The Total Concept method

Analyses of technical results and non-technical aspects of the national demonstration projects

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Written by:	Alireza Afshari, Niels C. Bergsjø (SBi/AAU) Mari-Liis Maripuu, Åsa Wahlström (CIT Energy Management AB), Graves K. Simonsen (Danish Association of Construction Clients), Tytti Bruce (Bionova)
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Project webpage: www.nordictotalconcept.info

For more information please contact:
Åsa Wahlström, asa.wahlstrom@cit.chalmers.se
Mari-Liis Maripuu, mari-liis.maripuu@cit.chalmers.se

SUMMARY

The Total Concept is a method for improving energy performance in existing non-residential buildings and applies a refined systematic approach to work with energy issues in the building with the aim to achieve maximum savings in a cost-efficient way.

Demonstration projects have been carried out in Sweden, Finland and Denmark in order to test and develop business strategies for the Total Concept method with the aim to increase the use of the method. The demonstrations include all three steps in the Total Concept method and the whole process has been studied and involved actors have been interviewed. The outcomes of the national demonstration studies are summarized in this report in two parts:

- **Technical part** describing the technical outcomes from each step of the Total Concept method, including details about the proposed action package, calculated savings and profitability, final action package carried out and savings and profitability achieved.
- **Non-technical part** describing the practical work process of the Total Concept method implementation in the demonstration buildings, including involvement of the different key actors, their needed knowledge, coordination of activities, lessons learned from the project execution and reflections of how this can be performed in larger scale.

The results show that the Total Concept method provides new business opportunities for a number of external key actors involved in a renovation project. One important key actor needed for the Total Concept method implementation is the role of a Total Concept Manager, who supports the building owner in the decision-making process regarding technical issues of the renovation process, coordinates the work between different actors and the follow up of the results in order to make sure that the expected energy and cost savings are achieved. This role could be internal or external. The report presents a number of lessons learned during the performance of the demonstration buildings.

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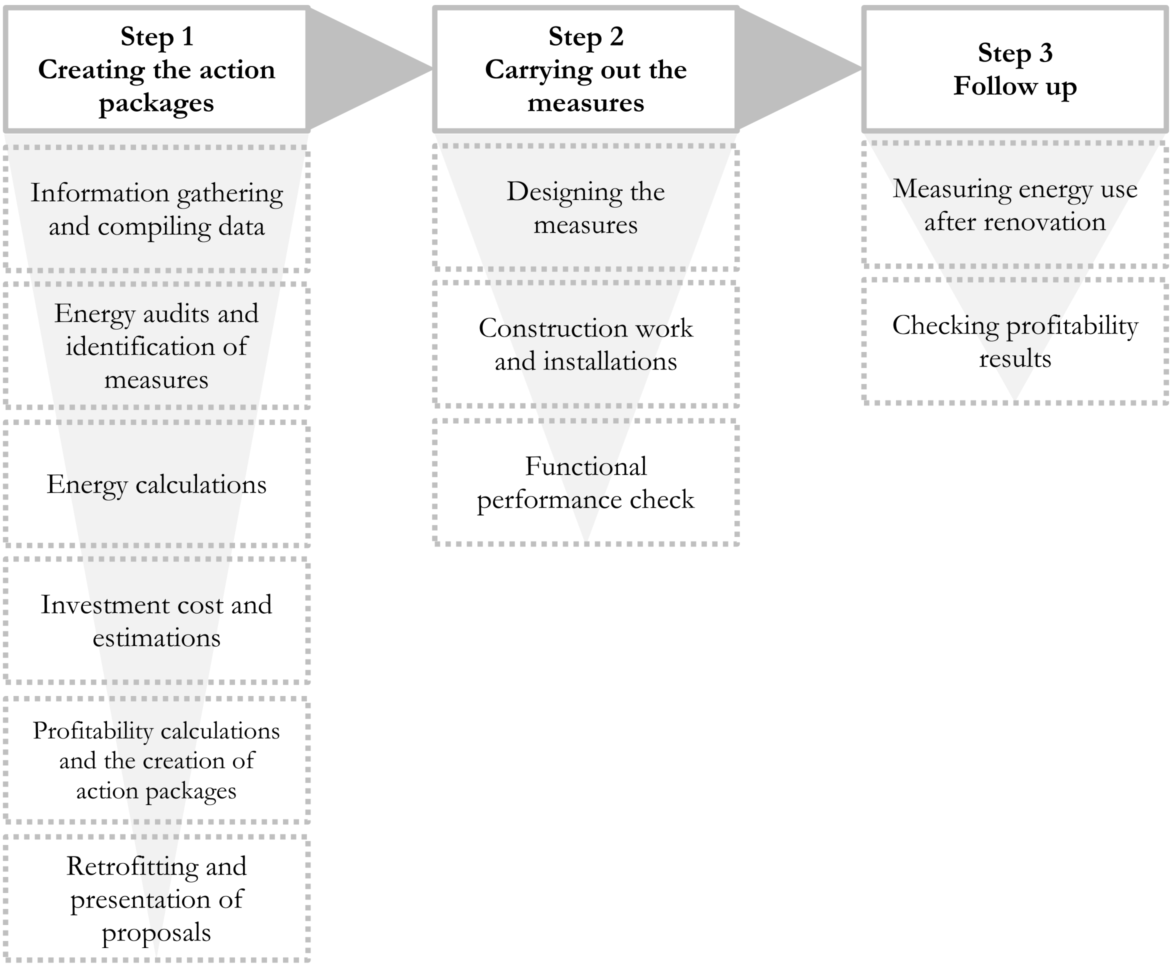
1 INTRODUCTION

The Total Concept is a method for improving energy performance in existing non-residential buildings and applies a refined systematic approach to work with energy issues in the building with the aim to achieve maximum savings in a cost efficient way. Total Concept method is based on an action plan comprising a package of measures which meets the profitability conditions stipulated by the building owner. The prerequisite for attaining profitability is that the whole action package is implemented in its entirety. The development of the Total Concept has been carried out within the BELOK group. BELOK is the purchaser group of the Swedish Energy Agency. The Total Concept is a method towards achieving energy savings of up to 50-60 % in existing buildings within the profitability frames set by the building owner. In a Nordic Built project the aim is to test, adopt and promote the Total Concept method as a business model in Sweden, Finland and Denmark. The idea of the Total Concept method consists of the following three steps:



Demonstration project have been carried out in Sweden, Finland and Denmark in order to test and develop business strategies for the Total Concept method. The demonstrations include all three steps in the Total Concept method. Starting with a detailed analysis of the buildings energy performance. Thereafter, packages of energy saving measures were formed for each building, which were then carried out by the building owner and the results were followed up. The whole process has been studied and involved actors have been interviewed in order to give input for developing strategies for increased use and promotion of the Total Concept method. The outcomes of the national demonstration studies are summarized in this report in two main parts

- **Technical part** describing the technical outcomes from each step of the Total Concept method, including details about the proposed action package, calculated savings and profitability, final action package carried out and savings and profitability achieved.
- **Non-technical part** describing the practical work process of the Total Concept method implementation in the demonstration buildings, including involvement of the different key actors, coordination of activities, lessons learned from the project execution and reflections of how this can be performed in larger scale.

