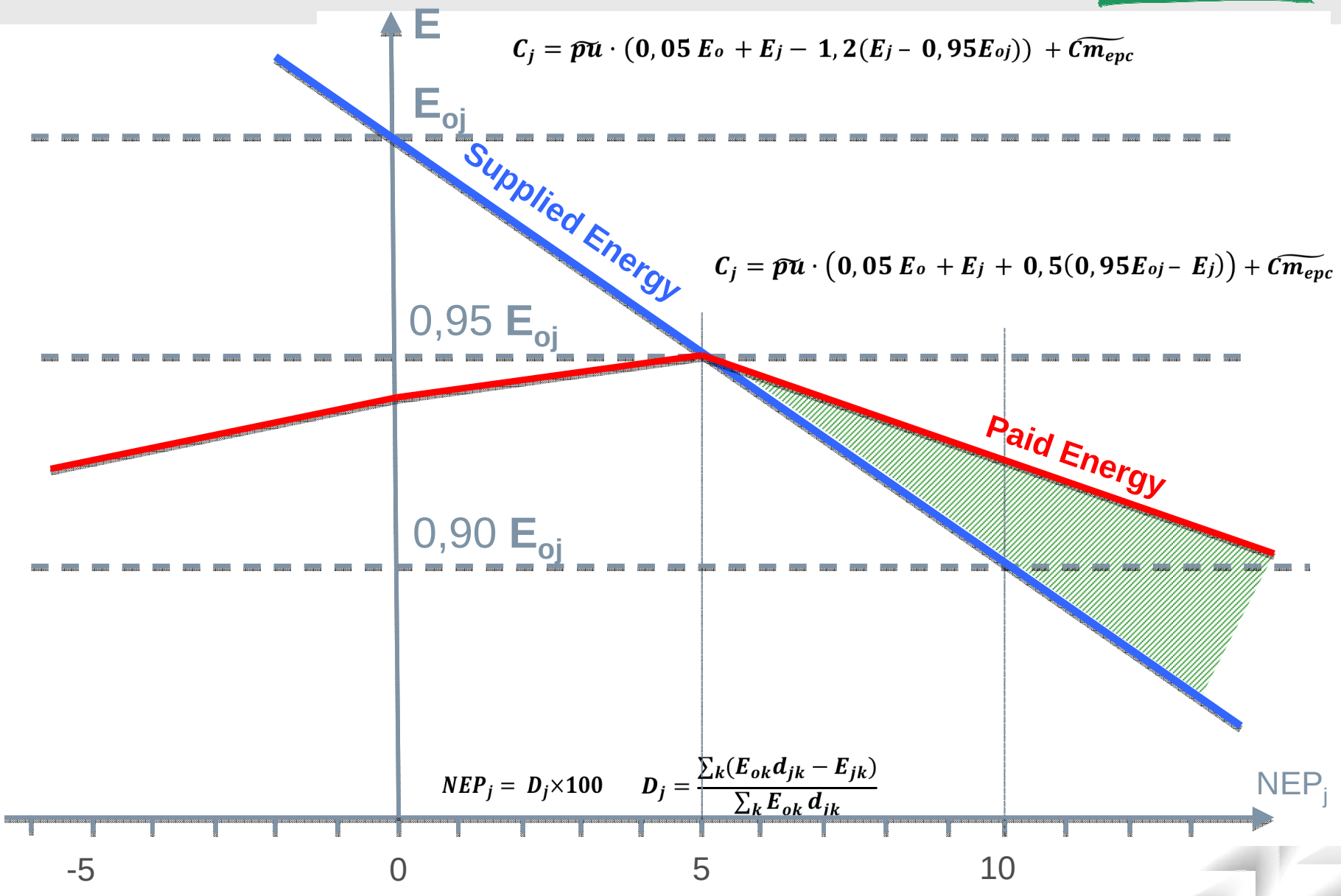
EPIC MODEL AT THE PROVINCE OF TREVISO : HOW IT REALLY WORKED

Interreg CENTRAL EUROPE TOGETHER

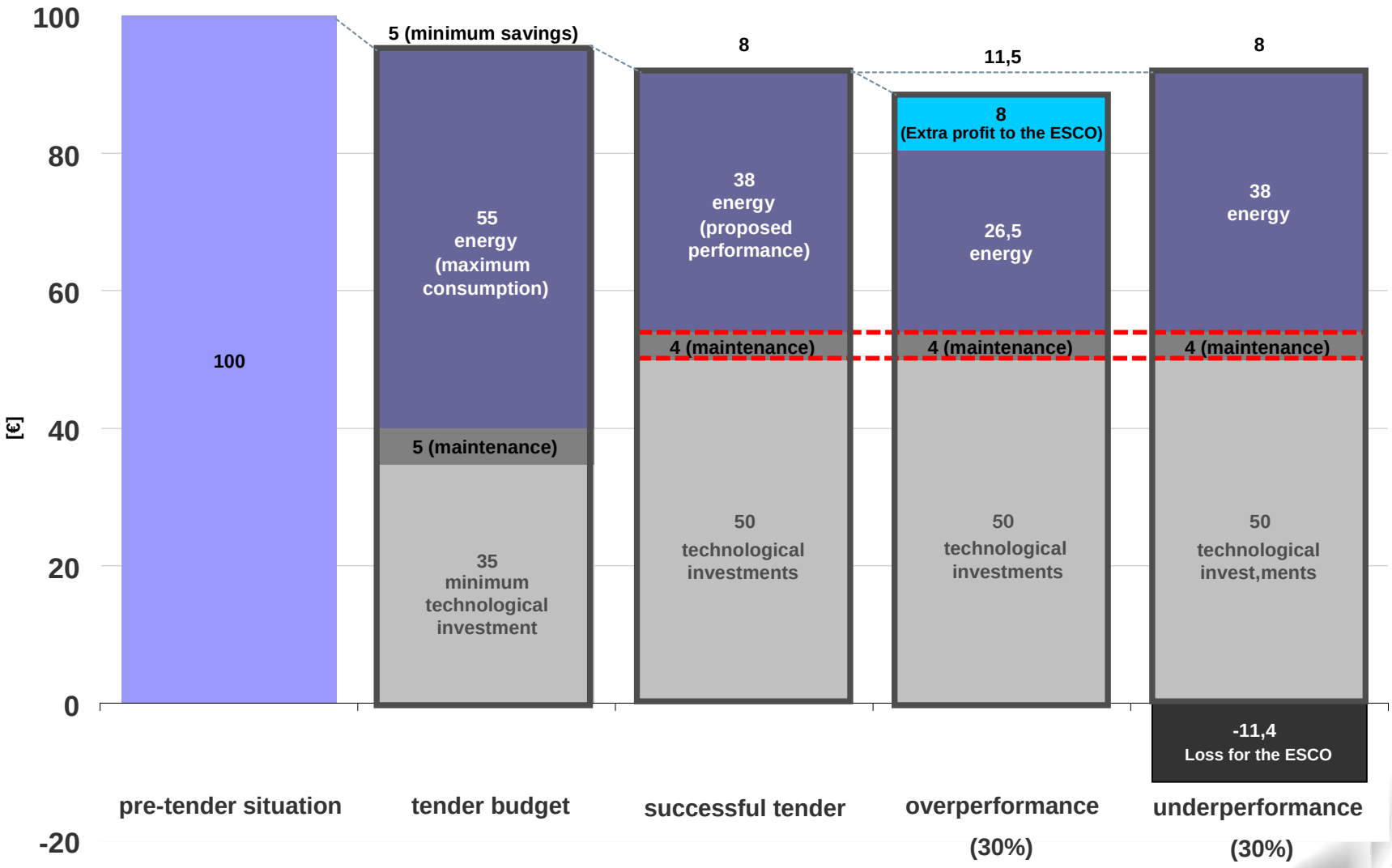
Energy Efficiency measures adopted for energy reduction in public buildings at the province of Treviso : the Energy Performance Integrated Contract



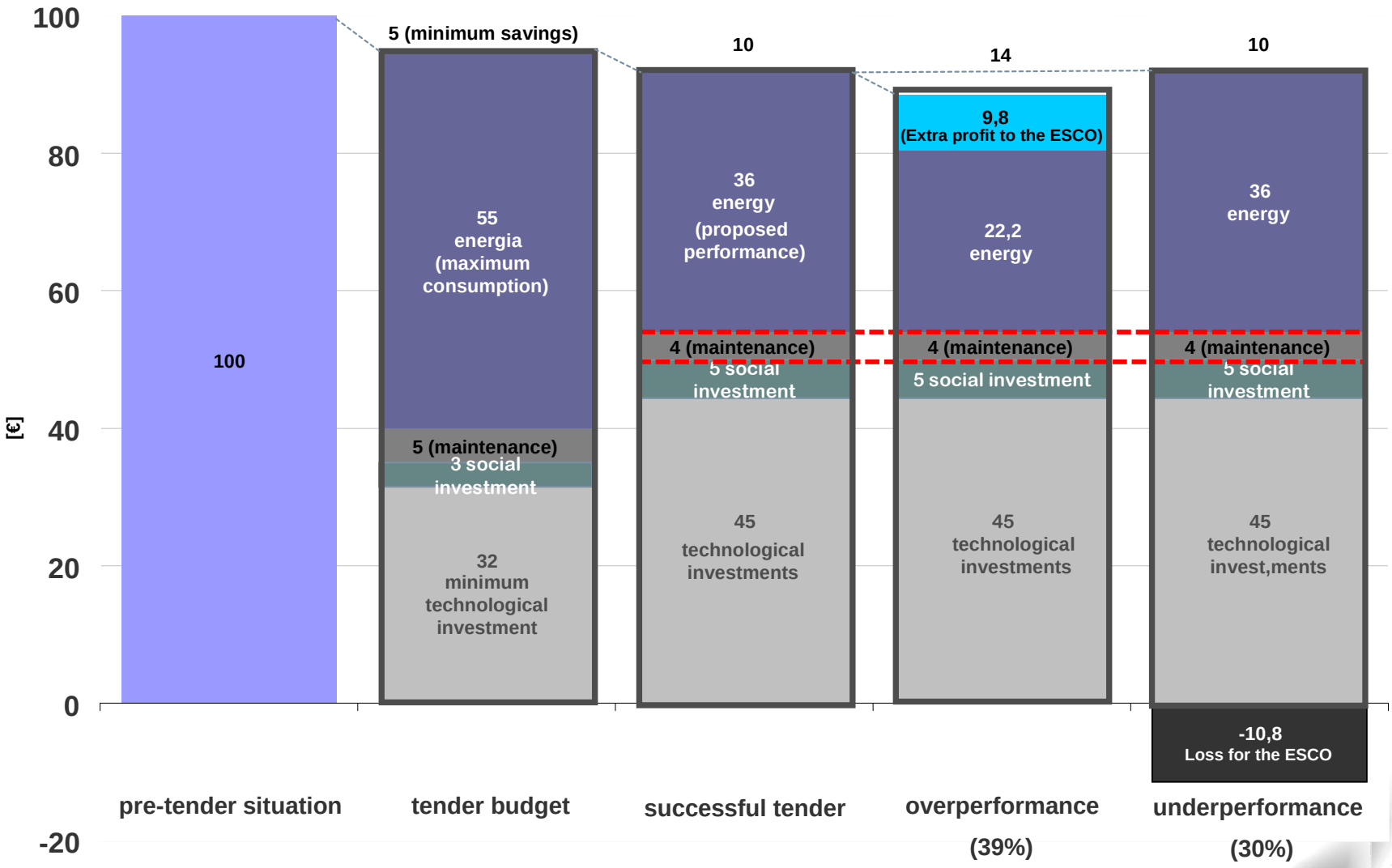
SUPPLIED ENERGY / PAID ENERGY



TECHNOLOGICAL EPC



TECHNOLOGICAL - BEHAVIOURAL EPC (EPIC)



BID EVALUATION CRITERIA

Criteria	Pts.		
Energy savings	22	60	technical
Useful life	20		
ESCO UNI - CEI 11352 certification	2		
Quality of O&M plan	2		
Further CO2 emission reduction (thanks to increased renewables)	8		
Clarity and completeness	6		
Investments amount	20	40	economic
Overall monetary savings amount	20		

EPIC BID EVALUATION CRITERIA

Criteria	Pts.		
Energy savings	18	60	technical
Useful life	16		
ESCO UNI - CEI 11352 certification	2		
Quality of O&M plan	2		
Quality of behavioural action plan	10		
Further CO2 emission reduction (thanks to increased renewables)	6		
Clarity and completeness	6		
Technological investments amount	15	40	economic
Behavioural investments amount	5		
Overall monetary savings amount	20		

THANK YOU FOR YOUR ATTENTION

Antonio Zonta
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TOGETHER

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SLED 2

Planning an Energy Efficiency Program in Public Buildings of Albania

30 June 2016

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Thermal efficiency retrofit of public buildings in Albania

Contents

Assumptions

Country-wise analysis, improvement 1
Country-wise analysis, improvement 2

Analysis for municipalities in climate zone A
Analysis for municipalities in climate zone B
Analysis for municipalities in climate zone C

Analysis per m2, improvement 1, climate zone A
Analysis per m2, improvement 1, climate zone B
Analysis per m2, improvement 1, climate zone C
Analysis per m2, improvement 2, climate zone A
Analysis per m2, improvement 2, climate zone B
Analysis per m2, improvement 2, climate zone C

Thermal efficiency retrofit of public buildings in Albania, assumptions

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerious benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price			CO2 emission factor	Primary-to-final energy factor
	2016 [EUR/kWh]	2045 [EUR/kWh]	nnual growth [%]	[gCO2/kWh]	[kWh/kWh]
Electricity	0,104	0,160	1,5%	0	1,0
Wood	0,024	0,037	1,5%	0	0,2
LPG	0,061	0,247	4,9%	227	1,1
Diesel oil	0,117	0,473	4,9%	267	1,2
Solar	0,000	0,000	N/A	0	0,0

Financial analysis

Measure lifetime	[years]	30
Discount rate	[%]	4%
Annuity factor	[%]	6%
Maintenance costs	[EUR/m2-yr.]	0,5

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view

GDP increase	[EUR/EUR]	0,65
direct	[EUR/EUR]	0,30
multiplier effects	[EUR/EUR]	0,35
Labour income	[EUR/EUR]	0,30
direct	[EUR/EUR]	0,17
multiplier effects	[EUR/EUR]	0,13
Annual employment	[jobs/million EUR]	148
Employment	[jobs/million EUR]	85
multiplier effects	[jobs/million EUR]	63
Monetized CO2 emissions avoided	EUR/tCO2	5
Air quality including health impacts	EUR/MWh	1,38
Improved comfort and services of buildings refle	[% value]	2%

*Assumed estate value is EUR 300 per m2

Conversion units

GWh / 1 ktoe	11,63

Extra: in case if a credit line will be established

Capital structure		
Share of equity	[%]	0%
Share of debt	[%]	100%
Cost of capital		
Equity	[%]	14%
Public loan	[%]	0%
Commercial loan	[%]	8%
Debt payment period	[years]	10

Program budget

Program budget	million EUR	46,0
Other costs	million EUR	6,0
Budget excluding other costs	million EUR	40,0
Other costs as a share of the program budget	[%]	15%
Period of implementation	[years]	4,0

Thermal efficiency retrofit of public buildings in Albania, country-wide analysis

Improvement 1
Climate zone A, B, C

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerious benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific		Energy source price 2016 [EUR/kWh]	2030 [EUR/kWh]	annual growth [%]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity		0,104	0,160	1%	0	1,0
Wood		0,024	0,037	1%	0	0,2
LPG		0,061	0,247	5%	227	1,1
Diesel oil		0,117	0,473	5%	267	1,2
Solar		0,000	0,000	N/A	0	0,0
Financial analysis						
Measure lifetime	[years]	30				
Discount rate	[%]	4%				
Annuity factor	[%]	6%				
Maintenance costs	[EUR/m2-yr.]	0,5				
Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view						
GDP increase	[EUR/EUR]	0,65				
direct	[EUR/EUR]	0,30				
multiplier effects	[EUR/EUR]	0,35				
Labour income	[EUR/EUR]	0,30				
direct	[EUR/EUR]	0,17				
multiplier effects	[EUR/EUR]	0,13				
Annual employment	[jobs/million EUR]	148				
Employment	[jobs/million EUR]	85				
multiplier effects	[jobs/million EUR]	63				
Monetized CO2 emissions avoided	EUR/tCO2	5				
Air quality including health impacts	EUR/MWh	1,38				
Improved comfort and services of buildings reflec	[% value]	2%	*Assumed estate value is	EUR 300	per m2	
Conversion units						
GWh / 1 ktoe		11,63				
Extra: in case if a credit line will be established						
Capital structure						
Share of equity	[%]	0%				
Shae of debt	[%]	100%				
Cost of capital						
Equity	[%]	14%				
Public loan	[%]	0%				
Commercial loan	[%]	8%				
Debt payment period	[years]	10				
Program budget						
Program budget			million EUR	46		
Other costs			million EUR	6		
Budget excluding other costs			million EUR	40		
Other costs as a share of the program budget			[%]	15%		
Period of implementation			[years]	4		

Building stock

Characteristics	Units	Dormitory	Hospital	Kindergarten	Office	School	University	
Sector		Education	Public health	Education	Other	Education	Education	
Governance level		Central Municipal	Central Municipal	Municipal	Central Municipal	Municipal	Central	
Stock	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Retrofit need	[thousand m2]	**9,0**	**759**	**2.531**	**856**	**2.464**	**11,0**	**6.629**
climate zone A	[thousand m2]	5,3	424	1.482	448	1.443	6,4	3.809
climate zone B	[thousand m2]	2,2	208	629	245	613	2,7	1.700
climate zone C	[thousand m2]	1,5	126	419	163	408	1,8	1.119

Program results

Stock retrofitted by the program	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Share of the need	[%/stock]	**0%**	**17%**	**17%**	**0%**	**0%**	**0%**	**8%**
climate zone A	[%/stock]	0%	0%	0%	0%	0%	0%	0%
climate zone B	[%/stock]	0%	0%	0%	0%	0%	0%	0%
climate zone C	[%/stock]	0%	100%	100%	0%	0%	0%	49%
Floor area	[thousand m2]	-	**126**	**419**	-	-	-	**545**
climate zone A	[thousand m2]	-	-	-	-	-	-	-
climate zone B	[thousand m2]	-	-	-	-	-	-	-
climate zone C	[thousand m2]	-	126	419	-	-	-	545
Investment and maintenance costs	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Investment cost, per m2	[EUR/m2]	**#DIV/0!**	**80**	**71**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**73**
climate zone A	[EUR/m2]	63	80	76	81	75	77	#DIV/0!
climate zone B	[EUR/m2]	63	80	76	81	75	77	#DIV/0!
climate zone C	[EUR/m2]	71	80	71	73	81	82	73
Maintenance cost, per m2	[EUR/m2-yr.]	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Costs of energy conserved	[EUR/kWh]	**#DIV/0!**	**0,03**	**0,07**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**0,05**
climate zone A	[EUR/kWh]	0,07	0,14	0,22	0,22	0,28	0,98	#DIV/0!
climate zone B	[EUR/kWh]	0,05	0,11	0,17	0,16	0,21	0,52	#DIV/0!
climate zone C	[EUR/kWh]	0,02	0,03	0,07	0,06	0,11	0,10	#DIV/0!
Investment cost, total	[million EUR]	**-**	**10**	**30**	**-**	**-**	**-**	**40**
climate zone A	[million EUR]	-	-	-	-	-	-	-
climate zone B	[million EUR]	-	-	-	-	-	-	-
climate zone C	[million EUR]	-	10,1	29,7	-	-	-	40

Energy/CO2 savings: improvement vs BAU	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
			per m2					
Total CO2	[gCO2/m2]	#DIV/0!	30.515	2.558	#DIV/0!	#DIV/0!	#DIV/0!	9.017
climate zone A	[gCO2/m2]	3.462	7.456	1.827	2.090	881	1.171	#DIV/0!
climate zone B	[gCO2/m2]	4.655	9.133	2.248	2.734	964	1.995	#DIV/0!
climate zone C	[gCO2/m2]	16.904	30.515	2.558	5.348	1.902	7.502	9.017
Total primary energy	[kWh/m2]	#DIV/0!	140	30	#DIV/0!	#DIV/0!	#DIV/0!	56
climate zone A	[kWh/m2]	63	43	24	21	17	6	#DIV/0!
climate zone B	[kWh/m2]	83	54	31	28	22	11	#DIV/0!
climate zone C	[kWh/m2]	115	140	30	44	27	36	56
Total final energy	[kWh/m2]	#DIV/0!	157	66	#DIV/0!	#DIV/0!	#DIV/0!	87
climate zone A	[kWh/m2]	59	36	21	24	17	5	#DIV/0!
climate zone B	[kWh/m2]	79	47	28	32	23	10	#DIV/0!
climate zone C	[kWh/m2]	189	157	66	84	48	55	87
			for the whole stock retrofitted					
Total CO2	[tCO2]	**-**	**3.841**	**1.072**	**-**	**-**	**-**	**4.913**
climate zone A	[tCO2]	-	-	-	-	-	-	-
climate zone B	[tCO2]	-	-	-	-	-	-	-
climate zone C	[tCO2]	-	3.841	1.072	-	-	-	4.913
Total primary energy	[GWh]	**0,0**	**18**	**13**	**0**	**0**	**0,0**	**30**
climate zone A	[GWh]	0,00	0	0	0	0	0,00	0
climate zone B	[GWh]	0,00	0	0	0	0	0,00	0
climate zone C	[GWh]	0,00	18	13	0	0	0,00	30
Total primary energy	[ktoe]	**0,00**	**1,52**	**1,10**	**0,00**	**0,00**	**0,00**	**2,61**
climate zone A	[ktoe]	0,00	0,00	0,00	0,00	0,00	0,00	0,00
climate zone B	[ktoe]	0,00	0,00	0,00	0,00	0,00	0,00	0,00
climate zone C	[ktoe]	0,00	1,52	1,10	0,00	0,00	0,00	2,61
Total final energy	[GWh]	**0,0**	**20**	**28**	**0**	**0**	**0,0**	**48**
climate zone A	[GWh]	0,0	0	0	0	0	0,0	0
climate zone B	[GWh]	0,0	0	0	0	0	0,0	0
climate zone C	[GWh]	0,0	20	28	0	0	0,0	48
Total final energy	[ktoe]	**0,00**	**1,70**	**2,39**	**0,00**	**0,00**	**0,00**	**4,09**
climate zone A	[ktoe]	0,00	0,00	0,00	0,00	0,00	0,00	0,00
climate zone B	[ktoe]	0,00	0,00	0,00	0,00	0,00	0,00	0,00
climate zone C	[ktoe]	0,00	1,70	2,39	0,00	0,00	0,00	4,09

Saved energy costs: improvement vs BAU	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Total over measure lifetime (NPV)	[EUR/m2]	**#DIV/0!**	**461,7**	**82,3**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**169,9**
climate zone A	[EUR/m2]	165,8	129,8	56,1	60,2	42,0	18,8	#DIV/0!
climate zone B	[EUR/m2]	218,1	163,5	71,8	80,1	52,9	33,9	#DIV/0!
climate zone C	[EUR/m2]	366,7	461,7	82,3	133,2	70,0	113,0	169,9
Annual over measure lifetime	[EUR/m2]	**#DIV/0!**	**26,70**	**4,76**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**9,83**
climate zone A	[EUR/m2]	9,6	7,5	3,2	3,5	2,4	1,1	#DIV/0!
climate zone B	[EUR/m2]	12,6	9,5	4,2	4,6	3,1	2,0	#DIV/0!
climate zone C	[EUR/m2]	21,2	26,7	4,8	7,7	4,1	6,5	9,8
Total over measure lifetime (NPV)	[million EUR]	**-**	**58**	**34**	**-**	**-**	**-**	**93**
climate zone A	[million EUR]	-	-	-	-	-	-	-
climate zone B	[million EUR]	-	-	-	-	-	-	-
climate zone C	[million EUR]	-	58,1	34,5	-	-	-	93
Annual over measure lifetime	[million EUR]	**-**	**3**	**2**	**0**	**0**	**-**	**5**
climate zone A	[million EUR]	-	-	-	-	-	-	-
climate zone B	[million EUR]	-	-	-	-	-	-	-
climate zone C	[million EUR]	-	3,4	2,0	-	-	-	5

Financial analysis	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Simple payback	[years]	#DIV/0!	3	15	#DIV/0!	#DIV/0!	#DIV/0!	7
Internal rate of return	[%]	#NUM!	22,6%	5,1%	#NUM!	#NUM!	#NUM!	10,9%
NPV	[EUR/m2]	0,0	46,2	4,6	0,0	0,0	0,0	50,7
Cost - benefit ratio		#DIV/0!	0,2	0,9	#DIV/0!	#DIV/0!	#DIV/0!	0,4

Analysis of co-benefits	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
			per m2					
GDP increase	[EUR/m2]	#DIV/0!	52	46	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Labour income	[EUR/m2]	#DIV/0!	24	21	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Employment	[jobs/m2]	#DIV/0!	0,01	0,01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Monetized CO2 emissions avoided	[EUR/m2]	#DIV/0!	0,15	0,01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Air quality including health impacts	[EUR/m2]	#DIV/0!	0,22	0,09	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Improved comfort and services of buildings	[EUR/m2]	6	6	6	6	6	6	6
			for the whole stock retrofitted					
GDP increase	[million EUR]	#DIV/0!	6,6	19,3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Labour income	[million EUR]	#DIV/0!	3,0	8,8	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Employment	[jobs]	#DIV/0!	1.490	4.383	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Monetized CO2 emissions avoided	[million EUR]	#DIV/0!	0,0	0,0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Air quality including health impacts	[million EUR]	#DIV/0!	0,0	0,0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Improved comfort and services of buildings	[million EUR]	0,0	0,8	2,5	0,0	0,0	0,0	3

Extra: in case if a credit line will be established	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Cost of investors								
Debt service, annual over the loan repayment pe	[million EUR/yr.]	-	1	3	-	-	-	**4**
Cost of administrator (state)								
Costs of low interest rate, annual over the loan r	[million EUR/yr.]	-	0,5	1,5	-	-	-	**2,0**
Technical assistance (energy audits, design, arn	[million EUR]	-	1,5	4,5	-	-	-	**6**
Costs and benefits of commercial banks								
Provision of loans for investment costs	[million EUR]	0,00	10	30	-	-	-	**40**
Interest payments from investors	[million EUR]	0,00	-	-	-	-	-	-
Interest payments from the state	[million EUR]	-	5	15	-	-	-	**20**

- Loan Amount EUR 1
- Loan Tenor years 10
- Interest Rate % 8%
- Interest Rate, subsidized % 0%

municipalities without subsidized rate

	Debt Service Interest	Principa	Total Debt Service
0			
1	0,08	0,07	0,15
2	0,07	0,07	0,15
3	0,07	0,08	0,15
4	0,06	0,09	0,15
5	0,06	0,09	0,15
6	0,05	0,10	0,15
7	0,04	0,11	0,15
8	0,03	0,12	0,15
9	0,02	0,13	0,15
10	0,01	0,14	0,15
	0,49		1,49

municipalities with subsidized rate

	Debt Service Interest Payment	Principa	Total Debt Service
0			
1	0,00	0,10	0,10
2	0,00	0,10	0,10
3	0,00	0,10	0,10
4	0,00	0,10	0,10
5	0,00	0,10	0,10
6	0,00	0,10	0,10
7	0,00	0,10	0,10
8	0,00	0,10	0,10
9	0,00	0,10	0,10
10	0,00	0,10	0,10
	0,00		1,00

	Saved energy costs: Changing energy prices						
Year	Dormitory	Hospital	Kindergar	Office	School	University	total
0	0,0	-10,1	-29,7	0,0	0,0	0,0	-39,8
1	0,000	1,751	1,367	0,000	0,000	0,000	3,1
2	0,000	1,921	1,428	0,000	0,000	0,000	3,3
3	0,000	2,011	1,466	0,000	0,000	0,000	3,5
4	0,000	2,106	1,506	0,000	0,000	0,000	3,6
5	0,000	2,204	1,548	0,000	0,000	0,000	3,8
6	0,000	2,311	1,592	0,000	0,000	0,000	3,9
7	0,000	2,422	1,637	0,000	0,000	0,000	4,1
8	0,000	2,536	1,684	0,000	0,000	0,000	4,2
9	0,000	2,655	1,732	0,000	0,000	0,000	4,4
10	0,000	2,766	1,778	0,000	0,000	0,000	4,5
11	0,000	2,895	1,829	0,000	0,000	0,000	4,7
12	0,000	3,030	1,882	0,000	0,000	0,000	4,9
13	0,000	3,171	1,937	0,000	0,000	0,000	5,1
14	0,000	3,319	1,994	0,000	0,000	0,000	5,3
15	0,000	3,474	2,054	0,000	0,000	0,000	5,5
16	0,000	3,636	2,116	0,000	0,000	0,000	5,8
17	0,000	3,806	2,180	0,000	0,000	0,000	6,0
18	0,000	3,984	2,246	0,000	0,000	0,000	6,2
19	0,000	4,170	2,316	0,000	0,000	0,000	6,5
20	0,000	4,365	2,389	0,000	0,000	0,000	6,8
21	0,000	4,569	2,462	0,000	0,000	0,000	7,0
22	0,000	4,783	2,540	0,000	0,000	0,000	7,3
23	0,000	5,007	2,621	0,000	0,000	0,000	7,6
24	0,000	5,241	2,705	0,000	0,000	0,000	7,9
25	0,000	5,487	2,793	0,000	0,000	0,000	8,3
26	0,000	5,744	2,884	0,000	0,000	0,000	8,6
27	0,000	6,014	2,978	0,000	0,000	0,000	9,0
28	0,000	6,296	3,077	0,000	0,000	0,000	9,4
29	0,000	6,591	3,180	0,000	0,000	0,000	9,8
30	0,000	6,900	3,286	0,000	0,000	0,000	10,2

Fig. Cost of energy conserved

	A: Dormit	A: Hospit	A: Kinder	A: Office	A: School	A: Univers	B: Dormit	B: Hospit	B: Kinder	B: Office	B: School	B: Univers	C: Dormit	C: Hospit	C: Kinder	C: Office	C: School	C: University
Ranking of options	6	10	15	14	16	18	2	8	12	11	13	17	1	9	4	3	5	7
Cost of en	EUR/kWh	0,1	0,1	0,2	0,2	0,3	1,0	0,1	0,1	0,2	0,2	0,5	0,02	0,0	0,1	0,1	0,1	0,1
Final ener	kWh/m2	59,2	36,3	21,3	23,6	17,4	5,1	78,5	46,7	27,6	31,5	23,1	9,5	189,3	156,9	66,3	83,5	47,9	54,9
Final ener	GWh	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	19,7	27,8	0,0	0,0	0,0

Cost of energy conserved: Improvement 1

	EUR/kWh y	kWh/m2 x	
1	0,02	0,0	C: Dormitory
	0,02	189,3	
2	0,03	189,3	C: Hospital
	0,03	346,2	
3	0,05	346,2	B: Dormitory
	0,05	424,7	
4	0,06	424,7	C: Office
	0,06	508,3	
5	0,07	508,3	C: Kindergarten
	0,07	574,5	

Supply curve of energy conserved: Improvement 1

	EUR/kWh y	GWh x	
1	0,02	0,0	C: Dormitory
	0,02	0,0	
2	0,03	0,0	C: Hospital
	0,03	19,7	
3	0,05	19,7	B: Dormitory
	0,05	19,7	
4	0,06	19,7	C: Office
	0,06	19,7	
5	0,07	19,7	C: Kindergarten
	0,07	47,5	

6	0,07 0,07	574,5 A: Dormitory 633,7	
7	0,10 0,10	633,7 C: University 688,6	
8	0,11 0,11	688,6 B: Hospital 735,4	
9	0,11 0,11	735,4 C: School 783,3	
10	0,14 0,14	783,3 A: Hospital 819,6	
11	0,16 0,16	819,6 B: Office 851,1	
12	0,17 0,17	851,1 B: Kindergarten 878,7	
13	0,21 0,21	878,7 B: School 901,8	
14	0,22 0,22	901,8 A: Office 925,4	
15	0,22 0,22	925,4 A: Kindergarten 946,7	
16	0,28 0,28	946,7 A: School 964,1	
17	0,52 0,52	964,1 B: University 973,6	
18	0,98 0,98	973,6 A: University 978,7	

6	0,07 0,07	47,5 A: Dormitory 47,5	
7	0,10 0,10	47,5 C: University 47,5	
8	0,11 0,11	47,5 B: Hospital 47,5	
9	0,11 0,11	47,5 C: School 47,5	
10	0,14 0,14	47,5 A: Hospital 47,5	
11	0,16 0,16	47,5 B: Office 47,5	
12	0,17 0,17	47,5 B: Kindergarten 47,5	
13	0,21 0,21	47,5 B: School 47,5	
14	0,22 0,22	47,5 A: Office 47,5	
15	0,22 0,22	47,5 A: Kindergarten 47,5	
16	0,28 0,28	47,51 A: School 47,51	
17	0,52 0,52	47,51 B: University 47,51	
18	0,98 0,98	47,51 A: University 47,51	

Thermal efficiency retrofit of public buildings in Albania, country-wide analysis

Improvement 1
Climate zone A, B, C

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerious benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price 2016 [EUR/kWh]	2030 [EUR/kWh]	annual growth [%]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity	0,104	0,160	1%	0	1,0
Wood	0,024	0,037	1%	0	0,2
LPG	0,061	0,247	5%	227	1,1
Diesel oil	0,117	0,473	5%	267	1,2
Solar	0,000	0,000	N/A	0	0,0

Financial analysis

Measure lifetime	[years]	30
Discount rate	[%]	4%
Annuity factor	[%]	6%
Maintenance costs	[EUR/m2-yr.]	0,5

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view

GDP increase	[EUR/EUR]	0,65
direct	[EUR/EUR]	0,30
multiplier effects	[EUR/EUR]	0,35
Labour income	[EUR/EUR]	0,30
direct	[EUR/EUR]	0,17
multiplier effects	[EUR/EUR]	0,13
Annual employment	[jobs/million EUR]	148
Employment	[jobs/million EUR]	85
multiplier effects	[jobs/million EUR]	63
Monetized CO2 emissions avoided	EUR/tCO2	5
Air quality including health impacts	EUR/MWh	1,38
Improved comfort and services of buildings reflec	[% value]	2% *Assumed estate value is EUR 300 per m2

Conversion units

GWh / 1 ktoe	11,63

Extra: in case if a credit line will be established

Capital structure		
Share of equity	[%]	0%
Share of debt	[%]	100%
Cost of capital		
Equity	[%]	14%
Public loan	[%]	0%
Commercial loan	[%]	8%
Debt payment period	[years]	10

Program budget

Program budget		million EUR	46
Other costs		million EUR	6
Budget excluding other costs		million EUR	40
Other costs as a share of the program budget		[%]	15%
Period of implementation		[years]	4

Building stock

Characteristics	Units	Dormitory	Hospital	Kindergarten	Office	School	University	
Sector		Education	Public health	Education	Other	Education	Education	
Governance level		Central Municipal	Central Municipal	Municipal	Central Municipal	Municipal	Central	
Stock	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Retrofit need	[thousand m2]	**9,0**	**759**	**2.531**	**856**	**2.464**	**11,0**	**6.629**
climate zone A	[thousand m2]	5,3	424	1.482	448	1.443	6,4	3.809
climate zone B	[thousand m2]	2,2	208	629	245	613	2,7	1.700
climate zone C	[thousand m2]	1,5	126	419	163	408	1,8	1.119

Program results

Stock retrofitted by the program	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Share of the need	[%/stock]	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
climate zone A	[%/stock]	100%	100%	100%	100%	100%	100%	100%
climate zone B	[%/stock]	100%	100%	100%	100%	100%	100%	100%
climate zone C	[%/stock]	100%	100%	100%	100%	100%	100%	100%
Floor area	[thousand m2]	**9,0**	**759**	**2.531**	**856**	**2.464**	**11,0**	**6.629**
climate zone A	[thousand m2]	5,3	424	1.482	448	1.443	6,4	3.809
climate zone B	[thousand m2]	2,2	208	629	245	613	2,7	1.700
climate zone C	[thousand m2]	1,5	126	419	163	408	1,8	1.119
Investment and maintenance costs	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Investment cost, per m2	[EUR/m2]	**64**	**80**	**75**	**80**	**76**	**78**	**77**
climate zone A	[EUR/m2]	63	80	76	81	75	77	77
climate zone B	[EUR/m2]	63	80	76	81	75	77	77
climate zone C	[EUR/m2]	71	80	71	73	81	82	76
Maintenance cost, per m2	[EUR/m2-yr.]	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Costs of energy conserved	[EUR/kWh]	**0,05**	**0,09**	**0,16**	**0,14**	**0,21**	**0,35**	**0,15**
climate zone A	[EUR/kWh]	0,07	0,14	0,22	0,22	0,28	0,98	0,21
climate zone B	[EUR/kWh]	0,05	0,11	0,17	0,16	0,21	0,52	0,16
climate zone C	[EUR/kWh]	0,02	0,03	0,07	0,06	0,11	0,10	0,06
Investment cost, total	[million EUR]	**0,6**	**61**	**190**	**68**	**187**	**0,9**	**507**
climate zone A	[million EUR]	0,3	34,0	112,2	36,4	108,3	0,5	292
climate zone B	[million EUR]	0,1	16,7	47,7	19,9	46,0	0,2	131
climate zone C	[million EUR]	0,1	10,1	29,7	11,9	33,1	0,1	85

Energy/CO2 savings: improvement vs BAU	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
			per m2					
Total CO2	[gCO2/m2]	5.984	11.743	2.053	2.895	1.071	2.424	2.912
climate zone A	[gCO2/m2]	3.462	7.456	1.827	2.090	881	1.171	2.128
climate zone B	[gCO2/m2]	4.655	9.133	2.248	2.734	964	1.995	2.702
climate zone C	[gCO2/m2]	16.904	30.515	2.558	5.348	1.902	7.502	5.897
Total primary energy	[kWh/m2]	77	62	27	28	20	12	28
climate zone A	[kWh/m2]	63	43	24	21	17	6	23
climate zone B	[kWh/m2]	83	54	31	28	22	11	30
climate zone C	[kWh/m2]	115	140	30	44	27	36	44
Total final energy	[kWh/m2]	86	59	30	37	24	14	32
climate zone A	[kWh/m2]	59	36	21	24	17	5	22
climate zone B	[kWh/m2]	79	47	28	32	23	10	29
climate zone C	[kWh/m2]	189	157	66	84	48	55	72
			for the whole stock retrofitted					
Total CO2	[tCO2]	**54**	**8.909**	**5.195**	**2.478**	**2.638**	**27**	**19.300**
climate zone A	[tCO2]	18	3.163	2.708	937	1.271	8	8.104
climate zone B	[tCO2]	10	1.904	1.415	669	591	5	4.595
climate zone C	[tCO2]	25	3.841	1.072	872	776	14	6.600
Total primary energy	[GWh]	**0,7**	**47**	**67**	**24**	**49**	**0,1**	**188**
climate zone A	[GWh]	0,33	18	35	9	25	0,04	88
climate zone B	[GWh]	0,19	11	19	7	13	0,03	51
climate zone C	[GWh]	0,17	18	13	7	11	0,07	49
Total primary energy	[ktoe]	**0,06**	**4,05**	**5,80**	**2,04**	**4,23**	**0,01**	**16,17**
climate zone A	[ktoe]	0,03	1,56	3,04	0,82	2,13	0,00	7,57
climate zone B	[ktoe]	0,02	0,97	1,66	0,60	1,15	0,00	4,40
climate zone C	[ktoe]	0,01	1,52	1,10	0,62	0,95	0,01	4,20
Total final energy	[GWh]	**0,8**	**45**	**77**	**32**	**59**	**0,2**	**213**
climate zone A	[GWh]	0,3	15	32	11	25	0,0	83
climate zone B	[GWh]	0,2	10	17	8	14	0,0	49
climate zone C	[GWh]	0,3	20	28	14	20	0,1	81
Total final energy	[ktoe]	**0,07**	**3,86**	**6,59**	**2,75**	**5,06**	**0,01**	**18,33**
climate zone A	[ktoe]	0,03	1,32	2,71	0,91	2,16	0,00	7,14
climate zone B	[ktoe]	0,02	0,84	1,49	0,66	1,22	0,00	4,23
climate zone C	[ktoe]	0,02	1,70	2,39	1,17	1,68	0,01	6,97

Saved energy costs: improvement vs BAU	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Total over measure lifetime (NPV)	[EUR/m2]	**212,1**	**194,1**	**64,3**	**79,8**	**49,4**	**38,2**	**75,8**
climate zone A	[EUR/m2]	165,8	129,8	56,1	60,2	42,0	18,8	59,5
climate zone B	[EUR/m2]	218,1	163,5	71,8	80,1	52,9	33,9	77,6
climate zone C	[EUR/m2]	366,7	461,7	82,3	133,2	70,0	113,0	128,3
Annual over measure lifetime	[EUR/m2]	**12,26**	**11,23**	**3,72**	**4,61**	**2,86**	**2,21**	**4,38**
climate zone A	[EUR/m2]	9,6	7,5	3,2	3,5	2,4	1,1	3,4
climate zone B	[EUR/m2]	12,6	9,5	4,2	4,6	3,1	2,0	4,5
climate zone C	[EUR/m2]	21,2	26,7	4,8	7,7	4,1	6,5	7,4
Total over measure lifetime (NPV)	[million EUR]	**1,90**	**147**	**163**	**68**	**122**	**0,42**	**502**
climate zone A	[million EUR]	0,9	55,1	83,1	27,0	60,6	0,12	227
climate zone B	[million EUR]	0,5	34,1	45,2	19,6	32,4	0,09	132
climate zone C	[million EUR]	0,5	58,1	34,5	21,7	28,6	0,2	144
Annual over measure lifetime	[million EUR]	**0,11**	**9**	**9**	**4**	**7**	**0,02**	**29**
climate zone A	[million EUR]	0,05	3,2	4,8	1,6	3,5	0,01	13
climate zone B	[million EUR]	0,03	2,0	2,6	1,1	1,9	0,01	8
climate zone C	[million EUR]	0,03	3,4	2,0	1,3	1,7	0,01	8

Financial analysis	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Simple payback	[years]	5	7	20	17	27	n/a	17
Internal rate of return	[%]	15,7%	11,1%	3,0%	4,0%	1,1%	-0,2%	3,9%
NPV	[EUR/m2]	1,3	83,2	-25,8	0,2	-63,3	-0,4	-4,8
Cost - benefit ratio		0,3	0,4	1,2	1,0	1,5	2,1	1,0

Analysis of co-benefits	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
			per m2					
GDP increase	[EUR/m2]	42	52	49	52	49	51	50
Labour income	[EUR/m2]	19	24	22	24	23	23	23
Employment	[jobs/m2]	0,01	0,01	0,01	0,01	0,01	0,01	0,07
Monetized CO2 emissions avoided	[EUR/m2]	0,03	0,06	0,01	0,01	0,01	0,01	0
Air quality including health impacts	[EUR/m2]	0,12	0,08	0,04	0,05	0,03	0,02	0
Improved comfort and services of buildings	[EUR/m2]	6	6	6	6	6	6	6
			for the whole stock retrofitted					
GDP increase	[million EUR]	0,4	39,4	123,0	44,2	121,6	0,6	329
Labour income	[million EUR]	0,2	18,1	56,4	20,3	55,8	0,3	151
Employment	[jobs]	85	8.963	27.969	10.048	27.652	127	74.844
Monetized CO2 emissions avoided	[million EUR]	0,00	0,0	0,0	0,0	0,0	0,0	0
Air quality including health impacts	[million EUR]	0,0	0,1	0,1	0,0	0,1	0,0	0
Improved comfort and services of buildings	[million EUR]	0,1	4,6	15,2	5,1	14,8	0,1	40

Extra: in case if a credit line will be established	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Cost of investors								
Debt service, annual over the loan repayment pe	[million EUR/yr.]	0	6	19	7	19	0	**51**
Cost of administrator (state)								
Costs of low interest rate, annual over the loan r	[million EUR/yr.]	0,03	3,0	9,3	3,3	9,2	0,04	**24,9**
Technical assistance (energy audits, design, an	[million EUR]	0,1	9,1	28,4	10,2	28,1	0,1	**76**
Costs and benefits of commercial banks								
Provision of loans for investment costs	[million EUR]	0,58	61	190	68	187	1	**507**
Interest payments from investors	[million EUR]	0,00	-	-	-	-	-	-
Interest payments from the state	[million EUR]	0,3	30	93	33	92	0,4	**249**

- Loan Amount EUR 1
- Loan Tenor years 10
- Interest Rate % 8%
- Interest Rate, subsidized % 0%

municipalities without subsidized rate

	Debt Service Interest I	Principa	Total Debt Service
0			
1	0,08	0,07	0,15
2	0,07	0,07	0,15
3	0,07	0,08	0,15
4	0,06	0,09	0,15
5	0,06	0,09	0,15
6	0,05	0,10	0,15
7	0,04	0,11	0,15
8	0,03	0,12	0,15
9	0,02	0,13	0,15
10	0,01	0,14	0,15
	0,49		1,49

municipalities with subsidized rate

	Debt Service Interest Payment	Principa	Total Debt Service
0			
1	0,00	0,10	0,10
2	0,00	0,10	0,10
3	0,00	0,10	0,10
4	0,00	0,10	0,10
5	0,00	0,10	0,10
6	0,00	0,10	0,10
7	0,00	0,10	0,10
8	0,00	0,10	0,10
9	0,00	0,10	0,10
10	0,00	0,10	0,10
	0,00		1,00

	Saved energy costs: Changing energy prices						
Year	Dormitory	Hospital	Kindergar	Office	School	University	total
0	-0,6	-60,7	-189,6	-68,1	-187,4	-0,9	-507,3
1	0,075	4,663	6,583	2,552	5,112	0,013	19,0
2	0,078	5,065	6,855	2,691	5,292	0,014	20,0
3	0,080	5,284	7,032	2,775	5,418	0,015	20,6
4	0,083	5,512	7,215	2,862	5,543	0,016	21,2
5	0,085	5,750	7,404	2,952	5,674	0,016	21,9
6	0,087	6,007	7,604	3,048	5,812	0,017	22,6
7	0,090	6,274	7,810	3,148	5,954	0,018	23,3
8	0,093	6,550	8,022	3,256	6,100	0,019	24,0
9	0,095	6,838	8,240	3,356	6,250	0,019	24,8
10	0,098	7,103	8,450	3,457	6,395	0,020	25,5
11	0,101	7,412	8,682	3,570	6,553	0,021	26,3
12	0,104	7,736	8,923	3,688	6,717	0,022	27,2
13	0,107	8,074	9,172	3,811	6,887	0,023	28,1
14	0,110	8,428	9,431	3,939	7,062	0,024	29,0
15	0,113	8,798	9,699	4,073	7,244	0,025	30,0
16	0,117	9,185	9,978	4,211	7,431	0,026	30,9
17	0,121	9,590	10,267	4,356	7,626	0,027	32,0
18	0,124	10,014	10,567	4,507	7,827	0,028	33,1
19	0,128	10,457	10,878	4,663	8,035	0,030	34,2
20	0,132	10,921	11,201	4,827	8,251	0,031	35,4
21	0,136	11,407	11,537	4,997	8,474	0,033	36,6
22	0,141	11,915	11,885	5,175	8,706	0,034	37,9
23	0,145	12,447	12,247	5,360	8,946	0,036	39,2
24	0,150	13,003	12,624	5,553	9,196	0,037	40,6
25	0,155	13,585	13,015	5,754	9,453	0,039	42,0
26	0,160	14,195	13,421	5,964	9,720	0,041	43,5
27	0,166	14,832	13,844	6,182	9,997	0,042	45,1
28	0,171	15,500	14,283	6,411	10,285	0,044	46,7
29	0,177	16,198	14,740	6,649	10,584	0,046	48,4
30	0,183	16,929	15,215	6,897	10,894	0,049	50,2

Fig. Cost of energy conserved

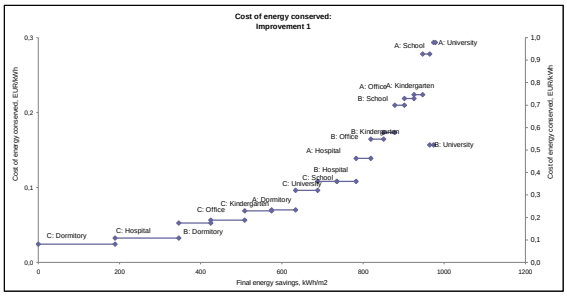
	A: Dormit	A: Hospit	A: Kinder	A: Office	A: School	A: Univers	B: Dormit	B: Hospit	B: Kinder	B: Office	B: School	B: Univers	C: Dormit	C: Hospit	C: Kinder	C: Office	C: School	C: University
Ranking of options	6	10	15	14	16	18	3	8	12	11	13	17	1	2	5	4	9	7
Cost of en EUR/kWh	0,1	0,1	0,2	0,2	0,3	1,0	0,1	0,1	0,2	0,2	0,2	0,5	0,03	0,0	0,1	0,1	0,1	0,1
Final ener kWh/m2	59,2	36,3	21,3	23,6	17,4	5,1	78,5	46,7	27,6	31,5	23,1	9,5	189,3	156,9	66,3	83,5	47,9	54,9
Final ener GWh	0,3	15,4	31,5	10,6	25,1	0,0	0,3	9,7	17,4	7,7	14,1	0,0	0,3	19,7	27,8	13,6	19,5	0,1

Cost of energy conserved: Improvement 1

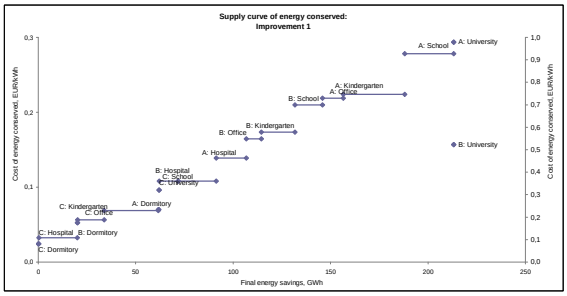
	EUR/kWh y	kWh/m2 x	
1	0,02	0,0	C: Dormitory
	0,02	189,3	
2	0,03	189,3	C: Hospital
	0,03	346,2	

Supply curve of energy conserved: Improvement 1

	EUR/kWh y	GWh x	
1	0,02	0,0	C: Dormitory
	0,02	0,3	
2	0,03	0,3	C: Hospital
	0,03	20,0	



Supply curve of energy conserved



3	0,05	346,2	B: Dormitory	3	0,05	20,0	B: Dormitory
	0,05	424,7			0,05	20,2	
4	0,06	424,7	C: Office	4	0,06	20,2	C: Office
	0,06	508,3			0,06	33,8	
5	0,07	508,3	C: Kindergarten	5	0,07	33,8	C: Kindergarten
	0,07	574,5			0,07	61,6	
6	0,07	574,5	A: Dormitory	6	0,07	61,6	A: Dormitory
	0,07	633,7			0,07	61,9	
7	0,10	633,7	C: University	7	0,10	61,9	C: University
	0,10	688,6			0,10	62,0	
8	0,11	688,6	B: Hospital	8	0,11	62,0	B: Hospital
	0,11	735,4			0,11	71,8	
9	0,11	735,4	C: School	9	0,11	71,8	C: School
	0,11	783,3			0,11	91,3	
10	0,14	783,3	A: Hospital	10	0,14	91,3	A: Hospital
	0,14	819,6			0,14	106,7	
11	0,16	819,6	B: Office	11	0,16	106,7	B: Office
	0,16	851,1			0,16	114,4	
12	0,17	851,1	B: Kindergarten	12	0,17	114,4	B: Kindergarten
	0,17	878,7			0,17	131,8	
13	0,21	878,7	B: School	13	0,21	131,8	B: School
	0,21	901,8			0,21	145,9	
14	0,22	901,8	A: Office	14	0,22	145,9	A: Office
	0,22	925,4			0,22	156,5	
15	0,22	925,4	A: Kindergarten	15	0,22	156,5	A: Kindergarten
	0,22	946,7			0,22	188,0	
16	0,28	946,7	A: School	16	0,28	188,03	A: School
	0,28	964,1			0,28	213,16	
17	0,52	964,1	B: University	17	0,52	213,16	B: University
	0,52	973,6			0,52	213,18	
18	0,98	973,6	A: University	18	0,98	213,18	A: University
	0,98	978,7			0,98	213,22	

Thermal efficiency retrofit of public buildings in Albania, country-wide analysis

Improvement 2
Climate zone A, B, C

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerious benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price 2016 [EUR/kWh]	2030 [EUR/kWh]	annual growth [%]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity	0,104	0,160	1%	0	1,0
Wood	0,024	0,037	1%	0	0,2
LPG	0,061	0,247	5%	227	1,1
Diesel oil	0,117	0,473	5%	267	1,2
Solar	0,000	0,000	N/A	0	0,0

Financial analysis

Measure lifetime	[years]	30
Discount rate	[%]	4%
Annuity factor	[%]	6%
Maintenance costs	[EUR/m2-yr.]	0,5

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view

GDP increase	[EUR/EUR]	0,65
direct	[EUR/EUR]	0,30
multiplier effects	[EUR/EUR]	0,35
Labour income	[EUR/EUR]	0,30
direct	[EUR/EUR]	0,17
multiplier effects	[EUR/EUR]	0,13
Annual employment	[jobs/million EUR]	148
Employment	[jobs/million EUR]	85
multiplier effects	[jobs/million EUR]	63
Monetized CO2 emissions avoided	EUR/tCO2	5
Air quality including health impacts	EUR/MWh	1,38
Improved comfort and services of buildings reflec	[% value]	2% *Assumed estate value is EUR 300 per m2

Conversion units

GWh / 1 ktoe		11,63

Extra: in case if a credit line will be established

Capital structure		
Share of equity	[%]	0%
Share of debt	[%]	100%
Cost of capital		
Equity	[%]	14%
Public loan	[%]	0%
Commercial loan	[%]	8%
Debt payment period	[years]	10

Program budget

Program budget		million EUR	46
Other costs		million EUR	6
Budget excluding other costs		million EUR	40
Other costs as a share of the program budget		[%]	15%
Period of implementation		[years]	4

Building stock

Characteristics	Units	Dormitory	Hospital	Kindergarten	Office	School	University	
Sector		Education	Public health	Education	Other	Education	Education	
Governance level		Central Municipal	Central Municipal	Municipal	Central Municipal	Municipal	Central	
Stock	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Retrofit need	[thousand m2]	**9,0**	**759**	**2.531**	**856**	**2.464**	**11,0**	**6.629**
climate zone A	[thousand m2]	5,3	424	1.482	448	1.443	6,4	3.809
climate zone B	[thousand m2]	2,2	208	629	245	613	2,7	1.700
climate zone C	[thousand m2]	1,5	126	419	163	408	1,8	1.119

Program results

Stock retrofitted by the program	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Share of the need	[%/stock]	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
climate zone A	[%/stock]	100%	100%	100%	100%	100%	100%	100%
climate zone B	[%/stock]	100%	100%	100%	100%	100%	100%	100%
climate zone C	[%/stock]	100%	100%	100%	100%	100%	100%	100%
Floor area	[thousand m2]	**9,0**	**759**	**2.531**	**856**	**2.464**	**11,0**	**6.629**
climate zone A	[thousand m2]	5,3	424	1.482	448	1.443	6,4	3.809
climate zone B	[thousand m2]	2,2	208	629	245	613	2,7	1.700
climate zone C	[thousand m2]	1,5	126	419	163	408	1,8	1.119
Investment and maintenance costs	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Investment cost, per m2	[EUR/m2]	**88**	**108**	**104**	**106**	**0**	**0**	**66**
climate zone A	[EUR/m2]	87	108	105	109			66
climate zone B	[EUR/m2]	87	108	105	109			68
climate zone C	[EUR/m2]	91	109	98	95			63
Maintenance cost, per m2	[EUR/m2-yr.]	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Costs of energy conserved	[EUR/kWh]	**0,06**	**0,09**	**0,17**	**0,17**	**#DIV/0!**	**#DIV/0!**	**0,15**
climate zone A	[EUR/kWh]	0,08	0,12	0,23	0,26			0,20
climate zone B	[EUR/kWh]	0,06	0,10	0,18	0,21			0,16
climate zone C	[EUR/kWh]	0,03	0,04	0,08	0,07			0,06
Investment cost, total	[million EUR]	**0,8**	**82**	**263**	**91**			**437**
climate zone A	[million EUR]	0,5	45,7	156,0	48,7			251
climate zone B	[million EUR]	0,2	22,4	66,3	26,6			115
climate zone C	[million EUR]	0,1	13,7	41,0	15,5			70

Energy/CO2 savings: improvement vs BAU	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
			per m2					
Total CO2	[gCO2/m2]	6.349	13.839	2.503	3.008			2.936
climate zone A	[gCO2/m2]	3.759	8.867	2.219	2.075			2.100
climate zone B	[gCO2/m2]	5.012	10.886	2.719	2.734			2.741
climate zone C	[gCO2/m2]	17.519	35.489	3.182	5.983			6.078
Total primary energy	[kWh/m2]	93	83	35	30			27
climate zone A	[kWh/m2]	79	61	32	24			22
climate zone B	[kWh/m2]	100	75	39	28			28
climate zone C	[kWh/m2]	134	174	42	50			43
Total final energy	[kWh/m2]	95	76	38	40			28
climate zone A	[kWh/m2]	67	52	28	26			20
climate zone B	[kWh/m2]	86	64	35	32			26
climate zone C	[kWh/m2]	205	175	77	92			62
			for the whole stock retrofitted					
Total CO2	[tCO2]	**57**	**10.499**	**6.334**	**2.575**			**19.465**
climate zone A	[tCO2]	20	3.762	3.289	930			8.001
climate zone B	[tCO2]	11	2.270	1.711	669			4.661
climate zone C	[tCO2]	26	4.468	1.333	976			6.803
Total primary energy	[GWh]	**0,8**	**63**	**89**	**26**			**179**
climate zone A	[GWh]	0,41	26	47	11			84
climate zone B	[GWh]	0,22	16	25	7			48
climate zone C	[GWh]	0,20	22	17	8			48
Total primary energy	[ktoe]	**0,07**	**5,44**	**7,67**	**2,21**			**15,39**
climate zone A	[ktoe]	0,04	2,22	4,05	0,91			7,21
climate zone B	[ktoe]	0,02	1,34	2,13	0,60			4,08
climate zone C	[ktoe]	0,02	1,88	1,50	0,70			4,10
Total final energy	[GWh]	**0,8**	**57**	**96**	**34**			**189**
climate zone A	[GWh]	0,4	22	42	11			76
climate zone B	[GWh]	0,2	13	22	8			44
climate zone C	[GWh]	0,3	22	32	15			69
Total final energy	[ktoe]	**0,07**	**4,93**	**8,28**	**2,93**			**16,21**
climate zone A	[ktoe]	0,03	1,88	3,61	0,99			6,51
climate zone B	[ktoe]	0,02	1,15	1,91	0,66			3,74
climate zone C	[ktoe]	0,03	1,89	2,76	1,28			5,96

Saved energy costs: improvement vs BAU	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Total over measure lifetime (NPV)	[EUR/m2]	**246,8**	**250,6**	**85,2**	**85,7**			**72,6**
climate zone A	[EUR/m2]	199,0	175,9	75,4	65,4			56,9
climate zone B	[EUR/m2]	253,0	216,5	93,2	80,1			72,9
climate zone C	[EUR/m2]	406,5	558,6	107,8	149,9			125,6
Annual over measure lifetime	[EUR/m2]	**14,27**	**14,49**	**4,92**	**4,96**			**4,20**
climate zone A	[EUR/m2]	11,5	10,2	4,4	3,8			3,3
climate zone B	[EUR/m2]	14,6	12,5	5,4	4,6			4,2
climate zone C	[EUR/m2]	23,5	32,3	6,2	8,7			7,3
Total over measure lifetime (NPV)	[million EUR]	**2,21**	**190**	**215**	**73**			**481**
climate zone A	[million EUR]	1,0	74,6	111,7	29,3			217
climate zone B	[million EUR]	0,6	45,1	58,6	19,6			124
climate zone C	[million EUR]	0,6	70,3	45,2	24,4			141
Annual over measure lifetime	[million EUR]	**0,13**	**11**	**12**	**4**			**28**
climate zone A	[million EUR]	0,06	4,3	6,5	1,7			13
climate zone B	[million EUR]	0,03	2,6	3,4	1,1			7
climate zone C	[million EUR]	0,03	4,1	2,6	1,4			8

Financial analysis	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Simple payback	[years]	6	7	21	21			16
Internal rate of return	[%]	11,7%	8,4%	0,9%	2,1%			5,0%
NPV	[EUR/m2]	1,1	62,9	-96,6	-21,6			63,1
Cost - benefit ratio		0,4	0,6	1,6	1,3			0,9

Analysis of co-benefits	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
			per m2					
GDP increase	[EUR/m2]	57	70	68	69			43
Labour income	[EUR/m2]	26	32	31	32			20
Employment	[jobs/m2]	0,01	0,02	0,02	0,02			0,06
Monetized CO2 emissions avoided	[EUR/m2]	0,03	0,07	0,01	0,02			0
Air quality including health impacts	[EUR/m2]	0,13	0,10	0,05	0,05			0
Improved comfort and services of buildings	[EUR/m2]	6	6	6	6			4
			for the whole stock retrofitted					
GDP increase	[million EUR]	0,5	53,1	170,8	58,9			283
Labour income	[million EUR]	0,2	24,4	78,4	27,0			130
Employment	[jobs]	116	12.075	38.844	13.388			64.423
Monetized CO2 emissions avoided	[million EUR]	0,00	0,1	0,0	0,0			0
Air quality including health impacts	[million EUR]	0,0	0,1	0,1	0,0			0
Improved comfort and services of buildings	[million EUR]	0,1	4,6	15,2	5,1			25

Extra: in case if a credit line will be established	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Cost of investors								
Debt service, annual over the loan repayment pe	[million EUR/yr.]	0	8	26	9			**44**
Cost of administrator (state)								
Costs of low interest rate, annual over the loan r	[million EUR/yr.]	0,04	4,0	12,9	4,4			**21,4**
Technical assistance (energy audits, design, arn	[million EUR]	0,1	12,3	39,5	13,6			**66**
Costs and benefits of commercial banks								
Provision of loans for investment costs	[million EUR]	0,79	82	263	91			**437**
Interest payments from investors	[million EUR]	0,00	-	-	-			**-**
Interest payments from the state	[million EUR]	0,4	40	129	44			**214**

- Loan Amount EUR 1
- Loan Tenor years 10
- Interest Rate % 8%
- Interest Rate, subsidized % 0%

municipalities without subsidized rate

	Debt Service Interest	Principa	Total Debt Service
0			
1	0,08	0,07	0,15
2	0,07	0,07	0,15
3	0,07	0,08	0,15
4	0,06	0,09	0,15
5	0,06	0,09	0,15
6	0,05	0,10	0,15
7	0,04	0,11	0,15
8	0,03	0,12	0,15
9	0,02	0,13	0,15
10	0,01	0,14	0,15
	0,49		1,49

municipalities with subsidized rate

	Debt Service Interest Payment	Principa	Total Debt Service
0			
1	0,00	0,10	0,10
2	0,00	0,10	0,10
3	0,00	0,10	0,10
4	0,00	0,10	0,10
5	0,00	0,10	0,10
6	0,00	0,10	0,10
7	0,00	0,10	0,10
8	0,00	0,10	0,10
9	0,00	0,10	0,10
10	0,00	0,10	0,10
	0,00		1,00

	Saved energy costs: Changing energy prices						
Year	Dormitory	Hospital	Kindergar	Office	School	University	total
0	-0,8	-81,8	-263,3	-90,7	0,0	0,0	-436,7
1	0,075	4.663	6.583	2.552	5.112	0,013	19,0
2	0,078	5.065	6.855	2.691	5.292	0,014	20,0
3	0,080	5.284	7.032	2.775	5.418	0,015	20,6
4	0,083	5.512	7.215	2.862	5.543	0,016	21,2
5	0,085	5.750	7.404	2.952	5.674	0,016	21,9
6	0,087	6.007	7.604	3.048	5.812	0,017	22,6
7	0,089	6.274	7.810	3.148	5.954	0,018	23,3
8	0,093	6.550	8.022	3.256	6.100	0,019	24,0
9	0,095	6.838	8.240	3.356	6.250	0,019	24,8
10	0,098	7.103	8.450	3.457	6.395	0,020	25,5
11	0,101	7.412	8.682	3.570	6.553	0,021	26,3
12	0,104	7.736	8.923	3.688	6.717	0,022	27,2
13	0,107	8.074	9.172	3.811	6.887	0,023	28,1
14	0,110	8.428	9.431	3.939	7.062	0,024	29,0
15	0,113	8.798	9.699	4.073	7.244	0,025	30,0
16	0,117	9.185	9.978	4.211	7.431	0,026	30,9
17	0,121	9.590	10.267	4.356	7.626	0,027	32,0
18	0,124	10.014	10.567	4.507	7.827	0,028	33,1
19	0,128	10.457	10.878	4.663	8.035	0,030	34,2
20	0,132	10.921	11.201	4.827	8.251	0,031	35,4
21	0,136	11.407	11.537	4.997	8.474	0,033	36,6
22	0,141	11.915	11.885	5.175	8.706	0,034	37,9
23	0,145	12.447	12.247	5.360	8.946	0,036	39,2
24	0,150	13.003	12.624	5.553	9.195	0,037	40,6
25	0,155	13.585	13.015	5.754	9.453	0,039	42,0
26	0,160	14.195	13.421	5.964	9.720	0,041	43,5
27	0,166	14.832	13.844	6.182	9.997	0,042	45,1
28	0,171	15.500	14.283	6.411	10.285	0,044	46,7
29	0,177	16.198	14.740	6.649	10.584	0,046	48,4
30	0,183	16.929	15.215	6.897	10.894	0,049	50,2

Fig. Cost of energy conserved

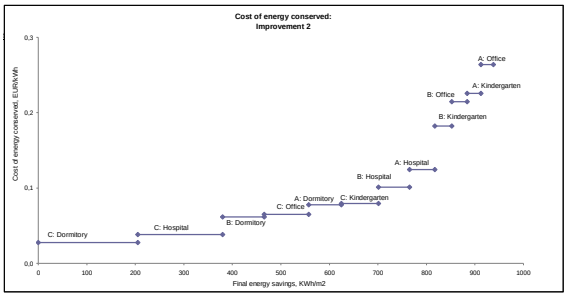
	A: Dormit	A: Hospit	A: Kinder	A: Office	A: School	A: Univers	B: Dormit	B: Hospit	B: Kinder	B: Office	B: School	B: Univers	C: Dormit	C: Hospit	C: Kinder	C: Office	C: School	C: University
Ranking of options	5	9	11	12			3	7	9	10			1	2	6	4		
Cost of en	EUR/kWh	0,1	0,1	0,2	0,2			0,1	0,1	0,2	0,2			0,03	0,0	0,1	0,1	
Final ener	kWh/m2	67,1	51,6	28,4	25,6			85,9	64,2	35,3	31,5			205,3	174,9	76,5	91,6	
Final ener	GWh	0,4	21,9	42,6	11,5			0,3	13,4	22,2	7,7			0,3	22,0	32,1	14,9	

Cost of energy conserved: Improvement 2

	EUR/kWh y	kWh/m2 x	
1	0,03	0,0	C: Dormitory
	0,03	205,3	
2	0,04	205,3	C: Hospital
	0,04	380,1	

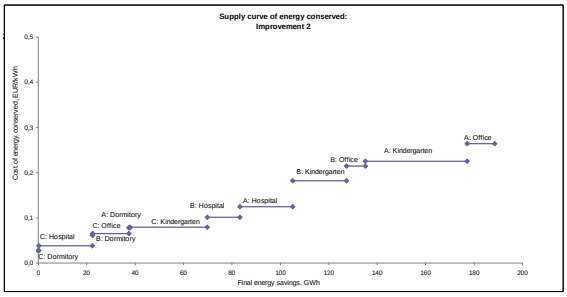
Supply curve of energy conserved: Improvement 2

	EUR/kWh y	kWh/m2 x	
1	0,03	0,0	C: Dormitory
	0,03	0,3	
2	0,04	0,3	C: Hospital
	0,04	22,3	



3	0,06	380,1 B: Dormitory
	0,06	466,0
4	0,07	466,0 C: Office
	0,07	557,6
5	0,08	557,6 A: Dormitory
	0,08	624,7
6	0,08	624,7 C: Kindergarten
	0,08	701,2
7	0,10	701,2 B: Hospital
	0,10	765,4
8	0,12	765,4 A: Hospital
	0,12	817,0
9	0,18	817,0 B: Kindergarten
	0,18	852,3
10	0,21	852,3 B: Office
	0,21	883,8
11	0,23	883,8 A: Kindergarten
	0,23	912,2
12	0,26	912,2 A: Office
	0,26	937,7

