BELOK

BELOK Total Projects

A summary

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Contents

Background

In order to facilitate measures for energy savings in existing non residential buildings the co-organization group BELOK [1] has developed and implemented a way of working, the Total Concept method, that has appeared to become quite successful. The basis is a competent and thorough audit aimed at identification of possible energy saving measures. Every measure is evaluated from energy saving and investment point of view. The individual measures are then arranged after profitability into a package, shown in an investment - real interest rate graph.

The task of BELOK Total Concept has been:

- to develop the method itself and develop carrying out routines, calculation methods, supporting utility programs and manuals for realization in practice
- to initiate a broad scale application of the Total Concept method, develop prerequisites for an extensive implementation

The prerequisite of a broad scale implementation in practice, and likewise the basis of the concept, is that the measures taken must, as a whole, must be profitable enough for the individual real estate owner. Consequently it is the individual property owner who has to decide about the profitability level needed for the investments required for carrying through the energy saving measures. This will then decide the extent of the package of energy saving measures.

Also, it is absolutely necessary for a wide realization of the Total Concept and the corresponding energy savings that the profitability estimated in the audit is reliable. It must be sure that the costs of reconstruction and the energy savings in operation after reconstruction, will become as predicted in the audit. Presupposing the measures taken should result in 40%-50% decrease of the energy need, the investments needed will be of about 50 – 100 €/m^2. That means more than 500 000 € for a 10 000 m^2 non-residential building. Few real estate owners could run the risk of carrying through such a quite extensive investment, if it is not really certain that they can rely upon the savings expected and the costs estimated. Therefore one initial task of BELOK was to develop a working model that ensures reliability and verify that by application in practice.

A number of buildings from the stock of the BELOK member companies were selected as test objects. Total Concept audits were carried through, packages of energy measures were worked out and reconstruction projects according to the packages were started

After three fulfilled projects, including verification of energy savings and profitability, a number of new projects were started up with some support from BELOK. First the BELOK member companies were involved, later on other non-residential building owners.

As mentioned, the basis of the Total Concept is a competent and thorough audit. The cost of the audit and the simulations and calculations needed might be close to 3 €/m^2. In the projects initiated by BELOK, a part of the auditing costs has been supported. About 45 buildings have been audited and are now in different stages of realization. The auditing of all the 45 buildings is accounted for by condensed four-page reports “kort rapporter” on http://belok.se/totalmetodiken/totalprojekt/, available unfortunately in Swedish only.

[1] BELOK is a co-organization between 18 of the dominating Swedish non-residential real estate owners, representing about 25% of the total Swedish non residential building stock. The organization is initiated and supported by the Swedish Energy Agency.

In addition to the above Total Concept projects supported by BELOK has the Total Concept method been applied by non-residential building companies in about 200 buildings.

The Total Concept method

The basis of a Total Concept project is a comprehensive audit. The building's energy certificate might be useful as a base, but the audit needed here must be much more thorough. It is not a question of the apparently most cost-efficient measures only, but of all measures that may have a reasonable energy saving potential. Then the costs and the savings of all measures are to be estimated, considering possible interaction between the individual measures taken.

The calculation of the energy saving of each measure forms a vital part of the audit. A method for simulation based estimation of energy savings. Inter alia, the method is based on a tuning of less certain assumed input data after former energy statistics of the building. According to energy measurements in buildings after realized reconstruction, the mode of procedure results in very reliable results.

