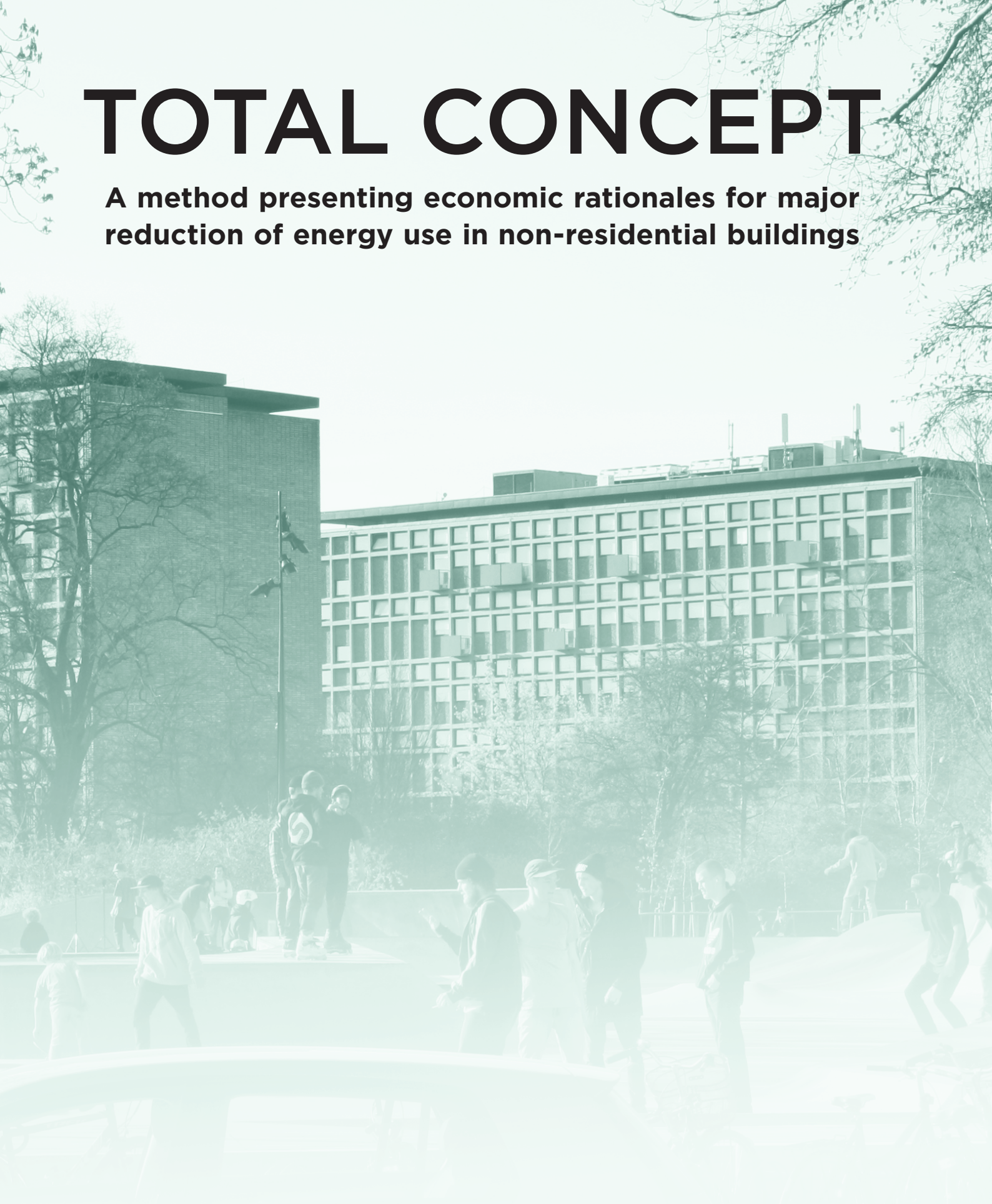
TOTAL CONCEPT

A method presenting economic rationales for major reduction of energy use in non-residential buildings



Total Concept

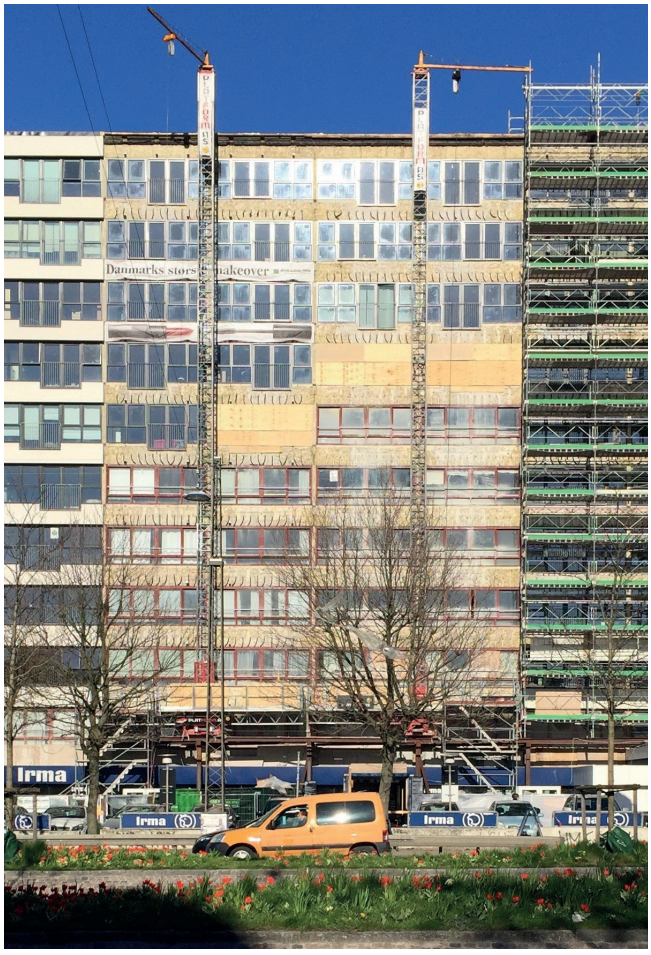
Intelligent Energy Europe Programme
of the European Union

Who benefits of the Total Concept?

