Intelligent Energy Europe Programme of the European Union

Total Concept-
The Total Concept method for major reduction of energy use in non-residential buildings

Introduction to the Total Concept method

Content

1. Summary of the Total Concept method

When energy efficiency measures are carried out in existing buildings it is important that they are performed so that:

- The quality of the building and its usefulness is maintained or improved.
- The greatest possible savings are achieved using the allocated resources.

In nearly all existing non-residential buildings it is possible, with a bit of effort, to identify a number of measures that could reduce energy needs. Every measure in itself results in a certain saving, large or small, for a certain cost, high or low. If only the most profitable measures are then selected, it will often just be a question of carrying out apparently profitable but, from an energy savings point of view, rather limited measures. If, on the other hand, an action package that as a whole meets the property owner's/client's requirements regarding profitability, is drawn up and carried out, the reduction in energy needs can be considerable.

One of the basic premises when developing the Total Concept 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 commercially profitable energy saving measures.

- The Total Concept method differs from traditional methods for improving energy efficiency that *all* the possible energy saving measures are carried out in one single package 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, which is the essence of the Total Concept method.

Fig. 1 illustrates how an action package can be visualized in an internal rate of return diagram. In such a diagram, with the reduced annual cost on the y-axis and investments on the x-axis, it is possible, for a given economic lifetime, to add lines to represent different rates of return. When number of energy saving measures have been identified, and their costs and energy savings calculated, they can be plotted in the diagram. This means that every measure can be represented by a line of a certain length and angle, and the greater the angle, the more profitable the measure. In the diagram in Fig. 1, the most profitable measure has been plotted to the left. The other measures have been plotted in falling degrees of profitability. At the end of the least profitable measure (M7 in Fig. 1) the combined profitability of the whole action package can be read off.

The criterion for how many measures are to be included is decided by the calculated internal rate of return for the whole action package and this should exceed the stipulated internal rate of return, i.e. calculation interest rate. The final result of the profitability calculation is the internal rate of return for the most comprehensive action package which, from an energy savings perspective, meets the profitability requirements stipulated by the property owner/client.

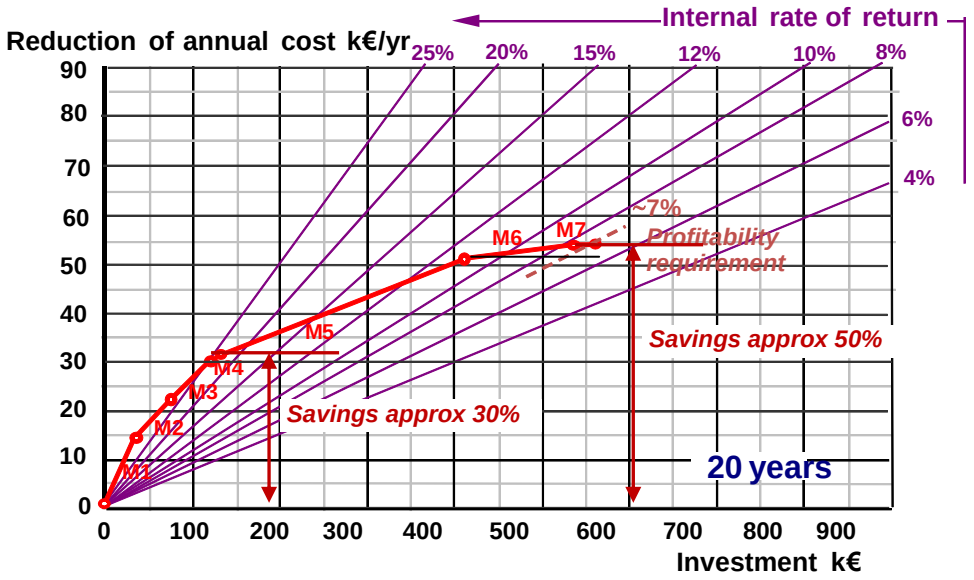

Figure 1 Visualization of an action package in an internal rate of return diagram. The diagram shows the actual returns, as real interest levels, given by each investment.