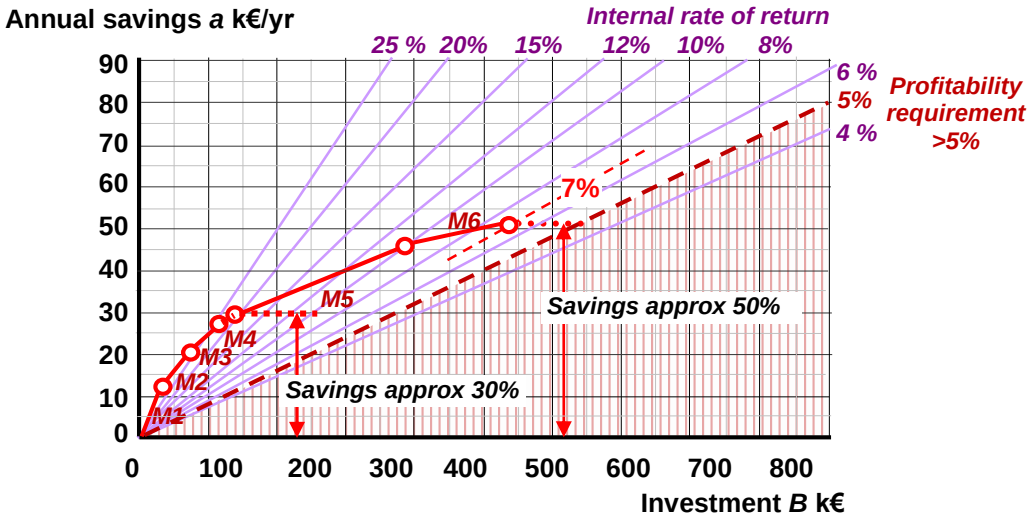
When possible energy saving measures have been identified and their energy saving efects and their costs estimated, an action package is formed. An action package becomes easily apprehensible when presented in an internal rate of return diagram, with the reduction of annual cost on the y-axis and investments on the x-axis. In such a diagram the slope of a line from origo represents a certain internal rate of return for a given economic lifetime.

An energy saving measure with the cost B € that results in the annual saving a €/a, can be represented by a line from origo with a certain length and slope. The slope represents the profitability of the measure in question. A "package" can be formed, by arranging the different energy saving measures after their profitability. The number of energy saving measures included in the package is decided by the requirements set by the building owner in terms of a lowest acceptable internal rate of return for the whole package.

Basically the package is a comprehensive systematic synthesis of possible energy saving measures in the building in question. The measures in the package could be carried through simultaneously as one reconstruction project or piecemeal in accordance with the owner's long time financing schedule. Yet, it is vital that the package will be carried through as a whole sooner or later. The outgoing from that the package as a whole should be profitable, implies that the most profitable measures contribute to the profitability of those less profitable. By accepting that, it is often possible to save up to 50% more energy compared with if only the most profitable individual measures should be carried through. The most profitable measures will assist the investments which, on their own, would have been unprofitable, but can be carried through as a part of the package.

There is a comprehensive manual in English available in the Tool kit *Total Concept: Guideline and Tools*. The manual is also available in Swedish in belok.se

The next figure shows a package of six energy saving measures, M1 – M6, in an internal rate of return diagram.



An action package with six measures (M1-M6) in an internal rate of return diagram. The measures are arranged after their profitability. In this case the property owner has demanded an internal rate of return higher than 5%. The whole package of measures in the example ends up at 7%. There were more measures found by the audit, but they could not be included due to the profitability requirement.

In the case shown in Figure 1, the package results in about 50% energy saving. If only measures giving more than 5% internal rate of return each had been included, only about 30% saving would have been achieved.

There is an easy to handle support program for the design of energy saving packages in accordance with Figure 1. It is available in English. www.Belok.se *Totalverktyget*. It makes the real interest rate graph with the action package and enables also a combination of measures with different economic lifetimes.

Results until now from Total Concept projects

As mentioned about 45 buildings have been audited under BELOK management. A few Total Concept projects were started up in office buildings 2009. The primary task was to test and develop the method under practical conditions in real reconstruction projects. Especially it was regarded vital to make sure that the energy and cost estimations from the audits were really reliable. This needs some completed Total Concept projects, i.e., the audit and the decision to go on, a detailed design, fulfilled construction works, commissioning and finally one year of monitoring.

The realization of a whole project takes often quite a long time. The time schedule has to be adopted to what is acceptable for the tenants, it must be coordinated with the investment program of the estate owning company, etc. Furthermore, verifying of the energy savings needs, as mentioned, at least one year of monitoring. To sum up, auditing, completed reconstruction and the following monitoring might take 3-5 years, often more.

