

Think Denmark

White papers for a green transition

ENERGY RENOVATION OF BUILDINGS

Retrofitting Buildings for Cost,
Comfort and Climate

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Regulatory Framework

The building regulation plays a key role in Denmark's renovation of buildings

Developing Holistic Renovation Scenarios

Unpacking how value can be created in sustainable renovation processes

Smart Energy Systems and Renovation in Buildings

How to decarbonise the energy sector in an affordable way

Non-Profit Housing and Climate Change

Renovating the non-profit housing sector



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Retrofitting buildings for cost, comfort and climate

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RenovActive - a renovation project by the social housing company Foyer Anderlechtsois.

Photo: Adam Mørk

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ENERGY RENOVATION IN BUILDINGS IS VITAL TO EUROPE

By Miguel Arias Cañete, European Commissioner for Climate Action and Energy

The European Commission wants the EU to be leading in the clean energy transition. Therefore, the EU has committed to cut CO₂ emissions by at least 40 per cent by 2030 while modernising the EU's economy and creating jobs and growth for European citizens. In doing so, the Commission is guided by three main goals: Putting energy efficiency first, achieving global leadership in renewable energies and providing a fair deal for consumers.

To achieve this, we need to realise the huge potential for energy efficiency that exists in Europe. About 75 per cent of buildings are considered energy inefficient. And the change is not around the corner, as only 0.4-1.2 per cent of the building stock is renovated each year, depending on the Member State. More needs to be done.

The revised Energy Performance of Buildings Directive is a substantial element of the European Commission's work to achieve this. This revision was agreed upon by Council and Parliament in December 2017 as the first of eight legislative proposals of the Clean Energy for All Europeans package brought forward by the European Commission in 2016.

The directive includes measures to strengthen the energy performance of new buildings to accelerate the rate of building renovation towards more energy efficient systems and realising the huge potential for efficiency gains in the building sector - the largest single energy consumer in Europe. The crucial tool to increase renovation rates is the newly established goal of decarbonising national building stocks by 2050, with stronger long-term roadmaps and measures, intermediary milestones in 2030 and 2040, and a solid financial component.



Energy renovations in buildings create economic opportunities. The construction industry generates about 9 per cent of European GDP and accounts for 18 million direct jobs. Construction activities including renovation work and energy retrofits add almost twice as much value as the construction of new buildings, and SMEs contribute with more than 70 per cent of the value added in the EU building sector. It is estimated that the revised Directive will contribute to the creation of a renovation market for local SMEs of approximately EUR 80bn - EUR 120bn/year by 2030.

Energy renovation of buildings takes place all over Europe in so many ways. Family houses, flats, social housing, commercial buildings, institutions and even historic buildings are renovated with improved energy performance as a goal. The benefits are multiple. Often the projects result in innovative and inspiring buildings that

improve the indoor climate, comfort and living conditions for the people living in them.

In conclusion, energy renovation of buildings is essential for the EU if we want to meet our climate goals. We need to pave the way for more energy renovations through regulation, investment and incentives. Innovation and sharing of experience and best practices are essential to accelerate energy renovation throughout Europe. By promoting energy renovation, we get better energy performance, more comfortable and healthy buildings and create jobs and growth for European citizens.

Through energy renovations of our buildings, we build a modern, stronger and greener Europe - for the benefit of our citizens, our economy and the climate. In doing this, we are setting new standards and providing an example to the world.

ABOUT THIS WHITE PAPER

Buildings are one of society's greatest energy consumers representing almost 40 per cent of all energy used. According to the Danish Energy Agency approximately 85 per cent of the buildings we will live in by 2050 already exist today. Therefore, in order to reach the goal of a fossil free society by 2050, it is of key importance that we decarbonise the buildings we live in today to move further towards a green transition.

Renovation creating multiple benefits

An innovative building materials industry coupled with strict building codes and energy labeling have made Denmark a world leader in energy-efficient buildings. When renovating the existing building stock several technologies exist within the areas of insulation, windows, smart control systems and other solutions in order to increase the energy efficiency as well as indoor climate.

Through this White Paper you will see solutions, technologies, research and partnerships exploiting the benefits of retrofitting existing buildings. There is the potential for large energy savings creating a strong business case for energy renovation by reducing cost for heat and electricity short-term as well as increasing the value of the building long-term. Furthermore, increased quality in the indoor climate is a derived benefit in many of the cases which can have an important impact on the health of the buildings' inhabitants.