3	0,06	22,3 B: Dormitory
	0,06	22,5
4	0,07	22,5 C: Office
	0,07	37,4
5	0,08	37,4 A: Dormitory
	0,08	37,8
6	0,08	37,8 C: Kindergarten
	0,08	69,9
7	0,10	69,9 B: Hospital
	0,10	83,2
8	0,12	83,2 A: Hospital
	0,12	105,1
9	0,18	105,1 B: Kindergarten
	0,18	127,4
10	0,21	127,4 B: Office
	0,21	135,1
11	0,23	135,1 A: Kindergarten
	0,23	177,1
12	0,26	177,1 A: Office
	0,26	188,6



Thermal efficiency retrofit of public buildings in Albania, analysis for municipalities by climate zone

Improvement 1 & 2
Climate zone A

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerious benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price 2016 [EUR/kWh]	Energy source price 2030 [EUR/kWh]	annual growth [%]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity	0,104	0,160	1%	0	1,0
Wood	0,024	0,037	1%	0	0,2
LPG	0,061	0,247	5%	227	1,1
Diesel oil	0,117	0,473	5%	267	1,2
Solar	0,000	0,000	N/A	0	0,0

Financial analysis

Measure lifetime	[years]	30
Discount rate	[%]	4%
Annuity factor	[%]	6%
Maintenance costs	[EUR/m2-yr.]	0,5

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view

GDP increase	[EUR/EUR]	0,65
direct	[EUR/EUR]	0,30
multiplier effects	[EUR/EUR]	0,35
Labour income	[EUR/EUR]	0,30
direct	[EUR/EUR]	0,17
multiplier effects	[EUR/EUR]	0,13
Annual employment	[jobs/million EUR]	148
Employment	[jobs/million EUR]	85
multiplier effects	[jobs/million EUR]	63
Monetized CO2 emissions avoided	EUR/tCO2	5
Air quality including health impacts	EUR/MWh	1,38
Improved comfort and services of buildings reflec	[% value]	2%

*Assumed estate value is EUR 300 per m2

Conversion units

GWh / 1 ktoe	11,63

Program budget

Program budget	million EUR	xx
Other costs	million EUR	xx
Budget excluding other costs	million EUR	xx
Other costs as a share of the program budget	[%]	#VALORE!
Period of implementation	[years]	xx

Building stock

	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Sector		Education	Public health	Education	Other	Education	Education	
Retrofit need	[thousand m2]	5,3	424	1.482	448	1.443	6,4	3.809

Program results: improvement 1

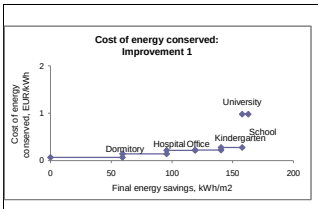
Stock retrofitted by the program	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Share of the need	[%/stock]	100%	100%	100%	100%	100%	100%	100%
Floor area	[thousand m2]	5,3	424	1.482	448	1.443	6,4	3.809
Investment	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Investment cost, per m2	[EUR/m2]	63	80	76	81	75	77	77
Maintenance cost, per m2	[EUR/m2-yr.]	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Costs of energy conserved	[EUR/kWh]	0,07	0,14	0,22	0,22	0,28	0,98	0,23
Investment cost, total	[million EUR]	0,3	34,0	112,2	36,4	108,3	0,5	292
Energy/CO2 savings (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total CO2	[gCO2/m2]	3.462	7.456	1.827	2.090	881	1.171	2.128
Total primary energy	[kWh/m2]	63	43	24	21	17	6	23
Total final energy	[kWh/m2]	59	36	21	24	17	5	22
			for the whole stock retrofitted					
Total CO2	[tCO2]	18	3.163	2.708	937	1.271	8	8.104
Total primary energy	[GWh]	0,33	18	35	9	25	0,04	88
Total final energy	[GWh]	0,3	15	32	11	25	0,0	83
Total final energy	[ktoe]	0,0	1,3	2,7	0,9	2,2	0,0	7,1
Saved energy costs (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total over measure lifetime (NPV)	[EUR/m2]	165,80	129,8	56,1	60,2	42,0	18,8	59,5
Annual over measure lifetime	[EUR/m2]	9,59	7,50	3,24	3,48	2,43	1,09	3,4
			for the whole stock retrofitted					
Total over measure lifetime (NPV)	[million EUR]	0,87	55,06	83,15	26,97	60,64	0,12	227
Annual over measure lifetime	[million EUR]	0,05	3,18	4,81	1,56	3,51	0,01	13
Financial analysis	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Simple payback	[years]	7	11	23	23	n/a	n/a	22
Internal rate of return	[%]	12,9%	7,5%	2,0%	2,0%	0,3%	#NUM!	2,3%
NPV	[EUR/m2]	0,5	20,3	-27,9	-9,0	-45,9	-0,4	-62,4
Cost - benefit ratio		0,4	0,6	1,3	1,3	1,8	4,1	1,3
Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
GDP increase	[EUR/m2]	40,9	51,9	49,1	52,7	48,7	50,3	294
Labour income	[EUR/m2]	18,7	23,8	22,5	24,2	22,4	23,1	135
Employment	[jobs/m2]	0,01	0,01	0,01	0,01	0,01	0,01	0
Monetized CO2 emissions avoided	[EUR/m2]	0,00	0,02	0,01	0,00	0,01	0,00	0
Air quality including health impacts	[EUR/m2]	0,00	0,02	0,04	0,01	0,03	0,00	0
Improved comfort and services of buildings	[EUR/m2]	6,0	6,0	6,0	6,0	6,0	6,0	36
			for the whole stock retrofitted					
GDP increase	[million EUR]	0,2	22,0	72,8	23,6	70,3	0,3	189
Labour income	[million EUR]	0,10	10,1	33,4	10,8	32,3	0,15	87
Employment	jobs	49	5.010	16.555	5.367	15.984	73	43.038
Monetized CO2 emissions avoided	[million EUR]	0,000	0,007	0,020	0,002	0,009	0,000	0
Air quality including health impacts	[million EUR]	0,000	0,009	0,064	0,007	0,050	0,000	0
Improved comfort and services of buildings	[million EUR]	0,03	2,5	8,9	2,7	8,7	0,04	23

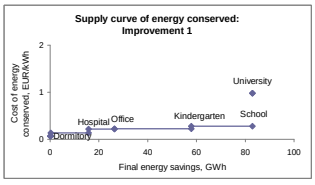
Saved energy costs
Changing energy prices

Year	Dormitory	Hospital	Kindergar	Office	School	University	total
0	-0,3	-34,0	-112,2	-36,4	-108,3	-0,5	-291,7
1	0,036	1,789	3,371	1,017	2,558	0,004	8,8
2	0,037	1,934	3,509	1,071	2,646	0,004	9,2
3	0,038	2,014	3,599	1,104	2,708	0,004	9,5
4	0,039	2,097	3,692	1,138	2,771	0,004	9,7
5	0,040	2,183	3,788	1,173	2,836	0,005	10,0
6	0,041	2,277	3,890	1,210	2,904	0,005	10,3
7	0,042	2,374	3,994	1,249	2,974	0,005	10,6
8	0,043	2,474	4,102	1,289	3,046	0,005	11,0
9	0,044	2,578	4,213	1,330	3,120	0,006	11,3
10	0,045	2,675	4,319	1,369	3,192	0,006	11,6
11	0,047	2,787	4,437	1,413	3,270	0,006	12,0
12	0,048	2,904	4,560	1,459	3,351	0,006	12,3
13	0,049	3,026	4,686	1,507	3,435	0,007	12,7
14	0,051	3,154	4,818	1,556	3,521	0,007	13,1
15	0,052	3,288	4,954	1,608	3,611	0,007	13,5
16	0,053	3,428	5,095	1,662	3,703	0,008	13,9
17	0,055	3,575	5,242	1,718	3,799	0,008	14,4
18	0,056	3,728	5,394	1,776	3,898	0,008	14,9
19	0,058	3,888	5,552	1,837	4,001	0,009	15,3
20	0,060	4,055	5,716	1,900	4,107	0,009	15,8
21	0,061	4,230	5,886	1,966	4,217	0,009	16,4
22	0,063	4,413	6,063	2,035	4,331	0,010	16,9
23	0,065	4,605	6,246	2,106	4,449	0,010	17,5
24	0,067	4,805	6,437	2,181	4,572	0,011	18,1
25	0,069	5,015	6,635	2,259	4,699	0,011	18,7
26	0,071	5,234	6,841	2,340	4,830	0,012	19,3
27	0,073	5,463	7,055	2,424	4,966	0,012	20,0
28	0,075	5,703	7,278	2,512	5,108	0,013	20,7
29	0,077	5,954	7,510	2,604	5,255	0,013	21,4
30	0,080	6,217	7,750	2,700	5,407	0,014	22,2

Fig. Cost of energy conserved

		Dormitory	Hospital	Kindergar	Office	School	University
Ranking of options		1	2	4	3	5	6
Cost of en	[EUR/kWh]	0,1	0,1	0,2	0,2	0,3	1,0
Final ener	[kWh/m2]	59,2	36,3	21,3	23,6	17,4	5,1
Final ener	[GWh]	0,3	15,4	31,5	10,6	25,1	0,0





Cost of energy conserved: Improvement 1

	EUR/kWh	kWh/m2	
	y	x	
1	0,07	0,0	Dormitory
	0,07	59,2	
2	0,14	59,2	Hospital
	0,14	95,5	
3	0,22	95,5	Office
	0,22	119,2	
4	0,22	119,2	Kindergarten
	0,22	140,4	
5	0,28	140,4	School
	0,28	157,8	
6	0,98	157,8	University
	0,98	162,9	

Supply curve of energy conserved: Improvement 1

	EUR/kWh	GWh	
	y	x	
1	0,07	0,0	Dormitory
	0,07	0,3	
2	0,14	0,3	Hospital
	0,14	15,7	
3	0,22	15,7	Office
	0,22	26,3	
4	0,22	26,3	Kindergarten
	0,22	57,8	
5	0,28	57,8	School
	0,28	83,0	
6	0,98	83,0	University
	0,98	83,0	

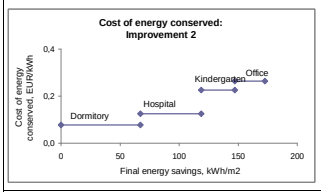
Program results: improvement 2

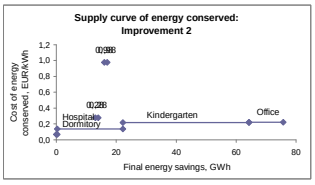
Stock retrofitted by the program	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Share of the need	[%/stock]	100%	100%	100%	100%			62%
Floor area	[thousand m2]	5,3	424,3	1.482,1	448,2			2.360
Investment	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Investment cost, per m2	[EUR/m2]	87	108	105	109			106
Maintenance cost, per m2	[EUR/m2-yr.]	0,5	0,5	0,5	0,5			0,5
Costs of energy conserved	[EUR/kWh]	0,08	0,12	0,23	0,26			0,21
Investment cost, total	[million EUR]	0,5	45,7	156,0	48,7			251
Energy/CO2 savings (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total CO2	[gCO2/m2]	3.759	8.867	2.219	2.075			3391
Total primary energy	[kWh/m2]	79	61	32	24			36
Total final energy	[kWh/m2]	67	52	28	26			32
			for the whole stock retrofitted					
Total CO2	[tCO2]	20	3.762	3.289	930			8.001
Total primary energy	[GWh]	0,41	26	47	11			84
Total final energy	[GWh]	0,4	22	42	11			76
Total final energy	[ktoe]	0,0	1,9	3,6	1,0			6,5
Saved energy costs (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Over measure lifetime, total (NPV)	[EUR/m2]	199,0	175,9	75,4	65,4			91,8
Annual, average	[EUR/m2]	11,5	10,2	4,4	3,8			5,3
			for the whole stock retrofitted					
Over measure lifetime, total (NPV)	[million EUR]	1,05	74,62	111,69	29,33			217
Annual, total	[million EUR]	0,06	4,32	6,46	1,70			13
Financial analysis	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Simple payback	[years]	8	11	24	29			20
Internal rate of return	[%]	11,3%	7,7%	1,8%	0,8%			3,0%
NPV	[EUR/m2]	0,6	27,8	-42,6	-18,6			-32,8
Cost - benefit ratio		0,4	0,6	1,4	1,7			1,2
Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
GDP increase	[EUR/m2]	56,7	69,8	68,3	70,5			265
Labour income	[EUR/m2]	26,0	32,0	31,3	32,4			122
Employment	[jobs/m2]	0,01	0,02	0,02	0,02			0,1
Monetized CO2 emissions avoided	[EUR/m2]	0,00	0,02	0,02	0,00			0
Air quality including health impacts	[EUR/m2]	0,00	0,03	0,06	0,02			0
Improved comfort and services of buildings	[EUR/m2]	6,0	6,0	6,0	6,0			24
			for the whole stock retrofitted					
GDP increase	[million EUR]	0,3	29,6	101,2	31,6			163
Labour income	[million EUR]	0,14	13,6	46,4	14,5			75
Employment	jobs	68	6738	23017	7186			37008
Monetized CO2 emissions avoided	[million EUR]	0,000	0,008	0,024	0,002			0,03
Air quality including health impacts	[million EUR]	0,000	0,013	0,086	0,007			0,11
Improved comfort and services of buildings	[million EUR]	0,03	2,5	8,9	2,7			14

	Saved energy costs						
	Changing energy prices						
Year	Dormitory	Hospital	Kindergar	Office	School	University	total
0	-0,5	-45,7	-156,0	-48,7	0,0	0,0	-250,8
1	0,044	2,569	4,578	1,132	0,000	0,000	8,3
2	0,046	2,748	4,757	1,188	0,000	0,000	8,7
3	0,047	2,849	4,876	1,222	0,000	0,000	9,0
4	0,048	2,955	4,999	1,258	0,000	0,000	9,3
5	0,049	3,065	5,125	1,295	0,000	0,000	9,5
6	0,050	3,183	5,259	1,334	0,000	0,000	9,8
7	0,051	3,306	5,397	1,374	0,000	0,000	10,1
8	0,052	3,432	5,538	1,416	0,000	0,000	10,4
9	0,054	3,563	5,683	1,459	0,000	0,000	10,8
10	0,055	3,686	5,823	1,500	0,000	0,000	11,1
11	0,056	3,827	5,978	1,546	0,000	0,000	11,4
12	0,058	3,973	6,138	1,594	0,000	0,000	11,8
13	0,059	4,127	6,304	1,643	0,000	0,000	12,1
14	0,061	4,287	6,476	1,695	0,000	0,000	12,5
15	0,062	4,454	6,654	1,749	0,000	0,000	12,9
16	0,064	4,629	6,838	1,804	0,000	0,000	13,3
17	0,066	4,811	7,030	1,862	0,000	0,000	13,8
18	0,067	5,002	7,228	1,923	0,000	0,000	14,2
19	0,069	5,200	7,434	1,985	0,000	0,000	14,7
20	0,071	5,408	7,647	2,051	0,000	0,000	15,2
21	0,073	5,625	7,869	2,119	0,000	0,000	15,7
22	0,075	5,852	8,099	2,190	0,000	0,000	16,2
23	0,077	6,089	8,337	2,263	0,000	0,000	16,8
24	0,079	6,336	8,585	2,340	0,000	0,000	17,3
25	0,081	6,595	8,843	2,420	0,000	0,000	17,9
26	0,083	6,865	9,110	2,503	0,000	0,000	18,6
27	0,086	7,147	9,387	2,590	0,000	0,000	19,2
28	0,088	7,442	9,676	2,680	0,000	0,000	19,9
29	0,091	7,751	9,976	2,775	0,000	0,000	20,6
30	0,093	8,073	10,288	2,873	0,000	0,000	21,3

Fig. Cost of energy conserved

		Dormitory	Hospital	Kindergar	Office
Ranking of options		1	2	3	4
Cost of en	EUR/kWh	0,1	0,1	0,2	0,3
Final ener	kWh/m2	67,1	51,6	28,4	25,6
Final ener	GWh]	0,4	21,9	42,0	11,5





Cost of energy conserved: Improvement 2

	EUR/kWh	kWh/m2	
	y	x	
1	0,08	0,0	Dormitory
	0,08	67,1	
2	0,12	67,1	Hospital
	0,12	118,7	
3	0,23	118,7	Kindergarten
	0,23	147,1	
4	0,26	147,1	Office
	0,26	172,6	

Supply curve of energy conserved: Improvement 2

	EUR/kWh	GWh	
	y	x	
1	0,08	0,0	Dormitory
	0,08	0,4	
2	0,12	0,4	Hospital
	0,12	22,3	
3	0,23	22,3	Kindergarten
	0,23	64,3	
4	0,26	64,3	Office
	0,26	75,7	

Thermal efficiency retrofit of public buildings in Albania, analysis for municipalities by climate zone

Improvement 1 & 2
Climate zone B

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerious benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific		Energy source price			CO2 emission factor	Primary-to-final energy factor
		2016 [EUR/kWh]	2030 [EUR/kWh]	annual growth [%]	[gCO2/kWh]	[kWh/kWh]
Electricity		0,104	0,160	1%	0	1,0
Wood		0,024	0,037	1%	0	0,2
LPG		0,061	0,247	5%	227	1,1
Diesel oil		0,117	0,473	5%	267	1,2
Solar		0,000	0,000	N/A	0	0,0
Financial analysis						
Measure lifetime	[years]	30				
Discount rate	[%]	4%				
Annuity factor	[%]	6%				
Maintenance costs	[EUR/m2-yr.]	0,5				
Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view						
GDP increase	[EUR/EUR]	0,65				
direct	[EUR/EUR]	0,30				
multiplier effects	[EUR/EUR]	0,35				
Labour income	[EUR/EUR]	0,30				
direct	[EUR/EUR]	0,17				
multiplier effects	[EUR/EUR]	0,13				
Annual employment	[jobs/million EUR]	148				
Employment	[jobs/million EUR]	85				
multiplier effects	[jobs/million EUR]	63				
Monetized CO2 emissions avoided	EUR/tCO2	5				
Air quality including health impacts	EUR/MWh	1,38				
Improved comfort and services of buildings reflec	[% value]	2%	*Assumed estate value is	EUR 300	per m2	
Conversion units						
GWh / 1 ktoe		11,63				

Program budget			
Program budget	million EUR	xx	
Other costs	million EUR	xx	
Budget excluding other costs	million EUR	xx	
Other costs as a share of the program budget	[%]	#VALORE!	
Period of implementation	[years]	xx	

Building stock

	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Sector		Education	Public health	Education	Other	Education	Education	
Retrofit need	[thousand m2]	2,2	208,5	629,5	244,7	612,8	2,7	1.700

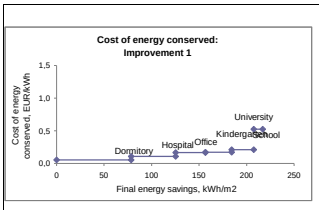
Program results: improvement 1

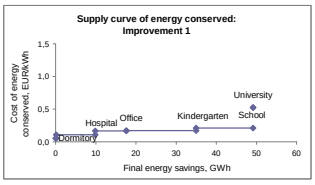
Stock retrofitted by the program	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Share of the need	[%/stock]	100%	100%	100%	100%	100%	100%	100%
Floor area	[thousand m2]	2,2	208	629	245	613	2,7	1.700
Investment	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Investment cost, per m2	[EUR/m2]	63	80	76	81	75	77	77
Maintenance cost, per m2	[EUR/m2-yr.]	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Costs of energy conserved	[EUR/kWh]	0,05	0,11	0,17	0,16	0,21	0,52	0,17
Investment cost, total	[million EUR]	0,1	16,7	47,7	19,9	46,0	0,2	131
Energy/CO2 savings (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total CO2	[gCO2/m2]	4.655	9.133	2.248	2.734	964	1.995	2.702
Total primary energy	[kWh/m2]	83	54	31	28	22	11	30
Total final energy	[kWh/m2]	79	47	28	32	23	10	29
			for the whole stock retrofitted					
Total CO2	[tCO2]	10	1.904	1.415	669	591	5	4.595
Total primary energy	[GWh]	0,19	11	19	7	13	0,03	51
Total final energy	[GWh]	0,2	10	17	8	14	0,0	49
Total final energy	[ktoe]	0,0	0,8	1,5	0,7	1,2	0,0	4,2
Saved energy costs (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total over measure lifetime (NPV)	[EUR/m2]	218,11	163,5	71,8	80,1	52,9	33,9	77,6
Annual over measure lifetime	[EUR/m2]	12,61	9,46	4,15	4,63	3,06	1,96	4,5
			for the whole stock retrofitted					
Total over measure lifetime (NPV)	[million EUR]	0,49	34,09	45,18	19,59	32,43	0,09	132
Annual over measure lifetime	[million EUR]	0,03	1,97	2,61	1,13	1,88	0,01	8
Financial analysis	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Simple payback	[years]	5	8	18	18	25	n/a	17
Internal rate of return	[%]	16,7%	9,6%	3,6%	3,9%	1,6%	-0,8%	4,1%
NPV	[EUR/m2]	0,3	16,7	-2,4	-0,3	-13,1	-0,1	1,2
Cost - benefit ratio		0,3	0,5	1,1	1,0	1,4	2,3	1,0
Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
GDP increase	[EUR/m2]	40,9	51,9	49,1	52,7	48,7	50,3	294
Labour income	[EUR/m2]	18,7	23,8	22,5	24,2	22,4	23,1	135
Employment	[jobs/m2]	0,01	0,01	0,01	0,01	0,01	0,01	0
Monetized CO2 emissions avoided	[EUR/m2]	0,00	0,01	0,01	0,00	0,00	0,00	0
Air quality including health impacts	[EUR/m2]	0,00	0,01	0,02	0,01	0,02	0,00	0
Improved comfort and services of buildings	[EUR/m2]	6,0	6,0	6,0	6,0	6,0	6,0	36
			for the whole stock retrofitted					
GDP increase	[million EUR]	0,1	10,8	30,9	12,9	29,9	0,1	85
Labour income	[million EUR]	0,04	5,0	14,2	5,9	13,7	0,06	39
Employment	jobs	21	2.462	7.031	2.930	6.789	31	19.264
Monetized CO2 emissions avoided	[million EUR]	0,000	0,002	0,004	0,001	0,002	0,000	0,01
Air quality including health impacts	[million EUR]	0,000	0,003	0,015	0,003	0,012	0,000	0,03
Improved comfort and services of buildings	[million EUR]	0,01	1,3	3,8	1,5	3,7	0,02	10

	Saved energy costs						
	Changing energy prices						
Year	Dormitory	Hospital	Kindergar	Office	School	University	total
0	-0,1	-16,7	-47,7	-19,9	-46,0	-0,2	-130,6
1	0,020	1,123	1,845	0,742	1,391	0,003	5,1
2	0,021	1,210	1,918	0,781	1,436	0,003	5,4
3	0,021	1,259	1,967	0,804	1,467	0,003	5,5
4	0,022	1,310	2,017	0,829	1,500	0,003	5,7
5	0,022	1,363	2,068	0,854	1,534	0,004	5,8
6	0,023	1,420	2,123	0,881	1,569	0,004	6,0
7	0,024	1,479	2,179	0,909	1,605	0,004	6,2
8	0,024	1,540	2,236	0,938	1,642	0,004	6,4
9	0,025	1,603	2,296	0,968	1,680	0,004	6,6
10	0,025	1,662	2,353	0,996	1,717	0,004	6,8
11	0,026	1,730	2,416	1,028	1,757	0,005	7,0
12	0,027	1,802	2,481	1,061	1,798	0,005	7,2
13	0,027	1,876	2,549	1,095	1,841	0,005	7,4
14	0,028	1,954	2,619	1,131	1,885	0,005	7,6
15	0,029	2,035	2,692	1,168	1,931	0,006	7,9
16	0,030	2,121	2,767	1,207	1,978	0,006	8,1
17	0,031	2,209	2,845	1,247	2,027	0,006	8,4
18	0,031	2,302	2,926	1,289	2,077	0,006	8,6
19	0,032	2,400	3,010	1,333	2,129	0,007	8,9
20	0,033	2,501	3,098	1,378	2,183	0,007	9,2
21	0,034	2,608	3,188	1,426	2,239	0,007	9,5
22	0,035	2,719	3,282	1,475	2,296	0,007	9,8
23	0,036	2,835	3,380	1,527	2,356	0,008	10,1
24	0,037	2,956	3,481	1,581	2,417	0,008	10,5
25	0,038	3,084	3,587	1,636	2,481	0,008	10,8
26	0,040	3,217	3,696	1,695	2,547	0,009	11,2
27	0,041	3,356	3,810	1,756	2,618	0,009	11,6
28	0,042	3,501	3,928	1,819	2,687	0,010	12,0
29	0,043	3,653	4,051	1,885	2,760	0,010	12,4
30	0,045	3,812	4,179	1,954	2,836	0,011	12,8

Fig. Cost of energy conserved

		Dormitory	Hospital	Kindergar	Office	School	University
Ranking of options		1	2	4	3	5	6
Cost of en	[EUR/kWh]	0,1	0,1	0,2	0,2	0,2	0,5
Final ener	[kWh/m2]	78,5	46,7	27,6	31,5	23,1	9,5
Final ener	[GWh]	0,2	9,7	17,4	7,7	14,1	0,0





Program results: improvement 2

Stock retrofitted by the program	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Share of the need	[%/stock]	100%	100%	100%	100%			64%
Floor area	[thousand m2]	2,2	208,5	629,5	244,7			1.085
Investment	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Investment cost, per m2	[EUR/m2]	87	108	105	109			106
Maintenance cost, per m2	[EUR/m2-yr.]	0,5	0,5	0,5	0,5			0,5
Costs of energy conserved	[EUR/kWh]	0,06	0,10	0,18	0,21			0,17
Investment cost, total	[million EUR]	0,2	22,4	66,3	26,6			115
Energy/CO2 savings (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total CO2	[gCO2/m2]	5.012	10.886	2.719	2.734			4296
Total primary energy	[kWh/m2]	100	75	39	28			44
Total final energy	[kWh/m2]	86	64	35	32			40
			for the whole stock retrofitted					
Total CO2	[tCO2]	11	2.270	1.711	669			4.661
Total primary energy	[GWh]	0,22	16	25	7			48
Total final energy	[GWh]	0,2	13	22	8			44
Total final energy	[ktoe]	0,0	1,2	1,9	0,7			3,7
Saved energy costs (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total over measure lifetime (NPV)	[EUR/m2]	253,0	216,5	93,2	80,1			114,2
Annual over measure lifetime	[EUR/m2]	14,6	12,5	5,4	4,6			6,6
			for the whole stock retrofitted					
Total over measure lifetime (NPV)	[million EUR]	0,56	45,14	58,65	19,59			124
Annual over measure lifetime	[million EUR]	0,03	2,61	3,39	1,13			7
Financial analysis	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Simple payback	[years]	6	9	20	23			16
Internal rate of return	[%]	14,3%	9,5%	3,2%	2,0%			4,5%
NPV	[EUR/m2]	0,4	21,8	-7,3	-6,7			8,1
Cost - benefit ratio		0,3	0,5	1,1	1,4			0,9
Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
GDP increase	[EUR/m2]	56,7	69,8	68,3	70,5			265
Labour income	[EUR/m2]	26,0	32,0	31,3	32,4			122
Employment	[jobs/m2]	0,01	0,02	0,02	0,02			0,1
Monetized CO2 emissions avoided	[EUR/m2]	0,00	0,01	0,01	0,00			0
Air quality including health impacts	[EUR/m2]	0,00	0,02	0,03	0,01			0
Improved comfort and services of buildings	[EUR/m2]	6,0	6,0	6,0	6,0			24
			for the whole stock retrofitted					
GDP increase	[million EUR]	0,1	14,6	43,0	17,3			75
Labour income	[million EUR]	0,06	6,7	19,7	7,9			34
Employment	jobs	29	3311	9776	3923			17039
Monetized CO2 emissions avoided	[million EUR]	0,000	0,002	0,005	0,001			0,01
Air quality including health impacts	[million EUR]	0,000	0,004	0,019	0,003			0,03
Improved comfort and services of buildings	[million EUR]	0,01	1,3	3,8	1,5			7

Cost of energy conserved: Improvement 1

	EUR/kWh	kWh/m2	
	y	x	
1	0,05	0,0	Dormitory
	0,05	78,5	
2	0,11	78,5	Hospital
	0,11	125,3	
3	0,16	125,3	Office
	0,16	156,8	
4	0,17	156,8	Kindergarten
	0,17	184,4	
5	0,21	184,4	School
	0,21	207,4	
6	0,52	207,4	University
	0,52	217,0	

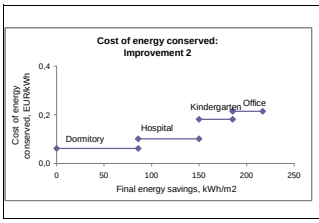
Supply curve of energy conserved: Improvement 1

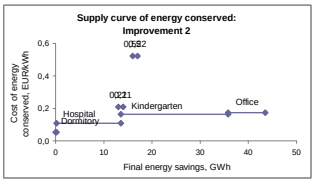
	EUR/kWh	GWh	
	y	x	
1	0,05	0,0	Dormitory
	0,05	0,2	
2	0,11	0,2	Hospital
	0,11	9,9	
3	0,16	9,9	Office
	0,16	17,6	
4	0,17	17,6	Kindergarten
	0,17	35,0	
5	0,21	35,0	School
	0,21	49,1	
6	0,52	49,1	University
	0,52	49,2	

	Saved energy costs						
	Changing energy prices						
Year	Dormitory	Hospital	Kindergar	Office	School	University	total
0	-0,2	-22,4	-66,3	-26,6	0,0	0,0	-115,5
1	0,024	1,555	2,408	0,742	0,000	0,000	4,7
2	0,025	1,663	2,501	0,781	0,000	0,000	5,0
3	0,025	1,725	2,564	0,804	0,000	0,000	5,1
4	0,026	1,789	2,628	0,829	0,000	0,000	5,3
5	0,026	1,855	2,694	0,854	0,000	0,000	5,4
6	0,027	1,926	2,764	0,881	0,000	0,000	5,6
7	0,028	2,000	2,836	0,909	0,000	0,000	5,8
8	0,028	2,077	2,910	0,938	0,000	0,000	6,0
9	0,029	2,156	2,986	0,968	0,000	0,000	6,1
10	0,030	2,230	3,059	0,996	0,000	0,000	6,3
11	0,030	2,315	3,140	1,028	0,000	0,000	6,5
12	0,031	2,404	3,224	1,061	0,000	0,000	6,7
13	0,032	2,496	3,311	1,095	0,000	0,000	6,9
14	0,033	2,593	3,400	1,131	0,000	0,000	7,2
15	0,034	2,694	3,494	1,168	0,000	0,000	7,4
16	0,035	2,799	3,590	1,207	0,000	0,000	7,6
17	0,035	2,910	3,690	1,247	0,000	0,000	7,9
18	0,036	3,025	3,794	1,289	0,000	0,000	8,1
19	0,037	3,145	3,901	1,333	0,000	0,000	8,4
20	0,038	3,270	4,013	1,378	0,000	0,000	8,7
21	0,039	3,401	4,129	1,426	0,000	0,000	9,0
22	0,040	3,538	4,249	1,475	0,000	0,000	9,3
23	0,042	3,681	4,374	1,527	0,000	0,000	9,6
24	0,043	3,830	4,503	1,581	0,000	0,000	10,0
25	0,044	3,986	4,637	1,636	0,000	0,000	10,3
26	0,045	4,150	4,777	1,695	0,000	0,000	10,7
27	0,047	4,320	4,922	1,756	0,000	0,000	11,0
28	0,048	4,498	5,073	1,819	0,000	0,000	11,4
29	0,049	4,684	5,229	1,885	0,000	0,000	11,8
30	0,051	4,879	5,392	1,954	0,000	0,000	12,3

Fig. Cost of energy conserved

		Dormitory	Hospital	Kindergar	Office
Ranking of options		1	2	3	4
Cost of en	EUR/kWh	0,1	0,1	0,2	0,2
Final ener	kWh/m2	85,9	64,2	35,3	31,5
Final ener	GWh	0,2	13,4	22,2	7,7





Cost of energy conserved: Improvement 2

	EUR/kWh	kWh/m2	
	y	x	
1	0,06	0,0	Dormitory
	0,06	85,9	
2	0,10	85,9	Hospital
	0,10	150,1	
3	0,18	150,1	Kindergarten
	0,18	185,4	
4	0,21	185,4	Office
	0,21	216,9	

Supply curve of energy conserved: Improvement 2

	EUR/kWh	GWh	
	y	x	
1	0,06	0,0	Dormitory
	0,06	0,2	
2	0,10	0,2	Hospital
	0,10	13,6	
3	0,18	13,6	Kindergarten
	0,18	35,8	
4	0,21	35,8	Office
	0,21	43,5	

Thermal efficiency retrofit of public buildings in Albania, analysis for municipalities by climate zone

Improvement 1 & 2
Climate zone C

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerious benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price 2016 [EUR/kWh]	Energy source price 2030 [EUR/kWh]	annual growth [%]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity	0,104	0,160	1%	0	1,0
Wood	0,024	0,037	1%	0	0,2
LPG	0,061	0,247	5%	227	1,1
Diesel oil	0,117	0,473	5%	267	1,2
Solar	0,000	0,000	N/A	0	0,0

Financial analysis

Measure lifetime	[years]	30
Discount rate	[%]	4%
Annuity factor	[%]	6%
Maintenance costs	[EUR/m2-yr.]	0,5

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view

GDP increase	[EUR/EUR]	0,65
direct	[EUR/EUR]	0,30
multiplier effects	[EUR/EUR]	0,35
Labour income	[EUR/EUR]	0,30
direct	[EUR/EUR]	0,17
multiplier effects	[EUR/EUR]	0,13
Annual employment	[jobs/million EUR]	148
Employment	[jobs/million EUR]	85
multiplier effects	[jobs/million EUR]	63
Monetized CO2 emissions avoided	EUR/tCO2	5
Air quality including health impacts	EUR/MWh	1,38
Improved comfort and services of buildings reflec	[% value]	2% *Assumed estate value is EUR 300 per m2

Conversion units

GWh / 1 ktoe	11,63

Program budget

Program budget	million EUR	xx
Other costs	million EUR	xx
Budget excluding other costs	million EUR	xx
Other costs as a share of the program budget	[%]	#VALORE!
Period of implementation	[years]	xx

Building stock

	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Sector		Education	Public health	Education	Other	Education	Education	
Retrofit need	[thousand m2]	1,5	125,9	419,0	163,1	407,9	1,8	1.119

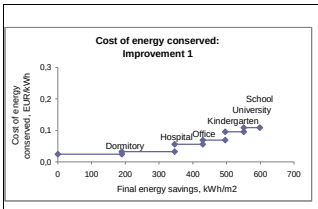
Program results: improvement 1

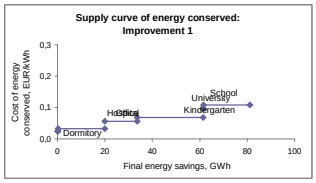
Stock retrofitted by the program	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Share of the need	[%/stock]	100%	100%	100%	100%	100%	100%	100%
Floor area	[thousand m2]	1,5	126	419	163	408	1,8	1.119
Investment	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Investment cost, per m2	[EUR/m2]	71	80	71	73	81	82	76
Maintenance cost, per m2	[EUR/m2-yr.]	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Costs of energy conserved	[EUR/kWh]	0,02	0,03	0,07	0,06	0,11	0,10	0,07
Investment cost, total	[million EUR]	0,1	10,1	29,7	11,9	33,1	0,1	85
Energy/CO2 savings (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total CO2	[gCO2/m2]	16.904	30.515	2.558	5.348	1.902	7.502	5.897
Total primary energy	[kWh/m2]	115	140	30	44	27	36	44
Total final energy	[kWh/m2]	189	157	66	84	48	55	72
			for the whole stock retrofitted					
Total CO2	[tCO2]	25	3.841	1.072	872	776	14	6.600
Total primary energy	[GWh]	0,17	18	13	7	11	0,07	49
Total final energy	[GWh]	0,3	20	28	14	20	0,1	81
Total final energy	[ktoe]	0,0	1,7	2,4	1,2	1,7	0,0	7,0
Saved energy costs (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total over measure lifetime (NPV)	[EUR/m2]	366,69	461,7	82,3	133,2	70,0	113,0	128,3
Annual over measure lifetime	[EUR/m2]	21,21	26,70	4,76	7,70	4,05	6,54	7,4
			for the whole stock retrofitted					
Total over measure lifetime (NPV)	[million EUR]	0,54	58,12	34,46	21,73	28,57	0,20	144
Annual over measure lifetime	[million EUR]	0,03	3,36	1,99	1,26	1,65	0,01	8
Financial analysis	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Simple payback	[years]	3	3	15	9	20	13	10
Internal rate of return	[%]	21,9%	22,6%	5,1%	8,8%	3,0%	6,2%	8,0%
NPV	[EUR/m2]	0,4	46,2	4,6	9,5	-4,3	0,1	56,4
Cost - benefit ratio		0,2	0,2	0,9	0,5	1,2	0,7	0,6
Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
GDP increase	[EUR/m2]	46,0	52,1	46,0	47,2	52,6	53,5	297
Labour income	[EUR/m2]	21,1	23,9	21,1	21,7	24,1	24,6	136
Employment	[jobs/m2]	0,01	0,01	0,01	0,01	0,01	0,01	0
Monetized CO2 emissions avoided	[EUR/m2]	0,00	0,02	0,01	0,00	0,00	0,00	0
Air quality including health impacts	[EUR/m2]	0,00	0,03	0,04	0,02	0,03	0,00	0
Improved comfort and services of buildings	[EUR/m2]	6,0	6,0	6,0	6,0	6,0	6,0	36
			for the whole stock retrofitted					
GDP increase	[million EUR]	0,1	6,6	19,3	7,7	21,5	0,1	55
Labour income	[million EUR]	0,03	3,0	8,8	3,5	9,8	0,04	25
Employment	jobs	16	1.490	4.383	1.751	4.880	22	12.541
Monetized CO2 emissions avoided	[million EUR]	0,000	0,002	0,002	0,001	0,002	0,000	0,01
Air quality including health impacts	[million EUR]	0,000	0,003	0,016	0,003	0,011	0,000	0,03
Improved comfort and services of buildings	[million EUR]	0,01	0,8	2,5	1,0	2,4	0,01	7

	Saved energy costs						
	Changing energy prices						
Year	Dormitory	Hospital	Kindergar	Office	School	University	total
0	-0,1	-10,1	-29,7	-11,9	-33,1	-0,1	-85,0
1	0,019	1,751	1,367	0,792	1,163	0,006	5,1
2	0,020	1,921	1,428	0,839	1,210	0,007	5,4
3	0,021	2,011	1,466	0,867	1,241	0,007	5,6
4	0,022	2,106	1,506	0,895	1,272	0,008	5,8
5	0,022	2,204	1,548	0,925	1,305	0,008	6,0
6	0,023	2,311	1,592	0,957	1,340	0,008	6,2
7	0,024	2,422	1,637	0,990	1,375	0,009	6,5
8	0,025	2,536	1,684	1,024	1,412	0,009	6,7
9	0,026	2,655	1,732	1,059	1,450	0,009	6,9
10	0,027	2,766	1,778	1,092	1,486	0,010	7,2
11	0,028	2,895	1,829	1,130	1,526	0,010	7,4
12	0,029	3,030	1,882	1,169	1,568	0,011	7,7
13	0,030	3,171	1,937	1,210	1,611	0,011	8,0
14	0,031	3,319	1,994	1,252	1,656	0,012	8,3
15	0,033	3,474	2,054	1,297	1,702	0,012	8,6
16	0,034	3,636	2,116	1,343	1,750	0,013	8,9
17	0,035	3,806	2,180	1,391	1,800	0,013	9,2
18	0,036	3,984	2,246	1,441	1,851	0,014	9,6
19	0,038	4,170	2,316	1,494	1,905	0,015	9,9
20	0,039	4,365	2,388	1,548	1,961	0,015	10,3
21	0,041	4,569	2,462	1,605	2,019	0,016	10,7
22	0,043	4,783	2,540	1,665	2,078	0,017	11,1
23	0,044	5,007	2,621	1,727	2,141	0,017	11,6
24	0,046	5,241	2,705	1,791	2,205	0,018	12,0
25	0,048	5,487	2,793	1,859	2,273	0,019	12,5
26	0,050	5,744	2,884	1,929	2,343	0,020	13,0
27	0,052	6,014	2,978	2,003	2,415	0,021	13,5
28	0,054	6,296	3,077	2,080	2,491	0,022	14,0
29	0,056	6,591	3,180	2,160	2,569	0,023	14,6
30	0,059	6,900	3,286	2,243	2,651	0,024	15,2

Fig. Cost of energy conserved

		Dormitory	Hospital	Kindergar	Office	School	University
Ranking of options		1	2	4	3	6	5
Cost of en	EUR/kWh	0,0	0,0	0,1	0,1	0,1	0,1
Final ener	kWh/m2	189,3	156,9	66,3	83,5	47,9	54,9
Final ener	[GWh]	0,3	19,7	27,8	13,6	19,5	0,1





Program results: improvement 2

Stock retrofitted by the program	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Share of the need	[%/stock]	100%	100%	100%	100%			63%
Floor area	[thousand m2]	1,5	125,9	419,0	163,1			709
Investment	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Investment cost, per m2	[EUR/m2]	91	109	98	95			99
Maintenance cost, per m2	[EUR/m2-yr.]	0,5	0,5	0,5	0,5			0,5
Costs of energy conserved	[EUR/kWh]	0,03	0,04	0,08	0,07			0,06
Investment cost, total	[million EUR]	0,1	13,7	41,0	15,5			70
Energy/CO2 savings (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total CO2	[gCO2/m2]	17.519	35.489	3.182	5.983			9588
Total primary energy	[kWh/m2]	134	174	42	50			67
Total final energy	[kWh/m2]	205	175	77	92			98
			for the whole stock retrofitted					
Total CO2	[tCO2]	26	4.468	1.333	976			6.803
Total primary energy	[GWh]	0,20	22	17	8			48
Total final energy	[GWh]	0,3	22	32	15			69
Total final energy	[ktoe]	0,0	1,9	2,8	1,3			6,0
Saved energy costs (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total over measure lifetime (NPV)	[EUR/m2]	406,5	558,6	107,8	149,9			198,1
Annual over measure lifetime	[EUR/m2]	72,7	14,5	37,4	25,5			30,7
			for the whole stock retrofitted					
Total over measure lifetime (NPV)	[million EUR]	0,60	70,32	45,15	24,45			141
Annual over measure lifetime	[million EUR]	0,11	1,82	15,66	4,17			22
Financial analysis	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Simple payback	[years]	1	8	3	4			3
Internal rate of return	[%]	19,6%	20,7%	4,7%	7,5%			9,5%
NPV	[EUR/m2]	0,5	54,4	4,0	8,7			67,5
Cost - benefit ratio		0,2	0,2	0,9	0,6			0,5
Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
GDP increase	[EUR/m2]	59,0	70,8	63,5	61,5			255
Labour income	[EUR/m2]	27,1	32,5	29,1	28,2			117
Employment	[jobs/m2]	0,01	0,02	0,01	0,01			0,1
Monetized CO2 emissions avoided	[EUR/m2]	0,00	0,02	0,01	0,00			0
Air quality including health impacts	[EUR/m2]	0,00	0,03	0,04	0,02			0
Improved comfort and services of buildings	[EUR/m2]	6,0	6,0	6,0	6,0			24
			for the whole stock retrofitted					
GDP increase	[million EUR]	0,1	8,9	26,6	10,0			46
Labour income	[million EUR]	0,04	4,1	12,2	4,6			21
Employment	jobs	20	2026	6051	2280			10376
Monetized CO2 emissions avoided	[million EUR]	0,000	0,003	0,003	0,001			0,01
Air quality including health impacts	[million EUR]	0,000	0,004	0,019	0,003			0,03
Improved comfort and services of buildings	[million EUR]	0,01	0,8	2,5	1,0			4

Cost of energy conserved: Improvement 1

	y	x	
1	0,02	0,0	Dormitory
	0,02	189,3	
2	0,03	189,3	Hospital
	0,03	346,2	
3	0,06	346,2	Office
	0,06	429,7	
4	0,07	429,7	Kindergarten
	0,07	496,0	
5	0,10	496,0	University
	0,10	550,9	
6	0,11	550,9	School
	0,11	598,8	

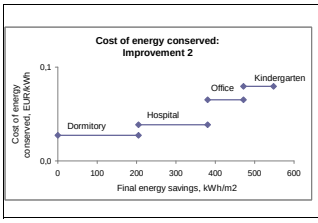
Supply curve of energy conserved: Improvement 1

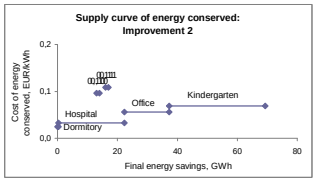
	y	x	
1	0,02	0,0	Dormitory
	0,02	0,3	
2	0,03	0,3	Hospital
	0,03	20,0	
3	0,06	20,0	Office
	0,06	33,7	
4	0,07	33,7	Kindergarten
	0,07	61,4	
5	0,10	61,4	University
	0,10	61,5	
6	0,11	61,5	School
	0,11	81,1	

	Saved energy costs						
	Changing energy prices						
Year	Dormitory	Hospital	Kindergar	Office	School	University	total
0	-0,1	-13,7	-41,0	-15,5	0,0	0,0	-70,3
1	0,022	2,168	1,820	0,892	0,000	0,000	4,9
2	0,023	2,367	1,896	0,945	0,000	0,000	5,2
3	0,024	2,474	1,945	0,976	0,000	0,000	5,4
4	0,024	2,586	1,997	1,008	0,000	0,000	5,6
5	0,025	2,703	2,049	1,041	0,000	0,000	5,8
6	0,026	2,829	2,105	1,077	0,000	0,000	6,0
7	0,027	2,960	2,163	1,114	0,000	0,000	6,3
8	0,028	3,096	2,222	1,152	0,000	0,000	6,5
9	0,029	3,236	2,283	1,192	0,000	0,000	6,7
10	0,030	3,367	2,341	1,229	0,000	0,000	7,0
11	0,031	3,520	2,406	1,271	0,000	0,000	7,2
12	0,032	3,679	2,473	1,315	0,000	0,000	7,5
13	0,034	3,845	2,543	1,361	0,000	0,000	7,8
14	0,035	4,020	2,615	1,409	0,000	0,000	8,1
15	0,036	4,202	2,690	1,458	0,000	0,000	8,4
16	0,037	4,393	2,768	1,510	0,000	0,000	8,7
17	0,039	4,593	2,849	1,564	0,000	0,000	9,0
18	0,040	4,802	2,933	1,621	0,000	0,000	9,4
19	0,042	5,022	3,020	1,680	0,000	0,000	9,8
20	0,043	5,251	3,110	1,741	0,000	0,000	10,1
21	0,045	5,491	3,204	1,805	0,000	0,000	10,5
22	0,047	5,742	3,302	1,872	0,000	0,000	11,0
23	0,049	6,006	3,403	1,941	0,000	0,000	11,4
24	0,050	6,281	3,509	2,014	0,000	0,000	11,9
25	0,052	6,569	3,618	2,089	0,000	0,000	12,3
26	0,054	6,871	3,732	2,168	0,000	0,000	12,8
27	0,057	7,187	3,850	2,251	0,000	0,000	13,3
28	0,059	7,518	3,973	2,337	0,000	0,000	13,9
29	0,061	7,865	4,101	2,427	0,000	0,000	14,5
30	0,064	8,228	4,235	2,521	0,000	0,000	15,0

Fig. Cost of energy conserved

		Dormitory	Hospital	Kindergar	Office
Ranking of options		1	2	4	3
Cost of en	EUR/kWh	0,0	0,0	0,1	0,1
Final ener	kWh/m2	205,3	174,9	76,5	91,6
Final ener	GWh	0,3	22,0	32,1	14,9





Cost of energy conserved: Improvement 2

	y	x	
1	0,03	0,0	Dormitory
	0,03	205,3	
2	0,04	205,3	Hospital
	0,04	380,1	
3	0,07	380,1	Office
	0,07	471,7	
4	0,08	471,7	Kindergarten
	0,08	548,2	

Supply curve of energy conserved: Improvement 2

	y	x	
1	0,03	0,0	Dormitory
	0,03	0,3	
2	0,04	0,3	Hospital
	0,04	22,3	
3	0,07	22,3	Office
	0,07	37,3	
4	0,08	37,3	Kindergarten
	0,08	69,3	

Thermal efficiency retrofit of public buildings in Albania, analysis per m2

Improvement 1
Climate zone A

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerous benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price 2016 [EUR/kWh]	2030 [EUR/kWh]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity	0,104	0,160	0	1,0
Wood	0,024	0,037	0	0,2
LPG	0,061	0,247	227	1,1
Diesel oil	0,117	0,473	267	1,2
Solar	0,000	0,000	0	0,0

Financial analysis	**Units**	**Value**	**References**
Measure lifetime	[years]	30	
Discount rate	[%]	4%	
Annuity factor	[%]	6%	
Maintenance costs	[EUR/m2-yr.]	0,5	

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view						
GDP increase	[EUR/EUR]	0,65				
direct	[EUR/EUR]	0,30				
multiplier effects	[EUR/EUR]	0,35				
Labour income	[EUR/EUR]	0,30				
direct	[EUR/EUR]	0,17				
multiplier effects	[EUR/EUR]	0,13				
Employment	[jobs/million EUR]	148				
direct	[jobs/million EUR]	85				
multiplier effects	[jobs/million EUR]	63				
Monetized CO2 emissions avoided	[EUR/tCO2]	5				
Air quality including health impacts	[EUR/MWh]	1,4				
Improved comfort and services of buildings refle	[% value]	2%	*Assumed estate value is	EUR	300	per m2

Summary of results

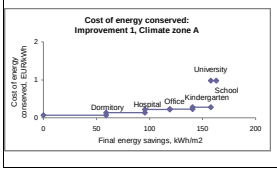
Investment and maintenance costs	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
Total	[EUR/m2]	**63**	**80**	**76**	**81**	**75**	**77**
Envelope cost	[EUR/m2]	15	14	21	19	19	22
HVAC system cost	[EUR/m2]	48	66	54	62	56	56
Maintenance cost	[EUR/m2-yr.]	0,5	0,5	0,5	0,5	0,5	0,5
Annualized total costs	[EUR/m2]	4,1	5,1	4,9	5,2	4,8	5,0
Cost of energy conserved (CEE)	[EUR/kWh]	0,1	0,1	0,2	0,2	0,3	1,0
Ranking of CEE		1	2	4	3	5	6

Energy/CO2 savings: improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
CO2 emissions	[gCO2/m2]	**3462**	**7456**	**1827**	**2090**	**881**	**1171**
Electricity	[gCO2/m2]	0	0	0	0	0	0
Wood	[gCO2/m2]	0	0	0	0	0	0
LPG	[gCO2/m2]	-2123	0	644	-572	-125	0
Oil	[gCO2/m2]	5585	7456	1183	2662	1006	1171
Solar	[gCO2/m2]	0	0	0	0	0	0
Primary energy	[kWh/m2]	**62,9**	**42,6**	**23,9**	**21,2**	**17,1**	**6,0**
Electricity	[kWh/m2]	48,1	9,1	15,6	10,9	13,0	0,7
Wood	[kWh/m2]	0,0	0,0	-0,2	1,1	0,3	0,0
LPG	[kWh/m2]	-10,3	0,0	3,1	-2,8	-0,6	0,0
Oil	[kWh/m2]	25,1	33,5	5,3	12,0	4,5	5,3
Solar	[kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0
Final energy	[kWh/m2]	**59,2**	**36,3**	**21,3**	**23,6**	**17,4**	**5,1**
Electricity	[kWh/m2]	47,6	9,0	15,4	10,8	12,8	0,7
Wood	[kWh/m2]	0,0	0,0	-0,9	5,5	1,4	0,0
LPG	[kWh/m2]	-9,4	0,0	2,8	-2,5	-0,6	0,0
Oil	[kWh/m2]	20,9	27,9	4,4	10,0	3,8	4,4
Solar	[kWh/m2]	0,0	-0,6	-0,5	-0,1	0,0	0,0

Saved energy costs / improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
Total over measure lifetime (NPV)	[EUR/m2]	**165,8**	**129,8**	**56,1**	**60,2**	**42,0**	**18,8**
Electricity	[EUR/m2]	102,4	19,4	33,2	23,2	27,6	1,5
Wood	[EUR/m2]	0,0	0,0	-0,5	2,8	0,7	0,0
LPG	[EUR/m2]	-19,3	0,0	5,8	-5,2	-1,1	0,0
Oil	[EUR/m2]	82,7	110,3	17,5	39,4	14,9	17,3
Solar	[EUR/m2]	0,0	0,0	0,0	0,0	0,0	0,0
Annual over measure lifetime	[EUR/m2]	**9,59**	**7,50**	**3,24**	**3,48**	**2,43**	**1,09**
Electricity	[EUR/m2]	5,92	1,12	1,92	1,34	1,59	0,09
Wood	[EUR/m2]	0,00	0,00	-0,03	0,16	0,04	0,00
LPG	[EUR/m2]	-1,11	0,00	0,34	-0,30	-0,07	0,00
Oil	[EUR/m2]	4,78	6,38	1,01	2,28	0,86	1,00
Solar	[EUR/m2]	0,00	0,00	0,00	0,00	0,00	0,00

Financial analysis / only saved energy	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
Simple payback	[years]	9,0	14,0	24,0	24,0	30,0	n/a
Internal rate of return	[%]	12,9%	7,5%	2,0%	2,0%	0,3%	#NUM!
NPV	[EUR/m2]	98,9	47,8	-18,9	-20,2	-31,8	-56,4
Cost - benefit ratio		0,4	0,6	1,3	1,3	1,8	4,1

Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
GDP increase	[EUR/m2]	40,9	51,9	49,1	52,7	48,7	50,3
Labour income	[EUR/m2]	18,7	23,8	22,5	24,2	22,4	23,1
Employment	[jobs/m2]	0,01	0,01	0,01	0,01	0,01	0,01
Monetized CO2 emissions avoided	[EUR/m2]	0,02	0,04	0,01	0,01	0,00	0,01
Air quality including health impacts	[EUR/m2]	0,08	0,05	0,03	0,03	0,02	0,01
Improved comfort and services of buildings	[EUR/m2]	6,00	6,00	6,00	6,00	6,00	6,00



	Saved energy costs					
	Changing energy prices					
Year	Dormitory	Hospital	Kindergar	Office	School	University
0	-63,0	-80,0	-75,7	-81,2	-75,1	-77,5
1	6,8	4,2	2,3	2,3	1,8	0,6
2	7,1	4,6	2,4	2,4	1,8	0,6
3	7,3	4,7	2,4	2,5	1,9	0,7
4	7,4	4,9	2,5	2,5	1,9	0,7
5	7,6	5,1	2,6	2,6	2,0	0,7
6	7,8	5,4	2,6	2,7	2,0	0,8
7	8,0	5,6	2,7	2,8	2,1	0,8
8	8,2	5,8	2,8	2,9	2,1	0,8
9	8,5	6,1	2,8	3,0	2,2	0,9
10	8,7	6,3	2,9	3,1	2,2	0,9
11	8,9	6,6	3,0	3,2	2,3	0,9
12	9,1	6,8	3,1	3,3	2,3	1,0
13	9,4	7,1	3,2	3,4	2,4	1,0
14	9,6	7,4	3,3	3,5	2,4	1,1
15	9,9	7,8	3,3	3,6	2,5	1,1
16	10,1	8,1	3,4	3,7	2,6	1,2
17	10,4	8,4	3,5	3,8	2,6	1,2
18	10,7	8,8	3,6	4,0	2,7	1,3
19	11,0	9,2	3,7	4,1	2,8	1,3
20	11,3	9,6	3,9	4,2	2,8	1,4
21	11,7	10,0	4,0	4,4	2,9	1,5
22	12,0	10,4	4,1	4,5	3,0	1,5
23	12,3	10,9	4,2	4,7	3,1	1,6
24	12,7	11,3	4,3	4,9	3,2	1,7
25	13,1	11,8	4,5	5,0	3,3	1,8
26	13,5	12,3	4,6	5,2	3,3	1,8
27	13,9	12,9	4,8	5,4	3,4	1,9
28	14,3	13,4	4,9	5,6	3,5	2,0
29	14,7	14,0	5,1	5,8	3,6	2,1
30	15,2	14,7	5,2	6,0	3,7	2,2

	Cumulative cash flow					
	Changing energy prices					
Year	Dormitory	Hospital	Kindergar	Office	School	University
0	-63,0	-80,0	-75,7	-81,2	-75,1	-77,5
1	-56,1	-75,8	-73,4	-78,9	-73,3	-76,9
2	-49,1	-71,3	-71,1	-76,5	-71,5	-76,3
3	-41,8	-66,5	-68,6	-74,0	-69,6	-75,6
4	-34,3	-61,6	-66,2	-71,5	-67,7	-74,9
5	-26,7	-56,4	-63,6	-68,9	-65,7	-74,2
6	-18,9	-51,1	-61,0	-66,2	-63,7	-73,4
7	-10,9	-45,5	-58,3	-63,4	-61,6	-72,6
8	-2,6	-39,6	-55,5	-60,5	-59,5	-71,8
9	5,8	-33,6	-52,7	-57,6	-57,4	-70,9
10	14,5	-27,3	-49,8	-54,5	-55,2	-70,0
11	23,4	-20,7	-46,8	-51,4	-52,9	-69,0
12	32,5	-13,8	-43,7	-48,1	-50,6	-68,0
13	41,9	-6,7	-40,5	-44,7	-48,2	-67,0
14	51,5	0,7	-37,3	-41,3	-45,7	-65,9
15	61,3	8,5	-33,9	-37,7	-43,2	-64,8
16	71,5	16,5	-30,5	-34,0	-40,7	-63,6
17	81,9	25,0	-27,0	-30,1	-38,0	-62,4
18	92,6	33,8	-23,3	-26,2	-35,3	-61,1
19	103,7	42,9	-19,6	-22,1	-32,6	-59,8
20	115,0	52,5	-15,7	-17,8	-29,7	-58,4
21	126,7	62,5	-11,7	-13,4	-26,8	-56,9
22	138,6	72,9	-7,6	-8,9	-23,8	-55,4
23	151,0	83,7	-3,4	-4,2	-20,7	-53,8
24	163,7	95,0	0,9	0,7	-17,5	-52,1
25	176,8	106,9	5,4	5,7	-14,3	-50,4
26	190,3	119,2	10,0	10,9	-10,9	-48,5
27	204,1	132,1	14,8	16,3	-7,5	-46,6
28	218,4	145,5	19,7	21,9	-4,0	-44,6
29	233,2	159,5	24,7	27,7	-0,3	-42,5
30	248,4	174,2	30,0	33,8	3,4	-40,3

Fig. Cost of energy conserved

	Dormitory	Hospital	Kindergar	Office	School	University
Ranking of options	1	2	4	3	5	6
Cost of en	EUR/kWh	0,1	0,1	0,2	0,2	0,3	1,0
Final ener	kWh/m2	59,2	36,3	21,3	23,6	17,4	5,1

Cost of energy conserved: Improvement 1, Climate zone A

	y EUR/kWh	x kWh/m2	
1	0,1	0,0	Dormitory
	0,1	59,2	
2	0,1	59,2	Hospital
	0,1	95,5	
3	0,2	95,5	Office
	0,2	119,2	
4	0,2	119,2	Kindergarten
	0,2	140,4	
5	0,3	140,4	School
	0,3	157,8	
6	1,0	157,8	University
	1,0	162,9	

Thermal efficiency retrofit of public buildings in Albania, analysis per m2

Improvement 1
Climate zone B

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerous benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price 2016 [EUR/kWh]	2030 [EUR/kWh]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity	0,104	0,160	0	1,0
Wood	0,024	0,037	0	0,2
LPG	0,061	0,247	227	1,1
Diesel oil	0,117	0,473	267	1,2
Solar	0,000	0,000	0	0,0

Financial analysis	**Units**	**Value**	**References**
Measure lifetime	[years]	30	
Discount rate	[%]	4%	
Annuity factor	[%]	6%	
Maintenance costs	[EUR/m2]	0,5	

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view			
GDP increase	[EUR/EUR]	0,65	
direct	[EUR/EUR]	0,30	
multiplier effects	[EUR/EUR]	0,35	
Labour income	[EUR/EUR]	0,30	
direct	[EUR/EUR]	0,17	
multiplier effects	[EUR/EUR]	0,13	
Employment	[jobs/million EUR]	148	
direct	[jobs/million EUR]	85	
multiplier effects	[jobs/million EUR]	63	
Monetized CO2 emissions avoided	[EUR/tCO2]	5	
Air quality including health impacts	[EUR/MWh]	1,4	
Improved comfort and services of buildings refle	[% value]	2%	*Assumed estate value is EUR 300 per m2

Summary of results

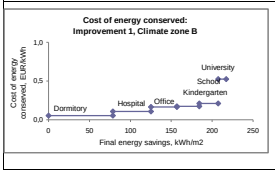
Investment and maintenance costs	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
Total	[EUR/m2]	**63**	**80**	**76**	**81**	**75**	**77**
Envelope cost	[EUR/m2]	15	14	21	19	19	22
HVAC system cost	[EUR/m2]	48	66	54	62	56	56
Maintenance cost	[EUR/m2-yr.]	0,5	0,5	0,5	0,5	0,5	0,5
Annualized total costs	[EUR/m2]	4,1	5,1	4,9	5,2	4,8	5,0
Cost of energy conserved (CEE)	[EUR/kWh]	0,1	0,1	0,2	0,2	0,2	0,5
Ranking of CEE		1	2	4	3	5	6

Energy/CO2 savings: improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
CO2 emissions	[gCO2/m2]	**4655**	**9133**	**2248**	**2734**	**964**	**1995**
Electricity	[gCO2/m2]	0	0	0	0	0	0
Wood	[gCO2/m2]	0	0	0	0	0	0
LPG	[gCO2/m2]	-2507	0	794	-765	-183	0
Oil	[gCO2/m2]	7162	9133	1454	3499	1147	1995
Solar	[gCO2/m2]	0	0	0	0	0	0
Primary energy	[kWh/m2]	**83,4**	**54,4**	**30,6**	**28,3**	**21,8**	**11,0**
Electricity	[kWh/m2]	63,4	13,3	20,5	14,8	17,0	2,1
Wood	[kWh/m2]	0,0	0,0	-0,2	1,4	0,5	0,0
LPG	[kWh/m2]	-12,1	0,0	3,8	-3,7	-0,9	0,0
Oil	[kWh/m2]	32,2	41,0	6,5	15,7	5,2	9,0
Solar	[kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0
Final energy	[kWh/m2]	**78,5**	**46,7**	**27,6**	**31,5**	**23,1**	**9,5**
Electricity	[kWh/m2]	62,7	13,2	20,3	14,7	16,9	2,0
Wood	[kWh/m2]	0,0	0,0	-1,1	7,2	2,7	0,0
LPG	[kWh/m2]	-11,0	0,0	3,5	-3,4	-0,8	0,0
Oil	[kWh/m2]	26,8	34,2	5,4	13,1	4,3	7,5
Solar	[kWh/m2]	0,0	-0,6	-0,5	-0,1	0,0	0,0

Saved energy costs / improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
Total over measure lifetime (NPV)	[EUR/m2]	**218,1**	**163,5**	**71,8**	**80,1**	**52,9**	**33,9**
Electricity	[EUR/m2]	134,9	28,3	43,6	31,6	36,2	4,4
Wood	[EUR/m2]	0,0	0,0	-0,6	3,6	-1,4	0,0
LPG	[EUR/m2]	-22,8	0,0	7,2	-6,9	-1,7	0,0
Oil	[EUR/m2]	106,0	135,2	21,5	51,8	17,0	29,5
Solar	[EUR/m2]	0,0	0,0	0,0	0,0	0,0	0,0
Annual over measure lifetime	[EUR/m2]	**12,61**	**9,46**	**4,15**	**4,63**	**3,06**	**1,96**
Electricity	[EUR/m2]	7,80	1,64	2,52	1,83	2,10	0,25
Wood	[EUR/m2]	0,00	0,00	-0,03	0,21	0,08	0,00
LPG	[EUR/m2]	-1,32	0,00	0,42	-0,40	-0,10	0,00
Oil	[EUR/m2]	6,13	7,92	1,24	3,00	0,98	1,71
Solar	[EUR/m2]	0,00	0,00	0,00	0,00	0,00	0,00

Financial analysis / only saved energy	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
Simple payback	[years]	7,0	12,0	20,0	20,0	25,0	n/a
Internal rate of return	[%]	16,7%	9,6%	3,6%	3,9%	1,6%	-0,8%
NPV	[EUR/m2]	149,2	80,2	-3,8	-1,1	-21,3	-41,9
Cost - benefit ratio		0,3	0,5	1,1	1,0	1,4	2,3

Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
GDP increase	[EUR/m2]	40,9	51,9	49,1	52,7	48,7	50,3
Labour income	[EUR/m2]	18,7	23,8	22,5	24,2	22,4	23,1
Annual employment	[jobs/m2]	0,01	0,01	0,01	0,01	0,01	0,01
Monetized CO2 emissions avoided	[EUR/m2]	0,02	0,05	0,01	0,01	0,00	0,01
Air quality including health impacts	[EUR/m2]	0,11	0,06	0,04	0,04	0,03	0,01
Improved comfort and services of buildings	[EUR/m2]	6,00	6,00	6,00	6,00	6,00	6,00



Saved energy costs

Changing energy prices

Year	Dormitory	Hospital	Kindergar	Office	School	University
0	-63,0	-80,0	-75,7	-81,2	-75,1	-77,5
1	9,0	5,4	2,9	3,0	2,3	1,1
2	9,3	5,8	3,0	3,2	2,3	1,2
3	9,6	6,0	3,1	3,3	2,4	1,2
4	9,8	6,3	3,2	3,4	2,4	1,3
5	10,0	6,5	3,3	3,5	2,5	1,3
6	10,3	6,8	3,4	3,6	2,6	1,4
7	10,6	7,1	3,5	3,7	2,6	1,5
8	10,8	7,4	3,6	3,8	2,7	1,5
9	11,1	7,7	3,6	4,0	2,7	1,6
10	11,4	8,0	3,7	4,1	2,8	1,6
11	11,7	8,3	3,8	4,2	2,9	1,7
12	12,0	8,6	3,9	4,3	2,9	1,8
13	12,3	9,0	4,0	4,5	3,0	1,9
14	12,6	9,4	4,2	4,6	3,1	1,9
15	13,0	9,8	4,3	4,8	3,2	2,0
16	13,3	10,2	4,4	4,9	3,2	2,1
17	13,7	10,6	4,5	5,1	3,3	2,2
18	14,1	11,0	4,6	5,3	3,4	2,3
19	14,5	11,5	4,8	5,4	3,5	2,4
20	14,9	12,0	4,9	5,6	3,6	2,5
21	15,3	12,5	5,1	5,8	3,7	2,6
22	15,8	13,0	5,2	6,0	3,7	2,7
23	16,2	13,6	5,4	6,2	3,8	2,9
24	16,7	14,2	5,5	6,5	3,9	3,0
25	17,2	14,8	5,7	6,7	4,0	3,1
26	17,7	15,4	5,9	6,9	4,2	3,2
27	18,3	16,1	6,1	7,2	4,3	3,4
28	18,8	16,8	6,2	7,4	4,4	3,5
29	19,4	17,5	6,4	7,7	4,5	3,7
30	20,0	18,3	6,6	8,0	4,6	3,9

