Belok

Period: 2012 - 2014

Evaluation report 2015-03-04 – rev 02, 2015-03-09
## Contents

**PREFACE** 3

**SUMMARY** 4

1 **INTRODUCTION** 2
   1.1 **BELOK** 2
   1.2 **Background** 2
   1.3 **Aim of the evaluation process** 3

2 **EARLIER EVALUATIONS** 4
   2.1 **Evaluation of Belok 2005 Lars J. Nilsson/AID-EE** 4
   2.2 **Evaluation 2007 N.H.Bertelsen** 5
   2.3 **Former results** 5

3 **BELOK TOTAL CONCEPT – BTC** 6
   3.1 **Summary of the BTC** 6
   3.2 **Main benefits with the Belok Total Concept** 8

4 **BELOK TOOLS** 9
   4.1 **Belok LCC, Life Cycle Cost** 9
   4.2 **Belok BV²-arch** 10
   4.3 **Belok – Heat recovery from exhaust air** 10
   4.4 **Belok – Operational Analysis** 11
   4.5 **Belok – Total Tools** 11

5 **ONGOING PROJECTS** 13
   5.1 **Energy efficient commercial kitchens (Energieffektiva storkök)** 13
   5.2 **Technical integration control (Samordnad funktionskontroll)** 13
   5.3 **Methodology for energy calculations (Metodic för energieräkningar)** 14
   5.4 **Smart windows - a practical study (Smarta fönster - en praktisk studie)** 14
   5.5 **Responsibilities for implementation of Total Concept projects (Ansvarsförhållande vid genomförande av Totalprojekt)** 15
   5.6 **Building value increase in efficiency (Bygnaders värdeökning vid energieffektivisering)** 15
   5.7 **Evaporative cooling and free cooling (Tekniskuphandling evaporative kyla (friskyla)** 15
5.8 The Future of control and monitoring for energy management system (Framtidens styr- och övervakning) 16

6 EDUCATION AND INFORMATION 17

7 BELOK - USE IS SPREADING 19

8 EXPERIENCE FROM BTC PROJECTS 21

9 EVALUATION 2012 - 2014 24

10 CONCLUSIONS 28

11 RECOMMENDATIONS FOR FURTHER WORK 30

12 REFERENCES 31

13 APPENDIX Evaluation Goal in Swedish 32
PREFACE

The evaluation work has been done from late 2013 and ended in March 2015.

The evaluation team has consisted of professor Bent A Børresen and associate professor Trond Thorgeir Harsem. Both have their daily work as engineering consultants at Norconsult, Sandvika, Norway

Nesøya, March 4th 2015

Bent A. Børresen Trond Thorgeir Harsem
SUMMARY

The Swedish government has the aim of a 50% energy reduction from 1995 within 2050. One of the keys to success is to use demonstration-projects to dissipate good solutions. The government has now stressed this aspect by focusing energy savings in buildings by using network cooperation through Belok.

The Belok membership concept provides advantages for the government as well as for the Belok members. The Belok strategy is using innovative real estate owners for implementation of improved technology methods. The companies represent about 25% of the heated non-residential buildings and more than 30% of the investments in the commercial building segment. The governmental strategy is to generate a symbiotic effect generating visible and applicable results within short time. One of the effects is based on the fact that the members are chosen from key personal in their respective companies. They are close to decision making.

Looking into the projects covered by Belok in 2012 to 2015, as well as the earlier projects, Belok has a focus of gathering and developing energy saving technics and work methods. The application of the methods are definitely growing and the quality of the methods will effect existing work. This covers systematic quality assurance that is developed in and for the Belok projects.

An important part of the practical equipment implementation and system testing. Belok apparently utilises their new as well as, their refurbished buildings for new energy design and testing. This must have its expense sides, but also positive sides. The governmental support, combined with the fact that the Belok group has a progressive aim, economic strength and willingness make things happen. We believe that an important part of this is due to a progressive strategy chosen by the Government to involve Belok.

An important part of the Belok work covers implementation and development of clear specification. These cover indoor climate, energy consumption specs, building automation specs and also specs that cover new engineering education and positions aimed at efficient and economic low energy running of buildings.

A rather long list of activities, papers and articles addressing their findings, shows that the Belok knowhow dissipation is active. This is in accordance with the governmental requirements. The activities also cover other parts of the Nordic, as well as the Baltic states and India.

Conclusion
The Belok strategy as chosen by the government seems to be an efficient way of implementing new energy efficient technics and design in to the market. The systematic work is impressive, and a significant saving potential is well within sight. We find the Belok way concrete and well documented.

It is expected that the results coming in will be an inspiration in the market, covering engineering design, system implementation and practical knowhow as well as showing quality assuring technics.

Recommendation
Especially Belok Total Concept, BTC, is a success, and we highly recommend that the backing up and the development of BTC by Belok continues.
1 INTRODUCTION

1.1 BELOK

Belok (The Swedish Procurement Group for Commercial Buildings) is a cooperation for active energy saving between 16 dominating Swedish non-residential real estate owners. The Belok group thereby represents about 20% of the non-residential real estate owners. The group is formed by owners with ambitions regarding development of, installation of, and running of energy efficient as well as environmental efficient solutions. The two main Belok goals are as follows:

- To introduce, test and improve new energy saving technologies, solutions, methods and construction process
- To disseminate the results by the group tested and improved technologies, solutions and methods the whole Swedish non-residential building sector

1.2 BACKGROUND

The Swedish government has the aim of a 50% energy reduction from 1995 within 2050. One of the keys to success is to use demonstration-projects to dissipate good solutions. The government has now stressed this aspect by focusing on energy savings in non-residential buildings by using a network cooperation through Belok.

The Belok membership concept provides advantages for the government as well as for the Belok members. The Belok strategy is using innovative real estate owners for implementation of improved technology methods. The companies represent close to 25% of the heated non residential buildings and more than 30% of the investments in that segment. The governmental strategy is to generate a symbiotic effect generating visible and applicable results within a short time. One of the effects is based on the fact that the members are chosen from key personal in their respective companies. They are close to decision makers.