Undiscovered potential

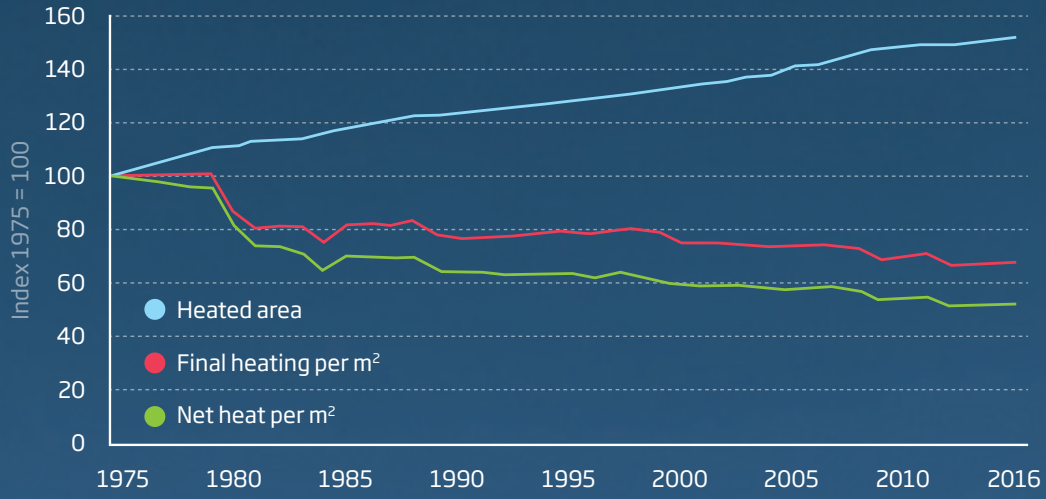
This publication shows that there are both economic, climate and health reasons in favour of energy renovations, but an important enabler to further accelerate the energy renovations globally is the dissemination of information. Information on solutions and the derived benefits in cost, climate and comfort is necessary to realise the potential of retrofitting buildings, also in terms of the effect it can have on the common energy and district heating system towards a low-carbon future.

There is still a long journey ahead in order to realise the large potential, which is seen globally within energy renovation where many solutions have yet to be developed. We hope this White Paper can contribute towards more efficient solutions in a green transition of the global building stock.

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Significant decline in energy demand for heating per m² from 1975 to 2016.



REGULATORY FRAMEWORK

The building regulation plays a key role in Denmark's renovation of buildings

To utilise the window of opportunity and make energy renovation cost efficient, the Danish building code has demands on how to improve the energy efficiency of a building when it is renovated.

*Renato Ezban, Special Advisor, Danish Energy Agency
Niels Bruus Varming, Special Advisor at the Danish Transport, Construction and Housing Authority*

Existing buildings have a key role to play in the green transition

The Danish government has an ambitious energy policy goal. In 2050, the energy supply will be independent of fossil fuels. In order to ensure that a transition to renewable energy is carried out as efficiently as possible, it is necessary to both expand renewable energy supply and reduce energy consumption. As 35 per cent of energy consumption in Denmark is used for heating and hot water in buildings, energy savings in buildings constitute an important element in energy policies.

The building industry has developed significantly over the last decades. Buildings that are built today have an energy consumption of about 30 per cent of those built in 1995. Hence approximately 70 per cent improvement. New buildings are therefore relatively energy efficient, but since new buildings only constitute a small part of overall building stock, there are still many older buildings with a relatively high energy

consumption. If energy consumption for buildings is to be reduced, it is important to focus on the older buildings.

Energy savings in buildings in Denmark are generally only cost-efficient when they are carried out in conjunction with maintenance work and other changes. A central element in the effort for energy savings is therefore to encourage building owners to utilise building renovations as an opportunity to carry out energy savings.

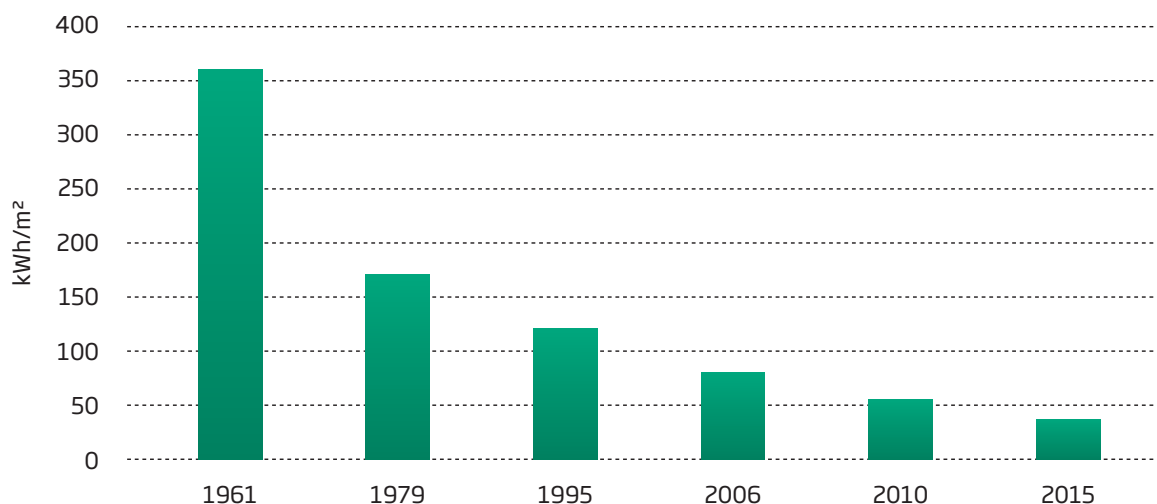
The Danish building code

One of the main policy instruments to achieve energy savings is the Danish building code. The code contains regulations regarding the energy performance of building components that are renovated or replaced. For example, if a renovation of a building includes the replacement of a window, a ventilation system or a roof, the building code defines the minimum standard of the energy performance of the component replacing the older one. The building codes