Cumulative cash flow

Changing energy prices

Year	Dormitory	Hospital	Kindergar	Office	School	University
0	-63,0	-80,0	-75,7	-81,2	-75,1	-77,5
1	-54,0	-74,7	-72,8	-78,1	-72,8	-76,4
2	-44,7	-68,9	-69,7	-74,9	-70,5	-75,2
3	-35,1	-62,8	-66,6	-71,7	-68,1	-74,0
4	-25,3	-56,5	-63,4	-68,3	-65,6	-72,7
5	-15,3	-50,0	-60,1	-64,8	-63,1	-71,4
6	-5,0	-43,2	-56,7	-61,2	-60,6	-70,0
7	5,6	-36,1	-53,3	-57,5	-57,9	-68,5
8	16,4	-28,7	-49,7	-53,6	-55,3	-67,0
9	27,5	-21,0	-46,1	-49,7	-52,5	-65,4
10	38,9	-13,0	-42,4	-45,6	-49,7	-63,8
11	50,6	-4,7	-38,5	-41,4	-46,9	-62,1
12	62,6	3,9	-34,6	-37,1	-43,9	-60,3
13	74,9	12,9	-30,5	-32,6	-40,9	-58,4
14	87,6	22,3	-26,4	-28,0	-37,8	-56,5
15	100,6	32,0	-22,1	-23,2	-34,7	-54,4
16	113,9	42,2	-17,7	-18,3	-31,5	-52,3
17	127,6	52,8	-13,2	-13,2	-28,2	-50,1
18	141,7	63,8	-8,5	-7,9	-24,8	-47,8
19	156,2	75,4	-3,7	-2,5	-21,3	-45,4
20	171,1	87,4	1,2	3,2	-17,7	-42,9
21	186,5	99,9	6,2	9,0	-14,1	-40,3
22	202,2	112,9	11,5	15,0	-10,3	-37,6
23	218,5	126,5	16,8	21,3	-6,5	-34,7
24	235,2	140,7	22,4	27,7	-2,5	-31,7
25	252,4	155,5	28,1	34,4	1,5	-28,6
26	270,1	170,9	33,9	41,3	5,7	-25,4
27	288,4	187,0	40,0	48,5	9,9	-22,0
28	307,2	203,8	46,2	55,9	14,2	-18,5
29	326,6	221,3	52,7	63,7	18,8	-14,8
30	346,6	239,6	59,3	71,6	23,4	-10,9

Fig. Cost of energy conserved

		Dormitory	Hospital	Kindergar	Office	School	University
Ranking of options		1	2	4	3	5	6
Cost of en	[EUR/kWh	0,1	0,1	0,2	0,2	0,2	0,5
Final ener	[kWh/m2]	78,5	46,7	27,6	31,5	23,1	9,5

Cost of energy conserved: Improvement 1, Climate zone B

	y EUR/kWh	x kWh/m2	
1	0,1	0,0	Dormitory
	0,1	78,5	
2	0,1	78,5	Hospital
	0,1	125,3	
3	0,2	125,3	Office
	0,2	156,8	
4	0,2	156,8	Kindergarten
	0,2	184,4	
5	0,2	184,4	School
	0,2	207,4	
6	0,5	207,4	University
	0,5	217,0	

Thermal efficiency retrofit of public buildings in Albania, analysis per m2

Improvement 1
Climate zone C

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerous benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price 2016 [EUR/kWh]	2030 [EUR/kWh]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity	0,104	0,160	0	1,0
Wood	0,024	0,037	0	0,2
LPG	0,061	0,247	227	1,1
Diesel oil	0,117	0,473	267	1,2
Solar	0,000	0,000	0	0,0

Financial analysis	**Units**	**Value**	**References**
Measure lifetime	[years]	30	
Discount rate	[%]	4%	
Annuity factor	[%]	6%	
Maintenance costs	[EUR/m2]	0,5	

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view						
GDP increase	[EUR/EUR]	0,65				
direct	[EUR/EUR]	0,30				
multiplier effects	[EUR/EUR]	0,35				
Labour income	[EUR/EUR]	0,30				
direct	[EUR/EUR]	0,17				
multiplier effects	[EUR/EUR]	0,13				
Employment	[jobs/million EUR]	148				
direct	[jobs/million EUR]	85				
multiplier effects	[jobs/million EUR]	63				
Monetized CO2 emissions avoided	[EUR/tCO2]	5				
Air quality including health impacts	[EUR/MWh]	1,4				
Improved comfort and services of buildings refle	[% value]	2%	*Assumed estate value is	EUR	300	per m2

Summary of results

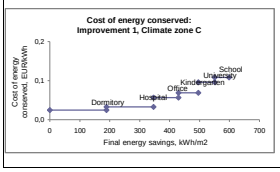
Investment and maintenance costs	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
Total	[EUR/m2]	**71**	**80**	**71**	**73**	**81**	**82**
Envelope cost	[EUR/m2]	15	14	21	19	19	22
HVAC system cost	[EUR/m2]	56	66	49	53	62	61
Maintenance cost	[EUR/m2-yr.]	0,5	0,5	0,5	0,5	0,5	0,5
Annualized total costs	[EUR/m2]	4,6	5,1	4,6	4,7	5,2	5,3
Cost of energy conserved (CEE)	[EUR/kWh]	0,0	0,0	0,1	0,1	0,1	0,1
Ranking of CEE		1	2	4	3	6	5

Energy/CO2 savings: improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
CO2 emissions	[gCO2/m2]	**16904**	**30515**	**2658**	**5348**	**1902**	**7502**
Electricity	[gCO2/m2]	0	0	0	0	0	0
Wood	[gCO2/m2]	0	0	0	0	0	0
LPG	[gCO2/m2]	-3759	0	-49	-990	-60	884
Oil	[gCO2/m2]	20663	30515	2607	6338	1962	6618
Solar	[gCO2/m2]	0	0	0	0	0	0
Primary energy	[kWh/m2]	**115,2**	**140,0**	**30,4**	**44,4**	**27,0**	**36,2**
Electricity	[kWh/m2]	18,6	-7,2	9,4	9,9	12,9	-3,8
Wood	[kWh/m2]	22,0	10,1	9,6	10,9	5,6	6,0
LPG	[kWh/m2]	-18,2	0,0	-0,2	-4,8	-0,3	4,3
Oil	[kWh/m2]	92,9	137,1	11,7	28,5	8,8	29,7
Solar	[kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0
Final energy	[kWh/m2]	**189,3**	**156,9**	**66,3**	**83,5**	**47,9**	**54,9**
Electricity	[kWh/m2]	18,4	-7,1	9,3	9,8	12,7	-3,8
Wood	[kWh/m2]	110,1	50,3	48,0	54,5	28,1	30,0
LPG	[kWh/m2]	-16,6	0,0	-0,2	-4,4	-0,3	3,9
Oil	[kWh/m2]	77,4	114,3	9,8	23,7	7,3	24,8
Solar	[kWh/m2]	0,0	-0,6	-0,5	-0,1	0,0	0,0

Saved energy costs / improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
Total over measure lifetime (NPV)	[EUR/m2]	**366,7**	**461,7**	**82,3**	**133,2**	**70,0**	**113,0**
Electricity	[EUR/m2]	39,5	-15,3	19,9	21,0	27,4	-8,1
Wood	[EUR/m2]	55,5	25,3	24,2	27,4	14,1	15,1
LPG	[EUR/m2]	-34,1	0,0	-0,4	-9,0	-0,5	8,0
Oil	[EUR/m2]	305,8	451,6	38,6	93,8	29,0	98,0
Solar	[EUR/m2]	0,0	0,0	0,0	0,0	0,0	0,0
Annual over measure lifetime	[EUR/m2]	**21,21**	**26,70**	**4,76**	**7,70**	**4,05**	**6,54**
Electricity	[EUR/m2]	2,29	-0,88	1,15	1,21	1,58	-0,47
Wood	[EUR/m2]	3,21	1,47	1,40	1,59	0,82	0,87
LPG	[EUR/m2]	-1,97	0,00	-0,03	-0,52	-0,03	0,46
Oil	[EUR/m2]	17,69	26,12	2,23	5,42	1,68	5,68
Solar	[EUR/m2]	0,00	0,00	0,00	0,00	0,00	0,00

Financial analysis / only saved energy	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
Simple payback	[years]	6,0	6,0	17,0	13,0	22,0	16,0
Internal rate of return	[%]	21,9%	22,6%	5,1%	8,8%	3,0%	6,2%
NPV	[EUR/m2]	284,3	366,8	10,9	58,2	-10,6	29,3
Cost - benefit ratio		0,2	0,2	0,9	0,5	1,2	0,7

Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
GDP increase	[EUR/m2]	46,0	52,1	46,0	47,2	52,6	53,5
Labour income	[EUR/m2]	21,1	23,9	21,1	21,7	24,1	24,6
Annual employment	[jobs/m2]	0,01	0,01	0,01	0,01	0,01	0,01
Monetized CO2 emissions avoided	[EUR/m2]	0,08	0,15	0,01	0,03	0,01	0,04
Air quality including health impacts	[EUR/m2]	0,26	0,22	0,09	0,12	0,07	0,08
Improved comfort and services of buildings	[EUR/m2]	6,00	6,00	6,00	6,00	6,00	6,00



Saved energy costs

Changing energy prices

Year	Dormitory	Hospital	Kindergar	Office	School	University
0	-71,0	-80,2	-70,9	-72,7	-81,1	-82,5
1	12,7	13,9	3,3	4,9	2,9	3,5
2	13,5	15,3	3,4	5,1	3,0	3,8
3	14,0	16,0	3,5	5,3	3,0	4,0
4	14,5	16,7	3,6	5,5	3,1	4,2
5	15,1	17,5	3,7	5,7	3,2	4,3
6	15,7	18,4	3,8	5,9	3,3	4,5
7	16,3	19,2	3,9	6,1	3,4	4,8
8	16,9	20,1	4,0	6,3	3,5	5,0
9	17,5	21,1	4,1	6,5	3,6	5,2
10	18,1	22,0	4,2	6,7	3,6	5,4
11	18,8	23,0	4,4	6,9	3,7	5,7
12	19,5	24,1	4,5	7,2	3,8	5,9
13	20,3	25,2	4,6	7,4	3,9	6,2
14	21,1	26,4	4,8	7,7	4,1	6,5
15	21,9	27,6	4,9	7,9	4,2	6,8
16	22,7	28,9	5,0	8,2	4,3	7,1
17	23,6	30,2	5,2	8,5	4,4	7,4
18	24,6	31,6	5,4	8,8	4,5	7,7
19	25,5	33,1	5,5	9,2	4,7	8,1
20	26,6	34,7	5,7	9,5	4,8	8,4
21	27,6	36,3	5,9	9,8	4,9	8,8
22	28,7	38,0	6,1	10,2	5,1	9,2
23	29,9	39,8	6,3	10,6	5,2	9,6
24	31,1	41,6	6,5	11,0	5,4	10,1
25	32,4	43,6	6,7	11,4	5,6	10,5
26	33,7	45,6	6,9	11,8	5,7	11,0
27	35,1	47,8	7,1	12,3	5,9	11,5
28	36,5	50,0	7,3	12,7	6,1	12,1
29	38,0	52,4	7,6	13,2	6,3	12,6
30	39,6	54,8	7,8	13,8	6,5	13,2

Cumulative cash flow

Changing energy prices

Year	Dormitory	Hospital	Kindergar	Office	School	University
0	-71,0	-80,2	-70,9	-72,7	-81,1	-82,5
1	-58,3	-66,3	-67,6	-67,9	-78,2	-79,0
2	-44,8	-51,1	-64,2	-62,7	-75,3	-75,2
3	-30,7	-35,1	-60,7	-57,4	-72,2	-71,2
4	-16,2	-18,4	-57,1	-51,9	-69,1	-67,0
5	-1,1	-0,9	-53,4	-46,3	-65,9	-62,7
6	14,6	17,5	-49,6	-40,4	-62,6	-58,1
7	30,8	36,7	-45,7	-34,3	-59,3	-53,4
8	47,7	56,9	-41,7	-28,1	-55,8	-48,4
9	65,2	78,0	-37,6	-21,6	-52,2	-43,2
10	83,4	99,9	-33,3	-14,9	-48,6	-37,8
11	102,2	122,9	-29,0	-7,9	-44,9	-32,1
12	121,7	147,0	-24,5	-0,8	-41,0	-26,2
13	142,0	172,2	-19,9	6,6	-37,1	-20,0
14	163,1	198,6	-15,1	14,3	-33,0	-13,6
15	184,9	226,2	-10,2	22,3	-28,8	-6,8
16	207,7	255,1	-5,2	30,5	-24,5	0,2
17	231,3	285,3	0,0	39,0	-20,1	7,6
18	255,9	316,9	5,4	47,9	-15,6	15,3
19	281,4	350,1	10,9	57,0	-10,9	23,4
20	308,0	384,7	16,6	66,5	-6,1	31,8
21	335,6	421,0	22,5	76,3	-1,2	40,6
22	364,3	459,0	28,6	86,5	3,9	49,9
23	394,2	498,8	34,8	97,1	9,2	59,5
24	425,3	540,4	41,3	108,1	14,6	69,6
25	457,6	584,0	48,0	119,5	20,2	80,1
26	491,3	629,7	54,8	131,3	25,9	91,2
27	526,4	677,4	61,9	143,6	31,8	102,7
28	562,9	727,4	69,3	156,4	37,9	114,9
29	600,9	779,8	76,9	169,6	44,2	127,4
30	640,5	834,6	84,7	183,3	50,7	140,6

Fig. Cost of energy conserved

	Dormitory	Hospital	Kindergar	Office	School	University
Ranking of options	1	2	4	3	6	5
Cost of en	EUR/kWh	0,0	0,0	0,1	0,1	0,1
Final ener	kWh/m2	189,3	156,9	66,3	83,5	47,9	54,9

Cost of energy conserved: Improvement 1, Climate zone C

	y	x	
	EUR/kWh	kWh/m2	
1	0,0	0,0	Dormitory
	0,0	189,3	
2	0,0	189,3	Hospital
	0,0	346,2	
3	0,1	346,2	Office
	0,1	429,7	
4	0,1	429,7	Kindergarten
	0,1	496,0	
5	0,1	496,0	University
	0,1	550,9	
6	0,1	550,9	School
	0,1	598,8	

Thermal efficiency retrofit of public buildings in Albania, analysis per m2

Improvement 2
Climate zone A

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerous benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price 2016 [EUR/kWh]	2030 [EUR/kWh]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity	0,104	0,160	0	1,0
Wood	0,024	0,037	0	0,2
LPG	0,061	0,247	227	1,1
Diesel oil	0,117	0,473	267	1,2
Solar	0,000	0,000	0	0,0

Financial analysis	**Units**	**Value**	**References**
Measure lifetime	[years]	30	
Discount rate	[%]	4%	
Annuity factor	[%]	6%	
Maintenance costs	[EUR/m2]	0,5	

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view

GDP increase	[EUR/EUR]	0,65				
direct	[EUR/EUR]	0,30				
multiplier effects	[EUR/EUR]	0,35				
Labour income	[EUR/EUR]	0,30				
direct	[EUR/EUR]	0,17				
multiplier effects	[EUR/EUR]	0,13				
Employment	[jobs/million EUR]	148				
direct	[jobs/million EUR]	85				
multiplier effects	[jobs/million EUR]	63				
Monetized CO2 emissions avoided	[EUR/tCO2]	5				
Air quality including health impacts	[EUR/MWh]	1,4				
Improved comfort and services of buildings refle	[% value]	2%	*Assumed estate value is	EUR	300	per m2

Summary of results

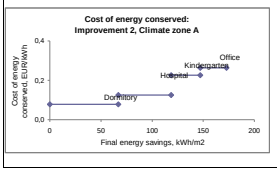
Investment and maintenance costs	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
Total	[EUR/m2]	**87**	**108**	**105**	**109**
Envelope cost	[EUR/m2]	20	24	30	27
HVAC system cost	[EUR/m2]	67	84	76	81
Maintenance cost	[EUR/m2-yr.]	0,5	0,5	0,5	0,5
Annualized total costs	[EUR/m2]	5,6	6,7	6,6	6,8
Cost of energy conserved (CEE)	[EUR/kWh]	0,1	0,1	0,2	0,3
Ranking of CEE		1	2	3	4

Energy/CO2 savings: improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
CO2 emissions	[gCO2/m2]	**3759**	**8867**	**2219**	**2075**
Electricity	[gCO2/m2]	0	0	0	0
Wood	[gCO2/m2]	0	0	0	0
LPG	[gCO2/m2]	-1826	0	578	-587
Oil	[gCO2/m2]	5585	8867	1641	2662
Solar	[gCO2/m2]	0	0	0	0
Primary energy	[kWh/m2]	**78,9**	**60,8**	**31,7**	**23,7**
Electricity	[kWh/m2]	63,5	21,0	21,8	13,6
Wood	[kWh/m2]	-0,9	0,0	-0,2	1,0
LPG	[kWh/m2]	-8,8	0,0	2,8	-2,8
Oil	[kWh/m2]	25,1	39,9	7,4	12,0
Solar	[kWh/m2]	0,0	0,0	0,0	0,0
Final energy	[kWh/m2]	**67,1**	**51,6**	**28,4**	**25,6**
Electricity	[kWh/m2]	62,9	20,8	21,6	13,5
Wood	[kWh/m2]	-4,4	0,0	-1,0	4,8
LPG	[kWh/m2]	-8,0	0,0	2,5	-2,6
Oil	[kWh/m2]	20,9	33,2	6,1	10,0
Solar	[kWh/m2]	-4,3	-2,4	-0,9	-0,1

Saved energy costs / improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
Total over measure lifetime (NPV)	[EUR/m2]	**199,0**	**175,9**	**75,4**	**65,4**
Electricity	[EUR/m2]	135,1	44,7	46,3	28,9
Wood	[EUR/m2]	-2,2	0,0	-0,5	2,4
LPG	[EUR/m2]	-16,6	0,0	5,2	-5,3
Oil	[EUR/m2]	82,7	131,2	24,3	39,4
Solar	[EUR/m2]	0,0	0,0	0,0	0,0
Annual over measure lifetime	[EUR/m2]	**11,51**	**10,17**	**4,36**	**3,78**
Electricity	[EUR/m2]	7,82	2,58	2,68	1,67
Wood	[EUR/m2]	-0,13	0,00	-0,03	0,14
LPG	[EUR/m2]	-0,96	0,00	0,30	-0,31
Oil	[EUR/m2]	4,78	7,59	1,40	2,28
Solar	[EUR/m2]	0,00	0,00	0,00	0,00

Financial analysis / only saved energy	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
Simple payback	[years]	10,0	14,0	25,0	28,0
Internal rate of return	[%]	11,3%	7,7%	1,8%	0,8%
NPV	[EUR/m2]	107,4	65,6	-28,8	-41,6
Cost - benefit ratio		0,4	0,6	1,4	1,7

Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
GDP increase	[EUR/m2]	56,7	69,8	68,3	70,5
Labour income	[EUR/m2]	26,0	32,0	31,3	32,4
Annual employment	[jobs/m2]	0,01	0,02	0,02	0,02
Monetized CO2 emissions avoided	[EUR/m2]	0,02	0,04	0,01	0,01
Air quality including health impacts	[EUR/m2]	0,09	0,07	0,04	0,04
Improved comfort and services of buildings	[EUR/m2]	6,00	6,00	6,00	6,00



Saved energy costs — Changing energy prices

Year	Dormitory	Hospital	Kindergar	Office	0	0
0	-87,4	-107,6	-105,3	-108,7	0,0	0,0
1	8,4	6,1	3,1	2,5	0,0	0,0
2	8,7	6,5	3,2	2,7	0,0	0,0
3	8,9	6,7	3,3	2,7	0,0	0,0
4	9,1	7,0	3,4	2,8	0,0	0,0
5	9,3	7,2	3,5	2,9	0,0	0,0
6	9,5	7,5	3,5	3,0	0,0	0,0
7	9,8	7,8	3,6	3,1	0,0	0,0
8	10,0	8,1	3,7	3,2	0,0	0,0
9	10,2	8,4	3,8	3,3	0,0	0,0
10	10,5	8,7	3,9	3,3	0,0	0,0
11	10,7	9,0	4,0	3,4	0,0	0,0
12	11,0	9,4	4,1	3,6	0,0	0,0
13	11,3	9,7	4,3	3,7	0,0	0,0
14	11,6	10,1	4,4	3,8	0,0	0,0
15	11,9	10,5	4,5	3,9	0,0	0,0
16	12,2	10,9	4,6	4,0	0,0	0,0
17	12,5	11,3	4,7	4,2	0,0	0,0
18	12,8	11,8	4,9	4,3	0,0	0,0
19	13,1	12,3	5,0	4,4	0,0	0,0
20	13,5	12,7	5,2	4,6	0,0	0,0
21	13,9	13,3	5,3	4,7	0,0	0,0
22	14,2	13,8	5,5	4,9	0,0	0,0
23	14,6	14,4	5,6	5,0	0,0	0,0
24	15,0	14,9	5,8	5,2	0,0	0,0
25	15,4	15,5	6,0	5,4	0,0	0,0
26	15,9	16,2	6,1	5,6	0,0	0,0
27	16,3	16,8	6,3	5,8	0,0	0,0
28	16,8	17,5	6,5	6,0	0,0	0,0
29	17,3	18,3	6,7	6,2	0,0	0,0
30	17,8	19,0	6,9	6,4	0,0	0,0

Cumulative cash flow — Changing energy prices

Year	Dormitory	Hospital	Kindergar	Office	0	0
0	-87,4	-107,6	-105,3	-108,7	0,0	0,0
1	-79,0	-101,6	-102,2	-106,1	0,0	0,0
2	-70,3	-95,1	-99,0	-103,5	0,0	0,0
3	-61,5	-88,4	-95,7	-100,8	0,0	0,0
4	-52,4	-81,4	-92,3	-98,0	0,0	0,0
5	-43,1	-74,2	-88,8	-95,1	0,0	0,0
6	-33,6	-66,7	-85,3	-92,1	0,0	0,0
7	-23,8	-58,9	-81,7	-89,0	0,0	0,0
8	-13,8	-50,8	-77,9	-85,9	0,0	0,0
9	-3,6	-42,4	-74,1	-82,6	0,0	0,0
10	6,9	-33,7	-70,2	-79,3	0,0	0,0
11	17,6	-24,7	-66,1	-75,8	0,0	0,0
12	28,6	-15,4	-62,0	-72,3	0,0	0,0
13	39,9	-5,6	-57,7	-68,6	0,0	0,0
14	51,4	4,5	-53,4	-64,8	0,0	0,0
15	63,3	15,0	-48,9	-60,9	0,0	0,0
16	75,5	25,9	-44,3	-56,9	0,0	0,0
17	87,9	37,2	-39,5	-52,7	0,0	0,0
18	100,7	49,0	-34,6	-48,4	0,0	0,0
19	113,9	61,3	-29,6	-44,0	0,0	0,0
20	127,4	74,0	-24,5	-39,4	0,0	0,0
21	141,2	87,3	-19,1	-34,7	0,0	0,0
22	155,4	101,1	-13,7	-29,8	0,0	0,0
23	170,1	115,4	-8,1	-24,8	0,0	0,0
24	185,1	130,4	-2,3	-19,6	0,0	0,0
25	200,5	145,9	3,7	-14,2	0,0	0,0
26	216,4	162,1	9,8	-8,6	0,0	0,0
27	232,8	178,9	16,2	-2,8	0,0	0,0
28	249,6	196,5	22,7	3,2	0,0	0,0
29	266,9	214,7	29,4	9,4	0,0	0,0
30	284,6	233,8	36,4	15,8	0,0	0,0

Fig. Cost of energy conserved

	Dormitory	Hospital	Kindergar	Office		
Ranking of options	1	2	3	4		
Cost of ene EUR/kWh	0,1	0,1	0,2	0,3		
Final ener kWh/m2	67,1	51,6	28,4	25,6		

Cost of energy conserved: Improvement 2, Climate zone A

	EUR/kWh y	kWh/m2 x	
1	0,1	0,0	Dormitory
	0,1	67,1	
2	0,1	67,1	Hospital
	0,1	118,7	
3	0,2	118,7	Kindergarten
	0,2	147,1	
4	0,3	147,1	Office
	0,3	172,6	

Thermal efficiency retrofit of public buildings in Albania, analysis per m2

Improvement 2
Climate zone B

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerous benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price 2016 [EUR/kWh]	2030 [EUR/kWh]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity	0,104	0,160	0	1,0
Wood	0,024	0,037	0	0,2
LPG	0,061	0,247	227	1,1
Diesel oil	0,117	0,473	267	1,2
Solar	0,000	0,000	0	0,0

Financial analysis	**Units**	**Value**	**References**
Measure lifetime	[years]	30	
Discount rate	[%]	4%	
Annuity factor	[%]	6%	
Maintenance costs	[EUR/m2]	0,5	

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view						
GDP increase	[EUR/EUR]	0,65				
direct	[EUR/EUR]	0,30				
multiplier effects	[EUR/EUR]	0,35				
Labour income	[EUR/EUR]	0,30				
direct	[EUR/EUR]	0,17				
multiplier effects	[EUR/EUR]	0,13				
Employment	[jobs/million EUR]	148				
direct	[jobs/million EUR]	85				
multiplier effects	[jobs/million EUR]	63				
Monetized CO2 emissions avoided	[EUR/tCO2]	5				
Air quality including health impacts	[EUR/MWh]	1,4				
Improved comfort and services of buildings refle	[% value]	2%	*Assumed estate value is	EUR	300	per m2

Summary of results

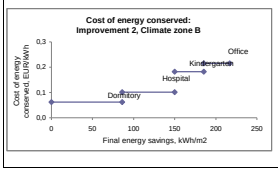
Investment and maintenance costs	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
Total	[EUR/m2]	**87**	**108**	**105**	**109**
Envelope cost	[EUR/m2]	20	24	30	27
HVAC system cost	[EUR/m2]	67	84	76	81
Maintenance cost	[EUR/m2-yr.]	0,5	0,5	0,5	0,5
Annualized total costs	[EUR/m2]	5,6	6,7	6,6	6,8
Cost of energy conserved (CEE)	[EUR/kWh]	0,1	0,1	0,2	0,2
Ranking of CEE		1	2	3	4

Energy/CO2 savings: improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
CO2 emissions	[gCO2/m2]	**5012**	**10886**	**2719**	**2734**
Electricity	[gCO2/m2]	0	0	0	0
Wood	[gCO2/m2]	0	0	0	0
LPG	[gCO2/m2]	-2149	0	709	-765
Oil	[gCO2/m2]	7162	10886	2010	3499
Solar	[gCO2/m2]	0	0	0	0
Primary energy	[kWh/m2]	**100,2**	**74,9**	**39,3**	**28,3**
Electricity	[kWh/m2]	79,7	26,0	27,1	14,8
Wood	[kWh/m2]	-1,2	0,0	-0,3	1,4
LPG	[kWh/m2]	-10,4	0,0	3,4	-3,7
Oil	[kWh/m2]	32,2	48,9	9,0	15,7
Solar	[kWh/m2]	0,0	0,0	0,0	0,0
Final energy	[kWh/m2]	**85,9**	**64,2**	**35,3**	**31,5**
Electricity	[kWh/m2]	78,9	25,8	26,8	14,7
Wood	[kWh/m2]	-6,0	0,0	-1,3	7,2
LPG	[kWh/m2]	-9,5	0,0	3,1	-3,4
Oil	[kWh/m2]	26,8	40,8	7,5	13,1
Solar	[kWh/m2]	-4,3	-2,4	-0,9	-0,1

Saved energy costs / improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
Total over measure lifetime (NPV)	[EUR/m2]	**253,0**	**216,5**	**93,2**	**80,1**
Electricity	[EUR/m2]	169,6	55,4	57,6	31,6
Wood	[EUR/m2]	-3,0	0,0	-0,7	3,6
LPG	[EUR/m2]	-19,5	0,0	6,4	-6,9
Oil	[EUR/m2]	106,0	161,1	29,7	51,8
Solar	[EUR/m2]	0,0	0,0	0,0	0,0
Annual over measure lifetime	[EUR/m2]	**14,63**	**12,52**	**5,39**	**4,63**
Electricity	[EUR/m2]	9,81	3,20	3,33	1,83
Wood	[EUR/m2]	-0,18	0,00	-0,04	0,21
LPG	[EUR/m2]	-1,13	0,00	0,37	-0,40
Oil	[EUR/m2]	6,13	9,32	1,72	3,00
Solar	[EUR/m2]	0,00	0,00	0,00	0,00

Financial analysis / only saved energy	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
Simple payback	[years]	8,0	12,0	21,0	24,9
Internal rate of return	[%]	14,3%	9,5%	3,2%	2,0%
NPV	[EUR/m2]	159,3	104,7	-11,6	-27,5
Cost - benefit ratio		0,3	0,5	1,1	1,4

Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
GDP increase	[EUR/m2]	56,7	69,8	68,3	70,5
Labour income	[EUR/m2]	26,0	32,0	31,3	32,4
Annual employment	[jobs/m2]	0,01	0,02	0,02	0,02
Monetized CO2 emissions avoided	[EUR/m2]	0,03	0,05	0,01	0,01
Air quality including health impacts	[EUR/m2]	0,12	0,09	0,05	0,04
Improved comfort and services of buildings	[EUR/m2]	6,00	6,00	6,00	6,00



	Saved energy costs					
	Changing energy prices					
Year	Dormitory	Hospital	Kindergar	Office	0	0
0	-87,4	-107,6	-105,3	-108,7	0,0	0,0
1	10,6	7,5	3,8	3,0	0,0	0,0
2	11,0	8,0	4,0	3,2	0,0	0,0
3	11,2	8,3	4,1	3,3	0,0	0,0
4	11,5	8,6	4,2	3,4	0,0	0,0
5	11,8	8,9	4,3	3,5	0,0	0,0
6	12,1	9,2	4,4	3,6	0,0	0,0
7	12,4	9,6	4,5	3,7	0,0	0,0
8	12,7	10,0	4,6	3,8	0,0	0,0
9	13,0	10,3	4,7	4,0	0,0	0,0
10	13,3	10,7	4,9	4,1	0,0	0,0
11	13,6	11,1	5,0	4,2	0,0	0,0
12	14,0	11,5	5,1	4,3	0,0	0,0
13	14,3	12,0	5,3	4,5	0,0	0,0
14	14,7	12,4	5,4	4,6	0,0	0,0
15	15,1	12,9	5,5	4,8	0,0	0,0
16	15,5	13,4	5,7	4,9	0,0	0,0
17	15,9	14,0	5,9	5,1	0,0	0,0
18	16,3	14,5	6,0	5,3	0,0	0,0
19	16,7	15,1	6,2	5,4	0,0	0,0
20	17,2	15,7	6,4	5,6	0,0	0,0
21	17,6	16,3	6,6	5,8	0,0	0,0
22	18,1	17,0	6,7	6,0	0,0	0,0
23	18,6	17,7	6,9	6,2	0,0	0,0
24	19,2	18,4	7,2	6,5	0,0	0,0
25	19,7	19,1	7,4	6,7	0,0	0,0
26	20,3	19,9	7,6	6,9	0,0	0,0
27	20,8	20,7	7,8	7,2	0,0	0,0
28	21,4	21,6	8,1	7,4	0,0	0,0
29	22,1	22,5	8,3	7,7	0,0	0,0
30	22,7	23,4	8,6	8,0	0,0	0,0

	Cumulative cash flow					
	Changing energy prices					
Year	Dormitory	Hospital	Kindergar	Office	0	0
0	-87,4	-107,6	-105,3	-108,7	0,0	0,0
1	-76,8	-100,2	-101,4	-105,6	0,0	0,0
2	-65,8	-92,2	-97,5	-102,4	0,0	0,0
3	-54,5	-83,9	-93,4	-99,2	0,0	0,0
4	-43,0	-75,4	-89,2	-95,8	0,0	0,0
5	-31,3	-66,5	-84,9	-92,3	0,0	0,0
6	-19,2	-57,2	-80,5	-88,7	0,0	0,0
7	-6,8	-47,6	-76,0	-85,0	0,0	0,0
8	5,9	-37,7	-71,4	-81,1	0,0	0,0
9	18,8	-27,3	-66,7	-77,2	0,0	0,0
10	32,1	-16,6	-61,8	-73,1	0,0	0,0
11	45,8	-5,5	-56,8	-68,9	0,0	0,0
12	59,7	6,0	-51,7	-64,6	0,0	0,0
13	74,0	18,0	-46,4	-60,1	0,0	0,0
14	88,7	30,4	-41,0	-55,5	0,0	0,0
15	103,8	43,3	-35,5	-50,7	0,0	0,0
16	119,3	56,8	-29,8	-45,8	0,0	0,0
17	135,1	70,7	-23,9	-40,7	0,0	0,0
18	151,4	85,2	-17,9	-35,4	0,0	0,0
19	168,1	100,3	-11,7	-30,0	0,0	0,0
20	185,3	116,0	-5,3	-24,3	0,0	0,0
21	203,0	132,3	1,2	-18,5	0,0	0,0
22	221,1	149,3	8,0	-12,5	0,0	0,0
23	239,7	167,0	14,9	-6,2	0,0	0,0
24	258,9	185,3	22,1	0,2	0,0	0,0
25	278,6	204,4	29,4	6,9	0,0	0,0
26	298,9	224,4	37,0	13,8	0,0	0,0
27	319,7	245,1	44,9	21,0	0,0	0,0
28	341,1	266,7	52,9	28,4	0,0	0,0
29	363,2	289,1	61,2	36,2	0,0	0,0
30	386,0	312,5	69,8	44,1	0,0	0,0

Fig. Cost of energy conserved

		Dormitory	Hospital	Kindergar	Office		
Ranking of options		1	2	3	4		
Cost of en	[EUR/kW	0,1	0,1	0,2	0,2		
Final ener	[kWh/m2]	85,9	64,2	35,3	31,5		

Cost of energy conserved: Improvement 2, Climate zone B

	EUR/kWh	kWh/m2	
	y	x	
1	0,1	0,0	Dormitory
	0,1	85,9	
2	0,1	85,9	Hospital
	0,1	150,1	
3	0,2	150,1	Kindergarten
	0,2	185,4	
4	0,2	185,4	Office
	0,2	216,9	

Thermal efficiency retrofit of public buildings in Albania, analysis per m2

Improvement 2
Climate zone C

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerous benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price 2016 [EUR/kWh]	2030 [EUR/kWh]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity	0,104	0,160	0	1,0
Wood	0,024	0,037	0	0,2
LPG	0,061	0,247	227	1,1
Diesel oil	0,117	0,473	267	1,2
Solar	0,000	0,000	0	0,0

Financial analysis	**Units**	**Value**	**References**
Measure lifetime	[years]	30	
Discount rate	[%]	4%	
Annuity factor	[%]	6%	
Maintenance costs	[EUR/m2]	0,5	

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view

GDP increase	[EUR/EUR]	0,65				
direct	[EUR/EUR]	0,30				
multiplier effects	[EUR/EUR]	0,35				
Labour income	[EUR/EUR]	0,30				
direct	[EUR/EUR]	0,17				
multiplier effects	[EUR/EUR]	0,13				
Employment	[jobs/million EUR]	148				
direct	[jobs/million EUR]	85				
multiplier effects	[jobs/million EUR]	63				
Monetized CO2 emissions avoided	[EUR/tCO2]	5				
Air quality including health impacts	[EUR/MWh]	1,4				
Improved comfort and services of buildings refle	[% value]	2%	*Assumed estate value is	EUR	300	per m2

Summary of results

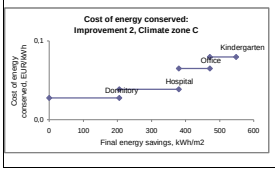
Investment and maintenance costs	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
Total	[EUR/m2]	**91**	**109**	**98**	**95**
Envelope cost	[EUR/m2]	20	24	30	27
HVAC system cost	[EUR/m2]	71	85	68	67
Maintenance cost	[EUR/m2-yr.]	0,5	0,5	0,5	0,5
Annualized total costs	[EUR/m2]	5,8	6,8	6,2	6,0
Cost of energy conserved (CEE)	[EUR/kWh]	0,0	0,0	0,1	0,1
Ranking of CEE		1	2	4	3

Energy/CO2 savings: improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
CO2 emissions	[gCO2/m2]	**17519**	**35489**	**3182**	**5983**
Electricity	[gCO2/m2]	0	0	0	0
Wood	[gCO2/m2]	0	0	0	0
LPG	[gCO2/m2]	-3144	0	152	-1133
Oil	[gCO2/m2]	20663	35489	3030	7117
Solar	[gCO2/m2]	0	0	0	0
Primary energy	[kWh/m2]	**134,2**	**173,8**	**41,5**	**50,1**
Electricity	[kWh/m2]	34,1	6,8	17,6	12,0
Wood	[kWh/m2]	22,4	7,5	9,6	11,6
LPG	[kWh/m2]	-15,2	0,0	0,7	-5,5
Oil	[kWh/m2]	92,9	159,5	13,6	32,0
Solar	[kWh/m2]	0,0	0,0	0,0	0,0
Final energy	[kWh/m2]	**205,3**	**174,9**	**76,5**	**91,6**
Electricity	[kWh/m2]	33,8	6,7	17,4	11,9
Wood	[kWh/m2]	112,2	37,6	48,0	58,2
LPG	[kWh/m2]	-13,8	0,0	0,7	-5,0
Oil	[kWh/m2]	77,4	132,9	11,3	26,7
Solar	[kWh/m2]	-4,3	-2,4	-0,9	-0,1

Saved energy costs / improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
Total over measure lifetime (NPV)	[EUR/m2]	**406,5**	**558,6**	**107,8**	**149,9**
Electricity	[EUR/m2]	72,7	14,5	37,4	25,5
Wood	[EUR/m2]	56,5	18,9	24,2	29,3
LPG	[EUR/m2]	-28,5	0,0	1,4	-10,3
Oil	[EUR/m2]	305,8	525,3	44,8	105,3
Solar	[EUR/m2]	0,0	0,0	0,0	0,0
Annual over measure lifetime	[EUR/m2]	**23,51**	**32,31**	**6,23**	**8,67**
Electricity	[EUR/m2]	4,20	0,84	2,16	1,48
Wood	[EUR/m2]	3,27	1,09	1,40	1,69
LPG	[EUR/m2]	-1,65	0,00	0,08	-0,59
Oil	[EUR/m2]	17,69	30,38	2,59	6,09
Solar	[EUR/m2]	0,00	0,00	0,00	0,00

Financial analysis / only saved energy	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
Simple payback	[years]	6,0	6,0	18,0	14,0
Internal rate of return	[%]	19,6%	20,7%	4,7%	7,5%
NPV	[EUR/m2]	303,5	432,3	9,5	53,0
Cost - benefit ratio		0,2	0,2	0,9	0,6

Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
GDP increase	[EUR/m2]	59,0	70,8	63,5	61,5
Labour income	[EUR/m2]	27,1	32,5	29,1	28,2
Annual employment	[jobs/m2]	0,01	0,02	0,01	0,01
Monetized CO2 emissions avoided	[EUR/m2]	0,09	0,18	0,02	0,03
Air quality including health impacts	[EUR/m2]	0,28	0,24	0,11	0,13
Improved comfort and services of buildings	[EUR/m2]	6,00	6,00	6,00	6,00



Saved energy costs
Changing energy prices

Year	Dormitory	Hospital	Kindergar	Office		
0	-90,9	-109,1	-97,9	-94,7	0,0	0,0
1	14,5	17,2	4,3	5,5	0,0	0,0
2	15,4	18,8	4,5	5,8	0,0	0,0
3	15,9	19,7	4,8	6,0	0,0	0,0
4	16,5	20,5	4,8	6,2	0,0	0,0
5	17,0	21,5	4,9	6,4	0,0	0,0
6	17,7	22,5	5,0	6,6	0,0	0,0
7	18,3	23,5	5,2	6,8	0,0	0,0
8	19,0	24,6	5,3	7,1	0,0	0,0
9	19,6	25,7	5,4	7,3	0,0	0,0
10	20,3	26,8	5,6	7,5	0,0	0,0
11	21,0	28,0	5,7	7,8	0,0	0,0
12	21,8	29,2	5,9	8,1	0,0	0,0
13	22,6	30,5	6,1	8,3	0,0	0,0
14	23,4	31,9	6,2	8,6	0,0	0,0
15	24,3	33,4	6,4	8,9	0,0	0,0
16	25,2	34,9	6,6	9,3	0,0	0,0
17	26,1	36,5	6,8	9,6	0,0	0,0
18	27,1	38,2	7,0	9,9	0,0	0,0
19	28,1	39,9	7,2	10,3	0,0	0,0
20	29,2	41,7	7,4	10,7	0,0	0,0
21	30,3	43,6	7,6	11,1	0,0	0,0
22	31,4	45,6	7,9	11,5	0,0	0,0
23	32,7	47,7	8,1	11,9	0,0	0,0
24	33,9	49,9	8,4	12,3	0,0	0,0
25	35,2	52,2	8,6	12,8	0,0	0,0
26	36,6	54,6	8,9	13,3	0,0	0,0
27	38,1	57,1	9,2	13,8	0,0	0,0
28	39,6	59,7	9,5	14,3	0,0	0,0
29	41,1	62,5	9,8	14,9	0,0	0,0
30	42,8	65,4	10,1	15,5	0,0	0,0

Cumulative cash flow
Changing energy prices

Year	Dormitory	Hospital	Kindergar	Office		
0	-90,9	-109,1	-97,9	-94,7	0,0	0,0
1	-76,4	-91,9	-93,5	-89,2	0,0	0,0
2	-61,0	-73,0	-89,0	-83,5	0,0	0,0
3	-45,1	-53,4	-84,4	-77,5	0,0	0,0
4	-28,6	-32,8	-79,6	-71,3	0,0	0,0
5	-11,6	-11,4	-74,7	-64,9	0,0	0,0
6	6,1	11,1	-69,7	-58,3	0,0	0,0
7	24,4	34,6	-64,5	-51,5	0,0	0,0
8	43,4	59,2	-59,2	-44,4	0,0	0,0
9	63,0	84,9	-53,8	-37,1	0,0	0,0
10	83,3	111,7	-48,2	-29,6	0,0	0,0
11	104,3	139,6	-42,4	-21,8	0,0	0,0
12	126,1	168,8	-36,5	-13,7	0,0	0,0
13	148,6	199,4	-30,5	-5,4	0,0	0,0
14	172,0	231,3	-24,2	3,3	0,0	0,0
15	196,3	264,7	-17,8	12,2	0,0	0,0
16	221,4	299,6	-11,2	21,4	0,0	0,0
17	247,5	336,1	-4,4	31,0	0,0	0,0
18	274,6	374,2	2,6	41,0	0,0	0,0
19	302,7	414,1	9,8	51,3	0,0	0,0
20	331,8	455,8	17,2	61,9	0,0	0,0
21	362,1	499,5	24,9	73,0	0,0	0,0
22	393,6	545,1	32,9	84,5	0,0	0,0
23	426,2	592,8	40,9	96,4	0,0	0,0
24	460,1	642,7	49,2	108,7	0,0	0,0
25	495,4	694,9	57,9	121,5	0,0	0,0
26	532,0	749,5	66,8	134,8	0,0	0,0
27	570,1	806,6	76,0	148,6	0,0	0,0
28	609,7	866,3	85,5	162,9	0,0	0,0
29	650,8	928,8	95,3	177,8	0,0	0,0
30	693,6	994,1	105,4	193,3	0,0	0,0

Fig. Cost of energy conserved

		Dormitory	Hospital	Kindergar	Office		
Ranking of options		1	2	4	3		
Cost of en	[EUR/kW	0,03	0,04	0,08	0,07		
Final ener	[kWh/m2]	205,3	174,9	76,5	91,6		

Cost of energy conserved: Improvement 2, Climate zone C

	EUR/kWh	kWh/m2	
	y	x	
1	0,03	0,0	Dormitory
	0,03	205,3	
2	0,04	205,3	Hospital
	0,04	380,1	
3	0,07	380,1	Office
	0,07	471,7	
4	0,08	471,7	Kindergarten
	0,08	548,2	

Estimate

Stock of public buildings: 2012		Dormitory	Hospital	Kindergarten	Office	School	University	Total
Sector		Education	Public health	Education		Education	Education	
Owned and occupied by government								
Central		x	x		x		x	
Municipal		x	x	x	x	x		
Retrofit need	[m2]	8.971	758.630	2.530.518	856.030	2.463.626	10.955	6.628.729
climate zone A	[m2]	5.254	424.273	1.482.059	448.201	1.442.882	6.416	3.809.084
climate zone B	[m2]	2.231	208.473	629.470	244.698	612.831	2.725	1.700.429
climate zone C	[m2]	1.485	125.883	418.989	163.132	407.913	1.814	1.119.216

Total area

	Tertiary buildings	Public buildings
	2012	2012
Hospitals	897900	758630
Offices	1397200	856030
Education	6382300	5014069

Stock of public buildings, 2012

	unit	total	climate zone 1	climate zone 2	climate zone 3
Hospitals	[number of buildin	1139	637	313	189
Offices	[number of buildin	1039	544	297	198
Education	[number of buildin	6408	3753	1594	1061
School	[number of buildin	3149			
Kindergarden	[number of buildin	3234			
Universities	[number of buildin	14			
Dormitories	[number of buildin	11			

Floor area of public buildings, 2012

	unit	total	climate zone 1	climate zone 2	climate zone 3
Hospitals	[m2]	758630	424273	208473	125883
Offices	[m2]	856030	448201	244698	163132
Education	[m2]	5014069	2936611	1247257	830201
School	[m2]	2463626	1442882	612831	407913
Kindergarden	[m2]	2530518	1482059	629470	418989
Universities and	[m2]	10955	6416	2725	1814
Dormitories	[m2]	8971	5254	2231	1485

Institutions of health

	2009	2010	2011	2012	2013
hospitals	44	44	44	44	44
number of healthc	2434	2448	2472	2460	2453
health centers	624	475	456	421	409
ambulances	1812	1927	1970	1946	1998
polyclinics	46	46	46	46	46
	2482	2448	2472	2413	2453
total healthcare fa	2434	2448	2472	2460	2453
growth rate of institutions of health		0,2%	0,2%	0,2%	0,2%

ref.: INSTAT. Albania in figures 2013

Educational institutions

		2010	2011	2012	2013	CAGR 2010-2013
pre-shool	total	1799	1907	1911	1900	1,4%
	private	80	146	133	127	12,2%
	public	1719	1761	1778	1773	0,8%
primary and lower	total	1496	1473	1472	1464	-0,5%
	private	140	132	126	127	-2,4%
	public	1356	1341	1346	1337	-0,4%
upper sec	total	508	507	511	512	0,2%
	private	124	124	126	126	0,4%
	public	384	383	385	386	0,1%
tertiary	total	41	54	58	58	9,1%
	private	30	43	44	44	10,0%
	public	11	11	14	14	6,2%
total	total	3844	3941	3952	3934	0,6%
	private	374	445	429	424	3,2%
	public	3470	3496	3523	3510	0,3%

ref.: INSTAT. Albania in figures 2013

INSTITUTIONS OF HEALTH

Hospitals	2009	2010	2011	2012	2013
Number of hospitals	**44**	**44**	**44**	**44**	**44**
Number of hospital beds	8.805	8.707	8.711	8.723	8.283
Hospitalized persons	**265.200**	**258.407**	**240.562**	**247.391**	**260.727**
Number of beds per 100 thousand inhabitants	300	300	300	300	290
Average length of stay (in days)	5,7	5,8	5,7	6,1	5,5
Days in bed realized (in thousands)	1.509	1.472	1.404	1.509	1.442
Bed occupancy (in days)	172	168	161	173	174
Number of institutions total:	**2.434**	**2.448**	**2.472**	**2.460**	**2.453**
– Health centers	624	475	456	421	409
– Ambulances	1.812	1.927	1.970	1.946	1.998
– Polyclinics	46	46	46	46	46
Total visits (in thousands)	**5.749**	**6.551**	**6.925**	**6.983**	**6.252**

Source: Ministry of Health

Institucione Shëndetësore	2009	2010	2011	2012	Health Institutions
Numri i institucioneve gjithsej:	**2.434**	**2.448**	**2472**	**2.460**	**Number of institutions total:**
– Qëndrat shëndetësore	316	475	456	421	– Health centers
– Ambulanca	1.772	1.927	1.970	1.992	– Ambulances
– Poliklinika	46	46	46	47	– Polyclinics
Vizita gjithsej (mijë)	**5.749**	**6.551**	**6.925**	**6.983**	**Total visits (thousands)**
Spitale					**Hospitals**
Numri i spitaleve	**44**	**44**	**44**	**44**	Number of hospitals
Numri i shtretërve spitalor	8.805	8.707	8392	8.410	Number of hospital beds
Të shtruar në spitale	**265.200**	**258.407**	**240.562**	**247.391**	Hospitalized persons.
Numri i shtretërve për 100 mijë banorë	276	273	311	299	Number of beds per 100 thousand inhabitants
Ditë qëndrimi mesatar	5,7	5,8	5,7	6,1	Average length of stay (in days)
Ditë-shtretër të realizuar (mijë)	1.509	1.472	1.404	1.509	Days in bed realized (thousands)
Shfrytëzimi i shtratit (mijë)	172	169	161	173	Bed occupancy (in days)
Xhiro e shtratit	30	29	29	29	Bed turn-over
Konsulteri i Gruas					**Women's Consultancy**
Konsultoreve	**2.016**	**1.945**	**2.077**	**2.072**	Women's consultation
		1.834	1.966	1.959	In rural
		306	318	294	Visit's in consultation (thousands)
		168	179	161	Visit's in consultation, rural (thousands)
					Children's Consultancy
		2.090	**2.142**	**2.113**	**Child consultations**
		144	150	149	Urban
		1.946	1.992	1.964	Rural
		1.012	992	973	Visit's in consultation (thousands)
		580	535	548	Visit's in consultation, rural (thousands)

50%

38%

11%

0,4%

Institucione arsimore
Educational institutions

Arsimi	10-11	11-12	12-13	13-14	Education
Gjithsej	**3.844**	**3.941**	**3.952**	**3.934**	**Total**
Kopshte	1.799	1.907	1.911	1.900	Pre-school
sektori privat	80	146	133	127	private sector
9 vjeçare	1.496	1.473	1.472	1.464	Primary & Lower sec.
sektori privat	140	132	126	127	private sector
I mesëm	508	507	511	512	Upper secondary
sektori privat	124	124	126	126	private sector
I larte	41	54	58	58	Tertiary
sektori privat	30	43	44	44	private sector

Energy prices

Assumptions

Energy prices

Energy source price

	Price	Unit	Year	
Electricity	0,102	[EUR/kWh]	2015	ERE. Online http://www.ere.gov.al/rub.php?idr=207&lang=2
Wood	35,5	[EUR/m3]	2011	GLOBAL GAZ Sh.a.: checked with policy-makers at the project workshop in July 2015
LPG	0,41	[EUR/liter]	2016	Global petrol prices. online. "Albania LPG Prices." http://www.globalpetrolprices.com/Albania/lpg_prices/
Oil	1,17	[EUR/liter]	2016	Global petrol prices. online. "Albania Diesel Oil Prices." http://www.globalpetrolprices.com/Albania/diesel_prices/
Solar	0			

Conversion

LPG		Diesel oil		Wood			
1915	liter/tonne	0,832	kg/liter	Total consumpt	Fuelwood	Pellets&Briquettes	
46	GJ/t	43,1	MJ/kg	1422007	1422063	14	m3
278	kWh/GJ	35,9	MJ/liter	7,6	7,4	0,19	PJ
7	kWh/liter	10,0	kWh/liter	1483	kWh/m3		

ref.: IEA. 2004. Energy Statistics Manual. Paq ref.: correspondence to Rodon

ref.: CRES, Quantos, Ipsos. 2012. Biomass consumption survey for energy purposes in the energy community. Albania. National Report.

Changing energy prices

			Electricity	Wood	LPG	Diesel oil	Solar energy		oil price change
0	2015	[EUR/kWh]	0,102	0,024			0,00		
1	2016	[EUR/kWh]	0,104	0,024	0,061	0,117	0,00		
2	2017	[EUR/kWh]	0,105	0,025	0,067	0,129	0,00		10%
3	2018	[EUR/kWh]	0,107	0,025	0,071	0,135	0,00		5%
4	2019	[EUR/kWh]	0,108	0,025	0,074	0,142	0,00		5%
5	2020	[EUR/kWh]	0,110	0,026	0,078	0,149	0,00		5%
6	2021	[EUR/kWh]	0,112	0,026	0,081	0,156	0,00		5%
7	2022	[EUR/kWh]	0,113	0,027	0,085	0,164	0,00		5%
8	2023	[EUR/kWh]	0,115	0,027	0,089	0,172	0,00		5%
9	2024	[EUR/kWh]	0,117	0,027	0,094	0,180	0,00		5%
10	2025	[EUR/kWh]	0,119	0,028	0,098	0,187	0,00		4%
11	2026	[EUR/kWh]	0,120	0,028	0,102	0,196	0,00		5%
12	2027	[EUR/kWh]	0,122	0,029	0,107	0,206	0,00		5%
13	2028	[EUR/kWh]	0,124	0,029	0,112	0,215	0,00		5%
14	2029	[EUR/kWh]	0,126	0,029	0,118	0,226	0,00		5%
15	2030	[EUR/kWh]	0,128	0,030	0,123	0,236	0,00		5%
16	2031	[EUR/kWh]	0,130	0,030	0,129	0,247	0,00		5%
17	2032	[EUR/kWh]	0,132	0,031	0,135	0,259	0,00		5%
18	2033	[EUR/kWh]	0,134	0,031	0,142	0,271	0,00		5%
19	2034	[EUR/kWh]	0,136	0,032	0,148	0,284	0,00		5%
20	2035	[EUR/kWh]	0,138	0,032	0,155	0,298	0,00		5%
21	2036	[EUR/kWh]	0,140	0,033	0,163	0,312	0,00		5%
22	2037	[EUR/kWh]	0,142	0,033	0,170	0,327	0,00		5%
23	2038	[EUR/kWh]	0,144	0,034	0,178	0,342	0,00		5%
24	2039	[EUR/kWh]	0,146	0,034	0,187	0,358	0,00		5%
25	2040	[EUR/kWh]	0,148	0,035	0,196	0,375	0,00		5%
26	2041	[EUR/kWh]	0,151	0,035	0,205	0,393	0,00		5%
27	2042	[EUR/kWh]	0,153	0,036	0,215	0,412	0,00		5%
28	2043	[EUR/kWh]	0,155	0,036	0,225	0,431	0,00		5%
29	2044	[EUR/kWh]	0,157	0,037	0,236	0,452	0,00		5%
30	2045	[EUR/kWh]	0,160	0,037	0,247	0,473	0,00		5%

Constant energy prices

			Electricity	Wood	LPG	Diesel oil	Solar energy
0	2015	[EUR/kWh]					
1	2016	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
2	2017	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
3	2018	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
4	2019	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
5	2020	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
6	2021	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
7	2022	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
8	2023	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
9	2024	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
10	2025	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
11	2026	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
12	2027	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
13	2028	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
14	2029	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
15	2030	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
16	2031	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
17	2032	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
18	2033	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
19	2034	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
20	2035	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
21	2036	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
22	2037	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
23	2038	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
24	2039	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
25	2040	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
26	2041	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
27	2042	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
28	2043	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
29	2044	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
30	2045	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000

electricity price forecast, EU

European Commission. 2013. EU energy, transport and GHG emissions trends to 2050. *reference scenario 2013*

	2010	2020	2025	2030
services, EU	0,15	0,19	0,19	0,19
growth rate		0,27	0,00	0,00

average support for renewable energy sources for electricity from end consumers (EUR/MWh)

		2015	2020	2025	2030
RES support	EUR-kWh	0,0005	0,009	0,0045	0,002

ref.: Szabo, Laszlo, Andras Mezosi, Zsuzsanna Pato, and Slobodan Markovic. 2015. "Support for Low-Emission Development in South Eastern Europe (SLED). Electricity Sector Modelling Assessm

electricity wholesale price forecast, Albania

		2015	2020	2025	2030
Prices	Baseload	65,1	46,7	54,8	57,9
EUR/MWh	Peakload	76,9	51,1	59,5	60,0
	Mix	68,7	48,0	56,2	58,6
	Trend		72%	117%	106%
			-6%	3%	1%

Note: in 2015, the wholesale price equals the household price, means it is suppressed

ref.: Szabo, Laszlo, Andras Mezosi, Zsuzsanna Pato, and Slobodan Markovic. 2015. "Support for Low-Emission Development in South Eastern Europe (SLED). Electricity Sector Modelling Assessment in Montenegro."

crude oil, avg spot (constant US dollar)

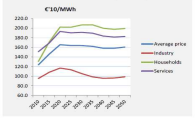
	unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
absolute value	$/bbl	98,1	90	48	38,1	45,7	47,9	50,2	52,6	55,2	57,9	60,7	63,6	66,3																				
annual growth	%/yr.		-8%	-47%	-21%	20%	5%	5%	5%	5%	5%	5%	5%	4%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%

ref.: World Bank Commodities Price Forecast (constant US dollars), Released: July 19, 2016.
http://www.worldbank.org/en/research/commodity-markets

World Bank Commodities Price Forecast (constant US dollars) — Released: April 19, 2016

Commodity	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Energy														
Coal, Australia	$/mt	79.7	66.2	54.4	46.5	46.6	46.8	47.0	47.3	47.5	47.6	47.8	48.0	48.1
Crude oil, avg, spot	$/bbl	98.1	90.9	48.0	38.1	45.7	47.9	50.2	52.6	55.2	57.9	60.7	63.6	66.3
Natural gas, Europe	$/mmbtu	11.1	9.5	6.9	4.2	4.4	4.6	4.8	5.1	5.3	5.6	5.8	6.1	6.4
Natural gas, US	$/mmbtu	3.5	4.1	2.5	2.3	2.7	3.1	3.3	3.4	3.5	3.6	3.7	3.9	4.0
Natural gas LNG, Japan	$/mmbtu	15.0	15.1	9.8	7.4	7.5	7.6	7.6	7.7	7.8	7.8	7.9	8.0	8.0

FIGURE 34: PRICE OF ELECTRICITY (PRE-TAX) BY SECTOR



ref.: Szabo, Laszlo, Andras Mezosi, Zsuzsanna Pato, and Slobodan Markovic. 2015. "Support for Low-Emission Development in South Eastern Europe (SLED). Electricity Sector Modelling Assessment in Montenegro."

version: 31.08.2015

					1	
			REF	REF	REF	REF
			2015	2020	2025	2030
AL	Prices	Baseload	65,1192	46,65187	54,81025	57,92356
		Peakload	76,91525	51,12438	59,47422	60,03272
	Generation mix, GWh	Total gene	3410,044	4508,702	5152,331	5648,524
		Nuclear	0	0	0	0
		Coal and li	0	0	0	0
		Natural gas	0	18,70527	41,09407	108,2827
		Hydro	3374,894	4354,943	4755,583	5078,831
		Wind	0	55,1869	114,9727	183,9563
		Biomass	32,79678	32,79678	161,2509	161,2509
		HFO, LFO	0	0	0	0
		PV	2,353491	47,06982	79,43032	116,2036
		Geotherma	0	0	0	0
		Net export	-4471,17	-4721,38	-5610,14	-6805,81
	Fuel consumption, TJ	Total consu	0	120,2482	262,1163	690,6752
		Coal and li	0	0	0	0
		Natural gas	0	120,2482	262,1163	690,6752
		HFO, LFO	0	0	0	0
	CO2 emission	Total emiss	0	6,712254	14,63133	38,55349
		Coal and li	0	0	0	0
		Natural gas	0	6,712254	14,63133	38,55349
		HFO, LFO	0	0	0	0
	Surplus	Consumer	25,60573	30,08003	35,0298	40,51806
		Producer	222181,8	208154,3	281272,6	321829
		Rent	17520,65	8350,113	3287,581	2781,752

Unit Euro/MWh

SLED 2

Planning an Energy Efficiency Program in Public Buildings of Albania

30 June 2016

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Thermal efficiency retrofit of public buildings in Albania

Contents

Assumptions

Country-wise analysis, improvement 1
Country-wise analysis, improvement 2

Analysis for municipalities in climate zone A
Analysis for municipalities in climate zone B
Analysis for municipalities in climate zone C

Analysis per m2, improvement 1, climate zone A
Analysis per m2, improvement 1, climate zone B
Analysis per m2, improvement 1, climate zone C
Analysis per m2, improvement 2, climate zone A
Analysis per m2, improvement 2, climate zone B
Analysis per m2, improvement 2, climate zone C

Thermal efficiency retrofit of public buildings in Albania, assumptions

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerious benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price			CO_2 emission factor	Primary-to-final energy factor
	2016 [EUR/kWh]	2045 [EUR/kWh]	nnual growth [%]	[gCO2/kWh]	[kWh/kWh]
Electricity	0,104	0,160	1,5%	0	1,0
Wood	0,024	0,037	1,5%	0	0,2
LPG	0,061	0,247	4,9%	227	1,1
Diesel oil	0,117	0,473	4,9%	267	1,2
Solar	0,000	0,000	N/A	0	0,0

Financial analysis

Measure lifetime	[years]	30
Discount rate	[%]	4%
Annuity factor	[%]	6%
Maintenance costs	[EUR/m2-yr.]	0,5

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view

GDP increase	[EUR/EUR]	0,65
direct	[EUR/EUR]	0,30
multiplier effects	[EUR/EUR]	0,35
Labour income	[EUR/EUR]	0,30
direct	[EUR/EUR]	0,17
multiplier effects	[EUR/EUR]	0,13
Annual employment	[jobs/million EUR]	148
Employment	[jobs/million EUR]	85
multiplier effects	[jobs/million EUR]	63
Monetized CO_2 emissions avoided	EUR/tCO2	5
Air quality including health impacts	EUR/MWh	1,38
Improved comfort and services of buildings refle	[% value]	2%

*Assumed estate value is EUR 300 per m2

Conversion units

GWh / 1 ktoe	11,63

Extra: in case if a credit line will be established

Capital structure		
Share of equity	[%]	0%
Share of debt	[%]	100%
Cost of capital		
Equity	[%]	14%
Public loan	[%]	0%
Commercial loan	[%]	8%
Debt payment period	[years]	10

Program budget

Program budget	million EUR	46,0
Other costs	million EUR	6,0
Budget excluding other costs	million EUR	40,0
Other costs as a share of the program budget	[%]	15%
Period of implementation	[years]	4,0

Thermal efficiency retrofit of public buildings in Albania, country-wide analysis

Improvement 1
Climate zone A, B, C

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerious benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price			CO_2 emission factor	Primary-to-final energy factor
	2016 [EUR/kWh]	2030 [EUR/kWh]	annual growth [%]	[gCO_2/kWh]	[kWh/kWh]
Electricity	0,104	0,160	1%	0	1,0
Wood	0,024	0,037	1%	0	0,2
LPG	0,061	0,247	5%	227	1,1
Diesel oil	0,117	0,473	5%	267	1,2
Solar	0,000	0,000	N/A	0	0,0

Financial analysis

Measure lifetime	[years]	30
Discount rate	[%]	4%
Annuity factor	[%]	6%
Maintenance costs	[EUR/m2-yr.]	0,5

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view

GDP increase	[EUR/EUR]	0,65
direct	[EUR/EUR]	0,30
multiplier effects	[EUR/EUR]	0,35
Labour income	[EUR/EUR]	0,30
direct	[EUR/EUR]	0,17
multiplier effects	[EUR/EUR]	0,13
Annual employment	[jobs/million EUR]	148
Employment	[jobs/million EUR]	85
multiplier effects	[jobs/million EUR]	63
Monetized CO_2 emissions avoided	EUR/tCO_2	5
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Improved comfort and services of buildings refle	[% value]	2%

*Assumed estate value is EUR 300 per m2

Conversion units

GWh / 1 ktoe		11,63

Extra: in case if a credit line will be established

Capital structure		
Share of equity	[%]	0%
Share of debt	[%]	100%
Cost of capital		
Equity	[%]	14%
Public loan	[%]	0%
Commercial loan	[%]	8%
Debt payment period	[years]	10

Program budget

Program budget	million EUR	46	
Other costs	million EUR	6	
Budget excluding other costs	million EUR	40	
Other costs as a share of the program budget	[%]	15%	
Period of implementation	[years]	4	

Building stock

Characteristics	Units	Dormitory	Hospital	Kindergarten	Office	School	University	
Sector		Education	Public health	Education	Other	Education	Education	
Governance level		Central Municipal	Central Municipal	Municipal	Central Municipal	Municipal	Central	
Stock	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Retrofit need	[thousand m2]	**9,0**	**759**	**2.531**	**856**	**2.464**	**11,0**	**6.629**
climate zone A	[thousand m2]	5,3	424	1.482	448	1.443	6,4	3.809
climate zone B	[thousand m2]	2,2	208	629	245	613	2,7	1.700
climate zone C	[thousand m2]	1,5	126	419	163	408	1,8	1.119

Program results

Stock retrofitted by the program	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Share of the need	[%/stock]	**0%**	**17%**	**17%**	**0%**	**0%**	**0%**	**8%**
climate zone A	[%/stock]	0%	0%	0%	0%	0%	0%	0%
climate zone B	[%/stock]	0%	0%	0%	0%	0%	0%	0%
climate zone C	[%/stock]	0%	100%	100%	0%	0%	0%	49%
Floor area	[thousand m2]	**-**	**126**	**419**	**-**	**-**	**-**	**545**
climate zone A	[thousand m2]	-	-	-	-	-	-	-
climate zone B	[thousand m2]	-	-	-	-	-	-	-
climate zone C	[thousand m2]	-	126	419	-	-	-	545
Investment and maintenance costs	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Investment cost, per m2	[EUR/m2]	**#DIV/0!**	**80**	**71**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**73**
climate zone A	[EUR/m2]	63	80	76	81	75	77	#DIV/0!
climate zone B	[EUR/m2]	63	80	76	81	75	77	#DIV/0!
climate zone C	[EUR/m2]	71	80	71	73	81	82	73

Maintenance cost, per m2	[EUR/m2-yr.]	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Costs of energy conserved	[EUR/kWh]	**#DIV/0!**	**0,08**	**0,09**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**0,09**
climate zone A	[EUR/kWh]	0,17	0,32	0,30	0,30	0,40	2,74	#DIV/0!
climate zone B	[EUR/kWh]	0,13	0,26	0,24	0,22	0,31	1,03	#DIV/0!
climate zone C	[EUR/kWh]	0,05	0,08	0,09	0,08	0,16	0,14	#DIV/0!
Investment cost, total	[million EUR]	**-**	**10**	**30**	**-**	**-**	**-**	**40**
climate zone A	[million EUR]	-	-	-	-	-	-	-
climate zone B	[million EUR]	-	-	-	-	-	-	-
climate zone C	[million EUR]	-	10,1	29,7	-	-	-	40

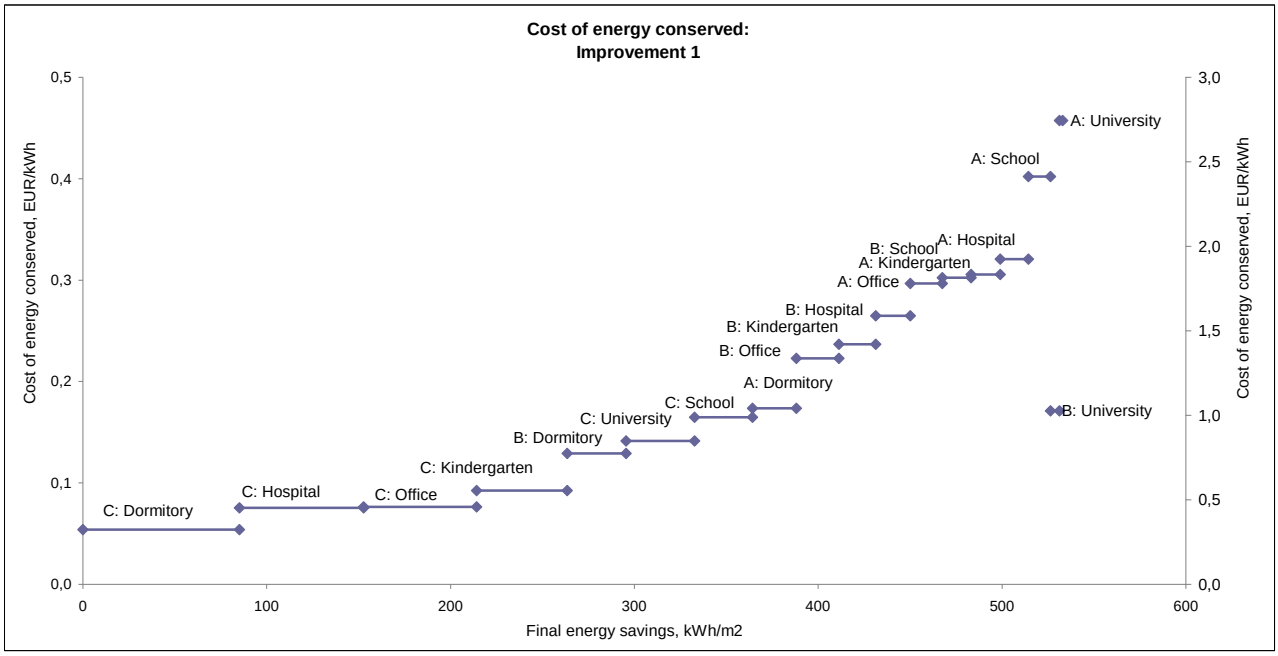
Energy/CO2 savings: improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total CO2	[gCO2/m2]	#DIV/0!	16.382	1.796	#DIV/0!	#DIV/0!	#DIV/0!	5.166
climate zone A	[gCO2/m2]	1.240	4.721	1.458	1.589	532	849	#DIV/0!
climate zone B	[gCO2/m2]	1.727	5.437	1.754	2.065	545	1.456	#DIV/0!
climate zone C	[gCO2/m2]	7.552	16.382	1.796	3.926	1.147	5.688	5.166
Total primary energy	[kWh/m2]	#DIV/0!	67	22	#DIV/0!	#DIV/0!	#DIV/0!	33
climate zone A	[kWh/m2]	26	20	18	16	12	2	#DIV/0!
climate zone B	[kWh/m2]	34	23	23	21	15	6	#DIV/0!
climate zone C	[kWh/m2]	52	67	22	33	18	25	33
Total final energy	[kWh/m2]	#DIV/0!	68	49	#DIV/0!	#DIV/0!	#DIV/0!	53
climate zone A	[kWh/m2]	24	15	16	17	12	2	#DIV/0!
climate zone B	[kWh/m2]	32	19	20	23	16	5	#DIV/0!
climate zone C	[kWh/m2]	85	68	49	62	31	37	53
			for the whole stock retrofitted					
Total CO2	[tCO2]	**-**	**2.062**	**753**	**-**	**-**	**-**	**2.815**
climate zone A	[tCO2]	-	-	-	-	-	-	-
climate zone B	[tCO2]	-	-	-	-	-	-	-
climate zone C	[tCO2]	-	2.062	753	-	-	-	2.815
Total primary energy	[GWh]	**0,0**	**8**	**9**	**0**	**0**	**0,0**	**18**
climate zone A	[GWh]	0,00	0	0	0	0	0,00	0
climate zone B	[GWh]	0,00	0	0	0	0	0,00	0
climate zone C	[GWh]	0,00	8	9	0	0	0,00	18
Total primary energy	[ktoe]	**0,00**	**0,72**	**0,80**	**0,00**	**0,00**	**0,00**	**1,53**
climate zone A	[ktoe]	0,00	0,00	0,00	0,00	0,00	0,00	0,00
climate zone B	[ktoe]	0,00	0,00	0,00	0,00	0,00	0,00	0,00
climate zone C	[ktoe]	0,00	0,72	0,80	0,00	0,00	0,00	1,53
Total final energy	[GWh]	**0,0**	**8**	**21**	**0**	**0**	**0,0**	**29**
climate zone A	[GWh]	0,0	0	0	0	0	0,0	0
climate zone B	[GWh]	0,0	0	0	0	0	0,0	0
climate zone C	[GWh]	0,0	8	21	0	0	0,0	29
Total final energy	[ktoe]	**0,00**	**0,73**	**1,77**	**0,00**	**0,00**	**0,00**	**2,50**
climate zone A	[ktoe]	0,00	0,00	0,00	0,00	0,00	0,00	0,00
climate zone B	[ktoe]	0,00	0,00	0,00	0,00	0,00	0,00	0,00
climate zone C	[ktoe]	0,00	0,73	1,77	0,00	0,00	0,00	2,50