Together the Belok group represent a strong financial, as well as a technical group, with a high potential of activating, and finalizing projects. The general backing from the government seems to make it easier to initiate and drive through large and coordinated projects. Belok has an aspect of ‘All for one and one for all’. In addition the strategy has several aspects for the Belok members. An added advantage for the real-estate owners is the attractive position providing:

- To be in an important decision and strategy centre
- the possibility of having strength and advantage of making things happen
1.3 AIM OF THE EVALUATION PROCESS

The evaluation, as underlined by the given goals is, to play a somewhat active part in the Belok work. The aim of the evaluation is to be based on the main goals of the research program, in short:

1. Adjust and develop methods and technical solutions regarding efficient energy use in Belok buildings
2. The evaluation process is to be regarded as a way of providing steady improvement of the methods used in the Belok projects
3. The evaluation shall show strengths as well as proposed further work
4. Areas of potential for improvement shall be identified

The evaluation covers a limited number of years, 2012 to 2014. It is focusing over-all approaches. The verifications of details are limited.

The aim of the evaluation is presented in Swedish in the Appendix.
2 EARLIER EVALUATIONS

2.1 EVALUATION OF BELOK 2005 LARS J. NILSSON/AID-EE

Nilsson underlines that Belok is working mainly in the market transformation and technology procurement. The primary goal is to bring energy efficient technologies to the market through technology procurements, tests, demonstrations and evaluations. Nilsson then goes into general aspects of monitoring and evaluation. He states that Belok (started in 2001) already by 2004 is poised to have a considerable impact in the longer term. The reason is that it gathers a group of dedicated and competent representatives of companies that own a substantial share of the commercial floor area in Sweden. An overall success factor is that it is user driven.

Nilsson concludes in the following manner:

Belok is working mainly in the areas of market transformation and technology procurement, and is not preliminarily aiming at realising short term savings potentials through various incentives. The primary goal is to bring energy efficient technologies to the market through technology procurements, tests, demonstrations, and increasing prices.

Reasons for the likely success of the technology procurement for an energy management and monitoring system is that a qualified group of individuals could put together a viable specification for a better system, and that there were suppliers that could meet the specifications.

One of the reasons for the almost certain success of the air-diffuser is that Belok provided for a demonstration of the technology, including a careful and independent evaluation that the supplier can refer to when approaching potential buyers.

It is difficult to judge at present whether the air-filter will become a success, but results so far are promising. From the perspective of the inventor, the support from Belok and the access it provides to final users who are willing to test the filter, appears invaluable.

General energy performance specifications that can be used in procurements were successfully developed through pooling the experience and expertise of Belok members. Whether they will be a success in terms of actually being used depends on (a) if they are known by builders, and (b) if builders will increasingly put such demands on contractors.

The way Belok has been set up organisationally as a group, or network, of about 12-15 individuals facilitates efficient cooperation. The way from idea, to project proposal by Belok, to decision by the Belok board is short. This is a factor which is highly valued by the members, as is the possibility to interact with peers, and to share experiences, risks, etc. The immediate feed-back on ideas is noted by members as important.
2.2 EVALUATION 2007 N.H. BERTELSSEN

A main summary has been given for the former evaluation due to the fact that it corresponds to a large extent to our views, still in 2014. It further provides a good platform regarding the development of the project. The 2007 evaluation, as well as this one (2015), has four main parts based on the characteristics of the Belok work and organisation:

1. Belok organisation, members and meetings
2. Development of technologies and product projects
3. Information and dissemination

The 2007 evaluation states that Belok is a success. It refers to the Swedish Energy Agency praise of the strategies of using innovative real estate owners for implementation of improved technology methods. The companies represent close to 20% of the heated buildings and more than 30% of the investments in the commercial building segment. The decision process is short.

The given interviews point out the meeting form: two half day meetings, the member team and their enthusiasm and qualifications.

2.3 FORMER RESULTS

Main summary of results from earlier work:

- Controls/Building control Consequence of different hydronics / pipeline design /control valves
- Design procedures
- Building installations included building sizes/ energy use split in heating/cooling/Electricity/costs
- Installations
- Measurements
- Economic results
- Energy savings
- Indoor climate measurements/enquêtes
- Project / areas that there has be no report
- Knowledge dissemination: Courses/meetings /papers/

Baristia alpine ‘Svarthõ’
3 BELOK TOTAL CONCEPT – BTC

3.1 Summary of the BTC

Considering that the BTC project has been a dominant part of the BELOK activities during the last years, we focus on that to start with.

BTC is a methodology for energy efficiency, based on forming a package of measures that as a whole full-fills the profitability demands of property owner. The package is formed and presented in a prerequisite that all measures implemented with a total internal rate of the specified targets.

BTC has a systematic implementation of energy efficient measures. So when taking energy measures in existing buildings, it is important that this is done so that this can be seen to:

- building quality and usefulness at the same time that there is a reasonable
- balance between savings and the resources invested

Virtually all existing local buildings can with little effort to identify correct many measures that can reduce energy requirements. Any act itself provides some more or less energy to a certain higher or lower cost. If selects and gradually implements only the most profitable measures, it usually question, admittedly profitable, but from energy often limited action. If, instead forming and implementing a package of measures together satisfies the property owner's requirements for investments profitability, the reduction of energy can be significant.

A starting point in designing the overall project methodology has been that the energy savings must be profitable for the property owner.

- BTC provides an opportunity to the economically profitable energy saving measures to access a significant portion of the large energy saving potential of existing local properties.

- What distinguishes BTC from traditional approaches to energy efficiency, is that it takes the decision to implement a package of measures where all the energy saving measures that together meet the real estate company profitability conditions are included. They can then be carried out together at once, which can be advantageous from the viewpoint procurement and enables a clear entrepreneurial responsibility. If this is not possible with regard to tenants or budget, the decision may apply to a binding implementation plan, where the whole package included but the measures are implemented gradually.