The current report provides the discussion about major outcomes from the demonstration studies. Detailed outcomes are reported separately. Factsheets and reports for each demonstration study can be found from the project homepage. In Denmark and Finland one demonstration building has been followed during all three steps of the Total Concept method. In Sweden step one has been followed in one demonstration building while step 2 and 3 has been followed in two other demonstration buildings.

For getting feedback on the work process of the Total Concept method implementation in the demonstration buildings n face-to-face interviews were conducted with the stakeholders and key actors involved. This information has been relevant for developing further the strategies for commercialization. The main questionnaire used is given in Appendix I.

2 TECHNICAL PART

Five buildings, in three different participating countries were selected as demonstration buildings in this project. Among five selected buildings three are situated in Sweden, one in Finland and one in Denmark. The selected buildings in Sweden are (1) Perukmakaren, (2) Nordstan Objekt 6, and (3) Drivhuset – all are located in Gothenburg. The selected building in Finland is Barrack in southern Finland and the selected building in Denmark is the Gladsaxe sport centre situated in Gladsaxe municipality in the greater Copenhagen area.

2.1 Brief description of the buildings

2.1.1 Barrack Southern Finland

The building was constructed in 1953 and is currently used by Fininsh military. The building consists of three stories and has a heated area of 3260 m^2. The entire building has been rented to the Construction Establishment of Defence Administration and the main purpose of use (50 %) before and after the renovation is to accommodate soldiers. In addition, the building includes teaching and exercise facilities, offices for permanent staff as well as related social premises and storage areas.

In 2011 the roof was repaired and originally designed natural ventilation was replaced with mechanical extract ventilation system with no user control. The building had a poor envelope insulation and energy inefficient windows before renovations. Likewise, the heat distribution system was very old.

2.1.2 Gladsaxe Sports Center – Gladsaxe Denmark

The buildings includes a public swimming pool with bathing and changing rooms and two sports halls (Sports Hall 1 and Sports Hall 2), both with their own bathing and changing rooms. The buildings are owned by Gladsaxe Municipality.

The building is from 1970, but some parts where added later. Throughout the years there have been different renovations and some of the technical installations have been made more efficient.

Before the current renovations there were problems with humidity levels in public area which is due to the problem in the BMS-system. Moreover, air temperatures in the pool area were lower than the recommended temperatures. Additionally, problems with ventilation air flow rates, mixing of air and problems with draught occurred in different areas. The building envelope is not air tight and windows are energy inefficient.

2.1.3 Drivhuset – Gothenburg Sweden

Drivhuset is an office building constructed in 1989. The heated area of the building (A_{temp}) is 16 238 m^2, which is divided into four quadrants: Yellow, Red, Green and Blue. The quadrants are connected together with a large glass covered atrium. The building's eight floors houses nine tenants with a number of different activities. Floors 3-7 incorporate mostly office premises, while on the 8th floor there is a gym, conference rooms and technical facilities. Floors 1 and 2 consist of a garage, technical rooms, and archives. Approximately 93 percent of the building was rented out in 2014. In average there are about 200 people working in the building during normal working hours.

A total renovation will be carried out in this building in order to improve the function of the building and to adjust for new tenants. The aim of the Total Concept project has been to incorporate energy efficiency measures to the total renovation of the building and to achieve energy savings of more than 50%. The building envelope is in a rather good condition, however a number of windows have rather high U-values. The heating system needs to be adjusted to optimize the system performance and assure required indoor climate. Room temperature regulators are original from 1989 and need inspection. A number of air-handling units have rather poor heat recovery and fans with low efficiency. Most of the office premises have modern lighting fixtures, however there are old type of lighting fixtures with manual control still in some areas.

2.1.4 Perukmakaren Gothenburg Sweden

Perukmakaren is a six store building with the total area of 26 000 m^2 and heated area 9 881 m^2. The building has six stories and is used for multiple activities including shops in the basement and first floor, upper floors are used as hotel and garage. Percentage of garages is 62% of the total area, 28% is shop and warehouses and only 10% is hotel area. The building is connected to the local district heating and district cooling system. The building was built in 1966 and was totally refurbished in 2011-2014 in order to change use of the building to hotel. The aim was to incorporate energy efficiency measures to the overall renovation and to reach a yearly energy use of 80 kWh/m^2 (exklusive tenants). The building will also be certified according to LEED with the aim of achieving rating Gold.

This building was included to the project as a demonstration study in order to follow up the work process in Step 2 and Step 3 in the Total Concept method.

2.1.5 Nordstan Object 6 - Gothenburg Sweden

The Nordstan Object 6 building is from 1968. Originally the building was built as a bank office but now it hosts offices (50%) and shops (46%). The total heated area of the building is 48 600 m^2. The building is connected to the local district heating and district cooling system.

The building was refurbished in 2012-2013. The implementation of the energy saving measures has been done in three phases, with three packages of measures. The first two packages of measures have already been implemented. The aim for the two first phases was to achieve a total energy use of 84 kWh/m^2, year. With the third renovation phase the aim is to come down to a total energy use of about 50-60 kWh/m^2 in year 2020.

This building was included to the project as a demonstration study in order to follow up the work process in Step 2 and Step 3 in the Total Concept method.

2.2 Description of the technical part of the study

Detailed descriptions of the technical aspects of the selected demonstration buildings are described in fact sheets and reports found on project homepage (www.nordictotalconcept.info). However, the summary is tabulated in Table 1 & Table 2 followed by a brief status of the all three steps of technical part of the study.