Saved energy costs: improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Total over measure lifetime (NPV)	[EUR/m2]	**#DIV/0!**	**229,5**	**60,8**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**99,8**
climate zone A	[EUR/m2]	71,6	66,2	43,1	45,4	29,1	9,6	#DIV/0!
climate zone B	[EUR/m2]	94,1	78,3	54,5	60,3	36,3	20,3	#DIV/0!
climate zone C	[EUR/m2]	171,4	229,5	60,8	100,2	47,9	80,5	99,8
Annual over measure lifetime	[EUR/m2]	**#DIV/0!**	**13,27**	**3,52**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**5,77**
climate zone A	[EUR/m2]	4,1	3,8	2,5	2,6	1,7	0,6	#DIV/0!
climate zone B	[EUR/m2]	5,4	4,5	3,2	3,5	2,1	1,2	#DIV/0!
climate zone C	[EUR/m2]	9,9	13,3	3,5	5,8	2,8	4,7	5,8
Total over measure lifetime (NPV)	[million EUR]	**-**	**29**	**25**	**-**	**-**	**-**	**54**
climate zone A	[million EUR]	-	-	-	-	-	-	-
climate zone B	[million EUR]	-	-	-	-	-	-	-
climate zone C	[million EUR]	-	28,9	25,5	-	-	-	54
Annual over measure lifetime	[million EUR]	**-**	**2**	**1**	**0**	**0**	**-**	**3**
climate zone A	[million EUR]	-	-	-	-	-	-	-
climate zone B	[million EUR]	-	-	-	-	-	-	-
climate zone C	[million EUR]	-	1,7	1,5	-	-	-	3

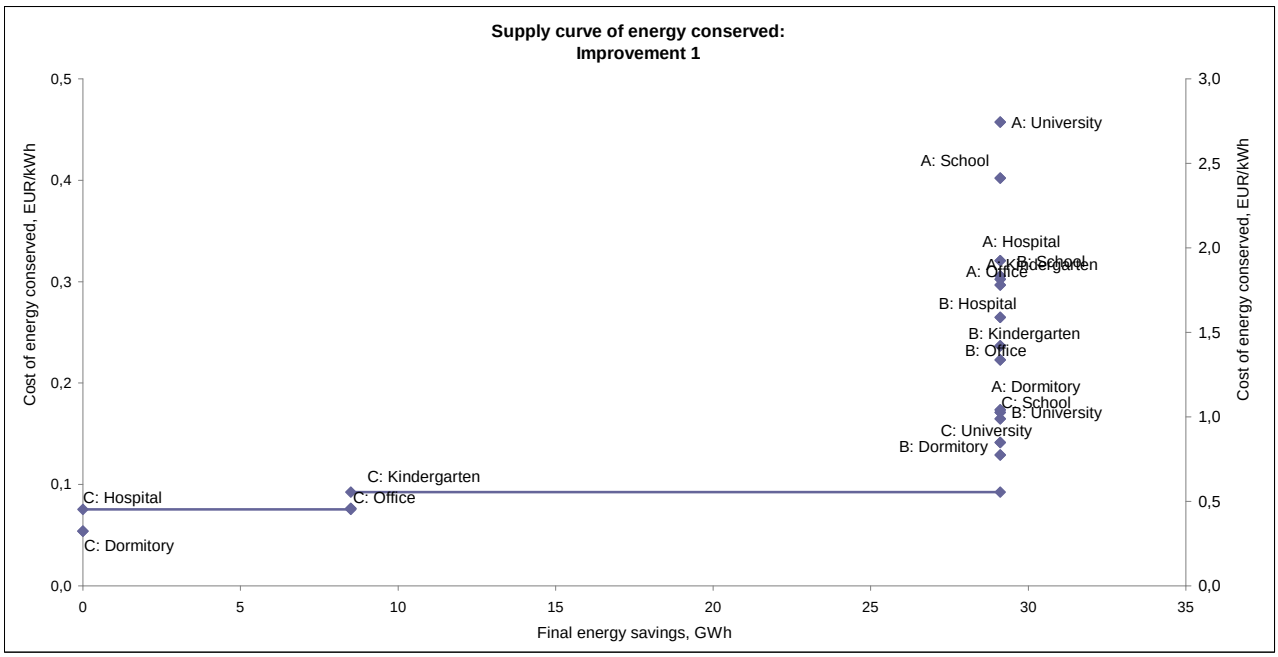
Financial analysis	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Simple payback	[years]	#DIV/0!	6	20	#DIV/0!	#DIV/0!	#DIV/0!	13
Internal rate of return	[%]	#NUM!	12,5%	3,0%	#NUM!	#NUM!	#NUM!	6,2%
NPV	[EUR/m2]	0,0	18,1	-4,1	0,0	0,0	0,0	14,0
Cost - benefit ratio		#DIV/0!	0,3	1,2	#DIV/0!	#DIV/0!	#DIV/0!	0,7

Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
GDP increase	[EUR/m2]	#DIV/0!	52	46	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Labour income	[EUR/m2]	#DIV/0!	24	21	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Employment	[jobs/m2]	#DIV/0!	0,01	0,01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Monetized CO2 emissions avoided	[EUR/m2]	#DIV/0!	0,08	0,01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Air quality including health impacts	[EUR/m2]	#DIV/0!	0,09	0,07	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Improved comfort and services of buildings	[EUR/m2]	6	6	6	6	6	6	6
			for the whole stock retrofitted					
GDP increase	[million EUR]	#DIV/0!	6,6	19,3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Labour income	[million EUR]	#DIV/0!	3,0	8,8	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Employment	[jobs]	#DIV/0!	1.490	4.383	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Monetized CO2 emissions avoided	[million EUR]	#DIV/0!	0,0	0,0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Air quality including health impacts	[million EUR]	#DIV/0!	0,0	0,0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Improved comfort and services of buildings	[million EUR]	0,0	0,8	2,5	0,0	0,0	0,0	3

Extra: in case if a credit line will be establish	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Cost of investors								
Debt service, annual over the loan repayment	[million EUR/yr.]	-	1	3	-	-	-	**4**
Cost of administrator (state)								
Costs of low interest rate, annual over the loar	[million EUR/yr.]	-	0,5	1,5	-	-	-	**2,0**
Technical assistance (energy audits, design, a	[million EUR]	-	1,5	4,5	-	-	-	**6**
Costs and benefits of commercial banks								
Provision of loans for investment costs	[million EUR]	0,00	10	30	-	-	-	**40**
Interest payments from investors	[million EUR]	0,00	-	-	-	-	-	**-**
Interest payments from the state	[million EUR]	-	5	15	-	-	-	**20**



Supply curve of energy conserved



Thermal efficiency retrofit of public buildings in Albania, country-wide analysis

Improvement 1
Climate zone A, B, C

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerious benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific		Energy source price			CO2 emission factor	Primary-to-final energy factor
		2016 [EUR/kWh]	2030 [EUR/kWh]	annual growth [%]	[gCO2/kWh]	[kWh/kWh]
Electricity		0,104	0,160	1%	0	1,0
Wood		0,024	0,037	1%	0	0,2
LPG		0,061	0,247	5%	227	1,1
Diesel oil		0,117	0,473	5%	267	1,2
Solar		0,000	0,000	N/A	0	0,0
Financial analysis						
Measure lifetime	[years]	30				
Discount rate	[%]	4%				
Annuity factor	[%]	6%				
Maintenance costs	[EUR/m2-yr.]	0,5				
Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view						
GDP increase	[EUR/EUR]	0,65				
direct	[EUR/EUR]	0,30				
multiplier effects	[EUR/EUR]	0,35				
Labour income	[EUR/EUR]	0,30				
direct	[EUR/EUR]	0,17				
multiplier effects	[EUR/EUR]	0,13				
Annual employment	[jobs/million EUR]	148				
Employment	[jobs/million EUR]	85				
multiplier effects	[jobs/million EUR]	63				
Monetized CO2 emissions avoided	EUR/tCO2	5				
Air quality including health impacts	EUR/MWh	1,38				
Improved comfort and services of buildings reflec	[% value]	2%	*Assumed estate value is	EUR 300	per m2	
Conversion units						
GWh / 1 ktoe		11,63				
Extra: in case if a credit line will be established						
Capital structure						
Share of equity	[%]	0%				
Share of debt	[%]	100%				
Cost of capital						
Equity	[%]	14%				
Public loan	[%]	0%				
Commercial loan	[%]	8%				
Debt payment period	[years]	10				
Program budget						
Program budget				million EUR	46	
Other costs				million EUR	6	
Budget excluding other costs				million EUR	40	
Other costs as a share of the program budget				[%]	15%	
Period of implementation				[years]	4	

Building stock

Characteristics	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	
Sector		Education	Public health	Education	Other	Education	Education	
Governance level		Central Municipal	Central Municipal	Municipal	Central Municipal	Municipal	Central	
Stock	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Retrofit need	[thousand m2]	**9,0**	**759**	**2.531**	**856**	**2.464**	**11,0**	**6.629**
climate zone A	[thousand m2]	5,3	424	1.482	448	1.443	6,4	3.809
climate zone B	[thousand m2]	2,2	208	629	245	613	2,7	1.700
climate zone C	[thousand m2]	1,5	126	419	163	408	1,8	1.119

Program results

Stock retrofitted by the program	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Share of the need	[%/stock]	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
climate zone A	[%/stock]	100%	100%	100%	100%	100%	100%	100%
climate zone B	[%/stock]	100%	100%	100%	100%	100%	100%	100%
climate zone C	[%/stock]	100%	100%	100%	100%	100%	100%	100%
Floor area	[thousand m2]	**9,0**	**759**	**2.531**	**856**	**2.464**	**11,0**	**6.629**
climate zone A	[thousand m2]	5,3	424	1.482	448	1.443	6,4	3.809
climate zone B	[thousand m2]	2,2	208	629	245	613	2,7	1.700
climate zone C	[thousand m2]	1,5	126	419	163	408	1,8	1.119
Investment and maintenance costs	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Investment cost, per m2	[EUR/m2]	**64**	**80**	**75**	**80**	**76**	**78**	**77**
climate zone A	[EUR/m2]	63	80	76	81	75	77	77
climate zone B	[EUR/m2]	63	80	76	81	75	77	77
climate zone C	[EUR/m2]	71	80	71	73	81	82	76
Maintenance cost, per m2	[EUR/m2-yr.]	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Costs of energy conserved	[EUR/kWh]	**0,12**	**0,21**	**0,22**	**0,19**	**0,30**	**0,60**	**0,23**
climate zone A	[EUR/kWh]	0,17	0,32	0,30	0,30	0,40	2,74	0,32
climate zone B	[EUR/kWh]	0,13	0,26	0,24	0,22	0,31	1,03	0,25
climate zone C	[EUR/kWh]	0,05	0,08	0,09	0,08	0,16	0,14	0,10
Investment cost, total	[million EUR]	**0,6**	**61**	**190**	**68**	**187**	**0,9**	**507**
climate zone A	[million EUR]	0,3	34,0	112,2	36,4	108,3	0,5	292
climate zone B	[million EUR]	0,1	16,7	47,7	19,9	46,0	0,2	131
climate zone C	[million EUR]	0,1	10,1	29,7	11,9	33,1	0,1	85

Energy/CO2 savings: improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total CO2	[gCO2/m2]	2.406	6.853	1.588	2.170	637	1.801	1.914
climate zone A	[gCO2/m2]	1.240	4.721	1.458	1.589	532	849	1.485
climate zone B	[gCO2/m2]	1.727	5.437	1.754	2.065	545	1.456	1.814
climate zone C	[gCO2/m2]	7.552	16.382	1.796	3.926	1.147	5.688	3.524
Total primary energy	[kWh/m2]	32	28	20	20	14	7	19
climate zone A	[kWh/m2]	26	20	18	16	12	2	16
climate zone B	[kWh/m2]	34	23	23	21	15	6	20
climate zone C	[kWh/m2]	52	67	22	33	18	25	27
Total final energy	[kWh/m2]	36	25	22	27	16	8	21
climate zone A	[kWh/m2]	24	15	16	17	12	2	14
climate zone B	[kWh/m2]	32	19	20	23	16	5	19
climate zone C	[kWh/m2]	85	68	49	62	31	37	47
			for the whole stock retrofitted					
Total CO2	[tCO2]	**22**	**5.199**	**4.018**	**1.858**	**1.570**	**20**	**12.685**
climate zone A	[tCO2]	7	2.003	2.161	712	768	5	5.656
climate zone B	[tCO2]	4	1.134	1.104	505	334	4	3.085
climate zone C	[tCO2]	11	2.062	753	641	468	10	3.945
Total primary energy	[GWh]	**0,3**	**22**	**51**	**17**	**34**	**0,1**	**124**
climate zone A	[GWh]	0,13	8	27	7	17	0,02	59
climate zone B	[GWh]	0,08	5	15	5	9	0,02	34
climate zone C	[GWh]	0,08	8	9	5	8	0,05	31
Total primary energy	[ktoe]	**0,02**	**1,86**	**4,37**	**1,50**	**2,89**	**0,01**	**10,64**
climate zone A	[ktoe]	0,01	0,71	2,32	0,60	1,46	0,00	5,10
climate zone B	[ktoe]	0,01	0,42	1,25	0,44	0,78	0,00	2,90
climate zone C	[ktoe]	0,01	0,72	0,80	0,46	0,65	0,00	2,65
Total final energy	[GWh]	**0,3**	**19**	**56**	**24**	**40**	**0,1**	**139**
climate zone A	[GWh]	0,1	7	23	8	17	0,0	55
climate zone B	[GWh]	0,1	4	13	6	10	0,0	32
climate zone C	[GWh]	0,1	8	21	10	13	0,1	52
Total final energy	[ktoe]	**0,03**	**1,63**	**4,85**	**2,02**	**3,43**	**0,01**	**11,96**
climate zone A	[ktoe]	0,01	0,56	1,99	0,67	1,49	0,00	4,72
climate zone B	[ktoe]	0,01	0,34	1,09	0,49	0,83	0,00	2,75
climate zone C	[ktoe]	0,01	0,73	1,77	0,86	1,10	0,01	4,49

Saved energy costs: improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Total over measure lifetime (NPV)	[EUR/m2]	**93,7**	**96,6**	**48,9**	**60,1**	**34,0**	**24,0**	**50,3**
climate zone A	[EUR/m2]	71,6	66,2	43,1	45,4	29,1	9,6	40,6
climate zone B	[EUR/m2]	94,1	78,3	54,5	60,3	36,3	20,3	51,7
climate zone C	[EUR/m2]	171,4	229,5	60,8	100,2	47,9	80,5	81,0
Annual over measure lifetime	[EUR/m2]	**5,42**	**5,59**	**2,83**	**3,48**	**1,97**	**1,39**	**2,91**
climate zone A	[EUR/m2]	4,1	3,8	2,5	2,6	1,7	0,6	2,3
climate zone B	[EUR/m2]	5,4	4,5	3,2	3,5	2,1	1,2	3,0
climate zone C	[EUR/m2]	9,9	13,3	3,5	5,8	2,8	4,7	4,7
Total over measure lifetime (NPV)	[million EUR]	**0,84**	**73**	**124**	**51**	**84**	**0,26**	**333**
climate zone A	[million EUR]	0,4	28,1	63,9	20,3	42,0	0,06	155
climate zone B	[million EUR]	0,2	16,3	34,3	14,8	22,2	0,06	88
climate zone C	[million EUR]	0,3	28,9	25,5	16,4	19,5	0,1	91
Annual over measure lifetime	[million EUR]	**0,05**	**4**	**7**	**3**	**5**	**0,02**	**19**
climate zone A	[million EUR]	0,02	1,6	3,7	1,2	2,4	0,00	9
climate zone B	[million EUR]	0,01	0,9	2,0	0,9	1,3	0,00	5
climate zone C	[million EUR]	0,01	1,7	1,5	0,9	1,1	0,01	5

Financial analysis	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Simple payback	[years]	12	14	27	23	n/a	n/a	26
Internal rate of return	[%]	6,9%	5,3%	1,2%	2,2%	-1,0%	#NUM!	1,3%
NPV	[EUR/m2]	0,3	12,1	-63,4	-16,0	-99,7	-0,6	-167,3
Cost - benefit ratio		0,7	0,8	1,5	1,3	2,2	3,3	1,5

Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
GDP increase	[EUR/m2]	42	52	49	52	49	51	50
Labour income	[EUR/m2]	19	24	22	24	23	23	23
Employment	[jobs/m2]	0,01	0,01	0,01	0,01	0,01	0,01	0,07
Monetized CO2 emissions avoided	[EUR/m2]	0,01	0,03	0,01	0,01	0,00	0,01	0
Air quality including health impacts	[EUR/m2]	0,05	0,03	0,03	0,04	0,02	0,01	0
Improved comfort and services of buildings	[EUR/m2]	6	6	6	6	6	6	6
			for the whole stock retrofitted					
GDP increase	[million EUR]	0,4	39,4	123,0	44,2	121,6	0,6	329
Labour income	[million EUR]	0,2	18,1	56,4	20,3	55,8	0,3	151
Employment	[jobs]	85	8.963	27.969	10.048	27.652	127	74.844
Monetized CO2 emissions avoided	[million EUR]	0,00	0,0	0,0	0,0	0,0	0,0	0
Air quality including health impacts	[million EUR]	0,0	0,0	0,1	0,0	0,1	0,0	0
Improved comfort and services of buildings	[million EUR]	0,1	4,6	15,2	5,1	14,8	0,1	40

Extra: in case if a credit line will be established	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Cost of investors								
Debt service, annual over the loan repayment pe	[million EUR/yr.]	0	6	19	7	19	0	**51**
Cost of administrator (state)								
Costs of low interest rate, annual over the loan r	[million EUR/yr.]	0,03	3,0	9,3	3,3	9,2	0,04	**24,9**
Technical assistance (energy audits, design, an	[million EUR]	0,1	9,1	28,4	10,2	28,1	0,1	**76**
Costs and benefits of commercial banks								
Provision of loans for investment costs	[million EUR]	0,58	61	190	68	187	1	**507**
Interest payments from investors	[million EUR]	0,00	-	-	-	-	-	-
Interest payments from the state	[million EUR]	0,3	30	93	33	92	0,4	**249**

- Loan Amount EUR 1
- Loan Tenor years 10
- Interest Rate % 8%
- Interest Rate, subsidized % 0%

municipalities without subsidized rate

	Debt Service			
	Interest I	Principa	Total Debt Service	
0				
1	0,08	0,07	0,15	
2	0,07	0,07	0,15	
3	0,07	0,08	0,15	
4	0,06	0,09	0,15	
5	0,06	0,09	0,15	
6	0,05	0,10	0,15	
7	0,04	0,11	0,15	
8	0,03	0,12	0,15	
9	0,02	0,13	0,15	
10	0,01	0,14	0,15	
	0,49		1,49	

municipalities with subsidized rate

	Debt Service			
	Interest Payment		Principa	Total Debt Service
0				
1	0,00		0,10	0,10
2	0,00		0,10	0,10
3	0,00		0,10	0,10
4	0,00		0,10	0,10
5	0,00		0,10	0,10
6	0,00		0,10	0,10
7	0,00		0,10	0,10
8	0,00		0,10	0,10
9	0,00		0,10	0,10
10	0,00		0,10	0,10
	0,00			1,00

	Saved energy costs						
	Changing energy prices						
Year	Dormitor	Hospital	Kindergar	Office	School	University	total
0	-0,6	-60,7	-189,6	-68,1	-187,4	-0,9	-507,3
1	0,033	2,112	4,973	1,909	3,557	0,007	12,6
2	0,034	2,338	5,182	2,016	3,677	0,008	13,3
3	0,035	2,456	5,318	2,079	3,760	0,009	13,7
4	0,036	2,580	5,459	2,146	3,846	0,009	14,1
5	0,037	2,709	5,604	2,214	3,935	0,010	14,5
6	0,039	2,850	5,757	2,287	4,028	0,010	15,0
7	0,040	2,995	5,915	2,363	4,123	0,011	15,4
8	0,041	3,147	6,078	2,441	4,221	0,011	15,9
9	0,042	3,303	6,246	2,522	4,322	0,012	16,4
10	0,043	3,449	6,406	2,599	4,419	0,012	16,8
11	0,044	3,619	6,585	2,685	4,526	0,013	17,5
12	0,046	3,797	6,770	2,775	4,636	0,014	18,0
13	0,047	3,984	6,962	2,869	4,749	0,014	18,6
14	0,049	4,179	7,161	2,967	4,867	0,015	19,2
15	0,050	4,384	7,367	3,068	4,988	0,016	19,9
16	0,052	4,599	7,582	3,174	5,113	0,017	20,5
17	0,053	4,824	7,804	3,285	5,243	0,017	21,2
18	0,055	5,059	8,035	3,400	5,377	0,018	21,9
19	0,057	5,306	8,275	3,520	5,516	0,019	22,7
20	0,059	5,565	8,524	3,645	5,660	0,020	23,5
21	0,060	5,836	8,783	3,775	5,809	0,021	24,3
22	0,062	6,121	9,052	3,911	5,963	0,022	25,1
23	0,064	6,418	9,331	4,052	6,122	0,023	26,0
24	0,067	6,730	9,621	4,200	6,287	0,024	26,9
25	0,069	7,057	9,923	4,354	6,459	0,026	27,9
26	0,071	7,400	10,237	4,514	6,636	0,027	28,9
27	0,074	7,759	10,563	4,682	6,820	0,028	29,9
28	0,076	8,135	10,902	4,856	7,010	0,030	31,0
29	0,079	8,529	11,256	5,039	7,208	0,031	32,1
30	0,081	8,941	11,623	5,229	7,413	0,032	33,3

Fig. Cost of energy conserved

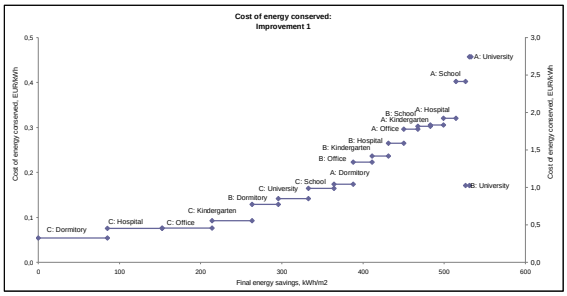
	A: Dormit	A: Hospit	A: Kinder	A: Office	A: School	A: Univers	B: Dormit	B: Hospit	B: Kinder	B: Office	B: School	B: Univers	C: Dormit	C: Hospit	C: Kinder	C: Office	C: School	C: University
Ranking of options	8	15	13	12	16	18	5	11	10	9	14	17	1	2	4	3	7	6
Cost of en	EUR/kWh	0,2	0,3	0,3	0,2	0,4	2,7	0,1	0,3	0,2	0,2	0,3	1,0	0,08	0,1	0,1	0,1	0,2	0,1
Final ener	kWh/m2	23,9	15,3	15,6	17,4	12,0	1,8	32,1	18,7	20,1	23,2	15,8	4,9	85,2	67,5	49,2	61,5	31,5	37,2
Final ener	GWh	0,1	6,5	23,1	7,8	17,4	0,0	0,1	3,9	12,6	5,7	9,7	0,0	0,1	8,5	20,6	10,0	12,8	0,1

Cost of energy conserved: Improvement 1

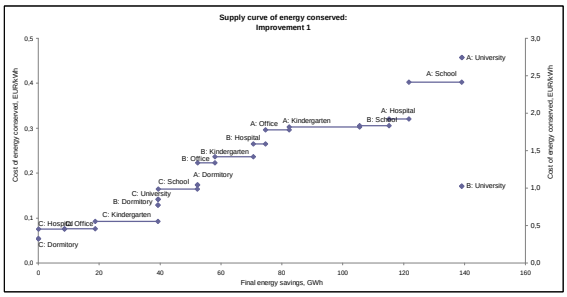
	EUR/kWh	kWh/m2	
	y	x	
1	0,05	0,0	C: Dormitory
	0,05	85,2	

Supply curve of energy conserved: Improvement 1

	EUR/kWh	GWh	
	y	x	
1	0,05	0,0	C: Dormitory
	0,05	0,1	



Supply curve of energy conserved



2	0,08	85,2	C: Hospital
	0,08	152,7	
3	0,08	152,7	C: Office
	0,08	214,2	
4	0,09	214,2	C: Kindergarten
	0,09	263,4	
5	0,13	263,4	B: Dormitory
	0,13	295,5	
6	0,14	295,5	C: University
	0,14	332,7	
7	0,16	332,7	C: School
	0,16	364,2	
8	0,17	364,2	A: Dormitory
	0,17	388,1	
9	0,22	388,1	B: Office
	0,22	411,3	
10	0,24	411,3	B: Kindergarten
	0,24	431,4	
11	0,26	431,4	B: Hospital
	0,26	450,1	
12	0,30	450,1	A: Office
	0,30	467,5	
13	0,30	467,5	A: Kindergarten
	0,30	483,1	
14	0,31	483,1	B: School
	0,31	499,0	
15	0,32	499,0	A: Hospital
	0,32	514,3	
16	0,40	514,3	A: School
	0,40	526,3	
17	1,03	526,3	B: University
	1,03	531,2	
18	2,74	531,2	A: University
	2,74	533,0	

2	0,08	0,1	C: Hospital
	0,08	8,6	
3	0,08	8,6	C: Office
	0,08	18,7	
4	0,09	18,7	C: Kindergarten
	0,09	39,3	
5	0,13	39,3	B: Dormitory
	0,13	39,3	
6	0,14	39,3	C: University
	0,14	39,4	
7	0,16	39,4	C: School
	0,16	52,2	
8	0,17	52,2	A: Dormitory
	0,17	52,4	
9	0,22	52,4	B: Office
	0,22	58,1	
10	0,24	58,1	B: Kindergarten
	0,24	70,7	
11	0,26	70,7	B: Hospital
	0,26	74,6	
12	0,30	74,6	A: Office
	0,30	82,4	
13	0,30	82,4	A: Kindergarten
	0,30	105,5	
14	0,31	105,5	B: School
	0,31	115,2	
15	0,32	115,2	A: Hospital
	0,32	121,7	
16	0,40	121,74	A: School
	0,40	139,11	
17	1,03	139,11	B: University
	1,03	139,12	
18	2,74	139,12	A: University
	2,74	139,14	

Thermal efficiency retrofit of public buildings in Albania, country-wide analysis

Improvement 2
Climate zone A, B, C

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerious benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific		Energy source price			CO2 emission factor	Primary-to-final energy factor
		2016 [EUR/kWh]	2030 [EUR/kWh]	annual growth [%]	[gCO2/kWh]	[kWh/kWh]
Electricity		0,104	0,160	1%	0	1,0
Wood		0,024	0,037	1%	0	0,2
LPG		0,061	0,247	5%	227	1,1
Diesel oil		0,117	0,473	5%	267	1,2
Solar		0,000	0,000	N/A	0	0,0
Financial analysis						
Measure lifetime	[years]	30				
Discount rate	[%]	4%				
Annuity factor	[%]	6%				
Maintenance costs	[EUR/m2-yr.]	0,5				
Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view						
GDP increase	[EUR/EUR]	0,65				
direct	[EUR/EUR]	0,30				
multiplier effects	[EUR/EUR]	0,35				
Labour income	[EUR/EUR]	0,30				
direct	[EUR/EUR]	0,17				
multiplier effects	[EUR/EUR]	0,13				
Annual employment	[jobs/million EUR]	148				
Employment	[jobs/million EUR]	85				
multiplier effects	[jobs/million EUR]	63				
Monetized CO2 emissions avoided	EUR/tCO2	5				
Air quality including health impacts	EUR/MWh	1,38				
Improved comfort and services of buildings reflec	[% value]	2%	*Assumed estate value is	EUR 300	per m2	
Conversion units						
GWh / 1 ktoe		11,63				
Extra: in case if a credit line will be established						
Capital structure						
Share of equity	[%]	0%				
Shae of debt	[%]	100%				
Cost of capital						
Equity	[%]	14%				
Public loan	[%]	0%				
Commercial loan	[%]	8%				
Debt payment period	[years]	10				
Program budget						
Program budget				million EUR	46	
Other costs				million EUR	6	
Budget excluding other costs				million EUR	40	
Other costs as a share of the program budget				[%]	15%	
Period of implementation				[years]	4	

Building stock

Characteristics	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	
Sector		Education	Public health	Education	Other	Education	Education	
Governance level		Central	Central		Central	Central		
		Municipal	Municipal	Municipal	Municipal	Municipal		
Stock	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Retrofit need	[thousand m2]	**9,0**	**759**	**2.531**	**856**	**2.464**	**11,0**	**6.629**
climate zone A	[thousand m2]	5,3	424	1.482	448	1.443	6,4	3.809
climate zone B	[thousand m2]	2,2	208	629	245	613	2,7	1.700
climate zone C	[thousand m2]	1,5	126	419	163	408	1,8	1.119

Program results

Stock retrofitted by the program	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Share of the need	[%/stock]	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
climate zone A	[%/stock]	100%	100%	100%	100%	100%	100%	100%
climate zone B	[%/stock]	100%	100%	100%	100%	100%	100%	100%
climate zone C	[%/stock]	100%	100%	100%	100%	100%	100%	100%
Floor area	[thousand m2]	**9,0**	**759**	**2.531**	**856**	**2.464**	**11,0**	**6.629**
climate zone A	[thousand m2]	5,3	424	1.482	448	1.443	6,4	3.809
climate zone B	[thousand m2]	2,2	208	629	245	613	2,7	1.700
climate zone C	[thousand m2]	1,5	126	419	163	408	1,8	1.119
Investment and maintenance costs	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Investment cost, per m2	[EUR/m2]	**88**	**108**	**104**	**106**	**0**	**0**	**66**
climate zone A	[EUR/m2]	87	108	105	109			66
climate zone B	[EUR/m2]	87	108	105	109			68
climate zone C	[EUR/m2]	91	109	98	95			63
Maintenance cost, per m2	[EUR/m2-yr.]	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Costs of energy conserved	[EUR/kWh]	**0,15**	**0,16**	**0,22**	**0,22**	**#DIV/0!**	**#DIV/0!**	**0,21**
climate zone A	[EUR/kWh]	0,17	0,21	0,28	0,35			0,28
climate zone B	[EUR/kWh]	0,15	0,18	0,23	0,29			0,23
climate zone C	[EUR/kWh]	0,07	0,08	0,10	0,09			0,09
Investment cost, total	[million EUR]	**0,8**	**82**	**263**	**91**			**437**
climate zone A	[million EUR]	0,5	45,7	156,0	48,7			251
climate zone B	[million EUR]	0,2	22,4	66,3	26,6			115
climate zone C	[million EUR]	0,1	13,7	41,0	15,5			70

Energy/CO2 savings: improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total CO2	[gCO2/m2]	2.171	8.928	2.038	2.284			2.098
climate zone A	[gCO2/m2]	1.090	6.110	1.851	1.574			1.587
climate zone B	[gCO2/m2]	1.467	7.160	2.224	2.065			2.000
climate zone C	[gCO2/m2]	7.055	21.356	2.420	4.562			3.982
Total primary energy	[kWh/m2]	43	50	29	23			29
climate zone A	[kWh/m2]	37	37	26	18			16
climate zone B	[kWh/m2]	45	44	32	21			20
climate zone C	[kWh/m2]	61	101	33	39			30
Total final energy	[kWh/m2]	38	41	30	30			29
climate zone A	[kWh/m2]	28	30	23	19			15
climate zone B	[kWh/m2]	34	36	28	23			18
climate zone C	[kWh/m2]	83	86	59	70			42
			for the whole stock retrofitted					
Total CO2	[tCO2]	**19**	**6.773**	**5.157**	**1.955**			**13.904**
climate zone A	[tCO2]	6	2.592	2.743	705			6.046
climate zone B	[tCO2]	3	1.493	1.400	505			3.401
climate zone C	[tCO2]	10	2.688	1.014	744			4.457
Total primary energy	[GWh]	**0,4**	**38**	**73**	**19**			**130**
climate zone A	[GWh]	0,19	16	39	8			63
climate zone B	[GWh]	0,10	9	20	5			34
climate zone C	[GWh]	0,09	13	14	6			33
Total primary energy	[ktoe]	**0,03**	**3,24**	**6,24**	**1,67**			**11,19**
climate zone A	[ktoe]	0,02	1,36	3,32	0,69			5,40
climate zone B	[ktoe]	0,01	0,78	1,72	0,44			2,95
climate zone C	[ktoe]	0,01	1,09	1,20	0,54			2,84
Total final energy	[GWh]	**0,3**	**31**	**76**	**26**			**133**
climate zone A	[GWh]	0,1	13	34	9			55
climate zone B	[GWh]	0,1	7	17	6			31
climate zone C	[GWh]	0,1	11	25	11			47
Total final energy	[ktoe]	**0,03**	**2,67**	**6,54**	**2,21**			**11,45**
climate zone A	[ktoe]	0,01	1,11	2,89	0,75			4,76
climate zone B	[ktoe]	0,01	0,64	1,50	0,49			2,64
climate zone C	[ktoe]	0,01	0,93	2,14	0,98			4,05

Saved energy costs: improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Total over measure lifetime (NPV)	[EUR/m2]	**116,7**	**152,4**	**69,7**	**66,0**			**52,7**
climate zone A	[EUR/m2]	96,0	111,6	62,4	50,6			42,8
climate zone B	[EUR/m2]	116,8	130,3	75,9	60,3			52,8
climate zone C	[EUR/m2]	189,9	326,4	86,3	116,9			86,3
Annual over measure lifetime	[EUR/m2]	**6,75**	**8,81**	**4,03**	**3,82**			**3,05**
climate zone A	[EUR/m2]	5,5	6,5	3,6	2,9			2,5
climate zone B	[EUR/m2]	6,8	7,5	4,4	3,5			3,1
climate zone C	[EUR/m2]	11,0	18,9	5,0	6,8			5,0
Total over measure lifetime (NPV)	[million EUR]	**1,05**	**116**	**176**	**57**			**349**
climate zone A	[million EUR]	0,5	47,3	92,4	22,7			163
climate zone B	[million EUR]	0,3	27,2	47,8	14,8			90
climate zone C	[million EUR]	0,3	41,1	36,2	19,1			97
Annual over measure lifetime	[million EUR]	**0,06**	**7**	**10**	**3**			**20**
climate zone A	[million EUR]	0,03	2,7	5,3	1,3			9
climate zone B	[million EUR]	0,02	1,6	2,8	0,9			5
climate zone C	[million EUR]	0,02	2,4	2,1	1,1			6

Financial analysis	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Simple payback	[years]	13	12	26	28			22
Internal rate of return	[%]	4,5%	3,3%	-0,7%	0,5%			2,2%
NPV	[EUR/m2]	0,0	-8,2	-134,3	-37,8			-99,4
Cost - benefit ratio		0,9	1,1	2,1	1,8			1,3

Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
GDP increase	[EUR/m2]	57	70	68	69			43
Labour income	[EUR/m2]	26	32	31	32			20
Employment	[jobs/m2]	0,01	0,02	0,02	0,02			0,06
Monetized CO2 emissions avoided	[EUR/m2]	0,01	0,04	0,01	0,01			0
Air quality including health impacts	[EUR/m2]	0,05	0,06	0,04	0,04			0
Improved comfort and services of buildings	[EUR/m2]	6	6	6	6			4
			for the whole stock retrofitted					
GDP increase	[million EUR]	0,5	53,1	170,8	58,9			283
Labour income	[million EUR]	0,2	24,4	78,4	27,0			130
Employment	[jobs]	116	12.075	38.844	13.388			64.423
Monetized CO2 emissions avoided	[million EUR]	0,00	0,0	0,0	0,0			0
Air quality including health impacts	[million EUR]	0,0	0,0	0,1	0,0			0
Improved comfort and services of buildings	[million EUR]	0,1	4,6	15,2	5,1			25

Extra: in case if a credit line will be established	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Cost of investors								
Debt service, annual over the loan repayment pe	[million EUR/yr.]	0	8	26	9			**44**
Cost of administrator (state)								
Costs of low interest rate, annual over the loan r	[million EUR/yr.]	0,04	4,0	12,9	4,4			**21,4**
Technical assistance (energy audits, design, arr	[million EUR]	0,1	12,3	39,5	13,6			**66**
Costs and benefits of commercial banks								
Provision of loans for investment costs	[million EUR]	0,79	82	263	91			**437**
Interest payments from investors	[million EUR]	0,00	-	-	-			**-**
Interest payments from the state	[million EUR]	0,4	40	129	44			**214**

- Loan Amount EUR 1
- Loan Tenor years 10
- Interest Rate % 8%
- Interest Rate, subsidized % 0%

municipalities without subsidized rate

	Debt Service			
	Interest I	Principa	Total Debt Service	
0				
1	0,08	0,07	0,15	
2	0,07	0,07	0,15	
3	0,07	0,08	0,15	
4	0,06	0,09	0,15	
5	0,06	0,09	0,15	
6	0,05	0,10	0,15	
7	0,04	0,11	0,15	
8	0,03	0,12	0,15	
9	0,02	0,13	0,15	
10	0,01	0,14	0,15	
	0,49		1,49	

municipalities with subsidized rate

	Debt Service			
	Interest Payment		Principa	Total Debt Service
0				
1	0,00		0,10	0,10
2	0,00		0,10	0,10
3	0,00		0,10	0,10
4	0,00		0,10	0,10
5	0,00		0,10	0,10
6	0,00		0,10	0,10
7	0,00		0,10	0,10
8	0,00		0,10	0,10
9	0,00		0,10	0,10
10	0,00		0,10	0,10
	0,00			1,00

	Saved energy costs						
	Changing energy prices						
Year	Dormitory	Hospital	Kindergar	Office	School	University	total
0	-0,8	-81,8	-263,3	-90,7	0,0	0,0	-436,7
1	0,033	2,112	4,973	1,909	3,557	0,007	12,6
2	0,034	2,336	5,182	2,016	3,677	0,008	13,3
3	0,035	2,456	5,318	2,079	3,760	0,009	13,7
4	0,036	2,580	5,459	2,146	3,846	0,009	14,1
5	0,037	2,709	5,604	2,214	3,935	0,010	14,5
6	0,039	2,850	5,757	2,287	4,028	0,010	15,0
7	0,040	2,995	5,916	2,363	4,123	0,011	15,4
8	0,041	3,147	6,078	2,441	4,221	0,011	15,9
9	0,042	3,303	6,246	2,522	4,322	0,012	16,4
10	0,043	3,449	6,406	2,599	4,419	0,012	16,8
11	0,044	3,619	6,585	2,685	4,526	0,013	17,5
12	0,046	3,797	6,770	2,775	4,636	0,014	18,0
13	0,047	3,984	6,962	2,869	4,749	0,014	18,6
14	0,049	4,179	7,161	2,967	4,867	0,015	19,2
15	0,050	4,384	7,367	3,068	4,988	0,016	19,9
16	0,052	4,599	7,582	3,174	5,113	0,017	20,5
17	0,053	4,824	7,804	3,285	5,243	0,017	21,2
18	0,055	5,059	8,035	3,400	5,377	0,018	21,9
19	0,057	5,306	8,275	3,520	5,516	0,019	22,7
20	0,059	5,565	8,524	3,645	5,660	0,020	23,5
21	0,060	5,836	8,783	3,775	5,809	0,021	24,3
22	0,062	6,121	9,052	3,911	5,963	0,022	25,1
23	0,064	6,418	9,331	4,052	6,122	0,023	26,0
24	0,067	6,730	9,621	4,200	6,287	0,024	26,9
25	0,069	7,057	9,923	4,354	6,459	0,026	27,9
26	0,071	7,400	10,237	4,514	6,636	0,027	28,9
27	0,074	7,759	10,563	4,682	6,820	0,028	29,9
28	0,076	8,135	10,902	4,856	7,010	0,030	31,0
29	0,079	8,529	11,256	5,039	7,208	0,031	32,1
30	0,081	8,941	11,623	5,229	7,413	0,032	33,3

Fig. Cost of energy conserved

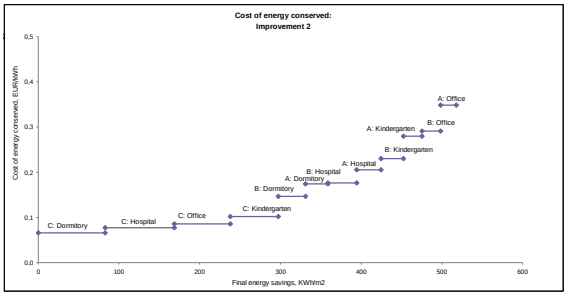
	A: Dormit	A: Hospit	A: Kinder	A: Office	A: School	A: Univers	B: Dormit	B: Hospit	B: Kinder	B: Office	B: School	B: Univers	C: Dormit	C: Hospit	C: Kinder	C: Office	C: School	C: University
Ranking of options	8	9	10	12			5	7	9	11			1	2	4	3		
Cost of en	EUR/kWh	0,2	0,2	0,3	0,2			0,1	0,2	0,2	0,3			0,07	0,1	0,1	0,1	
Final ener	kWh/m2	27,5	30,4	22,7	19,3			33,6	35,8	27,8	23,2			83,1	85,5	59,4	69,5	
Final ener	GWh	0,1	12,9	33,6	8,7			0,1	7,5	17,5	5,7			0,1	10,8	24,9	11,3	

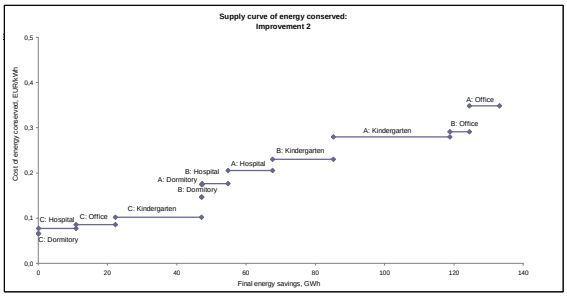
Cost of energy conserved: Improvement 2

	EUR/kWh	kWh/m2	
	y	x	
1	0,07	0,0	C: Dormitory
	0,07	83,1	

Supply curve of energy conserved: Improvement 2

	EUR/kWh	kWh/m2	
	y	x	
1	0,07	0,0	C: Dormitory
	0,07	0,1	





2	0,08	83,1	C: Hospital
	0,08	168,6	
3	0,09	168,6	C: Office
	0,09	238,1	
4	0,10	238,1	C: Kindergarten
	0,10	297,6	
5	0,15	297,6	B: Dormitory
	0,15	331,2	
6	0,17	331,2	A: Dormitory
	0,17	358,7	
7	0,18	358,7	B: Hospital
	0,18	394,5	
8	0,21	394,5	A: Hospital
	0,21	424,8	
9	0,23	424,8	B: Kindergarten
	0,23	452,6	
10	0,28	452,6	A: Kindergarten
	0,28	475,3	
11	0,29	475,3	B: Office
	0,29	498,5	
12	0,35	498,5	A: Office
	0,35	517,9	

2	0,08	0,1	C: Hospital
	0,08	10,9	
3	0,09	10,9	C: Office
	0,09	22,2	
4	0,10	22,2	C: Kindergarten
	0,10	47,1	
5	0,15	47,1	B: Dormitory
	0,15	47,2	
6	0,17	47,2	A: Dormitory
	0,17	47,4	
7	0,18	47,4	B: Hospital
	0,18	54,8	
8	0,21	54,8	A: Hospital
	0,21	67,7	
9	0,23	67,7	B: Kindergarten
	0,23	85,2	
10	0,28	85,2	A: Kindergarten
	0,28	118,8	
11	0,29	118,8	B: Office
	0,29	124,5	
12	0,35	124,5	A: Office
	0,35	133,2	

Thermal efficiency retrofit of public buildings in Albania, analysis for municipalities by climate zone

Improvement 1 & 2
Climate zone A

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerious benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price 2016 [EUR/kWh]	Energy source price 2030 [EUR/kWh]	annual growth [%]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity	0,104	0,160	1%	0	1,0
Wood	0,024	0,037	1%	0	0,2
LPG	0,061	0,247	5%	227	1,1
Diesel oil	0,117	0,473	5%	267	1,2
Solar	0,000	0,000	N/A	0	0,0

Financial analysis

Measure lifetime	[years]	30
Discount rate	[%]	4%
Annuity factor	[%]	6%
Maintenance costs	[EUR/m2-yr.]	0,5

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view

GDP increase	[EUR/EUR]	0,65
direct	[EUR/EUR]	0,30
multiplier effects	[EUR/EUR]	0,35
Labour income	[EUR/EUR]	0,30
direct	[EUR/EUR]	0,17
multiplier effects	[EUR/EUR]	0,13
Annual employment	[jobs/million EUR]	148
Employment	[jobs/million EUR]	85
multiplier effects	[jobs/million EUR]	63
Monetized CO2 emissions avoided	EUR/tCO2	5
Air quality including health impacts	EUR/MWh	1,38
Improved comfort and services of buildings reflec	[% value]	2% *Assumed estate value is EUR 300 per m2

Conversion units

GWh / 1 ktoe		11,63

Extra: in case if a credit line will be established

Capital structure		
Share of equity	[%]	0%
Share of debt	[%]	100%
Cost of capital		
Equity	[%]	14%
Public loan	[%]	0%
Commercial loan	[%]	8%
Debt payment period	[years]	10

Program budget

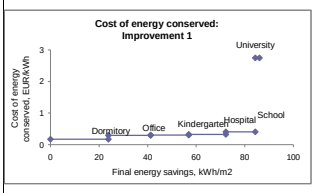
Program budget	million EUR	xx
Other costs	million EUR	xx
Budget excluding other costs	million EUR	xx
Other costs as a share of the program budget	[%]	#VALORE!
Period of implementation	[years]	xx

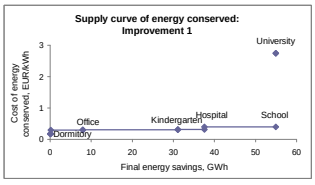
Building stock

	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Sector		Education	Public health	Education	Other	Education	Education	
Retrofit need	[thousand m2]	5,3	424	1.482	448	1.443	6,4	3.809

Program results: improvement 1

Stock retrofitted by the program	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Share of the need	[%/stock]	100%	100%	100%	100%	100%	100%	100%
Floor area	[thousand m2]	5,3	424	1.482	448	1.443	6,4	3.809
Investment	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Investment cost, per m2	[EUR/m2]	63	80	76	81	75	77	77
Maintenance cost, per m2	[EUR/m2-yr.]	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Costs of energy conserved	[EUR/kWh]	0,17	0,32	0,30	0,30	0,40	2,74	0,34
investment cost, total	[million EUR]	0,3	34,0	112,2	36,4	108,3	0,5	292
Energy/CO2 savings (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total CO2	[gCO2/m2]	1.240	4.721	1.458	1.589	532	849	1.485
Total primary energy	[kWh/m2]	26	20	18	16	12	2	16
Total final energy	[kWh/m2]	24	15	16	17	12	2	14
			for the whole stock retrofitted					
Total CO2	[tCO2]	7	2.003	2.161	712	768	5	5.656
Total primary energy	[GWh]	0,13	8	27	7	17	0,02	59
Total final energy	[GWh]	0,1	7	23	8	17	0,0	55
Total final energy	[ktoe]	0,0	0,6	2,0	0,7	1,5	0,0	4,7
Saved energy costs (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total over measure lifetime (NPV)	[EUR/m2]	71,62	66,2	43,1	45,4	29,1	9,6	40,6
Annual over measure lifetime	[EUR/m2]	4,14	3,83	2,49	2,62	1,68	0,56	2,3
			for the whole stock retrofitted					
Total over measure lifetime (NPV)	[million EUR]	0,38	28,10	63,86	20,34	42,00	0,06	155
Annual over measure lifetime	[million EUR]	0,02	1,63	3,69	1,18	2,43	0,00	9
Financial analysis	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Simple payback	[years]	15	21	30	n/a	n/a	n/a	n/a
Internal rate of return	[%]	4,9%	2,8%	0,4%	#NUM!	#NUM!	#NUM!	0,1%
NPV	[EUR/m2]	0,0	-5,6	-46,5	-15,4	-63,8	-0,4	-131,7
Cost - benefit ratio		0,9	1,2	1,8	1,8	2,6	8,0	1,9
Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
GDP increase	[EUR/m2]	40,9	51,9	49,1	52,7	48,7	50,3	294
Labour income	[EUR/m2]	18,7	23,8	22,5	24,2	22,4	23,1	135
Employment	[jobs/m2]	0,01	0,01	0,01	0,01	0,01	0,01	0
Monetized CO2 emissions avoided	[EUR/m2]	0,00	0,01	0,01	0,00	0,00	0,00	0
Air quality including health impacts	[EUR/m2]	0,00	0,01	0,03	0,01	0,02	0,00	0
Improved comfort and services of buildings	[EUR/m2]	6,0	6,0	6,0	6,0	6,0	6,0	36
			for the whole stock retrofitted					
GDP increase	[million EUR]	0,2	22,0	72,8	23,6	70,3	0,3	189
Labour income	[million EUR]	0,10	10,1	33,4	10,8	32,3	0,15	87
Employment	jobs	49	5.010	16.555	5.367	15.984	73	43.038
Monetized CO2 emissions avoided	[million EUR]	0,000	0,004	0,016	0,002	0,006	0,000	0
Air quality including health impacts	[million EUR]	0,000	0,004	0,047	0,005	0,035	0,000	0
Improved comfort and services of buildings	[million EUR]	0,03	2,5	8,9	2,7	8,7	0,04	23
Extra: in case if a credit line will be establish	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Cost of investors								
Debt service, annual over the loan repayment p	[million EUR/yr.]	0,0	3	11	4	11	0	**29**
Cost of administrator (state)								
Costs of low interest rate, annual over the loan	[million EUR/yr.]	0,02	1,7	5,5	1,8	5,3	0,02	**14**
Technical assistance (energy audits, design, ar	[million EUR]	#VALORE!	#VALORE!	#VALORE!	#VALORE!	#VALORE!	#VALORE!	**#VALORE!**
Costs and benefits of commercial banks								
Provision of loans for investment costs	[million EUR]	0,3	34,0	112,2	36,4	108,3	0,5	**292**
Interest payments from investors	[million EUR]	0,0	3,4	11,2	3,6	10,8	0,0	**29**
Interest payments from the state	[million EUR]	0,2	17	55	18	53	0,2	**143**





- Loan Amount EUR 1
- Loan Tenor years 10
- Interest Rate % 8%
- Interest Rate, subsidized % 0%

	municipalities without subsidized rate Debt Service Interest	Principa	Total Debt Service	municipalities with subsidized rate Debt Service Interest Payment	Principa	Total Debt Service
0				0		
1	0,08	0,07	0,15	1 0,00	0,10	0,10
2	0,07	0,07	0,15	2 0,00	0,10	0,10
3	0,07	0,08	0,15	3 0,00	0,10	0,10
4	0,06	0,09	0,15	4 0,00	0,10	0,10
5	0,06	0,09	0,15	5 0,00	0,10	0,10
6	0,05	0,10	0,15	6 0,00	0,10	0,10
7	0,04	0,11	0,15	7 0,00	0,10	0,10
8	0,03	0,12	0,15	8 0,00	0,10	0,10
9	0,02	0,13	0,15	9 0,00	0,10	0,10
10	0,01	0,14	0,15	10 0,00	0,10	0,10
	0,49		1,49	0,00		1,00

	Saved energy costs Changing energy prices						
Year	Dormitory	Hospital	Kindergar	Office	School	University	total
0	-0,3	-34,0	-112,2	-36,4	-108,3	-0,5	-291,7
1	0,015	0,807	2,566	0,759	1,788	0,001	5,9
2	0,016	0,894	2,675	0,800	1,847	0,002	6,2
3	0,016	0,939	2,745	0,825	1,889	0,002	6,4
4	0,017	0,987	2,818	0,851	1,932	0,002	6,6
5	0,017	1,036	2,893	0,878	1,976	0,002	6,8
6	0,018	1,090	2,972	0,907	2,022	0,002	7,0
7	0,018	1,146	3,054	0,937	2,070	0,002	7,2
8	0,019	1,205	3,138	0,967	2,119	0,002	7,5
9	0,019	1,265	3,225	0,999	2,169	0,003	7,7
10	0,020	1,321	3,308	1,029	2,218	0,003	7,9
11	0,020	1,386	3,400	1,063	2,271	0,003	8,1
12	0,021	1,455	3,496	1,098	2,325	0,003	8,4
13	0,021	1,526	3,595	1,135	2,382	0,003	8,7
14	0,022	1,602	3,698	1,173	2,441	0,003	8,9
15	0,022	1,680	3,805	1,213	2,501	0,004	9,2
16	0,023	1,763	3,916	1,254	2,563	0,004	9,5
17	0,024	1,850	4,031	1,297	2,628	0,004	9,8
18	0,024	1,940	4,151	1,342	2,695	0,004	10,2
19	0,025	2,035	4,275	1,389	2,764	0,005	10,5
20	0,026	2,135	4,404	1,438	2,836	0,005	10,8
21	0,026	2,239	4,538	1,489	2,910	0,005	11,2
22	0,027	2,349	4,677	1,542	2,986	0,005	11,6
23	0,028	2,463	4,822	1,597	3,065	0,006	12,0
24	0,029	2,583	4,972	1,655	3,148	0,006	12,4
25	0,030	2,709	5,128	1,715	3,233	0,006	12,8
26	0,031	2,841	5,291	1,778	3,321	0,007	13,3
27	0,032	2,979	5,460	1,843	3,412	0,007	13,7
28	0,033	3,124	5,636	1,911	3,507	0,007	14,2
29	0,034	3,275	5,819	1,982	3,605	0,008	14,7
30	0,035	3,434	6,009	2,056	3,707	0,008	15,2

Fig. Cost of energy conserved

		Dormitory	Hospital	Kindergar	Office	School	University
Ranking of options		1	4	3	2	5	6
Cost of en	EUR/kWh	0,2	0,3	0,3	0,3	0,4	2,7
Final ener	kWh/m2	23,9	15,3	15,6	17,4	12,0	1,8
Final ener	GWh]	0,1	6,5	23,1	7,8	17,4	0,0

Cost of energy conserved: Improvement 1

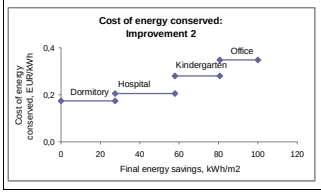
	y EUR/kWh	x kWh/m2	
1	0,17	0,0	Dormitory
	0,17	23,9	
2	0,30	23,9	Office
	0,30	41,3	
3	0,30	41,3	Kindergarten
	0,30	56,9	
4	0,32	56,9	Hospital
	0,32	72,2	
5	0,40	72,2	School
	0,40	84,3	
6	2,74	84,3	University

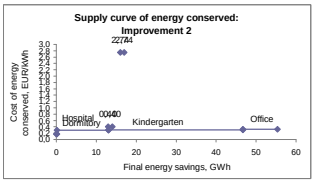
Supply curve of energy conserved: Improvement 1

	y EUR/kWh	x GWh	
1	0,17	0,0	Dormitory
	0,17	0,1	
2	0,30	0,1	Office
	0,30	7,9	
3	0,30	7,9	Kindergarten
	0,30	31,1	
4	0,32	31,1	Hospital
	0,32	37,6	
5	0,40	37,6	School
	0,40	54,9	
6	2,74	54,9	University

Program results: improvement 2

Stock retrofitted by the program	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Share of the need	[%/stock]	100%	100%	100%	100%			62%
Floor area	[thousand m2]	5,3	424,3	1.482,1	448,2			2.360
Investment	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Investment cost, per m2	[EUR/m2]	87	108	105	109			106
Maintenance cost, per m2	[EUR/m2-yr.]	0,5	0,5	0,5	0,5			0,5
Costs of energy conserved	[EUR/kWh]	0,17	0,21	0,28	0,35			0,28
Investment cost, total	[million EUR]	0,5	45,7	156,0	48,7			251
Energy/CO2 savings (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total CO2	[gCO2/m2]	1.090	6.110	1.851	1.574			2562
Total primary energy	[kWh/m2]	37	37	26	18			27
Total final energy	[kWh/m2]	28	30	23	19			23
			for the whole stock retrofitted					
Total CO2	[tCO2]	6	2.592	2.743	705			6.046
Total primary energy	[GWh]	0,19	16	39	8			63
Total final energy	[GWh]	0,1	13	34	9			55
Total final energy	[ktoe]	0,0	1,1	2,9	0,7			4,8
Saved energy costs (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Over measure lifetime, total (NPV)	[EUR/m2]	96,0	111,6	62,4	50,6			69,1
Annual, average	[EUR/m2]	5,5	6,5	3,6	2,9			4,0
			for the whole stock retrofitted					
Over measure lifetime, total (NPV)	[million EUR]	0,50	47,34	92,41	22,70			163
Annual, total	[million EUR]	0,03	2,74	5,34	1,31			9
Financial analysis	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Simple payback	[years]	16	17	29	n/a			27
Internal rate of return	[%]	4,7%	4,2%	0,6%	-0,7%			1,2%
NPV	[EUR/m2]	0,0	1,6	-61,2	-25,0			-84,5
Cost - benefit ratio		0,9	1,0	1,7	2,1			1,5
Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
GDP increase	[EUR/m2]	56,7	69,8	68,3	70,5			265
Labour income	[EUR/m2]	26,0	32,0	31,3	32,4			122
Employment	[jobs/m2]	0,01	0,02	0,02	0,02			0,1
Monetized CO2 emissions avoided	[EUR/m2]	0,00	0,01	0,01	0,00			0
Air quality including health impacts	[EUR/m2]	0,00	0,02	0,05	0,01			0
Improved comfort and services of buildings	[EUR/m2]	6,0	6,0	6,0	6,0			24
			for the whole stock retrofitted					
GDP increase	[million EUR]	0,3	29,6	101,2	31,6			163
Labour income	[million EUR]	0,14	13,6	46,4	14,5			75
Employment	jobs	68	6738	23017	7186			37008
Monetized CO2 emissions avoided	[million EUR]	0,000	0,005	0,020	0,002			0,03
Air quality including health impacts	[million EUR]	0,000	0,008	0,069	0,005			0,08
Improved comfort and services of buildings	[million EUR]	0,03	2,5	8,9	2,7			14
Extra: in case if a credit line will be establish	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Cost of investors								
Debt service, annual over the loan repayment p	[million EUR/yr.]	0,0	5	16	5			**25**
Cost of administrator (state)								
Costs of low interest rate, annual over the loan	[million EUR/yr.]	0,02	2,24	7,65	2,39			**12**
Technical assistance (energy audits, design, ar	[million EUR]	#VALORE!	#VALORE!	#VALORE!	#VALORE!			**#VALORE!**
Costs and benefits of commercial banks								
Provision of loans for investment costs	[million EUR]	0,5	45,7	156,0	48,7			**251**
Interest payments from investors	[million EUR]	0,0	4,6	15,6	4,9			**25**
Interest payments from the state	[million EUR]	0,2	22	76	24			**123**





						2,74	86,1	

	municipalities without subsidized rate				municipalities with subsidized rate			
	Debt Service				Debt Service			
	Interest	Principa	Total Debt Service		Interest Payment	Principa	Total Debt Service	
0								
1	0,08	0,07	0,15		0,00	0,10	0,10	
2	0,07	0,07	0,15		0,00	0,10	0,10	
3	0,07	0,08	0,15		0,00	0,10	0,10	
4	0,06	0,09	0,15		0,00	0,10	0,10	
5	0,06	0,09	0,15		0,00	0,10	0,10	
6	0,05	0,10	0,15		0,00	0,10	0,10	
7	0,04	0,11	0,15		0,00	0,10	0,10	
8	0,03	0,12	0,15		0,00	0,10	0,10	
9	0,02	0,13	0,15		0,00	0,10	0,10	
10	0,01	0,14	0,15		0,00	0,10	0,10	
	0,49		1,49		0,00		1,00	

	Saved energy costs						
	Changing energy prices						
Year	Dormitory	Hospital	Kindergar	Office	School	University	total
0	-0,5	-45,7	-156,0	-48,7	0,0	0,0	-250,8
1	0,022	1,573	3,774	0,874	0,000	0,000	6,2
2	0,022	1,694	3,923	0,917	0,000	0,000	6,6
3	0,023	1,761	4,022	0,944	0,000	0,000	6,7
4	0,023	1,830	4,125	0,972	0,000	0,000	6,9
5	0,024	1,903	4,230	1,000	0,000	0,000	7,2
6	0,024	1,981	4,341	1,031	0,000	0,000	7,4
7	0,025	2,062	4,456	1,062	0,000	0,000	7,6
8	0,026	2,146	4,574	1,095	0,000	0,000	7,8
9	0,026	2,233	4,695	1,128	0,000	0,000	8,1
10	0,027	2,314	4,812	1,160	0,000	0,000	8,3
11	0,027	2,408	4,941	1,196	0,000	0,000	8,6
12	0,028	2,506	5,074	1,233	0,000	0,000	8,8
13	0,029	2,608	5,213	1,271	0,000	0,000	9,1
14	0,029	2,715	5,356	1,312	0,000	0,000	9,4
15	0,030	2,827	5,505	1,353	0,000	0,000	9,7
16	0,031	2,943	5,659	1,397	0,000	0,000	10,0
17	0,031	3,065	5,819	1,442	0,000	0,000	10,4
18	0,032	3,193	5,985	1,489	0,000	0,000	10,7
19	0,033	3,326	6,157	1,538	0,000	0,000	11,1
20	0,034	3,465	6,335	1,589	0,000	0,000	11,4
21	0,035	3,611	6,521	1,642	0,000	0,000	11,8
22	0,036	3,763	6,713	1,697	0,000	0,000	12,2
23	0,037	3,922	6,913	1,754	0,000	0,000	12,6
24	0,037	4,089	7,120	1,814	0,000	0,000	13,1
25	0,038	4,263	7,336	1,876	0,000	0,000	13,5
26	0,039	4,444	7,559	1,941	0,000	0,000	14,0
27	0,040	4,635	7,792	2,009	0,000	0,000	14,5
28	0,042	4,834	8,034	2,079	0,000	0,000	15,0
29	0,043	5,042	8,285	2,153	0,000	0,000	15,5
30	0,044	5,259	8,546	2,229	0,000	0,000	16,1

Fig. Cost of energy conserved

		Dormitory	Hospital	Kindergar	Office
Ranking of options		1	2	3	4
Cost of en	EUR/kWh	0,2	0,2	0,3	0,3
Final ener	kWh/m2	27,5	30,4	22,7	19,3
Final ener	GWh]	0,1	12,9	33,6	8,7

Cost of energy conserved: Improvement 2

	EUR/kWh	kWh/m2		
	y	x		
1	0,17	0,0	Dormitory	
	0,17	27,5		
2	0,21	27,5	Hospital	
	0,21	57,9		
3	0,28	57,9	Kindergarten	
	0,28	80,6		
4	0,35	80,6	Office	
	0,35	99,9		

Supply curve of energy conserved: Improvement 2

	EUR/kWh	GWh	
	y	x	
1	0,17	0,0	Dormitory
	0,17	0,1	
2	0,21	0,1	Hospital
	0,21	13,0	
3	0,28	13,0	Kindergarten
	0,28	46,7	
4	0,35	46,7	Office
	0,35	55,3	

Thermal efficiency retrofit of public buildings in Albania, analysis for municipalities by climate zone

Improvement 1 & 2
Climate zone B

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerious benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price 2016 [EUR/kWh]	2030 [EUR/kWh]	annual growth [%]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity	0,104	0,160	1%	0	1,0
Wood	0,024	0,037	1%	0	0,2
LPG	0,061	0,247	5%	227	1,1
Diesel oil	0,117	0,473	5%	267	1,2
Solar	0,000	0,000	N/A	0	0,0

Financial analysis

Measure lifetime	[years]	30
Discount rate	[%]	4%
Annuity factor	[%]	6%
Maintenance costs	[EUR/m2-yr.]	0,5

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view

GDP increase	[EUR/EUR]	0,65
direct	[EUR/EUR]	0,30
multiplier effects	[EUR/EUR]	0,35
Labour income	[EUR/EUR]	0,30
direct	[EUR/EUR]	0,17
multiplier effects	[EUR/EUR]	0,13
Annual employment	[jobs/million EUR]	148
Employment	[jobs/million EUR]	85
multiplier effects	[jobs/million EUR]	63
Monetized CO2 emissions avoided	EUR/tCO2	5
Air quality including health impacts	EUR/MWh	1,38
Improved comfort and services of buildings reflec	[% value]	2% *Assumed estate value is EUR 300 per m2

Conversion units

GWh / 1 ktoe	11,63

Extra: in case if a credit line will be established

Capital structure		
Share of equity	[%]	0%
Share of debt	[%]	100%
Cost of capital		
Equity	[%]	14%
Public loan	[%]	0%
Commercial loan	[%]	8%
Debt payment period	[years]	10

Program budget

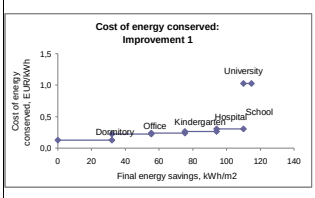
Program budget	million EUR	xx
Other costs	million EUR	xx
Budget excluding other costs	million EUR	xx
Other costs as a share of the program budget	[%]	#VALORE!
Period of implementation	[years]	xx

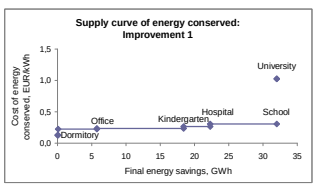
Building stock

	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Sector		Education	Public health	Education	Other	Education	Education	
Retrofit need	[thousand m2]	2,2	208,5	629,5	244,7	612,8	2,7	1.700