- By forming and implementing the package of measures, the most profitable measures to bear with the programs on their own had been unprofitable while the package as a whole will nevertheless be profitable. Overall this reach a significantly larger total savings than if the most profitable measures had been carried out separately, which is the finesse of BTC.

The figure below illustrates how a package can be visualized in an internal rate of return diagram. In such a diagram, with the annual cost on one axis and investment on the other, one can for a
certain amount of time to put lines with the inclusions that apply for different values of interest. Once you have identified a number of energy saving measures and estimated their cost and energy cost savings, you can add them into the chart. The diagram is thus represented each measure of a line with a certain length and slope. The greater the slope is more profitable operation. In the diagram in Figure under, the most profitable action added to the far left of the graph. Subsequently, measures been put in descending order of profitability. At the end point of the least profitable action (Action 6 in the figure) can be read by the whole package of measures for overall profitability.

**Figure 2.1 Internal rate of return diagram**

The package in the internal rate of return diagram. The diagram shows the actual yield, which the investment gives. By combining measures in one package, where the most profitable parts contribute to the parts on their own had been unprofitable, the energy savings can be increased up to 50%

This way of working, where the “package” of measures is carried out instead of just making the first very profitable measures, provides the major benefit in terms of achieving much more energy savings within the profitability requirements of the real estate owner. The most profitable measures make up for the investments that, on their own, would have been unprofitable at the same time as the action package, as a whole, is still profitable. In this way, a considerably larger saving can be made than by allowing the most profitable measures to be carried out independently. This together with the systematic approach is the essence of the Total Concept method.

In the example shown in Fig.2.1, the profitability requirements are that the internal rate of return is to be at least 5%. The complete action package (M1 – M7) meets this demand with an internal rate of return of 7% and leads to a halving of the annual energy costs, which approximately corresponds to a halving of the use of energy. If only the measures that were profitable on their own were carried out (M1 – M4), then the savings would have been only 30%. The complete action package is profitable as the most profitable measures make up for the other measures. It would be disadvantageous to first carry out the most profitable measures and postpone the others to a later date. In that case, the measures that were not profitable on their own, but important from an energy
point of view, would most probably never be carried out. This is because there would no longer be any profitable measures to make up for the unprofitable measures.

It must be strongly stressed that the requirements to attain this considerable saving at such a reasonable cost are that the action package is drawn up and sooner or later carried out as an undividable whole.

3.2 Main benefits with the Belok Total Concept

One of the basic starting-point when developing the BTC method was that the energy savings were to be profitable for the property owner/client. The following applies for the Total Concept method:

- The Total Concept method provides an opportunity to access an essential part of the great energy savings potential in existing buildings by carrying out energy saving measures in a commercially profitable way.

- The Total Concept method differs from traditional methods for improving energy efficiency that a package of measure is formed and all the energy saving measures are carried out in their entirety and that they together meet the property company’s/client’s profitability requirements.

- The most profitable measures make up for the investments that, on their own, would have been unprofitable at the same time as the action package, as a whole, is still profitable. In this way, a considerably larger saving can be made than by allowing the most profitable measures to be carried out independently.

As we see, expressed in simple words, the ‘BTC is ‘a Robin Hood’ method’, giving rate ability from the most profitable measures to the less profitable measures so that the total still has the required internal rate of return. This way of thinking increases the energy savings with up to 50%.
4 BELOK TOOLS

4.1 Belok LCC, Life Cycle Cost

With the help of the LCC, Life Cycle Cost, one can compare the cost of competing systems or equipment throughout their lifetime, the so-called life cycle cost. Belok LCC is therefore an appropriate tool to use before making investment decisions. In order to make the calculations more manageable, excludes program expense items that are not deemed to affect the comparison.

Belok LCC is designed for the following types of investments:

- General calculation
- Pumps
- Fans
- Rear
- Lighting systems
- Window

Figure 4-1 – Web-based Belok -LCC
Belok LCC is web-based and free to use, but at the users own risk.

4.2 Belok BV²-arch

Energy Estimation in the early stages of the construction process

Belok BV²-arch intends to use in the problem of weighting the energy aspects in the early stages of the construction process. Using the tool it is possible that at a very early stage of the construction process rough able to compare different architectural proposals also from an energy perspective.

Belok BV²-arch is developed from the energy calculation program BV² and are further developed to architectural level with use of minimal technical input.

Belok BV²-arch is web-based and free to use, but at the users own risk.

4.3 Belok – Heat recovery from exhaust air

Heat recovery Belok shows how:

- The outdoor temperature $t_u$
- Heat recovery temperature efficiency $\eta_T$
- Return air temperature $t_F$
- The selected supply air temperature $t_T$
- Operating times

the annual heat demand for heating the incoming air, the electricity needs for the operation of the fans and the annual cost of heating and electricity.

Belok heat recovery can be used:

- CAV system with constant air flow
- VAV systems with demand control ventilation

It is possible to choose between four outdoor climate: Lulea, Stockholm, Gothenburg and Lund.
4.4 Belok – Operational Analysis

Belok Operational Analysis helps owner of hosting energy efficient.

Tuned technology systems, powered energy efficient, the key to an energy efficient building. To succeed you need to be able to follow the operation with the help of intensive trend logging - and use software to analyse the information.

Together with the company member of Belok, Belok have developed the Operational Analysis software in collaboration with ÅF Infrastructure. With Belok Operational Analysis property owner can evaluate e.g. HVAC system control functions, save energy thieves and overall analyse how the system works in detail. It is a platform to identify opportunities for improvement.

The software, formerly known as PIA, has been used for ten years in different versions. The new Belok Operational Analysis finds the user the good old ideas of WIP, but in robust, user-friendly and modern software. The user interface is clean and clear, installation is simple and the software is license-free and suitable for ordinary Windows PC. In addition to knowledge of the property analysis requires no computer skills in addition to the Windows habit.

4.5 Belok – Total Tools

Software Total Tools is a central part of Beloks Overall Methodology and used at the end of Stage 1. All identified, energy calculated and priced actions is compiled. With Total Tool expected since the front which of those measures contained within the package of measures based on the profitability requirements (IRR) that the organization has decided.

