Serpente Project

FINAL PUBLICATION

Surpassing Energy Targets through Efficient Public Buildings

SERPENTE

European Union
European Regional Development Fund

INTERREG IVC

Contents:

Introduction

Energy consumption in European buildings must be tackled with improved public policy.

Nearly 40% of final energy consumption – as well as 36% of all greenhouse gas (GHG) emissions - is attributable to buildings across the public and private sector[1].

This includes buildings such as schools, offices, sports facilities, social housing and historical buildings. Consequently, an increase in public and private investments for energy efficiency in buildings is needed for the European Union to meet its 2020 energy targets and to take forward the 2050 de-carbonisation agenda.

PPublic authorities have a key role in leading by example in terms of energy policy. However, in their own buildings they are hampered by obstacles that fall into the following categories:

- Technical: construction materials and applied technologies, level of building depreciation
- Financial: limited sources for investments
- Managerial: for example, complex procedures related to applications for subsidies' the necessity to coordinate numerous actors involved in low-energy investments

SERPENTE, implemented within the Interregional Cooperation Operational Programme INTERREG IV C (www.interreg4c.eu) and co-financed by the European Regional Development Fund, helps public authorities to address these challenges.

The main goal of the project is to improve energy efficiency in publicly owned and managed buildings, through improved public policies.

Its specific objectives are:

- To raise awareness and knowledge among policy makers, citizens and target groups, on the potential and practical application of energy efficiency in publicly owned and managed buildings
- To promote responsible energy consumption among public building users, through practical, tested solutions
- To enhance energy performance of publicly owned and managed buildings through the development of a manual, with good practices for increasing energy effectiveness and guidelines for developing rational energy policy

[1] *From Technical Guidance: inancing the energy renovation of buildings with Cohesion Policy funding, Final Report, DG Energy, 2014. ISBN 978-92-79-35999-6*

The project brings together 10 partners from 10 different countries:

- Florentine Energy Agency LEAD PARTNER
- City of Malmö
- Local Energy and Climate Agency
  Metropolitan district of Bordeaux and the Gironde
- Cyprus Energy Agency
- Urban Centre - Brussels Energy
- Agency Slovak University of Technology in Bratislava
- Barcelona Provincial Council
- Energy Agency of Vysocina
- Metropolitan Association of Upper Silesia
- Cork County Council

SERPENTE, led by Florentine Energy Agency, Italy, is based on exchange of experiences, both positive ones to be replicated and negative ones to avoid further mistakes.

Activities included:

- Meetings, study visits, subgroup work
- Identification of good practices and elaboration of context analysis at regional and EU level – coordinated by Urban Centre - Brussels Energy Agency, Belgium
- Pilot actions to test identified good practices – coordinated by City of Malmö, Sweden
- Communication activities – coordinated by the Metropolitan Association of Upper Silesia, Poland

A brief overview of the SERPENTE project

The SERPENTE project tackles the specific theme of energy efficiency in publicly owned or managed buildings. SERPENTE kicked off in April 2012.

At project outset partners identified the main focus of their analysis to be chosen between: historical buildings, social housing, sports facilities, offices and schools.

5 criteria were used to analyse good practices available within these categories: Availability of results, Level of Innovation, Sustainability, Building maintenance, Transferability. The aim was to facilitate an in-depth exchange and to ease potential transfer of good practices from one partner to another by looking for specific information from the very beginning of project activities.

Partners undertook an analysis of their territories to identify strengths and weaknesses and drafted their context analysis.

Each partner focused on listing and studying relevant good practices related to existing buildings, belonging to their subgroups and to energy efficiency policy. 5 pilot partners also undertook activities for the development of specific pilot actions inspired by good practices and policies identified and analysed by project partners.
During the project, partners organised activities to involve relevant external stakeholders and study visits / seminars to examine the exchanged good practices and learn more about energy efficiency improvement. Examples include the visit to Sofielundsskolan (Malmö), a thought-provoking example of how to design and carry out coordinated investment in overall building performance, not only to improve energy efficiency but also overall functionality. The renovation was linked to educational initiatives, which explained the importance of energy efficiency to the next generation and made them accustomed to energy efficiency systems as part of their everyday life. The study visit to the Meyer Hospital in Florence, Italy allowed partners to appreciate the importance of linking architectural style to energy efficiency in order to create efficient, comfortable and sustainable venues. They visited also renovated historical buildings such as La Fàbrica del Sol (Barcelona), which used to contain the offices of the Catalan Gas factory and was fully refurbished, incorporating environmental solutions and the Strovolos Muncipal Library in Cyprus. In terms of social housing one good example of urban rehabilitation presented within the project was the Savonnerie Heymans in Bruxelles.

Over the 3 year project partners organised Regional focus group meetings to involve relevant stakeholders. The aims was to share the results of all project activities and to understand their needs using a bottom up approach with the idea of matching local problems with solutions available in the SERPENTE partnership. Partners successfully involved representatives of Local Councils, Enterprises, Associations, and Public Administrations at regional and national level.

Objective of the SERPENTE Final Publication

The objective of this publication is to share results and information collected thanks to the project with stakeholders involved in the activities and with the general public interested in energy efficiency.

The first chapters focus on policy, regulations and financial issues, while the others present practical means to improve energy efficiency, collected thanks to the good practices identified during the project. These include: behavioral changes, technical improvement, auditing and monitoring. Practical case studies undertaken during the project are presented in the final chapter dedicated to pilot actions.

I Policy and regulations

Introduction

This Chapter sets out the policy and regulatory aspects associated with buildings across the EU.

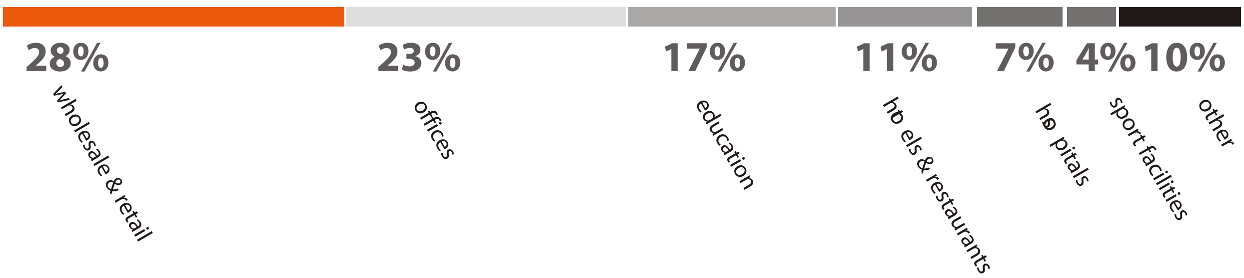
In October 2011, the Buildings Performance Institute Europe (BPIE) published an extensive report on the built environment in Europe. According to the figures in this report, the EU27 has 24 billion square meters of floor space in the built environment, of which 75% in the residential sector and 25% in the non-residential sector. Data for the residential sector is further split in an EU average 64% share for single family houses and 36% for apartment blocks. The non-residential floor space is split in an EU average 28% wholesale & retail, 23% offices, 17% education, 11% hotels & restaurants, 7% hospitals, 4% sport facilities and 11% other.

Data for the residential sector is further split in an EU average:

64% share
for single family houses

36%
for apartment blocks.

The non-residential floor space is split in an EU average:



When looking at offices in particular as the largest user in the non-residential buildings sector we see that energy use in offices has risen in recent years because of the growth in information technology, air-conditioning (sometimes specified when not required), and intensity of use. However, this trend is offset by considerable improvements in insulation, plant, lighting and controls.

According the Energy Action UK office bills can range from about €5 to €35 per year per square metre of treated floor area. Various policies have been proposed and adopted to help the EU reverse the trend of escalating energy usage in the built environment and we will look at these further in this chapter.

Policy

2.1.1 Overall EU Policy

In 2007, the EU Member States (MSs) committed themselves to achieving by 2020:

- 20% reduction of GHG emissions compared with 1990 levels
- 20% share of renewables in EU energy consumption; and
- 20% reduction in energy consumption by improving energy efficiency

The general EU 2020 policy objectives have been translated into National Targets so that each MS can check its own progress towards these goals. National indicative energy efficiency (EE) targets have been identified by each MS in April 2013 as required by Article 3 of the Energy Efficiency Directive (EED). The targets taken together show that currently the EU is not on track to achieve the energy efficiency goal. Looking beyond 2020 the EU presented in 2011 a "Roadmap for moving to a competitive low carbon economy in 2050", which provides a long term pathway to achieving an 80% cut in domestic emissions compared to 1990 by 2050 and the "Energy Roadmap 2050", which sets indicative priorities for the longer-term and illustrates three 'no regrets' options: EE, renewable energy (RE) and better energy infrastructure to connect markets. In March 2013 the European Commission (EC) adopted a Green Paper entitled "A 2030 Framework for Climate and Energy Policies", which sets out a framework for action in the medium term. (*Technical Guidance, Financing the energy renovation of buildings, with cohesion policy funding, Final report, European Commission, DG Energy Brussels, February2014*)

Several key pieces of legislation have been introduced by the EU to help achieve the 20% EE target, including the recast Energy Performance of Buildings Directive (EPBD) and the recent Energy Efficiency Directive. The Renewable Energy Directive (RED) is also an important piece of legislation driving the deployment of RE in buildings and their integration in local energy infrastructures. These three Directives seek to focus resources on SE in buildings and to mobilise investment.

2.1.2 Energy Performance of Buildings Directive

From 5 June 2014 transposition deadline of the EED the EED will repeal the Directive on energy services and the Directive on cogeneration. The EED contains a number of mandatory measures designed to deliver energy savings across all sectors and prescribes that MSs establish a long-term strategy for mobilising investment in the renovation of residential and commercial buildings. The strategy must include an overview of the national building stock, identify cost-effective approaches to renovations and encompass policies and measures to stimulate cost-effective deep renovations of buildings and a forward-looking perspective to guide investment decisions.

Alongside the EED the recast EPBD sets out numerous requirements including the roll-out of energy performance certification for buildings, inspection regimes for boilers and air conditioning plants and requirements for new buildings to be nearly zero-energy. Under the EPBD new public buildings are to be nearly zero-energy by 2019 and all new buildings by 2021. The EPBD also requires MSs to set minimum energy performance requirements for new buildings and buildings undergoing renovation with a view to achieving cost-optimal levels.

Together, EED and EPBD provide a framework for MSs to drive the reduction of energy use in buildings thereby delivering a range of economic, environmental, societal and energy security benefits.

5 Dec 2013	30 Apr 2014	5 Jun 2014	30 Jun 2014	31 Dec 2014
Notification of plans on Article 7 implementation	National Energy Efficiency Action Plans Renovation Roadmaps	Transposition deadlines	Billing information must be accurate and based on actual consumption	Assessment of potential for district heating and co-generation

Figure 1: EED Transposition and implementation schedule for Energy Efficiency in Buildings

2.1.3 National Energy Efficiency Action Plans (NEEAP's)

National strategies are established through various provisions of the EED and in particular through the National Energy Efficiency Action Plans (NEEAPs), which according to Article 24(2) of the EED need to be prepared by 30 April 2014 (and every three years thereafter) and submitted to the EC. NEEAPs shall cover significant EE improvement measures expected and / or achieved energy savings. As part of the NEEAPs MSs shall establish a long-term strategy for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private. A template adopted by the Commission on 22 May 2013 specifies the information that MSs are required to provide in their NEEAPs measures adopted or planned to be adopted and to implement the main elements of the directive, although the actual format of the reporting remains non-binding. MSs were already required to submit NEEAPs under the Energy Services Directive. They therefore submitted their first and second NEEAPs to the Commission in 2007 and 2011, respectively.

2.1.4 National Renovation Roadmaps

Under Article 4 of the EED all MSs are required to "*establish long-term strategies for mobilising investment in the renovation of the national stock of residential and commercial buildings both public and private*". Article 4 specifies that one of the elements of these long-term strategies must be a "forward-looking perspective to guide investment decisions of individuals, the construction industry and financial institutions". *The principal mechanism for achieving this is the preparation of "National Renovation Roadmaps"* which will be published and submitted to the Commission as part of the MS's NEEAP.

Each Roadmap requires MSs to provide:

- An overview of their existing building stock based on statistical data–this might include a detailed assessment of building categories and age bands, type of ownership and tenure, and location split. For each building category, the roadmap might assess the energy use and performance characteristics.
- A package of cost effective renovation measures both for energy efficiency and renewable energies, based on an appraisal of the existing building stock.
- An appraisal of the required investments to implement such measures.

A specific requirement of the EED for the roadmaps mandates that renovation strategies must include policies and measures to incentivise cost-effective deep renovations, including staged deep renovations, for which National Energy Efficiency funds can be designed.

2.1.5 Article 5 of EED

Article 5 of the EED also sets a target of 3% annual renovation from 2014 of all public buildings owned and occupied by a MS central Government. These renovations are required to meet at least the national minimum energy performance requirements as set out in Article 4 of the EPBD. Should MS chose to be exemplars and go beyond this target, these renovations could contribute significantly to the achievement of the indicative national and energy end-use savings targets.

2.1.6 Article 6 of EED

Article 6 of the EED requires MS to have in place concrete policy measures to stimulate individual Energy Efficiency improvements and reach certain amount of energy savings in final energy use sectors over the period 2014 -2020.

2.1.7 Article 7 of EED

Article 7 tackles the information gap which is one of the main barriers to Energy Efficiency. Article 8 of the EED requires enterprises other than Small and Medium Enterprises (SME's) to carry out an audit at least every 4 years, with a first energy audit by 5th December 2015. Further to this mandatory requirement Article 8 recognises that energy audits are an essential tool to achieve energy savings and requires MS to promote the availability of high quality and cost effective energy audits. Article 8 requires an energy audit to include the technical characteristics of the building, an analysis of the amount of energy consumed per end-use and the impact on behavioural change.

In conclusion energy upgrade renovations are central to policy at a European level and are a priority in achieving the 2020 and 2050 targets. The onus is now firmly being put on member States to transpose the directives and ensure the message is being received at all levels. MS's must put in place a roadmap which will be measurable and verifiable, they will also need to make access to essential tools such as financial support, technical capacity and work on educating all sectors around energy efficiency.

What's missing in the legal regulation?

More thorough controls made by authorities and experts on existing buildings

Financial Issues

(payback periods, efficiency of investments)

Financial results of building reconstruction always depend on many factors, while most of them influence each other.

Key factors to be considerd:

- Building type (purpose, usage, size and shape)
- Year of construction
- Energy demand before reconstruction
- Used construction materials / structures
- Location of the building and its orientation in relation to the sun (cardinals)
- Building's level (degree) of usage

Other main factors affecting economic efficiency of building reconstruction are the following:

- **Designed scope of reconstruction:** required to be performed in order for the resulting state to meet criteria stated by legislation regarding energy efficiency of buildings. Such scope should always respect the project design, or better - energy audit, if there is one (in such case the energy audit is a crucial background document for the project documentation).

- **Level of energy unit prices concerning purchased and/or obtained fuels and/or energy:** this also depends on various facts, e.g. whether the building has its own energy source and what is the state of such source, if the building is connected to the centralised heating system, if the building already uses any renewable sources, etc.