The Total Concept method is aimed at stakeholders and actors in the property and construction sector who want to obtain benefits of major energy savings in existing non-residential buildings. Equally, these stakeholders and actors will need to be looking for attractive financial returns in the renovation of this type of property.

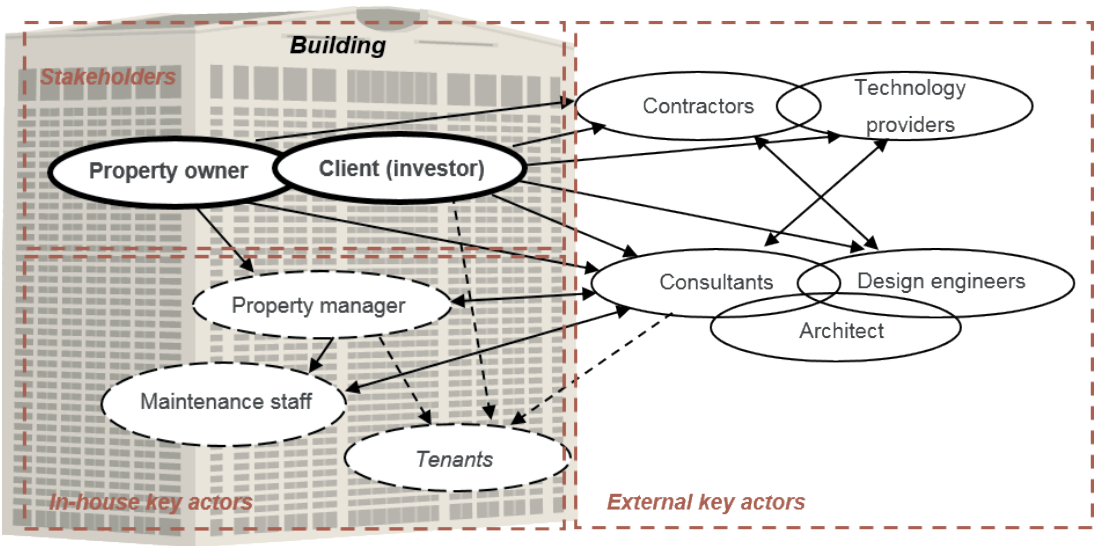
The benefits are financial, technical, comfort-related, carbon reduction and business opportunities for the following actors:

- Owners and administrators of non-residential buildings used for offices, health care, shopping malls, administration, trade, schools and similar public purposes;
- Technical and financial advisors of the client and energy consultants, design engineers and architects who work professionally with the planning, auditing, calculations, analyses and design of these non-residential buildings, which are a presupposition for using the method and its associated tools;
- Large entrepreneur companies and developers of existing non-residential buildings who execute the construction work for the client and/ or are able to use the concept directly in their own companies;
- Those public authorities who are responsible for the political, legal and financial frameworks for national energy-saving efforts.



Stakeholders and key actors

Carrying out the Total Concept method successfully involves all actors in a renovation project. The picture below illustrates the interaction between different stakeholders and key actors involved in a project based on Total Concept. It is up to the property owner or client to decide who will be responsible for organizing the process and run the procedure described on in the brochure.