Overall tool shows the IRR of a diagram with axes Investment and Annual cost savings.

When the internal rate curve is produced, check that the order of operations in the diagram corresponds to the order in which the adoption of the measures when energy savings are calculated. It is therefore required that you work with Total utility and energy calculation program in parallel.

This program which is the heart of the whole Belok is described in Chapter 6.
Comments

A possible way of improving a tool set is, in our opinion, to use and generate a one-page standard set-up of the main inputs as well as the main outputs. The layout should then be given a best possible standard layout, so that the main results are clearly shown and easy to find.

We look upon the strategy of having a dedicated, general tool set as very useful and educational. It is, however, reasonable that priority has been given to streamlining the BTC method, the measurements and the system simulations.

The evaluators opinion:  *The BELOK tools are important and make the whole concept complete.*
5 ONGOING PROJECTS

This chapter covers some on-going Belok projects. To our opinion, their choice of projects clearly show that Belok has its focus on both overall strategies (for instance Technical integration control, Building automation, and Simulations) and on details around specialities (for instance Commercial kitchens or Checking how, if and when energy calculations fail or succeed). Some of the projects are shown here to illustrate this.

The evaluators opinion: These projects are exciting and will be able to give good advice to consultants, suppliers and clients.

5.1 Energy efficient commercial kitchens (Energieffektiva storkök)

There is a significant potential for energy efficiency in existing and newly built commercial kitchens by known techniques. Unfortunately, this potential is overseen when commercial kitchens are being built or rebuilt. The principal reason is negligence by consultants, suppliers or owners. There is an obvious need for clear requirements and specifications for energy-efficient design.

Today's technology needs to be smarter, and possibly, in modified form. This must be based on a better understanding of how the kitchen staff can operate in an energy-efficient manner. In order to increase the share of energy efficient commercial kitchens there is a need to demonstrate technologies in products and systems and in developing specifications and guidance notes.

Already in the existing stock of commercial kitchens has the potential of improving energy efficiency by at least 30%. This has been reported in various reports and documents. By implementing new design an energy saving of at least 50% is possible to reach. I.e. based on utilizing today's best technology and activating the staff involvement.

The project "Energy efficient commercial kitchens" aims at clarifying and demonstrating how to best use available technology and knowledge. The final dissemination of knowhow is stressed.

The evaluators opinion: The project is expected to provide important input for energy savings in kitchens.

5.2 Technical integration control (Samordnad funktionskontroll)

A significant economic potential for building energy savings is often found in the technical installations. To achieve the expected savings for these installations, it is important that the installations work as intended. It has too often been found that main control systems and ventilation systems have rather large functional deficiencies regarding energy use. The deficiencies are discovered after commissioning - or they are not discovered at all. Both cases mean that cost savings are not realized for quite some time.
In Total projects, carried out both within and outside Belok, a function check always should be included. The aim of the project “Technical integration control” is to develop a practical methodology for coordinated control verification in a Total project.

Functional testing must be carried out at a reasonable cost and still provide a good picture of whether the control functions are acceptable. Assessments of the performance will be performed by analysing the control and monitoring systems, including some measurements. A methodology adapted to the overall methodology is therefore currently being developed. Recommendation of a function check is added to the overall methodology as well as suggestions on how to implement the project.

The evaluators opinion: The project is exciting and should be able to give good advice to consultants, suppliers and clients.

5.3 Methodology for energy calculations (Metod för energieräkningar)

Belok has for some time observed that the real energy demand in new buildings, especially in buildings planned for low energy consumption can be significantly higher than the calculated. Belok has started a project to identify the reasons for the discrepancy between calculated and measured results.

Several activities have been initiated to increase accuracy in calculations. In many projects the results correspond relatively good. However, there are other buildings with too many shortcomings. The project “Methodology for energy calculations” aims at clarifying the conditions for the development of a methodology that ensures the energy calculations / simulations methodology is consistent with the actual energy obtained in the finished building. As substrates will be used experiences in building local real estate over the past few years.

The evaluators opinion: The project is exciting and will be able to give good advice to consultants, suppliers and clients.

5.4 Smart windows - a practical study (Smarta fönster - en praktisk studie)

The development of intelligent window is advancing rapidly. Even today there are commercial products available on the market. This type of window that can be controlled to limit solar radiation, should (at least eventually) be seen as an alternative to traditional solar shading for windows. Belok is currently carrying out a practical study on site at one of the Belok members.

Today there are few, if any, studies of intelligent window, where you have installed the windows of a building in actual operation. In order to make a direct comparison with traditional solar shading has Belok decided to conduct such a study. This is done by one of the member companies of Belok. In the test rooms there are both an opportunity for the installation of smart windows and there are also rooms with traditional solar shading. In addition to this there are ordinary rooms in which you may also make personal experiences.

The evaluators opinion: The project is exciting and will be able to give good advice to consultants, suppliers and clients.
5.5 Responsibilities for implementation of Total Concept projects (Ansvarsförhållande vid genomförande av Totalprojekt)

In existing buildings there are large energy saving potentials in technical installations. Experiences from the Total project conducted by Belok members show that even when measures are implemented in a satisfactory manner, the calculated energy targets and savings are not always achieved.

When adapting various applications to other projects there is a risk that all measures are not implemented and this is not detected. Thus, a large part of the energy savings might be lost. To avoid this, it is required that contractors in the Total Projects must have a clearer functional responsibility. This applies mainly to the technical installation phase, where the main saving potential lies.

This project therefore aims at developing procurement and contract basis with explicit functional responsibility primarily for entrepreneurs in the Total Project.

The evaluators opinion: The project is important in a phase where new concepts are to be implemented.

5.6 Building value increase in efficiency (Bygnaders värdeökning vid energieffektivisering)

The energy consumption of a building constitutes a significant part of the total operating costs. Develop a documentation of the relationship between energy consumption and value of the building is important, interesting and would provide a greater incentive to implement energy conservation.