At present the Total Concept has been carried through completely, i.e., inclusive one year energy monitoring, in three office buildings. These completed projects indicated that the calculated energy savings corresponded very well with the measured results in the

reconstructed buildings in operation. The cost calculations, however, diverged between the calculated cost and the real outfalls. Yet, still the profitability remained very good, about 12% real internal interest.

The divergence between estimated and final cost may need some explanation.

Building	Locality	Floor area m^2	Calculated		Real outfall	
			Cost K€	Energy kWh/(m^2·a)	Cost K€	Energy kWh/(m^2·a)
Getholmen"	Stockholm	8 500	550	81	400	80
Pennfäktaren	Stockholm	12 600	450	120	690	120
Hägern	Stockholm	19 100	420	88	840	88

As can be seen from the above table, the real outfall after one year monitoring after implementation of the energy saving measures, corresponds very well with the calculated energy end use. The estimated cost and the real cost differ.

Getholmen
The buying of the reconstruction occurred during an occasional recession, which resulted in quite low bids

Pennfäktaren
The TCM was a limited part of an extensive reconstruction of the building with a well defined separation between the TCM project and the reconstruction as a whole. The TCM project included some quite advanced technical solutions, which did not work as expected. E.g., two big solar operated desiccant cooling air handling units had to be replaced with conventional ones.

Hägern
The large, almost 20 000 m^2, centrally placed in Stockholm, was in full operation including many shops, during the reconstruction works. This implied considerable complications, among other things much more complicated duct solutions than initially planned.

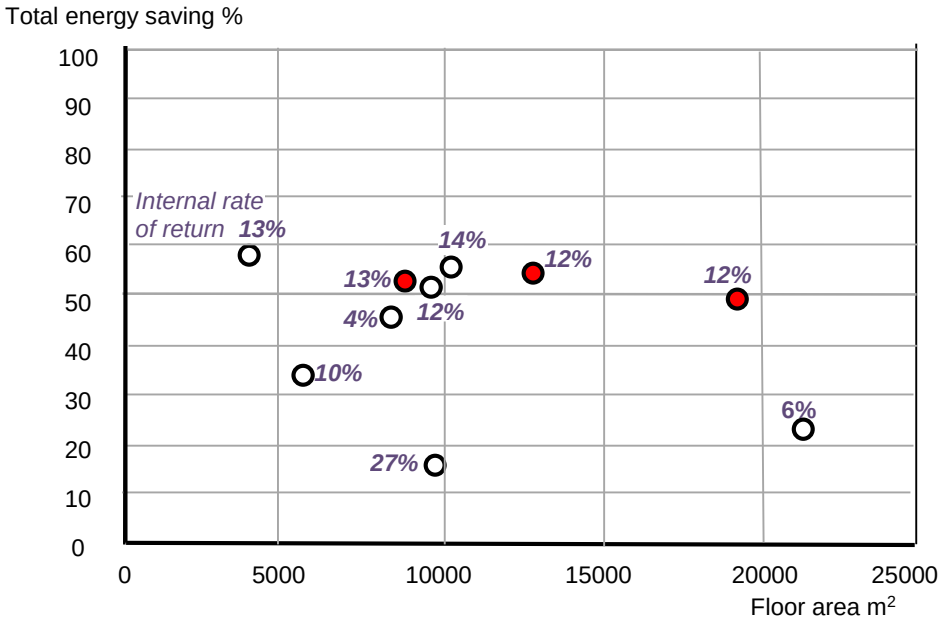
In the following is compiled information about the Total Projects supported by BELOK. The buildings in question are divided in three groups:

- Offices
- Schools
- Other buildings

The projects are in different stages of realization. About half of the buildings shown had the initial audit completed at the end of 2013 and the beginning of 2014. It will take some years before the projects will be completed, including one year of monitoring. Of the earlier projects are three finished and a number more are on the way.

Office buildings

The three offices marked red are finished having been monitored during at least one year after reconstruction, i.e. both the costs and the energy savings are verified. The ones marked white, are still in the process and thus based on calculations performed by the audit.