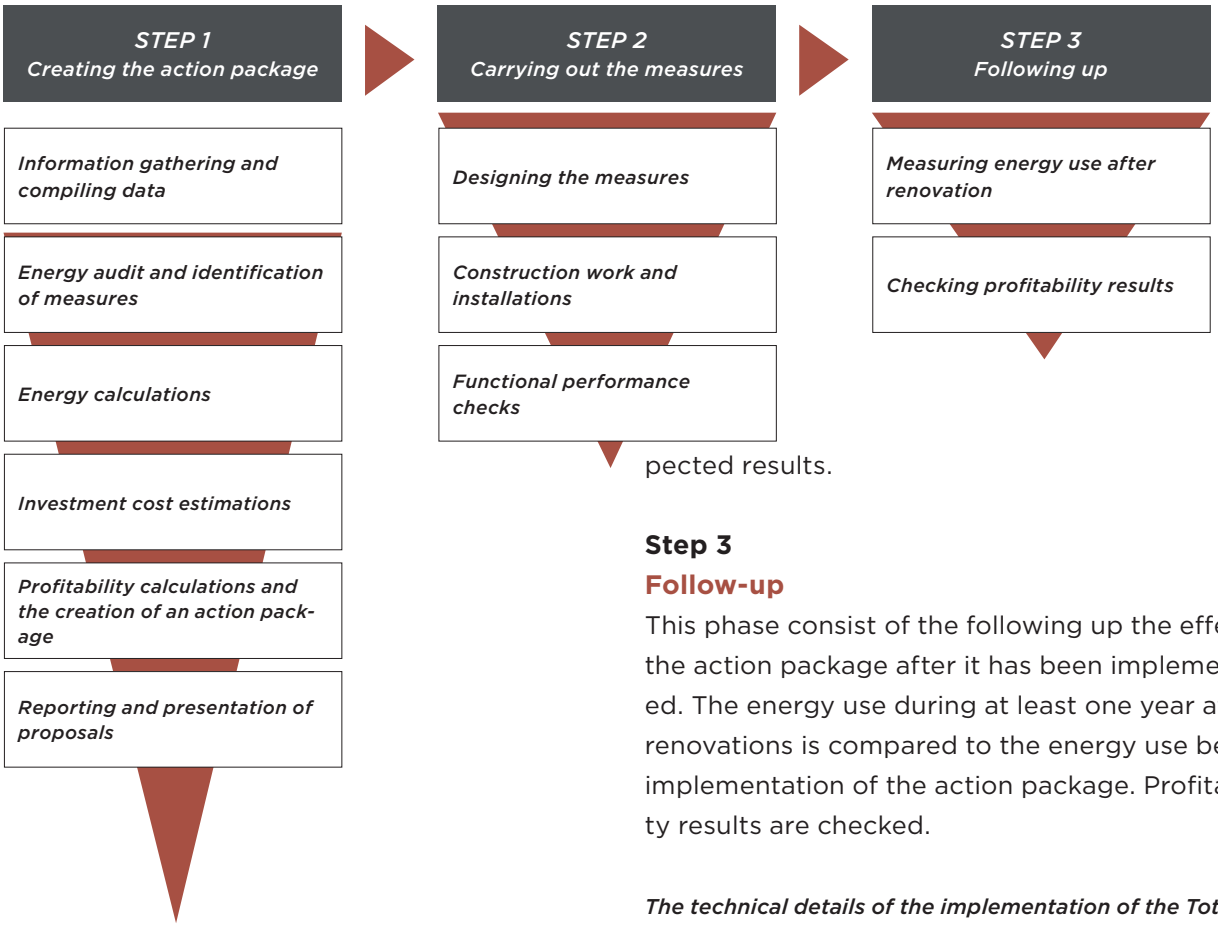


The Total Concept method

The Total Concept is a method for improving energy performance in existing non-residential buildings and applies a refined systematic approach throughout the project. The method aims at achieving maximum energy savings in a cost efficient way and includes economic realities which building owners need to consider.

The method is based on an action plan comprising a package of measures that as a whole fulfils the property owner's profitability requirements. When forming the action package both the single cost-efficient measures ("low hanging fruits") and the more costly measures are considered. From an economic point of view, the single cost-efficient measure are related to and support the more costly measures. This way of working has shown that total energy savings of more than 50% are possible.

In order to make sure that the expected savings will actually be reached, a systematic approach is important throughout the complete process of the energy retrofitting. The work process of Total Concept has therefore been structured into three main steps.



Step 1
Creating the action package

Includes a comprehensive inventory in the building to identify all conceivable energy saving measures. Various calculations and an analysis based on the compiled data lead to a profitable action package that as a whole provides maximized energy savings. The results of Step 1 provide an informed basis on which the owner of the building can make decisions.

Step 2
Carrying out the measures

In this step the energy saving measures in the action package are carried out. The focus here is on the quality of the work and on making sure that the designed intent will lead to the expected energy savings. The functional and performance checks are significant in order to reach the expected results.

Step 3
Follow-up

This phase consist of the following up the effect of the action package after it has been implemented. The energy use during at least one year after renovations is compared to the energy use before implementation of the action package. Profitability results are checked.

The technical details of the implementation of the Total Concept is described in the guidebook "The Total Concept.

Guidebook for implementation and quality assurance".

The economic principles of the Total Concept method

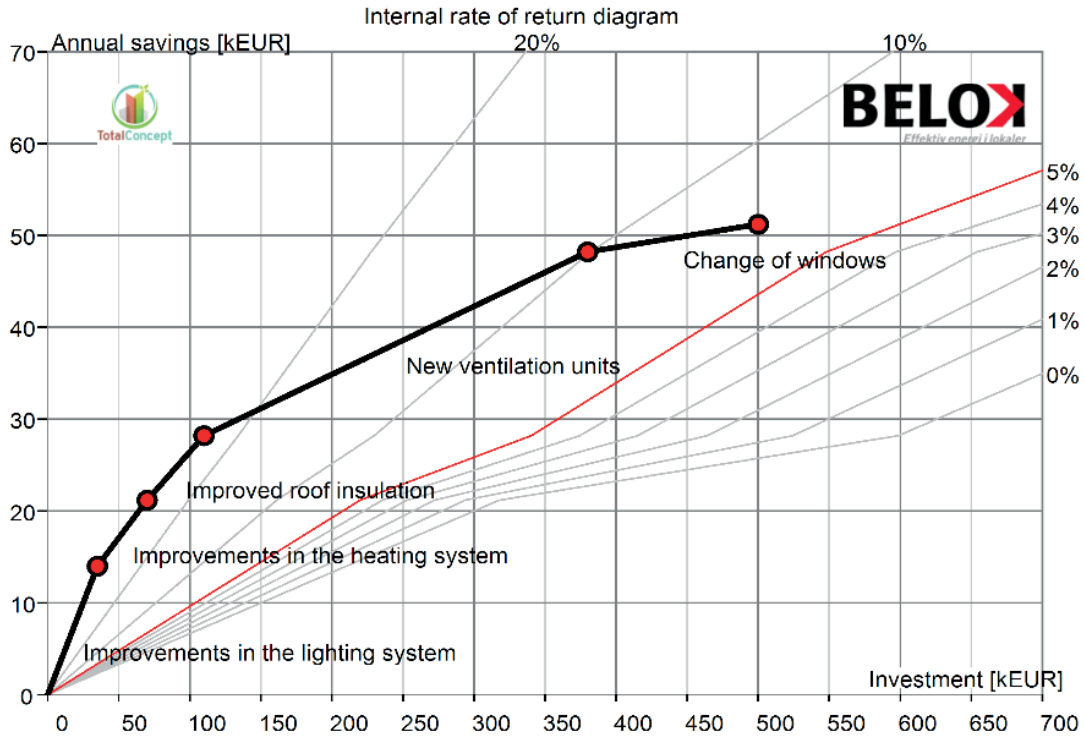
The profitability assessment in the Total Concept method is based on internal rate of return method, where each investment is assessed by the actual yields that it creates, expressed as an internal rate of return.

The action package is formed by arranging the different energy saving measures according to their profitability and calculating a common internal rate of return for a number of simultaneous measures, taking into account also possible future changes in energy prices and the specific lifetime of each measure. The criterion for how many measures are included to the action package is that the internal rate of return of the action package in its entirety is higher than the stipulated real calculation interest rate by the property owner.