ensure that the existing building stock continuously becomes more energy efficient. This is reflected in the energy statistics, which show, that the energy consumption of buildings has been declining for many years. At the same time, the rules ensure that savings are made in the buildings when it also is economically feasible for the residents.

The building code as a driver for innovation

The building code is regularly revised in line with technological developments taking place in the construction industry. Whenever changes are made, it is usually preceded by an extensive consultation process with the industry to ensure ambitious and realistic changes. The changes are announced several years before they come into force, in order for the industry to develop new solutions and invest in the necessary production apparatus. In this way the building code is also used as a means to spur innovation in the industry.



This graph shows the energy requirement of new buildings in the Danish building code in different periods of construction. Energy requirements have been steadily declining over the last 50 years.

ENERGY LABELLING OF BUILDINGS

Status on Energy Performance Certificates (EPC) in Denmark

It is mandatory to have a valid EPC before a sale or rental contract is signed. Large public buildings must always have a valid EPC, even if the owner or tenant has not changed.

Henrik Blyt, Special Advisor, Danish Energy Agency

Energy Performance Certification

The responsibility for implementing the EPC lies with the Danish Energy Agency (DEA), including the daily operations, supervision, quality assurance and future development of the scheme. Energy performance requirements for new residential and non-residential buildings are found in the Danish Building Regulation from 2006. All EPCs are registered in a central database administered by the DEA and are displayed on its public website. The EPC documents rate buildings on an energy efficiency scale ranging from A (high energy efficiency) to G (poor energy efficiency). The EPC assigns an energy rating and lists cost-effective measures for improving the buildings' energy performance.

How the Energy Performance Certificate is done

Energy certification (EC) of single-family houses constructed less than 25 years prior to the certification can take place without an on-site visit to the building. EC of selected rental buildings can be based on the calculated or measured energy consumption. Buildings that can be certified by measured energy consumption include non-residential buildings, as well as multifamily buildings with a detailed and updated operational log. However, for office buildings and buildings used for administration, the EPC

has to be based on the calculated energy consumption if the rental represents more than 25 per cent of the total heated area of the building. An EPC based on measured energy consumption is not valid for sales. The validity of the EPC is 10 years.

Public Buildings and central web-based information

All public buildings with more than 250 m² of useable floor area are required to have and display a valid EPC. Since July 2012 this affects all buildings owned or used by the public. As of 1 January 2013, all other buildings which consist of an area spanning more than 600 m² is frequently visited by the public are required to display their EPC in a place visible to the public. Only the actual rating of the EPC is required on physical display. All other key information of the certificate is publicly available on the central web-based information server www.boligejer.dk. It is possible to view the EPC report on the website, description of the buildings, calculated consumption, as well as the name of the energy expert and the certified company who issued the certificate.

Improving EPCs of public buildings

In 2017, the Danish Energy Agency, in cooperation with a network of property managers of larger public buildings, took

the initiative to improve the EPC of public buildings. The impetus behind the initiative was a number of municipalities and regions providing feedback that the statutory energy labelling of public buildings today could be more effectively utilised as a tool for making public buildings more energy efficient. Based on the initiative, a number of specific barriers were identified as initial measures to overcome in order to ensure the Energy Label Certification more effectively supports efforts with the energy efficiency of public buildings.

Average pricing of energy standards

In 2013, the consultancy Copenhagen Economics was commissioned by the Danish Energy Agency to examine the relationship between house prices and energy standards. One of the key results that emerged was that the energy standard has a clear and significant influence on the house price and the purchaser's willingness to pay a premium for a higher energy rating. For example, in the case of a 100 m² house with a C-label rating compared to a D-label rating house it was found, that it capitalised into a willingness for the house-owner to pay a premium price of DKK 44,000 for the higher rated house, a figure which is equivalent to EUR 6,000.



LEGO® House - Home of the Brick in Billund has got an Energy Performance Certification A2020.



B Porskær 17
8220 Brabrand

Type: Detached single-family house
Built: 2009
Heat: District Heating

→ [See the Energy Certificate](#)

ENERGY PERFORMANCE CERTIFICATES IN DENMARK

In the current EPC scheme, from September 2006 until April 2018, the number of EPCs issued is approximately 660,000. The Danish Energy Agency registers about 60,000 new EPCs every year, with a total of more than 1.4 million EPCs issued in Denmark since the initiation of the certification in 1997. At sparenergi.dk, you can find an overview of all the EPCs in Denmark.