Table 1 Summary of buildings technical description – before the renovations

Name	**Barrack Southern Finland**	**Gladsaxe Sports Center Denmark**	**Drivhuset Gothenburg Sweden**	**Perukmakaren Gothenburg Sweden**	**Nordstan Object 6 Gothenburg Sweden**
Year Built	1953	1970	1989	1966	1968
Type	Military	Swimming pool and sports hall	Office, Gym Conference Garage	Shops, Office and Garage	Offices, and Shops
Nr of floors	3	1	8	6	N/A
Heated Area {m²}	3260	14900	16238	9881	48600
U *values* {W/m²k}					
Wall	0.5 - 0.62	N/A	0.14	1.05	N/A
Roof	0.26 - 0.54	N/A	0.14	0.3	N/A
Windows	2.75	N/A	1.9 - 2.7	2.2	N/A
Heating System	District heating with hydronic radiators	District heating with hydronic radiators or air handling unit	District heating, hydronic radiators and ventilation air	District heating with hydronic radiators or ventilation air	District heating and a heat pump along with hydronic radiators
Cooling System	no cooling system	No cooling system	District cooling system, chilled beams and ventilation air	District cooling system & cooling with ventilation systems	District cooling system & cooling with outdoor air using air handling units
Ventilation System	Mechanical Exhaust	Mechanical ventilation with recovery and at some places only Mechanical extract	6 air handling units	4 air handling units	12 Air handling units
Lighting System	Fluorescent tubes with manual control	Usually manual but there are PIR sensor too at some locations	Fluorescent tubes, energy light bulbs, halogen spotlights. Most of the lighting is with manual control	N/A	N/A
Energy Use {kWh/m².Yr}					
Total measured inclusive tenants (baseline)	N/A	N/A	231 (272)	N/A	N/A
Total measured exclusive tenants (baseline)	146 (193)	168 (225)	171	185	155

Table 2 Summary of buildings technical description – after the renovations

Name	**Barrack Southern Finland**	**Gladsaxe Sports Center Denmark**	**Drivhuset Gothenburg Sweden**	**Perukmakaren Gothenburg Sweden**	**Nordstan Object 6 Gothenburg Sweden**
Time for renovation	2015	2015	2016-2017	2014	2012
Type	Military	Swimming pool and sports hall	Office, Gym Conference Garage	Shops, Hotel and Garage	Offices, Warehouses and Shops
Nr of floors	3	1	8	6	N/A
Heated Area {m²}	3260	14900	16238	9881	48600
U *values* {W/m²k}					
Wall	0.5- 0.62	N/A	0.14	0.23 - 0.35	N/A
Roof	0.09- 0.16	N/A	0.14	0.15	N/A
Windows	1.0	N/A	1.3-1.6	1.1	N/A
Heating System	District heating with hydronic radiators, partly floor heating	No change	Installation of new room regulators and optimisation of the system	New district heating substation and new distribution system for hotel part	District heating and new heat pump
Cooling System	Cooling compressors in office	N/A	Optimisation	New district cooling substation with new pumps	District cooling with new pump and new air handling unit with optimisation and night cooling
Ventilation system	New ventilation system	New ventilation system	New efficient ventilation units	New more efficient ventilation systems with new ducting and air devices	Demand control ventilation system in offices. Night cooling
Lighting system	Modern lighting with automatic controls	No change	New lighting fixtures and control in some office areas and garage	Energy efficient lighting for some parts and better control system	No change
Energy Use {kWh/m².Yr}					
Total measured incl. tenants (baseline)	n/a	161	105	n/a	n/a
Total measured excl. tenants (baseline)	116	n/a	55	67	93

2.3 Step 1 – Creating the action package

2.3.1 Barrack Southern Finland

The identified energy savings measures were related to the efficiency of the new ventilation systems, improving the energy transfer through envelope, energy efficient lighting and water equipment. Some actions related to moisture control and presence of asbestos was also identified during the process.

The proposed action plan consisted of eight energy savings measures and gave and internal rate of return (IRR) of 5%. The estimated total energy saving potential was about 50%.

Table 3. Summary of the proposed action package for Barrack in Step 1.

Total annual cost saving:	16 k€/yr
Calculated total energy savings	282 MWh/yr
Total energy saving:	50%
Energy investment cost (without taxes):	277 k€
Internal rate of return for the package	Ca 5%

2.3.2 Gladsaxe Sports Centre – Gladsaxe Denmark

12 energy saving measures are identified but only 10 are the part of final package. The measures were efficient ventilation systems, efficient lights, energy efficient doors and windows and improved insulation of some parts of building envelope.

The number of implemented measures was strongly dependent on the financial capabilities of the investor as well as condition of building's elements.

Table 4. Summary of the proposed action package for Gladsaxe Sports centre in Step 1

Total annual cost saving:	256 kDKK/yr
Calculated total energy savings	486 MWh/yr
Total energy saving:	23 %
Energy investment cost (without taxes):	3770 kDKK
Internal rate of return for the package	6.8 %

2.3.3 Drivhuset – Gothenburg Sweden

Fifteen energy saving measures were identified in Step 1 with the biggest saving potential in ventilation systems. Likewise additional savings are proposed by optimisation of cooling and heating systems. A number of proposed measures in the action package will be carried out as part of the upcoming renovation for the tenant adjustments or for building maintenance. Therefore only part of the investment cost is included to the costs for energy efficiency improvement. Several proposed measures contribute also to reduction in power demand and reduced power costs.

Table 5. Summary of the proposed action package for Drivhuset office building.

Total annual cost saving:	ca 1 720 kSEK/yr
Calculated total energy savings	2462 MWh/yr
Total energy saving:	Ca 60 % (compared to the baseline) Ca 55 % (compared to the measured before)
Energy investment cost:	ca 15 350 kSEK (34 % of the total investment)
Internal rate of return for the package	ca 11 %

2.3.4 Perukmakaren - Gothenburg Sweden

During renovation process 9 energy saving measures were identified with energy savings of about 60%. The measures included renovation of façades, floor structure and replacement of windows in order to minimize heat transfer through building envelope. The heating and cooling systems were planned to be renovated entirely, as well as installing new more energy efficient ventilation systems and better control for the lighting system.

Profitability calculation was done on an overall basis and not for each specific measure.

2.3.5 Nordstan Object 6 - Gothenburg Sweden

The implementation of the energy saving measures is done in three phases, with three packages of measures. The action packages in Phase 1 included four measures: optimizing the operation of existing air-handling units, replacing one of the air handling units, installation of heat recovery from cooling system and installation of new heat pump. The action package in Phase 2 included five measures: adjustments/ renovation of three air handling units, optimization of cooling system pump operation, removing reheat coils from existing air-handling units, installation of demand controlled ventilation and adding night cooling.

Table 6. Summary of the proposed action packages for Nordstan Objekt 6 in Step 1 in Phase 1 and Phase 2.