This calculation can be easily done with the Total Concept tool, called the TotalTool. The results of the profitability calculations are illustrated on an internal rate of return diagram (see figure below). Every identified energy saving measure leads to certain annual net savings in operating cost (k€/year), requires certain investment cost (k€) and can be represented by a line in the diagram with a certain length and angle. This angle represents the internal rate of return (%) of the investment. In the example shown in the figure below the action package comprises five energy saving measures. The profitability requirement is here set as minimum 5% interest rate.

The complete action package provides a combined internal rate of return of 7% and leads to halving the annual energy costs, which approximately corresponds to a halving of the use of energy. The most profitable measures make up for the less profitable measures while the complete action package will fulfil the profitability frame set by the building owner. If only the measures that were profitable on their own were carried out, the first three measures, the savings would have been only 30%.

This is the main essence of the Total Concept method that it provides a method to take one step



further with energy savings in a cost efficient way.

Guidelines and Tools

To make sure that the expected saving actually will be achieved in relation to the economic conditions defined, a systematic approach for all actors involved is used throughout the complete project.

The website www.totalconcept.info contains a number of guidelines and free tools, which guide through the planning and implementation of the energy-saving project.

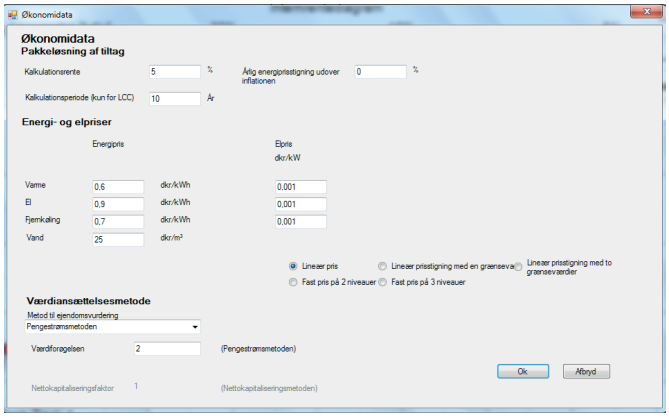
The guidelines and tools includes e.g.:

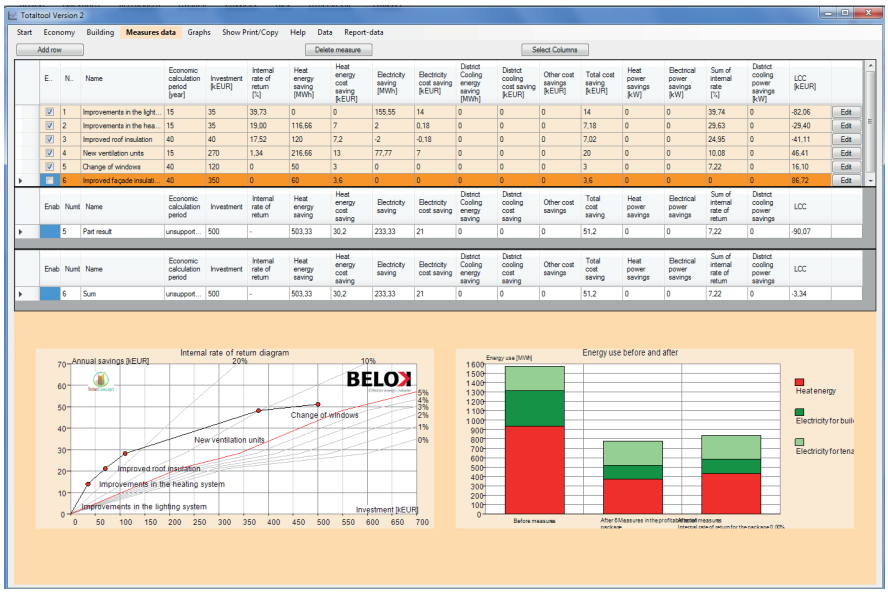
The Guidebook for Implementation and Quality assurance, which provides detailed information about the Total Concept method and provides step-by-step guidelines about the practical implementation.

Checklists for the property owner / client for collecting Information about the property and creating tender documents, to be used in the tendering of Step 1 of the Total Concept method.

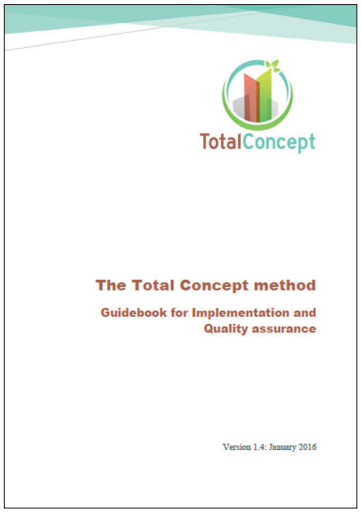
Checklists and templates for energy consultants for carrying out Step 1, as well as templates for measurement and follow-up in Step 3.

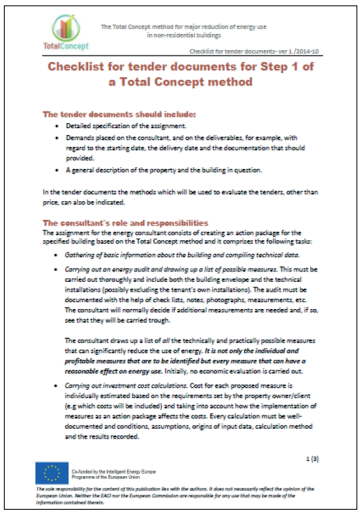
And finally the **TotalTool software**, which are used to determine the profitability of the action package.





Screenshots from the TotalTool, which is free software for use to define the energy-savings and the profitability of measures by following the Total Concept method.





Total Concept, Guidelines and tools.