Program results: improvement 1

Stock retrofitted by the program	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Share of the need	[%/stock]	100%	100%	100%	100%	100%	100%	100%
Floor area	[thousand m2]	2,2	208	629	245	613	2,7	1.700
Investment	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Investment cost, per m2	[EUR/m2]	63	80	76	81	75	77	77
Maintenance cost, per m2	[EUR/m2-yr.]	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Costs of energy conserved	[EUR/kWh]	0,13	0,26	0,24	0,22	0,31	1,03	0,26
Investment cost, total	[million EUR]	0,1	16,7	47,7	19,9	46,0	0,2	131
Energy/CO2 savings (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
per m2								
Total CO2	[gCO2/m2]	1.727	5.437	1.754	2.065	545	1.456	1.814
Total primary energy	[kWh/m2]	34	23	23	21	15	6	20
Total final energy	[kWh/m2]	32	19	20	23	16	5	19
for the whole stock retrofitted								
Total CO2	[tCO2]	4	1.134	1.104	505	334	4	3.085
Total primary energy	[GWh]	0,08	5	15	5	9	0,02	34
Total final energy	[GWh]	0,1	4	13	6	10	0,0	32
Total final energy	[ktoe]	0,0	0,3	1,1	0,5	0,8	0,0	2,8
Saved energy costs (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
per m2								
Total over measure lifetime (NPV)	[EUR/m2]	94,13	78,3	54,5	60,3	36,3	20,3	51,7
Annual over measure lifetime	[EUR/m2]	5,44	4,53	3,15	3,49	2,10	1,17	3,0
for the whole stock retrofitted								
Total over measure lifetime (NPV)	[million EUR]	0,21	16,33	34,31	14,76	22,22	0,06	88
Annual over measure lifetime	[million EUR]	0,01	0,94	1,98	0,85	1,28	0,00	5
Financial analysis	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Simple payback	[years]	12	18	24	23	n/a	n/a	26
Internal rate of return	[%]	7,1%	3,9%	1,8%	2,1%	-0,6%	#NUM!	1,4%
NPV	[EUR/m2]	0,1	-0,3	-12,8	-4,9	-22,9	-0,1	-41,1
Cost - benefit ratio		0,7	1,0	1,4	1,3	2,1	3,8	1,5
Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
per m2								
GDP increase	[EUR/m2]	40,9	51,9	49,1	52,7	48,7	50,3	294
Labour income	[EUR/m2]	18,7	23,8	22,5	24,2	22,4	23,1	135
Employment	[jobs/m2]	0,01	0,01	0,01	0,01	0,01	0,01	0
Monetized CO2 emissions avoided	[EUR/m2]	0,00	0,01	0,01	0,00	0,00	0,00	0
Air quality including health impacts	[EUR/m2]	0,00	0,01	0,02	0,01	0,01	0,00	0
Improved comfort and services of buildings	[EUR/m2]	6,0	6,0	6,0	6,0	6,0	6,0	36
for the whole stock retrofitted								
GDP increase	[million EUR]	0,1	10,8	30,9	12,9	29,9	0,1	85
Labour income	[million EUR]	0,04	5,0	14,2	5,9	13,7	0,06	39
Employment	jobs	21	2.462	7.031	2.930	6.789	31	19.264
Monetized CO2 emissions avoided	[million EUR]	0,000	0,001	0,003	0,001	0,001	0,000	0,01
Air quality including health impacts	[million EUR]	0,000	0,001	0,011	0,002	0,008	0,000	0,02
Improved comfort and services of buildings	[million EUR]	0,01	1,3	3,8	1,5	3,7	0,02	10
Extra: in case if a credit line will be establish	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Cost of investors								
Debt service, annual over the loan repayment p	[million EUR/yr.]	0,0	2	5	2	5	0	**13**
Cost of administrator (state)								
Costs of low interest rate, annual over the loan	[million EUR/yr.]	0,01	0,8	2,3	1,0	2,3	0,01	**6**
Technical assistance (energy audits, design, ar	[million EUR]	#VALORE!	#VALORE!	#VALORE!	#VALORE!	#VALORE!	#VALORE!	**#VALORE!**
Costs and benefits of commercial banks								
Provision of loans for investment costs	[million EUR]	0,1	16,7	47,7	19,9	46,0	0,2	**131**
Interest payments from investors	[million EUR]	0,0	1,7	4,8	2,0	4,6	0,0	**13**
Interest payments from the state	[million EUR]	0,1	8	23	10	23	0,1	**64**





- Loan Amount EUR 1
- Loan Tenor years 10
- Interest Rate % 8%
- Interest Rate, subsidized % 0%

municipalities without subsidized rate

	Debt Service Interest	Principa	Total Debt Service
0			
1	0,08	0,07	0,15
2	0,07	0,07	0,15
3	0,07	0,08	0,15
4	0,06	0,09	0,15
5	0,06	0,09	0,15
6	0,05	0,10	0,15
7	0,04	0,11	0,15
8	0,03	0,12	0,15
9	0,02	0,13	0,15
10	0,01	0,14	0,15
	0,49		1,49

municipalities with subsidized rate

	Debt Service Interest Payment	Principa	Total Debt Service
0			
1	0,00	0,10	0,10
2	0,00	0,10	0,10
3	0,00	0,10	0,10
4	0,00	0,10	0,10
5	0,00	0,10	0,10
6	0,00	0,10	0,10
7	0,00	0,10	0,10
8	0,00	0,10	0,10
9	0,00	0,10	0,10
10	0,00	0,10	0,10
	0,00		1,00

Saved energy costs
Changing energy prices

Year	Dormitory	Hospital	Kindergar	Office	School	University	total
0	-0,1	-16,7	-47,7	-19,9	-46,0	-0,2	-130,6
1	0,009	0,477	1,392	0,554	0,963	0,002	3,4
2	0,009	0,527	1,449	0,584	0,992	0,002	3,6
3	0,009	0,553	1,486	0,602	1,014	0,002	3,7
4	0,009	0,580	1,524	0,620	1,036	0,002	3,8
5	0,010	0,608	1,564	0,640	1,058	0,002	3,9
6	0,010	0,639	1,606	0,660	1,082	0,002	4,0
7	0,010	0,671	1,649	0,682	1,106	0,002	4,1
8	0,010	0,705	1,693	0,704	1,130	0,002	4,2
9	0,011	0,739	1,739	0,726	1,156	0,002	4,4
10	0,011	0,771	1,783	0,748	1,180	0,003	4,5
11	0,011	0,808	1,831	0,772	1,207	0,003	4,6
12	0,012	0,847	1,882	0,798	1,235	0,003	4,8
13	0,012	0,888	1,934	0,824	1,263	0,003	4,9
14	0,012	0,931	1,988	0,852	1,292	0,003	5,1
15	0,013	0,976	2,044	0,880	1,323	0,003	5,2
16	0,013	1,023	2,102	0,910	1,354	0,003	5,4
17	0,013	1,073	2,162	0,941	1,386	0,004	5,6
18	0,014	1,125	2,225	0,973	1,419	0,004	5,8
19	0,014	1,179	2,290	1,007	1,454	0,004	5,9
20	0,014	1,236	2,358	1,042	1,489	0,004	6,1
21	0,015	1,295	2,428	1,078	1,526	0,004	6,3
22	0,015	1,357	2,500	1,116	1,564	0,005	6,6
23	0,016	1,423	2,576	1,156	1,603	0,005	6,8
24	0,016	1,491	2,654	1,197	1,643	0,005	7,0
25	0,017	1,563	2,736	1,240	1,685	0,005	7,2
26	0,017	1,638	2,821	1,285	1,729	0,006	7,5
27	0,018	1,716	2,909	1,332	1,774	0,006	7,8
28	0,018	1,799	3,001	1,381	1,820	0,006	8,0
29	0,019	1,885	3,096	1,432	1,868	0,006	8,3
30	0,019	1,975	3,195	1,485	1,918	0,007	8,6

Fig. Cost of energy conserved

		Dormitory	Hospital	Kindergar	Office	School	University
Ranking of options		1	4	3	2	5	6
Cost of en	EUR/kWh	0,1	0,3	0,2	0,2	0,3	1,0
Final ener	kWh/m2	32,1	18,7	20,1	23,2	15,8	4,9
Final ener	GWh	0,1	3,9	12,6	5,7	9,7	0,0

Cost of energy conserved: Improvement 1

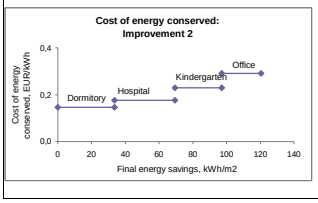
	y EUR/kWh	x kWh/m2	
1	0,13	0,0	Dormitory
	0,13	32,1	
2	0,22	32,1	Office
	0,22	55,3	
3	0,24	55,3	Kindergarten
	0,24	75,4	
4	0,26	75,4	Hospital
	0,26	94,1	
5	0,31	94,1	School
	0,31	110,0	
6	1,03	110,0	University

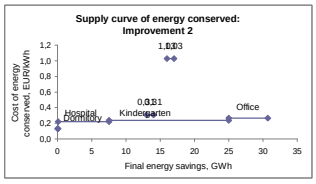
Supply curve of energy conserved: Improvement 1

	y EUR/kWh	x GWh	
1	0,13	0,0	Dormitory
	0,13	0,1	
2	0,22	0,1	Office
	0,22	5,8	
3	0,24	5,8	Kindergarten
	0,24	18,4	
4	0,26	18,4	Hospital
	0,26	22,3	
5	0,31	22,3	School
	0,31	32,0	
6	1,03	32,0	University

Program results: improvement 2

Stock retrofitted by the program	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Share of the need	[%/stock]	100%	100%	100%	100%			64%
Floor area	[thousand m2]	2,2	208,5	629,5	244,7			1.085
Investment	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Investment cost, per m2	[EUR/m2]	87	108	105	109			106
Maintenance cost, per m2	[EUR/m2-yr.]	0,5	0,5	0,5	0,5			0,5
Costs of energy conserved	[EUR/kWh]	0,15	0,18	0,23	0,29			0,24
Investment cost, total	[million EUR]	0,2	22,4	66,3	26,6			115
Energy/CO2 savings (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total CO2	[gCO2/m2]	1.467	7.160	2.224	2.065			3135
Total primary energy	[kWh/m2]	45	44	32	21			32
Total final energy	[kWh/m2]	34	36	28	23			28
			for the whole stock retrofitted					
Total CO2	[tCO2]	3	1.493	1.400	505			3.401
Total primary energy	[GWh]	0,10	9	20	5			34
Total final energy	[GWh]	0,1	7	17	6			31
Total final energy	[ktoe]	0,0	0,6	1,5	0,5			2,6
Saved energy costs (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total over measure lifetime (NPV)	[EUR/m2]	116,8	130,3	75,9	60,3			82,9
Annual over measure lifetime	[EUR/m2]	6,8	7,5	4,4	3,5			4,8
			for the whole stock retrofitted					
Total over measure lifetime (NPV)	[million EUR]	0,26	27,16	47,77	14,76			90
Annual over measure lifetime	[million EUR]	0,02	1,57	2,76	0,85			5
Financial analysis	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Simple payback	[years]	13	14	24	n/a			22
Internal rate of return	[%]	6,2%	5,3%	1,8%	0,3%			2,3%
NPV	[EUR/m2]	0,1	4,5	-17,8	-11,4			-24,6
Cost - benefit ratio		0,7	0,8	1,4	1,8			1,3
Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
GDP increase	[EUR/m2]	56,7	69,8	68,3	70,5			265
Labour income	[EUR/m2]	26,0	32,0	31,3	32,4			122
Employment	[jobs/m2]	0,01	0,02	0,02	0,02			0,1
Monetized CO2 emissions avoided	[EUR/m2]	0,00	0,01	0,01	0,00			0
Air quality including health impacts	[EUR/m2]	0,00	0,01	0,02	0,01			0
Improved comfort and services of buildings	[EUR/m2]	6,0	6,0	6,0	6,0			24
			for the whole stock retrofitted					
GDP increase	[million EUR]	0,1	14,6	43,0	17,3			75
Labour income	[million EUR]	0,06	6,7	19,7	7,9			34
Employment	jobs	29	3311	9776	3923			17039
Monetized CO2 emissions avoided	[million EUR]	0,000	0,002	0,004	0,001			0,01
Air quality including health impacts	[million EUR]	0,000	0,002	0,015	0,002			0,02
Improved comfort and services of buildings	[million EUR]	0,01	1,3	3,8	1,5			7
Extra: in case if a credit line will be establish	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Cost of investors								
Debt service, annual over the loan repayment p	[million EUR/yr.]	0,0	2	7	3			**12**
Cost of administrator (state)								
Costs of low interest rate, annual over the loan	[million EUR/yr.]	0,01	1,10	3,25	1,30			**6**
Technical assistance (energy audits, design, ar	[million EUR]	#VALORE!	#VALORE!	#VALORE!	#VALORE!			**#VALORE!**
Costs and benefits of commercial banks								
Provision of loans for investment costs	[million EUR]	0,2	22,4	66,3	26,6			**115**
Interest payments from investors	[million EUR]	0,0	2,2	6,6	2,7			**12**
Interest payments from the state	[million EUR]	0,1	11	32	13			**57**





1,03 114,8 1,03 32,0

municipalities without subsidized rate

	Debt Service			municipalities with subsidized rate Debt Service		
	Interest	Principa	Total Debt Service	Interest Payment	Principa	Total Debt Service
0				0		
1	0,08	0,07	0,15	1 0,00	0,10	0,10
2	0,07	0,07	0,15	2 0,00	0,10	0,10
3	0,07	0,08	0,15	3 0,00	0,10	0,10
4	0,06	0,09	0,15	4 0,00	0,10	0,10
5	0,06	0,09	0,15	5 0,00	0,10	0,10
6	0,05	0,10	0,15	6 0,00	0,10	0,10
7	0,04	0,11	0,15	7 0,00	0,10	0,10
8	0,03	0,12	0,15	8 0,00	0,10	0,10
9	0,02	0,13	0,15	9 0,00	0,10	0,10
10	0,01	0,14	0,15	10 0,00	0,10	0,10
	0,49		1,49	0,00		1,00

	Saved energy costs						
	Changing energy prices						
Year	Dormitory	Hospital	Kindergar	Office	School	University	total
0	-0,2	-22,4	-66,3	-26,6	0,0	0,0	-115,5
1	0,011	0,901	1,955	0,554	0,000	0,000	3,4
2	0,012	0,970	2,032	0,584	0,000	0,000	3,6
3	0,012	1,009	2,083	0,602	0,000	0,000	3,7
4	0,012	1,049	2,135	0,620	0,000	0,000	3,8
5	0,012	1,090	2,190	0,640	0,000	0,000	3,9
6	0,013	1,135	2,247	0,660	0,000	0,000	4,1
7	0,013	1,182	2,306	0,682	0,000	0,000	4,2
8	0,013	1,230	2,367	0,704	0,000	0,000	4,3
9	0,013	1,280	2,429	0,726	0,000	0,000	4,4
10	0,014	1,327	2,489	0,748	0,000	0,000	4,6
11	0,014	1,381	2,556	0,772	0,000	0,000	4,7
12	0,014	1,437	2,624	0,798	0,000	0,000	4,9
13	0,015	1,496	2,696	0,824	0,000	0,000	5,0
14	0,015	1,557	2,769	0,852	0,000	0,000	5,2
15	0,016	1,621	2,846	0,880	0,000	0,000	5,4
16	0,016	1,689	2,925	0,910	0,000	0,000	5,5
17	0,016	1,759	3,007	0,941	0,000	0,000	5,7
18	0,017	1,832	3,093	0,973	0,000	0,000	5,9
19	0,017	1,909	3,181	1,007	0,000	0,000	6,1
20	0,018	1,989	3,273	1,042	0,000	0,000	6,3
21	0,018	2,072	3,368	1,078	0,000	0,000	6,5
22	0,018	2,160	3,467	1,116	0,000	0,000	6,8
23	0,019	2,252	3,569	1,156	0,000	0,000	7,0
24	0,019	2,347	3,676	1,197	0,000	0,000	7,2
25	0,020	2,447	3,787	1,240	0,000	0,000	7,5
26	0,020	2,552	3,902	1,285	0,000	0,000	7,8
27	0,021	2,661	4,021	1,332	0,000	0,000	8,0
28	0,022	2,776	4,145	1,381	0,000	0,000	8,3
29	0,022	2,896	4,274	1,432	0,000	0,000	8,6
30	0,023	3,021	4,408	1,485	0,000	0,000	8,9

Fig. Cost of energy conserved

		Dormitory	Hospital	Kindergar	Office
Ranking of options		1	2	3	4
Cost of en	EUR/kWh	0,1	0,2	0,2	0,3
Final ener	kWh/m2	33,6	35,8	27,8	23,2
Final ener	[GWh]	0,1	7,5	17,5	5,7

Cost of energy conserved: Improvement 2

	EUR/kWh	kWh/m2	
	y	x	
1	0,15	0,0	Dormitory
	0,15	33,6	
2	0,18	33,6	Hospital
	0,18	69,4	
3	0,23	69,4	Kindergarten
	0,23	97,2	
4	0,29	97,2	Office
	0,29	120,4	

Supply curve of energy conserved: Improvement 2

	EUR/kWh	GWh	
	y	x	
1	0,15	0,0	Dormitory
	0,15	0,1	
2	0,18	0,1	Hospital
	0,18	7,5	
3	0,23	7,5	Kindergarten
	0,23	25,0	
4	0,29	25,0	Office
	0,29	30,7	

Thermal efficiency retrofit of public buildings in Albania, analysis for municipalities by climate zone

Improvement 1 & 2
Climate zone C

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerious benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price 2016 [EUR/kWh]	Energy source price 2030 [EUR/kWh]	annual growth [%]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity	0,104	0,160	1%	0	1,0
Wood	0,024	0,037	1%	0	0,2
LPG	0,061	0,247	5%	227	1,1
Diesel oil	0,117	0,473	5%	267	1,2
Solar	0,000	0,000	N/A	0	0,0

Financial analysis

Measure lifetime	[years]	30
Discount rate	[%]	4%
Annuity factor	[%]	6%
Maintenance costs	[EUR/m2-yr.]	0,5

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view

GDP increase	[EUR/EUR]	0,65
direct	[EUR/EUR]	0,30
multiplier effects	[EUR/EUR]	0,35
Labour income	[EUR/EUR]	0,30
direct	[EUR/EUR]	0,17
multiplier effects	[EUR/EUR]	0,13
Annual employment	[jobs/million EUR]	148
Employment	[jobs/million EUR]	85
multiplier effects	[jobs/million EUR]	63
Monetized CO2 emissions avoided	EUR/tCO2	5
Air quality including health impacts	EUR/MWh	1,38
Improved comfort and services of buildings reflec	[% value]	2% *Assumed estate value is EUR 300 per m2

Conversion units

GWh / 1 ktoe		11,63

Extra: in case if a credit line will be established

Capital structure		
Share of equity	[%]	0%
Share of debt	[%]	100%
Cost of capital		
Equity	[%]	14%
Public loan	[%]	0%
Commercial loan	[%]	8%
Debt payment period	[years]	10

Program budget

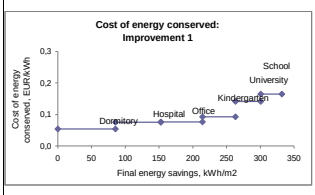
Program budget	million EUR	xx
Other costs	million EUR	xx
Budget excluding other costs	million EUR	xx
Other costs as a share of the program budget	[%]	#VALORE!
Period of implementation	[years]	xx

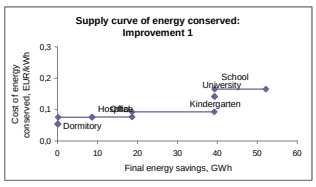
Building stock

	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Sector		Education	Public health	Education	Other	Education	Education	
Retrofit need	[thousand m2]	1,5	125,9	419,0	163,1	407,9	1,8	1.119

Program results: improvement 1

Stock retrofitted by the program	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Share of the need	[%/stock]	100%	100%	100%	100%	100%	100%	100%
Floor area	[thousand m2]	1,5	126	419	163	408	1,8	1.119
Investment	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Investment cost, per m2	[EUR/m2]	71	80	71	73	81	82	76
Maintenance cost, per m2	[EUR/m2-yr.]	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Costs of energy conserved	[EUR/kWh]	0,05	0,08	0,09	0,08	0,16	0,14	0,10
investment cost, total	[million EUR]	0,1	10,1	29,7	11,9	33,1	0,1	85
Energy/CO2 savings (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total CO2	[gCO2/m2]	7.552	16.382	1.796	3.926	1.147	5.688	3.524
Total primary energy	[kWh/m2]	52	67	22	33	18	25	27
Total final energy	[kWh/m2]	85	68	49	62	31	37	47
			for the whole stock retrofitted					
Total CO2	[tCO2]	11	2.062	753	641	468	10	3.945
Total primary energy	[GWh]	0,08	8	9	5	8	0,05	31
Total final energy	[GWh]	0,1	8	21	10	13	0,1	52
Total final energy	[ktoe]	0,0	0,7	1,8	0,9	1,1	0,0	4,5
Saved energy costs (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
Total over measure lifetime (NPV)	[EUR/m2]	171,41	229,5	60,8	100,2	47,9	80,5	81,0
Annual over measure lifetime	[EUR/m2]	9,91	13,27	3,52	5,80	2,77	4,65	4,7
			for the whole stock retrofitted					
Total over measure lifetime (NPV)	[million EUR]	0,25	28,88	25,48	16,35	19,55	0,15	91
Annual over measure lifetime	[million EUR]	0,01	1,67	1,47	0,95	1,13	0,01	5
Financial analysis	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Simple payback	[years]	7	6	20	13	29	18	16
Internal rate of return	[%]	11,3%	12,5%	3,0%	6,4%	0,6%	3,8%	4,4%
NPV	[EUR/m2]	0,1	18,1	-4,1	4,3	-13,0	0,0	5,4
Cost - benefit ratio		0,4	0,3	1,2	0,7	1,7	1,0	0,9
Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
			per m2					
GDP increase	[EUR/m2]	46,0	52,1	46,0	47,2	52,6	53,5	297
Labour income	[EUR/m2]	21,1	23,9	21,1	21,7	24,1	24,6	136
Employment	[jobs/m2]	0,01	0,01	0,01	0,01	0,01	0,01	0
Monetized CO2 emissions avoided	[EUR/m2]	0,00	0,01	0,00	0,00	0,00	0,00	0
Air quality including health impacts	[EUR/m2]	0,00	0,01	0,03	0,01	0,02	0,00	0
Improved comfort and services of buildings	[EUR/m2]	6,0	6,0	6,0	6,0	6,0	6,0	36
			for the whole stock retrofitted					
GDP increase	[million EUR]	0,1	6,6	19,3	7,7	21,5	0,1	55
Labour income	[million EUR]	0,03	3,0	8,8	3,5	9,8	0,04	25
Employment	jobs	16	1.490	4.383	1.751	4.880	22	12.541
Monetized CO2 emissions avoided	[million EUR]	0,000	0,001	0,002	0,001	0,001	0,000	0,00
Air quality including health impacts	[million EUR]	0,000	0,001	0,012	0,002	0,007	0,000	0,02
Improved comfort and services of buildings	[million EUR]	0,01	0,8	2,5	1,0	2,4	0,01	7
Extra: in case if a credit line will be establish	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Cost of investors								
Debt service, annual over the loan repayment p	[million EUR/yr.]	0,0	1	3	1	3	0	**9**
Cost of administrator (state)								
Costs of low interest rate, annual over the loan	[million EUR/yr.]	0,01	0,5	1,5	0,6	1,6	0,01	**4**
Technical assistance (energy audits, design, ar	[million EUR]	#VALORE!	#VALORE!	#VALORE!	#VALORE!	#VALORE!	#VALORE!	**#VALORE!**
Costs and benefits of commercial banks								
Provision of loans for investment costs	[million EUR]	0,1	10,1	29,7	11,9	33,1	0,1	**85**
Interest payments from investors	[million EUR]	0,0	1,0	3,0	1,2	3,3	0,0	**9**
Interest payments from the state	[million EUR]	0,1	5	15	6	16	0,1	**42**





- Loan Amount EUR 1
- Loan Tenor years 10
- Interest Rate % 8%
- Interest Rate, subsidized % 0%

	municipalities without subsidized rate Debt Service Interest	Principa	Total Debt Service	municipalities with subsidized rate Debt Service Interest Payment	Principa	Total Debt Service
0				0		
1	0,08	0,07	0,15	1 0,00	0,10	0,10
2	0,07	0,07	0,15	2 0,00	0,10	0,10
3	0,07	0,08	0,15	3 0,00	0,10	0,10
4	0,06	0,09	0,15	4 0,00	0,10	0,10
5	0,06	0,09	0,15	5 0,00	0,10	0,10
6	0,05	0,10	0,15	6 0,00	0,10	0,10
7	0,04	0,11	0,15	7 0,00	0,10	0,10
8	0,03	0,12	0,15	8 0,00	0,10	0,10
9	0,02	0,13	0,15	9 0,00	0,10	0,10
10	0,01	0,14	0,15	10 0,00	0,10	0,10
	0,49		1,49	0,00		1,00

	Saved energy costs Changing energy prices						
Year	Dormitory	Hospital	Kindergar	Office	School	University	total
0	-0,1	-10,1	-29,7	-11,9	-33,1	-0,1	-85,0
1	0,009	0,828	1,014	0,596	0,806	0,004	3,3
2	0,009	0,918	1,059	0,632	0,837	0,005	3,5
3	0,010	0,964	1,087	0,652	0,858	0,005	3,6
4	0,010	1,013	1,117	0,674	0,879	0,005	3,7
5	0,010	1,064	1,147	0,696	0,901	0,005	3,8
6	0,011	1,120	1,179	0,720	0,924	0,006	4,0
7	0,011	1,178	1,213	0,745	0,948	0,006	4,1
8	0,012	1,237	1,247	0,770	0,972	0,006	4,2
9	0,012	1,299	1,282	0,797	0,997	0,007	4,4
10	0,013	1,357	1,316	0,822	1,021	0,007	4,5
11	0,013	1,424	1,353	0,850	1,048	0,007	4,7
12	0,014	1,495	1,392	0,879	1,076	0,008	4,9
13	0,014	1,569	1,433	0,910	1,104	0,008	5,0
14	0,015	1,646	1,475	0,942	1,134	0,008	5,2
15	0,015	1,727	1,518	0,976	1,164	0,009	5,4
16	0,016	1,812	1,563	1,010	1,196	0,009	5,6
17	0,016	1,901	1,610	1,047	1,229	0,010	5,8
18	0,017	1,995	1,659	1,084	1,263	0,010	6,0
19	0,018	2,092	1,710	1,124	1,299	0,010	6,3
20	0,018	2,195	1,762	1,165	1,335	0,011	6,5
21	0,019	2,302	1,817	1,208	1,373	0,012	6,7
22	0,020	2,415	1,874	1,252	1,413	0,012	7,0
23	0,021	2,533	1,933	1,299	1,454	0,013	7,3
24	0,022	2,656	1,995	1,348	1,496	0,013	7,5
25	0,022	2,786	2,059	1,399	1,541	0,014	7,8
26	0,023	2,921	2,125	1,451	1,586	0,015	8,1
27	0,024	3,064	2,194	1,507	1,634	0,015	8,4
28	0,025	3,212	2,266	1,564	1,683	0,016	8,8
29	0,026	3,368	2,341	1,625	1,735	0,017	9,1
30	0,027	3,532	2,419	1,688	1,788	0,017	9,5

Fig. Cost of energy conserved

		Dormitory	Hospital	Kindergar	Office	School	University
Ranking of options		1	2	4	3	6	5
Cost of en	EUR/kWh	0,1	0,1	0,1	0,1	0,2	0,1
Final ener	kWh/m2	85,2	67,5	49,2	61,5	31,5	37,2
Final ener	GWh]	0,1	8,5	20,6	10,0	12,8	0,1

Cost of energy conserved: Improvement 1

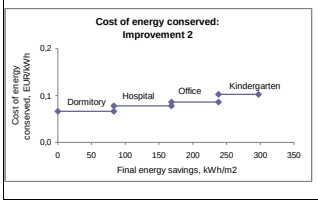
	EUR/kWh	kWh/m2	
	y	x	
1	0,05	0,0	Dormitory
	0,05	85,2	
2	0,08	85,2	Hospital
	0,08	152,7	
3	0,08	152,7	Office
	0,08	214,2	
4	0,09	214,2	Kindergarten
	0,09	263,4	
5	0,14	263,4	University
	0,14	300,7	
6	0,16	300,7	School
	0,16	332,1	

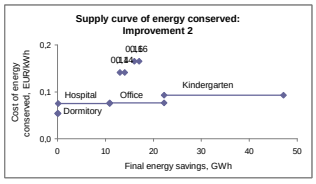
Supply curve of energy conserved: Improvement 1

	EUR/kWh	GWh	
	y	x	
1	0,05	0,0	Dormitory
	0,05	0,1	
2	0,08	0,1	Hospital
	0,08	8,6	
3	0,08	8,6	Office
	0,08	18,7	
4	0,09	18,7	Kindergarten
	0,09	39,3	
5	0,14	39,3	University
	0,14	39,3	
6	0,16	39,3	School
	0,16	52,2	

Program results: improvement 2

Stock retrofitted by the program	Units	Dormitory	Hospital	Kindergarten	Office	School	University	Total
Share of the need	[%/stock]	100%	100%	100%	100%			63%
Floor area	[thousand m2]	1,5	125,9	419,0	163,1			709
Investment	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Investment cost, per m2	[EUR/m2]	91	109	98	95			99
Maintenance cost, per m2	[EUR/m2-yr.]	0,5	0,5	0,5	0,5			0,5
Costs of energy conserved	[EUR/kWh]	0,07	0,08	0,10	0,09			0,09
Investment cost, total	[million EUR]	0,1	13,7	41,0	15,5			70
Energy/CO2 savings (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
per m2								
Total CO2	[gCO2/m2]	7.055	21.356	2.420	4.562			6282
Total primary energy	[kWh/m2]	61	101	33	39			47
Total final energy	[kWh/m2]	83	86	59	70			66
for the whole stock retrofitted								
Total CO2	[tCO2]	10	2.688	1.014	744			4.457
Total primary energy	[GWh]	0,09	13	14	6			33
Total final energy	[GWh]	0,1	11	25	11			47
Total final energy	[ktoe]	0,0	0,9	2,1	1,0			4,1
Saved energy costs (improvement vs BAU)	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
per m2								
Total over measure lifetime (NPV)	[EUR/m2]	189,9	326,4	86,3	116,9			136,2
Annual over measure lifetime	[EUR/m2]	46,7	8,2	32,3	20,9			25,5
for the whole stock retrofitted								
Total over measure lifetime (NPV)	[million EUR]	0,28	41,08	36,17	19,07			97
Annual over measure lifetime	[million EUR]	0,07	1,04	13,55	3,41			18
Financial analysis	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Simple payback	[years]	2	13	3	5			4
Internal rate of return	[%]	10,0%	13,2%	3,1%	5,5%			6,3%
NPV	[EUR/m2]	0,1	26,3	-4,7	3,5			25,3
Cost - benefit ratio		0,5	0,3	1,1	0,8			0,7
Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
per m2								
GDP increase	[EUR/m2]	59,0	70,8	63,5	61,5			255
Labour income	[EUR/m2]	27,1	32,5	29,1	28,2			117
Employment	[jobs/m2]	0,01	0,02	0,01	0,01			0,1
Monetized CO2 emissions avoided	[EUR/m2]	0,00	0,01	0,01	0,00			0
Air quality including health impacts	[EUR/m2]	0,00	0,01	0,03	0,02			0
Improved comfort and services of buildings	[EUR/m2]	6,0	6,0	6,0	6,0			24
for the whole stock retrofitted								
GDP increase	[million EUR]	0,1	8,9	26,6	10,0			46
Labour income	[million EUR]	0,04	4,1	12,2	4,6			21
Employment	jobs	20	2026	6051	2280			10376
Monetized CO2 emissions avoided	[million EUR]	0,000	0,002	0,002	0,001			0,00
Air quality including health impacts	[million EUR]	0,000	0,002	0,014	0,003			0,02
Improved comfort and services of buildings	[million EUR]	0,01	0,8	2,5	1,0			4
Extra: in case if a credit line will be establish	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**	**Total**
Cost of investors								
Debt service, annual over the loan repayment p	[million EUR/yr.]	0,0	1	4	2			**7**
Cost of administrator (state)								
Costs of low interest rate, annual over the loan	[million EUR/yr.]	0,01	0,67	2,01	0,76			**3**
Technical assistance (energy audits, design, ar	[million EUR]	#VALORE!	#VALORE!	#VALORE!	#VALORE!			**#VALORE!**
Costs and benefits of commercial banks								
Provision of loans for investment costs	[million EUR]	0,1	13,7	41,0	15,5			**70**
Interest payments from investors	[million EUR]	0,0	1,4	4,1	1,5			**7**
Interest payments from the state	[million EUR]	0,1	7	20	8			**34**





municipalities without subsidized rate

	Debt Service		
	Interest	Principa	Total Debt Service
0			
1	0,08	0,07	0,15
2	0,07	0,07	0,15
3	0,07	0,08	0,15
4	0,06	0,09	0,15
5	0,06	0,09	0,15
6	0,05	0,10	0,15
7	0,04	0,11	0,15
8	0,03	0,12	0,15
9	0,02	0,13	0,15
10	0,01	0,14	0,15
	0,49		1,49

municipalities with subsidized rate

	Debt Service		
	Interest Payment	Principa	Total Debt Service
0			
1	0,00	0,10	0,10
2	0,00	0,10	0,10
3	0,00	0,10	0,10
4	0,00	0,10	0,10
5	0,00	0,10	0,10
6	0,00	0,10	0,10
7	0,00	0,10	0,10
8	0,00	0,10	0,10
9	0,00	0,10	0,10
10	0,00	0,10	0,10
	0,00		1,00

	Saved energy costs						
	Changing energy prices						
Year	Dormitory	Hospital	Kindergar	Office	School	University	total
0	-0,1	-13,7	-41,0	-15,5	0,0	0,0	-70,3
1	0,010	1,245	1,468	0,696	0,000	0,000	3,4
2	0,011	1,364	1,527	0,737	0,000	0,000	3,6
3	0,011	1,428	1,567	0,761	0,000	0,000	3,8
4	0,012	1,494	1,607	0,786	0,000	0,000	3,9
5	0,012	1,563	1,649	0,812	0,000	0,000	4,0
6	0,012	1,638	1,693	0,840	0,000	0,000	4,2
7	0,013	1,716	1,738	0,869	0,000	0,000	4,3
8	0,013	1,797	1,785	0,899	0,000	0,000	4,5
9	0,014	1,880	1,833	0,929	0,000	0,000	4,7
10	0,014	1,958	1,879	0,958	0,000	0,000	4,8
11	0,015	2,049	1,931	0,991	0,000	0,000	5,0
12	0,015	2,144	1,984	1,026	0,000	0,000	5,2
13	0,016	2,243	2,039	1,061	0,000	0,000	5,4
14	0,016	2,347	2,096	1,099	0,000	0,000	5,6
15	0,017	2,455	2,155	1,137	0,000	0,000	5,8
16	0,017	2,569	2,216	1,178	0,000	0,000	6,0
17	0,018	2,688	2,280	1,220	0,000	0,000	6,2
18	0,019	2,813	2,346	1,264	0,000	0,000	6,4
19	0,019	2,944	2,414	1,310	0,000	0,000	6,7
20	0,020	3,081	2,485	1,358	0,000	0,000	6,9
21	0,021	3,224	2,559	1,407	0,000	0,000	7,2
22	0,022	3,374	2,636	1,459	0,000	0,000	7,5
23	0,022	3,531	2,715	1,514	0,000	0,000	7,8
24	0,023	3,696	2,798	1,570	0,000	0,000	8,1
25	0,024	3,868	2,884	1,629	0,000	0,000	8,4
26	0,025	4,049	2,973	1,691	0,000	0,000	8,7
27	0,026	4,237	3,066	1,755	0,000	0,000	9,1
28	0,027	4,435	3,163	1,822	0,000	0,000	9,4
29	0,028	4,642	3,263	1,892	0,000	0,000	9,8
30	0,029	4,859	3,368	1,965	0,000	0,000	10,2

Fig. Cost of energy conserved

		Dormitory	Hospital	Kindergar	Office
Ranking of options		1	2	4	3
Cost of en	EUR/kWh	0,1	0,1	0,1	0,1
Final ener	kWh/m2	83,1	85,5	59,4	69,5
Final ener	GWh]	0,1	10,8	24,9	11,3

Cost of energy conserved: Improvement 2

	EUR/kWh	kWh/m2	
	y	x	
1	0,07	0,0	Dormitory
	0,07	83,1	
2	0,08	83,1	Hospital
	0,08	168,6	
3	0,09	168,6	Office
	0,09	238,1	
4	0,10	238,1	Kindergarten
	0,10	297,6	

Supply curve of energy conserved: Improvement 2

	EUR/kWh	GWh	
	y	x	
1	0,07	0,0	Dormitory
	0,07	0,1	
2	0,08	0,1	Hospital
	0,08	10,9	
3	0,09	10,9	Office
	0,09	22,2	
4	0,10	22,2	Kindergarten
	0,10	47,1	

Thermal efficiency retrofit of public buildings in Albania, analysis per m2

Improvement 1
Climate zone A

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerous benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price 2016 [EUR/kWh]	2030 [EUR/kWh]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity	0,104	0,160	0	1,0
Wood	0,024	0,037	0	0,2
LPG	0,061	0,247	227	1,1
Diesel oil	0,117	0,473	267	1,2
Solar	0,000	0,000	0	0,0

Financial analysis	**Units**	**Value**	**References**
Measure lifetime	[years]	30	
Discount rate	[%]	4%	
Annuity factor	[%]	6%	
Maintenance costs	[EUR/m2-yr.]	0,5	

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view			
GDP increase	[EUR/EUR]	0,65	
direct	[EUR/EUR]	0,30	
multiplier effects	[EUR/EUR]	0,35	
Labour income	[EUR/EUR]	0,30	
direct	[EUR/EUR]	0,17	
multiplier effects	[EUR/EUR]	0,13	
Employment	[jobs/million EUR]	148	
direct	[jobs/million EUR]	85	
multiplier effects	[jobs/million EUR]	63	
Monetized CO2 emissions avoided	[EUR/tCO2]	5	
Air quality including health impacts	[EUR/MWh]	1,4	
Improved comfort and services of buildings refle	[% value]	2%	*Assumed estate value is EUR 300 per m2

Summary of results

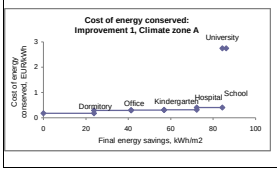
Investment and maintenance costs	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
Total	[EUR/m2]	**63**	**80**	**76**	**81**	**75**	**77**
Envelope cost	[EUR/m2]	15	14	21	19	19	22
HVAC system cost	[EUR/m2]	48	66	54	62	56	56
Maintenance cost	[EUR/m2-yr.]	0,5	0,5	0,5	0,5	0,5	0,5
Annualized total costs	[EUR/m2]	4,1	5,1	4,9	5,2	4,8	5,0
Cost of energy conserved (CEE)	[EUR/kWh]	0,2	0,3	0,3	0,3	0,4	2,7
Ranking of CEE		1	4	3	2	5	6

Energy/CO2 savings: improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
CO2 emissions	[gCO2/m2]	**1240**	**4721**	**1458**	**1589**	**532**	**849**
Electricity	[gCO2/m2]	0	0	0	0	0	0
Wood	[gCO2/m2]	0	0	0	0	0	0
LPG	[gCO2/m2]	-1676	0	491	-572	-186	0
Oil	[gCO2/m2]	2916	4721	967	2161	718	849
Solar	[gCO2/m2]	0	0	0	0	0	0
Primary energy	[kWh/m2]	**25,5**	**19,5**	**18,2**	**15,5**	**11,8**	**2,4**
Electricity	[kWh/m2]	20,5	-1,7	11,7	7,7	9,2	-1,4
Wood	[kWh/m2]	0,0	0,0	-0,3	0,9	0,2	0,0
LPG	[kWh/m2]	-8,1	0,0	2,4	-2,8	-0,9	0,0
Oil	[kWh/m2]	13,1	21,2	4,3	9,7	3,2	3,8
Solar	[kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0
Final energy	[kWh/m2]	**23,9**	**15,3**	**15,6**	**17,4**	**12,0**	**1,8**
Electricity	[kWh/m2]	20,3	-1,7	11,6	7,6	9,1	-1,4
Wood	[kWh/m2]	0,0	0,0	-1,3	4,3	1,0	0,0
LPG	[kWh/m2]	-7,4	0,0	2,2	-2,5	-0,8	0,0
Oil	[kWh/m2]	10,9	17,7	3,6	8,1	2,7	3,2
Solar	[kWh/m2]	0,0	-0,6	-0,5	-0,1	0,0	0,0

Saved energy costs / improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
Total over measure lifetime (NPV)	[EUR/m2]	**71,6**	**66,2**	**43,1**	**45,4**	**29,1**	**9,6**
Electricity	[EUR/m2]	43,7	-3,6	25,0	16,4	19,7	-2,9
Wood	[EUR/m2]	0,0	0,0	-0,6	2,2	0,5	0,0
LPG	[EUR/m2]	-15,2	0,0	4,5	-5,2	-1,7	0,0
Oil	[EUR/m2]	43,2	69,9	14,3	32,0	10,6	12,6
Solar	[EUR/m2]	0,0	0,0	0,0	0,0	0,0	0,0
Annual over measure lifetime	[EUR/m2]	**4,14**	**3,83**	**2,49**	**2,62**	**1,68**	**0,56**
Electricity	[EUR/m2]	2,53	-0,21	1,44	0,95	1,14	-0,17
Wood	[EUR/m2]	0,00	0,00	-0,04	0,13	0,03	0,00
LPG	[EUR/m2]	-0,88	0,00	0,26	-0,30	-0,10	0,00
Oil	[EUR/m2]	2,50	4,04	0,83	1,85	0,61	0,73
Solar	[EUR/m2]	0,00	0,00	0,00	0,00	0,00	0,00

Financial analysis / only saved energy	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
Simple payback	[years]	18,0	23,0	29,0	29,0	n/a	n/a
Internal rate of return	[%]	4,9%	2,8%	0,4%	0,4%	#NUM!	#NUM!
NPV	[EUR/m2]	8,3	-13,3	-31,4	-34,4	-44,2	-65,2
Cost - benefit ratio		0,9	1,2	1,8	1,8	2,6	8,0

Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
GDP increase	[EUR/m2]	40,9	51,9	49,1	52,7	48,7	50,3
Labour income	[EUR/m2]	18,7	23,8	22,5	24,2	22,4	23,1
Employment	[jobs/m2]	0,01	0,01	0,01	0,01	0,01	0,01
Monetized CO2 emissions avoided	[EUR/m2]	0,01	0,02	0,01	0,01	0,00	0,00
Air quality including health impacts	[EUR/m2]	0,03	0,02	0,02	0,02	0,02	0,00
Improved comfort and services of buildings	[EUR/m2]	6,00	6,00	6,00	6,00	6,00	6,00



Year	Saved energy costs: Changing energy prices Dormitory	Hospital	Kindergar	Office	School	University
0	-63,0	-80,0	-75,7	-81,2	-75,1	-77,5
1	2,9	1,9	1,7	1,7	1,2	0,2
2	3,1	2,1	1,8	1,8	1,3	0,3
3	3,1	2,2	1,9	1,8	1,3	0,3
4	3,2	2,3	1,9	1,9	1,3	0,3
5	3,3	2,4	2,0	2,0	1,4	0,3
6	3,4	2,6	2,0	2,0	1,4	0,3
7	3,5	2,7	2,1	2,1	1,4	0,4
8	3,6	2,8	2,1	2,2	1,5	0,4
9	3,6	3,0	2,2	2,2	1,5	0,4
10	3,7	3,1	2,2	2,3	1,5	0,4
11	3,8	3,3	2,3	2,4	1,6	0,5
12	3,9	3,4	2,4	2,5	1,6	0,5
13	4,0	3,6	2,4	2,5	1,7	0,5
14	4,2	3,8	2,5	2,6	1,7	0,5
15	4,3	4,0	2,6	2,7	1,7	0,6
16	4,4	4,2	2,6	2,8	1,8	0,6
17	4,5	4,4	2,7	2,9	1,8	0,6
18	4,6	4,6	2,8	3,0	1,9	0,7
19	4,8	4,8	2,9	3,1	1,9	0,7
20	4,9	5,0	3,0	3,2	2,0	0,8
21	5,0	5,3	3,1	3,3	2,0	0,8
22	5,2	5,5	3,2	3,4	2,1	0,9
23	5,3	5,8	3,3	3,6	2,1	0,9
24	5,5	6,1	3,4	3,7	2,2	0,9
25	5,7	6,4	3,5	3,8	2,2	1,0
26	5,8	6,7	3,6	4,0	2,3	1,0
27	6,0	7,0	3,7	4,1	2,4	1,1
28	6,2	7,4	3,8	4,3	2,4	1,1
29	6,4	7,7	3,9	4,4	2,5	1,2
30	6,6	8,1	4,1	4,6	2,6	1,3

Year	Cumulative cash flow: Changing energy prices Dormitory	Hospital	Kindergar	Office	School	University
0	-63,0	-80,0	-75,7	-81,2	-75,1	-77,5
1	-60,0	-78,1	-74,0	-79,5	-73,8	-77,2
2	-57,0	-76,0	-72,2	-77,7	-72,6	-77,0
3	-53,8	-73,8	-70,3	-75,8	-71,3	-76,7
4	-50,6	-71,5	-68,4	-73,9	-69,9	-76,4
5	-47,4	-69,1	-66,5	-72,0	-68,5	-76,1
6	-44,0	-66,5	-64,5	-70,0	-67,1	-75,7
7	-40,5	-63,8	-62,4	-67,9	-65,7	-75,4
8	-37,0	-60,9	-60,3	-65,7	-64,2	-75,0
9	-33,3	-58,0	-58,1	-63,5	-62,7	-74,6
10	-29,6	-54,8	-55,9	-61,2	-61,2	-74,1
11	-25,8	-51,6	-53,6	-58,8	-59,6	-73,7
12	-21,8	-48,2	-51,2	-56,4	-58,0	-73,2
13	-17,8	-44,6	-48,8	-53,8	-56,4	-72,7
14	-13,6	-40,8	-46,3	-51,2	-54,7	-72,1
15	-9,4	-36,8	-43,7	-48,5	-52,9	-71,5
16	-5,0	-32,7	-41,1	-45,7	-51,2	-70,9
17	-0,5	-28,3	-38,4	-42,8	-49,3	-70,3
18	4,2	-23,7	-35,6	-39,8	-47,5	-69,6
19	8,9	-18,9	-32,7	-36,7	-45,6	-68,9
20	13,8	-13,9	-29,7	-33,5	-43,6	-68,1
21	18,9	-8,6	-26,7	-30,2	-41,6	-67,3
22	24,1	-3,1	-23,5	-26,8	-39,5	-66,5
23	29,4	2,7	-20,2	-23,2	-37,4	-65,6
24	34,9	8,8	-16,9	-19,5	-35,2	-64,7
25	40,6	15,2	-13,4	-15,7	-33,0	-63,7
26	46,4	21,9	-9,9	-11,7	-30,7	-62,6
27	52,4	28,9	-6,2	-7,6	-28,3	-61,5
28	58,6	36,3	-2,4	-3,3	-25,9	-60,4
29	65,0	44,0	1,5	1,1	-23,4	-59,1
30	71,6	52,1	5,6	5,7	-20,8	-57,9

Fig. Cost of energy conserved

	Dormitory	Hospital	Kindergar	Office	School	University
Ranking of options	1	4	3	2	5	6
Cost of en	EUR/kWh	0,2	0,3	0,3	0,3	0,4	2,7
Final ener	kWh/m2	23,9	15,3	15,6	17,4	12,0	1,8

Cost of energy conserved: Improvement 1, Climate zone A

	y EUR/kWh	x kWh/m2	
1	0,2	0,0	Dormitory
	0,2	23,9	
2	0,3	23,9	Office
	0,3	41,3	
3	0,3	41,3	Kindergarten
	0,3	56,9	
4	0,3	56,9	Hospital
	0,3	72,2	
5	0,4	72,2	School
	0,4	84,3	
6	2,7	84,3	University
	2,7	86,1	

Thermal efficiency retrofit of public buildings in Albania, analysis per m2

Improvement 1
Climate zone B

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerous benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price 2016 [EUR/kWh]	2030 [EUR/kWh]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity	0,104	0,160	0	1,0
Wood	0,024	0,037	0	0,2
LPG	0,061	0,247	227	1,1
Diesel oil	0,117	0,473	267	1,2
Solar	0,000	0,000	0	0,0

Financial analysis	**Units**	**Value**	**References**
Measure lifetime	[years]	30	
Discount rate	[%]	4%	
Annuity factor	[%]	6%	
Maintenance costs	[EUR/m2]	0,5	

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view						
GDP increase	[EUR/EUR]	0,65				
direct	[EUR/EUR]	0,30				
multiplier effects	[EUR/EUR]	0,35				
Labour income	[EUR/EUR]	0,30				
direct	[EUR/EUR]	0,17				
multiplier effects	[EUR/EUR]	0,13				
Employment	[jobs/million EUR]	148				
direct	[jobs/million EUR]	85				
multiplier effects	[jobs/million EUR]	63				
Monetized CO2 emissions avoided	[EUR/tCO2]	5				
Air quality including health impacts	[EUR/MWh]	1,4				
Improved comfort and services of buildings refle	[% value]	2%	*Assumed estate value is	EUR	300	per m2

Summary of results

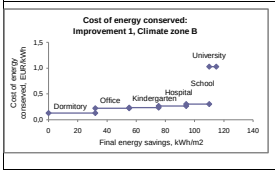
Investment and maintenance costs	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
Total	[EUR/m2]	**63**	**80**	**76**	**81**	**75**	**77**
Envelope cost	[EUR/m2]	15	14	21	19	19	22
HVAC system cost	[EUR/m2]	48	66	54	62	56	56
Maintenance cost	[EUR/m2-yr.]	0,5	0,5	0,5	0,5	0,5	0,5
Annualized total costs	[EUR/m2]	4,1	5,1	4,9	5,2	4,8	5,0
Cost of energy conserved (CEE)	[EUR/kWh]	0,1	0,3	0,2	0,2	0,3	1,0
Ranking of CEE		1	4	3	2	5	6

Energy/CO2 savings: improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
CO2 emissions	[gCO2/m2]	**1727**	**5437**	**1754**	**2065**	**545**	**1456**
Electricity	[gCO2/m2]	0	0	0	0	0	0
Wood	[gCO2/m2]	0	0	0	0	0	0
LPG	[gCO2/m2]	-1890	0	589	-765	-265	0
Oil	[gCO2/m2]	3617	5437	1165	2831	810	1456
Solar	[gCO2/m2]	0	0	0	0	0	0
Primary energy	[kWh/m2]	**34,2**	**23,4**	**23,1**	**20,7**	**14,8**	**5,9**
Electricity	[kWh/m2]	27,1	-1,0	15,4	10,6	12,0	-0,6
Wood	[kWh/m2]	0,0	0,0	-0,3	1,1	0,4	0,0
LPG	[kWh/m2]	-9,2	0,0	2,9	-3,7	-1,3	0,0
Oil	[kWh/m2]	16,3	24,4	5,2	12,7	3,6	6,5
Solar	[kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0
Final energy	[kWh/m2]	**32,1**	**18,7**	**20,1**	**23,2**	**15,8**	**4,9**
Electricity	[kWh/m2]	26,9	-1,0	15,2	10,5	11,9	-0,6
Wood	[kWh/m2]	0,0	0,0	-1,6	5,6	2,1	0,0
LPG	[kWh/m2]	-8,3	0,0	2,6	-3,4	-1,2	0,0
Oil	[kWh/m2]	13,5	20,4	4,4	10,6	3,0	5,5
Solar	[kWh/m2]	0,0	-0,6	-0,5	-0,1	0,0	0,0

Saved energy costs / improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
Total over measure lifetime (NPV)	[EUR/m2]	**94,1**	**78,3**	**54,5**	**60,3**	**36,3**	**20,3**
Electricity	[EUR/m2]	57,7	-2,1	32,7	22,6	25,6	-1,3
Wood	[EUR/m2]	0,0	0,0	-0,8	2,8	1,0	0,0
LPG	[EUR/m2]	-17,2	0,0	5,3	-6,9	-2,4	0,0
Oil	[EUR/m2]	53,5	80,5	17,2	41,9	12,0	21,6
Solar	[EUR/m2]	0,0	0,0	0,0	0,0	0,0	0,0
Annual over measure lifetime	[EUR/m2]	**5,44**	**4,53**	**3,15**	**3,49**	**2,10**	**1,17**
Electricity	[EUR/m2]	3,34	-0,12	1,89	1,30	1,48	-0,07
Wood	[EUR/m2]	0,00	0,00	-0,05	0,16	0,06	0,00
LPG	[EUR/m2]	-0,99	0,00	0,31	-0,40	-0,14	0,00
Oil	[EUR/m2]	3,10	4,65	1,00	2,42	0,69	1,25
Solar	[EUR/m2]	0,00	0,00	0,00	0,00	0,00	0,00

Financial analysis / only saved energy	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
Simple payback	[years]	14,0	21,0	25,0	24,0	n/a	n/a
Internal rate of return	[%]	7,1%	3,9%	1,8%	2,1%	-0,6%	#NUM!
NPV	[EUR/m2]	30,0	-1,6	-20,4	-20,0	-37,3	-55,0
Cost - benefit ratio		0,7	1,0	1,4	1,3	2,1	3,8

Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
GDP increase	[EUR/m2]	40,9	51,9	49,1	52,7	48,7	50,3
Labour income	[EUR/m2]	18,7	23,8	22,5	24,2	22,4	23,1
Annual employment	[jobs/m2]	0,01	0,01	0,01	0,01	0,01	0,01
Monetized CO2 emissions avoided	[EUR/m2]	0,01	0,03	0,01	0,01	0,00	0,01
Air quality including health impacts	[EUR/m2]	0,04	0,03	0,03	0,03	0,02	0,01
Improved comfort and services of buildings	[EUR/m2]	6,00	6,00	6,00	6,00	6,00	6,00



Year	Saved energy costs: Changing energy prices Dormitory	Hospital	Kindergar	Office	School	University
0	-63,0	-80,0	-75,7	-81,2	-75,1	-77,5
1	3,9	2,9	2,2	2,3	1,6	0,6
2	4,0	2,5	2,3	2,4	1,6	0,6
3	4,1	2,7	2,4	2,5	1,7	0,7
4	4,2	2,8	2,4	2,5	1,7	0,7
5	4,3	2,9	2,5	2,6	1,7	0,7
6	4,4	3,1	2,6	2,7	1,8	0,8
7	4,6	3,2	2,6	2,8	1,8	0,8
8	4,7	3,4	2,7	2,9	1,8	0,9
9	4,8	3,5	2,8	3,0	1,9	0,9
10	4,9	3,7	2,8	3,1	1,9	1,0
11	5,0	3,9	2,9	3,2	2,0	1,0
12	5,2	4,1	3,0	3,3	2,0	1,0
13	5,3	4,3	3,1	3,4	2,1	1,1
14	5,5	4,5	3,2	3,5	2,1	1,2
15	5,6	4,7	3,2	3,6	2,2	1,2
16	5,8	4,9	3,3	3,7	2,2	1,3
17	5,9	5,1	3,4	3,8	2,3	1,3
18	6,1	5,4	3,5	4,0	2,3	1,4
19	6,3	5,7	3,6	4,1	2,4	1,5
20	6,4	5,9	3,7	4,3	2,4	1,5
21	6,6	6,2	3,9	4,4	2,5	1,6
22	6,8	6,5	4,0	4,6	2,6	1,7
23	7,0	6,8	4,1	4,7	2,6	1,8
24	7,2	7,2	4,2	4,9	2,7	1,9
25	7,4	7,5	4,3	5,1	2,8	2,0
26	7,7	7,9	4,5	5,3	2,8	2,1
27	7,9	8,2	4,6	5,4	2,9	2,2
28	8,1	8,6	4,8	5,6	3,0	2,3
29	8,4	9,0	4,9	5,9	3,0	2,4
30	8,6	9,5	5,1	6,1	3,1	2,5

Year	Cumulative cash flow: Changing energy prices Dormitory	Hospital	Kindergar	Office	School	University
0	-63,0	-80,0	-75,7	-81,2	-75,1	-77,5
1	-59,1	-77,8	-73,5	-78,9	-73,5	-76,9
2	-55,1	-75,2	-71,2	-76,5	-71,9	-76,3
3	-51,0	-72,6	-68,8	-74,1	-70,2	-75,6
4	-46,7	-69,8	-66,4	-71,5	-68,6	-74,9
5	-42,4	-66,9	-63,9	-68,9	-66,8	-74,1
6	-38,0	-63,8	-61,4	-66,2	-65,1	-73,4
7	-33,4	-60,6	-58,8	-63,4	-63,3	-72,5
8	-28,8	-57,2	-56,1	-60,6	-61,4	-71,7
9	-24,0	-53,7	-53,3	-57,6	-59,5	-70,7
10	-19,0	-50,0	-50,5	-54,5	-57,6	-69,8
11	-14,0	-46,1	-47,6	-51,4	-55,6	-68,8
12	-8,8	-42,0	-44,6	-48,1	-53,6	-67,8
13	-3,5	-37,8	-41,5	-44,7	-51,6	-66,7
14	1,9	-33,3	-38,4	-41,3	-49,4	-65,5
15	7,5	-28,6	-35,1	-37,7	-47,3	-64,3
16	13,3	-23,7	-31,8	-33,9	-45,1	-63,0
17	19,2	-18,6	-28,3	-30,1	-42,8	-61,7
18	25,3	-13,2	-24,8	-26,1	-40,5	-60,3
19	31,6	-7,5	-21,2	-22,0	-38,1	-58,8
20	38,0	-1,6	-17,4	-17,8	-35,7	-57,3
21	44,6	4,6	-13,6	-13,3	-33,2	-55,7
22	51,5	11,1	-9,6	-8,8	-30,7	-54,0
23	58,5	18,0	-5,5	-4,1	-28,0	-52,2
24	65,7	25,1	-1,3	0,8	-25,4	-50,3
25	73,1	32,6	3,1	5,9	-22,6	-48,4
26	80,8	40,5	7,6	11,2	-19,8	-46,3
27	88,7	48,7	12,2	16,6	-16,9	-44,2
28	96,8	57,3	16,9	22,2	-13,9	-41,9
29	105,2	66,4	21,9	28,1	-10,9	-39,5
30	113,9	75,8	26,9	34,2	-7,7	-37,0

Fig. Cost of energy conserved

	Dormitory	Hospital	Kindergar	Office	School	University
Ranking of options	1	4	3	2	5	6
Cost of en	EUR/kWh	0,1	0,3	0,2	0,2	0,3	1,0
Final ener	kWh/m2	32,1	18,7	20,1	23,2	15,8	4,9

Cost of energy conserved: Improvement 1, Climate zone B

	y EUR/kWh	x kWh/m2	
1	0,1	0,0	Dormitory
	0,1	32,1	
2	0,2	32,1	Office
	0,2	55,3	
3	0,2	55,3	Kindergarten
	0,2	75,4	
4	0,3	75,4	Hospital
	0,3	94,1	
5	0,3	94,1	School
	0,3	110,0	
6	1,0	110,0	University
	1,0	114,8	

Thermal efficiency retrofit of public buildings in Albania, analysis per m2

Improvement 1
Climate zone C

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerous benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price 2016 [EUR/kWh]	2030 [EUR/kWh]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity	0,104	0,160	0	1,0
Wood	0,024	0,037	0	0,2
LPG	0,061	0,247	227	1,1
Diesel oil	0,117	0,473	267	1,2
Solar	0,000	0,000	0	0,0

Financial analysis	**Units**	**Value**	**References**
Measure lifetime	[years]	30	
Discount rate	[%]	4%	
Annuity factor	[%]	6%	
Maintenance costs	[EUR/m2]	0,5	

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view			
GDP increase	[EUR/EUR]	0,65	
direct	[EUR/EUR]	0,30	
multiplier effects	[EUR/EUR]	0,35	
Labour income	[EUR/EUR]	0,30	
direct	[EUR/EUR]	0,17	
multiplier effects	[EUR/EUR]	0,13	
Employment	[jobs/million EUR]	148	
direct	[jobs/million EUR]	85	
multiplier effects	[jobs/million EUR]	63	
Monetized CO2 emissions avoided	[EUR/tCO2]	5	
Air quality including health impacts	[EUR/MWh]	1,4	
Improved comfort and services of buildings refle	[% value]	2%	*Assumed estate value is EUR 300 per m2

Summary of results

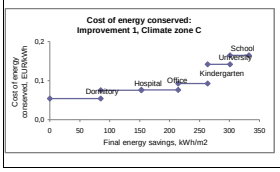
Investment and maintenance costs	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
Total	[EUR/m2]	**71**	**80**	**71**	**73**	**81**	**82**
Envelope cost	[EUR/m2]	15	14	21	19	19	22
HVAC system cost	[EUR/m2]	56	66	49	53	62	61
Maintenance cost	[EUR/m2-yr.]	0,5	0,5	0,5	0,5	0,5	0,5
Annualized total costs	[EUR/m2]	4,6	5,1	4,6	4,7	5,2	5,3
Cost of energy conserved (CEE)	[EUR/kWh]	0,1	0,1	0,1	0,1	0,2	0,1
Ranking of CEE		1	2	4	3	6	5

Energy/CO2 savings: improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
CO2 emissions	[gCO2/m2]	**7552**	**16382**	**1796**	**3926**	**1147**	**5688**
Electricity	[gCO2/m2]	0	0	0	0	0	0
Wood	[gCO2/m2]	0	0	0	0	0	0
LPG	[gCO2/m2]	-2647	0	-190	-990	-199	688
Oil	[gCO2/m2]	10199	16382	1986	4916	1346	5000
Solar	[gCO2/m2]	0	0	0	0	0	0
Primary energy	[kWh/m2]	**52,1**	**66,9**	**22,2**	**33,0**	**18,4**	**25,2**
Electricity	[kWh/m2]	9,2	-10,1	7,0	7,7	9,9	-4,6
Wood	[kWh/m2]	9,9	3,4	7,2	8,0	3,5	4,0
LPG	[kWh/m2]	-12,8	0,0	-0,9	-4,8	-1,0	3,3
Oil	[kWh/m2]	45,8	73,6	8,9	22,1	6,1	22,5
Solar	[kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0
Final energy	[kWh/m2]	**85,2**	**67,5**	**49,2**	**61,5**	**31,5**	**37,2**
Electricity	[kWh/m2]	9,1	-10,0	6,9	7,6	9,8	-4,6
Wood	[kWh/m2]	49,6	16,8	36,2	39,9	17,6	20,1
LPG	[kWh/m2]	-11,7	0,0	-0,8	-4,4	-0,9	3,0
Oil	[kWh/m2]	38,2	61,4	7,4	18,4	5,0	18,7
Solar	[kWh/m2]	0,0	-0,6	-0,5	-0,1	0,0	0,0

Saved energy costs / improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
Total over measure lifetime (NPV)	[EUR/m2]	**171,4**	**229,5**	**60,8**	**100,2**	**47,9**	**80,5**
Electricity	[EUR/m2]	19,5	-21,5	14,9	16,4	21,0	-9,9
Wood	[EUR/m2]	25,0	8,5	18,2	20,1	8,8	10,1
LPG	[EUR/m2]	-24,0	0,0	-1,7	-9,0	-1,8	6,2
Oil	[EUR/m2]	150,9	242,5	29,4	72,8	19,9	74,0
Solar	[EUR/m2]	0,0	0,0	0,0	0,0	0,0	0,0
Annual over measure lifetime	[EUR/m2]	**9,91**	**13,27**	**3,52**	**5,80**	**2,77**	**4,65**
Electricity	[EUR/m2]	1,13	-1,24	0,86	0,95	1,21	-0,57
Wood	[EUR/m2]	1,44	0,49	1,05	1,16	0,51	0,59
LPG	[EUR/m2]	-1,39	0,00	-0,10	-0,52	-0,10	0,36
Oil	[EUR/m2]	8,73	14,02	1,70	4,21	1,15	4,28
Solar	[EUR/m2]	0,00	0,00	0,00	0,00	0,00	0,00

Financial analysis / only saved energy	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
Simple payback	[years]	10,0	10,0	22,0	16,0	28,0	21,0
Internal rate of return	[%]	11,3%	12,5%	3,0%	6,4%	0,6%	3,8%
NPV	[EUR/m2]	96,6	143,5	-9,7	26,5	-31,9	-1,9
Cost - benefit ratio		0,4	0,3	1,2	0,7	1,7	1,0

Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**	**School**	**University**
GDP increase	[EUR/m2]	46,0	52,1	46,0	47,2	52,6	53,5
Labour income	[EUR/m2]	21,1	23,9	21,1	21,7	24,1	24,6
Annual employment	[jobs/m2]	0,01	0,01	0,01	0,01	0,01	0,01
Monetized CO2 emissions avoided	[EUR/m2]	0,04	0,08	0,01	0,02	0,01	0,03
Air quality including health impacts	[EUR/m2]	0,12	0,09	0,07	0,08	0,04	0,05
Improved comfort and services of buildings	[EUR/m2]	6,00	6,00	6,00	6,00	6,00	6,00



Saved energy costs

Changing energy prices

Year	Dormitory	Hospital	Kindergar	Office	School	University
0	-71,0	-80,2	-70,9	-72,7	-81,1	-82,5
1	5,9	6,6	2,4	3,7	2,0	2,4
2	6,3	7,3	2,5	3,9	2,1	2,5
3	6,6	7,7	2,6	4,0	2,1	2,8
4	6,8	8,0	2,7	4,1	2,2	2,9
5	7,1	8,5	2,7	4,3	2,2	3,0
6	7,3	8,9	2,8	4,4	2,3	3,2
7	7,6	9,4	2,9	4,6	2,3	3,3
8	7,9	9,8	3,0	4,7	2,4	3,5
9	8,2	10,3	3,1	4,9	2,4	3,7
10	8,5	10,8	3,1	5,0	2,5	3,8
11	8,8	11,3	3,2	5,2	2,6	4,0
12	9,1	11,9	3,3	5,4	2,6	4,2
13	9,5	12,5	3,4	5,6	2,7	4,4
14	9,8	13,1	3,5	5,8	2,8	4,6
15	10,2	13,7	3,6	6,0	2,9	4,8
16	10,6	14,4	3,7	6,2	2,9	5,0
17	11,0	15,1	3,8	6,4	3,0	5,3
18	11,5	15,8	4,0	6,6	3,1	5,5
19	11,9	16,6	4,1	6,9	3,2	5,8
20	12,4	17,4	4,2	7,1	3,3	6,1
21	12,9	18,3	4,3	7,4	3,4	6,3
22	13,4	19,2	4,5	7,7	3,5	6,6
23	14,0	20,1	4,6	8,0	3,6	7,0
24	14,5	21,1	4,8	8,3	3,7	7,3
25	15,1	22,1	4,9	8,6	3,8	7,6
26	15,7	23,2	5,1	8,9	3,9	8,0
27	16,4	24,3	5,2	9,2	4,0	8,4
28	17,1	25,5	5,4	9,6	4,1	8,8
29	17,8	26,8	5,6	10,0	4,3	9,2
30	18,5	28,1	5,8	10,3	4,4	9,6

Cumulative cash flow

Changing energy prices

Year	Dormitory	Hospital	Kindergar	Office	School	University
0	-71,0	-80,2	-70,9	-72,7	-81,1	-82,5
1	-65,0	-73,7	-68,5	-69,1	-79,1	-80,1
2	-58,7	-66,4	-66,0	-65,2	-77,1	-77,5
3	-52,2	-58,7	-63,4	-61,2	-75,0	-74,7
4	-45,4	-50,7	-60,7	-57,1	-72,8	-71,8
5	-38,3	-42,2	-58,0	-52,8	-70,6	-68,8
6	-31,0	-33,3	-55,1	-48,4	-68,3	-65,6
7	-23,4	-24,0	-52,2	-43,8	-66,0	-62,2
8	-15,5	-14,1	-49,3	-39,1	-63,6	-58,8
9	-7,3	-3,8	-46,2	-34,2	-61,2	-55,1
10	1,2	7,0	-43,1	-29,2	-58,7	-51,3
11	10,0	18,3	-39,8	-24,0	-56,1	-47,3
12	19,1	30,2	-36,5	-18,6	-53,5	-43,1
13	28,6	42,6	-33,1	-13,0	-50,8	-38,7
14	38,4	55,7	-29,6	-7,2	-48,0	-34,1
15	48,7	69,4	-26,0	-1,3	-45,1	-29,3
16	59,3	83,8	-22,2	4,9	-42,2	-24,3
17	70,4	98,9	-18,4	11,4	-39,2	-19,0
18	81,8	114,8	-14,4	18,0	-36,1	-13,5
19	93,8	131,4	-10,3	24,9	-32,9	-7,7
20	106,2	148,8	-6,1	32,0	-29,6	-1,6
21	119,1	167,1	-1,8	39,4	-26,3	4,7
22	132,5	186,3	2,7	47,1	-22,8	11,4
23	146,5	206,4	7,3	55,1	-19,2	18,3
24	161,0	227,5	12,1	63,3	-15,6	25,6
25	176,1	249,6	17,0	71,9	-11,8	33,3
26	191,9	272,8	22,0	80,8	-7,9	41,3
27	208,3	297,2	27,3	90,0	-3,9	49,7
28	225,3	322,7	32,7	99,6	0,2	58,4
29	243,1	349,5	38,3	109,6	4,5	67,6
30	261,6	377,5	44,0	119,9	8,9	77,2