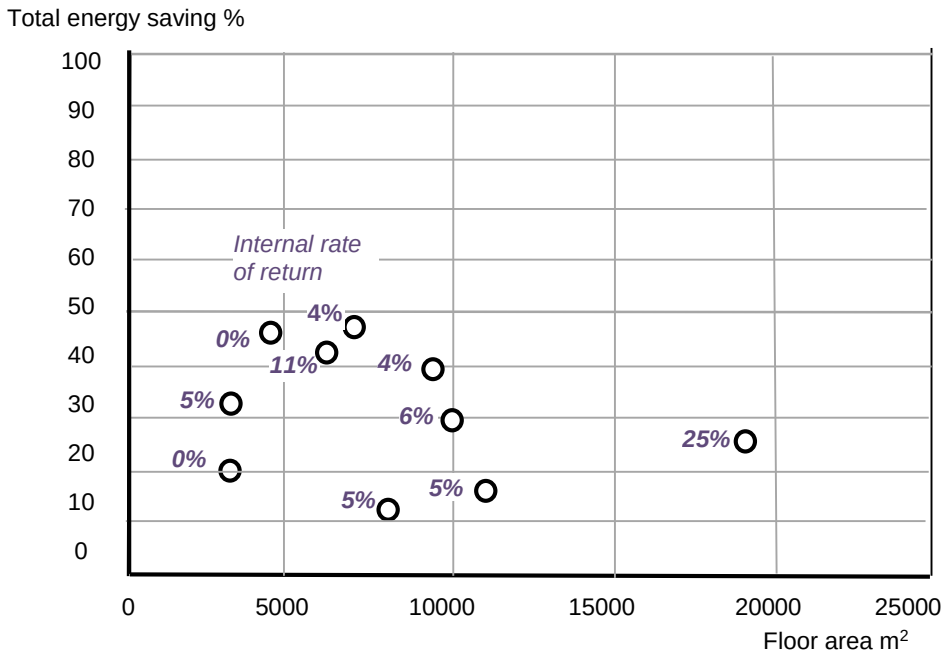
Office buildings from the BELOK Total Concept Implementation program.

Some information about the buildings above

The energy needs given in the table is the direct sum of heating and electricity for building operation. The tenant's use of electricity is not included.

Office building	Owner	Locality	Floor area m^2	Energy before kWh/(m^2·year)	Energy after kWh/(m^2·year)	Cost k€
Municipality centre	Storfors	Storfors	3 650	262	109	280
Garrison administration	FORTV	Gothenburg	5 700	102	65	120
Municipal administration	Stenungssund	Stenungssund	8 140	144	79	500
Offices "Getholmen"	Brostaden AB	Stockholm	8 500	162	80	400
Offices "Altona"	Stena AB	Malmö	9 500	196	94	540
Offices "Stampen"	Stena AB	Gothenburg	9 680	172	119	96
Offices "Glaven"	LOCUM	Stockholm	10 300	220	100	500
Offices "Pennfäktaren"	Vasakronan AB	Stockholm	12 600	287	120	690
Offices "Hägern"	Fabege AB	Stockholm	19 100	186	85	840
Administration "Johannes"	SFV	Stockholm	21 000	166	133	680