INVESTING IN ENERGY SAVING SKILLS

New skills are required to release the saving potential in buildings

In Denmark, a publicly funded Knowledge Centre works to improve the energy saving skills and hands-on knowledge of building sector professionals.

Vagn Holk, Head of the Knowledge Centre for Energy Efficiency in Buildings

The building sector in Denmark has a go-to place for guidance on energy savings in buildings. 10 years ago, the government established a national Knowledge Centre for Energy Savings in Buildings, and since then, the Centre has taken active part in improving the skills and knowledge regarding energy savings among building professionals in Denmark.

Head of the Knowledge Centre Vagn Holk says: "Strengthened knowledge about energy savings in practice and new skills are crucial to realise more energy savings in buildings. Here the Knowledge Center plays an important role by educating the building sector about the potential for energy savings and practical implementation. Further, we assist in ensuring that legislative actions designed to advance energy savings are communicated to builders."

Free access to information

Through the Knowledge Centre, professionals in the building industry have free access

to information, facts, instructions and guidance about how to choose the right technical solutions and construction methods for achieving energy savings in buildings. The main products of the centre are three catalogues containing descriptions of 80 specific energy saving measures, including insulation of various building elements and replacement of windows, boilers and other technical installations. "Our tasks fall into three categories: providing knowledge, developing solutions and communicating the results. So, organising and running motivational seminars, workshops and conferences for the building sector is just as important for us as it is to develop technical materials," says Vagn Holk.

Telephone hotline and web services

The Centre offers a telephone hotline and various web services to building professionals, including teachers and students at vocational colleges, contractors, tradesmen, installers, consulting engineers, architects and energy consultants. In most cases,

professionals contact the Knowledge Centre to obtain immediate, practical, hands-on answers to questions about how to implement a specific energy saving solution - regardless of whether it is for a small house or a big building.

Close contact with the market

One of the reasons for the success of the Centre can be found in its network strategy, according to which the Centre develops knowledge and materials and disseminates the results in cooperation with trade and other professional organisations, schools and authorities, etc. As part of this strategy, the Centre has an Advisory Committee consisting of 13 different trade organisations in addition to the Danish Energy Agency. The Advisory Committee supports the Centre by giving market input to the Centre's planned activities and disseminating tools and services, developed by the Centre, to their members.



FACTS AND FIGURES

From 2008 - 2011 the government allocated DKK 32 million (equivalent to EUR 4.3 million) to the establishment and operation of the Knowledge Centre. Since then the yearly appropriation of funds for the Centre has amounted to approximately DKK 5 million (equivalent to EUR 670,000).

Energy savings efforts in buildings have had a positive effect in Denmark; Energy consumption for household heating per square meter fell by 17.5 per cent from 1990 to 2015.

TARGETED AND COHERENT INFORMATION

Website and targeted campaigns go hand in hand with other measures for energy efficiency

Denmark has a huge potential for energy efficiency in buildings - especially in single-family houses. Information plays a large role in realising this potential.

Line Kold, Advisor, Danish Energy Agency

Denmark has a history of combining information campaigns with regulatory and economic measures regarding energy efficiency in buildings. Energy renovation and reduction of energy consumption is often complex and involves decision makers who lack insight regarding technical possibilities or the economic and comfort benefits of implementing energy savings. That is why communicating relevant information plays an important role in realising the potential.

One-point entry

Today, the Danish Energy Agency's information activities regarding energy efficiency are concentrated on the website, SparEnergi.dk. SparEnergi.dk is a one-point entry to all the agency's information regarding energy savings.

The site is based around 'landing pages' and 'theme pages' including facts, cases, guides and digital tools. The website supports initiatives to promote energy savings, such as energy labelling and is a joint platform for

all the agency's campaigns and initiatives aimed at end-users. The purpose is to create synergies between the various initiatives and make it easy for users to find impartial, quality content on the subject.

Targeted campaigns

In order to make energy efficiency messages effective, one needs to target the information to specific groups and make messages relevant for the target group. It is important to target efforts so that relevant information is readily available and for example, the homeowner is met with relevant messages in connection with the decision to refurbish the home when a house gets new owners, as this is where energy renovations are most cost-efficient.