Total Project has proven to be a successful way to become energy efficient buildings. A number of member companies within Belok embraced the methodology in various policy documents. So far, the methodology included the monetary savings exclusively linked to the energy saved. Completed and evaluated projects show energy savings of around 50% with a return on investment greater than 10%.

Belok has started a project that investigates whether additional value attributable to investments than those associated with saved kWh. Such a value may be an increased value of the entire building where the package has been implemented.

The evaluators opinion: The project is exciting and will be able to give good advice to consultants, suppliers and clients.

5.7 Evaporative cooling and free cooling (Teknikkuphandling evaporative kyla (friskyla))

The need for electricity for the operation of chillers for office buildings is normally in the range of 10-30 kWhel / (m² year). This represents approximately 10 - 30% of the total electricity consumption for the office building category. One of several ways to improve energy efficiency in comfort cooling system is to exploit opportunities for free cooling and evaporative cooling.

This way of evaporative cooling is a way to cool different waterborne system without use of a chiller.

The evaluators opinion: The project is exciting and will be able to give good advice to consultants, suppliers and clients. It is important to be aware of the Legionella growth.
5.8 The Future of control and monitoring for energy management system (Framtidens styr- och övervakning)

The Future of control and monitoring is the next step to further development of energy management systems.

Under the Belok web-side menu "Requirement" specifications are currently a requirement specification for the control and monitoring system. It focuses on features that increase usability and conditions for energy efficient operation.

The evaluators opinion: There is a general need for developing of better energy management system. We look forward to see the specification of a new system. The project is exciting and will be able to give good advice to consultant, suppliers and clients.
6 EDUCATION AND INFORMATION

Seminars / Presentations and courses

Looking at the last year as a characterisation of the on-going and growing work done to spread the Belok results and knowhow, these activities are clearly prioritised. The table covers the activities done by the Belok coordinator as well as the Belok president. In addition there are four meetings with the whole Belok group and another four meetings with the Belok board, each year.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cases</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Energiutblick</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>EMT Seminarium</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Totalprojektkurs i Tartu</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Totalprojektkurs Tallinn</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Norrporten</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>E-mynd nätverk</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Nordbygg</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Totalprojektutb Umeå</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>BeLivs</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Landsting+kommun Blekinge and more</td>
<td>70</td>
</tr>
<tr>
<td>2013</td>
<td>SIS</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Indien</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>E.mynd nätverksmöte</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Nordic Built</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Sweco</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>WSP</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>SGBC konferens</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Indien_2</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Umeå fast.företag</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Totalprojektutb</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Luleå NeNet</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Samhällsbyggargruppen and more</td>
<td>10</td>
</tr>
<tr>
<td>Year</td>
<td>Cases</td>
<td>Participants</td>
</tr>
<tr>
<td>------</td>
<td>------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>2014</td>
<td>Beställargrupp belysning</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Fastighetsägarna</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>energiutmaningen</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Förvaltare i Väst</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Svensk energi</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>EU workshop</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Totalutlysning</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Luleå NeNet</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>EU Köpenhamn</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Totalprojekt Tallinn</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and more</td>
<td></td>
</tr>
</tbody>
</table>
7 BELOK - USE IS SPREADING

An important part of the project is to show that the Belok approach performs in the energy saving market. An indication will be by how wide spread the use of the method is.

There is a steady growing interest in using the Belok home pages. This is a clear indication of growing interest of utilising the Belok results, see the statistics figure below.

Besöksstatistik för www.belok.se 2014

At the end of 2012 the BTC had been used in about 100 projects (reference Per-Erik Nilsson). Mona Norback/CIT has made a report (Dec. 2014) in Swedish on ‘The BTC spreading’. A questionnaire has been the main information basis of the use. The BTC method has been applied in additional 171 rentable building evaluations in addition to 80 – 90 other projects. The main use has been around Stockholm. The Gothenburg areas have a total of 75 buildings been analysed by owners outside the Belok member group. The mayor part of buildings are schools and office.
These dominate compared to the third large group which are ward localities. There are different buildings characterized by different owners:

- Municipalities normally plan activities focusing schools
- Counties focus on hospitals and ward buildings
- Private owners focus on office buildings
- Outside these, there are railway stations and museums.

The important active campaigning to achieve more buildings, named the “Total-campaign” has resulted in 30 buildings owned by non-members of Belok.

As a total this gives an impressive of about 260 buildings given the BTC-analyses. It can be concluded that a high number of building owners are using the BTC, and the numbers are steadily increasing.
EXPERIENCE FROM BTC PROJECTS

Within the Belok group an extensive evaluation of performed Total Concept projects are continuously ongoing. So far, comprehensive action packages of energy efficiency measures have been drawn up for 18 properties. In a number of these, the packages are still being implemented. In others, the packages have been carried out and energy use is now being followed up. Three projects have been carried out to completion, including measurements of energy use for a whole year after handover. It has taken 3 to 5 years to carry out these initial projects, among other things because of the requirement to carry out the follow-up energy measurements for a whole year.

The results from the demonstration buildings in Sweden indicate that with the Total Concept method, it seems to be possible to obtain a cost efficient decrease of energy end-use by 40-70%, which in some cases is improvement down to nearly zero-energy buildings and in some cases are a large step towards nearly zero-energy buildings. For example in the first Total Concept project that has been completed the energy use was cut from 180 kWh/m² per year to 80 kWh/m² per year and the energy costs for the more than 8000 m² building were reduced by 58 000 € per year. The follow-up work that was carried out during the first year after handover confirmed that the action package had been profitable, providing an internal rate of return of around 13%. Furthermore, the main benefit according to the technical departments in the real estate companies is that with the Total Concept method they got means making it possible to convince the economical department and the top management in the company to take the decisions of larger investments and improve the company’s ambitions to strive towards nearly zero-energy buildings.

In Figure 8-1 are given some results from a sample of office buildings forming a part of a Total Concept implementation programme arranged by the Belok group. The programme also includes schools, hospitals, university buildings, etc. The basis for the 10 projects in the figure is accounted for in Table 1.

![Figure 8-1](image-url)

*Figure 8-1 Energy savings and obtained internal interest rates for a number office buildings from the BELOK Total Concept Programme implementation programme.*
The buildings shown are in different stages of realization. The three marked red, have been finished and 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 in Step 1.