School buildings

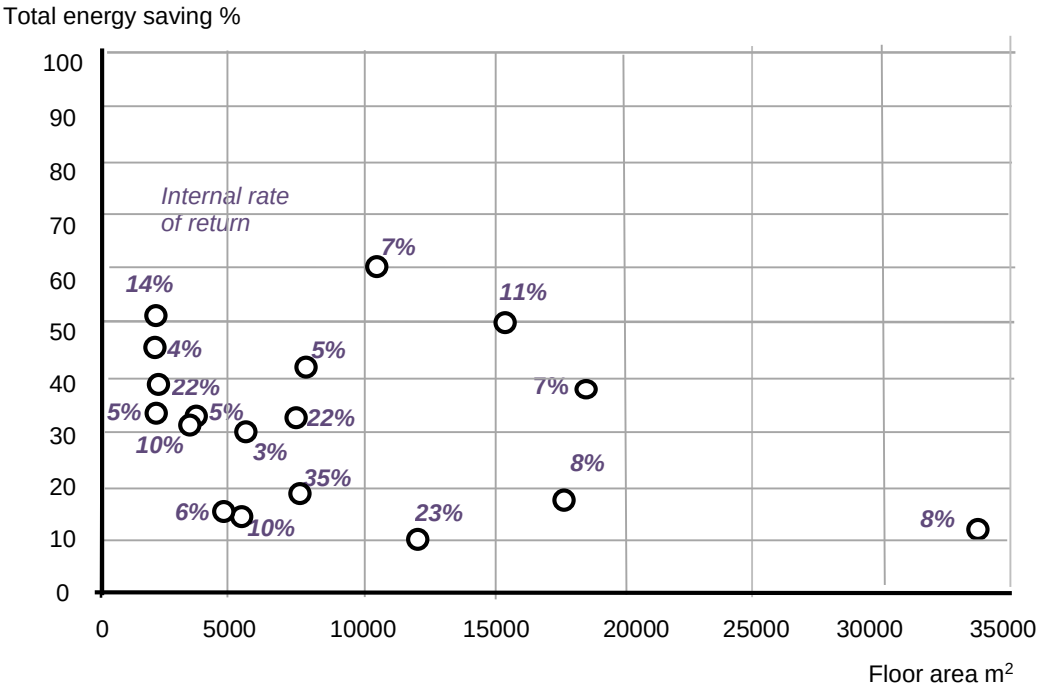


School buildings from the BELOK Total Concept Implementation programme.

Some information about the schools above
The energy needs given in the table is the direct sum of heating and electricity for building operation. The tenant's use of electricity is included.

School	Owner	Locality	Floor area m^2	Energy before kWh/(m^2·year)	Energy after kWh/(m^2·year)	Cost k€	Saving K€/a	Interest %
Sörby	Futurum	Örebro	3 200	198	158	440	9	<0
Skintebo	LF	Gothenburg	3 200	258	172	350	28	5
Bytorp	City of Borås	Borås	4 400	167	93	570	27	0
Appalby	City of Västerås	Västerås	6 250	223	120	390	48	11
Johanneberg	LF	Gothenburg	7 000	213	136	580	40	4
Bergum	LF	Gothenburg	8 030	170	145	320	25	4
Kapare	City of Kungsbacka	Kungsbacka	8 200	120	105	240	17	5
Tynnered	LF	Gothenburg	9 500	190	117	450	29	4
Råda	Mellerud	Mellerud	9 900	140	100	180	15	6
Torslanda	LF	Gothenburg	11 200	180	150	230	19	4,5
Anderstorp	Skellefteå city	Skellefteå	19 100	202	152	320	33	4

Other buildings



Some information about the buildings above
The energy needs given in the table is the direct sum of heating and electricity for building operation. The tenant's use of electricity is included.

Byggnad	Ägare	Plats	Atemp m2	Energy before kWh/m^2,år	Energy after kWh/m^2,år	Cost €
Railway station	Jernhusen	Norrköping	1960	730	450	115
Railway station	Jernhusen	Linköping	2050	203	152	160
Ice-skating, athletics	Lidköping	Lidköping	2100	178	85	470
Swim bath	Ale municipality	Skeppland	2270	450	300	280
Railway station	Jernhusen	Skövde	3330	371	260	190
Hotel	Tomt AB	Trollhättan	3700	175	120	195
Senior living.	Dals-Ed	Hagalid	4615	150	125	1250
Senior living.	Norrbotten	Vittangi	5300	272	229	145
Health care	Blåklinten	Töreboda	5400	282	204	590
Hospital SÖS1365	Locum	Stockholm	7300	611	404	405
Hospital SÖS1316	Locum	Stockholm	7800	146	138	530
Hospital SÖS 1316	Locum	Stockholm	7800	246	194	70
Hospital Sahlgr. 115	Västfastighet	Göteborg	10600	103	82	640
Ecologi University lab	AH	Lund	12000	356	320	110
Hospital St Göran	Locum	Sthlm	15400	160	80	550
Conservatorium Artisten	AH	Göteborg	17700	145	90	420
Hospital NUS 3A	NUS	Umeå	17740	363	298	1300
Hospital	City of Örebro	Lindesberg	33921	190	150	1250