In the example shown in Fig.1, the profitability requirements are that the internal rate of return is to be at least 7 %. The complete action package (M1 – M7) meets this demand 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 unfavourable 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 in the investment cost calculations.

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

2. The Total Concept method, step by step

The Total Concept method comprises three steps:

Step 1 – Creating the action package

This step includes:

An analysis of the building to identify all the energy saving measures that can be carried out. Energy calculations are made for all the identified and possible measures

and these are then costed. The measures form the basis for an action package which in its entirety must meet the profitability requirements stipulated by the property owner/client. The energy and costed action package is presented and used as a basis for the decision whether or not to carry it out.

Step 2 – Carrying out the measures

This step includes:

The measures that, together, are profitable are carried out in their entirety. A number of these will be so simple that they can be carried out without any special preparations being made. Others must be designed and planned in detail and carried out by contractors. The work is finalized by carrying out a thorough functional performance checks. Among other things, this is important in order to make sure that all the measures function correctly. If, for example, an upgraded ventilation system does not function in the required way, a large part of the energy savings and, thereby, the cost savings, can be lost.

Step 3 – Following up

This step includes:

Following up the results of carrying out the improvement measures by registering energy use at least on a monthly basis. The follow-up, which form an important part of the Total Concept method, should be carried out for at least one year period of time after handover and checked against the calculated figures presented in Step 1.

Step 1 – Creating an action package

A Total Concept project starts with a qualified technical assessment of the building in question. At this stage, all possible measures for improving energy efficiency are identified and costed, and the subsequent energy savings are calculated. This assessment is considerably more thorough than that required for energy certification, even if data from this can be used as a starting point.

In the next stage, the profitability calculations are carried out, after which the measures are ranked according to the internal rate of return method shown in the previous section. This method will be described in detail in Chapter 2. The profitability calculations are carried out best using the Total Concept calculation tool, *Totaltool*, developed by BELOK and freely available via their website, www.belok.se. The final result of the profitability calculation is the internal rate of return which, from an energy savings perspective, corresponds the most comprehensive action package that can be carried out and which meets the profitability requirements stipulated by the property owner/client.

Step 1 is divided into the following tasks:

- Gathering of basic information about the building and compiling technical data.
- Energy audit and identification of energy saving measures.

- Energy calculations.
- Investment cost estimations.
- Profitability calculations and the creation of an action package.
- Reporting and presentation of proposals for measures to be carried out.

Carrying out the profitability calculations provides a basis for a decision whether or not to invest in the action package. A prerequisite for being able to make such a decision is that the data is easy to interpret from both a financial and a technical point of view. Another condition is that it is possible to rely on that the calculated annual savings will be reached and that the actual cost of the action package will be as shown in the investment cost calculations.

Careful analysis is vital if the project is to be a success. It is therefore important that the consultant who is engaged is specialized in carrying out energy assessments of non-residential buildings. The consultant must also be able to use energy saving programs and have access to experienced cost accountants to carry out the investment cost calculations.

Establishing a basic case

One of the basic ideas behind the Total Concept method is that the pursuit of energy savings must not impair the usefulness, quality or durability of the building. This is especially important with respect to the indoor climate. If, for example, the premises do not fulfil the minimum requirements with regard to ventilation, the building's ventilation system must be upgraded before beginning to study possible energy saving measures. However, this could lead to an increase in the use of energy in the building. By including an upgrade like this in a Total Concept project, this increase in energy use can be limited and even changed so that both a good indoor climate *and* a lower energy use are achieved.