Total annual cost saving:	Ca 2500 kSEK/yr
Calculated total energy savings	3465 MWh/yr
Total energy saving:	45%
Energy investment cost (without taxes):	7900 kSEK
Internal rate of return for the package	Ca 32%

2.4 Step 2 – Carrying out the measures

2.4.1 Barrack, Southern Finland

After detailed analysis of ventilation system, insulation and structure, it was analysed that only 5 of 8 proposed measures were possible within the profitability requirement of the building owner. Also out of two ventilation options proposed, the finally chosen one had a bit lower HRU efficiency because of space limitations. The five energy savings measures chosen in the action package had an internal rate of return (IRR) of 6%. The renovation work was started at the beginning of the summer 2015.

2.4.2 Gladsaxe Sports Center – Gladsaxe Denmark

Not all of the ten energy measures in the profitable action package have been implemented yet, although all of them are a part of owner's renovation plan. Four measures were carried out in Step 2 as planned and one measure was implemented partly. The estimated internal rate of return of the package of measures already carried out is about 2%.

During 2017-2018 the next energy measures will be implemented, for instance the air tightness of the swimming hall building envelope will be improved.

2.4.3 Drivhuset – Gothenburg Sweden

Step 2 started 2016 and will be finished by May 2018. A number of adjustments are already planned to the action package in Step 2. Ten measures out of fifteen energy saving measures will be carried out as planned and five measures will be carried out with some modifications. Since not all of the measures will be carried out then the energy use for building operation after renovation will be somewhat higher and has been calculated to be about 70 kWh/m^2 yr by the HVAC design company and based on design values. According to the building owner optimizing the operation of the cooling system and heating system is not included to this updated calculation.

2.4.4 Perukmakaren - Gothenburg Sweden

The renovation was finished in March 2014. Nine different energy saving measures were carried out during the renovation process. A measure that was not included was installation of thermal solar panel for hot water since it was not cost effective. Careful commissioning plan was made and coordinated performance tests were carried out to verify the function of the systems. Since the building was certified with LEED the requested documentation and function verification was presented.

2.4.5 Nordstan Object 6 - Gothenburg Sweden

The renovation of Phase 1 was finished in April 2012 and Phase 2 was finished in September 2013. Nine measures were carried out in total. Carrying out measures in different steps have helped to plan ahead and prepare for future potential energy efficiency measures. The building owner considers the implementation in different phases as an advantage in complex projects where you can verify the function between each phase.

2.5 Step 3 – Follow up

2.5.1 Barrack, Southern Finland

The follow up of the targets during the follow-up process has been with the building owners own "7-points" evaluation method. The measurement period was started in April 2016 and continued until December 2016. During this period the whole building ventilation system of the building was run on full power to ensure that the system will be dried and that there will be no problems with emissions in indoor air which was a generic policy from the building owner due previous problems. Therefore the measured results had to be compared to a prediction model that was matched to the ventilation use during the first year of the building use. During the measurement period it was noticed that the water consumption was a lot higher than estimated in Step 1. The likely cause for this relies on the unreliability of old replaced measurement system with manual reading and original meter. When this was changed and the ventilation were added to the calculated model the predicted electricity use was close to the measured one and the heat consumption was a bit higher.

The estimated total energy use of the building after renovations will be about 116 kWh/m² yr, which corresponds to about 40 % savings compared to the updated baseline.

Also the cost of the package was followed up on general level and it seemed to come close to the estimated investment costs. However, because of the organizational structure and contracting model exact individual cost for all of the measures was not possible to be obtained but instead estimations were generated together with the building owner and contractor representatives based on available information.

2.5.2 Gladsaxe Sports Center – Gladsaxe Denmark

The data for measured energy use together with measurements of water and air temperatures in the swimming hall have been collected for the whole year 2015. This period also includes some balancing of the systems. The energy data has been collected through a network of submeters for heat, electricity and water.

The results for heating show that the achieved energy saving is 29% compared to the baseline and 8% compared to the situation before renovation. The results for electricity show that there has been achieved energy saving of 27% compared to the baseline and -20% compared to the situation before renovation. The negative value comparing to the measurements before renovation is a result of significant improvement of indoor climate.

The internal rate of return when comparing the results with the baseline is 14%.

The owner is interested in further optimization of the energy consumption. A sensitivity analysis will be performed to identify best set points for water and air temperature as well as max recirculation air flow and possibility for lower night temperatures in the pool hall.

2.5.3 Drivhuset – Gothenburg Sweden

A follow-up work will be started in 2018.

2.5.4 Perukmakaren - Gothenburg Sweden

The follow up took place during 2014 and 2015. At an early stage in the project a plan for follow up and monitoring were made to be able to verify the calculated energy savings. The certification with LEED demanded a good plan for follow up and installation of meters in the monitoring system. During the period of system adjustment and follow up (the first 12 months) the consultant, the building owner and the operational staff had meetings every third month in order to discuss adjustments made.

In follow up, hourly data of heating and cooling were monitored which instantly showed whether the system deviated from designed values or not. For example the follow up made it possible to adjust the control of lighting as the daylight control system did not work as intended at the beginning.

The total measured energy use after the first year was lower than estimated, about 67 kWh/m^2. The calculated energy use after renovation was 79 kWh/m^2 (excl. tenants). During the follow up period the measured heating consumption was lower than calculated energy, whereas measured values of cooling and electricity were somewhat higher than calculated values. The higher electricity demand was depending on increased operation hours for ventilation as well as problems with the control of the lighting system in the garage. The higher cooling demand was depending on the hot summer during the monitoring period.

The improvements on the results, along with adjustments of the systems is still ongoing.

In the profitability follow up the building owner have chosen to follow up the overall payback time only. The total annual cost saving with the measures carried out is about 250 k€/yr.

2.5.5 Nordstan Object 6 – Gothenburg Sweden

The follow up work of the two phases has been done on a monthly basis. The total energy use of the building after the renovation of Phase 1 and Phase 2 (December 2015) is 93 kWh/m^2.

Table 7. Actual outcome from action package for Nordstan Object 6 (without taxes).

Total annual cost saving:	1 666 kSEK/yr
Energy investment cost (without taxes):	8592 kSEK
Internal rate of return for the package	Ca 19%
Total energy saving:	40 %

The measured energy use is somewhat higher than the calculated values, which was 84 kWh/m^2. The higher measured values are primarily due to higher use of electricity. This is due to more hours of operation in the building and both pumps and fans use more electricity than calculated. The actual profitability is somewhat lower than the calculated, about 19%. However, the implemented packages still met the profitability demands from the owner. As there are many factors that affected the energy usage buildings, therefore there the further procedure of follow up is under discussion.