- **Nature and type of each arrangement designed:** in order to decrease energy demand / operation costs.

- **Level of energy / fuel regulation** at both delivery and consumption side before the reconstruction.

- **Level of so-called Annual Neglected Operation Costs required for building maintenance:** such costs are required to extend the lifetime of the building inevitable

SERPENTE

investments for maintenance, repairs and small reconstructions during the usage period of the building. Normally, it is necessary to create and keep financial amount for such activities. The amount represents a value between approximately 0.5% and 1.5% of building reproduction price (the price of new equal building). If the building is maintained well, the operation costs are lower and vice-versa.

- **Mutual economic connection of particular (normally separate) arrangements:** total costs reduction after implementation of 2 or more arrangements together compared to a mathematical sum of separate arrangements, when each of them is applied as a single one (without time synchronisation), are 2 different numbers. The savings are created due to the technical issues. For example, when staging is built for insulation of an exterior wall and it is also used for the roof and the replacement of windows / plumbing elements (otherwise, the staging would have to be ordered and paid 3 times). Other source of savings is the organisation / coordination part.

- **Mutual technical connection of particular arrangements:** the reconstruction of one element is interconnected with another one. The difference from economic connection is that the technical connection is compulsory, i.e. the elements would not work properly, if they are not replaced completely in the chain. This link also brings costs reduction.

- **Assessment method of energy-based, operational and economic benefits** of building reconstruction and the availability of real energy / fuel consumption data before and after the reconstruction.

The significance of particular factors varies with each project. Some elementary examples of resulting Simple Payback Period for various reconstructed buildings are listed within the following table.

Building (various locations)	**Heat price in 2012**		**Particular arrangement prices**						Total energy savings for space heating[%]	Simple payback period [years]
	Own boiler heating [€/MWh]	Centralised heating [€/MWh]	Basement ceiling insulation [€/m^2]	Exterior wall insulation [€/m^2]	Roof insulation [€/m^2]	Replacement of windows/ balcony doors [€/m^2]	Replacement of entrance doors [€/m^2]	Hydraulic adjustment of the heating system		
A	46,7	-	38	57	44	90	111	The price is calculated individually depending on the size of the building, amount of radiators, etc.	48,81	15,1
B	44,1	-	28	58	33	-	133		30,32	30,1
C	-	59,7	49	83	107	184	273		47,26	25,2
D	-	79,2	54	83	108	139	-		76,01*	23,5
E	-	75,2	49	78	103	173	-		59,17	19,0
F	-	77,2	48	70	73	-	-		38,68	8,3
G	-	89,5	49	53	103	182	-		32,79	15,1
H	-	56,3	44	70	83	-	-		41,04	39,1
I	-	75,3	20	59	43	159	-		54,66	5,2
J	-	51,3	54	83	107	187	224		51,15	23,0
K	-	78,5	43	72	70	118	-		56,06	14,3
L	-	89,6	15	76	44	-	-		68,65	8,6
M	-	77,8	23	52	47	-	248		65,08	12,6
N	-	86,0	31	71	21	183	-		58,7	11,3
O	-	61,8	51	73	86	193	275		48,28	43,4
Average	45,4	73,6	40	69	71	161	211		50,05	19,6
Maximum acceptable specific costs[€/m^2]			55	83	108	192	275			

*heat savings calculated including the installation of heat pumps

All prices are listed excluding VAT

The evaluation and consideration of all factors mentioned above is an inevitable phase to prevent an unpleasant surprise in form of unfulfilled expectations regarding final energy savings and costs reduction compared to those resulting from the project.

Investment grade audit

An investment grade audit (IGA) is the technical and economic foundation for any successful ESP. It is a detailed document that estimates all savings and costs for each energy savings or renewable energy measure. It is usually prepared at the same time that the Measurement and Verification (M&V) Plan is developed and may contain the M&V Plan. Its goal is to provide the Host with sufficient information to judge the technical and economical feasibility of the recommended measures.

- **An IGA should minimally include:**
- a listing and a detailed description of each recommended measure, with energy and other savings, design and construction cost, annual O&M costs and simple payback
- analysis of baseline energy data relative to other comparable facilities and to important independent variables such as weather or production
- allocation of baseline energy use to each energy using system
- a full description of the data gathered, analysis performed, and all assumptions for each measure; and
- a discussion for each recommended measure of the costs and savings risks, and risk mitigation costs

- **An IGA should also include:**
- Details sufficient to define the scope and plan of each measure
- Bases for the calculations of savings and costs for each measure
- Clearly identify the inputs and outputs for any modelling software so that another expert can approve the work
- Any potential non-energy operating and maintenance (O&M) cost savings (or increases)
- Any potential productivity gains from new equipment
- M&V Plan for each measure or the entire project, or linkage to the separate M&V Plan
- Clarification of interaction/dependencies between measures
- Schedule of work
- Amount of expected savings during construction period
- Impacts of the proposed measures on the work environment or production rate and quality
- Approximate impact of each measure on the site's "carbon footprint," or CO2 and other types

  Spreadsheet depiction over the life of the project of estimated cash flows showing:

  - savings by energy type, other operating cost changes, interest and principal
  - Risks associated with achieving savings and risk mitigation/management costs
  - Project cost breakdown for labor, contractors, materials and equipment, miscellaneous items (e.g. permits, bonds, taxes, insurance), overhead and profit; and
  - All assumed financial terms including interest rate, current energy prices, any escalation rates, payment terms to lender, investor
  - Estimated Net Present Value of total cash flow benefits to the Host, and discount rate used

There are many published references on the methods and contents of an IGA. One for IGAs of buildings is ASHRAE's Procedures for Commercial Building Energy Audits RP-669 (2004).

Technical-economic assessment of energy saving projects Introduction

The technical-economic assessment together with profitability assessment is a vital part of all projects. The first phase of project evaluation normally does not consider the importance of project financing, so the technical-economic assessment does not consider loan applications, taxes, grants, subsidies, etc.

The aim of technical-economic assessment is to define profitability of particular energy saving arrangements and it consists of the following elements:

- economic indicators
- basic economic relations
- calculation of profitability

Economic indicators

In relation to the accuracy of profitability analysis it is very important to quantify the following economic indicators as precisely as possible:

- investment costs
- annual savings
- technical end economic lifetime
- inflation rate
- interest rate

Investment costs

Investment costs include all the expenditures related to the total investment:

- the design / the creation of the documentation
- project management / quality control
- elements / materials
- implementation and construction
- delivery control and testing
- real implementation documentation
- acceptance and the launch of The Work
- other costs
- Taxes (VAT, etc.)

Annual savings

Annual financial savings of each energy saving arrangement can be calculated by the following formula (simplified calculation):

$$B = S \times E + O\&M$$

where:

B - Annual financial savings [€ p.a.]
S Annual energy savings [kWh p.a.]
E Energy price [€ per kWh]
O&M - Savings of Operation and Maintenance Costs [€ p.a.]

Technical and economic lifetime

Technical lifetime is the physical lifetime of The Work (equipment), i.e. period, during which the equipment is functional and in operation.
Economic lifetime is the practical life, i.e. period, after which it is more profitable to replace the equipment or a part of the building with completely new one. Economic lifetime is usually shorter than technical lifetime due to fast evolution of technologies, legislation changes, energy price changes and the change of operation comfort requirements.

Economic assessment of energy saving projects always considers technical lifetime of the designed arrangements.

Inflation rate

Inflation is a percentage defining average rise of prices. The number affects payback period. Project assessment normally uses annual values. Depending on the method of evaluation, multiple values can be used, i.e. one for energy prices, another for O&M or other costs. Considered levels are usually less than 5% p.a.

Interest rate

Interest rate is used for calculation of future savings brought by the project, or for calculation of total actual investment costs (i.e. loan costs).

Basic performance indicators

Payback period calculation

There are various methods of profitability calculation. Depending on the source indicator, profitability can be calculated using:

- simple payback period
- real payback period
- net present value
- net present value coefficient
- internal rate of return

Simple payback period

Simple payback period is a number, which represents time until all investments are paid back. It is expressed in years. The input conditions of simple payback period calculation imply that annual savings (energy, costs) are equal each year.

$$T_r = \frac{IC}{CF}$$

where:

IC - Investment costs
CF - Annual cash flow of project

The method has the following various limitations affecting credibility of the result and the real information value:

- it can be used with low real interest rate only
- it can be used for short payback periods, e.g. less than 5 years
- annual savings value after the project is paid back is not considered

Real payback period

The real payback period of the investment when considering a discount rate is calculated from following Tsd term:

$$\sum_{t=1}^{T_{sd}} CF_t \cdot (1+r)^{-t} - IC = 0$$

where:

CFt - annual project assets (change of money flows of the project)
r - discount factor
(1 + r)-t - discount

Net present value (NPV)

NPV is a sum of future annual savings. Reference year for savings calculation is normally the one when the reconstruction takes place (i.e. Year 0). NPV of an arrangement is the present value of all future annual savings during economic lifetime of The Work (from Year 1 to Year N) lowered by initial investment (Year 0). The basic criterion of project's profitability is a positive NPV value (more than zero).

$$NPV = \sum_{t=1}^{T_l} CF_t \cdot (1+r)^{-t} - IN$$

where:

CFt - project cash flow in t years
r - discount
t - evaluated period (1 up to n years)
Tl - lifetime of the project

NPV calculation example:

Building owner decides to install thermostatic valves.

Investment costs	I	2300€
Annual energy savings	S	15000 kWh/rok
Heat price	E	0,04 €/kWh
Technical lifetime	n	10 years
Interest rate	r	5 %

Net annual savings B = S x E = 15000 x 0.04 = € p.a.

NPV = 600 x 1-(1+0,05)-10 / 0,05 2300 = 2333 €

NPV value is positive. That means the investment is profitable.

Net present value coefficient (NPVQ)

NPVQ is expressed as a ratio of NPV and total investment costs.

NPVQ = NPV / I

The higher NPVQ value, the more profitable the project. NPVQ method is suitable when there is a need to order the arrangements by their benefits (profitability).

Internal rate of return (IRR)

IRR represents interest rate, at which the NPV equals investment costs, while considering economic lifetime of the investment.

$$IN - \sum_{t=1}^{T_i} \frac{CFt}{(1+r)^t} = 0$$

applies: IRR = r

Total profitability of the designed arrangements

If energy audit is performed, the final report normally contains a so-called package of arrangements (an alternative), for which the total profitability has to be calculated. Results of such calculation can be compared with results of another alternative and the packages can be subsequently ordered by their total profitability.
In order to perform the calculation of total profitability (for the complete package), it is required to define assessment period (p). Assessment period is a time value expressed in years and it represents time, for which the profitability is to be analysed. For the purposes of energy saving projects, the assessment period varies depending on the type of arrangement package and it is usually 10, 15 or 20 years.

Total profitability of the designed arrangements

LCC analysis is an economic assessment method considering all costs, i.e. building construction, operation, maintenance and final dismantling / disposal of the project. LCC analysis includes costs at varying time as their discounted present value.
LCC analysis is mainly suitable for evaluation of various building design alternatives under such conditions, which imply that all requirements are met, while each alternative has different initial costs, operation & maintenance, repair expenditures and lifetime. Analysis is as well suitable for evaluation of energy saving projects. It is capable of assessing profitability for arrangements designed differently as well as of comparing two alternatives between themselves.
Compared to other economic analyses, the LCC method offers a better estimation of long-term efficiency of project / arrangement costs, because the other methods focus simply on initial investment and operation costs during the first few years. On the other hand, the LCC method requires more input information compared to other analyses in order to evaluate profitability.

The lowest costs during building's lifetime indicate the most profitable investments, arrangements or a design. Such design does not necessarily have to comply with the best technical solution. Economic indicators, however, are more important than technical solution in most cases.
If LCC analysis is performed for comparison purposes, those indicators are neglected, which does not affect any alternatives, e.g. administration costs, cleaning costs or other services.

ENERGY EFFICIENCY PROJECT												
Investment	**€**	**- 297 000**										
Loan 1	**€**	**- 297 000**										
Loan 2	**€**	**-**										
Equity from investment	**€**	**-**										
Year		0	1	2	3	4	5	6	7	8	9	10
Energy savings - natural gas	*MWh p.a.*		89	89	89	89	89	89	89	89	89	89
Energy price - natural gas	*€/MWh*		89	97	104	113	122	131	142	153	166	179
Energy production - electricity	*MWh p.a.*		21	21	21	21	21	21	21	21	21	21
Energy price - electricity	*€/MWh*		161	174	188	203	220	237	256	277	299	323
O&M Savings	€		774	836	898	960	1 022	1 084	1 146	1 208	1 270	1 332
Revenues	**€**		**12 064**	**13 029**	**14 066**	**15 182**	**16 381**	**17 672**	**19 061**	**20 556**	**22 166**	**23 899**
Loan interest, loan amount 297000 €	€		- 14 429	- 13 273	- 12 058	- 10 782	- 9 440	- 8 030	- 6 548	- 4 990	- 3 354	- 1 634
Total costs increase	**€**		***- 14 429***	***- 13 273***	***- 12 058***	***- 10 782***	***- 9 440***	***- 8 030***	***- 6 548***	***- 4 990***	***- 3 354***	***- 1 634***
Prevadzkove naklady bez jednorazovych	**€**		***774***	***836***	***898***	***960***	***1 022***	***1 084***	***1 146***	***1 208***	***1 270***	***1 332***
Osobne naklady bez jednorazovych	**€**		-	-	-	-	-	-	-	-	-	-
Net Savings Before Tax	**€**		**- 2 365**	**- 244**	**2 008**	**4 400**	**6 941**	**9 642**	**12 513**	**15 566**	**18 812**	**22 266**
Accured depreciation - category 1 - life 4 years	€		-	-	-	-	-	-	-	-	-	-
Accured depreciation - category 2 - life 6 years	€		- 1 167	- 1 167	- 1 167	- 1 167	- 1 167	- 1 167	-	-	-	-
Accured depreciation - category 3 - life 12 years	€		-	-	-	-	-	-	-	-	-	-
Accured depreciation - category 4 - life 20 years	€		- 14 500	- 14 500	- 14 500	- 14 500	- 14 500	- 14 500	- 14 500	- 14 500	- 14 500	- 14 500
Net Taxable Income	€		- 18 032	- 15 911	- 13 659	- 11 267	- 8 725	- 6 024	- 1 987	1 066	4 312	7 766
Tax 10%	€		-	-	-	-	-	-	-	107	431	777
Year	-	-	1	2	3	4	5	6	7	8	9	10
Net cash flow after tax	**€**	**- 297 000**	**- 562**	**1 347**	**3 374**	**5 527**	**7 814**	**10 245**	**12 712**	**15 459**	**18 381**	**21 489**
Net cash flow after tax	**€**	**- 297 000**	**- 2 365**	**- 244**	**2 008**	**4 400**	**6 941**	**9 642**	**12 513**	**15 459**	**18 381**	**21 489**
Discount	%	1,00	0,95	0,91	0,86	0,82	0,78	0,75	0,71	0,68	0,64	0,61
Discounted cash flow after tax	€	- 297 000	- 535	1 222	2 914	4 547	6 122	7 645	9 034	10 463	11 849	13 193
Cumulative discounted cash flow after tax	€	- 297 000	- 297 535	- 296 314	- 293 399	- 288 852	- 282 730	- 275 085	- 266 051	- 255 588	- 243 739	- 230 547
Real payback period	*years*	- 554,89	244,55	103,67	67,53	51,18	41,98	36,45	32,43	29,57	27,48	26,00
Equity Contribution	€	-										
Grant incentive @ 0% of loan: 297000 €	€		-									
	€		-	-	-	-	-	-	-	-	-	-
Principal	€		- 22 689	- 23 845	- 25 060	- 26 337	- 27 678	- 29 088	- 30 570	- 32 128	- 33 765	- 35 485
Cash flow after financing	**€**	**-**	**-25 054**	**-24 089**	**-23 052**	**-21 937**	**-20 737**	**-19 446**	**-18 057**	**-16 669**	**-15 384**	**-13 995**
Project analysis												
Net present value @ discount 5%	€	**22 542**										
Internal rate of return		**5,48%**										
		- 297 000	- 562	1 347	3 374	5 527	7 814	10 245	12 712	15 459	18 381	21 489
Internal rate of return with grant		**5,48%**										
Equity analysis												
Net present value @ discount 5%	€	102 576										
Internal rate of return		0,0%										
Simple payback period	*years*	**10,16**										
Real payback period	*years*	**23,85**										

