SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Task 47

Solar Renovation of Non-Residential Buildings

Energy Upgrade of Non-Residential Buildings IEA SHC Position Paper

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Contents

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Solar Renovation on Non-Residential Buildings – Position Paper

Aim of the Position Paper

The purpose of this document is to provide an inside view to energy policy makers on why and how energy upgrades of non-residential buildings should be supported and promoted.

Executive Summary

The IEA's *Energy Technology Perspectives 2008* report shows that buildings are responsible for about 45% of the total energy consumption in OECD countries and 38% globally. More than half of the existing building stock will be standing in 2050 and more than 50% of the buildings in many OECD countries were built before 1970.

The EU Parliament approved in April 2009 a recommendation that member states have to set intermediate goals for existing buildings as a fixed minimum percentage of buildings to be net zero energy by 2015 and 2020. This also includes the existing non-residential buildings, and a dramatic reduction in primary energy consumption will be needed.

Experiences from many exemplary renovation projects in SHC Task 47 have documented energy saving from 50 to 85% in existing non-residential buildings. Examples from Austria and Norway have documented that it is possible within reasonable economic limits to upgrade conventional office buildings to plus-energy standards. This can be achieved with products and systems already commercially available.

Successful renovation projects are characterized by having a multidisciplinary high skill group working together towards a common goal. This group includes the building owner, architect, consulting engineers as well as builders and contractors.

Regarding heat supply systems, one challenge is to get products that are adapted and optimized for buildings with a very limited heat demand. SHC Task 47 has identified a demand for optimized heating delivery systems applicable for retrofit projects.

Major barriers identified during the interviews with key actors in exemplary projects studied were:

- Lack of tradition (of thinking of higher ambitions than the building code)
- Lack of experience
- Poor access to necessary expertise
- High upfront investment
- Scepticism and risk aversion

Based on the input from the interviews of key actors in NZEB (Net Zero Energy

Buildings) retrofitting projects, some recommendations to authorities and the building industry are given for strengthening motivation and driving forces, and reducing the identified barriers.

Introduction and Relevance

The IEA's *Energy Technology Perspectives 2008* report shows that buildings are responsible for about 45% of the total energy consumption in OECD countries and 38% globally. More than half of the existing building stock will be standing in 2050 and more than 50% of the buildings in many OECD countries were built before 1970. Studies have shown that 200 million residential dwellings in OECD countries will need to be upgraded to new energy standards to reach the IEA's 2°C Scenario (2DS).[1]

The EU Parliament approved in April 2009 a recommendation that member states have to set intermediate goals for existing buildings as a fixed minimum percentage of buildings to be net zero energy by 2015 and 2020. For the existing non-residential buildings, a dramatic reduction in primary energy consumption is crucial to achieve this goal. Energy savings measures in combination with increases in onsite energy production are needed.

A few exemplary renovation projects have demonstrated that total primary energy consumption can be drastically reduced together with improvements of the indoor climate. The experiences gained from these projects, however, have not been systematically analyzed to make them a reliable resource for planners. Because most property owners are not even aware that such savings are possible, they set very conservative energy targets. And, buildings renovated to mediocre performance can be a lost opportunity for decades. It is therefore important that building owners are aware of such successes and set ambitious energy efficiency targets.

SHC Task 47 has analyzed highly successful renovation projects among participating countries, and focused on the development of innovative concepts for the most important market segments.

The objectives of SHC Task 47 were to:

- Develop a solid knowledge base on how to renovate non-residential buildings towards the NZEB-standards (Net Zero Energy Buildings) in a sustainable and cost efficient way.
- Identify the most important market and policy issues as well as marketing strategies for such renovations.

The Task worked primarily with two types of non-residential buildings: offices and schools, including protected and historic buildings.

Status of the Technology/Industry

Experiences from many renovation projects show that it is possible to obtain a

[1] IEA Energy Technology Perspectives, http://www.iea.org/etp/

dramatic reduction in the energy demand in existing non-residential buildings. Examples from Austria and Norway show that it is possible within reasonable economic limits to upgrade conventional office buildings to plus-energy standards, which can be achieved with products and systems commercially available.