3 NON-TECHNICAL PART

Non-technical part of this report analyses the work process of the Total Concept method, roles and responsibilities of the different actors involved in the demonstration projects and motivation of the key actors and stakeholders in the project. It also includes the prerequisites from the owners' side for instance carrying out mayor renovations, profitability requirements, and benefits of implementing the Total Concept method. Future business opportunities and quality assurance is also considered in the non-technical part of the project.

In the non-technical part of this report the whole process of implementing the Total Concept method has been followed. It is primarily based on interviews carried out with key actors and main stakeholders in the demonstration projects. The interviews were carried out after each main step of the method. The questionnaire used in these interviews is presented in Appendix 1.

This section aims to compare the similarities and differences among the demonstration buildings in the project.

3.1 Stakeholders and key actors in the demonstration studies

The Total Concept method implementation requires an involvement from a number of stakeholders and key actors in order to assure the expected outcomes and quality of results. The main stakeholder in a Total Concept project is commonly a building owner, who has an interest to invest in energy efficiency measures. This was the case for example in the demonstration buildings in Sweden and Denmark. The role of the building owner is commonly to run the project and be involved in all steps.

However, it can also be the tenant who has an interest in energy efficiency improvement project. This was the case in the Finnish demonstration building, where the tenants were an important stakeholder, while the building owner was the investor.

Internal key actors in a Total Concept project implementation commonly include building manager and maintenance personnel, who are responsible for the building and its operation on daily basis. They can contribute with a lot of valuable knowledge in the project. In case the operational staff doesn't have a good understanding of the systems in the building, the responsibility of the consultant increase and they have to analyse the systems to identify energy efficiency measures. It is important to make sure that the tenants feel they benefit from the project since they also are important key actors.

In the Swedish demonstration buildings the building manager and maintenance personnel were actively involved in the project from an early stage. The tenants were also actively involved and in two of the buildings the tenants were involved through green contracts. In the Finnish and Danish demonstration building projects the involvement of some of the internal key actors was less active and therefore the consultants had also more responsibilities.

The external key actors commonly include the energy consultant carrying out Step 1, design engineers and contractors involved in Step 2 and energy controllers and strategist following up the process as a Total Concept manager. In three of the demonstration projects the energy consultants were part of the Nordic Built project team.

In Step 2 of the Finnish demonstration building the project manager was assigned by the building owner and the design team had the overall responsibility over the renovation and implementation of the measures, as the building owner wanted to use the same structure and organization as in their other projects. Thus in this case the Total Concept was considered as an addition to the normal process. The role of the consultant, who was also involved in Step 1, was to try to keep the energy related parts, that was planned in Step 1, included in the renovation and check that all the necessary metering was done. Thus it can be said that even though Total Concept consultant had the responsibility on the action package, the project was managed in a network between building owner's design team, tenant and the consultant with consultant having no project management role considering the whole project.

In two of the Swedish demonstration projects (Perukmakaren and Nordstan Object 6) the same consultant was involved in the entire renovation process, which was very beneficial in order to achieve expected results. The same consultant was responsible for planning the measurement and follow-up, including functional performance tests and energy coordination in the process and had similar responsible tasks as the proposed Total Concept Manager.

In the case of the Danish demonstration building the contractor and technology companies were also actively participating as external key actors. The technology providers were involved in the process to design the ventilation system of the swimming pools.

The stakeholders and key actors in the demonstration projects are summarized below.

Table 8 Stakeholders and key actors in in the demonstration projects Total Concept in participating countries.

Demonstration project	Stakeholders and key actors	
Barrack Southern Finland	Owner:	Senate
	Tenant:	Finish Defence Forces
	Consultant:	Bionova
Gladsaxe Sports Center Gladsaxe Denmark	Owner:	Gladsaxe municipality
	Consultant:	Rambøll Denmark
	Contractor:	Pro Ventilation A/S
	Technology company:	Exhausto System Air
Drivhuset Gothenburg Sweden	Owner:	Vasakronan
	Consultant	CIT Management Ramböll Sweden (design) GICON AB
	Contract:	Veidekke
	Maintenance:	Vasakronan
Perukmakar & Nordstan Object 6 Gothenburg Sweden	Owner:	Vasakronan
	Consultant:	GICON AB
	Maintenance:	Vasakronan

3.2 Prerequisites and reflections from the building owner´s side

The main motivation of the stakeholders in the Finnish demonstration project was to see and understand the Total Concept method approach and its potential for their future projects. They did not have any specific energy saving goal. The owner has their own methods for setting energy and environmental goals and follow up procedures. For example life cycle cost analysis are done for some energy saving measures which are considered to be interesting. Requirements for profitability of energy saving measures in Barrack building was set to 7% IRR but the requirement was not very strict as they wanted to see how this kind of an approach would work. In the opinion of the stakeholders of the Barrack building in Finland the difference in the Total Concept method in comparison with other renovation approaches is the financial evaluation. Tendering procedure is similar to other renovation processes.

In the Danish demonstration project the building owner was interested in to find out the status of the building and its energy use and find possibilities for renovation, improving indoor climate and implementing a systematic approach in a renovation process. In the Gladsaxe building the energy retrofitting was set in line with other associated projects such as indoor climate improvement. Also, follow up is commonly executed by the owner. All of the goals were set from the beginning and the majority of expectation of the stakeholders in the Danish project were fulfilled. The profitability for the Gladsaxe project was set by the management and it was 5 to 10 years of payback. On the other hand the stakeholders of the Gladsaxe project believe that the main difference in the Total Concept method comparted with other projects is the role of the Total Concept Manager, systematic approach and introduction of an action package that fulfils the requirement on internal rate of return.

In Swedish demonstration projects the building owner had clear energy reduction goals for their buildings. The overall goal is to have an average energy performance of their buildings about 80 kWh/m^2 per year. However, the building owner also consider that every building is unique and needs a customized approach. They also consider that it can be difficult to define very strict requirements on profitability at an early stage of the project and it might be more suitable with an estimation of an acceptable range. Usually there are some uncertainty involved with the cost and energy data at early stage of a project. However, they choose the profitability demand carefully taking into account both business and environmental aspects. By accepting a lower demand on internal rate of return, environmental aspects of an investment can be prioritized, which lead to environmental benefits.