Photo: CIT

CASE:

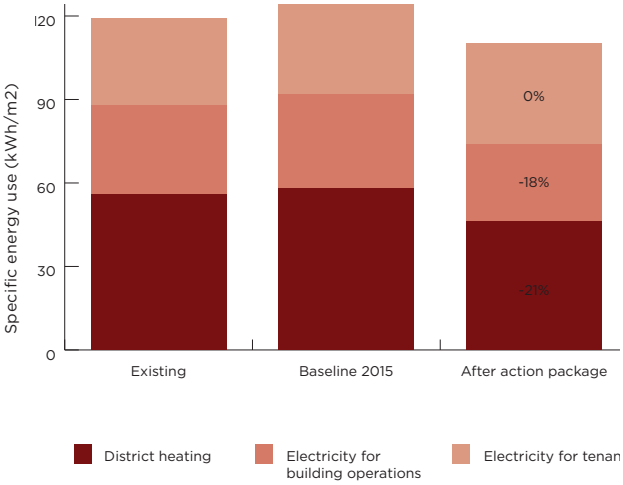
Office buildings Högsbo 20:22 Göteborg, Sweden

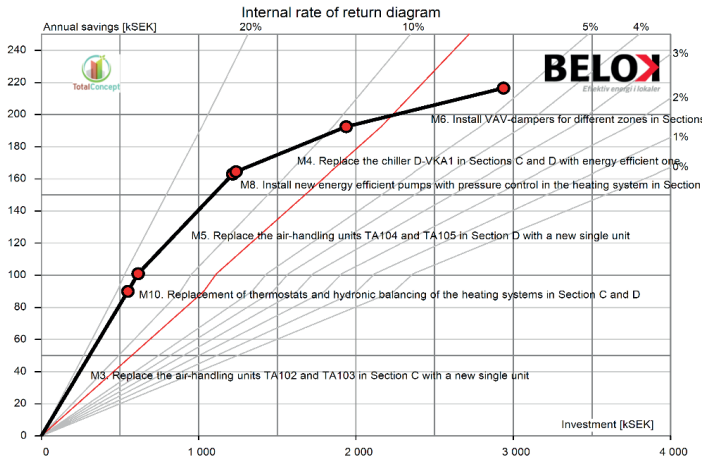
The Högsbo 20:22 office buildings in Gothenburg is one of the three pilot buildings carried out Sweden as part of the IEE Total Concept project. The total heated area of the property is 14.543 m2, divided into two buildings with four sections: A, B, C and D. All of the building sections incorporate mainly office rooms, but there are also a lunch restaurant and an underground garage. Before the renovations about 70% of the property was rented out and the buildings had rather low energy use compared to other similar office buildings in Sweden, about 120 kWh/m² yr (incl. tenants). A number of tenant adjustments will be carried out in the buildings as part of the renovation, which has been used as baseline for energy calculations. After these tenant adjustments, the annual energy use of the property will increase by about 8%.

Twelve energy saving measures were identified during the auditing, whereas six measures are included to the proposed action package. The selected measures involve Sections C and D and will be included to the upcoming tenant adjustments. Therefore only part of the investment cost is included to the costs for energy efficiency improvement.

The total energy saving potential with the proposed action package is approximately 14% compared to the new baseline. The total annual energy use of the property will be about 111 kWh/m² yr.

The internal rate of return of the proposed action package is 5.5%, which is somewhat lower than the property owner's profitability demand 8%. The last measure (M6) is included to the package as it is planned to be carried out by the property owner anyway. The estimated relative energy price increase 2% has also been taken into account.





Total annual cost savings:
217 kSEK/yr

Energy investment cost:
2 938 kSEK (28% of the total cost)

Internal rate of return for the package
5.5 %

Calculated energy savings - District heating:
173 MWh/yr (-21%)

Calculated energy savings – Electricity:
91 MWh/yr (-18%)

Photo: Nordea Ejendomme

CASE:

Office building - Lyngby Port, Denmark

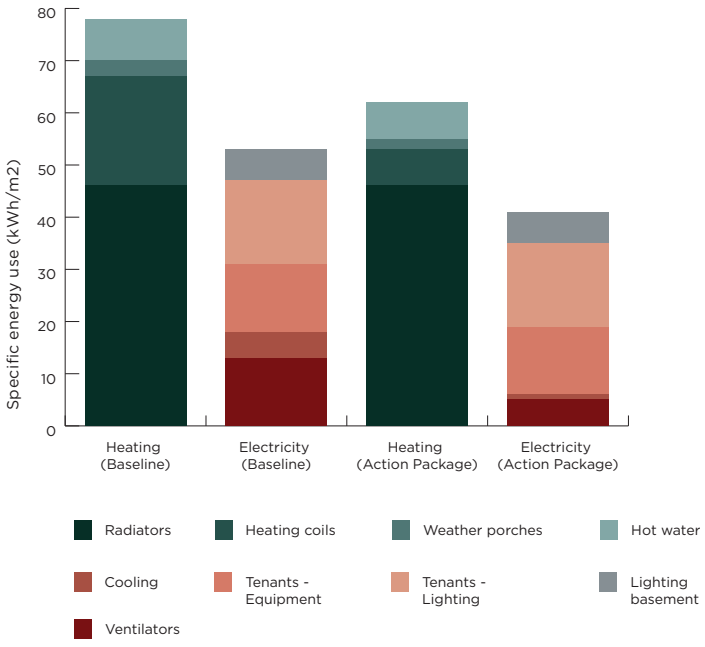
Lyngby Port is an office building in portfolio of a property company Nordea Ejendomme. The building is built in 1992 and divided into 3 building segments; A, B and C at Lyngby Hovedgade 94, 96 and 98. Lyngby Port has 7 floors including basement. Segment A has 7 floors, B has 6 floors and C has 5 floors. The building consists of cell offices grouped in modules. Lyngby Port, with several tenants, is being prepared for a new tenant in larger parts of the building. It is expected that there will be a general change from cell offices to more open office areas, supporting a higher number of employees.