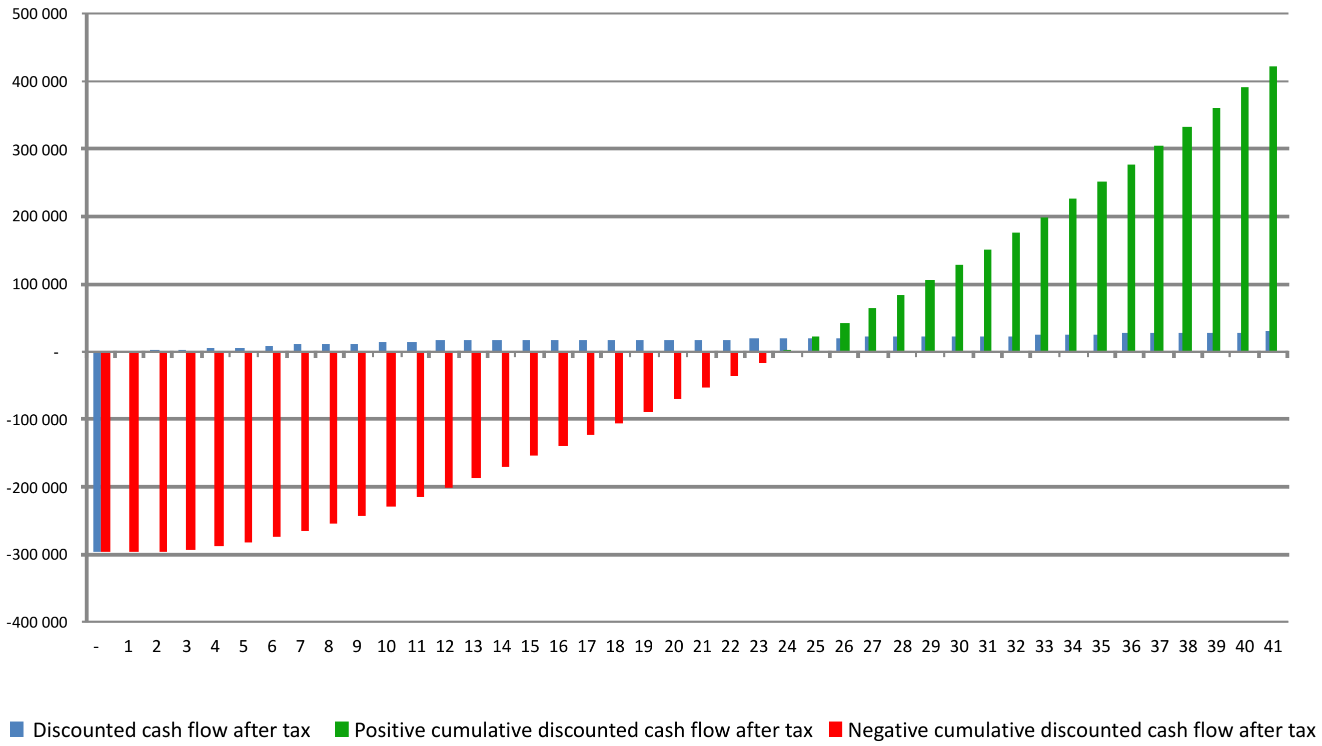
Cash flow

If the project investor is to become a borrower (they apply for a loan), annual economic implications are also very important for them. Those indicators depend on the project financing method. The investor would use partially their own financial resources (equity), repay a loan and should achieve reduction of energy / O&M costs. This data is available from the cash flow analysis.

Positive cash flow means that financial revenues from project savings are higher than loan repayment costs. Negative cash flow means that loan repayment costs are higher than financial revenues from project savings.

Own stock (equity) is provided by the investor. Therefore, this value represents negative cash flow in Year 0. When the cumulated cash flow changes from negative to positive value in Year N, it means that the investment was repaid the very same year.

The following table and chart show an example of economic assessment output. The following 2 indicators were used as input values for the evaluation: annual energy price increase (inflation) of 8% and loan repayment period of 10 years.


500 000
400 000
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100 000
-
-100 000
-200 000
-300 000
-400 000
- 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41
Discounted cash flow after tax
Positive cumulative discounted cash flow after tax
Negative cumulative discounted cash flow after tax

II Behavioural aspects

approach change of users habits

Introduction

The achievement of the EU 2020 targets requires significant changes in life style and economy from global to local ones.

There are different ways to achieve this. We can act on structure, with refurbishing actions, with improved technology but also we can act on management and on the use of the energy in the building. The first block of actions focuses on the structure and the systems/supplies, it requires large investments that we cannot always do. The other option is to act on energy demand through management and behavioural changes and doesn't require large investments. Introducing energy management in a public building means to work with its users, managers and workers. Principal actions are centred on building capacity of users on knowledge and energy management.

We all have the power and the opportunity to do something to tackle the climate change. Even small changes in our behaviour without important changes in our style of life we can make a contribution to the reduction of greenhouse gas emissions and consequently reducing global warming.

How do we make the current consumption of energy in the buildings more energy efficient?

- We have the habit of using electricity (energy) when we want to
- For most of us, the lights stay on most of the time, even when it’s not necessary
- Using the radiator, when the room is hot we tend to open a window before we turn off the radiator
- The same goes for the air conditioning, using it at low temperatures and opening the window when it gets too cold

But if there are no problems and the system works well, why do we need to change our habits?

- we need to tackle global warming. Most electricity today is produced from carbon rich energy and we need to move to a low carbon energy sources but also we need to reduce energy consumption.
- we need to make a more efficient use of energy.

In this chapter, we are looking at some of the characteristics/ideas that can help you to use energy more effectively and efficiently in public buildings by changing the energy consumption behaviour of the users.

We want to talk about the importance of the implication and engagement of the users of the different public buildings (schools, offices, sport facilities, libraries, etc) to achieve energy savings. They can make a considerable contribution towards the implementation of energy efficiency in public buildings by building capacity of important actors on energy efficiency, stimulating behavioural change and influencing relevant local, regional and national action plans.

Therefore we set a behavior-oriented goal in order to motivate people. Thus the users accept optimisation and support it through their own actions. The target are employees, administrators, staff and the strategies that can be used are participatory or individual activities, monthly tips, exhibits and rewards.

Driving towards energy efficiency buildings

Walking towards a sustainable future through community/citizens/users engagement/ collaboration / implication.

Introducing energy management in public buildings implies a change in our habits, an optimisation of our consumption without reducing our comfort and, over all, using common sense.

Energy management and behavioural changes can be done without economical cost or with very low investments. However it requires time, imagination, patience, tolerance and negotiation capacity with the users and the managers of the buildings.

But these efforts are rewarded because the response of the users is often very good since the savings achieved are important, leading to behavioural changes that often become permanent changes and (they could be transferred to home habits) will be further passed onto their families and to other aspects of their life. This is very important for achieving a sustainable and energy efficient future.

The energy savings will be achieved through raising awareness of the importance of energy efficiency and through changing the habits of the public building users.

Think about the process

Before we start introducing or searching behavioural changes is important to think about how we want to do it. Think about the answers of these questions may help you in the process:

- In which facility/facilities do we want to work? Who are the people that should be involved?
- Who will lead the process? What is our goal?
- For how long do we expect the process to last?
- Does energy information of the building exist? (bills, annual consumption, suppliers, …)
- Is there a possibility to give some incentives?

Think about the needs

When we decided where and when we want to start we must think about the important things that we could need during the process in order to assure a successful process. This is a short list with some essential issues that could help you:

- The more information we have on the building the better we can plan the process
- It is important to find a person or a group of people who are enthusiastic to take the idea on and keep it going. Someone that takes the process, the idea, as their own. users with the necessary information to become energy savers and to make decisions about their energy use
- Managers with a better understanding/ knowledge of the energy use of the building
- Caretakers with capacity to get involved in the process and to propose action to carry on energy savings
- A tool to (better) monitor the energy consumption (Energy Management Systems)
- People who will spread the new habits acquired among all the users (Human Resources Department or Energy dedicated team)
- Some kind of incentives for managers and users

Think about how to train users

Before the change you have to know what needs to change!
It is necessary to know what we have, our existing systems and how they work before starting!

Currently users of a building don't know how much energy is consumed by the building, how is the energy consumed, or how much they paying for it. Normally building users don't feel empowered to manage the energy use and don't feel an essential part in reducing energy consumption of the building.

We have to change this attitude, these feelings!

It's necessary to be aware of our own energy use and its associated cost and impacts. With awareness and information as well as with the resources to better manage consumption, we can save money through more efficient energy use.

We can have training sessions in order to give to the attendants some important information about energy consumption, energy production, energy efficiency, renewable energy, the effects of energy consumption on climate change, global warming and as well as some examples of how the EU is tackling the energy future and how also other similar organisations have succeeded in a more efficient use of energy. Also we need to give them ideas and knowledge that will permit them to act consequently and to empower the users to change energy consumption behaviours to a more efficient way.

Firstly we need to identify the users as groups and determine the effect they could have had on the energy usage in terms of time of usage, area of usage and what energy consuming equipment they are using. Then according to these, a number of training schemes could be programmed where the groups of users could be trained separately as well as the whole of the building users can be trained.

Also it could be beneficial to complete an energy tour in order to know how energy is consumed in the building (identify the points where energy is consumed in the building, types of energy, devices that consume energy, how much energy does the building consume per year, etc). Detect strengths and weakness of energy systems and use what are we doing correctly and what are we doing wrong, propose actions and suggest ways to reduce consumption. Collect all the energy information related to the building and is useful for the purpose.

Learn from others

We are not alone in the mission of reducing energy consumption. Around us there are public authorities, private and public companies, entities and citizens that are working with the same aim.
We have to be looking at other buildings, other towns, other countries that are possibly more skilled/experienced /advanced on energy efficient buildings and learn from their experiences. If this is done some frequent errors and wrong practices could be avoided. Then an adaptation to the specific case of each building can be implemented, leading to a less time consuming practice with the results becoming more imminent.

How we can introduce behavioural changes in order to reduce energy consumption

Introducing energy management in public buildings implies a change in our habits.
The goal is to optimise consumption without reducing the comfort, quite often using common sense could be enough.

In order to succeed it could be considered essential to have people dedicated for the energy efficiency of the building. This can be achieved by working with the people that run the building or by solely creating an energy team. These people need to know the building well and have the incentives and time to assess the efficiency and try to push it towards a higher percentage of efficiency.

The management of the facility could set the targets and the budgets. Then in a meeting all the stakeholders should be informed about those targets and the timeframes can be set. It is important to share the responsibility amongst as many people as possible within the facility; these could be within the working area and/or the floor in order to have as many people as possible involved. Workshops and seminars could be beneficiary through the process and it is important for people to be reminded on how beneficiary energy efficiency is in order to create the right culture.

The results of the energy saving process should be made available to everyone through e-mails, notes in office areas, corridors, published on the website and mentioned in meetings. This will give a sense of fulfilment to the people involved and should get more people to participate.

The responsibilities of the dedicated team for the energy efficiency of the building should be:

- Learning about energy use through dedicated seminars and workshops in order to develop a good understanding on what could be asked from them.
- Develop and enhance their knowledge of the building in order to identify the areas where energy is most consumed
- Create an action plan with suggestions on how people should be informed
- Run promotional and awareness campaign on the importance of energy efficiency
- Encouraging and engage users to implement energy efficiency measures. Training of users on how the building should work (e.g no open windows while heating/cooling)

However, as the literature review outlines despite the numerous theories and studies on pro environmental behaviour, Darnton sums it up by saying "models don't travel well". In order to devise and tailor a programme that will be of most relevance and benefit to the users, might be beneficial to the energy team to conduct the following:

- When possible to provide users with an energy meter
- Initial interview to find out patterns of energy use
- Identify common themes/topics of further knowledge
- Build a programme of support around these needs
- Conduct regular meetings to: discuss the month's topic, behaviour change measures, take meter readings and for a general discussion.

This action can be facilitated by technology e.g. energy monitors. An energy monitor allows you to view your real-time electricity usage in units of energy used (kWh), cost or carbon emissions. Some have additional features, such as allowing you to set daily electricity usage targets or alarms to alert you when you have used a set amount of electricity.

Example

Internal Administrative Instructions for energy savings in Strovolos Municipality.

The following communication has been provided to all users via email and notice boards in offices it also has been placed on the public boards. This internal communication should be written in simple language:

The use of the air conditioning system should be on only when it is necessary and the temperature should be set at 26°C in the summer season and 21°C in winter season.

In the case when the air conditioning is working the windows and doors should remain shut.

In the case where natural lighting is adequate (next to windows) do not turn on the lights. Also turn on only the lights that are essential.

In the event of one being the last person leaving the office, turn off lights and air conditioning.

Do not leave the lights on in the common areas.

In the case of prolonged absence, turn off all the electronic devices.

When leaving the building the personal computers should be closed using the shut down command, the screen and printers should be closed using the power button.

Wherever it is possible all devices should be switched off at the socket.

All chargers should be removed from the sockets when not in use.

By giving knowledge, empowering users

If you want to succeed in behavioural changes on energy consumption it is important to provide accurate and detailed information about energy use: consumption, distribution, supplies, users, cost with regards to the building at local level, national level and European level to the people that you want to get actively engaged.
If there is the possibility of monitoring the energy consumption then it is possible to follow-up the variations/the impact of energy consumption due to the behaviour changes of the users. Presentation of the results could be important on how people will see the impact of their actions. Sometimes it is ideal to use a graph (bars, pie chart, line graph etc.) sometimes just numbers could be as effective. This depends on what were the results and how you want to present them (positive or negative).

Engage users

By raising energy awareness among the users and workers of the public building.
Benefits for everybody, less consumptions means less emissions and less climate change.
By making people feel a key factor in the planning and the implementation of energy efficiency measures. Giving an important role in proposing ideas and measures to save energy.
By designing education/information/awareness campaigns/projects to reach/achieve energy efficient buildings.
By motivation: motivate adults to take part in energy efficiency projects.