The aim of the current Total Concept projects, Drivhuset and Perukmakaren, was to incorporate maximum possible energy efficiency measures in the total renovation of the buildings. The project in Nordstan Object 6 was more as a pure energy project. The building owner was also interested to develop and test out new methods that can support the increase of the value of their properties and therefore this project based on the Total Concept method implementation has been interesting for them. They believe the main strength of the Total Concept is holistic approach in energy renovation process and close involvement and teamwork with the different key actors. The Total Concept project process does not differ much from other projects the Swedish building owner has carried out during recent years. They have been working with similar goals and processes before. However, the measures have not been packaged the same way as in the current projects. According to them it is important to be actively involved in the project process, from the start and pre-planning of the project up to the measurements and follow-up and to have clear demands in the tendering documents. It is important to know and plan how to secure the entire process and results through tendering, implementation, functional performance tests and in operation.

3.3 Work process of the Total Concept method implementation

The work process of the Total Concept method involves defined activities and roles and responsibilities for different actors involved in the process. In Step 1 the action package is formed, including information gathering and compilation of data, energy auditing and identification of measures, energy calculations, cost calculations and finally a profitability calculations with the Total Concept calculation tool. In most of the demonstration buildings the consultants collected the data, identified the measures, performed energy simulations and carried out cost and profitability analysis. Additionally some costing was provided by the technology providers.

In one of the Swedish projects it was noted that the most time consuming task was energy simulations. Due to several complex measures energy simulations took time. It was also challenging to determine the level of details in the data collection and level of details in the calculations. At major renovation projects, where measures in the building envelope are included, the consultant usually makes an energy simulation for the entire building. The building owner had no special requirements regarding what energy calculation program should be used. How the consultant usually perform the calculations depends often on the type of the project. For Drivhuset building, IDA-ICE simulation software was used, which was rather time consuming considering the size of the building and complexity of the measures. For example, in the Nordstan Object 6 project, where no measures in the building envelope was conducted, it was better to calculate system by system in the first stage. Later a building model with a calculation software was made.

It is more important to set requirements on accuracy and not on which program to use. Then it is up to the consultant to choose a program that meets the requirements. The building owner thinks that by having the right competence and experience of energy renovation projects, you can have less strict demands on the calculations, which can take quite a lot of time in complex buildings.

According to the stakeholders in the Finnish demonstration building (Barrack), Step 1 could have been started earlier than at the beginning of design process. Also in the Gladsaxe project some decisions were already taken by the stakeholders before starting Step 1 of the Total Concept method. Therefore the decision making process was not entirely based on outcomes from the action packages as renovation had partly started before the Total Concept project.

The decision-making process both in the Finnish and Danish demonstration buildings were somewhat more complicated. In both demonstration projects the decisions were made by the building owner whereas the demand on the renovation was set and specified by the tenant. In the Finnish project the strict protocol and organizational structure between the building owner and the tenant made the communications sometimes a bit difficult as issues always needed to be agreed on a higher level and not directly between the ones actually executing the issues. In this case having an internal Total Concept Manager inside owner organization would have helped the communications and implementation a lot. Even though the final result can be considered to be close to the planned one, in some cases it required the Total Concept Manager a lot of extra work. To ensure that all key actors involved have necessary understanding and skills was a bit difficult from time to time.

As the Total Concept process involves a number of actors it is important to keep good communication in the project team and especially it is important to keep the building owner informed and updated with the project process. This was one of the important experiences and lessons learned from the Swedish demonstration buildings. In the Danish project the coordination and hand over between different stages could have been better if a Total Concept Manager had been involved from the beginning. The Total Concept Manager was assisting in the implementation and commissioning process along with the consulting engineers who were also responsible for functional checks besides the contractor. According to the Total Concept Manager of the Gladsaxe project, the engagement can be improved if all stakeholders understand the purpose of the retrofitting process instead of choosing the traditional inexpensive strategies.

In two of the Swedish demonstration projects (Perukmakaren and Objekt 6) the same consultant was involved in the entire renovation process, which was very beneficial for achieving the expected results. Furthermore, to have an energy coordinator in these kind of renovation projects was important for successful outcomes. Another important factor according to the building owner and consultant was to have the right competence. The best way to get to know each other's competence is to implement energy renovation projects in several stages (like in Object 6) so the project partners can get a feeling of how far it is possible to reach with the expertise available. It is also important to maintain simplicity in the communication so that everyone understands everything in the project and misunderstandings are avoided.

3.4 Business opportunities for the Total Concept method and development of new services

All of the building owners of the demonstration buildings in this project were interested in achieving a good and profitable renovation project and found the method to be interesting in that regard. For example, for the Finnish demonstration building stakeholder the method helped to get a wider understanding of the renovation process, budgeting and following up of the results. The Swedish building owner have been involved in similar projects in the past and they see a great business opportunities in the renovation projects if they are based similar methods as the Total Concept method. However, it is important to keep in mind that it is the results that the building owners buy rather than the particular method itself. The method needs to be flexible in terms of adapting to specific needs of an organisation. Furthermore, carrying out major renovation projects involves often also other aspects than just profitability, such as use of premises, relationships with the tenants, indoor climate, environmental aspects, etc. Large functional improvements are often obtained with energy efficiency measures, leading increased property value.

One of the challenges pointed out by the Swedish demonstration building owner was how to apply a sort of academic approach in the real life situations. Every building is unique as well as every building owner is different. It is important to be aware of who the receiver (end-user) of the method is and to present the outcomes accordingly.

The Total Concept method provides new business opportunities for a number of external key actors involved in a renovation project and the current demonstration projects gave a good insight about these opportunities, especially for the Danish and Finnish consultants. According to the Swedish consultants involved in these projects it is important to be mindful of the time and resources needed for carrying out the different tasks in a Total Concept project as an external key actor. Some of the process tasks may need to be simplified and there should be a clear overview on what accuracy of the results are expected and can be considered as good enough.

One of the key services needed for the Total Concept method implementation is the role of a Total Concept Manager. The main function of a Total Concept Manager is to coordinate the different tasks and activities carried out during the three steps of the Total Concept method and coordinate the hand-over between the different key actors involved in the different phases of a Total Concept project. A Total Concept Manager supports the building owner in the decision making process regarding technical issues of the renovation process and coordinates the work between different actors to make sure that the expected energy and cost savings are achieved. According to the experiences from the demonstration studies the knowledge and skills of the Total Concept Manager is very important for a successful project. It can be necessary to find a Total Concept Manager from an external organisation. Moreover, some building owners have experienced that they do not have enough time to take this role internally and therefore they prefer an external Total Concept Manager. The Swedish building owner thinks that this role could be included to the tendering process for the contractor as part of quality assurance of the results.