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

**Table 8-1** The office buildings shown in Figure 8-1

<table>
<thead>
<tr>
<th>Building</th>
<th>Owner</th>
<th>Locality</th>
<th>Floor area m²</th>
<th>Energy before kWh/(m²·year)</th>
<th>Energy after kWh/(m²·year)</th>
<th>Cost k€</th>
</tr>
</thead>
<tbody>
<tr>
<td>Municipality centre</td>
<td>Storfors</td>
<td>Storfors</td>
<td>3 650</td>
<td>262</td>
<td>109</td>
<td>28</td>
</tr>
<tr>
<td>Garrison administration</td>
<td>FORTV</td>
<td>Gothenburg</td>
<td>5 700</td>
<td>102</td>
<td>65</td>
<td>120</td>
</tr>
<tr>
<td>Municipal administration</td>
<td>Stenungssund</td>
<td>Stenungssund</td>
<td>8 140</td>
<td>144</td>
<td>79</td>
<td>500</td>
</tr>
<tr>
<td>Offices “Getholmen”</td>
<td>Brostad AB</td>
<td>Stockholm</td>
<td>8 500</td>
<td>162</td>
<td>80</td>
<td>400</td>
</tr>
<tr>
<td>Offices “Altona”</td>
<td>Stena AB</td>
<td>Malmö</td>
<td>9 500</td>
<td>196</td>
<td>94</td>
<td>540</td>
</tr>
<tr>
<td>Offices “Stampen”</td>
<td>Stena AB</td>
<td>Gothenburg</td>
<td>9 680</td>
<td>172</td>
<td>119</td>
<td>96</td>
</tr>
<tr>
<td>Offices “Glaven”</td>
<td>LOCUM</td>
<td>Stockholm</td>
<td>10 300</td>
<td>220</td>
<td>100</td>
<td>500</td>
</tr>
<tr>
<td>Offices “Pennfåktaren”</td>
<td>Vasakronan AB</td>
<td>Stockholm</td>
<td>12 600</td>
<td>287</td>
<td>120</td>
<td>690</td>
</tr>
<tr>
<td>Offices “Hägern”</td>
<td>Fabege AB</td>
<td>Stockholm</td>
<td>19 100</td>
<td>186</td>
<td>85</td>
<td>840</td>
</tr>
<tr>
<td>Administration “Johannes”</td>
<td>SFV</td>
<td>Stockholm</td>
<td>21 000</td>
<td>166</td>
<td>133</td>
<td>680</td>
</tr>
</tbody>
</table>

Based on reference projects in Sweden the investments needed for carrying through a package of measures enabling 40 - 70 % decrease in energy use, are relatively high. As an example, for a 10 000 square meter non residential building, built about 1990 an investment about 500 000 to 900 000 € may be needed. A prerequisite for a decision by the building owner to carry through such an investment is that the estimated costs and energy savings are reliable. The Total Concept method requires, as does any energy project, a systematic approach and professional execution. For attaining the desired results it is essential that careful consideration and implementation is given to all of the working moments needed and that the roles and responsibilities of different actors are well defined.

So far, Swedish experiences show that the investment for carrying out a Total Concept refurbishment project will be roughly between 55 and 90 € per square metre in order to halve the building’s energy use, see Table 8-2. This includes detail analysis of the building for identifying energy saving measures, calculating the investment costs and energy savings as well as forming an action package, design work and implementation of this action package and carrying out final functional performance checks.

**Table 8-2** Investment costs in completed Total Concept projects.

<table>
<thead>
<tr>
<th>Cost item</th>
<th>Cost in €/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrying out energy audit and identifying energy saving measures</td>
<td>3 – 4</td>
</tr>
<tr>
<td>Investment cost calculations</td>
<td></td>
</tr>
<tr>
<td>Energy simulations and feasibility calculations for an action package</td>
<td>3 – 4</td>
</tr>
<tr>
<td>Design work</td>
<td>2 – 3</td>
</tr>
<tr>
<td>Carrying out the action package</td>
<td>40 – 80</td>
</tr>
<tr>
<td>Final inspection, functional performance checks</td>
<td>2 – 3</td>
</tr>
<tr>
<td><strong>Total (excluding VAT)</strong></td>
<td>47 – 90</td>
</tr>
<tr>
<td>Annual savings €/(m²·year)</td>
<td>7 – 11</td>
</tr>
</tbody>
</table>
Typical total costs for refurbishing a building to meet a 50% energy savings:

- Analysis, design, investment and documentation: 50 to 100 €/m²
- The cost savings are approximately: 10 €/m²/year
- The energy savings are approximately: 100 kWh/m²/year
- Cost per energy unit: 0.10 €/kWh/year
EVALUATION 2012 - 2014

Belok is initiated and supported by the Swedish Energy Agency and developed and operated with high competence by professor Enno Abel and associate professor Per-Erik Nilsson, CEO, CIT Energy Management. Belok is a network between the Swedish Energy Agency (Statens energimyndighet) and 19 dominating Swedish non-residential real estate owners who in total manage about 25 per cent of the Swedish non-residential building stock (about 35 million square meters).

The evaluation of Belok has, to start with, focused on the BTC project, considering it is the dominating part of the activities the last years. It covers details of the BTC, and an analysis of the experiences so far. The analysis is based on a total of 22 projects.

The initial development of the Total Concept has been carried out within the Belok group. The initial project to apply and develop the Total Concept was started up in five office buildings six years ago by BELOK. It has now extended to a number of other types of non-residential buildings, i.e., school buildings, hospitals, museums. In addition, a number of municipalities have begun, or intend, to test it:

1. The total project involves an implementation of several energy saving measures in one package.
2. The Total Project is based on a thorough energy-technical survey of the building, where every possible way to reduce energy consumption is documented. The various measures are ranked according to the property owner's profitability requirements and the package is then carried out in a common project.
3. With the Belok's model you put together all the measures. This will include some measures which might on their own might not have been profitable. However, in a Total project they become profitable - along with other measures.