Fig. Cost of energy conserved

	Dormitory	Hospital	Kindergar	Office	School	University
Ranking of options	1	2	4	3	6	5
Cost of en	[EUR/kWh] 0,1	0,1	0,1	0,1	0,2	0,1
Final ener	[kWh/m2] 85,2	67,5	49,2	61,5	31,5	37,2

Cost of energy conserved: Improvement 1, Climate zone C

EUR/kWh kWh/m2

	y	x	
1	0,1	0,0	Dormitory
	0,1	85,2	
2	0,1	85,2	Hospital
	0,1	152,7	
3	0,1	152,7	Office
	0,1	214,2	
4	0,1	214,2	Kindergarten
	0,1	263,4	
5	0,1	263,4	University
	0,1	300,7	
6	0,2	300,7	School
	0,2	332,1	

Thermal efficiency retrofit of public buildings in Albania, analysis per m2

Improvement 2
Climate zone A

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerous benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price 2016 [EUR/kWh]	2030 [EUR/kWh]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity	0,104	0,160	0	1,0
Wood	0,024	0,037	0	0,2
LPG	0,061	0,247	227	1,1
Diesel oil	0,117	0,473	267	1,2
Solar	0,000	0,000	0	0,0

Financial analysis	**Units**	**Value**	**References**
Measure lifetime	[years]	30	
Discount rate	[%]	4%	
Annuity factor	[%]	6%	
Maintenance costs	[EUR/m2]	0,5	

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view						
GDP increase	[EUR/EUR]	0,65				
direct	[EUR/EUR]	0,30				
multiplier effects	[EUR/EUR]	0,35				
Labour income	[EUR/EUR]	0,30				
direct	[EUR/EUR]	0,17				
multiplier effects	[EUR/EUR]	0,13				
Employment	[jobs/million EUR]	148				
direct	[jobs/million EUR]	85				
multiplier effects	[jobs/million EUR]	63				
Monetized CO2 emissions avoided	[EUR/tCO2]	5				
Air quality including health impacts	[EUR/MWh]	1,4				
Improved comfort and services of buildings refle	[% value]	2%	*Assumed estate value is	EUR	300	per m2

Summary of results

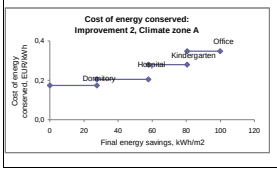
Investment and maintenance costs	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
Total	[EUR/m2]	**87**	**108**	**105**	**109**
Envelope cost	[EUR/m2]	20	24	30	27
HVAC system cost	[EUR/m2]	67	84	76	81
Maintenance cost	[EUR/m2-yr.]	0,5	0,5	0,5	0,5
Annualized total costs	[EUR/m2]	5,6	6,7	6,6	6,8
Cost of energy conserved (CEE)	[EUR/kWh]	0,2	0,2	0,3	0,3
Ranking of CEE		1	2	3	4

Energy/CO2 savings: improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
CO2 emissions	[gCO2/m2]	**1090**	**6110**	**1851**	**1574**
Electricity	[gCO2/m2]	0	0	0	0
Wood	[gCO2/m2]	0	0	0	0
LPG	[gCO2/m2]	-1826	0	425	-587
Oil	[gCO2/m2]	2916	6110	1426	2161
Solar	[gCO2/m2]	0	0	0	0
Primary energy	[kWh/m2]	**37,0**	**37,4**	**26,1**	**18,0**
Electricity	[kWh/m2]	33,6	9,9	17,9	10,4
Wood	[kWh/m2]	-0,9	0,0	-0,3	0,7
LPG	[kWh/m2]	-8,8	0,0	2,1	-2,8
Oil	[kWh/m2]	13,1	27,5	6,4	9,7
Solar	[kWh/m2]	0,0	0,0	0,0	0,0
Final energy	[kWh/m2]	**27,5**	**30,4**	**22,7**	**19,3**
Electricity	[kWh/m2]	33,3	9,8	17,7	10,3
Wood	[kWh/m2]	-4,4	0,0	-1,4	3,7
LPG	[kWh/m2]	-8,0	0,0	1,9	-2,6
Oil	[kWh/m2]	10,9	22,9	5,3	8,1
Solar	[kWh/m2]	-4,3	-2,4	-0,9	-0,1

Saved energy costs / improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
Total over measure lifetime (NPV)	[EUR/m2]	**96,0**	**111,6**	**62,4**	**50,6**
Electricity	[EUR/m2]	71,6	21,1	38,1	22,2
Wood	[EUR/m2]	-2,2	0,0	-0,7	1,8
LPG	[EUR/m2]	-16,6	0,0	3,9	-5,3
Oil	[EUR/m2]	43,2	90,4	21,1	32,0
Solar	[EUR/m2]	0,0	0,0	0,0	0,0
Annual over measure lifetime	[EUR/m2]	**5,55**	**6,45**	**3,61**	**2,93**
Electricity	[EUR/m2]	4,14	1,22	2,20	1,28
Wood	[EUR/m2]	-0,13	0,00	-0,04	0,11
LPG	[EUR/m2]	-0,96	0,00	0,22	-0,31
Oil	[EUR/m2]	2,50	5,23	1,22	1,85
Solar	[EUR/m2]	0,00	0,00	0,00	0,00

Financial analysis / only saved energy	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
Simple payback	[years]	18,0	20,0	28,0	n/a
Internal rate of return	[%]	4,7%	4,2%	0,6%	-0,7%
NPV	[EUR/m2]	8,3	3,8	-41,3	-55,8
Cost - benefit ratio		0,9	1,0	1,7	2,1

Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
GDP increase	[EUR/m2]	56,7	69,8	68,3	70,5
Labour income	[EUR/m2]	26,0	32,0	31,3	32,4
Annual employment	[jobs/m2]	0,01	0,02	0,02	0,02
Monetized CO2 emissions avoided	[EUR/m2]	0,01	0,03	0,01	0,01
Air quality including health impacts	[EUR/m2]	0,04	0,04	0,03	0,03
Improved comfort and services of buildings	[EUR/m2]	6,00	6,00	6,00	6,00



	Saved energy costs					
	Changing energy prices					
Year	Dormitory	Hospital	Kindergar	Office	0	0
0	-87,4	-107,6	-105,3	-108,7	0,0	0,0
1	4,1	3,7	2,5	2,0	0,0	0,0
2	4,3	4,0	2,6	2,0	0,0	0,0
3	4,4	4,1	2,7	2,1	0,0	0,0
4	4,5	4,3	2,8	2,2	0,0	0,0
5	4,6	4,5	2,9	2,2	0,0	0,0
6	4,7	4,7	2,9	2,3	0,0	0,0
7	4,8	4,9	3,0	2,4	0,0	0,0
8	4,9	5,1	3,1	2,4	0,0	0,0
9	5,0	5,3	3,2	2,5	0,0	0,0
10	5,1	5,5	3,2	2,6	0,0	0,0
11	5,2	5,7	3,3	2,7	0,0	0,0
12	5,3	5,9	3,4	2,8	0,0	0,0
13	5,5	6,1	3,5	2,8	0,0	0,0
14	5,6	6,4	3,6	2,9	0,0	0,0
15	5,7	6,7	3,7	3,0	0,0	0,0
16	5,9	6,9	3,8	3,1	0,0	0,0
17	6,0	7,2	3,9	3,2	0,0	0,0
18	6,1	7,5	4,0	3,3	0,0	0,0
19	6,3	7,8	4,2	3,4	0,0	0,0
20	6,4	8,2	4,3	3,5	0,0	0,0
21	6,6	8,5	4,4	3,7	0,0	0,0
22	6,8	8,9	4,5	3,8	0,0	0,0
23	6,9	9,2	4,7	3,9	0,0	0,0
24	7,1	9,6	4,8	4,0	0,0	0,0
25	7,3	10,0	4,9	4,2	0,0	0,0
26	7,5	10,5	5,1	4,3	0,0	0,0
27	7,7	10,9	5,3	4,5	0,0	0,0
28	7,9	11,4	5,4	4,6	0,0	0,0
29	8,1	11,9	5,6	4,8	0,0	0,0
30	8,3	12,4	5,8	5,0	0,0	0,0

	Cumulative cash flow					
	Changing energy prices					
Year	Dormitory	Hospital	Kindergar	Office	0	0
0	-87,4	-107,6	-105,3	-108,7	0,0	0,0
1	-83,2	-103,9	-102,7	-106,7	0,0	0,0
2	-79,0	-99,9	-100,1	-104,7	0,0	0,0
3	-74,8	-95,8	-97,4	-102,6	0,0	0,0
4	-70,2	-91,5	-94,6	-100,4	0,0	0,0
5	-65,6	-87,0	-91,7	-98,2	0,0	0,0
6	-60,9	-82,3	-88,8	-95,9	0,0	0,0
7	-56,2	-77,5	-85,8	-93,5	0,0	0,0
8	-51,3	-72,4	-82,7	-91,1	0,0	0,0
9	-46,3	-67,1	-79,5	-88,5	0,0	0,0
10	-41,2	-61,7	-76,3	-85,9	0,0	0,0
11	-36,0	-56,0	-73,0	-83,3	0,0	0,0
12	-30,7	-50,1	-69,5	-80,5	0,0	0,0
13	-25,3	-44,0	-66,0	-77,7	0,0	0,0
14	-19,7	-37,6	-62,4	-74,8	0,0	0,0
15	-14,0	-30,9	-58,7	-71,7	0,0	0,0
16	-8,1	-24,0	-54,9	-68,6	0,0	0,0
17	-2,1	-16,7	-50,9	-65,4	0,0	0,0
18	4,0	-9,2	-46,9	-62,1	0,0	0,0
19	10,3	-1,4	-42,7	-58,7	0,0	0,0
20	16,8	6,8	-38,5	-55,1	0,0	0,0
21	23,4	15,3	-34,1	-51,5	0,0	0,0
22	30,1	24,2	-29,5	-47,7	0,0	0,0
23	37,1	33,4	-24,9	-43,8	0,0	0,0
24	44,2	43,1	-20,1	-39,7	0,0	0,0
25	51,5	53,1	-15,1	-35,5	0,0	0,0
26	59,0	63,6	-10,0	-31,2	0,0	0,0
27	66,7	74,5	-4,8	-26,7	0,0	0,0
28	74,8	85,9	0,7	-22,1	0,0	0,0
29	82,7	97,8	6,2	-17,2	0,0	0,0
30	91,1	110,2	12,0	-12,3	0,0	0,0

Fig. Cost of energy conserved

		Dormitory	Hospital	Kindergar	Office		
Ranking of options		1	2	3	4		
Cost of en	[EUR/kWh	0,2	0,2	0,3	0,3		
Final ener	[kWh/m2]	27,5	30,4	22,7	19,3		

Cost of energy conserved: Improvement 2, Climate zone A

	EUR/kWh	kWh/m2	
	y	x	
1	0,2	0,0	Dormitory
	0,2	27,5	
2	0,2	27,5	Hospital
	0,2	57,9	
3	0,3	57,9	Kindergarten

Thermal efficiency retrofit of public buildings in Albania, analysis per m2

Improvement 2
Climate zone B

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerous benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price 2016 [EUR/kWh]	2030 [EUR/kWh]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity	0,104	0,160	0	1,0
Wood	0,024	0,037	0	0,2
LPG	0,061	0,247	227	1,1
Diesel oil	0,117	0,473	267	1,2
Solar	0,000	0,000	0	0,0

Financial analysis	**Units**	**Value**	**References**
Measure lifetime	[years]	30	
Discount rate	[%]	4%	
Annuity factor	[%]	6%	
Maintenance costs	[EUR/m2]	0,5	

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view						
GDP increase	[EUR/EUR]	0,65				
direct	[EUR/EUR]	0,30				
multiplier effects	[EUR/EUR]	0,35				
Labour income	[EUR/EUR]	0,30				
direct	[EUR/EUR]	0,17				
multiplier effects	[EUR/EUR]	0,13				
Employment	[jobs/million EUR]	148				
direct	[jobs/million EUR]	85				
multiplier effects	[jobs/million EUR]	63				
Monetized CO2 emissions avoided	[EUR/tCO2]	5				
Air quality including health impacts	[EUR/MWh]	1,4				
Improved comfort and services of buildings refle	[% value]	2%	*Assumed estate value is	EUR	300	per m2

Summary of results

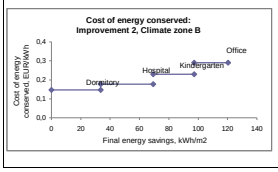
Investment and maintenance costs	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
Total	[EUR/m2]	**87**	**108**	**105**	**109**
Envelope cost	[EUR/m2]	20	24	30	27
HVAC system cost	[EUR/m2]	67	84	76	81
Maintenance cost	[EUR/m2-yr.]	0,5	0,5	0,5	0,5
Annualized total costs	[EUR/m2]	5,6	6,7	6,6	6,8
Cost of energy conserved (CEE)	[EUR/kWh]	0,1	0,2	0,2	0,3
Ranking of CEE		1	2	3	4

Energy/CO2 savings: improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
CO2 emissions	[gCO2/m2]	**1467**	**7160**	**2224**	**2065**
Electricity	[gCO2/m2]	0	0	0	0
Wood	[gCO2/m2]	0	0	0	0
LPG	[gCO2/m2]	-2149	0	504	-765
Oil	[gCO2/m2]	3617	7160	1720	2831
Solar	[gCO2/m2]	0	0	0	0
Primary energy	[kWh/m2]	**44,9**	**43,6**	**31,8**	**20,7**
Electricity	[kWh/m2]	40,3	11,4	22,0	10,6
Wood	[kWh/m2]	-1,2	0,0	-0,4	1,1
LPG	[kWh/m2]	-10,4	0,0	2,4	-3,7
Oil	[kWh/m2]	16,3	32,2	7,7	12,7
Solar	[kWh/m2]	0,0	0,0	0,0	0,0
Final energy	[kWh/m2]	**33,6**	**35,8**	**27,8**	**23,2**
Electricity	[kWh/m2]	39,9	11,3	21,7	10,5
Wood	[kWh/m2]	-6,0	0,0	-1,8	5,6
LPG	[kWh/m2]	-9,5	0,0	2,2	-3,4
Oil	[kWh/m2]	13,5	26,8	6,4	10,6
Solar	[kWh/m2]	-4,3	-2,4	-0,9	-0,1

Saved energy costs / improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
Total over measure lifetime (NPV)	[EUR/m2]	**116,8**	**130,3**	**75,9**	**60,3**
Electricity	[EUR/m2]	85,8	24,3	46,7	22,6
Wood	[EUR/m2]	-3,0	0,0	-0,9	2,8
LPG	[EUR/m2]	-19,5	0,0	4,6	-6,9
Oil	[EUR/m2]	53,5	106,0	25,5	41,9
Solar	[EUR/m2]	0,0	0,0	0,0	0,0
Annual over measure lifetime	[EUR/m2]	**6,75**	**7,53**	**4,39**	**3,49**
Electricity	[EUR/m2]	4,96	1,40	2,70	1,30
Wood	[EUR/m2]	-0,18	0,00	-0,05	0,16
LPG	[EUR/m2]	-1,13	0,00	0,26	-0,40
Oil	[EUR/m2]	3,10	6,13	1,47	2,42
Solar	[EUR/m2]	0,00	0,00	0,00	0,00

Financial analysis / only saved energy	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
Simple payback	[years]	15,0	18,0	25,0	29,0
Internal rate of return	[%]	6,2%	5,3%	1,8%	0,3%
NPV	[EUR/m2]	28,2	21,7	-28,2	-46,5
Cost - benefit ratio		0,7	0,8	1,4	1,8

Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
GDP increase	[EUR/m2]	56,7	69,8	68,3	70,5
Labour income	[EUR/m2]	26,0	32,0	31,3	32,4
Annual employment	[jobs/m2]	0,01	0,02	0,02	0,02
Monetized CO2 emissions avoided	[EUR/m2]	0,01	0,04	0,01	0,01
Air quality including health impacts	[EUR/m2]	0,05	0,05	0,04	0,03
Improved comfort and services of buildings	[EUR/m2]	6,00	6,00	6,00	6,00



	Saved energy costs, Changing energy prices					
Year	Dormitory	Hospital	Kindergar	Office	0	0
0	-87,4	-107,6	-105,3	-108,7	0,0	0,0
1	5,0	4,3	3,1	2,3	0,0	0,0
2	5,2	4,7	3,2	2,4	0,0	0,0
3	5,3	4,8	3,3	2,5	0,0	0,0
4	5,4	5,0	3,4	2,5	0,0	0,0
5	5,5	5,2	3,5	2,6	0,0	0,0
6	5,6	5,4	3,6	2,7	0,0	0,0
7	5,8	5,7	3,7	2,8	0,0	0,0
8	5,9	5,9	3,8	2,9	0,0	0,0
9	6,0	6,1	3,9	3,0	0,0	0,0
10	6,2	6,4	4,0	3,1	0,0	0,0
11	6,3	6,6	4,1	3,2	0,0	0,0
12	6,5	6,9	4,2	3,3	0,0	0,0
13	6,6	7,2	4,3	3,4	0,0	0,0
14	6,8	7,5	4,4	3,5	0,0	0,0
15	7,0	7,8	4,5	3,6	0,0	0,0
16	7,1	8,1	4,6	3,7	0,0	0,0
17	7,3	8,4	4,8	3,8	0,0	0,0
18	7,5	8,8	4,9	4,0	0,0	0,0
19	7,7	9,2	5,1	4,1	0,0	0,0
20	7,9	9,5	5,2	4,3	0,0	0,0
21	8,1	9,9	5,4	4,4	0,0	0,0
22	8,3	10,4	5,5	4,6	0,0	0,0
23	8,5	10,8	5,7	4,7	0,0	0,0
24	8,7	11,3	5,8	4,9	0,0	0,0
25	8,9	11,7	6,0	5,1	0,0	0,0
26	9,2	12,2	6,2	5,3	0,0	0,0
27	9,4	12,8	6,4	5,4	0,0	0,0
28	9,7	13,3	6,6	5,6	0,0	0,0
29	9,9	13,9	6,8	5,9	0,0	0,0
30	10,2	14,5	7,0	6,1	0,0	0,0

	Cumulative cash flow, Changing energy prices					
Year	Dormitory	Hospital	Kindergar	Office	0	0
0	-87,4	-107,6	-105,3	-108,7	0,0	0,0
1	-82,4	-103,3	-102,2	-106,4	0,0	0,0
2	-77,2	-98,7	-98,9	-104,0	0,0	0,0
3	-71,9	-93,8	-95,6	-101,6	0,0	0,0
4	-66,5	-88,8	-92,2	-99,0	0,0	0,0
5	-61,0	-83,6	-88,8	-96,4	0,0	0,0
6	-55,4	-78,1	-85,2	-93,7	0,0	0,0
7	-49,6	-72,5	-81,5	-90,9	0,0	0,0
8	-43,7	-66,6	-77,8	-88,1	0,0	0,0
9	-37,6	-60,4	-73,9	-85,1	0,0	0,0
10	-31,5	-54,0	-69,9	-82,0	0,0	0,0
11	-25,1	-47,4	-65,9	-78,9	0,0	0,0
12	-18,7	-40,5	-61,7	-75,6	0,0	0,0
13	-12,0	-33,4	-57,4	-72,2	0,0	0,0
14	-5,3	-25,9	-53,0	-68,8	0,0	0,0
15	1,7	-18,1	-48,5	-65,2	0,0	0,0
16	8,8	-10,0	-43,9	-61,4	0,0	0,0
17	16,1	-1,6	-39,1	-57,6	0,0	0,0
18	23,6	7,2	-34,2	-53,6	0,0	0,0
19	31,3	16,4	-29,1	-49,5	0,0	0,0
20	39,1	25,9	-23,9	-45,3	0,0	0,0
21	47,2	35,9	-18,6	-40,8	0,0	0,0
22	55,5	46,2	-13,1	-36,3	0,0	0,0
23	63,9	57,0	-7,4	-31,6	0,0	0,0
24	72,6	68,3	-1,6	-26,7	0,0	0,0
25	81,6	80,0	4,5	-21,6	0,0	0,0
26	90,8	92,3	10,7	-16,3	0,0	0,0
27	100,2	105,0	17,0	-10,9	0,0	0,0
28	109,9	118,3	23,6	-5,3	0,0	0,0
29	119,8	132,2	30,4	0,6	0,0	0,0
30	130,0	146,7	37,4	6,7	0,0	0,0

Fig. Cost of energy conserved

		Dormitory	Hospital	Kindergar	Office		
Ranking of options		1	2	3	4		
Cost of en	[EUR/kWh	0,1	0,2	0,2	0,3		
Final ener	[kWh/m2]	33,6	35,8	27,8	23,2		

Cost of energy conserved: Improvement 2, Climate zone B

	y	x	
	EUR/kWh	kWh/m2	
1	0,1	0,0	Dormitory
	0,1	33,6	
2	0,2	33,6	Hospital
	0,2	69,4	
3	0,2	69,4	Kindergarten
	0,2	97,2	
4	0,3	97,2	Office
	0,3	120,4	

Thermal efficiency retrofit of public buildings in Albania, analysis per m2

Improvement 2
Climate zone C

The calculations present costs and benefits of thermal efficiency improvement in the public buildings of Albania. The financial analysys of costs and benefits (simple payback period, NPV, IRR, and cost-benefit-ratio) is limited to the analysis of capital investments, maintenance costs, and saved energy costs . There are other numerous benefits of thermal efficiency improvement of public buildings. Some of them are monetized in the spreadsheets to give a feeling of their magnitude. They are however not included into the financial analysis.

Assumptions

Energy source specific

	Energy source price 2016 [EUR/kWh]	2030 [EUR/kWh]	CO2 emission factor [gCO2/kWh]	Primary-to-final energy factor [kWh/kWh]
Electricity	0,104	0,160	0	1,0
Wood	0,024	0,037	0	0,2
LPG	0,061	0,247	227	1,1
Diesel oil	0,117	0,473	267	1,2
Solar	0,000	0,000	0	0,0

Financial analysis	**Units**	**Value**	**References**
Measure lifetime	[years]	30	
Discount rate	[%]	4%	
Annuity factor	[%]	6%	
Maintenance costs	[EUR/m2]	0,5	

Co-benefits of thermal efficiency retrofits per unit of direct investment from the state point of view						
GDP increase	[EUR/EUR]	0,65				
direct	[EUR/EUR]	0,30				
multiplier effects	[EUR/EUR]	0,35				
Labour income	[EUR/EUR]	0,30				
direct	[EUR/EUR]	0,17				
multiplier effects	[EUR/EUR]	0,13				
Employment	[jobs/million EUR]	148				
direct	[jobs/million EUR]	85				
multiplier effects	[jobs/million EUR]	63				
Monetized CO2 emissions avoided	[EUR/tCO2]	5				
Air quality including health impacts	[EUR/MWh]	1,4				
Improved comfort and services of buildings refle	[% value]	2%	*Assumed estate value is	EUR	300	per m2

Summary of results

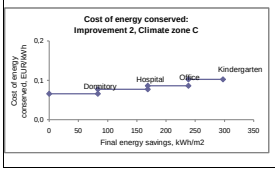
Investment and maintenance costs	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
Total	[EUR/m2]	**91**	**109**	**98**	**95**
Envelope cost	[EUR/m2]	20	24	30	27
HVAC system cost	[EUR/m2]	71	85	68	67
Maintenance cost	[EUR/m2-yr.]	0,5	0,5	0,5	0,5
Annualized total costs	[EUR/m2]	5,8	6,8	6,2	6,0
Cost of energy conserved (CEE)	[EUR/kWh]	0,1	0,1	0,1	0,1
Ranking of CEE		1	2	4	3

Energy/CO2 savings: improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
CO2 emissions	[gCO2/m2]	**7055**	**21356**	**2420**	**4562**
Electricity	[gCO2/m2]	0	0	0	0
Wood	[gCO2/m2]	0	0	0	0
LPG	[gCO2/m2]	-3144	0	11	-1133
Oil	[gCO2/m2]	10199	21356	2409	5695
Solar	[gCO2/m2]	0	0	0	0
Primary energy	[kWh/m2]	**60,8**	**100,7**	**33,3**	**38,7**
Electricity	[kWh/m2]	21,9	3,9	15,2	9,8
Wood	[kWh/m2]	8,3	0,8	7,2	8,7
LPG	[kWh/m2]	-15,2	0,0	0,1	-5,5
Oil	[kWh/m2]	45,8	96,0	10,8	25,6
Solar	[kWh/m2]	0,0	0,0	0,0	0,0
Final energy	[kWh/m2]	**83,1**	**85,5**	**59,4**	**69,5**
Electricity	[kWh/m2]	21,7	3,8	15,0	9,7
Wood	[kWh/m2]	41,3	4,0	36,2	43,6
LPG	[kWh/m2]	-13,8	0,0	0,0	-5,0
Oil	[kWh/m2]	38,2	80,0	9,0	21,3
Solar	[kWh/m2]	-4,3	-2,4	-0,9	-0,1

Saved energy costs / improvement vs BAU	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
Total over measure lifetime (NPV)	[EUR/m2]	**189,9**	**326,4**	**86,3**	**116,9**
Electricity	[EUR/m2]	46,7	8,2	32,3	20,9
Wood	[EUR/m2]	20,8	2,0	18,2	22,0
LPG	[EUR/m2]	-28,5	0,0	0,1	-10,3
Oil	[EUR/m2]	150,9	316,1	35,6	84,3
Solar	[EUR/m2]	0,0	0,0	0,0	0,0
Annual over measure lifetime	[EUR/m2]	**10,98**	**18,87**	**4,99**	**6,76**
Electricity	[EUR/m2]	2,70	0,48	1,87	1,21
Wood	[EUR/m2]	1,20	0,12	1,05	1,27
LPG	[EUR/m2]	-1,65	0,00	0,01	-0,59
Oil	[EUR/m2]	8,73	18,28	2,06	4,87
Solar	[EUR/m2]	0,00	0,00	0,00	0,00

Financial analysis / only saved energy	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
Simple payback	[years]	11,0	9,0	21,0	17,9
Internal rate of return	[%]	10,0%	13,2%	3,1%	5,5%
NPV	[EUR/m2]	95,2	208,9	-11,1	21,3
Cost - benefit ratio		0,5	0,3	1,1	0,8

Analysis of co-benefits	**Units**	**Dormitory**	**Hospital**	**Kindergarten**	**Office**
GDP increase	[EUR/m2]	59,0	70,8	63,5	61,5
Labour income	[EUR/m2]	27,1	32,5	29,1	28,2
Annual employment	[jobs/m2]	0,01	0,02	0,01	0,01
Monetized CO2 emissions avoided	[EUR/m2]	0,04	0,11	0,01	0,02
Air quality including health impacts	[EUR/m2]	0,11	0,12	0,08	0,10
Improved comfort and services of buildings	[EUR/m2]	6,00	6,00	6,00	6,00



Saved energy costs
Changing energy prices

Year	Dormitory	Hospital	Kindergar	Office		
0	-90,9	-109,1	-97,9	-94,7	0,0	0,0
1	6,9	9,9	3,5	4,3	0,0	0,0
2	7,3	10,8	3,6	4,5	0,0	0,0
3	7,5	11,3	3,7	4,7	0,0	0,0
4	7,8	11,9	3,8	4,8	0,0	0,0
5	8,1	12,4	3,9	5,0	0,0	0,0
6	8,3	13,0	4,0	5,2	0,0	0,0
7	8,6	13,6	4,1	5,3	0,0	0,0
8	8,9	14,3	4,3	5,5	0,0	0,0
9	9,2	14,9	4,4	5,7	0,0	0,0
10	9,5	15,6	4,5	5,9	0,0	0,0
11	9,9	16,3	4,6	6,1	0,0	0,0
12	10,2	17,0	4,7	6,3	0,0	0,0
13	10,6	17,8	4,9	6,5	0,0	0,0
14	10,9	18,6	5,0	6,7	0,0	0,0
15	11,3	19,5	5,1	7,0	0,0	0,0
16	11,7	20,4	5,3	7,2	0,0	0,0
17	12,2	21,4	5,4	7,5	0,0	0,0
18	12,6	22,3	5,6	7,7	0,0	0,0
19	13,1	23,4	5,8	8,0	0,0	0,0
20	13,5	24,5	5,9	8,3	0,0	0,0
21	14,0	25,6	6,1	8,6	0,0	0,0
22	14,6	26,8	6,3	8,9	0,0	0,0
23	15,1	28,1	6,5	9,3	0,0	0,0
24	15,7	29,4	6,7	9,6	0,0	0,0
25	16,3	30,7	6,9	10,0	0,0	0,0
26	16,9	32,2	7,1	10,4	0,0	0,0
27	17,5	33,7	7,3	10,8	0,0	0,0
28	18,2	35,2	7,5	11,2	0,0	0,0
29	18,9	36,9	7,8	11,6	0,0	0,0
30	19,7	38,6	8,0	12,0	0,0	0,0

Cumulative cash flow
Changing energy prices

Year	Dormitory	Hospital	Kindergar	Office		
0	-90,9	-109,1	-97,9	-94,7	0,0	0,0
1	-84,0	-99,2	-94,4	-90,4	0,0	0,0
2	-76,7	-88,3	-90,7	-85,9	0,0	0,0
3	-69,1	-77,0	-87,0	-81,3	0,0	0,0
4	-61,3	-65,1	-83,2	-76,4	0,0	0,0
5	-53,3	-52,7	-79,2	-71,5	0,0	0,0
6	-44,9	-39,7	-75,2	-66,3	0,0	0,0
7	-36,3	-26,1	-71,0	-61,0	0,0	0,0
8	-27,4	-11,8	-66,8	-55,5	0,0	0,0
9	-18,1	3,1	-62,4	-49,8	0,0	0,0
10	-8,6	18,7	-57,9	-43,9	0,0	0,0
11	1,3	35,0	-53,3	-37,8	0,0	0,0
12	11,5	52,0	-48,6	-31,5	0,0	0,0
13	22,0	69,8	-43,7	-25,0	0,0	0,0
14	33,0	88,5	-38,7	-18,3	0,0	0,0
15	44,3	108,0	-33,6	-11,3	0,0	0,0
16	56,0	128,4	-28,3	-4,1	0,0	0,0
17	68,2	149,7	-22,8	3,4	0,0	0,0
18	80,8	172,1	-17,2	11,1	0,0	0,0
19	93,8	195,5	-11,5	19,2	0,0	0,0
20	107,4	219,9	-5,5	27,5	0,0	0,0
21	121,4	245,5	0,6	36,1	0,0	0,0
22	136,0	272,4	6,9	45,1	0,0	0,0
23	151,1	300,4	13,3	54,3	0,0	0,0
24	166,8	329,8	20,0	64,0	0,0	0,0
25	183,1	360,5	26,9	73,9	0,0	0,0
26	200,0	392,7	34,0	84,3	0,0	0,0
27	217,5	426,3	41,3	95,1	0,0	0,0
28	235,7	461,5	48,9	106,2	0,0	0,0
29	254,7	498,4	56,8	117,8	0,0	0,0
30	274,3	537,0	64,7	129,9	0,0	0,0

Fig. Cost of energy conserved

		Dormitory	Hospital	Kindergar	Office		
Ranking of options		1	2	4	3		
Cost of en	[EUR/kWh	0,07	0,08	0,10	0,09		
Final ener	[kWh/m2]	83,1	85,5	59,4	69,5		

Cost of energy conserved: Improvement 2, Climate zone C

	EUR/kWh	kWh/m2	
	y	x	
1	0,07	0,0	Dormitory
	0,07	83,1	
2	0,08	83,1	Hospital
	0,08	168,6	
3	0,09	168,6	Office
	0,09	238,1	
4	0,10	238,1	Kindergarten
	0,10	297,6	

Estimate

Stock of public buildings: 2012		Dormitory	Hospital	Kindergarten	Office	School	University	Total
Sector		Education	Public health	Education		Education	Education	
Owned and occupied by government								
Central		x	x		x		x	
Municipal		x	x	x	x	x		
Retrofit need	[m2]	8.971	758.630	2.530.518	856.030	2.463.626	10.955	6.628.729
climate zone A	[m2]	5.254	424.273	1.482.059	448.201	1.442.882	6.416	3.809.084
climate zone B	[m2]	2.231	208.473	629.470	244.698	612.831	2.725	1.700.429
climate zone C	[m2]	1.485	125.883	418.989	163.132	407.913	1.814	1.119.216

Total area

	Tertiary buildings	Public buildings
	2012	2012
Hospitals	897900	758630
Offices	1397200	856030
Education	6382300	5014069

Stock of public buildings, 2012

	unit	total	climate zone 1	climate zone 2	climate zone 3
Hospitals	[number of buildin	1139	637	313	189
Offices	[number of buildin	1039	544	297	198
Education	[number of buildin	6408	3753	1594	1061
School	[number of buildin	3149			
Kindergarden	[number of buildin	3234			
Universities	[number of buildin	14			
Dormitories	[number of buildin	11			

Floor area of public buildings, 2012

	unit	total	climate zone 1	climate zone 2	climate zone 3
Hospitals	[m2]	758630	424273	208473	125883
Offices	[m2]	856030	448201	244698	163132
Education	[m2]	5014069	2936611	1247257	830201
School	[m2]	2463626	1442882	612831	407913
Kindergarden	[m2]	2530518	1482059	629470	418989
Universities and	[m2]	10955	6416	2725	1814
Dormitories	[m2]	8971	5254	2231	1485

Institutions of health

	2009	2010	2011	2012	2013
hospitals	44	44	44	44	44
number of healthc	2434	2448	2472	2460	2453
health centers	624	475	456	421	409
ambulances	1812	1927	1970	1946	1998
polyclinics	46	46	46	46	46
	2482	2448	2472	2413	2453
total healthcare fa	2434	2448	2472	2460	2453
growth rate of institutions of health	0,2%	0,2%	0,2%	0,2%	0,2%

ref.: INSTAT. Albania in figures 2013

Educational institutions

		2010	2011	2012	2013	CAGR 2010-2013
pre-shool	total	1799	1907	1911	1900	1,4%
	private	80	146	133	127	12,2%
	public	1719	1761	1778	1773	0,8%
primary and lower	total	1496	1473	1472	1464	-0,5%
	private	140	132	126	127	-2,4%
	public	1356	1341	1346	1337	-0,4%
upper sec	total	508	507	511	512	0,2%
	private	124	124	126	126	0,4%
	public	384	383	385	386	0,1%
tertiary	total	41	54	58	58	9,1%
	private	30	43	44	44	10,0%
	public	11	11	14	14	6,2%
total	total	3844	3941	3952	3934	0,6%
	private	374	445	429	424	3,2%
	public	3470	3496	3523	3510	0,3%

ref.: INSTAT. Albania in figures 2013

INSTITUTIONS OF HEALTH

Hospitals	2009	2010	2011	2012	2013
Number of hospitals	**44**	**44**	**44**	**44**	**44**
Number of hospital beds	8.805	8.707	8.711	8.723	8.283
Hospitalized persons	**265.200**	**258.407**	**240.562**	**247.391**	**260.727**
Number of beds per 100 thousand inhabitants	300	300	300	300	290
Average length of stay (in days)	5,7	5,8	5,7	6,1	5,5
Days in bed realized (in thousands)	1.509	1.472	1.404	1.509	1.442
Bed occupancy (in days)	172	168	161	173	174
Number of institutions total:	**2.434**	**2.448**	**2.472**	**2.460**	**2.453**
– Health centers	624	475	456	421	409
– Ambulances	1.812	1.927	1.970	1.946	1.998
– Polyclinics	46	46	46	46	46
Total visits (in thousands)	**5.749**	**6.551**	**6.925**	**6.983**	**6.252**

Source: Ministry of Health

Institucione Shëndetësore	2009	2010	2011	2012	Health Institutions
Numri i institucioneve gjithsej:	**2.434**	**2.448**	**2472**	**2.460**	**Number of institutions total:**
– Qëndrat shëndetësore	316	475	456	421	– Health centers
– Ambulanca	1.772	1.927	1.970	1.992	– Ambulances
– Poliklinika	46	46	46	47	– Polyclinics
Vizita gjithsej (mijë)	**5.749**	**6.551**	**6.925**	**6.983**	**Total visits (thousands)**
Spitale					**Hospitals**
Numri i spitaleve	**44**	**44**	**44**	**44**	Number of hospitals
Numri i shtretërve spitalor	8.805	8.707	8392	8.410	Number of hospital beds
Të shtruar në spitale	**265.200**	**258.407**	**240.562**	**247.391**	Hospitalized persons.
Numri i shtretërve për 100 mijë banorë	276	273	311	299	Number of beds per 100 thousand inhabitants
Ditë qëndrimi mesatar	5,7	5,8	5,7	6,1	Average length of stay (in days)
Ditë-shtretër të realizuar (mijë)	1.509	1.472	1.404	1.509	Days in bed realized (thousands)
Shfrytëzimi i shtratit (mijë)	172	169	161	173	Bed occupancy (in days)
Xhiro e shtratit	30	29	29	29	Bed turn-over
Konsulteri i Gruas					**Women's Consultancy**
Konsultoreve	**2.016**	**1.945**	**2.077**	**2.072**	Women's consultation
		1.834	1.966	1.959	In rural
		306	318	294	Visit's in consultation (thousands)
		168	179	161	Visit's in consultation, rural (thousands)
					Children's Consultancy
		2.090	**2.142**	**2.113**	**Child consultations**
		144	150	149	Urban
		1.946	1.992	1.964	Rural
		1.012	992	973	Visit's in consultation (thousands)
		580	535	548	Visit's in consultation, rural (thousands)

Institucione arsimore
Educational institutions

50%
38%
11%
0,4%

Arsimi	10-11	11-12	12-13	13-14	Education
Gjithsej	**3.844**	**3.941**	**3.952**	**3.934**	**Total**
Kopshte	1.799	1.907	1.911	1.900	Pre-school
sektori privat	80	146	133	127	private sector
9 vjeçare	1.496	1.473	1.472	1.464	Primary & Lower sec.
sektori privat	140	132	126	127	private sector
I mesëm	508	507	511	512	Upper secondary
sektori privat	124	124	126	126	private sector
I larte	41	54	58	58	Tertiary
sektori privat	30	43	44	44	private sector

Energy prices

Assumptions

Energy prices

Energy source price

	Price	Unit	Year	
Electricity	0,102	[EUR/kWh]	2015	ERE. Online http://www.ere.gov.al/rub.php?idr=207&lang=2
Wood	35,5	[EUR/m3]	2011	GLOBAL GAZ Sh.a.; checked with policy-makers at the project workshop in July 2015
LPG	0,41	[EUR/liter]	2016	Global petrol prices. online. "Albania LPG Prices." http://www.globalpetrolprices.com/Albania/lpg_prices/
Oil	1,17	[EUR/liter]	2016	Global petrol prices. online. "Albania Diesel Oil Prices." http://www.globalpetrolprices.com/Albania/diesel_prices/
Solar	0			

Conversion

LPG		Diesel oil		Wood			
1915	liter/tonne	0,832	kg/liter	Total consumpt	Fuelwood	Pellets&Briquettes	
46	GJ/t	43,1	MJ/kg	1422007	1422063	14	m3
278	kWh/GJ	35,9	MJ/liter	7,6	7,4	0,19	PJ
7	kWh/liter	10,0	kWh/liter	1483	kWh/m3		

ref.: IEA. 2004. Energy Statistics Manual. Paq ref.: correspondence to Rodon — ref.: CRES, Quantos, Ipsos. 2012. Biomass consumption survey for energy purposes in the energy community. Albania. National Report.

Changing energy prices

			Electricity	Wood	LPG	Diesel oil	Solar energy		oil price change
0	2015	[EUR/kWh]	0,102	0,024			0,00		
1	2016	[EUR/kWh]	0,104	0,024	0,061	0,117	0,00		
2	2017	[EUR/kWh]	0,105	0,025	0,067	0,129	0,00		10%
3	2018	[EUR/kWh]	0,107	0,025	0,071	0,135	0,00		5%
4	2019	[EUR/kWh]	0,108	0,025	0,074	0,142	0,00		5%
5	2020	[EUR/kWh]	0,110	0,026	0,078	0,149	0,00		5%
6	2021	[EUR/kWh]	0,112	0,026	0,081	0,156	0,00		5%
7	2022	[EUR/kWh]	0,113	0,027	0,085	0,164	0,00		5%
8	2023	[EUR/kWh]	0,115	0,027	0,089	0,172	0,00		5%
9	2024	[EUR/kWh]	0,117	0,027	0,094	0,180	0,00		5%
10	2025	[EUR/kWh]	0,119	0,028	0,098	0,187	0,00		4%
11	2026	[EUR/kWh]	0,120	0,028	0,102	0,196	0,00		5%
12	2027	[EUR/kWh]	0,122	0,029	0,107	0,206	0,00		5%
13	2028	[EUR/kWh]	0,124	0,029	0,112	0,215	0,00		5%
14	2029	[EUR/kWh]	0,126	0,029	0,118	0,226	0,00		5%
15	2030	[EUR/kWh]	0,128	0,030	0,123	0,236	0,00		5%
16	2031	[EUR/kWh]	0,130	0,030	0,129	0,247	0,00		5%
17	2032	[EUR/kWh]	0,132	0,031	0,135	0,259	0,00		5%
18	2033	[EUR/kWh]	0,134	0,031	0,142	0,271	0,00		5%
19	2034	[EUR/kWh]	0,136	0,032	0,148	0,284	0,00		5%
20	2035	[EUR/kWh]	0,138	0,032	0,155	0,298	0,00		5%
21	2036	[EUR/kWh]	0,140	0,033	0,163	0,312	0,00		5%
22	2037	[EUR/kWh]	0,142	0,033	0,170	0,327	0,00		5%
23	2038	[EUR/kWh]	0,144	0,034	0,178	0,342	0,00		5%
24	2039	[EUR/kWh]	0,146	0,034	0,187	0,358	0,00		5%
25	2040	[EUR/kWh]	0,148	0,035	0,196	0,375	0,00		5%
26	2041	[EUR/kWh]	0,151	0,035	0,205	0,393	0,00		5%
27	2042	[EUR/kWh]	0,153	0,036	0,215	0,412	0,00		5%
28	2043	[EUR/kWh]	0,155	0,036	0,225	0,431	0,00		5%
29	2044	[EUR/kWh]	0,157	0,037	0,236	0,452	0,00		5%
30	2045	[EUR/kWh]	0,160	0,037	0,247	0,473	0,00		5%

Constant energy prices

			Electricity	Wood	LPG	Diesel oil	Solar energy
0	2015	[EUR/kWh]					
1	2016	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
2	2017	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
3	2018	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
4	2019	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
5	2020	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
6	2021	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
7	2022	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
8	2023	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
9	2024	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
10	2025	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
11	2026	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
12	2027	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
13	2028	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
14	2029	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
15	2030	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
16	2031	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
17	2032	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
18	2033	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
19	2034	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
20	2035	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
21	2036	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
22	2037	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
23	2038	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
24	2039	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
25	2040	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
26	2041	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
27	2042	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
28	2043	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
29	2044	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000
30	2045	[EUR/kWh]	0,104	0,024	0,061	0,117	0,000

electricity price forecast, EU

European Commission. 2013. EU energy, transport and GHG emissions trends to 2050. *reference scenario 2013*

	2010	2020	2025	2030
services, EU	0,15	0,19	0,19	0,19
growth rate		0,27	0,00	0,00

average support for renewable energy sources for electricity from end consumers (EUR/MWh)

	2015	2020	2025	2030
RES support EUR-kWh	0,0005	0,009	0,0045	0,002

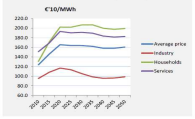
ref.: Szabo, Laszlo, Andras Mezosi, Zsuzsanna Pato, and Slobodan Markovic. 2015. "Support for Low-Emission Development in South Eastern Europe (SLED). Electricity Sector Modelling Assessm

electricity wholesale price forecast, Albania

		2015	2020	2025	2030
Prices	Baseload	65,1	46,7	54,8	57,9
EUR/MWh	Peakload	76,9	51,1	59,5	60,0
	Mix	68,7	48,0	56,2	58,6
	Trend		72%	117%	106%
			-6%	3%	1%

Note: in 2015, the wholesale price equals the household price, means it is suppressed
ref.: Szabo, Laszlo, Andras Mezosi, Zsuzsanna Pato, and Slobodan Markovic. 2015. "Support for Low-Emission Development in South Eastern Europe (SLED). Electricity Sector Modelling Assessment in Montenegro."

FIGURE 34: PRICE OF ELECTRICITY (PRE-TAX) BY SECTOR



crude oil, avg spot (constant US dollar)

	unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
absolute value	$/bbl	98,1	90	48	38,1	45,7	47,9	50,2	52,6	55,2	57,9	60,7	63,6	66,3																				
annual growth	%/yr.		-8%	-47%	-21%	20%	5%	5%	5%	5%	5%	5%	5%	4%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%

ref.: World Bank Commodities Price Forecast (constant US dollars), Released: July 19, 2016.
http://www.worldbank.org/en/research/commodity-markets

World Bank Commodities Price Forecast (constant US dollars) — Released: April 19, 2016

Commodity	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Energy														
Coal, Australia	$/mt	79.7	66.2	54.4	46.5	46.6	46.8	47.0	47.3	47.5	47.6	47.8	48.0	48.1
Crude oil, avg, spot	$/bbl	98.1	90.9	48.0	38.1	45.7	47.9	50.2	52.6	55.2	57.9	60.7	63.6	66.3
Natural gas, Europe	$/mmbtu	11.1	9.5	6.9	4.2	4.4	4.6	4.8	5.1	5.3	5.6	5.8	6.1	6.4
Natural gas, US	$/mmbtu	3.5	4.1	2.5	2.3	2.7	3.1	3.3	3.4	3.5	3.6	3.7	3.9	4.0
Natural gas LNG, Japan	$/mmbtu	15.0	15.1	9.8	7.4	7.5	7.6	7.6	7.7	7.8	7.8	7.9	8.0	8.0

ref.: Szabo, Laszlo, Andras Mezosi, Zsuzsanna Pato, and Slobodan Markovic. 2015. "Support for Low-Emission Development in South Eastern Europe (SLED). Electricity Sector Modelling Assessment in Montenegro."

version: 31.08.2015

					1	
			REF	REF	REF	REF
			2015	2020	2025	2030
AL	Prices	Baseload	65,1192	46,65187	54,81025	57,92356
		Peakload	76,91525	51,12438	59,47422	60,03272
	Generation mix, GWh	Total gene	3410,044	4508,702	5152,331	5648,524
		Nuclear	0	0	0	0
		Coal and li	0	0	0	0
		Natural gas	0	18,70527	41,09407	108,2827
		Hydro	3374,894	4354,943	4755,583	5078,831
		Wind	0	55,1869	114,9727	183,9563
		Biomass	32,79678	32,79678	161,2509	161,2509
		HFO, LFO	0	0	0	0
		PV	2,353491	47,06982	79,43032	116,2036
		Geotherma	0	0	0	0
		Net export	-4471,17	-4721,38	-5610,14	-6805,81
	Fuel consumption, TJ	Total consu	0	120,2482	262,1163	690,6752
		Coal and li	0	0	0	0
		Natural gas	0	120,2482	262,1163	690,6752
		HFO, LFO	0	0	0	0
	CO2 emission	Total emiss	0	6,712254	14,63133	38,55349
		Coal and li	0	0	0	0
		Natural gas	0	6,712254	14,63133	38,55349
		HFO, LFO	0	0	0	0
	Surplus	Consumer	25,60573	30,08003	35,0298	40,51806
		Producer	222181,8	208154,3	281272,6	321829
		Rent	17520,65	8350,113	3287,581	2781,752

Unit Euro/MWh

	Dormitory	Hospital	Kindergarten	Office	School	University	Additional insulation
Present state	Limited insulation, single glazed windows with metallic frame	Limited insulation, single windows with metallic frame and double glazed windows with wood/plastic frame	Limited insulation, single glazed windows with metallic frame	Limited insulation, single glazed windows with metallic frame	Limited insulation, single or double glazed windows with metallic frame	Limited insulation, single glazed windows with metallic frame	
BAU renovation	Additional insulation, single glazed windows with metallic frame	Additional insulation, single windows with metallic frame and double glazed windows with wood/plastic frame	Additional insulation, single glazed windows with metallic frame	Additional insulation, single glazed windows with metallic frame	Additional insulation, single or double glazed windows with metallic frame	Additional insulation, single glazed windows with metallic frame	External wall - 0 cm Wall to unheated space - 0 cm Attic slab - 5 cm Cellar ceiling - 3 cm Arcade slab - 0 cm Flat roof - 3 cm Pitched roof - 10 cm Floor on the ground - 0 cm Walls to the ground - 3 cm
Improvement 1	Additional insulation, double glazed windows with metallic frame and noble gas filling	Additional insulation, double glazed windows with metallic frame and noble gas filling	Additional insulation, double glazed windows with metallic frame and noble gas filling	Additional insulation, double glazed windows with metallic frame and noble gas filling	Additional insulation, double glazed windows with metallic frame and noble gas filling	Additional insulation, double glazed windows with metallic frame and noble gas filling	External wall - 5 cm Wall to unheated space - 5 cm Attic slab - 10 cm Cellar ceiling - 5 cm Arcade slab - 10 cm Flat roof - 5 cm Pitched roof - 10 cm Floor on the ground - 5 cm Walls to the ground - 5 cm
Improvement 2	Additional insulation, triple glazed windows with metallic frame and noble gas filling	Additional insulation, triple glazed windows with metallic frame and noble gas filling	Additional insulation, triple glazed windows with metallic frame and noble gas filling	Additional insulation, triple glazed windows with metallic frame and noble gas filling	Additional insulation, triple glazed windows with metallic frame and noble gas filling	Additional insulation, triple glazed windows with metallic frame and noble gas filling	External wall - 8 cm Wall to unheated space - 8 cm Attic slab - 10 cm Cellar ceiling - 8 cm Arcade slab - 10 cm Flat roof - 5 cm Pitched roof - 10 cm Floor on the ground - 5 cm Walls to the ground - 5 cm

Additional insulation		
BAU renovation	Improvement 1	Improvement 2
External wall - 0 cm	External wall - 5 cm	External wall - 8 cm
Wall to unheated space - 0 cm	Wall to unheated space - 5 cm	Wall to unheated space - 8 cm
Attic slab - 5 cm	Attic slab - 10 cm	Attic slab - 10 cm
Cellar ceiling - 3 cm	Cellar ceiling - 5 cm	Cellar ceiling - 8 cm
Arcade slab - 0 cm	Arcade slab - 10 cm	Arcade slab - 10 cm
Flat roof - 3 cm	Flat roof - 5 cm	Flat roof - 5 cm
Pitched roof - 10 cm	Pitched roof - 10 cm	Pitched roof - 10 cm
Floor on the ground - 0 cm	Floor on the ground - 5 cm	Floor on the ground - 5 cm
Walls to the ground - 3 cm	Walls to the ground - 5 cm	Walls to the ground - 5 cm

	Heating		Cooling		Yearly global radiation				
	HDD	ZH	CDD	ZC	North	East	South	West	Global
	hK/a	h/a	hK/a	h/a	kWh/(m^{2}a)				
Zone A	1330	4368,0	665,3	4392,0	372	951	1234	924	1552
Zone B	1673,7	4368,0	756,8	4392,0	372	951	1234	924	1552
Zone C	2600	4368,0	385,1	2208,0	362	922	1195	878	1480

		Dormitory	Hospital	Kindergarten	Office	School	University
Ventilation [1/h]		0,5	0,9	0,9	0,8	0,9	0,9
Internal heat gain [W/m^2]		7,5	9	7,5	8,5	7,5	8,75
Design temperature winter [°C]		20					
Design temperature summer [°C]		26					
DHW demand [kWh/m^2]	Present	20	20	8	2	0	5
	BAU renovation	20	20	12	2	8	5
	Standard renovation	20	16	10	1,5	7	10
	Ambitious renovation	20	16	8	1,5	7	10

Heated hours [h/week]					
Renovation options		Present	BAU	Improvement 1	Improvement 2
Zone A	Dormitory	42	126	126	126
	Hospital	56	168	168	168
	Kindergarten	30	50	50	50
	Office	30	50	50	50
	Schools	20	40	40	NA
	University	20	40	40	NA
Zone B	Dormitory	42	126	126	126
	Hospital	56	168	168	168
	Kindergarten	30	50	50	50
	Office	30	50	50	50
	Schools	20	40	40	NA
	University	20	40	40	NA
Zone C	Dormitory	49	133	133	133
	Hospital	63	168	168	168
	Kindergarten	35	55	55	55
	Office	35	55	55	55
	Schools	25	45	45	NA
	University	25	45	45	NA

Cooled hours [h/week]					
Renovation options		Present	BAU	Improvement 1	Improvement 2
Zone A	Dormitory	0	56	56	56
	Hospital	42	70	70	70
	Kindergarten	30	50	50	50
	Office	40	50	50	50
	Schools	15	30	30	NA
	University	15	30	30	NA
Zone B	Dormitory	0	56	56	56
	Hospital	42	70	70	70
	Kindergarten	30	50	50	50
	Office	40	50	50	50
	Schools	15	30	30	NA
	University	15	30	30	NA
Zone C	Dormitory	0	0	0	0
	Hospital	0	0	0	0
	Kindergarten	0	0	0	0
	Office	0	0	0	0
	Schools	0	0	0	NA
	University	0	0	0	NA

Ventilated hours [h/week]					
Renovation options		Present	BAU	Improvement 1	Improvement 2
Zone A	Dormitory	42	126	126	126
	Hospital	56	168	168	168
	Kindergarten	30	50	50	50
	Office	30	50	50	50
	Schools	20	40	40	NA
	University	20	40	40	NA
Zone B	Dormitory	42	126	126	126
	Hospital	56	168	168	168
	Kindergarten	30	50	50	50
	Office	30	50	50	50
	Schools	20	40	40	NA
	University	20	40	40	NA
Zone C	Dormitory	49	133	133	133
	Hospital	63	168	168	168
	Kindergarten	35	55	55	55
	Office	35	55	55	55
	Schools	25	45	45	NA
	University	25	45	45	NA

Heated floor areas [%]					
Renovation options		Present	BAU	Improvement 1	Improvement 2
Zone A	Dormitory	69	90	90	100
	Hospital	58	80	100	100
	Kindergarten	78	80	100	100
	Office	61	90	100	100
	Schools	70	80	100	NA
	University	72	80	80	NA
Zone B	Dormitory	69	90	90	100
	Hospital	58	80	100	100
	Kindergarten	78	80	100	100
	Office	61	90	100	100
	Schools	70	80	100	NA
	University	72	80	80	NA
Zone C	Dormitory	69	90	90	100
	Hospital	58	80	100	100
	Kindergarten	78	80	100	100
	Office	61	90	100	100
	Schools	70	80	100	NA
	University	72	80	80	NA

Cooled floor areas [%]					
Renovation options		Present	BAU	Improvement 1	Improvement 2
Zone A	Dormitory	0	20	50	70
	Hospital	17	50	80	90
	Kindergarten	22	30	50	80
	Office	40	70	90	100
	Schools	0	30	50	NA
	University	40	40	40	NA
Zone B	Dormitory	0	20	50	70
	Hospital	17	50	80	90
	Kindergarten	22	30	50	80
	Office	40	70	90	100
	Schools	0	30	50	NA
	University	40	40	40	NA
Zone C	Dormitory	0	0	0	0
	Hospital	0	0	0	0
	Kindergarten	0	0	0	0
	Office	0	0	0	0
	Schools	0	0	0	NA
	University	0	0	0	NA

Ventilated floor areas [%]					
Renovation options		Present	BAU	Improvement 1	Improvement 2
Zone A	Dormitory	0	20	30	50
	Hospital	0	30	40	60
	Kindergarten	0	0	20	50
	Office	0	10	50	60
	Schools	0	0	50	NA
	University	0	5	5	NA
Zone B	Dormitory	0	20	30	50
	Hospital	0	30	40	60
	Kindergarten	0	0	20	50
	Office	0	10	50	60
	Schools	0	0	50	NA
	University	0	5	5	NA
Zone C	Dormitory	0	20	30	50
	Hospital	0	30	40	60
	Kindergarten	0	0	20	50
	Office	0	10	50	60
	Schools	0	0	50	NA
	University	0	5	5	NA

Dormitory			
	Present and BAU	Improvement 1	Improvement 2
Climatic zone A	Direct electric heating, 80%, η_b=100%	Heat pump, 80%, SCOP=300%	Heat pump, 60%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 20%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 20%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 20%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
Climatic zone B	Direct electric heating, 80%, η_b=100%	Heat pump, 80%, SCOP=300%	Heat pump, 60%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 20%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 20%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 20%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
Climatic zone C	Direct electric heating, 15%, η_b=100%	Heat pump, 40%, SCOP=300%	Heat pump, 40%, SCOP=400%
	Wooden stove, 50%, η_b=60%	Pellet boiler, 40%, η_b=85%	Pellet boiler, 40%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 20%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 35%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%

Hospital			
	Present and BAU	Improvement 1	Improvement 2
Climatic zone A	Heat pump, 75%, SCOP=220%	Heat pump, 90%, SCOP=300%	Heat pump, 100%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 25%, η_b=80%	Oil boiler (low temperature), 10%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
Climatic zone B	Heat pump, 75%, SCOP=220%	Heat pump, 90%, SCOP=300%	Heat pump, 100%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 25%, η_b=80%	Oil boiler (low temperature), 10%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
Climatic zone C	Heat pump, 15%, SCOP=220%	Heat pump, 50%, SCOP=300%	Heat pump, 50%, SCOP=400%
	Wooden stove, 50%, η_b=60%	Pellet boiler, 30%, η_b=85%	Pellet boiler, 50%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 35%, η_b=80%	Oil boiler (low temperature), 20%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%

Kindergarten			
	Present and BAU	Improvement 1	Improvement 2
Climatic zone A	Direct electric heating, 74%, η_b=100%	Heat pump, 74%, SCOP=300%	Heat pump, 73%, SCOP=400%
	Wooden stove, 4%, η_b=60%	Pellet boiler, 12%, η_b=85%	Pellet boiler, 15%, η_b=85%
	Gas boiler, 10%, η_b=80%	Gas boiler (low temperature), 8%, η_b=90%	Gas boiler (condensing), 12%, η_b=98%
	Oil boiler, 12%, η_b=80%	Oil boiler (low temperature), 6%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
Climatic zone B	Direct electric heating, 74%, η_b=100%	Heat pump, 74%, SCOP=300%	Heat pump, 73%, SCOP=400%
	Wooden stove, 4%, η_b=60%	Pellet boiler, 12%, η_b=85%	Pellet boiler, 15%, η_b=85%
	Gas boiler, 10%, η_b=80%	Gas boiler (low temperature), 8%, η_b=90%	Gas boiler (condensing), 12%, η_b=98%
	Oil boiler, 12%, η_b=80%	Oil boiler (low temperature), 6%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
Climatic zone C	Direct electric heating, 21%, η_b=100%	Heat pump, 45%, SCOP=300%	Heat pump, 40%, SCOP=400%
	Wooden stove, 60%, η_b=60%	Pellet boiler, 35%, η_b=85%	Pellet boiler, 40%, η_b=85%
	Gas boiler, 4%, η_b=80%	Gas boiler (low temperature), 10%, η_b=90%	Gas boiler (condensing), 10%, η_b=98%
	Oil boiler, 15%, η_b=80%	Oil boiler (low temperature), 10%, η_b=90%	Oil boiler (low temperature), 10%, η_b=95%

Office			
	Present and BAU	Improvement 1	Improvement 2
Climatic zone A	Direct electric heating and heat pump, 70%, SCOP=150%	Heat pump, 80%, SCOP=300%	Heat pump, 70%, SCOP=400%
	Wooden stove, 10%, η_b=60%	Pellet boiler, 5%, η_b=85%	Pellet boiler, 10%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 15%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 20%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
Climatic zone B	Direct electric heating and heat pump, 70%, SCOP=150%	Heat pump, 80%, SCOP=300%	Heat pump, 70%, SCOP=400%
	Wooden stove, 10%, η_b=60%	Pellet boiler, 5%, η_b=85%	Pellet boiler, 10%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 15%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 20%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
Climatic zone C	Direct electric heating and heat pump, 21%, SCOP=150%	Heat pump, 20%, SCOP=300%	Heat pump, 15%, SCOP=400%
	Wooden stove, 54%, η_b=60%	Pellet boiler, 60%, η_b=85%	Pellet boiler, 60%, η_b=85%
	Gas boiler, 4%, η_b=80%	Gas boiler (low temperature), 10%, η_b=90%	Gas boiler (condensing), 15%, η_b=98%
	Oil boiler, 15%, η_b=80%	Oil boiler (low temperature), 15%, η_b=90%	Oil boiler (low temperature), 10%, η_b=95%

School		
	Present and BAU	Improvement 1
Climatic zone A	Direct electric heating, 76%, η_b=100%	Heat pump, 80%, SCOP=300%
	Wooden stove, 4%, η_b=60%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 4%, η_b=80%	Gas boiler (low temperature), 15%, η_b=90%
	Oil boiler, 16%, η_b=80%	Oil boiler (low temperature), 5%, η_b=90%
Climatic zone B	Direct electric heating, 76%, η_b=100%	Heat pump, 80%, SCOP=300%
	Wooden stove, 6%, η_b=60%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 4%, η_b=80%	Gas boiler (low temperature), 15%, η_b=90%
	Oil boiler, 14%, η_b=80%	Oil boiler (low temperature), 5%, η_b=90%
Climatic zone C	Direct electric heating, 27%, η_b=100%	Heat pump, 20%, SCOP=300%
	Wooden stove, 54%, η_b=60%	Pellet boiler, 60%, η_b=85%
	Gas boiler, 4%, η_b=80%	Gas boiler (low temperature), 10%, η_b=90%
	Oil boiler, 15%, η_b=80%	Oil boiler (low temperature), 10%, η_b=90%

University		
	Present and BAU	Improvement 1
Climatic zone A	Heat pump, 84%, SCOP=220%	Heat pump, 95%, SCOP=300%
	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%
	Oil boiler, 20%, η_b=16%	Oil boiler (low temperature), 5%, η_b=90%
Climatic zone B	Heat pump, 80%, SCOP=220%	Heat pump, 95%, SCOP=300%
	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%
	Oil boiler, 20%, η_b=80%	Oil boiler (low temperature), 5%, η_b=90%
Climatic zone C	Heat pump, 15%, SCOP=220%	Heat pump, 35%, SCOP=300%
	Wooden stove, 45%, η_b=60%	Pellet boiler, 55%, η_b=85%
	Gas boiler, 5%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%
	Oil boiler, 35%, η_b=80%	Oil boiler (low temperature), 10%, η_b=90%

Dormitory				
	Present	BAU	Improvement 1	Improvement 2
Climatic zone A	Direct electric heating, 80%, η_b=98%	Direct electric heating, 90%, η_b=98%	Direct electric heating, 80%, ηb=98%	Heat pump, 60%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 20%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 20%, η_b=80%	Oil boiler, 10%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%	Solar collector, 20%
Climatic zone B	Direct electric heating, 80%, η_b=98%	Direct electric heating, 90%, η_b=98%	Direct electric heating, 80%, ηb=98%	Heat pump, 60%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 20%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 20%, η_b=80%	Oil boiler, 10%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%	Solar collector, 20%
Climatic zone C	Direct electric heating, 35%, η_b=98%	Direct electric heating, 50%, η_b=98%	Direct electric heating, 40%, ηb=98%	Heat pump, 50%, SCOP=400%
	Wooden stove, 30%, η_b=60%	Wooden stove, 40%, η_b=60%	Pellet boiler, 40%, η_b=85%	Pellet boiler, 20%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 20%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 35%, η_b=80%	Oil boiler, 10%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%	Solar collector, 10%

Hospital				
	Present	BAU	Improvement 1	Improvement 2
Climatic zone A	Direct electric heating, 45%, η_b=98%	Direct electric heating, 55%, η_b=98%	Direct electric heating, 80%, ηb=98%	Heat pump, 80%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 50%, η_b=80%	Oil boiler, 40%, η_b=80%	Oil boiler (low temperature), 10%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 5%	Solar collector, 5%	Solar collector, 10%	Solar collector, 20%
Climatic zone B	Direct electric heating, 45%, η_b=98%	Direct electric heating, 55%, η_b=98%	Direct electric heating, 80%, ηb=98%	Heat pump, 80%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 50%, η_b=80%	Oil boiler, 40%, η_b=80%	Oil boiler (low temperature), 10%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 5%	Solar collector, 5%	Solar collector, 10%	Solar collector, 20%
Climatic zone C	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, η_b=98%	Direct electric heating, 40%, ηb=98%	Heat pump, 50%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 30%, η_b=85%	Pellet boiler, 30%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 0%, η_b=80%	Oil boiler, 0%, η_b=80%	Oil boiler (low temperature), 20%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 10%	Solar collector, 20%

Kindergarten				
	Present	BAU	Improvement 1	Improvement 2
Climatic zone A	Direct electric heating, 74%, η_b=98%	Direct electric heating, 74%, η_b=98%	Direct electric heating, 69%, ηb=98%	Heat pump, 63%, SCOP=400%
	Wooden stove, 4%, η_b=60%	Wooden stove, 4%, η_b=60%	Pellet boiler, 12%, η_b=85%	Pellet boiler, 15%, η_b=85%
	Gas boiler, 10%, η_b=80%	Gas boiler, 10%, η_b=80%	Gas boiler (low temperature), 8%, η_b=90%	Gas boiler (condensing), 12%, η_b=98%
	Oil boiler, 12%, η_b=80%	Oil boiler, 12%, η_b=80%	Oil boiler (low temperature), 6%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 5%	Solar collector, 10%
Climatic zone B	Direct electric heating, 74%, η_b=98%	Direct electric heating, 74%, η_b=98%	Direct electric heating, 69%, ηb=98%	Heat pump, 63%, SCOP=400%
	Wooden stove, 4%, η_b=60%	Wooden stove, 4%, η_b=60%	Pellet boiler, 12%, η_b=85%	Pellet boiler, 15%, η_b=85%
	Gas boiler, 10%, η_b=80%	Gas boiler, 10%, η_b=80%	Gas boiler (low temperature), 8%, η_b=90%	Gas boiler (condensing), 12%, η_b=98%
	Oil boiler, 12%, η_b=80%	Oil boiler, 12%, η_b=80%	Oil boiler (low temperature), 6%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 5%	Solar collector, 10%
Climatic zone C	Direct electric heating, 21%, η_b=98%	Direct electric heating, 21%, η_b=98%	Direct electric heating, 42%, ηb=98%	Heat pump, 35%, SCOP=400%
	Wooden stove, 60%, η_b=60%	Wooden stove, 60%, η_b=60%	Pellet boiler, 35%, η_b=85%	Pellet boiler, 40%, η_b=85%
	Gas boiler, 4%, η_b=80%	Gas boiler, 4%, η_b=80%	Gas boiler (low temperature), 10%, η_b=90%	Gas boiler (condensing), 10%, η_b=98%
	Oil boiler, 15%, η_b=80%	Oil boiler, 15%, η_b=80%	Oil boiler (low temperature), 10%, η_b=90%	Oil boiler (low temperature), 10%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 3%	Solar collector, 5%

Office				
	Present	BAU	Improvement 1	Improvement 2
Climatic zone A	Direct electric heating, 70%, η_b=98%	Direct electric heating, 75%, η_b=98%	Direct electric heating, 75%, ηb=98%	Heat pump, 62%, SCOP=400%
	Wooden stove, 10%, η_b=60%	Wooden stove, 5%, η_b=60%	Pellet boiler, 5%, η_b=85%	Pellet boiler, 10%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 10%, η_b=80%	Gas boiler (low temperature), 15%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 20%, η_b=80%	Oil boiler, 10%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 5%	Solar collector, 8%
Climatic zone B	Direct electric heating, 70%, η_b=98%	Direct electric heating, 80%, η_b=98%	Direct electric heating, 75%, ηb=98%	Heat pump, 62%, SCOP=400%
	Wooden stove, 10%, η_b=60%	Wooden stove, 5%, η_b=60%	Pellet boiler, 5%, η_b=85%	Pellet boiler, 10%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 5%, η_b=80%	Gas boiler (low temperature), 15%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 20%, η_b=80%	Oil boiler, 10%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 5%	Solar collector, 8%
Climatic zone C	Direct electric heating, 21%, η_b=98%	Direct electric heating, 15%, η_b=98%	Direct electric heating, 12%, ηb=98%	Heat pump, 10%, SCOP=400%
	Wooden stove, 54%, η_b=60%	Wooden stove, 60%, η_b=60%	Pellet boiler, 60%, η_b=85%	Pellet boiler, 60%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 10%, η_b=80%	Gas boiler (low temperature), 10%, η_b=90%	Gas boiler (condensing), 15%, η_b=98%
	Oil boiler, 25%, η_b=80%	Oil boiler, 15%, η_b=80%	Oil boiler (low temperature), 15%, η_b=90%	Oil boiler (low temperature), 10%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 3%	Solar collector, 5%

School				
	Present	BAU	Improvement 1	Improvement 2
Climatic zone A	Direct electric heating, 0%, η_b=98%	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, ηb=98%	Heat pump, 100%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 0%, η_b=80%	Oil boiler, 0%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%
Climatic zone B	Direct electric heating, 0%, η_b=98%	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, ηb=98%	Heat pump, 100%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 0%, η_b=80%	Oil boiler, 0%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%
Climatic zone C	Direct electric heating, 0%, η_b=98%	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, ηb=98%	Heat pump, 100%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 0%, η_b=80%	Oil boiler, 0%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%

University				
	Present	BAU	Improvement 1	Improvement 2
Climatic zone A	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, ηb=98%	Heat pump, 100%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 0%, η_b=80%	Oil boiler, 0%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%
Climatic zone B	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, ηb=98%	Heat pump, 100%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 0%, η_b=80%	Oil boiler, 0%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%
Climatic zone C	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, ηb=98%	Heat pump, 100%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 0%, η_b=80%	Oil boiler, 0%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%

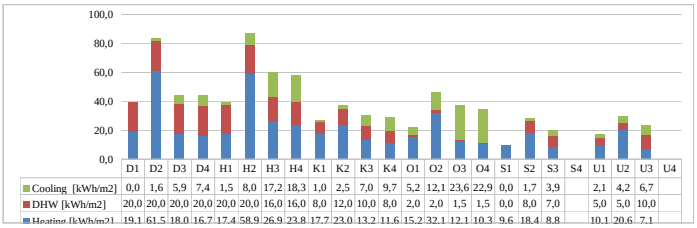
	Present state and BAU renovation	Improvement 1	Improvement 2
Climate zone A	Heat pump, EER=2	Heat pump, EER>3	Heat pump, EER>3
Climate zone B	Heat pump, EER=2	Heat pump, EER>3	Heat pump, EER>3
Climate zone C	Heat pump, EER=2	Heat pump, EER>3	Heat pump, EER>3

hőszivattyú esetén a fűtés és hűtés is egy egységről megy!