The energy use in the building before the measurements are carried out is set as a basic or reference case, to which the effects of the energy saving measures can be compared. This is on condition that the building fulfils all the relevant minimum requirements regarding thermal climate and air quality. If the building is in need of refurbishment to fulfil the minimum demands regarding indoor climate, the energy use after this refurbishment must be calculated and set as a reference case. This calculation is based on the technical properties that the building and its installations will have after refurbishment. The costs of any upgrading of the building to an acceptable quality level are not included in the profitability calculations when applying the Total Concept method.

Investment cost calculations

The property owner/client stipulates the financial terms and conditions on which the investment cost calculations are made. This is why the property owner/client must, from the beginning, state whether planning and design costs and client costs are to be included in the costing. The investment costs must also be examined in detail by an experienced cost

accountant, either a contracted consultant or staff member from the consultant company's cost accounting department.

Step 2 – Carrying out the measures

In Step 1 of a BTC project, the action package for energy efficiency improvement measures that provides the greatest energy savings and, at the same time, is profitable, is determined. Profitability is decided by the cost of capital that has been stipulated by the property owner/client. In Step 2 the property owner/client must carry out the entire action package that has been chosen.

Step 2 is divided into the following tasks:

- Planning and designing the measures
- Construction work and installations
- Functional performance checks

Step 2 is based on careful procurement, design work and construction work. Basically, these stages are the same as in any normal reconstruction project. However, mistakes must be avoided at all costs as the expected energy savings, and the whole point of carrying out a BTC project, could otherwise be lost. It is also especially important to ensure that the use of energy in a building can be followed up afterwards. This means that extra meters for electricity and heat might be needed. Some form of monitoring system as part of the Buildings Management System (BMS) is often already in place. It is then a case of making sure that it is suitable for following up future energy use. Some additions might have to be made and these should be carried out at the same time as the energy saving measures.

If the property owner has decided to carry out other projects in the building at the same time as the BTC project, the costs for each project must be kept separate. Only costs incurred by the action package are to be charged to the BTC project account.

It is also important to ensure that the measures that have been carried out function properly from the very beginning. Shortcomings due to substandard hydronic balancing or faulty connections can considerably increase energy use and ruin the profitability of the measures. Reaching the forecast energy savings is, in practice, dependent on the building and the technical systems functioning correctly. Before the effect of the action package can be evaluated, it is very important that functional performance checks are performed so that any faults can be rectified.

Step 3 – Following up

The purpose of Step 3 is to follow-up the energy use after the action package has been carried out and to check the profitability of the action package. Energy use in the building is followed up by taking readings every month for a whole year. The results are used in a final profitability analysis.

Stage 3 is divided into the following tasks:

- Measuring energy use
- Checking profitability results

Measuring energy use

When the correct functioning of the measures has been confirmed, the energy use is measured and data presented every month during the first year of operation. In addition to measuring the energy use for heat and district cooling (if any) it is important to differentiate between the power used by the tenant's operations/activities and power used for running the building itself, for example lighting in communal areas, lifts, etc.

When a building is in use and data is being collected it is important to be aware of how the building is actually being used. The aim here is to see whether there are differences in operational conditions and uses compared to those assumed in Stages 1 and 2. For example, the operations/activities carried on in the building might have changed or part of the building might not be in use, although it was originally planned to be. A follow–up investigation is thus necessary, so that any differences between expected and actual results can be explained.

Checking profitability results

When following up profitability calculations the figures from the measured energy use and the approved final costs for the action package are used, i.e. the costs used in Step 2. It must be clear whether or not planning and design costs and client's costs have been included in the investment cost calculations and this is something that the property owner/client must decide. The actual profitability result is calculated in the form of an internal rate of return for the whole action package. This is then compared to the internal rate of return that was calculated in Step 1. If there are any differences between the expected and actual profitability results, then the reasons for these must be investigated.

3. Key actors in the Total Concept project

The implementation of a Total Concept method involves a number of stakeholders and key actors, who directly or indirectly influence the results. These stakeholders and key actors are:

- **Property owners/clients** who will initiate future projects based on the Total Concept method. In this project proposal, the term *client* can refer to both a property owner and another investor or decision maker, who is motivated to invest in energy saving measures in the building, for example a tenant company that pays for its own energy costs, an ESCO company, etc.