Make the participation visible

It's important to make visible the participation of people, so that both visitors and users can be aware of their work for energy savings and can know what is being done all the time and what results are being obtained.

Also in a participatory process we cannot forget to establish mechanisms to hearing opinions, suggestions, comments, ideas, and improvements on current actions from the people involved in the process and to maintain feedback which could be either positive or negative.

Furthermore it is fundamental to promote successful activities/actions done inside buildings and the savings reached due these actions.

A good practice can also be the establishment of "the employee of the month", the person that has put most effort for energy savings. The hierarchy of the organisation can reward the "employee of the month" with some extra benefits.

Some results expected

Within the implementation of Euronet 50/50 project the schools achieved savings nearly **8% the first year** and **nearly 10% during the second year** of implementation. With this experience we can say that with behavioural changes public buildings are expected to achieve **savings of approximately 10%**.

At school:

Youth are the future and this needs to be emphasised when reaching schools and communities. Promoting energy awareness and changing the behaviour from an early age will be beneficiary in both the short and the long run. Young people tend to accept changing habits much easier than elders and they can in turn change the habits of their parents if a strong opinion on energy saving is developed. Small workshops, videos, school visits (renewable parks etc.) and dedicated lessons or seminars can have a great effect on the youth. This initiative could be taken by the teachers as they play a big role in their learning process.

The students are creative enough to have interesting propositions in energy saving measures.

In the office:

- computers
- lights
- HC system
- Windows
- Electrical Devices

In a sport facility:

- changing rooms
- field
- training schedule

In general:

- Easy actions
- turn off lights
- adjust schedules
- switch on lights only when needed

III Technologies

Introduction

Technical report

According to the context analysis and to the good practices developed by each partners, good energy efficiency measures are specific to buildings characteristics, external temperature and humidity conditions, uses of spaces, behaviours on energy use, occupancy rate and more.

The main energy efficiency measures

Many good practices have been presented in the SERPENTE project and the good practices include more than one energy efficiency measure. Energy measures listed below have been carried out in the good practices presented in SERPENTE:

In terms of building envelope:

- Insulation of rooms, foundations, roof, ceiling, external walls, facade
- Replacement external doors
- Energy efficient windows, double/triple glazing, low emission layer and solar protection layer Solar shading
- Reduce air infiltration

In terms of heating and cooling:

- Geothermal heat pumps
- Pellet boiler
- Gas condensing boilers
- District heating
- Pulse control of panel heaters
- Solar water heater systems
- Water saving showers
- Hydronic heating systems
- Free cooling

In terms of ventilation:

- Heat Recovery Ventilation
- VAV (Variable Air Volume) ventilation systems
- Variable speed fans
- Night ventilation during the summer season
- BMS: Adjusting the ventilation system according to the operation hours in the buildings. (e.g.: the application of timers on ventilation)

In terms of lighting:

- Energy efficient lights
- Maximise natural light conditions
- Substitution of incandescent lights and mercury-vapour lamps by LED lamps
- Occupancy sensors

In terms of electricity consumption:

- Reactive power compensation equipment's
- Photovoltaic panels
- Cogeneration heating

In terms of organization and management:

- Effective maintenance
- Presence of an "Energy Manager" and monitoring energy consumption in the buildings
- Developing energy audits of public buildings
- The elaboration of a full energy audit that include all type of improvements of the energy efficiency
- BMS: Install energy meters and digital control systems
- Supervise construction and installation works so that is in compliance with the project

In terms of training-changing behaviours:

- Training of service and maintenance staff on energy savings
- BMS: Make the control system control the technical systems in the building in a optimal way instead of letting the users control the systems
- Implementation of 50/50 methodology to increase energy efficiency in the school building by just changing behaviours

Motivation of design choices

- Select good quality and durable materials, including the use of certified materials for construction that have appropriate technical approval and fulfil the national and EU regulations
- Recycle old building materials and use recycled materials
- Improve the insulation (insulate ventilation rooms, ventilation ducts and heat pipes) as well as improve the features of materials used in the process of insulation
- Ensure the stability or the service level of the building (e.g. repairing roofs, chimneys, stairs and sidewalks, changing gutters and spouts, removing trees threatening the school building)
- Build green roofs to reduce the load on the stormwater system and consider the possibility of rainwater recuperation

Every type of energy efficiency measure will not work in every type of energy efficiency project. The energy efficiency works can't sometimes be carried out with the best technologies, it has to be the subject of compromise: for example because lack of technical competence, high prices and more. When making an energy efficiency work then the solutions also have to be adopted according to:

- The use of the building
- The occupation rate
- The weather conditions
- The technical characteristics of the buildings

When there is need of maintenance works to be done on a facility then this is often an opportunity to suggest energy efficiency work at the same time like sealing, restoration of walls, electricity works, improved ventilation and more.

Finally it is important to remind that each solution has to be adapted to the local context. For example triple glazing or heat recovery ventilation are not profitable in the Mediterranean countries, and air conditioning does not have to be in North Europe countries. Also, the cavity insulation is specially adapted for the constructive process of the Irish houses.

Technical solutions

The following part describes the various technical solutions.

Building envelope

System that is used to reduce the transmission losses or the cooling loads through the building envelope.

Insulation of rooms, foundations, roof, ceiling, external walls, facade

Insulation reduces the transmission through the Climate envelope, insulation can thus be effective both in reducing the heating and cooling loads. If additional insulation can be installed then it is important to consider that the effect of additional insulation will be the greatest if the existing surfaces are poorly insulated in the beginning. In a poorly insulated surface, the heat flow through the surface is greatly reduced with only a few centimeters of insulation, while a few centimeters insulation barely affects the energy use on an already well-insulated surface.

Additional insulation can be applied both on the inside and the outside of a surface, sometimes it can also be profitable to replace the existing insulation with new insulation that insulates more effectively. However, it is important to consider the risk of condensation inside the construction when additional insolation is applied, especially with interior insulation. The risk of moisture damage should always be investigated when applying additional insulation. Surfaces that can be isolated with additional insulation could be roofs, walls, basement walls, thermal bridging at joists and more.

Bordeaux

Replacement external doors

Doors that are poorly insulated and have leaks can leak a lot of energy out of the building, both thru transmission and convection. New energy effective doors can reduce this energy loss and create a better indoor climate. An important aspect to consider in terms of doors is to minimise energy loss when opening the doors. This can be done using various techniques such as door closers, which minimizes the time that the doors are open, revolving doors and entry vestibules.

Energy efficient windows

There are many different types of windows that can be used. Depending on the needs in a specific building, specific windows can be designed. When designing a window different aspects have to be considered, like for example if the window needs to be opened, self-cleaning, if there is need of safety glazing and solar shading. When it comes to energy efficiency there is various aspects that will influence the energy use on a window. Two values that are especially interesting concerning reducing the heating or cooling demand in a building is the U-value and the G-value. The U-value (heat flow through the glass) can be adjusted with double or triple glazing, type of frame, type of gas between the panes and with low emissivity coating. The G-value (the solar energy transmittance of glass) can be adjusted especially with different coatings. New windows often reduce the heat flow through a window with more than 50 %.

Solar shading

Solar shading is used to reduce the cooling load and to make climate better for the tenants. One technique is to have windows with high G-value that reduces the sunlight through the window. But this also reduces the solar gain in the winter and often also the visible light in the room, both which are desirable. Alternative to coatings on windows is external or internal solar shadings. This can be awnings, blinds, curtains and more. An alternative is also to use trees, balconies, solar cells placed above windows and other buildings in the surroundings to shield the sunlight. External sunshades are much more efficient than internal because they stop the heat outside the building, but they are more exposed to weather and therefore require more maintenance.

Reduce air infiltration

Air infiltration is when air leakage through the envelope is in an unplanned way. How large the air leakage is depends especially on how tight the building envelope is and what the type of the ventilation system that is used. The problem with air leakage is that energy flows through the envelope with convection. This not only uses more energy but also makes it harder the get the right climate inside the building with unpleasant drafts. If the building is equipped with heat recovery ventilation then air leakage lead to heat that is lost through the building envelope without being recovered. A measure to reduce air leakage can be to find leaks and seal them, especially around window frames and doors which are common areas with leakage.

Heating and cooling systems

Systems used to heat or cool facilities.

Geothermal heat pumps

A heat pump works like a refrigerator. It derives energy from a cold source, raising the temperature and supply energy to a heater source by utilising the aggregation states gas and liquid. By changing the pressure with a compressor (often use electricity) and a expansion valve it is possible to vaporize a liquid at low temperature so that the energy can be taken up and the reduce the pressure and make the gas condense at a high temperature, with the energy emitted. A heat pump can thus both provide heating or cooling, depending on the needs of a property. Common heat pump solutions are:

- Geothermal heating - retrieves geothermal energy from boreholes or ground loops
- Exhaust air heat pump - recovers energy from the exhaust air
- Air heat pump - draws energy from the outdoor air
- Cooling recovery - Recovers waste heat at cooling production

The efficiency of a heat pump depends much on the temperature difference between the heat source and the heat sink.

Pellet boiler (wood)

Wood boilers are adapted for a large power range, from several kilowatts to many megawatts. The fuel varies in relation to the power and the chosen technology, wood, wooden chips or pellets. Choosing the size of the wood boiler is an important step and must be in line with the energy consumption required. Several criteria have to be taken into account when choosing a wood boiler: the rate of combustion and the electrical consumption in the associated equipment (transport, stock, smoke treatment, hydraulic circuits) various technologies exist which provide the best response in a wide range of specific circumstances (site situation, stock location, security, smoke treatment).

Barcelona

Gas condensing boiler

Gas condensing boiler burns gas, and the waste product will contain mostly carbon dioxide and water. The water will be bound in the flue gas and by reducing the temperature in the flue gas to the condensing temperature (50-60 degrees C), the flue gas will start to condense and the gas boilers efficiency will increase. About 10 to 15% of the energy can be recovered in the flue gas in this manner and this make the gas condensing boiler more efficient than a non-condensing boiler. Modern condensing boilers are also equipped with variable speed fans and pumps, which mean that when the boiler reduces the load then the power consumption of the pumps and fans will also reduce. This contributes to a high efficiency.

District heating

District heating delivers heat through pipes instead of being produced in the property, the only thing that needs to be installed in the property is a heat exchanger. This means that heat can be produced in large heating plants with better efficiencies. Other types of fuel can be used such as waste incineration, renewable heat sources and heat from CHP plants. Since production is done in external plants then the emissions from the heat production do not need to occur in the central parts of the city. To be able to use district heating in a property there have to be a district heating network available nearby. A problem with district heating is the heat losses in the distribution, which can be significant since there are high temperatures in the pipes compared to the surrounding.

Pulse control of panel heaters

Panel heaters have often internal thermostats that can be set on individual temperature. This often leads to situations where panel heaters turn on when someone open windows to cool of the room and there will also be different temperatures in different places in the buildings. Pulse control of panel heaters means that you connect all panel heaters to a centralised thermostat that control all panel heaters by starting and stopping them at the same thermostat and same temperatures inside.

Solar water heater systems

The heat from the sun can be collected and used to heat a building, pool water or hot tap water with a solar collector. Sometimes they can also used in cooling systems with absorption cooling. There are different types of collectors which which have different properties in terms of insulation and absorption. This means that different types of panels are suitable for different purposes depending on the ambient temperature and where they are positioned in relation to the production temperature the solar system needs to deliver. If the heat won't be used directly then the heat can be supplied to a district heating system or stored in an isolated tank for later use. Some types of solar collectors are unglazed collectors, flat plate collectors or evacuated tube collectors.

Water saving showers

Showers can save water by various techniques. Some common techniques is that you can use shower heads that mix air into the water, increasing the pressure in the shower heads or self-closing shower mixer. The first two techniques is used to reduce the water flow and the last is used to reduce the time spent in the showers. This reduces the use of water and energy to heat the water.

Hydronic heating systems

Hydronic heating systems means systems where the heat carrier is water. Water circulates from a central heat source to radiant panels, ventilation heat batteries and floor heating. Depending on the temperature outside there can be a control of the hydronic system in how much power that will be sent to the heating system, by changing the temperature or flow, so that the facility won't be over heated. Hydronic systems also have the benefit that it is possible to use a centralised heat source and also a centralised control system. Correctly adjusted, it will also give a more stable indoor climate than panel heaters.
To make a hydronic heating system efficient there has to be insulation on the pipes otherwise there will be heat loses. With pressured controlled pumps in the hydronic system it will also be possible to reduce the electricity use when the heat carrier is circulating by reducing the flow if there is less need of power. The pumps control the pressure rise in the system (if the thermostats close) then reduce the flow. At room level it is often necessary to control the heat supplied when the internal temp raises in the room. Thermostats are often used for this purpose and also thermo electric valves connected to digital control systems.

Free cooling

Free cooling is a term used for several techniques of cooling without the use of a conventional cooling system. Examples of this are to cool a hydronic cooling system with outdoor air, cooling towers, aquifers, rivers, etc. To enhance the cooling effect, the system is sometimes combined with evaporative cooling, water that evaporates and then cools the air. With free cooling it will mostly be the pumps that are used for circulating the liquid that will use energy when cooling the property. But it will require that there is cooling available outside the property. To access the free cooling it may involve substantial costs depending on the cooling source. If the cooling load is large then the free cooling often has to be combined with a conventional air conditioner.

Ventilation

Systems mostly used to ventilate facilities.

Heat Recovery Ventilation

Heat recovery ventilation is used to recover heat from the exhaust air and deliver it to the supply air. Different methods can be used depending on the facility and ventilation systems. Since the exhaust air contains a large amount of energy, in cold climates this will often save a large part of the heat loses. Since heat recovery ventilation moves heat from a hot source to a cold source, there is a possibility to use the heat recovery ventilation to reduce the cooling needs by cooling off the supply air with the exhaust air. Some different types of heat recovery ventilation are cross plate exchanger, rotary heat exchanger and cross flow heat exchanger.

VAV (Variable Air Volume) ventilation systems

VAV stands for variable air volume ventilation systems and means that you adjust the airflow depending on the ventilation need in the room. The ventilation flow is often adjusted depending on the room temperature, CO2-content or if there is occupancy in the room. Because of the reduction in air flow, both electricity and heating or cooling can be reduced. The system is dependent on advanced digital control systems, frequency controlled fans, motorised ventilation valves and sensors which are expensive and this makes it only profitable to use when the ventilation flow can be significantly reduced.

Variable speed fans

Variable speed fans means that the fans ventilation flow can be adjusted depending on the need. The precise ventilation flow can be set so that the facility won't be over ventilated. If there is reduced use of the facility in weekends then the ventilation flow can be reduced. The savings will be both on electricity, heat and cooling. Variable speed fans are used in VAV ventilation systems.

Night ventilation

Night ventilation can be used when there is need of cooling in the building on the day and no activity on the night. At night time the temperature is often cooler than daytime. With ventilation flow at night time the air can cool off the building. This is most effective when you have stone or concrete in the walls, floors and joist since this have a high heat capacity so it will hold the temperature for a long time. When it gets hotter at daytime the colder walls, floors and joist will reduce the cooling needs.