In order for the method to be spread on a broader scale the method needs to be marketed more. Even though the method has been implemented in Sweden for some years now then the knowledge about the Total Concept method is still poor among many consultants. In order to make the newcomers interested in developing serviced based on the Total Concept method there should be a clear demand from the building owner´s side to order this kind of projects. The building owners need to have higher awareness of the opportunities that the method provide as well as examples of the results. From Danish prospect the consultant of Gladsaxe sports centre considers that the government incentives for projects like Total Concept are necessary in new markets like Denmark.

3.5 Quality assurance of the results

Swedish stakeholders and key actors in the demonstration studies believe that one of the key components for the quality assurance of the results of this kind of major energy retrofitting project is to have good coordination in the process, between the different key actors involved. It is important for the building owner to know and plan how to secure the entire process and results through tendering, implementation, functional performance tests and in operation.

According to the tenant of Barrack building in Finland the emphasis on following up both energy saving results and financial results is a really important part of the method as it enables them to learn about the process and use the information in their further projects. The building owner considers the financial follow-up and setting and re-evaluating the baseline to be an interesting additions to their current projects. They already use a method in which the building's energy model is recalculated in different phases of the project.

4 LESSON LEARNED

4.1 Lesson learned – Step 1 (Creating the action package)

This chapter presents "lesson learned" specific for Step 1.

Make sure that historical data is available
For a correct calibration of the energy simulation model in Step 1 there is a need for historical data of energy use. Before starting any calculations it is recommended to make sure that this data is available, and if not consider installing sub-meters for energy use measurements before carrying out calculations.

Calibration of the results by analysing momentary loads
While calibrating the energy calculation model on top of analysing energy data for respective months and years it is also recommended to analyse momentary loads. This can be for example done by comparing hourly loads for a cooling unit over one day with hourly load achieved with the energy simulation tool for a similar day (similar internal load and weather conditions).

Planning of resources
One of the most time consuming parts for the consultant in the Step 1 is carrying out energy simulations. There should be a clear view on what accuracy of the results is expected. Complex energy simulation tools may not always be needed and more time could be spent on other parts of the projects. Resources needed depends on building type and are different for each renovation project. Therefore the need for resources should be carefully analysed by the energy consultant.

It is also important to be mindful of the time and resources needed from the internal key actors in Step 1, e.g. from the maintenance personnel and building manager.

Communication with the building owner
It is important to keep good communication with the building owner and keep him/her updated about the project process. Building up a trust and cooperation will give benefits to the project as well as to future projects. The crucial moment in a project based on the Total Concept is a switch from Step 1 to Step 2. The previous projects in Sweden have shown that the main challenge has often been to continue after the pre-study, to get everything going and that all the key actors are aware of their tasks and expected results.

Energy audit – focus on BMS
It is recommended to conduct the audit in collaboration with the building manager and maintenance staff. Maintenance staff usually has a good picture of the present condition of the building and its systems and can support the consultant with relevant information.

When gathering the data and establishing the current status, it is recommended to start with analysing the technical data in the Building Management System (BMS system), if there is one. This is the best way to identify current settings for technical systems (set points, operating hours, heating curves, etc.) as well as what can be extracted from the current BMS system. Already at this stage it is possible to identify a number of measures which often involve optimization of settings in the BMS system.

Presentation of the results in the form of sensitivity analysis
No matter how precise the audit and the energy calculations are performed there is always an uncertainty about the outcomes of the pre-study phase. It is therefore recommended to carry out sensitivity analysed to the results. It can be proposed to prepare an internal rate of return diagram in several versions – for example for different energy saving variations, investment cost variations and energy prices. The building owner is in this way prepared for possible changes in the projects outcome.

4.2 Lesson learned – Step 2 (Implementation)

This chapter presents "lesson learned" specific for Step 2.

Early plans for functional and performance tests
It is recommended to describe requirements for functional and performance tests already in the design documentation, so that it is communicated to the contractor in order to make sure that the tests will take place.

Systems should also be tested under various operational conditions, such as during low cooling or heating loads, high loads, component failures, unoccupied mode, varying outside air temperatures and control system's sequences of operation. It is important to focus also on the interaction of the components with other systems and not just on the components itself.

Necessary additional measurements
It is not advised to rely entirely on the system documentation. Verification of assumptions made for specific systems in the project can be done by manual testing or by monitoring the performance of a system and analysing the results using the control system's trend log capabilities or by stand-alone data loggers. One example of such testing would be measurement of pressures in the ventilation system with the max air flow.

Network of sub-meters support the validation of the calculation from Step 1
Designing a network of sub-meters in the building will allow monitoring of energy consumption as well as validating the results from the calculations. It should be noted that making a clear plan for measurement and follow-up at an early stage of the renovation is very important for successful outcomes. The possibility for easy identification of potential errors and increased energy use will develop in-house competences of both consultants and facility maintenance staff.

Designing of BMS system with the focus on energy follow up
Installing a network of sub-meters is sometimes not sufficient to identify potential errors. While designing a new BMS system it is recommended to include extra BMS points for supervision of the systems – for example for temperature and flow measurement in different points of a system. The extra cost is often minimal when the BMS points are described in the design documentation. A good example is an output signal from flow regulator-limiters showing the actual flows.

4.3 Lesson learned – Step 3 (Follow-up)

This chapter presents "lesson learned" specific for Step 3.

Active sparring partner for a facility maintenance staff
Good communication with a facility manager is necessary in order to assure correct transfer of the assumptions from the design phase through contractor documentation until setting the values in the building.

Experiences from the Danish demonstration project show that being an active sparring partner with facility maintenance staff can be very valuable for consultants, technology suppliers as well as for the facility maintenance staff themselves. It is crucial for the maintenance staff to understand how the BMS system works in the building, what set points are the most optimal for indoor climate control and energy use, how to change settings on system, zone, room level, etc.

It is recommended to reserve time for a 2-3 days workshop and analyse the BMS system and asses if the requirements are fulfilled. Start with control of the global (overall system) values and in case of inconsistence with the assumptions, study the functionality of the system. If errors cannot be found on a global level, analyse on zone level and thereafter on component level.

No national standards for follow-up of energy use
There is no standardised method how to follow up the results in Step 3. In the follow-up process the outdoor conditions, operating conditions and use of the building must also be followed up. One of the methods of adjusting the results influenced by varying conditions is a simulation of the building with the weather dataset of the analysed period.

5 CONCLUSION

Total Concept is a well-structured method for improving energy efficiency in existing buildings, with clear financial evaluation and following up on the results. Previous experiences show that the reduction in energy use of 20 to 67 percent is possible while still meeting profitability demands.