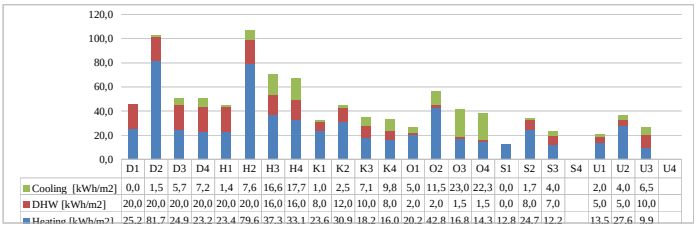
	Present state and BAU renovation	Improvement 1	Improvement 2
Climate zone A	Existing exhaust system	New exhaust system	Balanced ventilation system
Climate zone B	Existing exhaust system	New exhaust system	Balanced ventilation system
Climate zone C	Existing exhaust system	New exhaust system	Balanced ventilation system

Energy carrier	primary-to-final energy factor	specific CO_2 emissions
	[kWh/kWh]	[kg/kWh]
Wood biomass	0,2	0
Electrical energy	1,01	0
LPG	1,1	0,227
Oil	1,2	0,267
Solar energy	0	0

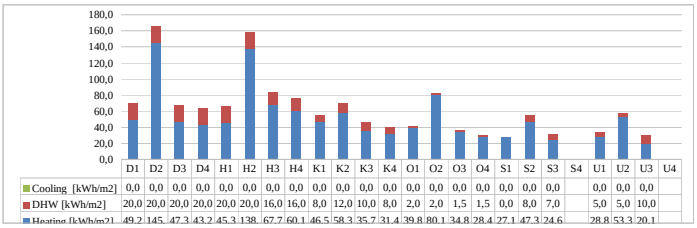
Climatic Zone A																										
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4		
Heating [kWh/m^2]	19,1	61,5	18,0	16,7	17,4	58,9	26,9	23,8	17,7	23,0	13,2	11,6	15,2	32,1	12,1	10,3	9,6	18,4	8,8		10,1	20,6	7,1			
DHW [kWh/m2]	20,0	20,0	20,0	20,0	20,0	20,0	16,0	16,0	8,0	12,0	10,0	8,0	2,0	2,0	1,5	1,5	0,0	8,0	7,0		5,0	5,0	10,0			
Cooling [kWh/m2]	0,0	1,6	5,9	7,4	1,5	8,0	17,2	18,3	1,0	2,5	7,0	9,7	5,2	12,1	23,6	22,9	0,0	1,7	3,9		2,1	4,2	6,7			



Climatic Zone B																										
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4		
Heating [kWh/m^2]	25,2	81,7	24,9	23,2	23,4	79,6	37,3	33,1	23,6	30,9	18,2	16,0	20,2	42,8	16,8	14,3	12,8	24,7	12,2		13,5	27,6	9,9			
DHW [kWh/m2]	20,0	20,0	20,0	20,0	20,0	20,0	16,0	16,0	8,0	12,0	10,0	8,0	2,0	2,0	1,5	1,5	0,0	8,0	7,0		5,0	5,0	10,0			
Cooling [kWh/m2]	0,0	1,5	5,7	7,2	1,4	7,6	16,6	17,7	1,0	2,5	7,1	9,8	5,0	11,5	23,0	22,3	0,0	1,7	4,0		2,0	4,0	6,5			

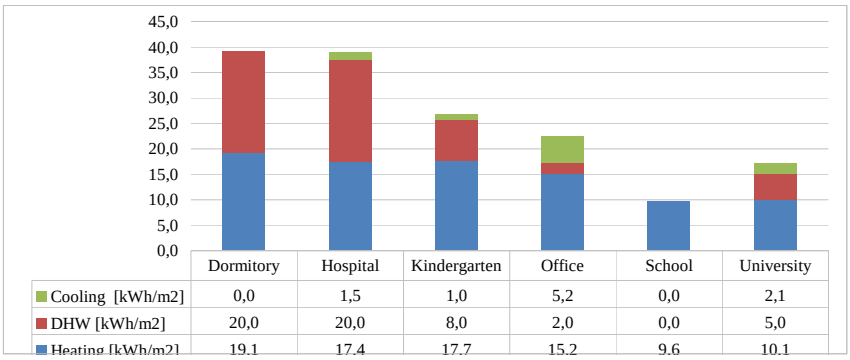


Climatic Zone C																										
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4		
Heating [kWh/m^2]	49,2	145,5	47,3	43,2	45,3	138,2	67,7	60,1	46,5	58,3	35,7	31,4	39,8	80,1	34,8	28,4	27,1	47,3	24,6		28,8	53,3	20,1			
DHW [kWh/m2]	20,0	20,0	20,0	20,0	20,0	20,0	16,0	16,0	8,0	12,0	10,0	8,0	2,0	2,0	1,5	1,5	0,0	8,0	7,0		5,0	5,0	10,0			
Cooling [kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0		0,0	0,0	0,0			



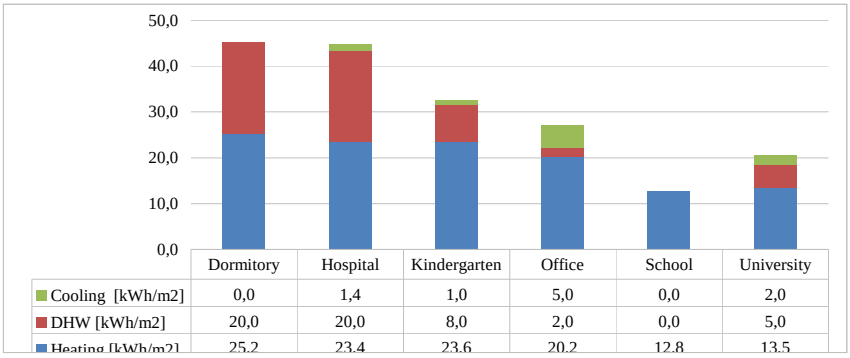
Climatic Zone A

	Dormitory	Hospital	Kindergarten	Office	School	University
Heating [kWh/m^2]	19,1	17,4	17,7	15,2	9,6	10,1
DHW [kWh/m2]	20,0	20,0	8,0	2,0	0,0	5,0
Cooling [kWh/m2]	0,0	1,5	1,0	5,2	0,0	2,1



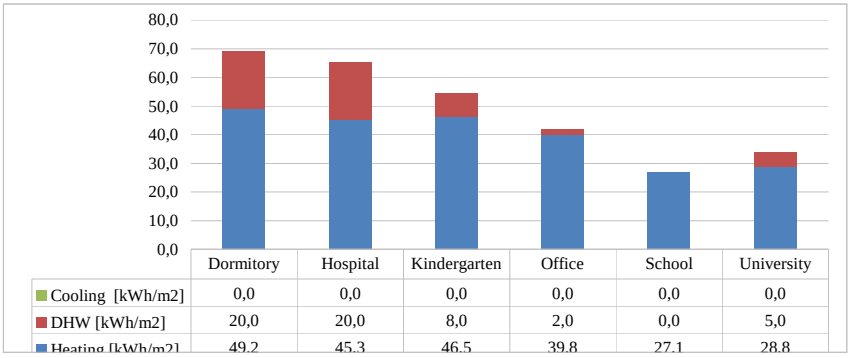
Climatic Zone B

	Dormitory	Hospital	Kindergarten	Office	School	University
Heating [kWh/m^2]	25,2	23,4	23,6	20,2	12,8	13,5
DHW [kWh/m2]	20,0	20,0	8,0	2,0	0,0	5,0
Cooling [kWh/m2]	0,0	1,4	1,0	5,0	0,0	2,0



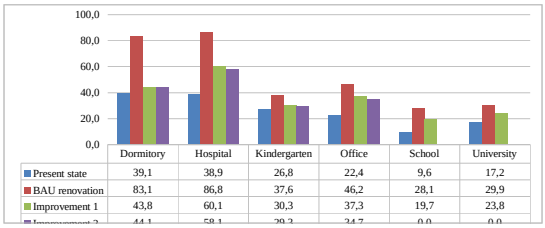
Climatic Zone C

	Dormitory	Hospital	Kindergarten	Office	School	University
Heating [kWh/m^2]	49,2	45,3	46,5	39,8	27,1	28,8
DHW [kWh/m2]	20,0	20,0	8,0	2,0	0,0	5,0
Cooling [kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0



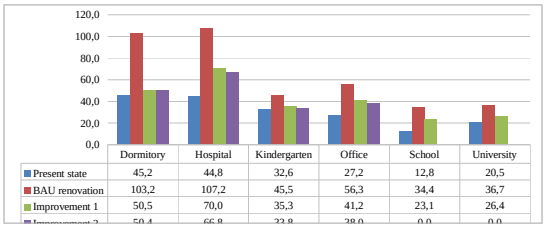
Climatic Zone A																								
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4
Heating [kWh/m^2]	19,1	61,5	18,0	16,7	17,4	58,9	26,9	23,8	17,7	23,0	13,2	11,6	15,2	32,1	12,1	10,3	9,6	18,4	8,8		10,1	20,6	7,1	
DHW [kWh/m2]	20,0	20,0	20,0	20,0	20,0	20,0	16,0	16,0	8,0	12,0	10,0	8,0	2,0	2,0	1,5	1,5	0,0	8,0	7,0		5,0	5,0	10,0	
Cooling [kWh/m2]	0,0	1,6	5,9	7,4	1,5	8,0	17,2	18,3	1,0	2,5	7,0	9,7	5,2	12,1	23,6	22,9	0,0	1,7	3,9		2,1	4,2	6,7	

	Dormitory	Hospital	Kindergarten	Office	School	University
Present state	39,1	38,9	26,8	22,4	9,6	17,2
BAU renovation	83,1	86,8	37,6	46,2	28,1	29,9
Improvement 1	43,8	60,1	30,3	37,3	19,7	23,8
Improvement 2	44,1	58,1	29,3	34,7	0,0	0,0



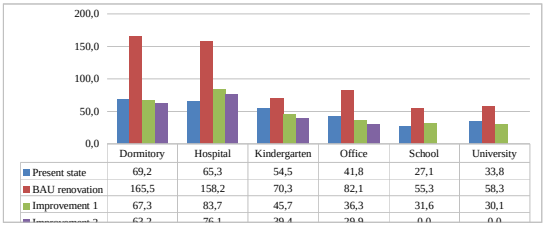
Climatic Zone B																								
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4
Heating [kWh/m^2]	25,2	81,7	24,9	23,2	23,4	79,6	37,3	33,1	23,6	30,9	18,2	16,0	20,2	42,8	16,8	14,3	12,8	24,7	12,2		13,5	27,6	9,9	
DHW [kWh/m2]	20,0	20,0	20,0	20,0	20,0	20,0	16,0	16,0	8,0	12,0	10,0	8,0	2,0	2,0	1,5	1,5	0,0	8,0	7,0		5,0	5,0	10,0	
Cooling [kWh/m2]	0,0	1,5	5,7	7,2	1,4	7,6	16,6	17,7	1,0	2,5	7,1	9,8	5,0	11,5	23,0	22,3	0,0	1,7	4,0		2,0	4,0	6,5	

	Dormitory	Hospital	Kindergarten	Office	School	University
Present state	45,2	44,8	32,6	27,2	12,8	20,5
BAU renovation	103,2	107,2	45,5	56,3	34,4	36,7
Improvement 1	50,5	70,0	35,3	41,2	23,1	26,4
Improvement 2	50,4	66,8	33,8	38,0	0,0	0,0

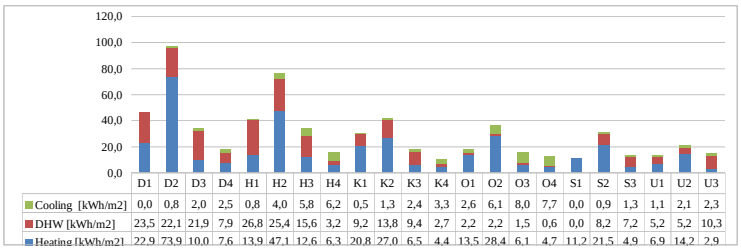


Climatic Zone C																								
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4
Heating [kWh/m^2]	49,2	145,5	47,3	43,2	45,3	138,2	67,7	60,1	46,5	58,3	35,7	31,4	39,8	80,1	34,8	28,4	27,1	47,3	24,6		28,8	53,3	20,1	
DHW [kWh/m2]	20,0	20,0	20,0	20,0	20,0	20,0	16,0	16,0	8,0	12,0	10,0	8,0	2,0	2,0	1,5	1,5	0,0	8,0	7,0		5,0	5,0	10,0	
Cooling [kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0		0,0	0,0	0,0	

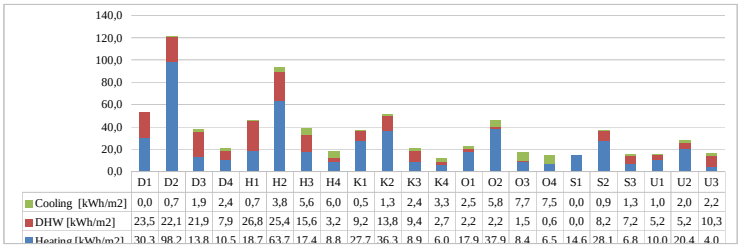
	Dormitory	Hospital	Kindergarten	Office	School	University
Present state	69,2	65,3	54,5	41,8	27,1	33,8
BAU renovation	165,5	158,2	70,3	82,1	55,3	58,3
Improvement 1	67,3	83,7	45,7	36,3	31,6	30,1
Improvement 2	63,2	76,1	39,4	29,9	0,0	0,0



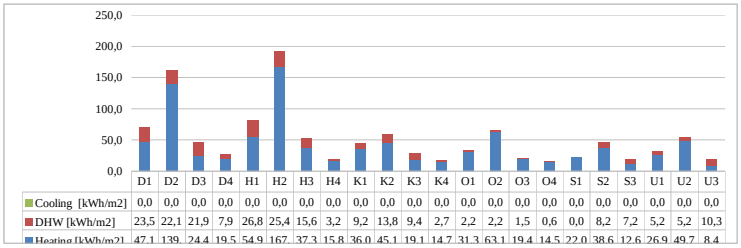
Climatic Zone A																							
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	U1	U2	U3
Heating [kWh/m^2]	22,9	73,9	10,0	7,6	13,9	47,1	12,6	6,3	20,8	27,0	6,5	4,4	13,5	28,4	6,1	4,7	11,2	21,5	4,9	6,9	14,2	2,9
DHW [kWh/m2]	23,5	22,1	21,9	7,9	26,8	25,4	15,6	3,2	9,2	13,8	9,4	2,7	2,2	2,2	1,5	0,6	0,0	8,2	7,2	5,2	5,2	10,3
Cooling [kWh/m2]	0,0	0,8	2,0	2,5	0,8	4,0	5,8	6,2	0,5	1,3	2,4	3,3	2,6	6,1	8,0	7,7	0,0	0,9	1,3	1,1	2,1	2,3



Climatic Zone B																						
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	U1	U2	U3
Heating [kWh/m^2]	30,3	98,2	13,8	10,5	18,7	63,7	17,4	8,8	27,7	36,3	8,9	6,0	17,9	37,9	8,4	6,5	14,6	28,1	6,8	10,0	20,4	4,0
DHW [kWh/m2]	23,5	22,1	21,9	7,9	26,8	25,4	15,6	3,2	9,2	13,8	9,4	2,7	2,2	2,2	1,5	0,6	0,0	8,2	7,2	5,2	5,2	10,3
Cooling [kWh/m2]	0,0	0,7	1,9	2,4	0,7	3,8	5,6	6,0	0,5	1,3	2,4	3,3	2,5	5,8	7,7	7,5	0,0	0,9	1,3	1,0	2,0	2,2

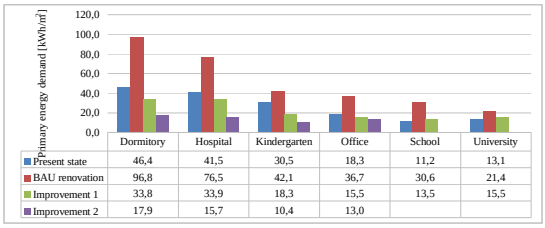


Climatic Zone C																						
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	U1	U2	U3
Heating [kWh/m^2]	47,1	139,5	24,4	19,5	54,9	167,5	37,3	15,8	36,0	45,1	19,1	14,7	31,3	63,1	19,4	14,5	22,0	38,6	12,6	26,9	49,7	8,4
DHW [kWh/m2]	23,5	22,1	21,9	7,9	26,8	25,4	15,6	3,2	9,2	13,8	9,4	2,7	2,2	2,2	1,5	0,6	0,0	8,2	7,2	5,2	5,2	10,3
Cooling [kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0



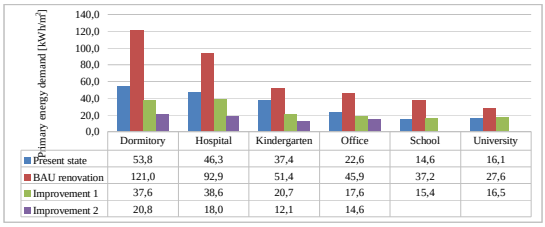
Climatic Zone A																								
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4
Heating [kWh/m^2]	22,9	73,9	10,0	7,6	13,9	47,1	12,6	6,3	20,8	27,0	6,5	4,4	13,5	28,4	6,1	4,7	11,2	21,5	4,9	4,1	6,9	14,2	2,9	2,3
DHW [kWh/m2]	23,5	22,1	21,9	7,9	26,8	25,4	15,6	3,2	9,2	13,8	9,4	2,7	2,2	2,2	1,5	0,6	0,0	8,2	7,2	1,8	5,2	5,2	10,3	2,5
Cooling [kWh/m2]	0,0	0,8	2,0	2,5	0,8	4,0	5,8	6,2	0,5	1,3	2,4	3,3	2,6	6,1	8,0	7,7	0,0	0,9	1,3	1,3	1,1	2,1	2,3	2,3

	Dormitory	Hospital	Kindergarten	Office	School	University
Present state	46,4	41,5	30,5	18,3	11,2	13,1
BAU renovation	96,8	76,5	42,1	36,7	30,6	21,4
Improvement 1	33,8	33,9	18,3	15,5	13,5	15,5
Improvement 2	17,9	15,7	10,4	13,0		



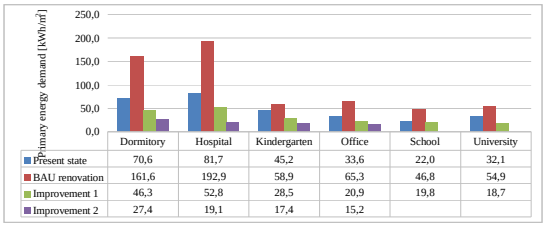
Climatic Zone B																								
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4
Heating [kWh/m^2]	30,3	98,2	13,8	10,5	18,7	63,7	17,4	8,8	27,7	36,3	8,9	6,0	17,9	37,9	8,4	6,5	14,6	28,1	6,8	5,6	10,0	20,4	4,0	3,2
DHW [kWh/m2]	23,5	22,1	21,9	7,9	26,8	25,4	15,6	3,2	9,2	13,8	9,4	2,7	2,2	2,2	1,5	0,6	0,0	8,2	7,2	1,8	5,2	5,2	10,3	2,5
Cooling [kWh/m2]	0,0	0,7	1,9	2,4	0,7	3,8	5,6	6,0	0,5	1,3	2,4	3,3	2,5	5,8	7,7	7,5	0,0	0,9	1,3	1,3	1,0	2,0	2,2	2,2

	Dormitory	Hospital	Kindergarten	Office	School	University
Present state	53,8	46,3	37,4	22,6	14,6	16,1
BAU renovation	121,0	92,9	51,4	45,9	37,2	27,6
Improvement 1	37,6	38,6	20,7	17,6	15,4	16,5
Improvement 2	20,8	18,0	12,1	14,6		



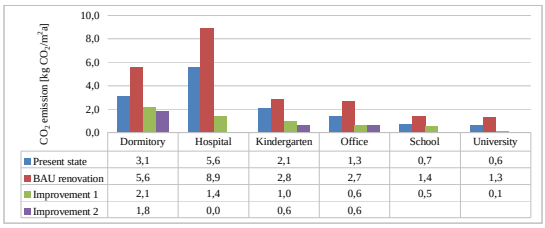
Climatic Zone C																								
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4
Heating [kWh/m^2]	47,1	139,5	24,4	19,5	54,9	167,5	37,3	15,8	36,0	45,1	19,1	14,7	31,3	63,1	19,4	14,5	22,0	38,6	12,6	11,5	26,9	49,7	8,4	7,5
DHW [kWh/m2]	23,5	22,1	21,9	7,9	26,8	25,4	15,6	3,2	9,2	13,8	9,4	2,7	2,2	2,2	1,5	0,6	0,0	8,2	7,2	1,8	5,2	5,2	10,3	2,5
Cooling [kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

	Dormitory	Hospital	Kindergarten	Office	School	University
Present state	70,6	81,7	45,2	33,6	22,0	32,1
BAU renovation	161,6	192,9	58,9	65,3	46,8	54,9
Improvement 1	46,3	52,8	28,5	20,9	19,8	18,7
Improvement 2	27,4	19,1	17,4	15,2		



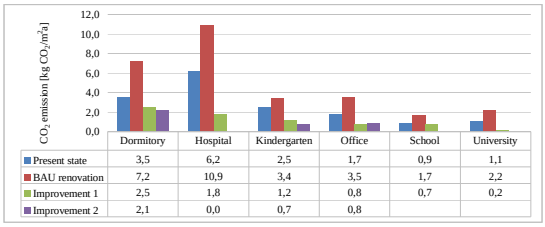
Climatic Zone A																								
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4
Heating [kWh/m^2]	1,5	4,8	1,0	0,8	1,7	5,7	0,9	0,0	1,4	1,8	0,6	0,3	1,2	2,5	0,5	0,5	0,7	1,4	0,5	0,5	0,6	1,3	0,1	0,1
DHW [kWh/m2]	1,6	0,8	1,1	1,0	3,9	3,1	0,5	0,0	0,6	1,0	0,4	0,2	0,2	0,2	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Cooling [kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

	Dormitory	Hospital	Kindergarten	Office	School	University
Present state	3,1	5,6	2,1	1,3	0,7	0,6
BAU renovation	5,6	8,9	2,8	2,7	1,4	1,3
Improvement 1	2,1	1,4	1,0	0,6	0,5	0,1
Improvement 2	1,8	0,0	0,6	0,6		



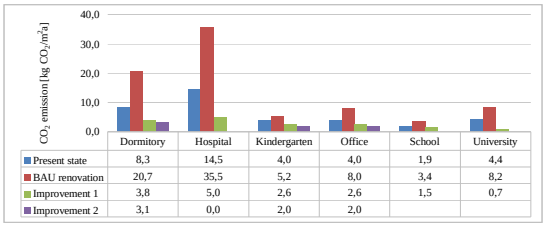
Climatic Zone B																								
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4
Heating [kWh/m^2]	2,0	6,4	1,4	1,2	2,3	7,8	1,2	0,0	1,9	2,5	0,8	0,5	1,6	3,3	0,7	0,7	0,9	1,7	0,7	0,6	1,1	2,2	0,2	0,1
DHW [kWh/m2]	1,6	0,8	1,1	1,0	3,9	3,1	0,5	0,0	0,6	1,0	0,4	0,2	0,2	0,2	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Cooling [kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

	Dormitory	Hospital	Kindergarten	Office	School	University
Present state	3,5	6,2	2,5	1,7	0,9	1,1
BAU renovation	7,2	10,9	3,4	3,5	1,7	2,2
Improvement 1	2,5	1,8	1,2	0,8	0,7	0,2
Improvement 2	2,1	0,0	0,7	0,8		



Climatic Zone C																								
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4
Heating [kWh/m^2]	6,7	19,9	2,6	2,1	10,6	32,4	4,4	0,0	3,3	4,2	2,2	1,7	3,9	7,8	2,6	1,9	1,9	3,4	1,5	1,4	4,4	8,2	0,7	0,6
DHW [kWh/m2]	1,6	0,8	1,1	1,0	3,9	3,1	0,5	0,0	0,6	1,0	0,4	0,2	0,2	0,2	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Cooling [kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

	Dormitory	Hospital	Kindergarten	Office	School	University
Present state	8,3	14,5	4,0	4,0	1,9	4,4
BAU renovation	20,7	35,5	5,2	8,0	3,4	8,2
Improvement 1	3,8	5,0	2,6	2,6	1,5	0,7
Improvement 2	3,1	0,0	2,0	2,0		



BAU renovation	Dormitory	Hospital	Kindergarten	Office	School	University
External wall	0	0	0	0	0	0
Wall to unheated space	0	0	0	0	0	0
Attic slab	5	5	5	5	5	5
Cellar ceiling	3	3	3	3	3	3
Arcade slab	0	0	0	0	0	0
Flat roof	3	3	3	3	3	3
Pitched roof	10	10	10	10	10	10
Floors of heated spaces to ground	0	0	0	0	0	0
External walls between heated spaces and ground	3	3	3	3	3	3
External unglazed doors	80	80	80	80	80	80
Glazed windows, glazed doors 1	0	0	0	0	0	0

Improvement 1	Dormitory	Hospital	Kindergarten	Office	School	University
External wall	5	5	5	5	8	8
Wall to unheated space	5	5	5	5	5	5
Attic slab	10	10	10	10	10	10
Cellar ceiling	5	5	5	5	5	5
Arcade slab	10	10	10	10	10	10
Flat roof	5	5	5	5	5	5
Pitched roof	10	10	10	10	10	10
Floors of heated spaces to ground	5	5	5	5	5	5
External walls between heated spaces and ground	5	5	5	5	5	5
External unglazed doors	150	150	150	150	150	150
Glazed windows, glazed doors 1	85	85	85	85	85	85

Improvement 2	Dormitory	Hospital	Kindergarten	Office	School	University
External wall	8	8	8	8	8	8
Wall to unheated space	8	8	8	8	5	5
Attic slab	10	10	10	10	10	10
Cellar ceiling	8	8	8	8	5	5
Arcade slab	10	10	10	10	10	10
Flat roof	5	5	5	5	5	5
Pitched roof	10	10	10	10	10	10
Floors of heated spaces to ground	5	5	5	5	5	5
External walls between heated spaces and ground	5	5	5	5	5	5
External unglazed doors	150	150	150	150	150	150
Glazed windows, glazed doors 1	120	150	120	120	85	85

Areas						
Floor area	2420,6	5031,6	543,571	892,143	2294,88	2798,14
External wall	1465	2137,2	338,494	668	1276,59	1571,57
Wall to unheated space	0	0	0	0	0	0
Attic slab	0	0	0	0	0	0
Cellar ceiling	0	708,4	0	0	69,6471	0
Arcade slab	588	0	0	0	0	0
Flat roof	488	1266,4	90,5714	238	565,588	710,571
Pitched roof	242	0	209,714	89,5714	280,588	0
Floors of heated spaces to ground	697	503,8	300	279,833	752,471	753,286
External walls between heated spaces and ground	0	288,667	0	0	0	0
External unglazed doors	0	0	0	0	0	0
Glazed windows, glazed doors 1	223,8	623,4	97,5057	142,857	335,929	513

Conversion factors						
Floor area	1,00	1,00	1,00	1,00	1,00	1,00
External wall	0,61	0,42	0,62	0,75	0,56	0,56
Wall to unheated space	0,00	0,00	0,00	0,00	0,00	0,00
Attic slab	0,00	0,00	0,00	0,00	0,00	0,00
Cellar ceiling	0,00	0,14	0,00	0,00	0,03	0,00
Arcade slab	0,24	0,00	0,00	0,00	0,00	0,00
Flat roof	0,20	0,25	0,17	0,27	0,25	0,25
Pitched roof	0,10	0,00	0,39	0,10	0,12	0,00
Floors of heated spaces to ground	0,29	0,10	0,55	0,31	0,33	0,27
External walls between heated spaces and ground	0,00	0,06	0,00	0,00	0,00	0,00
External unglazed doors	0,00	0,00	0,00	0,00	0,00	0,00
Glazed windows, glazed doors 1	0,09	0,12	0,18	0,16	0,15	0,18

BAU renovation	Dormitory	Hospital	Kindergarten	Office	School	University
External wall	NA	NA	NA	NA	NA	NA
Wall to unheated space	NA	NA	NA	NA	NA	NA
Attic slab	NA	NA	NA	NA	NA	NA
Cellar ceiling	NA	0,42	NA	NA	0,09	NA
Arcade slab	NA	NA	NA	NA	NA	NA
Flat roof	0,60	0,76	0,50	0,80	0,74	0,76
Pitched roof	1,00	NA	3,86	1,00	1,22	NA
Floors of heated spaces to ground	NA	NA	NA	NA	NA	NA
External walls between heated spaces and ground	NA	0,17	NA	NA	NA	NA
External unglazed doors	NA	NA	NA	NA	NA	NA
Glazed windows, glazed doors 1	NA	NA	NA	NA	NA	NA

Improvement 1	Dormitory	Hospital	Kindergarten	Office	School	University
External wall	3,03	2,12	3,11	3,74	4,45	4,49
Wall to unheated space	NA	NA	NA	NA	NA	NA
Attic slab	NA	NA	NA	NA	NA	NA
Cellar ceiling	NA	0,70	NA	NA	0,15	NA
Arcade slab	2,43	NA	NA	NA	NA	NA
Flat roof	1,01	1,26	0,83	1,33	1,23	1,27
Pitched roof	1,00	NA	3,86	1,00	1,22	NA
Floors of heated spaces to ground	1,44	0,50	2,76	1,57	1,64	1,35
External walls between heated spaces and ground	NA	0,29	NA	NA	NA	NA
External unglazed doors	NA	NA	NA	NA	NA	NA
Glazed windows, glazed doors 1	7,86	10,53	15,25	13,61	12,44	15,58

Improvement 2	Dormitory	Hospital	Kindergarten	Office	School	University
External wall	4,84	3,40	4,98	5,99	NA	NA
Wall to unheated space	NA	NA	NA	NA	NA	NA
Attic slab	NA	NA	NA	NA	NA	NA
Cellar ceiling	NA	1,13	NA	NA	NA	NA
Arcade slab	2,43	NA	NA	NA	NA	NA
Flat roof	1,01	1,26	0,83	1,33	NA	NA
Pitched roof	1,00	NA	3,86	1,00	NA	NA
Floors of heated spaces to ground	1,44	0,50	2,76	1,57	NA	NA
External walls between heated spaces and ground	NA	0,29	NA	NA	NA	NA
External unglazed doors	NA	NA	NA	NA	NA	NA
Glazed windows, glazed doors 1	11,09	18,58	21,53	19,22	NA	NA

BAU renovation	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	0	0	0	0	0	0
Heating system based on wood	0	0	0	0	0	0
Heating system based on gas	0	0	0	0	0	0
Heating system based on oil	0	0	0	0	0	0
DHW system based on electricity	0,8	0,8	0,8	0,8	0,8	0,8
DHW system based on wood	0,9	0,9	0,9	0,9	0,9	0,9
DHW system based on gas	0,9	0,9	0,9	0,9	0,9	0,9
DHW system based on oil	0,9	0,9	0,9	0,9	0,9	0,9
DHW system based on solar thermal	3,2	3,2	3,2	3,2	3,2	3,2
Ventilation system	0	0	0	0	0	0
Cooling system	0	0	0	0	0	0

Improvement 1	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	40	55	50	50	50	50
Heating system based on wood	60	60	32	32	60	60
Heating system based on gas	40	40	40	40	40	40
Heating system based on oil	40	40	40	40	40	40
DHW system based on electricity	0,8	0,8	0,8	0,8	0,8	0,8
DHW system based on wood	0,9	0,9	0,9	0,9	0,9	0,9
DHW system based on gas	0,9	0,9	0,9	0,9	0,9	0,9
DHW system based on oil	0,9	0,9	0,9	0,9	0,9	0,9
DHW system based on solar thermal	3,2	3,2	3,2	3,2	3,2	3,2
Ventilation system	1	1	1	1	1	1
Cooling system	15	15	15	15	15	15

Improvement 2	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	40	55	55	55	NA	NA
Heating system based on wood	60	60	32	32	NA	NA
Heating system based on gas	40	40	50	50	NA	NA
Heating system based on oil	40	40	50	50	NA	NA
DHW system based on electricity	5	5	5	5	NA	NA
DHW system based on wood	0,9	0,9	0,9	0,9	NA	NA
DHW system based on gas	0,9	0,9	0,9	0,9	NA	NA
DHW system based on oil	0,9	0,9	0,9	0,9	NA	NA
DHW system based on solar thermal	1,5	1,5	1,5	1,5	NA	NA
Ventilation system	20	20	20	20	NA	NA
Cooling system	15	15	15	15	NA	NA

	BAU						
	Floor area	1,00	1,00	1,00	1,00	1,00	1,00
	Heating system based on electricity	1,00	1,00	1,00	1,00	1,00	1,00
Alternative prices!	Heating system based on wood	1,00	1,00	1,00	1,00	1,00	1,00
	Heating system based on gas	1,00	1,00	1,00	1,00	1,00	1,00
	Heating system based on oil	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on electricity	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on wood	1,00	1,00	1,00	1,00	1,00	1,00
Alternative prices!	DHW system based on gas	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on oil	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on solar thermal	1,00	1,00	1,00	1,00	1,00	1,00
	Ventilation system	0,2	0,3	0	0,1	0	0,05
	Cooling system	0,2	0,5	0,3	0,7	0,3	0,4

	Improvement 1						
	Floor area	1,00	1,00	1,00	1,00	1,00	1,00
	Heating system based on electricity	1,00	1,00	1,00	1,00	1,00	1,00
Alternative prices!	Heating system based on wood	1,00	1,00	1,00	1,00	1,00	1,00
	Heating system based on gas	1,00	1,00	1,00	1,00	1,00	1,00
	Heating system based on oil	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on electricity	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on wood	1,00	1,00	1,00	1,00	1,00	1,00
Alternative prices!	DHW system based on gas	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on oil	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on solar thermal	1,00	1,00	1,00	1,00	1,00	1,00
	Ventilation system	0,3	0,4	0,2	0,5	0,5	0,05
	Cooling system	0,5	0,8	0,5	0,9	0,5	0,4

	Improvement 2						
	Floor area	1,00	1,00	1,00	1,00	1,00	1,00
	Heating system based on electricity	1,00	1,00	1,00	1,00	1,00	1,00
Alternative prices!	Heating system based on wood	1,00	1,00	1,00	1,00	1,00	1,00
	Heating system based on gas	1,00	1,00	1,00	1,00	1,00	1,00
	Heating system based on oil	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on electricity	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on wood	1,00	1,00	1,00	1,00	1,00	1,00
Alternative prices!	DHW system based on gas	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on oil	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on solar thermal	1,00	1,00	1,00	1,00	1,00	1,00
	Ventilation system	0,5	0,6	0,5	0,6	0,5	0,05
	Cooling system	0,7	0,9	0,8	1	0,5	0,4

ZONE A

BAU renovation	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	NA	NA	NA	NA	NA	NA
Heating system based on wood	NA	NA	NA	NA	NA	NA
Heating system based on gas	NA	NA	NA	NA	NA	NA
Heating system based on oil	NA	NA	NA	NA	NA	NA
DHW system based on electricity	0,7	0,4	0,6	0,6	0,8	0,8
DHW system based on wood	0,0	0,0	0,0	0,1	0,0	0,0
DHW system based on gas	0,0	0,0	0,1	0,0	0,0	0,0
DHW system based on oil	0,1	0,4	0,1	0,2	0,0	0,0
DHW system based on solar thermal	0,0	0,2	0,0	0,0	0,0	0,0
Ventilation system	NA	NA	NA	NA	NA	NA
Cooling system	NA	NA	NA	NA	NA	NA

Improvement 1	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	32,0	49,5	37,0	40,0	40,0	47,5
Heating system based on wood	0,0	0,0	3,8	1,6	0,0	0,0
Heating system based on gas	8,0	0,0	3,2	6,0	6,0	0,0
Heating system based on oil	0,0	4,0	2,4	0,0	2,0	2,0
DHW system based on electricity	0,6	0,6	0,6	0,6	0,8	0,8
DHW system based on wood	0,0	0,0	0,1	0,0	0,0	0,0
DHW system based on gas	0,2	0,0	0,1	0,1	0,0	0,0
DHW system based on oil	0,0	0,1	0,1	0,0	0,0	0,0
DHW system based on solar thermal	0,0	0,3	0,2	0,2	0,0	0,0
Ventilation system	0,3	0,4	0,2	0,5	0,5	0,1
Cooling system	7,5	12,0	7,5	13,5	7,5	6,0

Improvement 2	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	24,0	55,0	40,2	38,5	NA	NA
Heating system based on wood	12,0	0,0	4,8	3,2	NA	NA
Heating system based on gas	8,0	0,0	6,0	10,0	NA	NA
Heating system based on oil	0,0	0,0	0,0	0,0	NA	NA
DHW system based on electricity	3,0	4,0	3,2	3,1	NA	NA
DHW system based on wood	0,0	0,0	0,1	0,1	NA	NA
DHW system based on gas	0,2	0,0	0,1	0,2	NA	NA
DHW system based on oil	0,0	0,0	0,0	0,0	NA	NA
DHW system based on solar thermal	0,3	0,3	0,2	0,1	NA	NA
Ventilation system	10,0	12,0	10,0	12,0	NA	NA
Cooling system	10,5	13,5	12,0	15,0	NA	NA

	Climate zone A	Dormitory	Hospital	Kindergarten	Office	School	University	
BAU renovation	Heating system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	BAU renovation
	DHW system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	
	Cooling system [EUR/m^2]	0	0	0	0	0	0	
	Ventilation system [EUR/m^2]	0	0	0	0	0	0	
Improvement 1	Heating system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	Improvement 1
	DHW system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	
	Cooling system [EUR/m^2]	7,5	12	7,5	13,5	7,5	6	
	Ventilation system [EUR/m^2]	0,3	0,4	0,2	0,5	0,5	0,05	
Improvement 2	Heating system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	NA	NA	Improvement 2
	DHW system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	NA	NA	
	Cooling system [EUR/m^2]	10,5	13,5	12	15	NA	NA	
	Ventilation system [EUR/m^2]	10	12	10	12	NA	NA	

ZONE B

BAU renovation	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	NA	NA	NA	NA	NA	NA
Heating system based on wood	NA	NA	NA	NA	NA	NA
Heating system based on gas	NA	NA	NA	NA	NA	NA
Heating system based on oil	NA	NA	NA	NA	NA	NA
DHW system based on electricity	0,7	0,4	0,6	0,6	0,8	0,8
DHW system based on wood	0,0	0,0	0,0	0,1	0,0	0,0
DHW system based on gas	0,0	0,0	0,1	0,0	0,0	0,0
DHW system based on oil	0,1	0,4	0,1	0,2	0,0	0,0
DHW system based on solar thermal	0,0	0,2	0,0	0,0	0,0	0,0
Ventilation system	NA	NA	NA	NA	NA	NA
Cooling system	NA	NA	NA	NA	NA	NA

Improvement 1	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	32,0	49,5	37,0	40,0	40,0	47,5
Heating system based on wood	0,0	0,0	3,8	1,6	0,0	0,0
Heating system based on gas	8,0	0,0	3,2	6,0	6,0	0,0
Heating system based on oil	0,0	4,0	2,4	0,0	2,0	2,0
DHW system based on electricity	0,6	0,6	0,6	0,6	0,8	0,8
DHW system based on wood	0,0	0,0	0,1	0,0	0,0	0,0
DHW system based on gas	0,2	0,0	0,1	0,1	0,0	0,0
DHW system based on oil	0,0	0,1	0,1	0,0	0,0	0,0
DHW system based on solar thermal	0,0	0,3	0,2	0,2	0,0	0,0
Ventilation system	0,3	0,4	0,2	0,5	0,5	0,1
Cooling system	7,5	12,0	7,5	13,5	7,5	6,0

Improvement 2	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	24,0	55,0	40,2	38,5	NA	NA
Heating system based on wood	12,0	0,0	4,8	3,2	NA	NA
Heating system based on gas	8,0	0,0	6,0	10,0	NA	NA
Heating system based on oil	0,0	0,0	0,0	0,0	NA	NA
DHW system based on electricity	3,0	4,0	3,2	3,1	NA	NA
DHW system based on wood	0,0	0,0	0,1	0,1	NA	NA
DHW system based on gas	0,2	0,0	0,1	0,2	NA	NA
DHW system based on oil	0,0	0,0	0,0	0,0	NA	NA
DHW system based on solar thermal	0,3	0,3	0,2	0,1	NA	NA
Ventilation system	10,0	12,0	10,0	12,0	NA	NA
Cooling system	10,5	13,5	12,0	15,0	NA	NA

Climate zone B	Dormitory	Hospital	Kindergarten	Office	School	University	
Heating system [EUR/m^2]	#NOME?	######	#NOME?	#####	#####	#NOME?	BAU renovation
DHW system [EUR/m^2]	#NOME?	######	#NOME?	#####	#####	#NOME?	
Cooling system [EUR/m^2]	0	0	0	0	0	0	
Ventilation system [EUR/m^2]	0	0	0	0	0	0	
Heating system [EUR/m^2]	#NOME?	######	#NOME?	#####	#####	#NOME?	Improvement 1
DHW system [EUR/m^2]	#NOME?	######	#NOME?	#####	#####	#NOME?	
Cooling system [EUR/m^2]	7,5	12	7,5	13,5	7,5	6	
Ventilation system [EUR/m^2]	0,3	0,4	0,2	0,5	0,5	0,05	
Heating system [EUR/m^2]	#NOME?	######	#NOME?	#####	NA	NA	Improvement 2
DHW system [EUR/m^2]	#NOME?	######	#NOME?	#####	NA	NA	
Cooling system [EUR/m^2]	10,5	13,5	12	15	NA	NA	
Ventilation system [EUR/m^2]	10	12	10	12	NA	NA	

ZONE C

BAU renovation	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	NA	NA	NA	NA	NA	NA
Heating system based on wood	NA	NA	NA	NA	NA	NA
Heating system based on gas	NA	NA	NA	NA	NA	NA
Heating system based on oil	NA	NA	NA	NA	NA	NA
DHW system based on electricity	0,4	0,8	0,2	0,2	0,8	0,8
DHW system based on wood	0,4	0,0	0,5	0,5	0,0	0,0
DHW system based on gas	0,0	0,0	0,0	0,0	0,0	0,0
DHW system based on oil	0,1	0,0	0,1	0,2	0,0	0,0
DHW system based on solar thermal	0,0	0,0	0,0	0,0	0,0	0,0
Ventilation system	NA	NA	NA	NA	NA	NA
Cooling system	NA	NA	NA	NA	NA	NA

Improvement 1	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	16,0	27,5	22,5	10,0	10,0	17,5
Heating system based on wood	24,0	18,0	11,2	19,2	36,0	33,0
Heating system based on gas	8,0	0,0	4,0	4,0	4,0	0,0
Heating system based on oil	0,0	8,0	4,0	6,0	4,0	4,0
DHW system based on electricity	0,3	0,3	0,3	0,1	0,8	0,8
DHW system based on wood	0,4	0,3	0,3	0,5	0,0	0,0
DHW system based on gas	0,2	0,0	0,1	0,1	0,0	0,0
DHW system based on oil	0,0	0,2	0,1	0,1	0,0	0,0
DHW system based on solar thermal	0,0	0,3	0,1	0,1	0,0	0,0
Ventilation system	0,3	0,4	0,2	0,5	0,5	0,1
Cooling system	7,5	12,0	7,5	13,5	7,5	6,0

Improvement 2	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	16,0	27,5	22,0	8,3	NA	NA
Heating system based on wood	24,0	30,0	12,8	19,2	NA	NA
Heating system based on gas	8,0	0,0	5,0	7,5	NA	NA
Heating system based on oil	0,0	0,0	5,0	5,0	NA	NA
DHW system based on electricity	2,5	2,5	1,8	0,5	NA	NA
DHW system based on wood	0,2	0,3	0,4	0,5	NA	NA
DHW system based on gas	0,2	0,0	0,1	0,1	NA	NA
DHW system based on oil	0,0	0,0	0,1	0,1	NA	NA
DHW system based on solar thermal	0,2	0,3	0,1	0,1	NA	NA
Ventilation system	10,0	12,0	10,0	12,0	NA	NA
Cooling system	10,5	13,5	12,0	15,0	NA	NA

Climate zone C	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
DHW system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
Cooling system [EUR/m^2]	0	0	0	0	0	0
Ventilation system [EUR/m^2]	0	0	0	0	0	0
Heating system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
DHW system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
Cooling system [EUR/m^2]	7,5	12	7,5	13,5	7,5	6
Ventilation system [EUR/m^2]	0,3	0,4	0,2	0,5	0,5	0,05
Heating system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	NA	NA
DHW system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	NA	NA
Cooling system [EUR/m^2]	10,5	13,5	12	15	NA	NA
Ventilation system [EUR/m^2]	10	12	10	12	NA	NA

Climate zone A		Dormitory	Hospital	Kindergarten	Office	School	University
BAU renovation	Envelope cost [EUR/m^2]	1,60	1,35	4,36	1,80	2,05	0,76
	HVAC system cost [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
	Total cost [EUR/m^2]	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**
Improvement 1	Envelope cost [EUR/m^2]	16,76	15,40	25,81	21,26	21,14	22,69
	HVAC system cost [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
	Total cost [EUR/m^2]	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**
Improvement 2	Envelope cost [EUR/m^2]	21,81	25,15	33,96	29,11	NA	NA
	HVAC system cost [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	NA	NA
	Total cost [EUR/m^2]	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**NA**	**NA**

Climate zone B		Dormitory	Hospital	Kindergarten	Office	School	University
BAU renovation	Envelope cost [EUR/m^2]	1,60	1,35	4,36	1,80	2,05	0,76
	HVAC system cost [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
	Total cost [EUR/m^2]	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**
Improvement 1	Envelope cost [EUR/m^2]	16,76	15,40	25,81	21,26	21,14	22,69
	HVAC system cost [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
	Total cost [EUR/m^2]	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**
Improvement 2	Envelope cost [EUR/m^2]	21,81	25,15	33,96	29,11	NA	NA
	HVAC system cost [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	NA	NA
	Total cost [EUR/m^2]	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**NA**	**NA**

Climate zone C		Dormitory	Hospital	Kindergarten	Office	School	University
BAU renovation	Envelope cost [EUR/m^2]	1,60	1,35	4,36	1,80	2,05	0,76
	HVAC system cost [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
	Total cost [EUR/m^2]	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**
Improvement 1	Envelope cost [EUR/m^2]	16,76	15,40	25,81	21,26	21,14	22,69
	HVAC system cost [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
	Total cost [EUR/m^2]	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**
Improvement 2	Envelope cost [EUR/m^2]	21,81	25,15	33,96	29,11	NA	NA
	HVAC system cost [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	NA	NA
	Total cost [EUR/m^2]	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**NA**	**NA**

Present state		Dormitory	Hospital	Kindergarten	Office	School	University
Zone A	Electric	80	75	74	70	76	84
	Wood	0	0	4	10	4	0
	Gas	0	0	10	0	4	0
	Oil	20	25	12	20	16	16
Zone B	Electric	80	75	74	70	76	80
	Wood	0	0	4	10	6	0
	Gas	0	0	10	0	4	0
	Oil	20	25	12	20	14	20
Zone C	Electric	15	10	21	21	27	15
	Wood	50	30	60	54	54	45
	Gas	0	0	4	0	4	5
	Oil	35	60	15	25	15	35

BAU renovation		Dormitory	Hospital	Kindergarten	Office	School	University
Zone A	Electric	80	75	74	70	76	84
	Wood	0	0	4	10	4	0
	Gas	0	0	10	0	4	0
	Oil	20	25	12	20	16	16
Zone B	Electric	80	75	74	70	76	80
	Wood	0	0	4	10	6	0
	Gas	0	0	10	0	4	0
	Oil	20	25	12	20	14	20
Zone C	Electric	15	10	21	21	27	15
	Wood	50	30	60	54	54	45
	Gas	0	0	4	0	4	5
	Oil	35	60	15	25	15	35

Improvement 1		Dormitory	Hospital	Kindergarten	Office	School	University
Zone A	Electric	80	90	74	80	80	95
	Wood	0	0	12	5	0	0
	Gas	20	0	8	15	15	0
	Oil	0	10	6	0	5	5
Zone B	Electric	80	90	74	80	80	95
	Wood	0	0	12	5	0	0
	Gas	20	0	8	15	15	0
	Oil	0	10	6	0	5	5
Zone C	Electric	40	50	45	20	20	35
	Wood	40	30	35	60	60	55
	Gas	20	0	10	10	10	0
	Oil	0	20	10	15	10	10

Improvement 2		Dormitory	Hospital	Kindergarten	Office	School	University
Zone A	Electric	60	100	73	70	80	95
	Wood	20	0	15	10	0	0
	Gas	20	0	12	20	15	0
	Oil	0	0	0	0	5	5
Zone B	Electric	60	100	73	70	80	95
	Wood	20	0	15	10	0	0
	Gas	20	0	12	20	15	0
	Oil	0	0	0	0	5	5
Zone C	Electric	40	50	40	15	20	35
	Wood	40	50	40	60	60	55
	Gas	20	0	10	15	10	0
	Oil	0	0	10	10	10	10

Present state		Dormitory	Hospital	Kindergarten	Office	School	University
Zone A	Electric	80	45	74	70	0	100
	Wood	0	0	4	10	0	0
	Gas	0	0	10	0	0	0
	Oil	20	50	12	20	0	0
	Solar	0	5	0	0	0	0
Zone B	Electric	80	45	74	70	0	100
	Wood	0	0	4	10	0	0
	Gas	0	0	10	0	0	0
	Oil	20	50	12	20	0	0
	Solar	0	5	0	0	0	0
Zone C	Electric	35	100	21	21	0	100
	Wood	30	0	60	54	0	0
	Gas	0	0	4	0	0	0
	Oil	35	0	15	25	0	0
	Solar	0	0	0	0	0	0

BAU renovation		Dormitory	Hospital	Kindergarten	Office	School	University
Zone A	Electric	90	55	74	70	100	100
	Wood	0	0	4	10	0	0
	Gas	0	0	10	0	0	0
	Oil	10	40	12	20	0	0
	Solar	0	5	0	0	0	0
Zone B	Electric	90	55	74	70	100	100
	Wood	0	0	4	10	0	0
	Gas	0	0	10	0	0	0
	Oil	10	40	12	20	0	0
	Solar	0	5	0	0	0	0
Zone C	Electric	50	100	21	21	100	100
	Wood	40	0	60	54	0	0
	Gas	0	0	4	0	0	0
	Oil	10	0	15	25	0	0
	Solar	0	0	0	0	0	0

Improvement 1		Dormitory	Hospital	Kindergarten	Office	School	University
Zone A	Electric	80	80	69	75	100	100
	Wood	0	0	12	5	0	0
	Gas	20	0	8	15	0	0
	Oil	0	10	6	0	0	0
	Solar	0	10	5	5	0	0
Zone B	Electric	80	80	69	75	100	100
	Wood	0	0	12	5	0	0
	Gas	20	0	8	15	0	0
	Oil	0	10	6	0	0	0
	Solar	0	10	5	5	0	0
Zone C	Electric	40	40	42	12	100	100
	Wood	40	30	35	60	0	0
	Gas	20	0	10	10	0	0
	Oil	0	20	10	15	0	0
	Solar	0	10	3	3	0	0

Improvement 2		Dormitory	Hospital	Kindergarten	Office	School	University
Zone A	Electric	60	80	63	62	100	100
	Wood	0	0	15	10	0	0
	Gas	20	0	12	20	0	0
	Oil	0	0	0	0	0	0
	Solar	20	20	10	8	0	0
Zone B	Electric	60	80	63	62	100	100
	Wood	0	0	15	10	0	0
	Gas	20	0	12	20	0	0
	Oil	0	0	0	0	0	0
	Solar	20	20	10	8	0	0
Zone C	Electric	50	50	35	10	100	100
	Wood	20	30	40	60	0	0
	Gas	20	0	10	15	0	0
	Oil	0	0	10	10	0	0
	Solar	10	20	5	5	0	0

Climatic Zone A

	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	U1	U2	U3
Electricity [kWh/m^2]	32,4	71,0	23,3	8,1	16,2	36,3	27,3	15,6	20,4	28,3	12,8	6,7	11,5	23,2	12,4	9,8	7,7	23,8	10,9	10,2	15,5	14,8
Wood [kWh/m^2]	0,0	0,0	0,0	4,4	0,0	0,0	0,0	0,0	2,0	2,8	3,7	3,8	3,3	6,4	0,9	1,5	0,7	1,4	0,0	0,0	0,0	0,0
Gas [kWh/m^2]	0,0	0,0	9,4	8,0	0,0	0,0	0,0	0,0	3,8	5,1	2,3	2,6	0,0	0,0	2,5	2,6	0,6	1,1	1,6	0,0	0,0	0,0
Oil [kWh/m^2]	11,4	20,9	0,0	0,0	21,0	33,2	5,3	0,0	4,5	6,1	1,7	0,0	5,0	10,0	0,0	0,0	2,3	4,3	0,5	2,4	4,8	0,4
Solar [kWh/m^2]	0,0	0,0	0,0	4,3	1,1	1,1	1,7	3,4	0,0	0,0	0,5	0,9	0,0	0,0	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0

Climatic Zone B

	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	U1	U2	U3
Electricity [kWh/m^2]	37,5	87,9	25,2	9,1	18,3	43,6	30,4	17,8	24,9	34,4	14,1	7,6	13,8	28,2	13,5	10,3	10,2	28,7	11,9	11,3	17,7	15,7
Wood [kWh/m^2]	0,0	0,0	0,0	6,0	0,0	0,0	0,0	0,0	2,4	3,3	4,4	4,6	4,2	8,4	1,2	2,0	1,4	2,7	0,0	0,0	0,0	0,0
Gas [kWh/m^2]	0,0	0,0	11,0	9,5	0,0	0,0	0,0	0,0	4,6	6,3	2,8	3,2	0,0	0,0	3,4	3,5	0,7	1,4	2,2	0,0	0,0	0,0
Oil [kWh/m^2]	13,2	26,8	0,0	0,0	23,2	40,8	6,6	0,0	5,5	7,5	2,1	0,0	6,5	13,1	0,0	0,0	2,6	5,0	0,7	4,0	8,1	0,6
Solar [kWh/m^2]	0,0	0,0	0,0	4,3	1,1	1,1	1,7	3,4	0,0	0,0	0,5	0,9	0,0	0,0	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0

Climatic Zone C

	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	U1	U2	U3
Electricity [kWh/m^2]	24,1	41,3	23,0	7,5	11,4	17,8	24,9	11,1	16,3	22,0	12,7	4,6	7,3	13,2	3,5	1,4	7,7	21,6	8,9	7,2	8,9	12,7
Wood [kWh/m^2]	45,5	134,7	24,6	22,5	25,2	76,8	26,5	39,2	52,4	65,9	17,9	17,9	40,2	80,5	26,0	22,4	27,1	47,3	19,3	24,0	44,4	14,4
Gas [kWh/m^2]	0,0	0,0	16,6	13,8	0,0	0,0	0,0	0,0	3,9	5,2	5,4	4,5	0,0	0,0	4,4	5,0	1,6	2,8	3,0	2,1	3,9	0,0
Oil [kWh/m^2]	31,0	77,4	0,0	0,0	54,4	132,9	18,6	0,0	11,6	14,9	5,1	3,6	15,1	29,9	6,1	3,2	5,9	10,4	3,0	14,8	27,3	2,5
Solar [kWh/m^2]	0,0	0,0	0,0	4,3	1,1	1,1	1,7	3,4	0,0	0,0	0,5	0,9	0,0	0,0	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0

	Dormitory	Hospital	Kindergarten	Office	School	University	Additional insulation
Present state	Limited insulation, single glazed windows with metallic frame	Limited insulation, single windows with metallic frame and double glazed windows with wood/plastic frame	Limited insulation, single glazed windows with metallic frame	Limited insulation, single glazed windows with metallic frame	Limited insulation, single or double glazed windows with metallic frame	Limited insulation, single glazed windows with metallic frame	
BAU renovation	Additional insulation, single glazed windows with metallic frame	Additional insulation, single windows with metallic frame and double glazed windows with wood/plastic frame	Additional insulation, single glazed windows with metallic frame	Additional insulation, single glazed windows with metallic frame	Additional insulation, single or double glazed windows with metallic frame	Additional insulation, single glazed windows with metallic frame	External wall - 0 cm Wall to unheated space - 0 cm Attic slab - 5 cm Cellar ceiling - 3 cm Arcade slab - 0 cm Flat roof - 3 cm Pitched roof - 10 cm Floor on the ground - 0 cm Walls to the ground - 3 cm
Improvement 1	Additional insulation, double glazed windows with metallic frame and noble gas filling	Additional insulation, double glazed windows with metallic frame and noble gas filling	Additional insulation, double glazed windows with metallic frame and noble gas filling	Additional insulation, double glazed windows with metallic frame and noble gas filling	Additional insulation, double glazed windows with metallic frame and noble gas filling	Additional insulation, double glazed windows with metallic frame and noble gas filling	External wall - 5 cm Wall to unheated space - 5 cm Attic slab - 10 cm Cellar ceiling - 5 cm Arcade slab - 10 cm Flat roof - 5 cm Pitched roof - 10 cm Floor on the ground - 5 cm Walls to the ground - 5 cm
Improvement 2	Additional insulation, triple glazed windows with metallic frame and noble gas filling	Additional insulation, triple glazed windows with metallic frame and noble gas filling	Additional insulation, triple glazed windows with metallic frame and noble gas filling	Additional insulation, triple glazed windows with metallic frame and noble gas filling	Additional insulation, triple glazed windows with metallic frame and noble gas filling	Additional insulation, triple glazed windows with metallic frame and noble gas filling	External wall - 8 cm Wall to unheated space - 8 cm Attic slab - 10 cm Cellar ceiling - 8 cm Arcade slab - 10 cm Flat roof - 5 cm Pitched roof - 10 cm Floor on the ground - 5 cm Walls to the ground - 5 cm

Additional insulation		
BAU renovation	Improvement 1	Improvement 2
External wall - 0 cm	External wall - 5 cm	External wall - 8 cm
Wall to unheated space - 0 cm	Wall to unheated space - 5 cm	Wall to unheated space - 8 cm
Attic slab - 5 cm	Attic slab - 10 cm	Attic slab - 10 cm
Cellar ceiling - 3 cm	Cellar ceiling - 5 cm	Cellar ceiling - 8 cm
Arcade slab - 0 cm	Arcade slab - 10 cm	Arcade slab - 10 cm
Flat roof - 3 cm	Flat roof - 5 cm	Flat roof - 5 cm
Pitched roof - 10 cm	Pitched roof - 10 cm	Pitched roof - 10 cm
Floor on the ground - 0 cm	Floor on the ground - 5 cm	Floor on the ground - 5 cm
Walls to the ground - 3 cm	Walls to the ground - 5 cm	Walls to the ground - 5 cm

	Heating		Cooling		Yearly global radiation				
	HDD	ZH	CDD	ZC	North	East	South	West	Global
	hK/a	h/a	hK/a	h/a	kWh/(m^{2}a)				
Zone A	1330	4368,0	665,3	4392,0	372	951	1234	924	1552
Zone B	1673,7	4368,0	756,8	4392,0	372	951	1234	924	1552
Zone C	2600	4368,0	385,1	2208,0	362	922	1195	878	1480

		Dormitory	Hospital	Kindergarten	Office	School	University
Ventilation [1/h]		0,5	0,9	0,9	0,8	0,9	0,9
Internal heat gain [W/m^2]		7,5	9	7,5	8,5	7,5	8,75
Design temperature winter [°C]		20					
Design temperature summer [°C]		26					
DHW demand [kWh/m^2]	Present	20	20	8	2	0	5
	BAU renovation	20	20	12	2	8	5
	Standard renovation	20	16	10	1,5	7	10
	Ambitious renovation	20	16	8	1,5	7	10

Heated hours [h/week]					
Renovation options		Present	BAU	Improvement 1	Improvement 2
Zone A	Dormitory	42	56	70	126
	Hospital	56	84	126	168
	Kindergarten	30	40	50	50
	Office	30	40	50	50
	Schools	20	30	40	NA
	University	20	30	40	NA
Zone B	Dormitory	42	56	70	126
	Hospital	56	84	126	168
	Kindergarten	30	40	50	50
	Office	30	40	50	50
	Schools	20	30	40	NA
	University	20	30	40	NA
Zone C	Dormitory	49	63	77	133
	Hospital	63	91	133	168
	Kindergarten	35	45	55	55
	Office	35	45	55	55
	Schools	25	35	45	NA
	University	25	35	45	NA

Cooled hours [h/week]					
Renovation options		Present	BAU	Improvement 1	Improvement 2
Zone A	Dormitory	0	0	56	56
	Hospital	42	56	70	70
	Kindergarten	30	40	50	50
	Office	40	50	50	50
	Schools	15	30	30	NA
	University	15	30	30	NA
Zone B	Dormitory	0	0	56	56
	Hospital	42	56	70	70
	Kindergarten	30	40	50	50
	Office	40	50	50	50
	Schools	15	30	30	NA
	University	15	30	30	NA
Zone C	Dormitory	0	0	0	0
	Hospital	0	0	0	0
	Kindergarten	0	0	0	0
	Office	0	0	0	0
	Schools	0	0	0	NA
	University	0	0	0	NA

Ventilated hours [h/week]					
Renovation options		Present	BAU	Improvement 1	Improvement 2
Zone A	Dormitory	42	56	70	126
	Hospital	56	84	126	168
	Kindergarten	30	40	50	50
	Office	30	40	50	50
	Schools	20	30	40	NA
	University	20	30	40	NA
Zone B	Dormitory	42	56	70	126
	Hospital	56	84	126	168
	Kindergarten	30	40	50	50
	Office	30	40	50	50
	Schools	20	30	40	NA
	University	20	30	40	NA
Zone C	Dormitory	49	63	77	133
	Hospital	63	91	133	168
	Kindergarten	35	45	55	55
	Office	35	45	55	55
	Schools	25	35	45	NA
	University	25	35	45	NA

Heated floor areas [%]					
Renovation options		Present	BAU	Improvement 1	Improvement 2
Zone A	Dormitory	69	90	90	100
	Hospital	58	80	100	100
	Kindergarten	78	80	100	100
	Office	61	90	100	100
	Schools	70	80	100	NA
	University	72	80	80	NA
Zone B	Dormitory	69	90	90	100
	Hospital	58	80	100	100
	Kindergarten	78	80	100	100
	Office	61	90	100	100
	Schools	70	80	100	NA
	University	72	80	80	NA
Zone C	Dormitory	69	90	90	100
	Hospital	58	80	100	100
	Kindergarten	78	80	100	100
	Office	61	90	100	100
	Schools	70	80	100	NA
	University	72	80	80	NA

Cooled floor areas [%]					
Renovation options		Present	BAU	Improvement 1	Improvement 2
Zone A	Dormitory	0	20	50	70
	Hospital	17	50	80	90
	Kindergarten	22	30	50	80
	Office	40	70	90	100
	Schools	0	30	50	NA
	University	40	40	40	NA
Zone B	Dormitory	0	20	50	70
	Hospital	17	50	80	90
	Kindergarten	22	30	50	80
	Office	40	70	90	100
	Schools	0	30	50	NA
	University	40	40	40	NA
Zone C	Dormitory	0	0	0	0
	Hospital	0	0	0	0
	Kindergarten	0	0	0	0
	Office	0	0	0	0
	Schools	0	0	0	NA
	University	0	0	0	NA

Ventilated floor areas [%]					
Renovation options		Present	BAU	Improvement 1	Improvement 2
Zone A	Dormitory	0	20	30	50
	Hospital	0	30	40	60
	Kindergarten	0	0	20	50
	Office	0	10	50	60
	Schools	0	0	50	NA
	University	0	5	5	NA
Zone B	Dormitory	0	20	30	50
	Hospital	0	30	40	60
	Kindergarten	0	0	20	50
	Office	0	10	50	60
	Schools	0	0	50	NA
	University	0	5	5	NA
Zone C	Dormitory	0	20	30	50
	Hospital	0	30	40	60
	Kindergarten	0	0	20	50
	Office	0	10	50	60
	Schools	0	0	50	NA
	University	0	5	5	NA

Dormitory			
	Present and BAU	Improvement 1	Improvement 2
Climatic zone A	Direct electric heating, 80%, η_b=100%	Heat pump, 80%, SCOP=300%	Heat pump, 60%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 20%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 20%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 20%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
Climatic zone B	Direct electric heating, 80%, η_b=100%	Heat pump, 80%, SCOP=300%	Heat pump, 60%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 20%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 20%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 20%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
Climatic zone C	Direct electric heating, 15%, η_b=100%	Heat pump, 40%, SCOP=300%	Heat pump, 40%, SCOP=400%
	Wooden stove, 50%, η_b=60%	Pellet boiler, 40%, η_b=85%	Pellet boiler, 40%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 20%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 35%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%

Hospital			
	Present and BAU	Improvement 1	Improvement 2
Climatic zone A	Heat pump, 75%, SCOP=220%	Heat pump, 90%, SCOP=300%	Heat pump, 100%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 25%, η_b=80%	Oil boiler (low temperature), 10%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
Climatic zone B	Heat pump, 75%, SCOP=220%	Heat pump, 90%, SCOP=300%	Heat pump, 100%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 25%, η_b=80%	Oil boiler (low temperature), 10%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
Climatic zone C	Heat pump, 15%, SCOP=220%	Heat pump, 50%, SCOP=300%	Heat pump, 50%, SCOP=400%
	Wooden stove, 50%, η_b=60%	Pellet boiler, 30%, η_b=85%	Pellet boiler, 50%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 35%, η_b=80%	Oil boiler (low temperature), 20%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%