Light

Systems to produce light in a facility.

Energy efficient lights

Substantial efforts can be done on the lighting which can account for 30% to 40% of the total energy consumption in a building office. These efforts are promoted by the European commission through the EcoDesign directive. This directive established a schedule for new efficiency requirements and for the prohibition of certain types of lights. T12 fluorescent lamps are now one of the forbidden technologies (since 2010). The T8 fluorescent lamps can be a good replacement solution because the efficiency (lumen per watt) is 50% better. That means that it is possible to emit the same luminosity with less power. In addition, fixations are the same in both technologies and it seems that the T8 technology can deliver a better colour rendering. T8 fluorescent lamps are combined with high frequency ballast which avoids the blinking.

All incandescent lights will be banned in European Union by 2015; it is a good point to think now about the possible solutions. LED technology appears as the best replacement technology for several reasons. This technology is almost 9 times more efficient and its life time is substantially longer than the incandescent technology. Besides, the LED technology allows a reduced maintenance and is mercury free. By these ways, the light quality in all offices is improved, with a significant reduction in energy use.

Maximise natural light conditions

It is possible to decrease the energy consumption by optimising the daylight utilisation. Architects have to provide large windows (but be careful about heat losses), at strategic places. Even in high density places, where all the sunshine is blocked by other buildings, is it possible to drive daylight in the building through skylights, solar chimneys, solar spots and solar tubes.

Occupancy sensors

A way to control light is to install motion detectors. There are two types of motion detectors. Sensors with ultrasound technology, they have high sensitivity and can "see" through medium obstacles. Sensors with passive infrared technology are reliable detection at short to long distance. Motion detector utilisation can decrease the "lighting waste" by 13% to 90%.

Electricity consumption

Electricity used or produced in a facility.

Reactive power compensation equipments

Reactive power consumption is a poison for building owners and electricity distributors because it induces Joule losses, voltage drop, and oblige to overdesign the grid, to overestimate the subscribed power. Moreover the reactive power is billed to the building user at high prices.

The reactive power can be created by magnetic ballast from incandescent lamps or fluorescent lamps for example, but most of the motors (asynchronous motors) create reactive power as well.

In order to avoid consuming this reactive power, it has to be compensated. It can be compensated by a fixed block of capacitors manually or automatically activated. This fixed block can be split in several steps and gradually activated.

Photovoltaic panels

Photovoltaic convert the energy in the sunlight to electricity with semiconductors. Since the electricity will be direct current, the electricity has to be converted to alternative current with an inverter and transformed to the right voltage if it is to be used in the power grid. Today photovoltaic on the market often have between 12 to 18 % efficiency. Photovoltaic panels are often made in materials as mono/poly crystalline silicon but also as thin film solar cells that is made by cadmium and telluride or by copper, indium, gallium and selenide.

Malmö

Cogeneration heating

Cogeneration heating is often also called CHP (combined heat and power). When used in facilities then it is often small power and heat plants like a turbine or Otto engine run on gas. But it could be other types of CHP like fuel cells or sterling engines. When producing electricity there is often more waste heat produced than electricity. The waste heat can then be used to heat the facility, CHP therefore get a high efficiency when the facility uses both the electricity and the heat compared to if only the electricity was used.

Building management system

Systems used to control the installations in the building and used to follow up the efficiency of the installations.

Digital control system

Digital control systems are used to control and follow up the installations in the building. Sensors and technical installations can be connected, controlled and monitored. How to control the installations depends on the needs and values like temperature, humidity, occupancy, weather forecast, CO2 and more. This can be used for example to turn on and off radiators, light, adjust ventilation temperature and flow. The digital control system can also be used to control different zones in a building to have different climate.
This system can have a high impact on the energy use. Not only because it controls the criteria for the different systems but also because if something goes wrong in a installation then the digital control system sends alarms about the faults. To make it possible to control the building on distance the systems could be made remotely connected. This has advantages that it is possible to control many buildings remotely and compare them. When something is wrong then you also get alarm directly so that the faults can be solved quickly.

Monitoring

There are several reasons why energy savings can be achieved with energy meters. For example they create incentives for tenants to reduce its energy use, be used for monitoring of energy investments, used to find what draws a lot of energy in a property and also warn when an installation stops working optimally with the result that energy consumption increases. But in addition to installing the meters, the meters has to be read, the values ??have to be collected in statistical software and the data has to be analysed. Collecting the data from the energy meters can be done manually or from digital control systems, with remotely read meters or directly from the suppliers of the purchased energy. If the measurement is made of purchased and generated energy on for example, a heat pump or boiler this can be used to calculate the heat pumps efficiency and the pump can then be optimised based on this. Energy data used in an efficient way can both be used to save energy directly and to find the most optimal way to make energy efficiency retrofitting's.

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IV Audit and monitoring

Energy audit and monitoring of energy use in public buildings

One of the most important results of the project "Serpente" is the finding of a lack of consistency on the part of public authorities, in the approach to policies necessary for the energy efficiency of the housing stock owned by them.

The continuous monitoring of the energy consumption and the energy audit, possibly planned for the entire housing stock, are the first step by which the most virtuous European administrations have successfully set policies that have achieved the best results.

On the contrary, those who have neglected monitoring and energy audits found himself with sporadic interventions that have led to few positive results.
For these reasons, one of the conclusions we reached after three years of work is the absolute need for the government to implement accurate campaigns for monitoring the energy consumption and energy audits.

This are the first step in any effective and credible campaign for the energy efficiency of the housing stock in public ownership.

Energy Audit

Introduction

The issue of energy and environment management of public buildings is the responsibility of public authorities of all levels. These authorities are obliged to manage the property in rational manner and to use public money efficiently spending it to cover the cost of energy media consumption and investments. The expenditure of energy consumed by public buildings still remains a significant burden for the cities' budget. Nevertheless, there are still few good examples of a comprehensive solution to this problem. However, taking into account permanent increase of energy prices and its use, the issue of efficient use of the energy becomes substantial. One of the instruments available for that purpose is an energy audit.

What is an energy audit?

The European Standard EN 16247-1 - DRAFT(2011) defines energy audit:
systematic inspection and analysis of energy use and energy consumption of a system or organisation with the objective of identifying energy flows and the potential for energy efficiency improvements. The energy audit of the building is defined as a procedure, aimed at the systematic knowledge of the end-use of energy and the identification and analysis of inefficiencies and problems and building energy plants present. The energy audit involves a series of transactions in the detection and analysis of information about the building under standard conditions of operation in economic assessment of energy consumption building (geometric-dimensional data, thermo-physical components of the building envelope, the system performance plant, etc.).
Energy audit in a few simple words is a technical and economic expertise defining the scope and parameters of modernisation project. The concept of modernisation covers the combination of actions undertaken in order to decrease energy use in the buildings.
The purpose of energy audit is to answer the questions, which on the surface appear as simple: What to modernise? In what way? For what amount? What benefits do we get?
The audit serves indentifying tangible solutions (technical, organisational, formal) along with defining its cost-effectiveness relation in terms of energy and money. The definition of energy audit might be expanded or modified depending on the type of energy service.

What is the aim of an energy audit?

The aim of an energy audit is to identify ways in which to reduce the energy demand and assess a cost-benefit analysis of the possible energy saving measures, ranging from actions to retrofit exercise patterns/optimised management of energy resources.

The goals of an energy audit are:

- to define the energy balance of the building-plant system and identify the possible recovery of the lost energy
- to evaluate the conditions of comfort and security necessary
- to identify appropriate energy-saving technologies and assess the technical and economic opportunities
- to optimise the management arrangements of the building (contracts for the supply of energy, method of operation, etc..) for the purposes of a reduction in operating costs

Why do we need an audit?

1. It is the basis for decision making regarding properness of thermal modernisation and its range;
2. It might constitute the basis for change of: value type ordered power of district heating system, energy tariffs;
3. It provides guidelines for the retrofit of the construction project;
4. For the administrator of funds it might account for the evidence of economic efficiency of investment;
5. It may be necessary to obtain retrofit energy grants/funds i.e. state financial aid;
6. It is a base for preparation of EU grant application, or ecological funds.

What should the audit contain?

An energy audit of a building in addition to basic identifying information the investor and the entity performing the audit (energy auditor) should contain:
1. General building data, its energy use and the summary of the audit results;
2. Technical and building inventory including:

- general technical data
- simplified technical documentation
- technical description of basic building elements
  energy performance of the building
- characteristics of: the heating system, the hot water system, district heating substation or boiler room located in the building, the ventilation system, gas system and flue pipes installation
- characteristics of electrical system

1. Evaluation of technical condition of the building within the range relevant to identify proper improvements and thermal modernisation;

2. A list of types of improvements and projects performed accordingly to cost-efficiency evaluation and subjected to an optimalisation process;

3. Documentation regarding the implementation of optimalisation steps: the program of cost-efficiency evaluation and the selection of an optimal variant of thermal modernisation process including costs (calculated on the basis of estimated cost or submitted tenders);

4. Technical descriptions, necessary drawings and bill of quantities of the optimal solution of thermal modernisation procedures prescribed.

In order to obtain elements stated above the energy auditor has to undertake the following actions:

1. Determine the cost of heating in so called standard conditions and the cost of domestic hot water, forming the base for suggested thermal modernisation projects;

2. The evaluation of technical conditions and the method of construction on on-site, verification of work documentation and interviews with the building administrator or maintenance technician;

3. Presentation of possible improvements and thermal modifications aiming towards decrease of heating and hot water cost, along with defining the necessary financial investments;

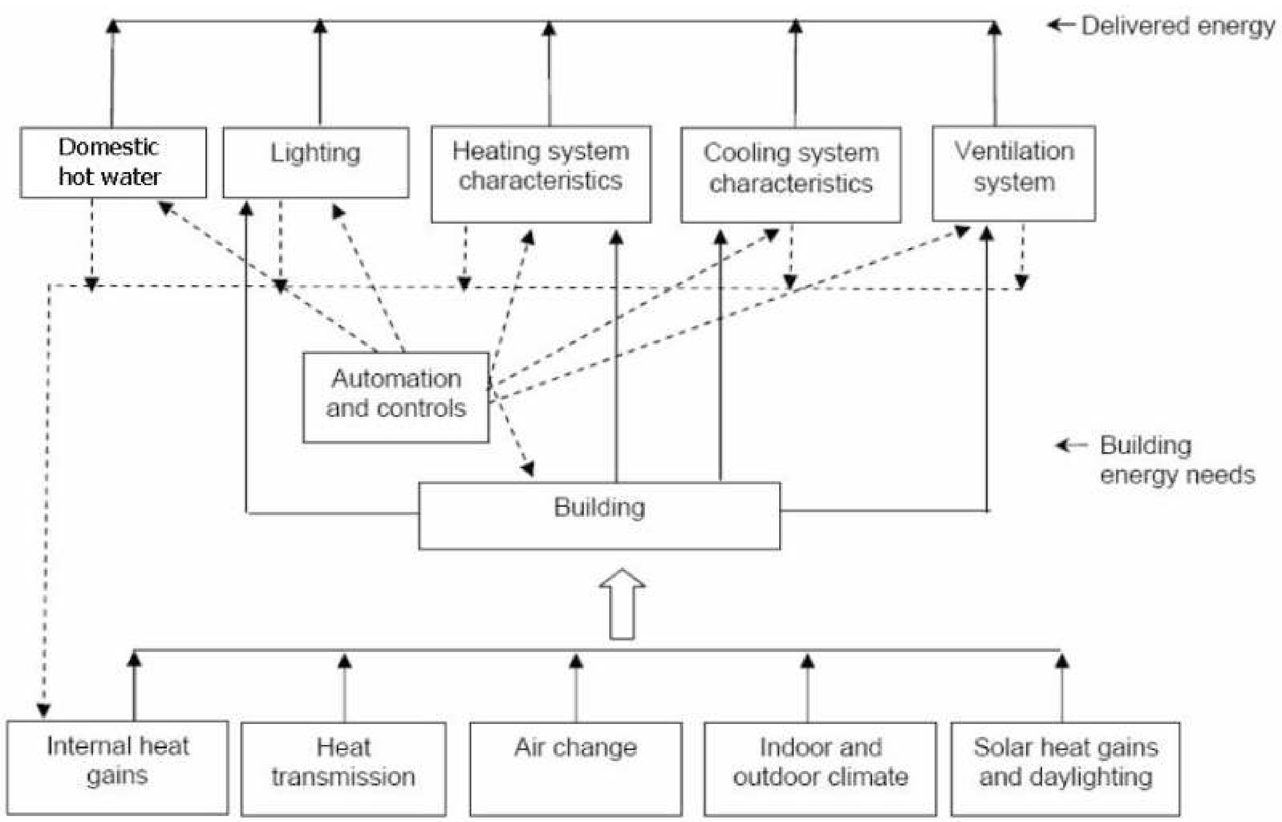
4. Calculation of savings for indicated optimal solution of thermal modernisation procedure.

A brief overview of basic thermal modernisation projects considered during the audit.

The basic thermal modernisation projects:

- insulation of external walls
- insulation of roofs, flat roofs, ceilings over/under unheated room, floors on the ground
- replacement of external woodwork (windows, door, garage door)
- modernisation or replacement of the source of heat (boilers, district heating substation)
- modernisation or replacement of heating distribution system (radiators, valves, pipelines)
- modernisation or replacement of domestic hot water system
- modernisation of ventilation system
- installation of automation control system
- the use of renewable energy sources

In the following diagram (taken from the UNI EN 15265:2008 " Energy performance of buildings - Calculation of energy needs for space heating and cooling using dynamic methods - General criteria and validation procedures"), shows the main energy flows of a building.
The energy saving measures can be related to each of these energy flows.



Summary

Well-performed energy audits in the hands of investors constitutes and excellent tool for confirming the feasibility of planned investment and in most cases it is an essentials document to obtain financial support for thermal modernisation project.

In the process of audit preparation it is crucial to determine between auditor and investor the range of study. It happens quite often that the investor needs the audit document only to apply for financial aid. The investor does not take into consideration the wider range of issues (the possibility of using different sources of energy, different thermal technologies etc.). It is worth taking advantage of the auditor not only as a service provider but also as energy saving adviser.

If the local government participates as an investor sometimes the choice of buildings subjected to an audit the thermal modernisation process is not entirely grounded. This usually happens in municipalities where energy management does not exist. This situation justifies the need of appointing offices (one person or more) to introduce and manage rational energy politics in the municipality in order to achieve measurable economic and environmental benefits.

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V

Monitoring of energy use

in public buildings

Introduction

In local government units without officers appointed to manage the energy consumption the responsibility for energy management is held by building administrators.

They are in charge of contracting and accounting of cost. It happens sometimes that the financial funds from municipality/city/district budget are spent without effective control. This situation could be modified through introducing the monitoring system of energy consumption in those buildings, and in consequence energy management; the system would include the cooperation among competent units (departments), supervision of contract execution and the flow of funds.