Motivational factors

Of course, not all people are driven by the same motives. In terms of reducing energy consumption, there are also different motivational factors at work. Some homeowners are driven by the possibility of a

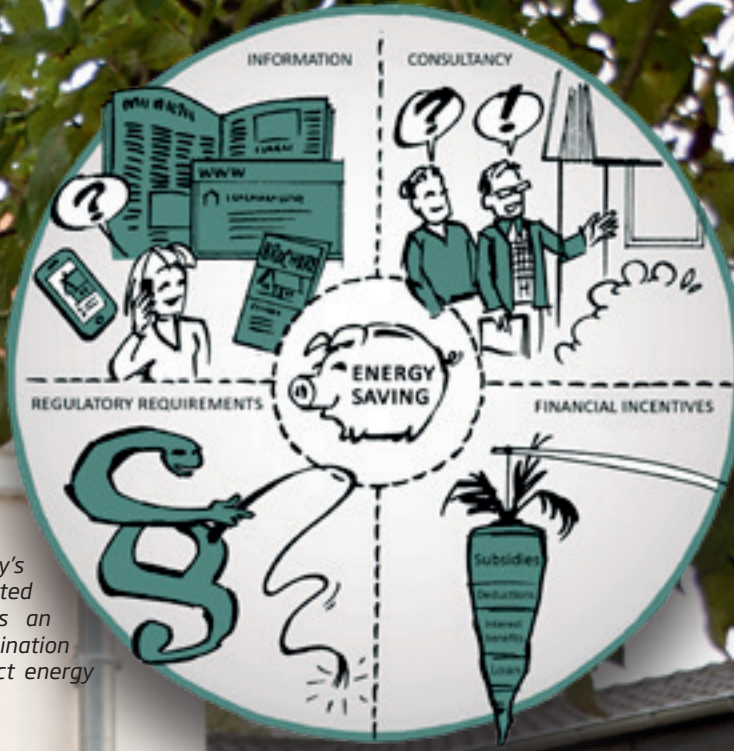
monthly saving while others do not really care. Instead, they may be driven by better comfort and indoor climate, while for others it is important to reduce CO₂ emissions and do something beneficial for the environment. The differing motives should be kept in mind, because the more accurately information campaigns address the needs of the homeowners, the larger the effect.

Network involvement

The Agency's information activities are, as much as possible, conducted in dialogue and interaction with key actors. This applies to the design, implementation and anchoring of concrete activities. When people seek information, they often ask the same people for advice time after time, because people seek a source of information they know and trust. Therefore, a trusted sender is important when conducting information campaigns. The Agency's experience is that the establishment of ambassadors within the network maximises impact and helps secure a longer life span.



The Danish Energy Agency has together with local authorities, successfully held more than 70 public meetings with a focus on the replacement of oil boilers. Invitations to the events are sent by the local authority via the digital mail system, e-boks to all homeowners with oil boilers in a certain area. At the event participants can ask questions to impartial energy counsellors, meet local craftsmen, heat pump companies etc. The events are popular and a preliminary evaluation reveals that half of the participants have subsequently taken energy-saving measures and approximately 30 per cent have replaced their oil boilers with a more energy efficient heat source.



The Danish Energy Agency's experiences show that targeted and coherent information is an important element in the combination of measures needed to impact energy efficiency.



DEVELOPING HOLISTIC RENOVATION

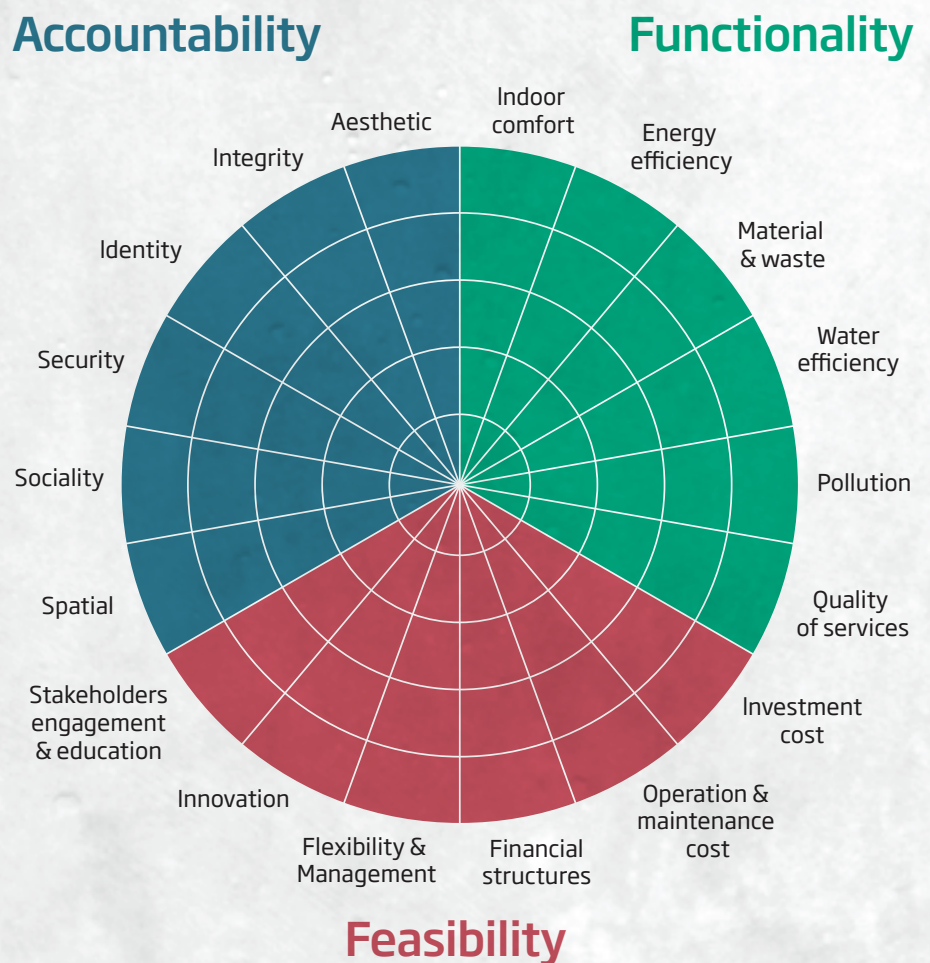
Unpacking how value can be created in sustainable renovation processes