Kindergarten			
	Present and BAU	Improvement 1	Improvement 2
Climatic zone A	Direct electric heating, 74%, η_b=100%	Heat pump, 74%, SCOP=300%	Heat pump, 73%, SCOP=400%
	Wooden stove, 4%, η_b=60%	Pellet boiler, 12%, η_b=85%	Pellet boiler, 15%, η_b=85%
	Gas boiler, 10%, η_b=80%	Gas boiler (low temperature), 8%, η_b=90%	Gas boiler (condensing), 12%, η_b=98%
	Oil boiler, 12%, η_b=80%	Oil boiler (low temperature), 6%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
Climatic zone B	Direct electric heating, 74%, η_b=100%	Heat pump, 74%, SCOP=300%	Heat pump, 73%, SCOP=400%
	Wooden stove, 4%, η_b=60%	Pellet boiler, 12%, η_b=85%	Pellet boiler, 15%, η_b=85%
	Gas boiler, 10%, η_b=80%	Gas boiler (low temperature), 8%, η_b=90%	Gas boiler (condensing), 12%, η_b=98%
	Oil boiler, 12%, η_b=80%	Oil boiler (low temperature), 6%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
Climatic zone C	Direct electric heating, 21%, η_b=100%	Heat pump, 45%, SCOP=300%	Heat pump, 40%, SCOP=400%
	Wooden stove, 60%, η_b=60%	Pellet boiler, 35%, η_b=85%	Pellet boiler, 40%, η_b=85%
	Gas boiler, 4%, η_b=80%	Gas boiler (low temperature), 10%, η_b=90%	Gas boiler (condensing), 10%, η_b=98%
	Oil boiler, 15%, η_b=80%	Oil boiler (low temperature), 10%, η_b=90%	Oil boiler (low temperature), 10%, η_b=95%

Office			
	Present and BAU	Improvement 1	Improvement 2
Climatic zone A	Direct electric heating and heat pump, 70%, SCOP=150%	Heat pump, 80%, SCOP=300%	Heat pump, 70%, SCOP=400%
	Wooden stove, 10%, η_b=60%	Pellet boiler, 5%, η_b=85%	Pellet boiler, 10%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 15%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 20%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
Climatic zone B	Direct electric heating and heat pump, 70%, SCOP=150%	Heat pump, 80%, SCOP=300%	Heat pump, 70%, SCOP=400%
	Wooden stove, 10%, η_b=60%	Pellet boiler, 5%, η_b=85%	Pellet boiler, 10%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 15%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 20%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
Climatic zone C	Direct electric heating and heat pump, 21%, SCOP=150%	Heat pump, 20%, SCOP=300%	Heat pump, 15%, SCOP=400%
	Wooden stove, 54%, η_b=60%	Pellet boiler, 60%, η_b=85%	Pellet boiler, 60%, η_b=85%
	Gas boiler, 4%, η_b=80%	Gas boiler (low temperature), 10%, η_b=90%	Gas boiler (condensing), 15%, η_b=98%
	Oil boiler, 15%, η_b=80%	Oil boiler (low temperature), 15%, η_b=90%	Oil boiler (low temperature), 10%, η_b=95%

School		
	Present and BAU	Improvement 1
Climatic zone A	Direct electric heating, 76%, η_b=100%	Heat pump, 80%, SCOP=300%
	Wooden stove, 4%, η_b=60%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 4%, η_b=80%	Gas boiler (low temperature), 15%, η_b=90%
	Oil boiler, 16%, η_b=80%	Oil boiler (low temperature), 5%, η_b=90%
Climatic zone B	Direct electric heating, 76%, η_b=100%	Heat pump, 80%, SCOP=300%
	Wooden stove, 6%, η_b=60%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 4%, η_b=80%	Gas boiler (low temperature), 15%, η_b=90%
	Oil boiler, 14%, η_b=80%	Oil boiler (low temperature), 5%, η_b=90%
Climatic zone C	Direct electric heating, 27%, η_b=100%	Heat pump, 20%, SCOP=300%
	Wooden stove, 54%, η_b=60%	Pellet boiler, 60%, η_b=85%
	Gas boiler, 4%, η_b=80%	Gas boiler (low temperature), 10%, η_b=90%
	Oil boiler, 15%, η_b=80%	Oil boiler (low temperature), 10%, η_b=90%

University		
	Present and BAU	Improvement 1
Climatic zone A	Heat pump, 84%, SCOP=220%	Heat pump, 95%, SCOP=300%
	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%
	Oil boiler, 20%, η_b=16%	Oil boiler (low temperature), 5%, η_b=90%
Climatic zone B	Heat pump, 80%, SCOP=220%	Heat pump, 95%, SCOP=300%
	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%
	Oil boiler, 20%, η_b=80%	Oil boiler (low temperature), 5%, η_b=90%
Climatic zone C	Heat pump, 15%, SCOP=220%	Heat pump, 35%, SCOP=300%
	Wooden stove, 45%, η_b=60%	Pellet boiler, 55%, η_b=85%
	Gas boiler, 5%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%
	Oil boiler, 35%, η_b=80%	Oil boiler (low temperature), 10%, η_b=90%

Dormitory				
	Present	BAU	Improvement 1	Improvement 2
Climatic zone A	Direct electric heating, 80%, η_b=98%	Direct electric heating, 90%, η_b=98%	Direct electric heating, 80%, ηb=98%	Heat pump, 60%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 20%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 20%, η_b=80%	Oil boiler, 10%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%	Solar collector, 20%
Climatic zone B	Direct electric heating, 80%, η_b=98%	Direct electric heating, 90%, η_b=98%	Direct electric heating, 80%, ηb=98%	Heat pump, 60%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 20%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 20%, η_b=80%	Oil boiler, 10%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%	Solar collector, 20%
Climatic zone C	Direct electric heating, 35%, η_b=98%	Direct electric heating, 50%, η_b=98%	Direct electric heating, 40%, ηb=98%	Heat pump, 50%, SCOP=400%
	Wooden stove, 30%, η_b=60%	Wooden stove, 40%, η_b=60%	Pellet boiler, 40%, η_b=85%	Pellet boiler, 20%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 20%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 35%, η_b=80%	Oil boiler, 10%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%	Solar collector, 10%

Hospital				
	Present	BAU	Improvement 1	Improvement 2
Climatic zone A	Direct electric heating, 45%, η_b=98%	Direct electric heating, 55%, η_b=98%	Direct electric heating, 80%, ηb=98%	Heat pump, 80%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 50%, η_b=80%	Oil boiler, 40%, η_b=80%	Oil boiler (low temperature), 10%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 5%	Solar collector, 5%	Solar collector, 10%	Solar collector, 20%
Climatic zone B	Direct electric heating, 45%, η_b=98%	Direct electric heating, 55%, η_b=98%	Direct electric heating, 80%, ηb=98%	Heat pump, 80%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 50%, η_b=80%	Oil boiler, 40%, η_b=80%	Oil boiler (low temperature), 10%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 5%	Solar collector, 5%	Solar collector, 10%	Solar collector, 20%
Climatic zone C	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, η_b=98%	Direct electric heating, 40%, ηb=98%	Heat pump, 50%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 30%, η_b=85%	Pellet boiler, 30%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 0%, η_b=80%	Oil boiler, 0%, η_b=80%	Oil boiler (low temperature), 20%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 10%	Solar collector, 20%

Kindergarten				
	Present	BAU	Improvement 1	Improvement 2
Climatic zone A	Direct electric heating, 74%, η_b=98%	Direct electric heating, 74%, η_b=98%	Direct electric heating, 69%, ηb=98%	Heat pump, 63%, SCOP=400%
	Wooden stove, 4%, η_b=60%	Wooden stove, 4%, η_b=60%	Pellet boiler, 12%, η_b=85%	Pellet boiler, 15%, η_b=85%
	Gas boiler, 10%, η_b=80%	Gas boiler, 10%, η_b=80%	Gas boiler (low temperature), 8%, η_b=90%	Gas boiler (condensing), 12%, η_b=98%
	Oil boiler, 12%, η_b=80%	Oil boiler, 12%, η_b=80%	Oil boiler (low temperature), 6%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 5%	Solar collector, 10%
Climatic zone B	Direct electric heating, 74%, η_b=98%	Direct electric heating, 74%, η_b=98%	Direct electric heating, 69%, ηb=98%	Heat pump, 63%, SCOP=400%
	Wooden stove, 4%, η_b=60%	Wooden stove, 4%, η_b=60%	Pellet boiler, 12%, η_b=85%	Pellet boiler, 15%, η_b=85%
	Gas boiler, 10%, η_b=80%	Gas boiler, 10%, η_b=80%	Gas boiler (low temperature), 8%, η_b=90%	Gas boiler (condensing), 12%, η_b=98%
	Oil boiler, 12%, η_b=80%	Oil boiler, 12%, η_b=80%	Oil boiler (low temperature), 6%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 5%	Solar collector, 10%
Climatic zone C	Direct electric heating, 21%, η_b=98%	Direct electric heating, 21%, η_b=98%	Direct electric heating, 42%, ηb=98%	Heat pump, 35%, SCOP=400%
	Wooden stove, 60%, η_b=60%	Wooden stove, 60%, η_b=60%	Pellet boiler, 35%, η_b=85%	Pellet boiler, 40%, η_b=85%
	Gas boiler, 4%, η_b=80%	Gas boiler, 4%, η_b=80%	Gas boiler (low temperature), 10%, η_b=90%	Gas boiler (condensing), 10%, η_b=98%
	Oil boiler, 15%, η_b=80%	Oil boiler, 15%, η_b=80%	Oil boiler (low temperature), 10%, η_b=90%	Oil boiler (low temperature), 10%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 3%	Solar collector, 5%

Office				
	Present	BAU	Improvement 1	Improvement 2
Climatic zone A	Direct electric heating, 70%, η_b=98%	Direct electric heating, 75%, η_b=98%	Direct electric heating, 75%, ηb=98%	Heat pump, 62%, SCOP=400%
	Wooden stove, 10%, η_b=60%	Wooden stove, 5%, η_b=60%	Pellet boiler, 5%, η_b=85%	Pellet boiler, 10%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 10%, η_b=80%	Gas boiler (low temperature), 15%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 20%, η_b=80%	Oil boiler, 10%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 5%	Solar collector, 8%
Climatic zone B	Direct electric heating, 70%, η_b=98%	Direct electric heating, 80%, η_b=98%	Direct electric heating, 75%, ηb=98%	Heat pump, 62%, SCOP=400%
	Wooden stove, 10%, η_b=60%	Wooden stove, 5%, η_b=60%	Pellet boiler, 5%, η_b=85%	Pellet boiler, 10%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 5%, η_b=80%	Gas boiler (low temperature), 15%, η_b=90%	Gas boiler (condensing), 20%, η_b=98%
	Oil boiler, 20%, η_b=80%	Oil boiler, 10%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 5%	Solar collector, 8%
Climatic zone C	Direct electric heating, 21%, η_b=98%	Direct electric heating, 15%, η_b=98%	Direct electric heating, 12%, ηb=98%	Heat pump, 10%, SCOP=400%
	Wooden stove, 54%, η_b=60%	Wooden stove, 60%, η_b=60%	Pellet boiler, 60%, η_b=85%	Pellet boiler, 60%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 10%, η_b=80%	Gas boiler (low temperature), 10%, η_b=90%	Gas boiler (condensing), 15%, η_b=98%
	Oil boiler, 25%, η_b=80%	Oil boiler, 15%, η_b=80%	Oil boiler (low temperature), 15%, η_b=90%	Oil boiler (low temperature), 10%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 3%	Solar collector, 5%

School				
	Present	BAU	Improvement 1	Improvement 2
Climatic zone A	Direct electric heating, 0%, η_b=98%	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, ηb=98%	Heat pump, 100%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 0%, η_b=80%	Oil boiler, 0%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%
Climatic zone B	Direct electric heating, 0%, η_b=98%	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, ηb=98%	Heat pump, 100%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 0%, η_b=80%	Oil boiler, 0%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%
Climatic zone C	Direct electric heating, 0%, η_b=98%	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, ηb=98%	Heat pump, 100%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 0%, η_b=80%	Oil boiler, 0%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%

University				
	Present	BAU	Improvement 1	Improvement 2
Climatic zone A	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, ηb=98%	Heat pump, 100%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 0%, η_b=80%	Oil boiler, 0%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%
Climatic zone B	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, ηb=98%	Heat pump, 100%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 0%, η_b=80%	Oil boiler, 0%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%
Climatic zone C	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, η_b=98%	Direct electric heating, 100%, ηb=98%	Heat pump, 100%, SCOP=400%
	Wooden stove, 0%, η_b=60%	Wooden stove, 0%, η_b=60%	Pellet boiler, 0%, η_b=85%	Pellet boiler, 0%, η_b=85%
	Gas boiler, 0%, η_b=80%	Gas boiler, 0%, η_b=80%	Gas boiler (low temperature), 0%, η_b=90%	Gas boiler (condensing), 0%, η_b=98%
	Oil boiler, 0%, η_b=80%	Oil boiler, 0%, η_b=80%	Oil boiler (low temperature), 0%, η_b=90%	Oil boiler (low temperature), 0%, η_b=95%
	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%	Solar collector, 0%

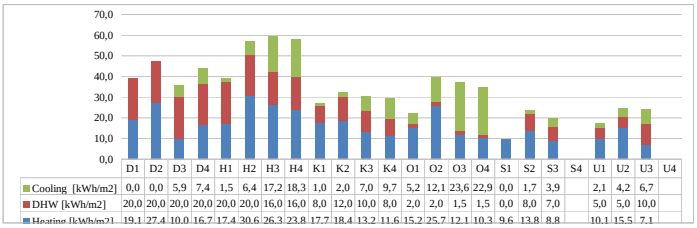
	Present state and BAU renovation	Improvement 1	Improvement 2
Climate zone A	Heat pump, EER=2	Heat pump, EER>3	Heat pump, EER>3
Climate zone B	Heat pump, EER=2	Heat pump, EER>3	Heat pump, EER>3
Climate zone C	Heat pump, EER=2	Heat pump, EER>3	Heat pump, EER>3

hőszivattyú esetén a fűtés és hűtés is egy egységről megy!

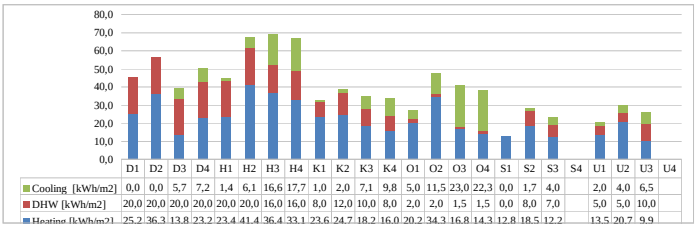
	Present state and BAU renovation	Improvement 1	Improvement 2
Climate zone A	Existing exhaust system	New exhaust system	Balanced ventilation system
Climate zone B	Existing exhaust system	New exhaust system	Balanced ventilation system
Climate zone C	Existing exhaust system	New exhaust system	Balanced ventilation system

Energy carrier	primary-to-final energy factor	specific CO_2 emissions
	[kWh/kWh]	[kg/kWh]
Wood biomass	0,2	0
Electrical energy	1,01	0
LPG	1,1	0,227
Oil	1,2	0,267
Solar energy	0	0

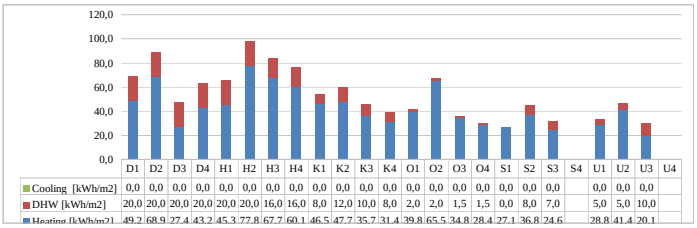
Climatic Zone A																										
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4		
Heating [kWh/m^2]	19,1	27,4	10,0	16,7	17,4	30,6	26,3	23,8	17,7	18,4	13,2	11,6	15,2	25,7	12,1	10,3	9,6	13,8	8,8		10,1	15,5	7,1			
DHW [kWh/m2]	20,0	20,0	20,0	20,0	20,0	20,0	16,0	16,0	8,0	12,0	10,0	8,0	2,0	2,0	1,5	1,5	0,0	8,0	7,0		5,0	5,0	10,0			
Cooling [kWh/m2]	0,0	0,0	5,9	7,4	1,5	6,4	17,2	18,3	1,0	2,0	7,0	9,7	5,2	12,1	23,6	22,9	0,0	1,7	3,9		2,1	4,2	6,7			



Climatic Zone B																										
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4		
Heating [kWh/m^2]	25,2	36,3	13,8	23,2	23,4	41,4	36,4	33,1	23,6	24,7	18,2	16,0	20,2	34,3	16,8	14,3	12,8	18,5	12,2		13,5	20,7	9,9			
DHW [kWh/m2]	20,0	20,0	20,0	20,0	20,0	20,0	16,0	16,0	8,0	12,0	10,0	8,0	2,0	2,0	1,5	1,5	0,0	8,0	7,0		5,0	5,0	10,0			
Cooling [kWh/m2]	0,0	0,0	5,7	7,2	1,4	6,1	16,6	17,7	1,0	2,0	7,1	9,8	5,0	11,5	23,0	22,3	0,0	1,7	4,0		2,0	4,0	6,5			

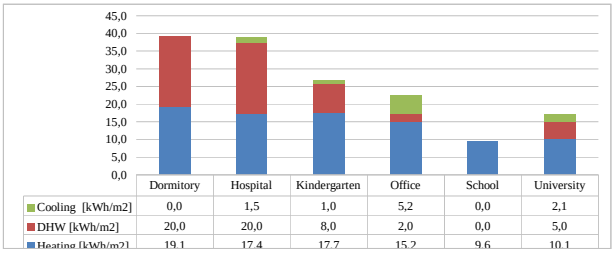


Climatic Zone C																										
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4		
Heating [kWh/m^2]	49,2	68,9	27,4	43,2	45,3	77,8	67,7	60,1	46,5	47,7	35,7	31,4	39,8	65,5	34,8	28,4	27,1	36,8	24,6		28,8	41,4	20,1			
DHW [kWh/m2]	20,0	20,0	20,0	20,0	20,0	20,0	16,0	16,0	8,0	12,0	10,0	8,0	2,0	2,0	1,5	1,5	0,0	8,0	7,0		5,0	5,0	10,0			
Cooling [kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0		0,0	0,0	0,0			



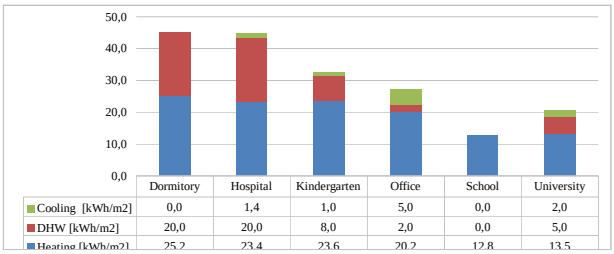
Climatic Zone A

	Dormitory	Hospital	Kindergarten	Office	School	University
Heating [kWh/m^2]	19,1	17,4	17,7	15,2	9,6	10,1
DHW [kWh/m2]	20,0	20,0	8,0	2,0	0,0	5,0
Cooling [kWh/m2]	0,0	1,5	1,0	5,2	0,0	2,1



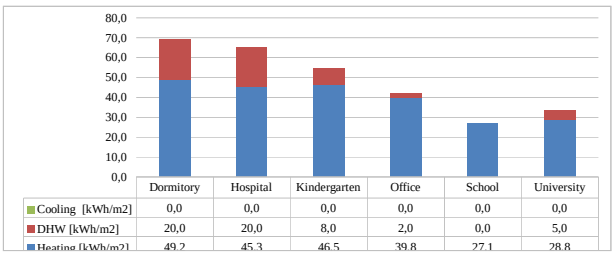
Climatic Zone B

	Dormitory	Hospital	Kindergarten	Office	School	University
Heating [kWh/m^2]	25,2	23,4	23,6	20,2	12,8	13,5
DHW [kWh/m2]	20,0	20,0	8,0	2,0	0,0	5,0
Cooling [kWh/m2]	0,0	1,4	1,0	5,0	0,0	2,0



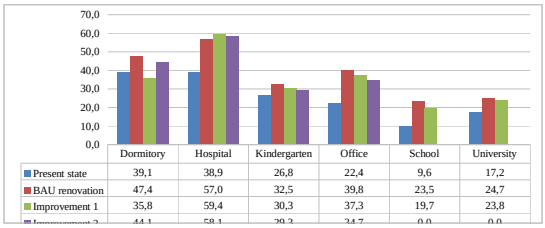
Climatic Zone C

	Dormitory	Hospital	Kindergarten	Office	School	University
Heating [kWh/m^2]	49,2	45,3	46,5	39,8	27,1	28,8
DHW [kWh/m2]	20,0	20,0	8,0	2,0	0,0	5,0
Cooling [kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0



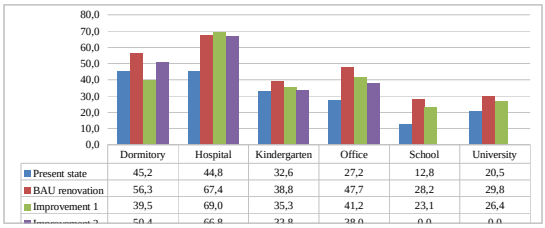
Climatic Zone A																								
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4
Heating [kWh/m^2]	19,1	27,4	10,0	16,7	17,4	30,6	26,3	23,8	17,7	18,4	13,2	11,6	15,2	25,7	12,1	10,3	9,6	13,8	8,8		10,1	15,5	7,1	
DHW [kWh/m2]	20,0	20,0	20,0	20,0	20,0	20,0	16,0	16,0	8,0	12,0	10,0	8,0	2,0	2,0	1,5	1,5	0,0	8,0	7,0		5,0	5,0	10,0	
Cooling [kWh/m2]	0,0	0,0	5,9	7,4	1,5	6,4	17,2	18,3	1,0	2,0	7,0	9,7	5,2	12,1	23,6	22,9	0,0	1,7	3,9		2,1	4,2	6,7	

	Dormitory	Hospital	Kindergarten	Office	School	University
Present state	39,1	38,9	26,8	22,4	9,6	17,2
BAU renovation	47,4	57,0	32,5	39,8	23,5	24,7
Improvement 1	35,8	59,4	30,3	37,3	19,7	23,8
Improvement 2	44,1	58,1	29,3	34,7	0,0	0,0



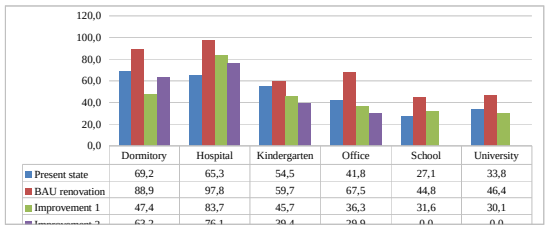
Climatic Zone B																								
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4
Heating [kWh/m^2]	25,2	36,3	13,8	23,2	23,4	41,4	36,4	33,1	23,6	24,7	18,2	16,0	20,2	34,3	16,8	14,3	12,8	18,5	12,2		13,5	20,7	9,9	
DHW [kWh/m2]	20,0	20,0	20,0	20,0	20,0	20,0	16,0	16,0	8,0	12,0	10,0	8,0	2,0	2,0	1,5	1,5	0,0	8,0	7,0		5,0	5,0	10,0	
Cooling [kWh/m2]	0,0	0,0	5,7	7,2	1,4	6,1	16,6	17,7	1,0	2,0	7,1	9,8	5,0	11,5	23,0	22,3	0,0	1,7	4,0		2,0	4,0	6,5	

	Dormitory	Hospital	Kindergarten	Office	School	University
Present state	45,2	44,8	32,6	27,2	12,8	20,5
BAU renovation	56,3	67,4	38,8	47,7	28,2	29,8
Improvement 1	39,5	69,0	35,3	41,2	23,1	26,4
Improvement 2	50,4	66,8	33,8	38,0	0,0	0,0

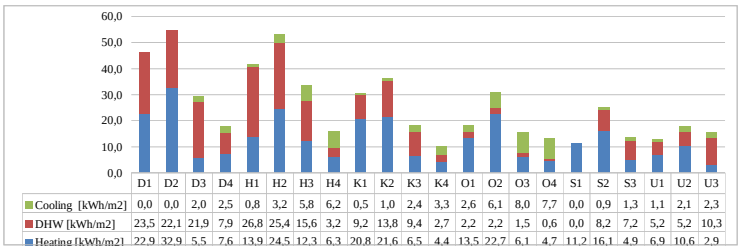


Climatic Zone C																								
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4
Heating [kWh/m^2]	49,2	68,9	27,4	43,2	45,3	77,8	67,7	60,1	46,5	47,7	35,7	31,4	39,8	65,5	34,8	28,4	27,1	36,8	24,6		28,8	41,4	20,1	
DHW [kWh/m2]	20,0	20,0	20,0	20,0	20,0	20,0	16,0	16,0	8,0	12,0	10,0	8,0	2,0	2,0	1,5	1,5	0,0	8,0	7,0		5,0	5,0	10,0	
Cooling [kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0		0,0	0,0	0,0	

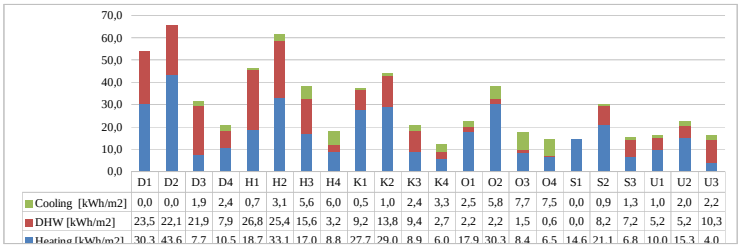
	Dormitory	Hospital	Kindergarten	Office	School	University
Present state	69,2	65,3	54,5	41,8	27,1	33,8
BAU renovation	88,9	97,8	59,7	67,5	44,8	46,4
Improvement 1	47,4	83,7	45,7	36,3	31,6	30,1
Improvement 2	63,2	76,1	39,4	29,9	0,0	0,0



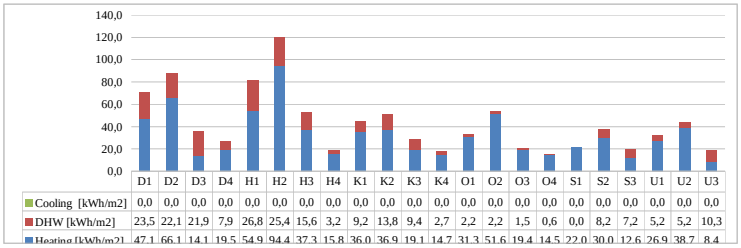
Climatic Zone A																							
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	U1	U2	U3
Heating [kWh/m^2]	22,9	32,9	5,5	7,6	13,9	24,5	12,3	6,3	20,8	21,6	6,5	4,4	13,5	22,7	6,1	4,7	11,2	16,1	4,9	6,9	10,6	2,9
DHW [kWh/m2]	23,5	22,1	21,9	7,9	26,8	25,4	15,6	3,2	9,2	13,8	9,4	2,7	2,2	2,2	1,5	0,6	0,0	8,2	7,2	5,2	5,2	10,3
Cooling [kWh/m2]	0,0	0,0	2,0	2,5	0,8	3,2	5,8	6,2	0,5	1,0	2,4	3,3	2,6	6,1	8,0	7,7	0,0	0,9	1,3	1,1	2,1	2,3



Climatic Zone B																						
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	U1	U2	U3
Heating [kWh/m^2]	30,3	43,6	7,7	10,5	18,7	33,1	17,0	8,8	27,7	29,0	8,9	6,0	17,9	30,3	8,4	6,5	14,6	21,1	6,8	10,0	15,3	4,0
DHW [kWh/m2]	23,5	22,1	21,9	7,9	26,8	25,4	15,6	3,2	9,2	13,8	9,4	2,7	2,2	2,2	1,5	0,6	0,0	8,2	7,2	5,2	5,2	10,3
Cooling [kWh/m2]	0,0	0,0	1,9	2,4	0,7	3,1	5,6	6,0	0,5	1,0	2,4	3,3	2,5	5,8	7,7	7,5	0,0	0,9	1,3	1,0	2,0	2,2

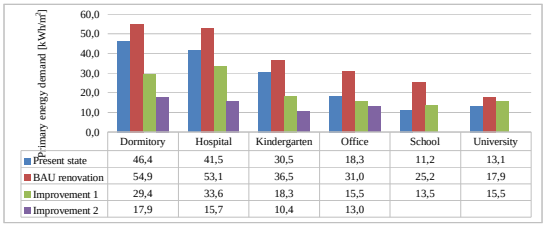


Climatic Zone C																						
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	U1	U2	U3
Heating [kWh/m^2]	47,1	66,1	14,1	19,5	54,9	94,4	37,3	15,8	36,0	36,9	19,1	14,7	31,3	51,6	19,4	14,5	22,0	30,0	12,6	26,9	38,7	8,4
DHW [kWh/m2]	23,5	22,1	21,9	7,9	26,8	25,4	15,6	3,2	9,2	13,8	9,4	2,7	2,2	2,2	1,5	0,6	0,0	8,2	7,2	5,2	5,2	10,3
Cooling [kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0



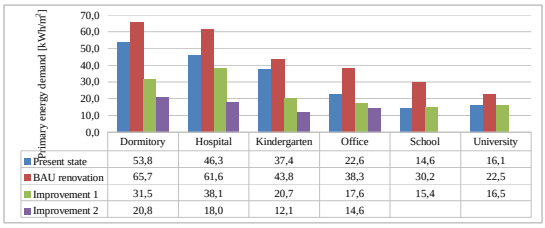
Climatic Zone A																									
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4
Heating [kWh/m^2]	22,9	32,9	5,5	7,6	13,9	24,5	12,3	6,3	20,8	21,6	6,5	4,4	13,5	22,7	6,1	4,7	11,2	16,1	4,9	4,1	6,9	10,6	2,9	2,3
DHW [kWh/m2]	23,5	22,1	21,9	7,9	26,8	25,4	15,6	3,2	9,2	13,8	9,4	2,7	2,2	2,2	1,5	0,6	0,0	8,2	7,2	1,8	5,2	5,2	10,3	2,5
Cooling [kWh/m2]	0,0	0,0	2,0	2,5	0,8	3,2	5,8	6,2	0,5	1,0	2,4	3,3	2,6	6,1	8,0	7,7	0,0	0,9	1,3	1,3	1,1	2,1	2,3	2,3

	Dormitory	Hospital	Kindergarten	Office	School	University
Present state	46,4	41,5	30,5	18,3	11,2	13,1
BAU renovation	54,9	53,1	36,5	31,0	25,2	17,9
Improvement 1	29,4	33,6	18,3	15,5	13,5	15,5
Improvement 2	17,9	15,7	10,4	13,0		



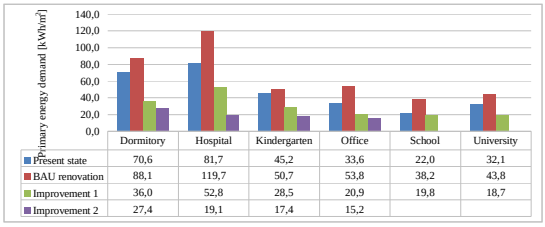
Climatic Zone B																								
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4
Heating [kWh/m^2]	30,3	43,6	7,7	10,5	18,7	33,1	17,0	8,8	27,7	29,0	8,9	6,0	17,9	30,3	8,4	6,5	14,6	21,1	6,8	5,6	10,0	15,3	4,0	3,2
DHW [kWh/m2]	23,5	22,1	21,9	7,9	26,8	25,4	15,6	3,2	9,2	13,8	9,4	2,7	2,2	2,2	1,5	0,6	0,0	8,2	7,2	1,8	5,2	5,2	10,3	2,5
Cooling [kWh/m2]	0,0	0,0	1,9	2,4	0,7	3,1	5,6	6,0	0,5	1,0	2,4	3,3	2,5	5,8	7,7	7,5	0,0	0,9	1,3	1,3	1,0	2,0	2,2	2,2

	Dormitory	Hospital	Kindergarten	Office	School	University
Present state	53,8	46,3	37,4	22,6	14,6	16,1
BAU renovation	65,7	61,6	43,8	38,3	30,2	22,5
Improvement 1	31,5	38,1	20,7	17,6	15,4	16,5
Improvement 2	20,8	18,0	12,1	14,6		



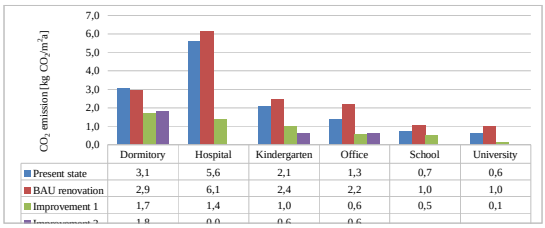
Climatic Zone C																								
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4
Heating [kWh/m^2]	47,1	66,1	14,1	19,5	54,9	94,4	37,3	15,8	36,0	36,9	19,1	14,7	31,3	51,6	19,4	14,5	22,0	30,0	12,6	11,5	26,9	38,7	8,4	7,5
DHW [kWh/m2]	23,5	22,1	21,9	7,9	26,8	25,4	15,6	3,2	9,2	13,8	9,4	2,7	2,2	2,2	1,5	0,6	0,0	8,2	7,2	1,8	5,2	5,2	10,3	2,5
Cooling [kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

	Dormitory	Hospital	Kindergarten	Office	School	University
Present state	70,6	81,7	45,2	33,6	22,0	32,1
BAU renovation	88,1	119,7	50,7	53,8	38,2	43,8
Improvement 1	36,0	52,8	28,5	20,9	19,8	18,7
Improvement 2	27,4	19,1	17,4	15,2		



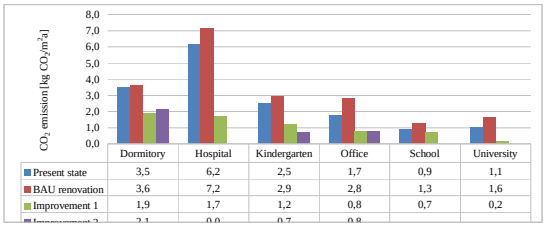
Climatic Zone A																								
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4
Heating [kWh/m^2]	1,5	2,1	0,6	0,8	1,7	3,0	0,9	0,0	1,4	1,5	0,6	0,3	1,2	2,0	0,5	0,5	0,7	1,0	0,5	0,5	0,6	1,0	0,1	0,1
DHW [kWh/m2]	1,6	0,8	1,1	1,0	3,9	3,1	0,5	0,0	0,6	1,0	0,4	0,2	0,2	0,2	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Cooling [kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

	Dormitory	Hospital	Kindergarten	Office	School	University
Present state	3,1	5,6	2,1	1,3	0,7	0,6
BAU renovation	2,9	6,1	2,4	2,2	1,0	1,0
Improvement 1	1,7	1,4	1,0	0,6	0,5	0,1
Improvement 2	1,8	0,0	0,6	0,6		



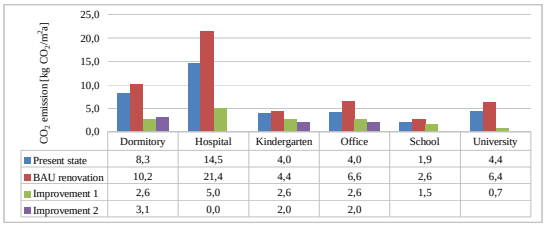
Climatic Zone B																								
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4
Heating [kWh/m^2]	2,0	2,8	0,8	1,2	2,3	4,0	1,2	0,0	1,9	2,0	0,8	0,5	1,6	2,7	0,7	0,7	0,9	1,3	0,7	0,6	1,1	1,6	0,2	0,1
DHW [kWh/m2]	1,6	0,8	1,1	1,0	3,9	3,1	0,5	0,0	0,6	1,0	0,4	0,2	0,2	0,2	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Cooling [kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

	Dormitory	Hospital	Kindergarten	Office	School	University
Present state	3,5	6,2	2,5	1,7	0,9	1,1
BAU renovation	3,6	7,2	2,9	2,8	1,3	1,6
Improvement 1	1,9	1,7	1,2	0,8	0,7	0,2
Improvement 2	2,1	0,0	0,7	0,8		



Climatic Zone C																								
	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	S4	U1	U2	U3	U4
Heating [kWh/m^2]	6,7	9,4	1,5	2,1	10,6	18,2	4,4	0,0	3,3	3,4	2,2	1,7	3,9	6,4	2,6	1,9	1,9	2,6	1,5	1,4	4,4	6,4	0,7	0,6
DHW [kWh/m2]	1,6	0,8	1,1	1,0	3,9	3,1	0,5	0,0	0,6	1,0	0,4	0,2	0,2	0,2	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Cooling [kWh/m2]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

	Dormitory	Hospital	Kindergarten	Office	School	University
Present state	8,3	14,5	4,0	4,0	1,9	4,4
BAU renovation	10,2	21,4	4,4	6,6	2,6	6,4
Improvement 1	2,6	5,0	2,6	2,6	1,5	0,7
Improvement 2	3,1	0,0	2,0	2,0		



BAU renovation	Dormitory	Hospital	Kindergarten	Office	School	University
External wall	0	0	0	0	0	0
Wall to unheated space	0	0	0	0	0	0
Attic slab	5	5	5	5	5	5
Cellar ceiling	3	3	3	3	3	3
Arcade slab	0	0	0	0	0	0
Flat roof	3	3	3	3	3	3
Pitched roof	10	10	10	10	10	10
Floors of heated spaces to ground	0	0	0	0	0	0
External walls between heated spaces and ground	3	3	3	3	3	3
External unglazed doors	80	80	80	80	80	80
Glazed windows, glazed doors 1	0	0	0	0	0	0

Areas						
Floor area	2420,6	5031,6	543,571	892,143	2294,88	2798,14
External wall	1465	2137,2	338,494	668	1276,99	1571,57
Wall to unheated space	0	0	0	0	0	0
Attic slab	0	0	0	0	0	0
Cellar ceiling	0	708,4	0	0	69,6471	0
Arcade slab	588	0	0	0	0	0
Flat roof	488	1266,4	90,5714	238	565,588	710,571
Pitched roof	242	0	209,714	89,5714	280,588	0
Floors of heated spaces to ground	697	503,8	300	279,833	752,471	753,286
External walls between heated spaces and ground	0	288,667	0	0	0	0
External unglazed doors	0	0	0	0	0	0
Glazed windows, glazed doors 1	223,8	623,4	97,5057	142,857	335,929	513

BAU renovation	Dormitory	Hospital	Kindergarten	Office	School	University
External wall	NA	NA	NA	NA	NA	NA
Wall to unheated space	NA	NA	NA	NA	NA	NA
Attic slab	NA	NA	NA	NA	NA	NA
Cellar ceiling	NA	0,42	NA	NA	0,09	NA
Arcade slab	NA	NA	NA	NA	NA	NA
Flat roof	0,60	0,76	0,50	0,80	0,74	0,76
Pitched roof	1,00	NA	3,86	1,00	1,22	NA
Floors of heated spaces to ground	NA	NA	NA	NA	NA	NA
External walls between heated spaces and ground	NA	0,17	NA	NA	NA	NA
External unglazed doors	NA	NA	NA	NA	NA	NA
Glazed windows, glazed doors 1	NA	NA	NA	NA	NA	NA

Improvement 1	Dormitory	Hospital	Kindergarten	Office	School	University
External wall	5	5	5	5	8	8
Wall to unheated space	5	5	5	5	5	5
Attic slab	10	10	10	10	10	10
Cellar ceiling	5	5	5	5	5	5
Arcade slab	10	10	10	10	10	10
Flat roof	5	5	5	5	5	5
Pitched roof	10	10	10	10	10	10
Floors of heated spaces to ground	5	5	5	5	5	5
External walls between heated spaces and ground	5	5	5	5	5	5
External unglazed doors	150	150	150	150	150	150
Glazed windows, glazed doors 1	85	85	85	85	85	85

Conversion factors						
Floor area	1,00	1,00	1,00	1,00	1,00	1,00
External wall	0,61	0,42	0,62	0,75	0,56	0,56
Wall to unheated space	0,00	0,00	0,00	0,00	0,00	0,00
Attic slab	0,00	0,00	0,00	0,00	0,00	0,00
Cellar ceiling	0,00	0,14	0,00	0,00	0,03	0,00
Arcade slab	0,24	0,00	0,00	0,00	0,00	0,00
Flat roof	0,20	0,25	0,17	0,27	0,25	0,25
Pitched roof	0,10	0,00	0,39	0,10	0,12	0,00
Floors of heated spaces to ground	0,29	0,10	0,55	0,31	0,33	0,27
External walls between heated spaces and ground	0,00	0,06	0,00	0,00	0,00	0,00
External unglazed doors	0,00	0,00	0,00	0,00	0,00	0,00
Glazed windows, glazed doors 1	0,09	0,12	0,18	0,16	0,15	0,18

Improvement 1	Dormitory	Hospital	Kindergarten	Office	School	University
External wall	3,03	2,12	3,11	3,74	4,45	4,49
Wall to unheated space	NA	NA	NA	NA	NA	NA
Attic slab	NA	NA	NA	NA	NA	NA
Cellar ceiling	NA	0,70	NA	NA	0,15	NA
Arcade slab	2,43	NA	NA	NA	NA	NA
Flat roof	1,01	1,26	0,83	1,33	1,23	1,27
Pitched roof	1,00	NA	3,86	1,00	1,22	NA
Floors of heated spaces to ground	1,44	0,50	2,76	1,57	1,64	1,35
External walls between heated spaces and ground	NA	0,29	NA	NA	NA	NA
External unglazed doors	NA	NA	NA	NA	NA	NA
Glazed windows, glazed doors 1	7,86	10,53	15,25	13,61	12,44	15,58

Improvement 2	Dormitory	Hospital	Kindergarten	Office	School	University
External wall	8	8	8	8		
Wall to unheated space	8	8	8	8		
Attic slab	10	10	10	10		
Cellar ceiling	8	8	8	8		
Arcade slab	10	10	10	10		
Flat roof	5	5	5	5		
Pitched roof	10	10	10	10		
Floors of heated spaces to ground	5	5	5	5		
External walls between heated spaces and ground	5	5	5	5		
External unglazed doors	150	150	150	150		
Glazed windows, glazed doors 1	120	150	120	120		

Improvement 2	Dormitory	Hospital	Kindergarten	Office	School	University
External wall	4,84	3,40	4,98	5,99	NA	NA
Wall to unheated space	NA	NA	NA	NA	NA	NA
Attic slab	NA	NA	NA	NA	NA	NA
Cellar ceiling	NA	1,13	NA	NA	NA	NA
Arcade slab	2,43	NA	NA	NA	NA	NA
Flat roof	1,01	1,26	0,83	1,33	NA	NA
Pitched roof	1,00	NA	3,86	1,00	NA	NA
Floors of heated spaces to ground	1,44	0,50	2,76	1,57	NA	NA
External walls between heated spaces and ground	NA	0,29	NA	NA	NA	NA
External unglazed doors	NA	NA	NA	NA	NA	NA
Glazed windows, glazed doors 1	11,09	18,58	21,53	19,22	NA	NA

	BAU renov	Improvem	Improvement 2
External wall	0	5-8	8
Wall to unheated space	0	5	8
Attic slab	5	10	10
Cellar ceiling	3	5	8
Arcade slab	0	10	10
Flat roof	3	5	5
Pitched roof	10	10	10
Floors of heated spaces to ground	0	5	5
External walls between heated spaces and ground	3	5	5
External unglazed doors	80	150	150
Glazed windows, glazed doors 1	0	85	120

BAU renovation	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	0	0	0	0	0	0
Heating system based on wood	0	0	0	0	0	0
Heating system based on gas	0	0	0	0	0	0
Heating system based on oil	0	0	0	0	0	0
DHW system based on electricity	0,8	0,8	0,8	0,8	0,8	0,8
DHW system based on wood	0,9	0,9	0,9	0,9	0,9	0,9
DHW system based on gas	0,9	0,9	0,9	0,9	0,9	0,9
DHW system based on oil	0,9	0,9	0,9	0,9	0,9	0,9
DHW system based on solar thermal	3,2	3,2	3,2	3,2	3,2	3,2
Ventilation system	0	0	0	0	0	0
Cooling system	0	0	0	0	0	0

Improvement 1	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	40	55	50	50	50	50
Heating system based on wood	60	60	32	32	60	60
Heating system based on gas	40	40	40	40	40	40
Heating system based on oil	40	40	40	40	40	40
DHW system based on electricity	0,8	0,8	0,8	0,8	0,8	0,8
DHW system based on wood	0,9	0,9	0,9	0,9	0,9	0,9
DHW system based on gas	0,9	0,9	0,9	0,9	0,9	0,9
DHW system based on oil	0,9	0,9	0,9	0,9	0,9	0,9
DHW system based on solar thermal	3,2	3,2	3,2	3,2	3,2	3,2
Ventilation system	1	1	1	1	1	1
Cooling system	15	15	15	15	15	15

Improvement 2	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	40	55	55	55	NA	NA
Heating system based on wood	60	60	32	32	NA	NA
Heating system based on gas	40	40	50	50	NA	NA
Heating system based on oil	40	40	50	50	NA	NA
DHW system based on electricity	5	5	5	5	NA	NA
DHW system based on wood	0,9	0,9	0,9	0,9	NA	NA
DHW system based on gas	0,9	0,9	0,9	0,9	NA	NA
DHW system based on oil	0,9	0,9	0,9	0,9	NA	NA
DHW system based on solar thermal	1,5	1,5	1,5	1,5	NA	NA
Ventilation system	20	20	20	20	NA	NA
Cooling system	15	15	15	15	NA	NA

	BAU						
	Floor area	1,00	1,00	1,00	1,00	1,00	1,00
	Heating system based on electricity	1,00	1,00	1,00	1,00	1,00	1,00
Alternative prices!	Heating system based on wood	1,00	1,00	1,00	1,00	1,00	1,00
	Heating system based on gas	1,00	1,00	1,00	1,00	1,00	1,00
	Heating system based on oil	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on electricity	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on wood	1,00	1,00	1,00	1,00	1,00	1,00
Alternative prices!	DHW system based on gas	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on oil	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on solar thermal	1,00	1,00	1,00	1,00	1,00	1,00
	Ventilation system	0,2	0,3	0	0,1	0	0,05
	Cooling system	0,2	0,5	0,3	0,7	0,3	0,4

	Improvement 1						
	Floor area	1,00	1,00	1,00	1,00	1,00	1,00
	Heating system based on electricity	1,00	1,00	1,00	1,00	1,00	1,00
Alternative prices!	Heating system based on wood	1,00	1,00	1,00	1,00	1,00	1,00
	Heating system based on gas	1,00	1,00	1,00	1,00	1,00	1,00
	Heating system based on oil	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on electricity	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on wood	1,00	1,00	1,00	1,00	1,00	1,00
Alternative prices!	DHW system based on gas	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on oil	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on solar thermal	1,00	1,00	1,00	1,00	1,00	1,00
	Ventilation system	0,3	0,4	0,2	0,5	0,5	0,05
	Cooling system	0,5	0,8	0,5	0,9	0,5	0,4

	Improvement 2						
	Floor area	1,00	1,00	1,00	1,00	1,00	1,00
	Heating system based on electricity	1,00	1,00	1,00	1,00	1,00	1,00
Alternative prices!	Heating system based on wood	1,00	1,00	1,00	1,00	1,00	1,00
	Heating system based on gas	1,00	1,00	1,00	1,00	1,00	1,00
	Heating system based on oil	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on electricity	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on wood	1,00	1,00	1,00	1,00	1,00	1,00
Alternative prices!	DHW system based on gas	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on oil	1,00	1,00	1,00	1,00	1,00	1,00
	DHW system based on solar thermal	1,00	1,00	1,00	1,00	1,00	1,00
	Ventilation system	0,5	0,6	0,5	0,6	0,5	0,05
	Cooling system	0,7	0,9	0,8	1	0,5	0,4

ZONE A

BAU renovation	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	NA	NA	NA	NA	NA	NA
Heating system based on wood	NA	NA	NA	NA	NA	NA
Heating system based on gas	NA	NA	NA	NA	NA	NA
Heating system based on oil	NA	NA	NA	NA	NA	NA
DHW system based on electricity	0,7	0,4	0,6	0,6	0,8	0,8
DHW system based on wood	0,0	0,0	0,0	0,1	0,0	0,0
DHW system based on gas	0,0	0,0	0,1	0,0	0,0	0,0
DHW system based on oil	0,1	0,4	0,1	0,2	0,0	0,0
DHW system based on solar thermal	0,0	0,2	0,0	0,0	0,0	0,0
Ventilation system	NA	NA	NA	NA	NA	NA
Cooling system	NA	NA	NA	NA	NA	NA

Improvement 1	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	32,0	49,5	37,0	40,0	40,0	47,5
Heating system based on wood	0,0	0,0	3,8	1,6	0,0	0,0
Heating system based on gas	8,0	0,0	3,2	6,0	6,0	0,0
Heating system based on oil	0,0	4,0	2,4	0,0	2,0	2,0
DHW system based on electricity	0,6	0,6	0,6	0,6	0,8	0,8
DHW system based on wood	0,0	0,0	0,1	0,0	0,0	0,0
DHW system based on gas	0,2	0,0	0,1	0,1	0,0	0,0
DHW system based on oil	0,0	0,1	0,1	0,0	0,0	0,0
DHW system based on solar thermal	0,0	0,3	0,2	0,2	0,0	0,0
Ventilation system	0,3	0,4	0,2	0,5	0,5	0,1
Cooling system	7,5	12,0	7,5	13,5	7,5	6,0

Improvement 2	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	24,0	55,0	40,2	38,5	NA	NA
Heating system based on wood	12,0	0,0	4,8	3,2	NA	NA
Heating system based on gas	8,0	0,0	6,0	10,0	NA	NA
Heating system based on oil	0,0	0,0	0,0	0,0	NA	NA
DHW system based on electricity	3,0	4,0	3,2	3,1	NA	NA
DHW system based on wood	0,0	0,0	0,1	0,1	NA	NA
DHW system based on gas	0,2	0,0	0,1	0,2	NA	NA
DHW system based on oil	0,0	0,0	0,0	0,0	NA	NA
DHW system based on solar thermal	0,3	0,3	0,2	0,1	NA	NA
Ventilation system	10,0	12,0	10,0	12,0	NA	NA
Cooling system	10,5	13,5	12,0	15,0	NA	NA

	Climate zone A	Dormitory	Hospital	Kindergarten	Office	School	University
BAU renovation	Heating system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
	DHW system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
	Cooling system [EUR/m^2]	0	0	0	0	0	0
	Ventilation system [EUR/m^2]	0	0	0	0	0	0
Improvement 1	Heating system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
	DHW system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
	Cooling system [EUR/m^2]	7,5	12	7,5	13,5	7,5	6
	Ventilation system [EUR/m^2]	0,3	0,4	0,2	0,5	0,5	0,05
Improvement 2	Heating system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	NA	NA
	DHW system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	NA	NA
	Cooling system [EUR/m^2]	10,5	13,5	12	15	NA	NA
	Ventilation system [EUR/m^2]	10	12	10	12	NA	NA

ZONE B

BAU renovation	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	NA	NA	NA	NA	NA	NA
Heating system based on wood	NA	NA	NA	NA	NA	NA
Heating system based on gas	NA	NA	NA	NA	NA	NA
Heating system based on oil	NA	NA	NA	NA	NA	NA
DHW system based on electricity	0,7	0,4	0,6	0,6	0,8	0,8
DHW system based on wood	0,0	0,0	0,0	0,1	0,0	0,0
DHW system based on gas	0,0	0,0	0,1	0,0	0,0	0,0
DHW system based on oil	0,1	0,4	0,1	0,2	0,0	0,0
DHW system based on solar thermal	0,0	0,2	0,0	0,0	0,0	0,0
Ventilation system	NA	NA	NA	NA	NA	NA
Cooling system	NA	NA	NA	NA	NA	NA

Improvement 1	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	32,0	49,5	37,0	40,0	40,0	47,5
Heating system based on wood	0,0	0,0	3,8	1,6	0,0	0,0
Heating system based on gas	8,0	0,0	3,2	6,0	6,0	0,0
Heating system based on oil	0,0	4,0	2,4	0,0	2,0	2,0
DHW system based on electricity	0,6	0,6	0,6	0,6	0,8	0,8
DHW system based on wood	0,0	0,0	0,1	0,0	0,0	0,0
DHW system based on gas	0,2	0,0	0,1	0,1	0,0	0,0
DHW system based on oil	0,0	0,1	0,1	0,0	0,0	0,0
DHW system based on solar thermal	0,0	0,3	0,2	0,2	0,0	0,0
Ventilation system	0,3	0,4	0,2	0,5	0,5	0,1
Cooling system	7,5	12,0	7,5	13,5	7,5	6,0

Improvement 2	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	24,0	55,0	40,2	38,5	NA	NA
Heating system based on wood	12,0	0,0	4,8	3,2	NA	NA
Heating system based on gas	8,0	0,0	6,0	10,0	NA	NA
Heating system based on oil	0,0	0,0	0,0	0,0	NA	NA
DHW system based on electricity	3,0	4,0	3,2	3,1	NA	NA
DHW system based on wood	0,0	0,0	0,1	0,1	NA	NA
DHW system based on gas	0,2	0,0	0,1	0,2	NA	NA
DHW system based on oil	0,0	0,0	0,0	0,0	NA	NA
DHW system based on solar thermal	0,3	0,3	0,2	0,1	NA	NA
Ventilation system	10,0	12,0	10,0	12,0	NA	NA
Cooling system	10,5	13,5	12,0	15,0	NA	NA

	Climate zone B	Dormitory	Hospital	Kindergarten	Office	School	University	
BAU renovation	Heating system [EUR/m^2]	#NOME?	#######	#NOME?	#####	######	#NOME?	BAU renovation
	DHW system [EUR/m^2]	#NOME?	#######	#NOME?	#####	######	#NOME?	
	Cooling system [EUR/m^2]	0	0	0	0	0	0	
	Ventilation system [EUR/m^2]	0	0	0	0	0	0	
Improvement 1	Heating system [EUR/m^2]	#NOME?	#######	#NOME?	#####	######	#NOME?	Improvement 1
	DHW system [EUR/m^2]	#NOME?	#######	#NOME?	#####	######	#NOME?	
	Cooling system [EUR/m^2]	7,5	12	7,5	13,5	7,5	6	
	Ventilation system [EUR/m^2]	0,3	0,4	0,2	0,5	0,5	0,05	
Improvement 2	Heating system [EUR/m^2]	#NOME?	#######	#NOME?	#####	NA	NA	Improvement 2
	DHW system [EUR/m^2]	#NOME?	#######	#NOME?	#####	NA	NA	
	Cooling system [EUR/m^2]	10,5	13,5	12	15	NA	NA	
	Ventilation system [EUR/m^2]	10	12	10	12	NA	NA	

ZONE C

BAU renovation	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	NA	NA	NA	NA	NA	NA
Heating system based on wood	NA	NA	NA	NA	NA	NA
Heating system based on gas	NA	NA	NA	NA	NA	NA
Heating system based on oil	NA	NA	NA	NA	NA	NA
DHW system based on electricity	0,4	0,8	0,2	0,2	0,8	0,8
DHW system based on wood	0,4	0,0	0,5	0,5	0,0	0,0
DHW system based on gas	0,0	0,0	0,0	0,0	0,0	0,0
DHW system based on oil	0,1	0,0	0,1	0,2	0,0	0,0
DHW system based on solar thermal	0,0	0,0	0,0	0,0	0,0	0,0
Ventilation system	NA	NA	NA	NA	NA	NA
Cooling system	NA	NA	NA	NA	NA	NA

Improvement 1	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	16,0	27,5	22,5	10,0	10,0	17,5
Heating system based on wood	24,0	18,0	11,2	19,2	36,0	33,0
Heating system based on gas	8,0	0,0	4,0	4,0	4,0	0,0
Heating system based on oil	0,0	8,0	4,0	6,0	4,0	4,0
DHW system based on electricity	0,3	0,3	0,3	0,1	0,8	0,8
DHW system based on wood	0,4	0,3	0,3	0,5	0,0	0,0
DHW system based on gas	0,2	0,0	0,1	0,1	0,0	0,0
DHW system based on oil	0,0	0,2	0,1	0,1	0,0	0,0
DHW system based on solar thermal	0,0	0,3	0,1	0,1	0,0	0,0
Ventilation system	0,3	0,4	0,2	0,5	0,5	0,1
Cooling system	7,5	12,0	7,5	13,5	7,5	6,0

Improvement 2	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system based on electricity	16,0	27,5	22,0	8,3	NA	NA
Heating system based on wood	24,0	30,0	12,8	19,2	NA	NA
Heating system based on gas	8,0	0,0	5,0	7,5	NA	NA
Heating system based on oil	0,0	0,0	5,0	5,0	NA	NA
DHW system based on electricity	2,5	2,5	1,8	0,5	NA	NA
DHW system based on wood	0,2	0,3	0,4	0,5	NA	NA
DHW system based on gas	0,2	0,0	0,1	0,1	NA	NA
DHW system based on oil	0,0	0,0	0,1	0,1	NA	NA
DHW system based on solar thermal	0,2	0,3	0,1	0,1	NA	NA
Ventilation system	10,0	12,0	10,0	12,0	NA	NA
Cooling system	10,5	13,5	12,0	15,0	NA	NA

Climate zone C	Dormitory	Hospital	Kindergarten	Office	School	University
Heating system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
DHW system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
Cooling system [EUR/m^2]	0	0	0	0	0	0
Ventilation system [EUR/m^2]	0	0	0	0	0	0
Heating system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
DHW system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
Cooling system [EUR/m^2]	7,5	12	7,5	13,5	7,5	6
Ventilation system [EUR/m^2]	0,3	0,4	0,2	0,5	0,5	0,05
Heating system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	NA	NA
DHW system [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	NA	NA
Cooling system [EUR/m^2]	10,5	13,5	12	15	NA	NA
Ventilation system [EUR/m^2]	10	12	10	12	NA	NA

Climate zone A		Dormitory	Hospital	Kindergarten	Office	School	University
BAU renovation	Envelope cost [EUR/m^2]	1,60	1,35	4,36	1,80	2,05	0,76
	HVAC system cost [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
	Total cost [EUR/m^2]	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**
Improvement 1	Envelope cost [EUR/m^2]	16,76	15,40	25,81	21,26	21,14	22,69
	HVAC system cost [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
	Total cost [EUR/m^2]	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**
Improvement 2	Envelope cost [EUR/m^2]	21,81	25,15	33,96	29,11	NA	NA
	HVAC system cost [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	NA	NA
	Total cost [EUR/m^2]	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**NA**	**NA**

Climate zone B		Dormitory	Hospital	Kindergarten	Office	School	University
BAU renovation	Envelope cost [EUR/m^2]	1,60	1,35	4,36	1,80	2,05	0,76
	HVAC system cost [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
	Total cost [EUR/m^2]	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**
Improvement 1	Envelope cost [EUR/m^2]	16,76	15,40	25,81	21,26	21,14	22,69
	HVAC system cost [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
	Total cost [EUR/m^2]	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**
Improvement 2	Envelope cost [EUR/m^2]	21,81	25,15	33,96	29,11	NA	NA
	HVAC system cost [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	NA	NA
	Total cost [EUR/m^2]	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**NA**	**NA**

Climate zone C		Dormitory	Hospital	Kindergarten	Office	School	University
BAU renovation	Envelope cost [EUR/m^2]	1,60	1,35	4,36	1,80	2,05	0,76
	HVAC system cost [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
	Total cost [EUR/m^2]	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**
Improvement 1	Envelope cost [EUR/m^2]	16,76	15,40	25,81	21,26	21,14	22,69
	HVAC system cost [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?	#NOME?
	Total cost [EUR/m^2]	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**
Improvement 2	Envelope cost [EUR/m^2]	21,81	25,15	33,96	29,11	NA	NA
	HVAC system cost [EUR/m^2]	#NOME?	#NOME?	#NOME?	#NOME?	NA	NA
	Total cost [EUR/m^2]	**#NOME?**	**#NOME?**	**#NOME?**	**#NOME?**	**NA**	**NA**

Present state		Dormitory	Hospital	Kindergarten	Office	School	University
Zone A	Electric	80	75	74	70	76	84
	Wood	0	0	4	10	4	0
	Gas	0	0	10	0	4	0
	Oil	20	25	12	20	16	16
Zone B	Electric	80	75	74	70	76	80
	Wood	0	0	4	10	6	0
	Gas	0	0	10	0	4	0
	Oil	20	25	12	20	14	20
Zone C	Electric	15	10	21	21	27	15
	Wood	50	30	60	54	54	45
	Gas	0	0	4	0	4	5
	Oil	35	60	15	25	15	35

BAU renovation		Dormitory	Hospital	Kindergarten	Office	School	University
Zone A	Electric	80	75	74	70	76	84
	Wood	0	0	4	10	4	0
	Gas	0	0	10	0	4	0
	Oil	20	25	12	20	16	16
Zone B	Electric	80	75	74	70	76	80
	Wood	0	0	4	10	6	0
	Gas	0	0	10	0	4	0
	Oil	20	25	12	20	14	20
Zone C	Electric	15	10	21	21	27	15
	Wood	50	30	60	54	54	45
	Gas	0	0	4	0	4	5
	Oil	35	60	15	25	15	35

Improvement 1		Dormitory	Hospital	Kindergarten	Office	School	University
Zone A	Electric	80	90	74	80	80	95
	Wood	0	0	12	5	0	0
	Gas	20	0	8	15	15	0
	Oil	0	10	6	0	5	5
Zone B	Electric	80	90	74	80	80	95
	Wood	0	0	12	5	0	0
	Gas	20	0	8	15	15	0
	Oil	0	10	6	0	5	5
Zone C	Electric	40	50	45	20	20	35
	Wood	40	30	35	60	60	55
	Gas	20	0	10	10	10	0

	Oil	0	20	10	15	10	10

Improvement 2		Dormitory	Hospital	Kindergarten	Office	School	University
Zone A	Electric	60	100	73	70	80	95
	Wood	20	0	15	10	0	0
	Gas	20	0	12	20	15	0
	Oil	0	0	0	0	5	5
Zone B	Electric	60	100	73	70	80	95
	Wood	20	0	15	10	0	0
	Gas	20	0	12	20	15	0
	Oil	0	0	0	0	5	5
Zone C	Electric	40	50	40	15	20	35
	Wood	40	50	40	60	60	55
	Gas	20	0	10	15	10	0
	Oil	0	0	10	10	10	10

Present state		Dormitory	Hospital	Kindergarten	Office	School	University
Zone A	Electric	80	45	74	70	0	100
	Wood	0	0	4	10	0	0
	Gas	0	0	10	0	0	0
	Oil	20	50	12	20	0	0
	Solar	0	5	0	0	0	0
Zone B	Electric	80	45	74	70	0	100
	Wood	0	0	4	10	0	0
	Gas	0	0	10	0	0	0
	Oil	20	50	12	20	0	0
	Solar	0	5	0	0	0	0
Zone C	Electric	35	100	21	21	0	100
	Wood	30	0	60	54	0	0
	Gas	0	0	4	0	0	0
	Oil	35	0	15	25	0	0
	Solar	0	0	0	0	0	0

BAU renovation		Dormitory	Hospital	Kindergarten	Office	School	University
Zone A	Electric	90	55	74	70	100	100
	Wood	0	0	4	10	0	0
	Gas	0	0	10	0	0	0
	Oil	10	40	12	20	0	0
	Solar	0	5	0	0	0	0
Zone B	Electric	90	55	74	70	100	100
	Wood	0	0	4	10	0	0
	Gas	0	0	10	0	0	0
	Oil	10	40	12	20	0	0
	Solar	0	5	0	0	0	0
Zone C	Electric	50	100	21	21	100	100
	Wood	40	0	60	54	0	0
	Gas	0	0	4	0	0	0
	Oil	10	0	15	25	0	0
	Solar	0	0	0	0	0	0

Improvement 1		Dormitory	Hospital	Kindergarten	Office	School	University
Zone A	Electric	80	80	69	75	100	100
	Wood	0	0	12	5	0	0
	Gas	20	0	8	15	0	0
	Oil	0	10	6	0	0	0
	Solar	0	10	5	5	0	0
Zone B	Electric	80	80	69	75	100	100
	Wood	0	0	12	5	0	0
	Gas	20	0	8	15	0	0
	Oil	0	10	6	0	0	0
	Solar	0	10	5	5	0	0
Zone C	Electric	40	40	42	12	100	100
	Wood	40	30	35	60	0	0
	Gas	20	0	10	10	0	0
	Oil	0	20	10	15	0	0
	Solar	0	10	3	3	0	0

Improvement 2		Dormitory	Hospital	Kindergarten	Office	School	University
Zone A	Electric	60	80	63	62	100	100
	Wood	0	0	15	10	0	0
	Gas	20	0	12	20	0	0
	Oil	0	0	0	0	0	0
	Solar	20	20	10	8	0	0
Zone B	Electric	60	80	63	62	100	100
	Wood	0	0	15	10	0	0
	Gas	20	0	12	20	0	0
	Oil	0	0	0	0	0	0
	Solar	20	20	10	8	0	0
Zone C	Electric	50	50	35	10	100	100
	Wood	20	30	40	60	0	0
	Gas	20	0	10	15	0	0
	Oil	0	0	10	10	0	0
	Solar	10	20	5	5	0	0

Climatic Zone A

	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	U1	U2	U3
Electricity [kWh/m^2]	32,4	41,4	21,1	8,1	16,2	25,4	27,1	15,6	20,4	24,4	12,8	6,7	11,5	20,1	12,4	9,8	7,7	20,1	10,9	10,2	13,4	14,8
Wood [kWh/m^2]	0,0	0,0	0,0	4,4	0,0	0,0	0,0	0,0	2,0	2,4	3,7	3,8	3,3	5,2	0,9	1,5	0,7	1,0	0,0	0,0	0,0	0,0
Gas [kWh/m^2]	0,0	0,0	7,4	8,0	0,0	0,0	0,0	0,0	3,8	4,4	2,3	2,6	0,0	0,0	2,5	2,6	0,6	0,8	1,6	0,0	0,0	0,0
Oil [kWh/m^2]	11,4	10,9	0,0	0,0	21,0	22,9	5,2	0,0	4,5	5,3	1,7	0,0	5,0	8,1	0,0	0,0	2,3	3,2	0,5	2,4	3,6	0,4
Solar [kWh/m^2]	0,0	0,0	0,0	4,3	1,1	1,1	1,7	3,4	0,0	0,0	0,5	0,9	0,0	0,0	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0

Climatic Zone B

	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	U1	U2	U3
Electricity [kWh/m^2]	37,5	49,0	22,1	9,1	18,3	29,1	30,1	17,8	24,9	29,3	14,1	7,6	13,8	24,0	13,5	10,3	10,2	23,8	11,9	11,3	15,1	15,7
Wood [kWh/m^2]	0,0	0,0	0,0	6,0	0,0	0,0	0,0	0,0	2,4	2,9	4,4	4,6	4,2	6,8	1,2	2,0	1,4	2,1	0,0	0,0	0,0	0,0
Gas [kWh/m^2]	0,0	0,0	8,3	9,5	0,0	0,0	0,0	0,0	4,6	5,4	2,8	3,2	0,0	0,0	3,4	3,5	0,7	1,1	2,2	0,0	0,0	0,0
Oil [kWh/m^2]	13,2	13,5	0,0	0,0	23,2	26,8	6,5	0,0	5,5	6,4	2,1	0,0	6,5	10,6	0,0	0,0	2,6	3,8	0,7	4,0	6,1	0,6
Solar [kWh/m^2]	0,0	0,0	0,0	4,3	1,1	1,1	1,7	3,4	0,0	0,0	0,5	0,9	0,0	0,0	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0

Climatic Zone C

	D1	D2	D3	D4	H1	H2	H3	H4	K1	K2	K3	K4	O1	O2	O3	O4	S1	S2	S3	U1	U2	U3
Electricity [kWh/m^2]	24,1	29,3	20,2	7,5	11,4	14,9	24,9	11,1	16,3	19,6	12,7	4,6	7,3	11,1	3,5	1,4	7,7	18,6	8,9	7,2	8,1	12,7
Wood [kWh/m^2]	45,5	63,8	14,3	22,5	25,2	43,2	26,5	39,2	52,4	54,1	17,9	17,9	40,2	66,0	26,0	22,4	27,1	36,8	19,3	24,0	34,5	14,4
Gas [kWh/m^2]	0,0	0,0	11,7	13,8	0,0	0,0	0,0	0,0	3,9	4,5	5,4	4,5	0,0	0,0	4,4	5,0	1,6	2,2	3,0	2,1	3,0	0,0
Oil [kWh/m^2]	31,0	38,2	0,0	0,0	54,4	80,0	18,6	0,0	11,6	12,6	5,1	3,6	15,1	24,5	6,1	3,2	5,9	8,1	3,0	14,8	21,2	2,5
Solar [kWh/m^2]	0,0	0,0	0,0	4,3	1,1	1,1	1,7	3,4	0,0	0,0	0,5	0,9	0,0	0,0	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0