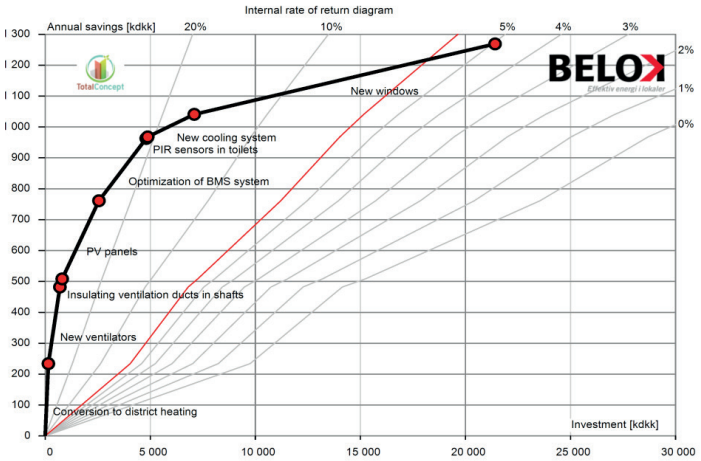
Specific annual energy use before measures is estimated at 131 kWh/m² (heat energy - 77 kWh/m², electricity for building operation like cooling, ventilation, lighting in parking - 25 kWh/m², electricity for tenants 29 kWh/m²).

Eight energy saving measures were identified during the auditing, whereas seven measures are included to the proposed action package. The total energy saving potential with the proposed action package is approximately 22% compared to the baseline. The graph below illustrates energy measures that fulfill owner's requirements for internal rate. The total annual energy use of the property will be about 102 kWh/m² yr, if all measures from the action package are carried out.

The internal rate of return of the proposed action package is 16%, which is much higher than the property owner's profitability demand 6%.

The energy saving for the package is 20% for heating and 23% for electricity. The graph also shows that reduction for the common electricity is around 50%. The electricity for tenant's energy consumption is a fixed value. The estimated relative energy price increase 2% has also been taken into account.





Total annual cost savings:
1.040 kDKK/yr (incl. price change gas->district heating)

Energy investment cost:
7.100 kDKK

Internal rate of return for the package:
16%

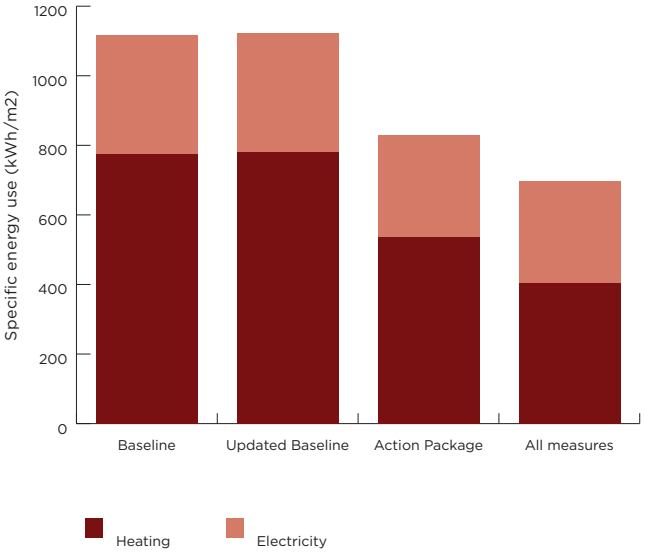
Calculated energy savings - District heating:
480 MWh/yr (20%)

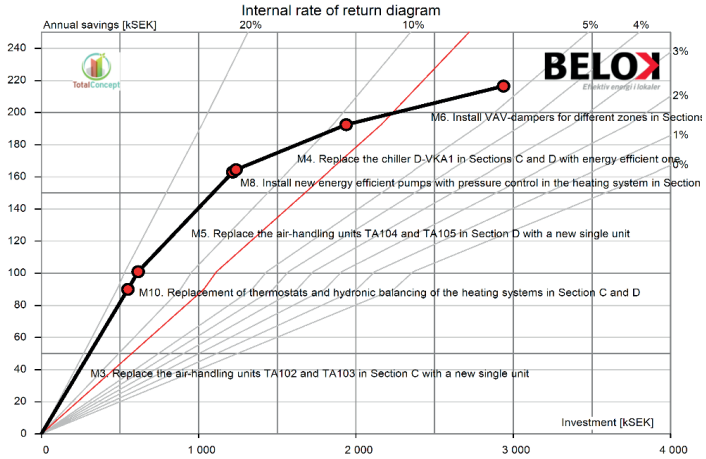
Calculated energy savings – Electricity:
416 MWh/yr (23%)

Photo: Bionova

CASE:

Oulu City Centre health care station - Oulu, Finland





The Oulu City Centre health care station was originally built as a school in 1934. It was turned into a municipal medical center in 1980 and the city council is now planning to renovate it. Additionally to basic health and psychological counselling services, the building hosts a dental surgery unit, a laboratory, a sports hall and a canteen. Though no final decision was yet taken regarding the use of the building after renovation, it is likely to become an administrative center. It is an L-shaped building on three floors, encompassing 5.303 m^2, of which 4.288 m^2 are heated.

The last major renovations go back to 1980. Parts of the HVAC system were successively modified or replaced since. In 2009, a new set of windows was installed. In 2012, electric cooling devices were installed in a number of rooms. The building's primary energy consumption is 260 kWh/m^2 (net). After a thorough energy audit, an action package was drafted to reach substantial energy savings. Out of eight measures, six could be arranged to match the interest rate of return defined by the City of Oulu (7%).

The package showed that energy consumption could be reduced by 26% in a profitable way. The largest potential lies in the ventilation system, as some devices still have no heat recovery units or obsolete ones. Also, consumption could be reduced through adequate control methods and replacement of the current exhaust fans with new ones. Replacing the old-fashioned lighting system and in the manual water faucets would be profitable too. Those projections are promising despite unfavorable factors. Extremely low heating energy prices in Oulu impair the profitability of any efficiency-oriented refurbishment. The past optimization of the HVAC system, easy and profitable, has reduced the economic incentive to support expensive renovations. Finally, the protection by law of the building's appearance induces extra costs for any measure concerning roof, façade, doors and windows. Those measures did not meet the profitability requirements under projected energy price increase (2% per year) but provide a firm basis for further decisions.