Inventory of energy the first step towards monitoring

Conducting and inventory in the object subjected to monitoring is a fundamental and essential element for system operation. The aim of inventory is to collect information and data needed to determine:

- the function of the building
- essential characteristics of construction of the building or a group of buildings
- demand of the building for energy and its cost
- the amount of energy demand
- the efficiency of energy transmission
- the opportunity to improve the energy situation of the building, together with defining capability and cost of suggested changes
- the order of detailed analysis performance (energy audits)
- planning of energy budgets of the buildings.

The easiest way to collect the inventory data is to place them on an excel sheet or dedicated database. Data is obtained using an inventory questionnaire. Data is placed manually or electronically by the facility's administrators and they require detailed verification. The analysis of the data should be credible and should concern:

- surface and gross building volume
- the number of used energy media and water
- the cost of energy and water consumption
- number of building users

It is important to remember that inventory is a periodical process (especially in its part regarding consumption and cost of media) requiring verification.

Types of monitoring

There are two basic types of monitoring of energy consumption: manual and automatic. In each one of them firstly we introduce archival data into system concerning energy consumption in the building, for example for last the three years and then inventory data. The monitoring is usually conducted by appointed department of the municipality or outsourced to a private company.

Automatic monitoring is conducted with the help of a dedicated analytical system (computer application), where meter readings are automatically delivered with the use of telecommunication network. This is why we are able to read the meters frequently and what gives a complete picture on functioning of the building. This type of monitoring requires significant investment expenditures regarding the installations (double meters, communicators, GSM modules etc.) and it is recommended for the facilities with high consumption of energy. First of all it is urgent to adjust existing meters (equip them with communication functions) or replace them for so called “intelligent meters”. Collected data can be sent to the central application and the access is possible through web site that requires standard office software and a browser (in a less flexible version data are concentrated only in managing unit with limited access).

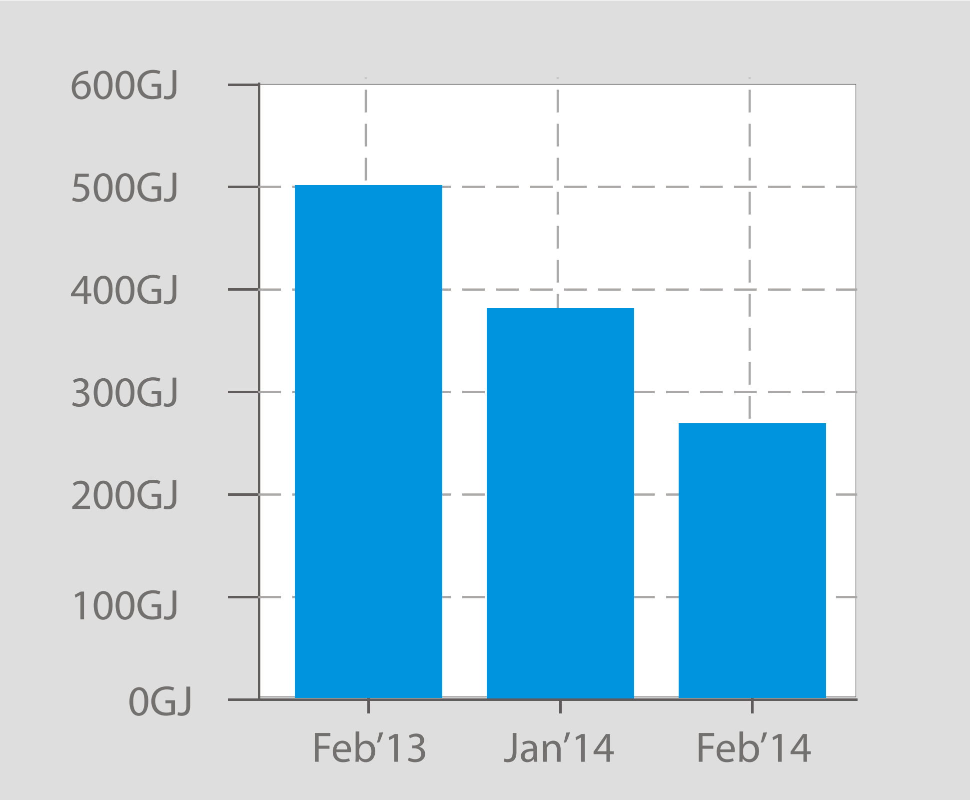
The use of automatic monitoring based on computer applications enables:

- graphic presentation of current consumption in arbitrary time intervals for all metered
- media (heat, gas, water, electricity)
- comparison of consumption in different period and objects
- generating annual and monthly detailed reports accordingly to individual requirements of the user
- setting alarms showing all irregularities
- access to data from any computer, at any place
- export data to spreadsheet (eg. Excel)

Manual monitoring means that data introduced into the system are taken from the value of current invoices from energy suppliers. Similar to automatic monitoring we can keep track and compile individual media consumption in monthly, quarterly, or annual terms and build up indicators and carry out benchmarking analysis. It is the simplest form of monitoring. However, if you add meter readings to the system (for example performed by technicians appointed by administrators) more frequent than once a month (in the morning and in the evening) its functional quality might be compatible to automatic monitoring.

On the grounds of collected data about the amount of electricity consumed, data concerning gross building volume and surface area of the building a ratio analysis could be performed which is an essential for reporting and drawing conclusions and comparing with other buildings. Collecting and analysing data ought to be conducted by appointed unit in the municipality or outsourcing company. Below the consumption of energy within period of a year is presented (figure 1), buildings with compatible functions nursery school (figure 2), as well as the example of rational analysis (figure 3).

Fig. 1. Heat energy consumption in the period of a year in a sample building



Potential savings source

Primary sources of savings in public utility buildings are:

1. Verification of ordered capacity and rates,
2. Reducing energy consumption beyond the standard work time of the object,
3. Reducing the occurrence of failure and effectiveness of its removal,
4. Changing the behavior of the users of the building.

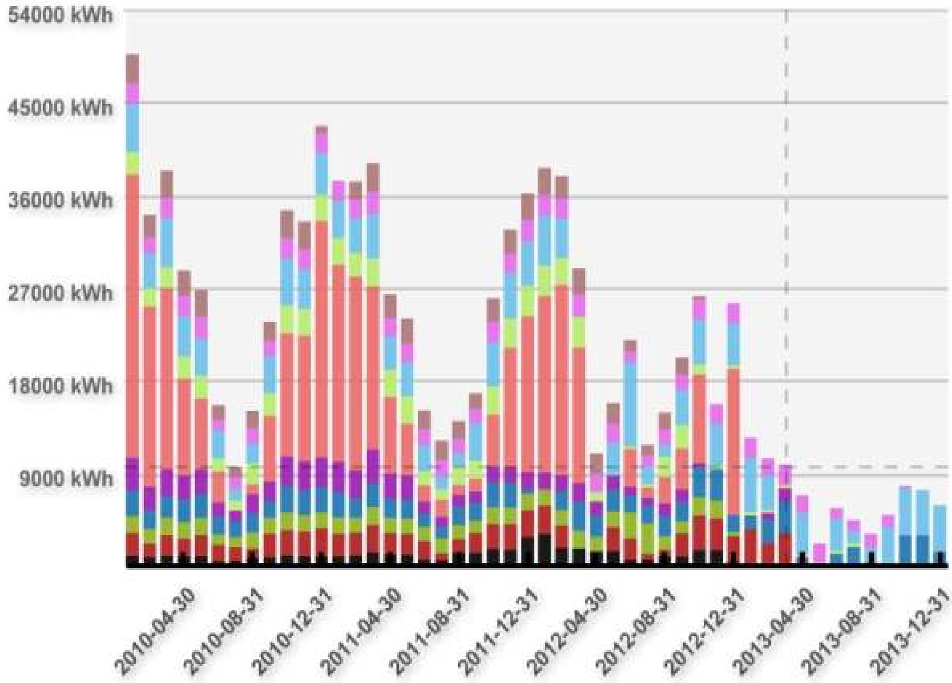


Fig. 2. Energy consumption in objects with similar function (nursery schools - buildings marked in colors).

Verification of ordered capacity and rates

The size of ordered capacity and costs are related accordingly to the contract for the energy supplier and constitute a separate invoice position. Sometimes the cost is more then a half of the amount to be paid so it is necessary to check if it meets the requirements of the building. What happens frequently is that administrators overestimate ordered power as a result of ignorance or fear of paying additional fees (commonly called penalties) for exceeding ordered power. There are also situations when the capacity is not lowered after conducted process of thermal modernisation, or complex replacement of energy users.
Arrangements regarding ordered power for electrical energy can be made by performing the experiment that is quite simple: we include all possible users of energy in the building, determine the maximum value and add a margin of safety about 20%.

Reducing energy consumption beyond standard work time of the object

If we look more closely at the example of typical school we notice that after deduction of holidays, breaks and vacation, on the assumption of 12 hours of work on weekdays we globally get that the object is occupied 1/3 of a year. In order to use that potential source of savings we need to prepare the building to use the absolute minimum of energy and other media during that remaining 2/3 of a year. In practice very simple interventions are sufficient:

- decreasing the temperature in the object during night and breaks
- turning off all unnecessary devices drawing energy, including stand-by mode

In order to determine potential savings beyond the standard work period of the facility it is necessary to define constant base and co called zero level. This is accomplished by measuring permanent energy consumption in the building and on stand-by.

Reducing the occurrence of failure and effectiveness of its removal

Malfunctioning equipment can cause an increase of energy consumption. In public utility buildings without monitoring the failures were detected with considerable delay, or never and this generates additional cost. The example is a failure of weather gauges and the control in district heating substations which frequently remains unrecognised.

Changing the behavior of the users of the building raising awareness

As it is confirmed in numerous research and observation the level of awareness of the users in the buildings influences the cost of energy purchase. In order to obtain savings simple things need to be taken into consideration as: turning off unnecessary energy users, switching off the lights in vacant rooms. Shaping the correct attitude of users of the buildings to what can be achieved as a result of training and information campaigns.

Reporting

For full and effective use of knowledge obtained during the process of monitoring the decision making bodies must be involved. Therefore it is suggested to prepare and conduct three kinds of reports:

- for local government authorities
- for the administrator of monitoring system (energy management)
- for the building administrator

The report for local government authorities should: be very consistent, include summary of analysed results and recommendations for further actions, cost and energy consumption analysis performed in certain period of time for example last 3 years in all monitored buildings.

The report for the administrator of monitoring system should be more extensive. It ought to contain detailed analysis of results including fuel and energy consumption cost, prices of energy media and information concerning the efficient use of district heating, gas, electric energy, but also define priorities within the range of energy cost and consumption reduction.

The report for the building administrator should include information about fuel and energy (cost, consumption, prices) and general guidance how to read the report, but also define the technical potential to decrease energy and fuel consumption and what projects of without or low cost projects. But what is most important is the solutions and summary with recommendation for further actions.

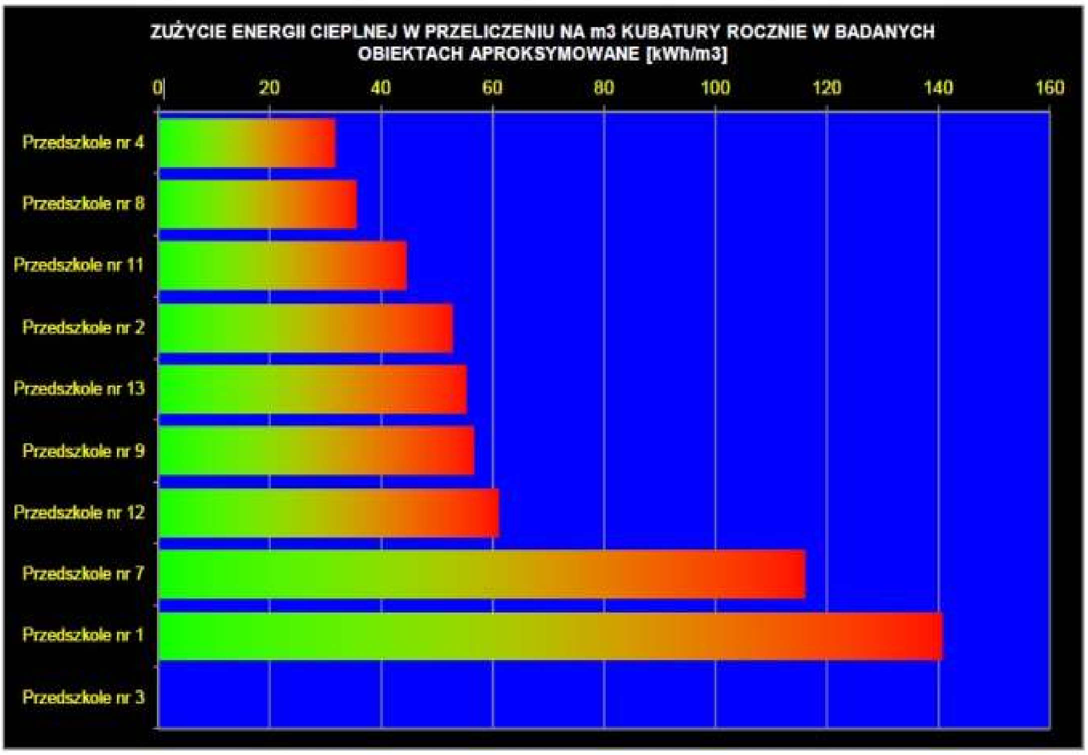


Fig. 3. Example of ratio analysis in buildings of similar function.

Summary

Monitoring of energy consumption is a valuable source of information which ought to be properly used. The results of monitoring in the form of reports to local governments, monitoring system and object administrator should contain data about technical potential to decrease the consumption of energy and recommendations for further actions towards increasing energy efficiency of the buildings and should give measurable benefits.

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VI

Serpente Project

Final report of the pilots

In the SERPENTE project five pilots have been developed and implemented in different regions of Europe.
The pilots are generated from the good practices/policies from all over Europe that were collected and analysed within the project. This report summarises the procedures and results of different pilots.

The five pilot partners are:

- Cork County
- The city of Malmö
- Alec Bordeaux
- Cyprus Energy Agency
- AFE Agenzia Fiorentina per l'Energia

The pilot process

The pilot partners had the support of a peer-review group. The peer-review group consisted of other project partners that did not have a pilot in the project. The support and communication in the peer review groups was important for the pilots, as peers became expert advisors. It was a way to transfer the extensive knowledge available among the project consortium. At the beginning of the pilot phase, face to face peer review meetings were conducted. These took the form of workshops where the pilot partner discussed the pilot with the peer review group, looking at elements such as process, time schedule and resources. As the pilot progressed, during project meetings pilot partners presented the status of the pilot, any deviations or updates and they always had some questions where the other project partners could help with advices or input. Between project meetings partners maintained contact with their peer group members (and with other peer groups) for specific questions and input. However, the most important and productive moments for exchange were always the face to face meetings.

Cork County

Pilot title: Free Cooling to Server Room cork County Hall

Description of pilot: The purpose of the project was to develop a mechanical system to enable the provision of free outside air cooling to the Library ICT server room.
This system was devised in order to reduce the energy consumed by the mechanical HVAC system that supplied chilled air to the ICT server room. This HVAC system was in operation 24hrs a day and consumed 35,000 kWh of electricity a year.
It was a complex project that involved numerous internal stakeholders and the coordination of a number of electrical and mechanical disciplines.