Building renovation in the future will encompass broader sustainability concerns and holistic renovation scenarios.

*Dr Aliakbar Kamari, Postdoctoral fellow, Dr Steffen Peterson, Associate Professor
Dr Søren Wandahl, Professor, Dr Poul Henning Kirkegaard, Professor
Department of Engineering, Aarhus University, Denmark*

WHAT

Value in sustainable renovation is a complex and dynamic design discipline, given its multifaceted value profile and involvement of many different stakeholders (architects, engineers, municipalities, contractors, building occupants etc.). The value of the renovation as the outcome of a sustainable building renovation project will be judged differently depending on the social context, and who is the “judge.” It is always interpreted and negotiated in a social context where personal interests and priorities shape the discourse and sometimes collide. The sociocultural context might remain unaltered during a renovation project, but values still change, dissipate or disappear entirely. Therefore, it is important to study the creation of values and where they can be added within the sustainable building renovation field, which is the key objective of the ReVALUE project. The concept is based on modern information and communication systems. As such, it is of special interest to verify the need for the deep understanding of sustainability as the pattern with the agglomerated set of indicators defined by the relevance criteria. For instance in the illustration on the right, the sustainability has been represented particularly for renovation field within three overall categories Functionality, Accountability and Feasibility and a total of 18 sustainable value oriented criteria.



Sustainable Renovation Value Map

It consists of three overall categories Functionality, Accountability and Feasibility (a total of 18 sustainable value oriented criteria and 118 sub-criteria). The major part of the criteria in the Functionality category are quantifiable (Hard), while criteria in Accountability are more qualitative (Soft). The Feasibility category contains a mix of quantitative (i.e. cost criteria) and qualitative criteria such as advantages in using an efficient renovation process where it embraces the key stakeholders.

SCENARIOS

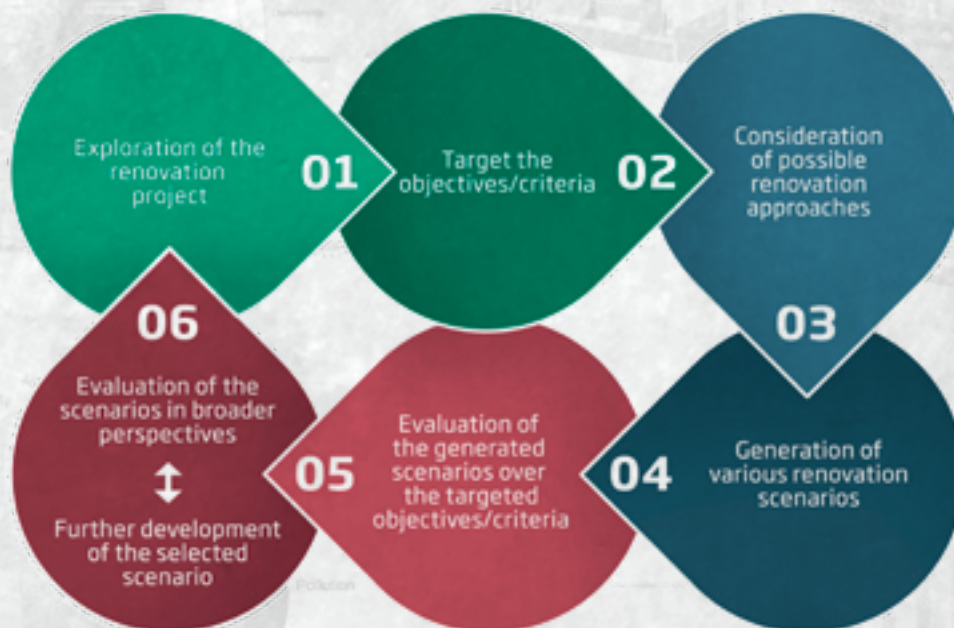
Reducing buildings' energy consumption and emissions is a key objective to meet the EU's energy and climate goals. In addition, it is also a necessity to ensure buildings' functions and qualities, and to provide a positive living environment. Therefore energy efficiency is not the only goal in renovation of buildings. Existing buildings can benefit from adopting a broader approach to sustainability, which seeks to