The main motivation of the stakeholders in the current demonstration projects was to understand the Total Concept method approach for improving energy efficiency in buildings and its potential. All of the building owners were interested in achieving a good and profitable renovation project and found the method to be interesting in that regard. Most of these expectations and preliminary set goals on project outcomes were fulfilled. It is important to be aware of that every building is unique as well as every building owner is different. To present the outcomes of the method it is important to be aware of who the receiver (end-user) is. Also, it is important to keep in mind that it is the results that the building owner buy rather than the particular method itself.

The work process of the Total Concept method involves defined activities and roles and responsibilities for the different actors involved in the process. These activities and roles were well tested in the demonstration studies of this project. It can be concluded that the key components for the quality assurance of the results of this kind of major energy retrofitting project is to set clear demands on competence on different key actors and to have good coordination and teamwork in the project process itself. It is beneficial for the successful results if the building owner is actively involved in the project and have clearly set demands in the tendering documents. Also, the method needs to be flexible in terms of adapting the model to the specific needs of an organisation. Carrying out major renovation projects involves often also other aspects than just profitability, such as relationships with the tenants, indoor climate improvements, environmental aspects, etc. Large functional improvements are often obtained with energy efficiency measures, leading increased property value. These aspects need to be considered.

The Total Concept method provides new business opportunities for a number of external key actors involved in a renovation project and the current demonstration projects gave a good insight about these opportunities, especially for the Danish and Finnish consultants. According to the Swedish consultants involved in these projects it is important to be mindful of the time and resources needed for carrying out the different tasks in a Total Concept project as an external key actor. Some of the process tasks may need to be simplified and there should be a clear overview on what accuracy of the results are expected and plan the resources accordingly.

One of the key services needed for the Total Concept method implementation is the role of a Total Concept Manager, who supports the building owner in the decision-making process regarding technical issues of the renovation process and coordinates the work between different actors to make sure that the expected energy and cost savings are achieved. This role could be included to the tendering process for the contractor as part of quality assurance of the results.

Annex I

Questionnaire 2

Questions for face-to-face interviews with the external key-actors involved in the demonstration studied

Aim

The aim of this questionnaire is to get feedback about the work process and progress of the BTC method implementation in the demonstration studies. This information on key elements of the BTC method implementation is relevant for developing further the strategies for commercialization. Also the role, responsibilities, leadership direction, and supervision for team member performance of a BTC manager can be tested and evaluated in these interviews, i.e. if the key actors would do the process again, could it work with the BTC manager role in the process.

The project aims to assure that commercialization of the BTC method takes place in the participating countries by developing strategies for commercialization and testing and evaluating them via demonstration studies. The face-to- face interviews based on this questionnaire supports further development of the strategy document by getting more detailed insight to the practical work process of BTC method implementation and how the services based on BTC method can be developed in the future.

Target group

The target group of this questionnaire is the stakeholders and key actors involved in the demonstration studies of this project, i.e. building owner, building manager, energy consultants, design engineers, contractors and technology providers, maintenance personnel. It is recommended that the interviews will be carried out after each step of the BTC method implementation in order to get most previous feedback from the delivered tasks. Also, the actors involved (persons to be interviewed) during the different stages of the project can be different.

Method

Face-to-face interviews should be carried out with the selected key actors after each main stage of the project (Step 1, Step 2 and Step3). During the meeting a presentation describing the method and developed strategies for the services can be used as a support. Descriptions of the method and developed business strategies are found from the Task 1.4 report “Strategies for commercialisation of the BTC method (right now the report can be used internally only). For documenting the results from the interviews use the format for reporting the outcomes from WT2 provided by SBI/AAU.

Proposal of questions for the face-to-face interviews

Organisation	
Address of the organisation	
Website of the organisation (if available):	
Size of the organisation (nr of employees, annual turnover)	
Person to be interviewed (name)	
Role in the company	
Role in the project	
Date of the interview	
Interviewer (person)	

Information about the organisation interviewed

CURRENT DEMONSTRATION PROJECT

1. Describe your role and work tasks in the current demonstration project? How have you practically carried out the specified tasks in the Total Concept method? Have you performed this kind of role/tasks before? What was new/ different?

    - Step 1- Forming an action package (involvement of the different key actors, collection of data, auditing, identifying measures, energy simulations, cost estimations, feasibility calculations, reporting, etc)

    - Step 2- Implementing the action package (involvement of the key actors, design process, carrying out the measures, functional performance testing, etc)

    - Step 3- Following up (involvement of the key actors, monitoring energy use, follow up of the profitability results, etc)

2. Do you find your current background to be sufficient to carry out specified role in the work process according to the BTC method?

3. Can you briefly describe how coordination of activities among the external key actors has taken place during the work process? How was information shared and how was handover made between the different stages?

4. Can you briefly describe decision-making in the work process of the demonstration project? How were the decision-makers involved and the decisions made? Were the roles and responsibilities clearly defined?

5. What do you think were main strengths in this energy retrofitting project? What were the main the main challenges and lessons to learn in this project? What would your do differently next time?

6. What were your general expectations in this project? Were these expectations fulfilled at the end?

Additional questions for building owners only

7. Describe the goals/expected outcomes that the building owner had at the beginning of this project? Were these goals fulfilled at the end of the project?

8. Do you usually set energy reduction goals in your energy retrofitting projects? How is energy savings followed up? Who is responsible for the follow-up?

9. How the profitability requirements are determined for this kind of major energy retrofitting projects in your organization?

10. How would engaging the external key actors differ in this kind of projects compared to other energy retrofitting projects? How should the tendering documents be made? What should be included?

TOTAL CONCEPT IN GENERAL

Business opportunities

1. How would you evaluate the market conditions for the major energy retrofitting projects based on the Total Concept method? Would the building owners be interested to invest in services based on Total Concept?

2. How do you evaluate the current situation with the key actors who could carry out different tasks in a project based on BTC method (consultants, design engineers, contractors)? Is their current background sufficient to work according to the method? Is there sufficient information available on the market to develop services based on BTC?

3. What would be required that the key actors would start to develop businesses based on BTC? Would there be potential service providers available? What would you consider doing in order to improve your business in this respect?

4. Based on your experience what are the prerequisites for the success of energy retrofitting project based on the BTC method? What are the possible challenges to overcome?

5. What would be required for the quality assurance of the results of this kind of major energy retrofitting project based on the BTC method?

Assessment of the BTC manager role

1. How do you see the role/function of the BTC manager in practice?

2. Could the functions of the BTC manager be managed by in-house experts (within the property owner organisation) or by external service providers? What would be the benefits/weaknesses of the two arrangements (e.g. positive learning spiral)?

3. Could your company take the role of a BTC manager for all three steps? What tasks would need to be outsourced?