Total annual cost savings:
16.200 €/yr

Energy investment cost:
205.000 €

Internal rate of return for the package:
7%

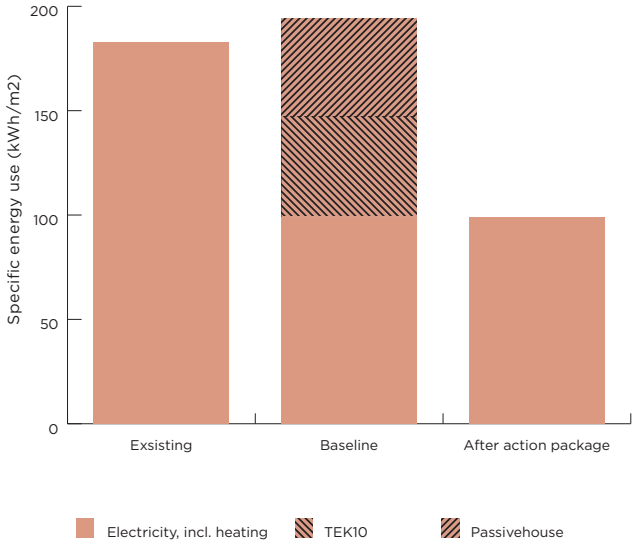
Calculated energy savings - Heating:
275 MWh/yr

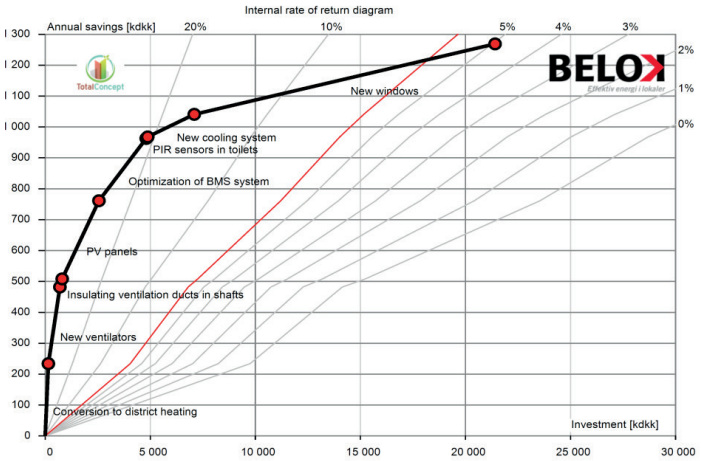
Calculated energy savings – Electricity:
50 MWh/yr

Photo: Statsbygg

CASE:

Road Office – Steinkjer, Norway





The road office in Steinkjer is one of the two Norwegian pilot buildings in the IEE Total Concept project. The total heated area of this office building is 4.330 m². The building consists of three parts built in 1967, 1976 and 1984. The building consists mainly of offices for the Public Roads Administration and canteen in the first floor. The road office require more office space. One part of the building is a control hall, but this will not be included in further evaluations.

Before the renovation, the staff complained about poor indoor air quality, especially in those parts of the building with the oldest HVAC-systems. Change of layout in the office area has also worsened the indoor climate. An important purpose of this upgrading is to improve the indoor climate in accordance with Class 2 in EN 15251. The temperature adjusted measured energy use for the building's office section, excluding the control hall, is 194 kWh/m²*Year.

Six major energy efficiency measures were identified during the auditing, whereas five measures are included in the proposed action package.

The measures are defined as energy savings and investment costs from building code requirements (minimum TEK10-level) to passive house level. Therefore, only part of the investment cost is included in the profitability analysis. The reason for this is that Statsbygg will upgrade in accordance with the building requirement (up to TEK10-levcel) and this is not an option.

The estimated energy saving with the proposed action package is 49% compared to the energy use before upgrading. The total annual energy use of the property is estimated to about 99 kWh/m² yr. 47 kWh/m² of the energy savings are included in the profitability analysis, while 48 kWh/m² is saved due to minimum upgrading up to TEK10-level. The internal rate of return of the proposed action package is 4.2%, above the property owner's profitability demand of 4.15%. The last measure (M6) is not profitable and included in the action package. It is estimated a relative increase of energy prices by 2% above inflation and economic lifetime is set to 60 years.

Total annual cost savings:
190 kNOK/yr

Energy investment cost:
2 827 kNOK (incl. in the profitability analysis)

Internal rate of return for the package:
4.2%

Calculated energy savings - District heating:
205 MWh/yr / 47 kWh/m2

Photo: Wikipedia

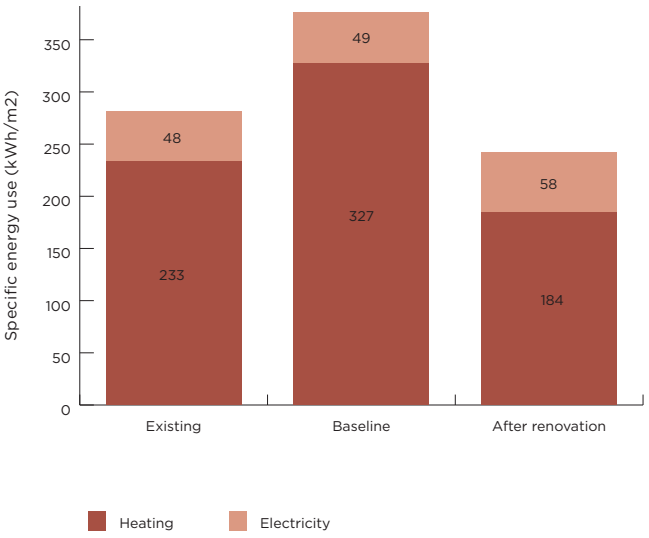
CASE:

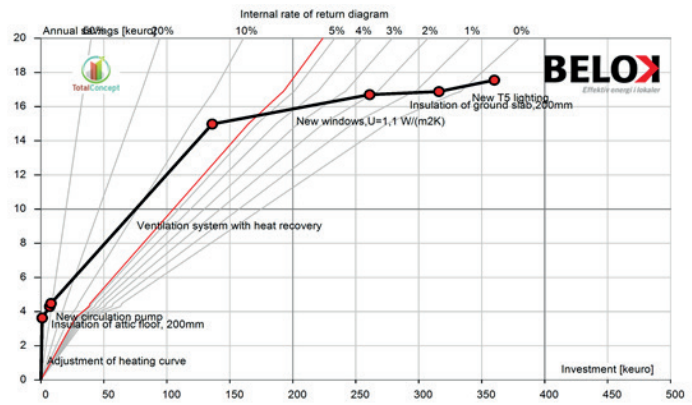
Office building – Kiriku 2/4, Tallinn, Estonia

The Kiriku 2/4 office building in Old Town Tallinn is one of the three pilot buildings carried out in Estonia as part of the IEE Total Concept project. The total heated area of the property is 1.877 m^2, divided into two connected buildings parts with different addresses. The building is under the protection of cultural heritage.
The building was last used by the state agencies in the 2010 and after the renovation, the building will be in use again. Energy consumption from 2009-2010 is taken as energy consumption in current condition of building. Taking into account the indoor climate requirements for the office buildings (ventilation airflow rates, indoor temperature), raises energy consumption approximately 30% and is taken as a baseline energy consumption before the energy renovation.

Seven energy saving measures were identified during the auditing. Four of them (adjustment of heating system, insulation of attic floor, new circulation pump and new ventilation system with heat recovery) were profitable measures. As major renovation is planned in the building, three less profitable measures (replacement of windows, insulation of ground slab and new lighting) were also taken into action package. Those measures were not the most profitable ones, but will help to increase the indoor climate (thermal comfort, lighting).

The total energy saving potential with the proposed action package is approximately 36% compared to the new baseline. The total energy use (heating + electricity) of the property will be about 242 kWh/(m^2·a).
The internal rate of return of the four first measures is 8%, which is higher than the property owner's profitability demand 5.5%. Last three less profitable measures are also included to the package as those measures are planned to be carried out by the property owner anyway.





Total annual cost savings:
17 000 €/year

Energy investment cost:
360 000 €

Internal rate of return for the package:
8% (profitable measures), 0% all measures

Calculated energy savings - District heating:
268 MWh/a (-44%)

Calculated energy savings – Electricity:
-17 MWh/a (+18%)

Photo: Jonas Löfvendahl

JAN-ERIK DANIELSSON

Energy & Technical Coordinator, Jernhusen:

"Total concept represents for us the basic model, which we have adapted to our own terms and conditions. We are using or have used the concept in approximately 15 properties throughout Sweden. A common methodology gives us many synergies. All our technicians using the concept, finds it useful.

A common model supports cooperation and exchange of experience and it provides greater efficiency and a better overall grip on energy consumption. Total Concept makes us go from thought to action, and a notion like durability becomes not just a cliché.

The result of applying the method is also used as a management tool for decision making.

Photo: Gladsaxe Kommune

POUL MATHIESEN

Project Manager, Municipality of Gladsaxe:

"Total concept is a highly structured analysis method that combines energy audits, evaluation of profitability of energy initiatives, and follow up on the measures implemented. With this method we can identify all possible energy saving measures and provide the best basis for an investment decision that improves the energy and indoor environment performance e.g. at Gladsaxe Sport Center.

Photo: Jonas Löfvendahl

LENNART LIFVENHJELM

Energy Expert, Vasakronan:

"It has been clearly profitable to work with Total Concept. We reduced energy consumption from 287 -> 124 kWh /m2/yr and got an internal rate of return on 15%. Today we have reached 100 kWh/m2/ yr. We use the experiences from this case in a major rebuilding project, Klara C, in Stockholm, where the goal is 55 kWh/m2/yr and LEED Platinum certification.

Total Concept is the right tool to use because of the holistic approach including construction, installation and economic rationales".

Photo: Nordea Ejendomme

MARTIN GRØNDAL

Project Manager, Nordea Property:

"We expect that the Total Concept will be a good decision tool because of the holistic methodology that uncovers all important issues early on in the planning process. This method combines the technical point of view with the commercial comprehension.

Who is behind the idea?

The development of the Total Concept method has been carried out within the BELOK group, which is a collaboration between the Swedish Energy Agency and 20 of the largest non-residential property owners in Sweden. More information: www.belok.se

The method has been successfully applied on a number of non-residential buildings in Sweden, and on this basis a northern European cooperative venture has been established, involving Sweden, Norway, Finland, Estonia and Denmark.

The aim is to further develop the method and try out the concept in the various national contexts, with a view to subsequently implementing it in the building sector of the respective countries.

Project partners

- CIT Energy Management, Sweden (Project coordinator)
- Swedish Construction Clients (Byggherrarna)
- The Danish Building Research Institute at Aalborg University
- Danish Association of Construction Clients (Bygherreforeningen)
- Rambøll, Denmark
- State Real Estate Ltd (Riigi Kinnisvara AS), Estonia
- Estonian Society of Heating and Ventilation
- Engineers (EKVÜ)
- Bionova, Finland
- SINTEF Byggforsk, Norway

The project runs from April 2014 to April 2017, and is co-financed by Intelligent Energy Europe Programme.

Intelligent Energy Europe Programme of the European Union

Total Concept

More information
www.totalconcept.info

DANISH BUILDING RESEARCH INSTITUTE
AALBORG UNIVERSITY COPENHAGEN

Riigi Kinnisvara
Estonian State Real Estate Ltd

EKVÜ

DANISH ASSOCIATION OF CONSTRUCTION CLIENTS

CIT Energy Management AB
A Chalmers Industriteknik Company

BIONOVA
Your partner for sustainable performance

RAMBØLL

BYGG HERR ARNA

SINTEF