- **Property managers** who are responsible for the buildings in question, might play important roles when it comes to investment decisions.

- **Energy consultants** who are to carry out the work in practice in Step 1 in the Total Concept method and who will present proposals for the action package.

- **Design engineers** who carry out the detailed design for the action package in Step 2 in the Total Concept method.

- **Contractors and technology providers** who participate in carrying out the cost-effective package of energy saving measures according to the consultants' proposals.

- **Maintenance staff** who are responsible for all the systems in a building and who can directly control the use of energy in the building and influence in long term.

All these groups, each in their own particular way, play important roles in the energy performance improvement process as a whole. As end users, the **tenants** have a significant influence on the energy used in the building and it is therefore essential for the client to keep them well–informed and to be responsive to their needs.

The common stakeholders and key actors in the Total Concept method applications are given in fig. 2. The arrows mark the connection links between the different stakeholders and key actors.

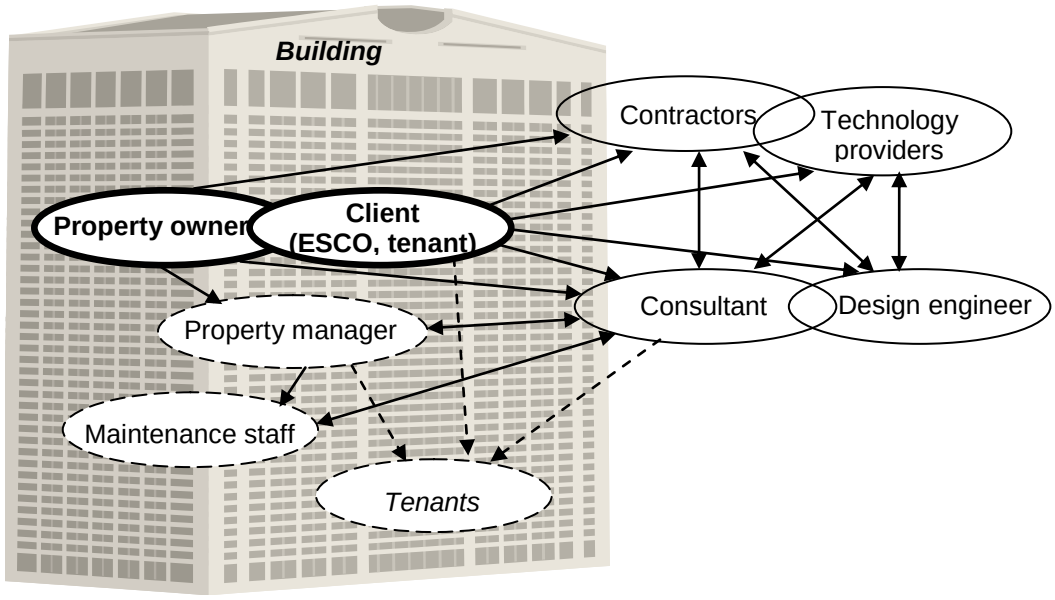

Figure 2 How the different parties involved in a Total Concept project interact.

4. Background information needed about the building

Before the practical inspection work on-site is carried out a certain amount of 'desk audit' work must be done. This will create the basis for the entire project, as it is here that existing documentation relevant to the energy audit is compiled. The person who will then inspect the building will hereby obtain a first insight into the layout and size of the building and the status of its structure and technical systems.

Normally, the property owner's/client's personnel supply the major part of the basic information, as they know where this information is to be found or can, reasonably easily, find out where it is. The checklist below can help when gathering this information. However, in practice, not all the information described in these checklists is readily available. Nonetheless, a clear and comprehensive picture should be strived for with regard to:

- The building.
- How the building is used.
- Indoor climate requirements.
- The technical systems
- The energy use.