With the cost model, Belok Total Tools on www.belok.se, property owners themselves will be able to find what interest rate they get back on invested capital. I.e. users see how much energy is money wised saved (in SEK/EUR) and the necessary investment.

1. The results indicate that the Total project often halves the consumption of electricity and thermal heat.
2. The method can be divided into 3 steps:
   - Building analysis. Listing of possible activities to be analysed for the building project and setting up the investments and finding and ranking payback (internal rent ability) for each of the activities
   - All activities which coincide with the profitability criteria is designed and installed
Follow-up – After the building has come to normal activity, the energy use is measured and the profitability is calculated.

The method is based on generating a multiple of activities that are set together so that the different activities are lined up according to decreasing profitability. Then all the activities within the package, that gives the desired profitability. The activities that have a high profitability then provide in reality a financing of the less rentable parts. The profitability is chosen by the estate owner, and seems to typically lie around 7% and up to 20%.

An average of this strategy generates an activity list where the savings are increased significantly, i.e. three times. For the ten analysed projects, the potential savings using the BTC method would have activated a doubling of the energy savings.

Based on the projects analysed and results measured by the Belok group the average savings were 116 kWh/(m² year), which correspond to 53% energy reduction.

Several of the owners were interviewed. They agreed that part of the economy is based on the fact that several activities were installed at the same time. This reduces design costs, building costs and reduces the disturbances generated when the work is done parallel with normal activities in the building.

An estimate of the savings potential has been done by the Belok group (based on the so called HEFTIG 2.0 model/Per-Erik Nilsson/2014). The potential is based on installation of all relevant rentable measures found by the BTC method. The savings are calculated to be 2 650 GWh/year in 2030. If the strategy is changed from the BTC method to the individual evaluation of activity-by-activity, the savings per year by 2030 will be reduced to about 1/3rd, i.e. 800 GWh.

Per 2014 only three buildings have gone through all three steps of the BTC. There are several owners who have gone through the first step of BTC and set up a package of rentable measures.

The use of the building is shown to limit some of the measures, even if they are rentable. To improve the method, step one should include an evaluation of the possibility of installing the different measures. This will make the recommendations more reliable.

BTC is the Belok jewel in the energy saving approach. It brings forward a unique and condensed presentation, summarizing and pointing out the direction to choose amongst the numerous measures.

To make a new method work one has to gather a momentum, so that the participants join and walk in the same direction. In the introductory phase the detailed method will only to a small degree allow short-cuts.

Quality assurance has been an important part in the BTC strategy.

The Belok coordinators are therefore required to follow procedures covering how to perform simulations, analysis, and how to document and decimate the results.

The project consists of the following main activities:

- Systemisation of the work tools
- Organisation of the group and working process
- Establishing how to work - the method
- Spreading the total project outside the Belok members
The strategy, in our view, has been a strategy of building a strong powerful member group, deciding how to work and stick to it, when implementing new energy saving measures in a professional way.

The BTC concept consists of utilizing available knowhow and new systems as well as components.

The BELOK group activity covers the following parts:

**Keys**

It is impressive how the BTC has taken into account what we see as the following 5 keys to generate an important and effective project:

- **IDEAS**
  The key ideas – The ‘Robin Hood Method’ – giving rent ability from the most profitable measures to the less profitable measures so that the total still has the required internal rate of return. This way of thinking nearly doubles the energy savings.

- **PEOPLE**
  Choosing the right people and companies to do it
  Convince them that it has benefits for the nation and for them (Sell the ideas)
  What's in it for me?
  - Participants feel that they receive and give experience
  - Interesting meetings
  - Participation in important decisions

- **GOVERNMENT**
  Activating the governmental potential

- **PROFESSIONALISM**
  Documenting the knowhow.
  Ensuring a qualified follow-up
  Ensuring continuity

- **THE PRACTICAL APPROACH**
  The size
  The financing
  The ‘QA’ Quality Assurance
  The follow-up and documentation

The BELOK group - meetings

The group size, the people, the ambitions:

- The strength
- The position sitting close to the R&D world
- The meetings
- The activities:

Setting a goal and activating both the governmental support, as well as company support covering:

- finances,
The way of working:

- i.e. building knowhow
- documenting

Generating qualifications:

- Spreading the knowhow
- Setting QA, quality assurance plans
- Generating qualifications

The BELOK Tools

The simulations tools are important and makes the whole concept complete.

The PRE - and post-analysis

A good strategy is to gather the focus by providing a tool-box with useful approaches or ways of simulation, calculating or measuring. The total method does this elegantly by using their handbook and filling it with a high number of useful examples.

Another way of streamlining the work is to work on unifying the inputs as well as the outputs and the way they are located in the systems saving reporting.

The toolbox is per date filled with the useful programs LCC, BV2 Arch; Heat recovery, heat measurements and air supply units

- Systemisation of the work tools
- Organisation of the group and working process
- Establishing how to work - the method

The BELOK specifications

BELOK provides also a set of necessary specification. The existing specifications cover:

- In-door climate
- Energy use
- Service and maintenance
- Air supply units
- Building automation systems (BAS).

They also introduce a qualification set-up which underlines the importance of service and maintenance personnel, as well a new position "energy technical operation person".
10 CONCLUSIONS

We conclude that the whole Belok concept is a success.

Looking into the projects covered by Belok in 2012 to 2015, as well as the earlier projects, Belok has a focus of gathering and developing energy saving technics and work methods. The application of the methods is definitely growing and the quality of the methods will effect existing work. This covers systematic quality assurance that is developed in and for the Belok projects.

An important part of the practical equipment is implementation and system testing. Belok apparently utilises the new as well as, the refurbished buildings of the member companies for new energy design and testing. This must have its expense sides, but also positive sides. The governmental support, combined with the fact that the Belok group has a progressive aim, economic strength and willingness, make things happen. We believe that an important part of this is due to a progressive strategy chosen by the Government to initiating Belok.