Used good practice/es: Retrofitting a free cooling into system into an existing server room

Result: The results of the project have been very successful and they have over achieved on their initial aims and objectives. All the stakeholders and users of the new free cooling system have noticed more than one benefit from this project.

Initially this project was pitched to management to get approval as a project to save money on heating and ventilation costs associated with the cooling of the ICT server room, but the added bonus to all the stakeholders and the organisation on a whole was the savings in electricity consumption with another bonus of the Co2 emissions reduction. All these electricity reductions and co2 reductions also helped the organisation (Cork County Council) reach their 2020 energy reduction target.

As an organisation and a local authority they have national and international targets for energy reduction by 2020. A number of years previously Cork County Council started out on an energy management system call EMAP (Energy Management Action Plan). These EMAP plan were set each year and each section of the organisation was given a specific target to meet. These targets are agreed with the Chief Executive Officer of Cork county Council and therefore are reportable to him/her at the end of the year. As a result of this pilot project the section (The ICT Dept) have now met their target for this year. This puts added pressure to the other departments to ensure that they are not the only department that has not met their energy target.

Another added benefit to completing energy projects, and in particular in this pilot project, is the awareness it brings to all the stakeholders and the sense of pride that is achieved after the completion of the project. This project is an exemplar project and is used in promotions as an example of what can be done in a situation that previous policy and so called best practice extolled.

Experiences:

- Communication with all stakeholders on the specific aims and goals of the project
- Good monitoring and verification of the pre project data and post project data to enable the verification of the savings
- Learning from best practices for other European Projects and in Particular other INTERREG IVC projects

Transferability: One of the foremost points of benefit to other potential projects is the procedure in justification of the project to management.

For any project the project justification is of key importance. Whether it is to justify the project with financial gains or whether it is to achieve energy consumption efficiency. The main driver in how to prove these saving or efficiencies to management is the capture of accurate data to prove that savings can be achieved.

In light of this Cork County Council decided to implement International Performance Measurement and Verification Protocol (IPMVP) This protocol is the international standard for measuring and verifying savings resulting from energy efficiency projects - both retrofits and new construction. It does this by managing project performance and related financial risks, quantifying emissions reductions from energy efficiency projects promoting sustainable and green construction through cost-effective and accurate accounting of energy savings.

One other key aspect that should be readily transferable is to get a robust Building Management System BMS strategy implemented and this new strategy for the room needs time for calibration and testing. The new BMS strategy and set points on the system needs careful tweaking and this strategy and set point should not be forgotten about after the project is installed. Time needs to be taken to ensure that everything is working and the set points for fans and Ac units are not set too low or too high.

Cost: The project cost approx. €15,000 in investments and took approx. two weeks of time

Improvement of current policy/ies: the partner intend to distribute this pilot project to other organisations in Ireland to maybe enable this best practice to change their national policy, but in the short term to change policy within local authorities and other small branches of local government or smaller government bodies.

This best practice will be disseminated and will be made freely available to any public service body. Therefore, it is Cork County Council Belief that this pilot project will greatly affect current policy going forward.

Useful for future policies: the project proved to be very useful for future projects within the organisation and on a whole for all local authorities in Ireland. The procedure and the justifications for the project will provide a very useful template going forward.

Lesson learned from other project partners: Cork City Council gained a vast wealth of knowledge for their partners in the project and another lesson they learned was not to be afraid to communicate with their partners. Even though the language barriers might have been seen a hurdle at time in the end up it was never an issue. They learned from a number of INTERREG IVC partners different methodologies in the measuring and verification of their energy saving. They also learned how to generate some back to basics calculations of estimated saving that should be possible if they completed some task and if they only changed one thing or if they changed a number of things. This was invaluable to their project as this stopped them from going down blind alleys and wasting their time and resources chasing red herrings that might have not achieved the perceived saving that they anticipated.

The city of Malmö

Pilot title: Standardised evaluation and experience feedback

Description of pilot: To create a database of best practices in energy efficiency and new constructions, two things are required. First, energy efficiency improvements must be carried out and new energy efficient buildings have to be built. Second, efficiency improvements and new construction must be evaluated. It is often time-consuming to evaluate and in the short term is it hard to see noticeable results of the work done on the evaluation. It is often also noted that the results of the evaluations cannot be compared with other evaluations since they are often done in different ways, thus reducing the possibility to use the results.

However, for those who have made good evaluations, it has often been noticed that properties with limited resources could further be improved in energy efficiency, this is especially true in new constructions, meaning that energy consumption could be significantly reduced after only an adjustment of the systems. There are both short-term and long-term benefits to evaluating buildings and creating a database of good practices.

The goals and objectives in the pilot project were to:

- Define a fast and effective method for evaluation of new buildings and retrofitting's
- Find errors and improve implemented measures in early stages
- Define clear and easy procedures for the use of the method
- Test the method on at least one new building and one retrofitting
- Ensure that the method is transferable to other climates

The model that has been created in the project uses calculate expected energy use and power-signature, which shows the relationship between power and outside temperature. The model compares the calculated expected energy use with the power-signature.

For new buildings the calculated data have to cover, everything in the building but for retrofitted buildings historical values can be used and only changes in the building have to be calculated. The model calculates the expected energy use, the temperature dependent factor (W/K) and the balance temperature (where the temperature dependent factor change value). When doing the follow up the calculated energy use and the power-signature is compared. The advantage of this model is that after a few months it is possible to see whether the actual values follow the calculated values. The model also gives an indication what the faults could be by looking at the temperature dependent factor.

Used good practice/es: Brussels - Development of exemplary buildings - The pilot is thought to evaluate good examples on new buildings and retrofitting's that can be used as exemplary buildings in the future

City of Malmö - Monitor, optimise and correct errors for heat pumps in heating systems - The pilot uses the experiences in the good practice and further develops the methods to use them on an entire building.

Result: An early description of how the model works have been made and parts of the programme have been finished. During the development of the programme further developments have been made continuously to the model.

Even if the programme is not finished early tests have shown good results when making follow ups. The results have been easy to evaluate and the method makes it easier to find faults.

The discoveries have raised awareness in Malmö Local Council Properties regarding energy use in new buildings and actions will be performed to prevent future problems.

One retrofitted building has also been followed. Although there was good energy savings in the building, the model shows that the energy savings could have been higher. The reason for the deviation has not been evaluated in the project, but there are potential savings to be made.

Experiences: To develop a model for energy monitoring combined with a computer programme based on the model are two separate projects. First, the model should be tested separately and quality assured before a computer programme is created. Unfortunately, in this pilot action this was been done, which meant unnecessary extra work.

It is easy to see that at a property is not working as intended; it is more difficult to say what does not work. The information have to be complete and easy to understand, otherwise this will not work.

One other important experience is that, if the model is to work in different communities and countries, a follow-up model requires flexibility in terms of how to insert the readings of energy data in the model.

Transferability: Often one large problem is the energy data, because many local councils in Europe do not store energy data more than once a year.

The idea of the model to compare a power signature with a calculated power signature is transferable everywhere. However, it is often more effective to use if a large portion of energy in facilities depends on the temperature. If only a small part of energy depends on temperature then it is often easier to use other models. The steps concerning follow up the energy use, looking for deviations and errors, correct errors and follow up again in a standardised way will always be transferable.

Cost: Implementation (research, testing, reports, presentations, programming and more): Approximately 800 hours. Energy calculation programme to compare result with: € 2000

Improvement of current policy/ies: In Malmö they have an energy goal to reduce their energy use. Their energy strategy has defined that they shall save energy by optimising their systems, making profitable energy retrofitting, producing renewable energy, building energy efficient new buildings and reducing the tenant's energy use. When saving energy they also reduce their operating costs. This model is used after a retrofitting is made or when a new building is built. The model gives indications if there is need to correct errors in installations or need for optimisation. When making corrections or optimising the building energy use and operation costs will be reduced without the need for large investments, especially since the errors will be corrected while the installations still have warranty. This means that the this model is cheap to implement, but can make sustainable savings. This is a step to follow their policies supporting energy retrofitting, buildings optimisation, and also to build new, energy efficient buildings.

Useful for future policy/ies: When following up energy measures it is easy to see what technical systems and energy efficiency measures really work. This will make it easier to focus on the right type of projects and technical systems in future projects. This will hopefully also change internal policies about what type of systems that should be used in projects.

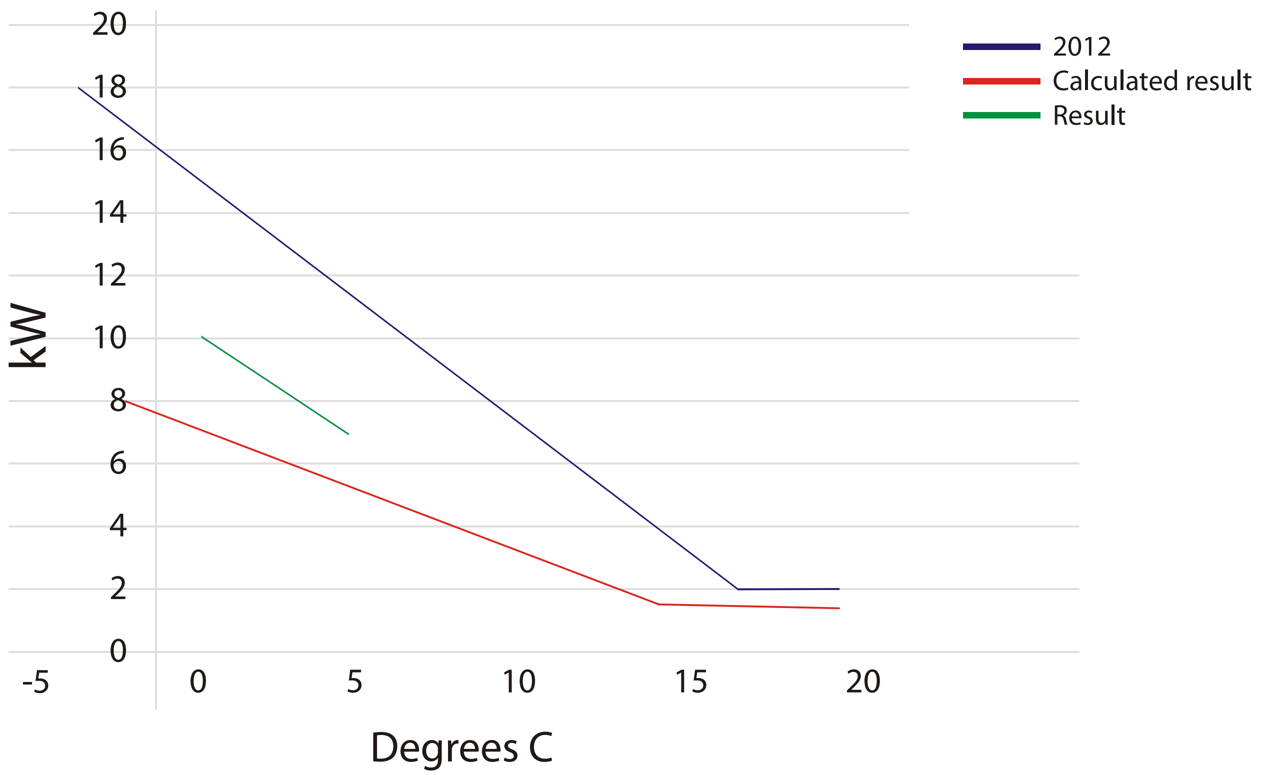
It can also raise interest for energy monitoring, which can lead to installation of more energy metres and more automated systems for reading energy metres.

When there are many good practices on energy efficiency and when follow up shows positive economic results, it will raise interest in spending more money on energy efficiency projects.

Lesson learned from other project partners: One lesson learnt is that almost every local council has different ways to collect energy data and most collect more seldom than every month, this made it hard to make the model transferable. This has led to adjustments so that it is possible to use energy data that is weekly, which can be collected manually under just a couple of months. However, it has not been tested yet.

Bordeaux have tried power signature when following up energy and made progress from it in social housing. However, in order to achieve real results in Bordeaux, it is still necessary to understand when to analyse the power signature and also resources to act on the analysis. This model tries to make the analysis easier.

Many partners have noticed problems with new and retrofitted buildings that deviate from calculated values and that it is hard to find the errors and correct them. This input has made an extra focus on making the programme useful not only in Sweden, but also at international.



Alec Bordeaux

Pilot title: Energy savings 50/50 school/city

Description of pilot: Their pilot is a participative and collaborative project for saving energy in schools. It concerns behaviour actions where the potential of savings can reach 10% without investments.

It is a win-win project, enhancing awareness of consumers who don't pay the bill: 50% of savings achieved from energy efficiency measures taken by the pupils and behaviour changes are returned by way of an economic transfer, while the other 50% will be a net saving on the bills for the body that pays them (city council). The result is that everyone wins: the school improves its implementation possibilities, the authorities have less energy costs and society benefits due to the reduction in the environmental impact.

Used good practice/es: Previously implemented by some SERPENTE partners (Barcelona, Florence and Cyprus) in the framework of the European project Euronet 50/50.

Result: For the local council who began the project in one school in January 2014, the results are really good concerning electricity consumptions, due to user awareness and improving adjustments in systems. Concerning water consumption, monitoring has enabled quick detection and repair of several leaks.

The project has been presented to eleven other local councils. Six of them could begin the project in September 2014 or 2015.

They prepared several documents to present and implement the project:

- a detailed note to present the project (aim, steps,...) which could be disseminated to local councillors to help decision making
- a standard agreement between local councils and school, which details their role and how to share energy savings
- a brochure which could be distributed to local councils and schools

An educational campaign on eco-citizenship for the schools of the Urban Community of Bordeaux ("Juniors of Sustainable Development") will include the 50/50 project in its 2014-2015 programme. This means that schools that are interested will obtain financing for students educational sessions (around 1600 € per school).

The project has also been approved by the Schools Inspectorate, who is in charge of teachers programme.

Finally, thanks to this 50/50 project, they mobilised many stakeholders on the issue of users of all types of buildings (social housing, offices, sport facilities...).

Experiences: If the 50/50 project offers the possibility to remove some obstacles observed through isolated initiatives implemented previously by some local actors, the methodology cannot be taken as an all-inclusive package. A French context adaptation is needed. That is the reason why the pilot phase allowed them to evaluate the necessary conditions for a good working and probably to disseminate more widely at a territorial and national scale.
It was also the opportunity for them to strengthen their position concerning the interest of: monitoring of energy consumptions, building knowledge and equipment maintenance actions.
Finally, they developed some expertise concerning buildings users and behaviours.

Transferability: The initiative includes energy savings actions which: are easy to implement; do not need financial investment; can reduce energy consumptions by around 10%.
The win-win concept can be used for many types of buildings (sport facilities, social housing...).
The workshops with local stakeholders that they organised on a quarterly basis are simple to replicate .

Cost: Implementation: SERPENTE staff costs (organisation and project dissemination)
External auditor: 1 500 €/year/school
Educational sessions: 1 600 €/year/school

The brochure created for local councils and schools

Un contexte : la facture énergétique des écoles

- Environ 30% de la facture énergétique des bâtiments communaux concernent les consommations dans les écoles.
- Les écoles qui paient leurs factures consomment moins que celles qui ne les paient pas (cf. schémas comparatifs écoles publiques et privées - Barcelone).