4.1. Checklists for gathering information for Step 1 of a Total Concept project

Building information

- The name of the property, its address
- Year built (originally and any rebuilding or extensions)
- Areas: gross floor area, non-residential area, heated area, etc. Use the definitions that are applicable to the building.
- Drawings: floor, sectional, elevation and general drawings. At least the architect's drawings, preferably also the structural drawings. The drawings should be in the form of as-built drawings. If this is not the case, the property owner/client must state this.
- Specifications: if there are building documents, also in the form of as-built documents, this is advantageous. If they are not as-built documents, the property owner/client must state this.
- Maintenance plans for the building.
- Structural changes made to the buildings or renovation work carried out over at least the past 10 years.

Information about how the building is used

- Description of its use, for example, as an office, shop, workshop, school, etc.
- The number of people using the building, for example, the number of workstations in offices, the number of visitors to museums or shops, the number of pupils attending schools, etc.
- Presence/occupancy/working hours.
- The use of different rooms and different parts of the building.

Indoor climate

- Air quality requirements: hygienic flow rates, CO_2 concentrations, etc.
- Thermal climate requirements: room temperatures, air velocities, relative humidity in special rooms, etc.
- Lighting requirements: intensity of illumination, etc.
- Noise requirements: noise from technical systems, dB(A), dB(C), etc.
- Is there a requirement specification for the indoor climate in the tenancy agreement/lease? Is it referred to?
- Is a requirements specification included in the room function specifications or other documentation?
- Are the indoor climate requirements fulfilled at present?
- Have any indoor climate assessments been made previously?

Information about the technical systems

- Drawings of the ventilation, heating, cooling and other technical installations. Primarily schematics and, if necessary, plan and sectional drawings. Electrical wiring drawings showing the types and numbers of the lighting fittings. The drawings should preferably be in the form of as-built documents. If this is not the case, the property owner/client must state this.
- Descriptions and layouts of piping, ventilation, electrical installations and control systems are required. If this documentation is not as-built, the property owner/client must state this.
- Information about other electrically powered installations, i.e. machines
- Mandatory ventilation inspection reports.
- Operating and maintenance instructions.
- Access to BMS computers to check control parameters and operating times for all systems. Are there any information logs for particular parameters in the heating, ventilation and cooling systems that could be essential to the investigation?
- Maintenance plans for technical systems.
- Any previous energy audits, for example, for energy certification or other types of investigations/analyses?
- Technical changes made to technical systems or renovation work carried out during at least the last 10 years. Talk to the maintenance staff about changes that have been carried out and whether there are any shortcomings in the existing documentation, for example, if the drawings are not up-to-date or accurate.

Energy statistics

Check all the details about the building. Sometimes the geographical area covered by the meters is not the same as that covered by the building.

- Heat energy use (MWh/yr or kWh/m^2.yr).
- Electrical energy use (MWh/yr or kWh/m^2.yr). Do the statistics include the electricity used by the tenants?
- District cooling energy use, if any, (MWh/yr or kWh/m^2.yr).
- Details should primarily be obtained from energy statistics, (adjusted to normal year) and secondly from bills/invoices.
- Statistics from at least the past year and preferably from a number of previous years.
- If there are sub-meters then readings/data from these must also be reported. Make sure it is clear what the meters actually measure: one ore a number of buildings, tenant's electricity use, etc.

Feasibility calculation input data

- Energy prices, possibly even fuel prices, power rating charges.
- What future increase in energy prices above inflation are to be assumed?
- The economic calculation periods of the structural measures and the technical installation measures.
- The profitability requirement for the action package. This is best expressed in the form of a calculation interest rate. If the client uses any other form of measure of profitability this must be recalculated and shown as a calculation interest rate.
- Which costs are to be added to the investment for the energy measures, for example, design and planning costs, client costs, etc.