decrease operation and maintenance costs and reduce environmental impacts. A broad approach can also increase the building's adaptability, durability, and resilience towards future challenges as well as a preferable, healthier, and more convenient environment for the occupants. This underline a holistic approach where various objectives linking to the sustainability are achieved in a balanced way. The key points and essential

factors to take into consideration when developing holistic renovation scenarios are 1) identification of sustainable renovation objectives and criteria 2) indication of the renovation approaches, and consequently 3) how to deal with the complexity of decision-making within a systematic design methodology.

HOW

The terms sustainable renovation and holistic renovation scenarios serve to underline a holistic approach where various objectives linking to the sustainability in its full sense are achieved in a balanced way. Identification of sustainable renovation objectives and criteria, indication of the renovation approaches, and consequently, how to deal with the complexity of decision-making within a systematic design methodology, are the key points and essential factors to take into consideration when developing holistic renovation scenarios.



Characteristics of a multi-methodology design for the development of holistic renovation scenarios

It is characterised by a mixed-methodology strategy that alternates between techno-economic and socio-cultural decision-making to establish renovation objectives and criteria as design goals, generate and evaluate a set of renovation alternatives (as renovation scenarios) against these objectives and criteria, and then guides stakeholders in selecting the alternative that best accommodates their needs.

SOCIAL AND ECONOMIC VALUE CREATION THROUGH ENERGY RENOVATION

Energy renovation aims to make comfortable living affordable for all

In addition to delivering reductions in energy consumption, the renovation of the Wilmcote House aimed to extend the lifetime of the buildings and transform their visual appearance to create attractive living conditions for the residents.

*Susanne Dyrbøl, Director, Group Public Affairs, ROCKWOOL Group
James Traynor, Managing Director, ECD Architects*

Poor housing and its consequences

Portsmouth's 100-home Wilmcote House development in the UK was built at a time when energy performance was less of a priority than it is today. Constructed in 1968 from prefabricated concrete panels that had just 25mm of insulation, it also featured electric heating that makes it very costly for residents to stay warm indoors. As a result, many residents were unable to afford adequate heating of their homes. This is a

serious issue in Europe, where 10.8 per cent of people cannot afford to keep their homes warm. Countries with the worst performing housing have higher winter mortality rates in both warm and cold climates. In Europe, over 80 million people also live in damp homes, which can cause respiratory illnesses.

At Wilmcote House, although residents liked their flats and the location, poor energy performance was a major problem. It led to high heating bills and homes with an unhealthy indoor climate caused by mould, damp and condensation, which can adversely affect health. Recognising that poor insulation was the main problem, the City Council embarked on a major energy efficiency upgrade, designed by ECD Architects to the EnerPHit standard, the Passive House Standard for retrofit. The aim was to reduce heating demand by 90 per cent and extend the building's lifespan by 30 years.

Deep retrofit improving living conditions

Prior to the renovation, the buildings were in very poor condition, resulting in an unhealthy indoor climate. Two thirds of the residents were experiencing excessive cold and damp in the winter and many were worried about rising energy bills. Insulation made a tangible difference. Significantly reducing heat loss through the thermal envelope by insulating the building wall, along with other measures, will help the project meet the EnerPHit standards. The entire neighbourhood has gone through an architectural upgrade and by using durable and high quality materials, the residents' positive perceptions of the new neighbourhood is now expected to endure for decades.

The "deep retrofit" project involved different insulation measures, with ROCKWOOL REDArt® providing external wall insulation, Rockpanel® used for cladding and a selection of fire protection products included for fire safety. The result will not only help take residents out of fuel poverty - it will also make Wilmcote House a more pleasant and safe place to live.

*Wilmcote House,
Portsmouth, UK, 2014
Source: ECD Architects*



IMPROVED INDOOR CLIMATE AS ADDED VALUE IN ENERGY EFFICIENT RENOVATION

Energy efficient renovation of facades improves learning of children

Solbjerg school is a good example of the added value that can be realised from improving the indoor climate at a minimum extra cost when renovating facades in schools.

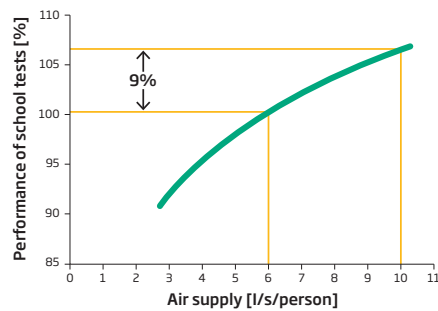
Alice Andersen, Specialist in indoor climate, energy and sustainability, COWI

Recent research in Danish schools show that in more than 50 per cent of cases, the air quality does not meet requirements. This is a problem for that affects the students' learning ability and concentration, which has wider societal ramifications. In comparison to adults, a bad indoor environment is more critical for children, as they are still developing. In fact, children can miss the equivalent of one educational year due to a poor indoor climate.