Une histoire : l'échange de bonnes pratiques à l'échelle européenne

Dans le cadre du projet européen Serpente sur le partage de bonnes pratiques en matière d'efficacité énergétique dans les bâtiments publics ou de gestion publique dont l'Alec est partenaire, ce dispositif a été évalué comme particulièrement efficace et transférable. L'Alec l'a adapté en phase pilote sur son territoire d'action.

Retour d'expérience d'Euronet 50/50 * :

- 6 900 élèves (9-11 ans), 58 écoles, 43 municipalités, 9 pays
- 70 % des écoles ont réalisé des économies
- 10 % d'économie en moyenne par rapport à l'année de référence
- Plus de 2 000 € par école à l'issue des 2 ans

** www.euronet50-50.eu, le site du projet européen mis en œuvre par quelques-uns des partenaires du projet Serpente*

Un principe de base : une initiative commune

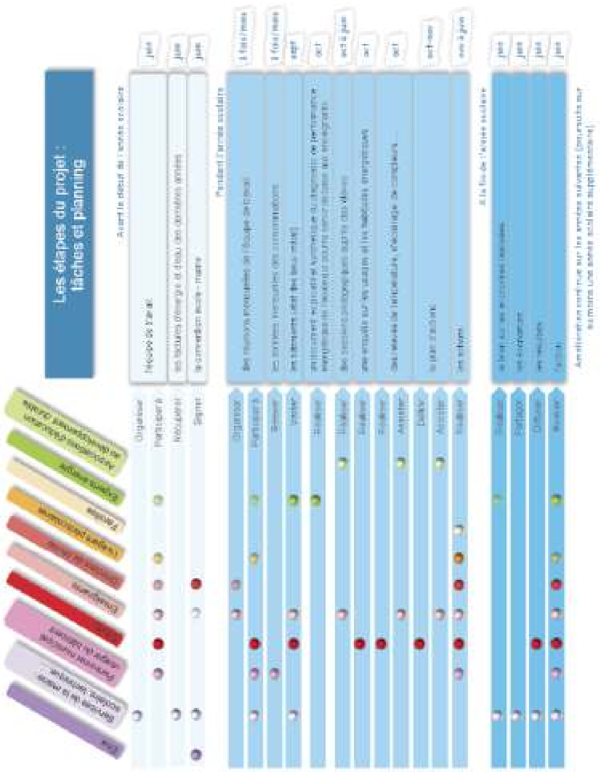
C'est une initiative portée par la mairie et l'école, matérialisée par une **convention** :

- Engagement de la **mairie** : désigner un responsable du projet, réaliser un diagnostic de performance énergétique, fournir un kit de suivi des consommations, partager les économies réalisées.
- Engagement de **l'école** : désigner un responsable du projet, suivre les consommations, réaliser des actions d'économie d'énergie.

Un projet collectif : des étapes structurantes pour des actions efficaces

Avant le début de l'année scolaire : création d'une équipe de travail, récolte des données (factures, ...), signature de la convention.
Pendant l'année scolaire : réunions, visite technique du bâtiment, sessions pédagogiques, enquête sur les usages, relevés (température, éclairage, compteurs,...), plan d'actions.
A la fin de l'année scolaire : bilan sur les économies réalisées, partage des économies, diffusion des résultats, évaluation de l'action et amélioration continue sur les années suivantes.

Poursuite sur au moins **une année scolaire supplémentaire**.



Improvement of current policy/ies: the partner noticed that this project pushes towns into buildings consumption monitoring.

After this pilot phase (one school per town), they would like to generalise the project in their pilot towns (all or several schools) and to disseminate the project more widely at a regional scale.

They will also try to transpose this project for their social housing partners, who are interested in for their dwellers, knowing that the way to return money is more complicated.

Useful for future policy/ies: Thanks to this project, they hope that users expertise will be taken into account in a more comprehensive reflection on works plans.
More generally, sustainable development aspects have to be integrated into all types of projects.

Lesson learned from other project partners: the partner learnt a lot from their partners who were involved in Euronet 50/50 project:

- methodology
- feedbacks with detailed data
- communication materials
- the cost of measuring devices used by pupils during the project

Cyprus Energy Agency

Pilot title: Preparation and issuing of the Energy Performance Certificate (EPC)

Description of pilot: In 2011 the building sector in Cyprus consumed 30% of total energy consumption. The total cost for energy consumption in the building sector for the same year is estimated to have surpassed 600 million. In accordance with legislative requirements and not only, the public sector should play an exemplary and exemplary role in energy saving. It is noted that the public sector consumes about 2-3% of total energy consumption in the country. The corresponding electricity consumption in the public sector is about 8% of total electricity consumption in the country.

The EPC is a building energy category. Its purpose is to provide useful information on overall energy consumption of the building and shows how energy efficient the building is compared with the reference building. It also shows the primary energy consumption, the carbon dioxide emissions and energy consumption covered by renewable energy sources.

For the implementation of the Pilot Project, CEA prepared a letter of expression of interest and was sent to all local authorities in Cyprus. The letter contained useful information about the SERPENTE project as well as the selection criteria for the pilots.

CEA received expression of interest from 12 Local Authorities, which own buildings with a useful area greater than 500m2.

CEA selected 5 buildings of local authorities which are:

- Multipurpose Centre of Lefkosia Local Council
- Offices of Community Council of Psimolofou
- Agios Athanasios Town Hall
- Aglantzia Town Hall
- Deryneia Town Hall

CEA was in touch with the Local Authorities and collected the necessary documents and data. The data that were requested are, geometry of the building (architectural drawings, sides, floor plans, sections and structural engineer), thermal characteristics building components (detailed of masonry, of roof, of floor, etc.), mechanical and electrical systems, (engineering studies, lighting) and location (address).
Then CEA analysed the data in such a way as to provide details for recommendations regarding the energy saving measures and finally issued the Energy Performance Certificates in 5 buildings of Local Authorities. The EPCs include recommendations on how to improve the energy efficiency.

Used good practice/es: The two schools presented by the Silesian partner (modernisation in General Secondary School Complex No 3 in Sosnowiec and Music School Complex in Tychy) were used as a starting point.

Result: After issuing the EPCs CEA informed the Political and Technical representatives of the Local Authorities about the results of the EPCs. Together with an expert they discussed the measures proposed through on site visits. Since March 2014 until today 1 local authority after receiving the recommendations contained in the EPC has installed a PV system for RES-e production to cover the electricity needs of the building. This resulted the improvement of the EPC by 1 class. The other 4 Local Authorities plan to implement measures by the end of 2014 / beginning of 2015.

To increase public awareness about the energy situation of those public buildings CEA printed stand-alone banners that have been delivered to the local authorities, were placed in prominent positions thus the citizens can be aware of the energy consumption of the buildings.

Experiences: The energy performance certificate helps owners to understand the building's energy costs, but also to understand the improvement of energy efficiency by implementing low medium high cost measures.

The energy performance certificate also helps assess the energy savings potential in buildings. Local Councils, for instance, can save up to 30% of their energy costs by exploiting cost-effective energy savings potentials. Public buildings with considerable public business and useable floor space of over 500 m^2 should obtain and display an energy performance certificate.

The pilot project has boosted the role of the energy performance certificate in Cyprus in public buildings.

Transferability: This specific pilot can be easily transferred to others. The most important element is proper communication with the technical teams of the buildings, the energy teams and the politicians so they can understand all the aspects on how to improve energy efficiency.

Cost: The implementation of the pilot in Cyprus involved some cost of external experts as well as staff cost estimated at about 10,000 euros.
The investment cost for the implementation of some measures are of low cost and some other are of high cost.

Improvement of current policy/ies: This pilot project has shown a bright way to other local authorities in Cyprus to implement similar projects. Through communication of the implementation of the pilot project in Cyprus other local authorities will follow the example to issue EPCs and to implement event low cost measures with significant effects on energy consumption of a building.

Useful for future policy/ies: Their project has been useful for the competent authority to understand the group of measures that should be undertaken in public buildings in order to improve energy efficiency. This experience has been transferred in the new requirements of the National Support Scheme that is related with the improvement of energy efficiency of the building stock in Cyprus.

AFE Agenzia Fiorentina per l'Energia

Pilot title: A light audit of Public Buildings

Description of pilot: The pilot consists of a light excel tool to analyse energy use and possible energy saving measures of a single building. The buildings connected to the pilot are schools and offices. The energy audit involves a series of transactions, collecting information in standard conditions.

Analysis of information about the building covers an economic assessment of energy consumption (geometric-dimensional data, thermo-physical components of the building envelope, the system performance plant, etc.). In some cases, all of this information is not available or an analysis is required quickly (not enough time for a full audit).

The Light audit tool is designed for this requirement. The instrument has been set up to allow for information in each country. The partner can insert data relating to the chosen building and can analyse the investments in terms of energy saving, money and payback time. The user must know some basic information related to the building: data could be inserted for the energy requalification (if it is available); otherwise the calculation will be based on percentage of energy savings derived from literature (national or Italian, if the user does not have the data, Italian national data can be used). It would not be possible to study an audit for each building, and then decide on what should intervene in terms of energy and cost. This would be a waste of time and money. The tool allows a preliminary analysis based on a series of information that are easy to find and not too detailed. The accuracy of the results is proportional not only to the accuracy of the data entered, but comes from the approximations of the instrument. The tool is only a first approach; it can be refined and extended to other types of buildings and energy-saving solutions.

Used good practice/es: The two schools presented by the Silesian partner (modernisation in General Secondary School Complex No 3 in Sosnowiec and Music School Complex in Tychy) were used as a starting point. Considerations were made to the types of intervention in those schools and a decision was made to design a light audit able to measure the results of similar interventions.

Result: The pilot is calibrated on efficient buildings with low energy.

- A careful audit of each building is not possible because the number of public building is high
- The overall view of the possibility of energy saving of public building is necessary
- The reconstruction of data of building and of energy use is the most expensive step in terms of time

The tool can represent a first solution because it collects a small amount of data, it is a fast audit and it is based on some approximations.

The results and graphics can be reported in a word document. It will be shown to Public Administrators to understand the potential energy saving of Public Heritage and to decide which energy saving measures to invest in.
A result of the pilot is the confirmation of the need to have a database with the structural characteristics of public buildings and a constant monitoring of energy consumption.

Experiences: they have learned from the pilot that the instrument is important and needs further extensions. In addition, the difficulty they have had is to extend it to all partner countries because each state has different internal rules on this topic.

Transferability: The Excel tool is a complementary system to other tools regarding refurbishment of buildings: financial incentives for the implementation of works, energy efficiency improvement of Public buildings. This light tool do not replace an energy audit, but will help to focus on main elements responsible for energy consumption, whether these are connected to the windows, the facades of the building, the roof and the control valves of the heating system.

As Barcelona Provincial Council is coordinator of the Covenant of Mayors and it has the role to spread it beyond its boundaries and it has a long experience in development of Seap's it could be a good opportunity to show and extend the light tool. The other provincial councils are now beginning the way of Seap's and they think that it could be very interesting to include this tool as a complement on the SEAP process specially during the implementation of VAE in order to improve them and to get more information during the energy visits.

In addition, they believe that they can take advantage of the opportunity that gives the creation of the Catalan Covenant Club spreading more the SEAPs methodology including the tool "light audit" in order to make a more detailed analysis and to assess energy use in buildings. With this tool they think it could be easier to know the lacks that need improvement according energy efficiency parameters.

Cost: 400 working hours.

Improvement of current policy/ies: The pilot improves the knowledge of what public buildings consumes and helps to enhance the practical knowledge that with some simple energy efficiency **measures can be a large financial and environmental savings.**

Useful for future policy/ies: The pilot is crucial for future policy. It can be used by local councils to analyse the buildings. This light tool do not replace an energy audit, but will help to focus on the main elements responsible for energy consumption, whether these are connected to the windows, the facades of the building, the roof and the control valves of the heating system.

Lesson learned from other project partners: The use of the same instrument in all of Europe is rather difficult due to the difference of the regulations existing in the various states.
The approach to an audit is different in every region. The purpose of the audit study was not to consider various types of audit regulations and the differences between them.

List of good practices

The project partners have identified the good practices contributing to energy efficiency in public buildings in partners cities and in other European regions. Below we present the list of the practices selected by the partners.

Historical building definition

Partners adopted the definition of the Directive 2002/91/EC of the European Parliament and of the Council, Article 4, point 3, that says:

"Buildings and monuments officially protected as part of a designated environment or because of their special architectural or historic merit."

List of good practice

- Brussels - Atelier Mommaerts
- Florence - Bardini Palace
- Florence - Villa Ognissanti
- Bordeaux - Eco-citizen house of Bordeaux
- Bordeaux - Saint Bruno school
- Bordeaux - Aquitaine Museum
- Silesia Metropolis - City Hall
- Silesia Metropolis - Primary school

Offices subgroup definition

Offices subgroup would focus on office buildings (administrative buildings) which are continually used for a set period of hours each week (e.g. in Ireland this would be offices with a 35 hour core working period per week i.e. 7 hours/day and 5 days /week) and also where the energy use is comprised of small office equipment, heating, lighting.

The type of building would include:

- Administrative Headquarters of the municipality
- Other Administrative Buildings (including citizen service centres, municipal libraries etc)
- Town Halls
- Energy Agency Offices

List of good practice

- Barcelona Province - Different public buildings
- Cork County - Annabella Offices
- Cyprus - Strovolos Municipal Library
- Vysocina - Municipal Office Hodice
- Wysocina - Municipal Office Kostelec
- Slovak University of Technology - Municipal Office Building

Schools definition

A school is an institution designed for the teaching of students under the direction of teachers. Only public schools are included in this subgroup.

List of good practices:

- Barcelona Province - Schools Benviure
- Malmo - Kroksbäcksskolan
- Silesia Metropolis - General Secondary School Complex No 3 Sosnowiec
- Silesia Metropolis - Music School Complex
- Vysocina - Primary and Nursery School
- Vysocina - Secondary Technical School
- Slovak University of Technology - Centre for Renewable Energy Resources Research and Application
- Slovak University of Technology - Municipal Primary School

Social housing definition

Definition relates to intervention of dedicated operators, specifically created to build, renovate and manage these social housings with no profit aims. Being the contracting authority, the social housing organisations can have different legal forms. Social houses are helped by public policies to guarantee affordable housing for beneficiary households.

List of good practices:

- Brussels - Atelier Mommaerts
- Brussels - Savonerie Heymans
- Cork County - Socialhousing upgrade scheme
- Bordeaux - Verlaine
- Bordeaux - Fraternité

Sport facilities definition

Individual buildings or groups of structures designed for exercising, sports training and practice, and competition in various sports.

List of good practices:

- Cyprus - Olympic Swimming Pool
- Malmo - Gullviksborgs IP
- Province of Florence - Bilancino lake
- Province of Pistoia - Stadium in Montale

SERPENTE

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All information and articles has been prepared by the partners of the SERPENTE project and are available on www.serpente-project.eu. For more information please contact Metropolitan Association of Upper Silesia (communication coordinator) serpente@gzm.org.pl or + 48 603 501 298.

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