Successful renovation projects are characterized by having a multidisciplinary highly skilled group working towards a common goal. This group includes the building owner, architect, consulting engineers as well as tenants and contractors.

A number of relevant energy efficient products and systems exist on the market. It seems, however, that some countries like Austria and Germany have a better-developed commercial market than many other countries.

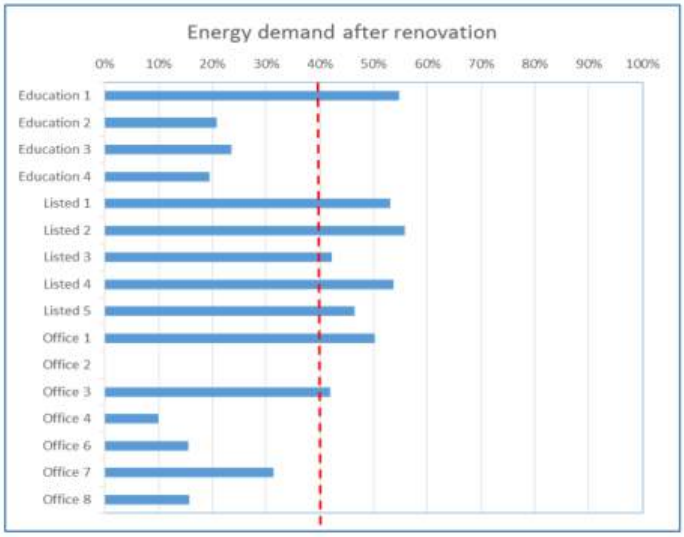
There is a need for optimized heating delivery systems for retrofit projects. The reason for this is that it is hard to find products that are adapted and optimized for buildings with very limited heat demand. Usually, the space heating demand in retrofitted buildings can be supplied with supply water temperatures in the range of 30 to 40°C, where solar heating as well as heat pump systems might work with a very high efficiency.

For some buildings, it is not possible to reduce the energy demand as much as wanted due to restrictions or difficulties with the building envelope. To make the climate footprint of these buildings better, increased use of renewable energy may be a favorable option.

For historic and protected buildings, many regular energy saving measures are not compatible with preserving the old buildings character. Listed protected buildings often have requirements to keep the expression and architecture of the building, in some cases a change of the buildings architecture expression is not legally possible.

Potential

Exemplary renovation projects from SHC Task 47 show a reduction in the heat demand of 50-90% and a 50-80% reduction in overall energy demand. In two of the buildings, the remaining energy demand is covered by electricity from PV transforming these two buildings into a plus-energy standard.



Percentage of energy demand after renovation. Red line task 47 target.

According to the IEA's *Energy Technology Perspectives 2012* report, the total energy demand in the building sector will increase from 115 EJ in 2009 to 160 EJ in 2050 in the 4°C Scenario[1], mainly driven by the services sub-sector. In the 2°C Scenario, the energy consumption is 20% lower than the 4°C Scenario.The services sub-sector is more energy-intensive in terms of electricity use than in the residential sub-sector.

The trend reflects much greater consumption of electrical end uses, notably space cooling, lighting, office equipment and other electrical devices.

From a Norwegian study (Enova 2012:01) looking at the energy saving potential by 2020 of non-residential buildings, it concluded with a technical potential of 55%, economic potential of 25%, and a high realizable potential of 13%.

It can be stated beyond any doubt that there is a huge potential for energy savings in the existing building stock.

Current Barriers

Through interviews with many key actors in the buildings sector, a number of major barriers have been identified:

- ***Lack of tradition*** *(of thinking of higher ambitions than the building code)*
  The "default idea" is to upgrade according to the current building code. This applies also for municipalities having a particular focus on sustainability in all of their activities.
- ***Lack of experience***
  As NZEB renovation is at a very early stage in the SHC Task 47 member countries, the actors involved in these projects had no or limited experience within this field.
- ***Poor access to knowledge***
  For the same reason, it has been a challenge in the projects to get access to the relevant knowledge and expertise for the different stages of the projects.
- ***High upfront investment***
  A NZEB upgrade implies a higher initial investment cost compared to a traditional renovation meeting the existing building code. For some of the projects studied, the additional costs were substantial. Without large subventions, these projects would not been realized.
- ***Scepticism and risk aversion***
  NZEB upgrading is an innovation that remains an unknown for most of the decision makers in the involved organisations/companies. What is unknown is often met with a natural scepticism, and for professional investors the unknown means higher risk. The pure investor will expect a risk premium, meaning an outlook for a higher profit at the end. This is difficult to document unless arguments as "improved image" and "superior indoor comfort" are given high priority.