An important part of the Belok work covers implementation and development of clear specifications. These cover indoor climate, energy consumption specs, building automation specs and also specs that cover new engineering education and positions aimed at efficient and economic low energy running of buildings.

A rather long list of activities, papers and articles addressing their findings, shows that the Belok knowhow dissipation is active. This is in accordance with the governmental requirements. The activities also covers other parts of Nordic countries, as well as the Baltic states and India.

The Belok strategy as chosen by the government seem to be an efficient way of implementing new energy efficient technics and design into the market. The systematic work is impressive, and a significant saving potential is well within sight. We find the Belok way concrete and well documented.

It is expected that the results coming in will be an inspiration in the market, covering engineering design, system implementation and practical knowhow as well as showing quality assuring technics.

The Swedish experiences show that the investment for carrying out a Total Concept refurbishment project lie roughly between 50 and 100 € per square metre in order to reduce the building’s energy use by 50%. The typical total costs for refurbishing a building to meet a 50% energy savings:

- Analysis, design, investment and documentation 50 to 100 €/m².
- The cost savings lie around 10 €/(m² year)
- The energy savings lie around 100 kWh/(m² year)
Belok BTC is a success, and we highly recommend it to be continued:

- BTC is in an important part of the work where results after many years of making the energy saving strategies have been developed.
- Several buildings are entering the BTC Stage three, and documented results will be available within few years.
- Several building projects are in the Stage one.

The indications given by the documentation of the activities document that the results are well within the expectations.

We see it as essential that efforts continue in the same lines and spirit as before. Our summary of suggested points that to prioritize:

1. Outside activities
   a. Increase the extent of BELOK and its activities with focus on actors outside the present group
2. Continuous general competences build up
3. Education: Initiate Education programs, i.e.,
   a. approved education of operation staff as Belok certification
   b. Training of lecturers
   c. Develop lecture materials
4. Further development of building energy management system requirements, no proprietary system – open bus communication
5. Belok standard and procedures
   a. Further development of requirements for general application in new and renovation buildings as a Belok standard
   b. Development of BTC for new buildings
   c. Development of the building process for permanent high energy efficiency

Eriophorum scheuzeri ‘Polarull’
11 RECOMMENDATIONS FOR FURTHER WORK

Belok is doing a very important work. We see it as essential that efforts continue in the same spirit as before. We recommend the following points to be prioritized for further work:

- Increase the extent of Belok and its activities with focus on actors outside the present group
- Further development of requirements for general application in new and renovation buildings as a Belok standard
- Initiate Education programs, i.e.,
  - approved education of operation staff as Belok certification
  - Training of lecturers
  - Develop lecture materials
- Continuous general competences build up
- Further development of building energy management system requirements, no proprietary system – open bus communication
- Development of BTC for new buildings
- Development of the building process for permanent high energy efficiency

SAXIFRAGA STELLARIS ‘Stjärnbräcka’
REFERENCES

www.Belok.se

N.H. Bertelsen / Danish Building Research Institute / 2008 ‘Evaluation of Belok 2007’
Nilsson et al. / CIT / PROFU / WSP / 2012 ‘Heftig. Future energy savings evaluated’ (in Swedish)
Per-Erik Nilsson / CIT / 2012 Belok Annual Report
Per-Erik Nilsson / CIT / 2013 Belok Annual Report
Per-Erik Nilsson / CIT / 2014 Belok Annual Report
Mona Norback / CIT / 2014 ‘The BTC Spreading’
Enno Abel / CIT / 2014 Preliminary summaries from BTC projects
Enno Abel / CIT / 2012-2015 Discussions and private communications
Per-Erik Nilsson / CIT / 2012 – 2015 Discussions and private communications
Annelie Helmersdottir Eriksson / Sweco / 2014 Private communications
13 APPENDIX Evaluation Goal in Swedish

Uppdraget

Byggherrarna Sverige AB, nedan benämnd Beställaren, uppdrar åt professor Bent Børresen, Oslo, nedan benämnd Utredaren, att utvärdera nätverket BELOK:s verksamhet.

Bakgrund

BELOK (Beställargruppen Lokaler) är ett samarbete mellan Energimyndigheten och lokalfastighetsägare i Sverige. BELOK, som startades 2001, driver utvecklingsprojekt med inriktning på energieffektivitet och miljöfrågor. För närvarande är 16 stora fastighetsföretag medlemmar i BELOK. Tillsammans representerar företagen drygt 20% av Sveriges lokalbyggnader. Under innevarande tre åriga programperiod (2012-2014) har BELOK en budget på ca 70 MSEK, där Energimyndigheten svarar för 28 MSEK och medlemsföretagen för resten, ca 40 MSEK.

BELOK skall fänga upp och utveckla energisparande tekniker och arbetsmetoder, som inte skulle komma till bredd tillämpning om inte någon tog risken och kostnaden för att tillämpa, prova och utveckla dem i verklig drift. BELOK företagen gör detta inom sitt fortlöpande nybyggnad och ombyggnad. BELOK grupper har också utformat inneklimatkrav, energikrav, krav på byggnadsautomation mm, som tillämpas i företagens upphandlingar. Genom att BELOK representerar en starkt dominerande beställargrupp har detta lett till att konsulter och leverantörer anpassat sitt arbete och sina produkter.

Allt som kommer fram genom BELOK:s verksamhet skall vara fritt tillgängligt. En grundläggande strävan är att BELOK:s verksamhet skall leda till en energibesparing i lokaler i stor skala.

Spridning av resultat och arbete för att få dessa brett tillämpade är därmed en viktig del av verksamheten.

Utgångspunkter för utvärdering

Utvärderingen skall ha utgångspunkt i programmets övergripande mål som är att genom tillämpning och utveckling av metoder och tekniska lösningar för energieffektivisering i BELOK:s fastighetsbestånd få till stånd energieffektivisering i hela lokalfastighetsområdet.

Utvärderingen skall ses som ett led i att ständigt förbättra och utveckla det sätt på vilket BELOK arbetar och drive. Övergripande skall utvärderingen belysa såväl styrkor hos BELOK, som områden där förbättringspotential identifieras.