Powerhouse Kjørbo, Norway, plus-energy office buildings and BREEAM-NOR classified: "Outstanding – As Built"

Actions Needed

Based on interviews with key actors in NZEB retrofitting projects, recommendations to strengthen the market drivers and to reduce the identified barriers are noted below.

Table 1. Recommendations for authorities.

AUTHORITIES	Strengthen drivers	Eliminate barriers
Increase attractiveness	• As part of information campaigns use relevant media and conferences to show good examples. • Place particular spotlight on the enthusiasts (both within owner organization and advisors). • Actors receiving grants also see this as confirmation of a good decision and see this strengthening the organization's image.	• Develop convincing arguments for nZEB. • Endorse serious frontrunners. • In some countries it is obligatory that companies have a statement about their impact on the environment. This could be extended by an obligation to state what energy labels their buildings hold. This increases the awareness of the issue of the energy efficiency of buildings.
Increase competitiveness	• Increased tax on energy. • Energy labelling systems provide a neutral reference for comparing buildings on energy performance and thereby increase the focus on this as a competitive advantage.	• Put in place training programs for all relevant crafts to be updated on nZEB upgrading. • Announce stepwise enforcement of building codes.
Make it more affordable	• Stronger subventions programs for owners upgrading towards nZEB (driver in some projects).	• Stronger subventions programs for owners upgrading towards nZEB standard (barrier in other projects).
Make it more available	• Make sure the top management of building owner companies see the benefits of nZEB upgrading and as a consequence they will be more open for such initiatives within their own projects.	• When public bodies upgrade their own buildings, nZEB ambition should be required. In this way both experience and good examples are developed locally. Tender processes must be defined adequately to avoid pure focus on price. A partnering contact for the design phase seems to be a good solution for this. • Facilitate arenas for the industry to meet with researchers and other companies to share experiences.

Table 2. Recomendations for the construction industry on how to increase the number of NZEB retrofitting projects.

INDUSTRY	Strengthen drivers	Eliminate barriers
Increase attractiveness	• Identify the owner segments which focus on sustainability. • Use relevant media and conferences to show good examples. • Place spotlight on the enthusiasts (both within owner organization and advisors).	• Develop convincing arguments for nZEB.
Increase competitiveness	• Research projects which focus on combining best innovations on component level in order to make more efficient retrofitting processes. • Smart changes of floor plan can improve the area efficiency per employee. Also smart extensions of the existing building, for instance add an extra floor on the top may also improve the economy of the project.	• Better initial audits of the building will reduce the amount of unforeseen challenges. • Systematic training programs to update the skills of all personnel involved in the projects; from planning, construction and hand over/use. • Use of QA tools to assure the quality of a) products/systems, b) competence of the involved actors and c) processes.
Make it more affordable	• Offer of ESCO contracts where the owner pays in accordance with the energy savings obtained.	• Offer of financing as part of the upgrading package.
Make it more available	• Spread the experiences to new regions so new potential clients can see good examples in their neighbourhood. • Make sure the top management of building owner companies see the benefits of nZEB upgrading and as a consequence they will be more open to such initiatives within their own projects.	• As it is a challenge to do deep retrofitting while the tenants stay in the building, use of prefabricated solutions may reduce the level of disturbance as well as the length of the on site retrofitting process.

The bullets in red are also reccomendations for the authorities, and therefore, should be joint efforts. The other bullets work in compliance with the measures that need to be taken by the authorities.

The final decision regarding ambition level of a renovation project will always be taken by the owner of the building. There are five principles that should be in place for a successful NZEB renovation project:

1. A holistic understanding of the tenant's needs – which normally encompasses more than just energy efficiency.
2. Solutions offering values that completely fulfill the needs.
3. One or more enthusiastic persons who are committed to the process.
4. A multi-disciplinary team (also involving occupants).
5. The project is supported by the top management and is in line with the company strategy.