Improved indoor climate creates added value

A holistic approach to the renovation of a school in Solbjerg in Aarhus created added benefits by improving the indoor climate. This was done by increasing the air change rate using natural ventilation through new façade modules. The natural ventilation air intake is located in the upper part of the façade modules. The air is then supplied through the entire area of the newly installed permeable ceiling, creating draught free conditions in the classrooms. Furthermore, the windows have built-in

solar shading, Microshades. The façade modules are prefabricated and designed with respect to the existing building geometry and usage.



Tests show that the performance of children can be improved by 9 per cent with a slight increase of the fresh air supply [Professor G. Clausen, Technical University of Denmark]

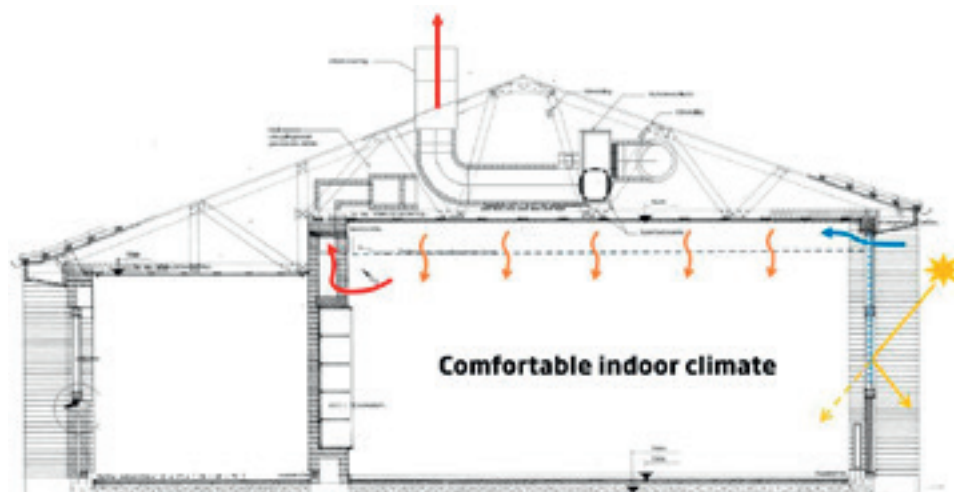
Added value in connection with future energy efficient façade renovation

The façades required additional controls for the natural ventilation openings and

the existing mechanical exhaust. However, the added value of an improved indoor climate is massive when compared to the minimal additional capital investment. In the period after the renovation (from 2010 to 2017) the average graduation grades (GPA) improved by 20 per cent. Additionally, absence due to illness was reduced from 5.1 per cent to 2.6 per cent. In energy efficient facade renovation, focus is often limited entirely to heat loss, but a holistic approach to solving indoor climate leads to added value for projects with improved results across parameters.

Despite huge investments in energy optimisation in Danish schools since 2010, measurements indicate that the indoor air quality has not improved significantly. The Solbjerg case is a good example of the potential to improve the indoor climate when renovating façades in schools.

Contributors: Municipality of Aarhus, COWI, Protec, Troldekt, MicroShade



Renovation concept of façades: Air intake occurs through grilles in the upper part of facades using natural ventilation. The even air supply makes it possible to increase the air change rate draught free. Additionally the Microshades in the windows minimise the risk of overheating.

RENOVACTIVE GIVES SOCIAL HOUSING A HEALTHY MAKE OVER

New concept shows that improving indoor comfort is a viable undertaking

One in six Europeans lives in buildings that are too damp, too dark, too warm or too cold. An unhealthy home is not only uncomfortable but also bad for society.

Henrik Norlander Smith, Architect, VELUX
Kurt Emil Eriksen, Senior Political Advisor, VELUX

A case of seven elements

RenovActive House is a single-family house constructed by the public housing company Foyer Anderlechtois, located in Brussels. In 2016, the house was renovated based on the concept of "Climate Renovation", which aims to create a first-rate indoor climate with good energy performance.

To make it affordable for social housing projects, the concept consists of seven different elements, which can be implemented individually or in any preferred combination. Each element supports specific properties that will improve ventilation, strengthen the climate envelope and expand the living space through densification or extension. The inherent flexibility and scalability of the elements makes RenovActive highly accessible.

Scalability provides opportunities

The financial side is important. When addressing the many public housing communities that need to be refurbished, budget issues are a common obstacle. By improving the financial viability of renovation, millions of existing homes suddenly become open to further investment.

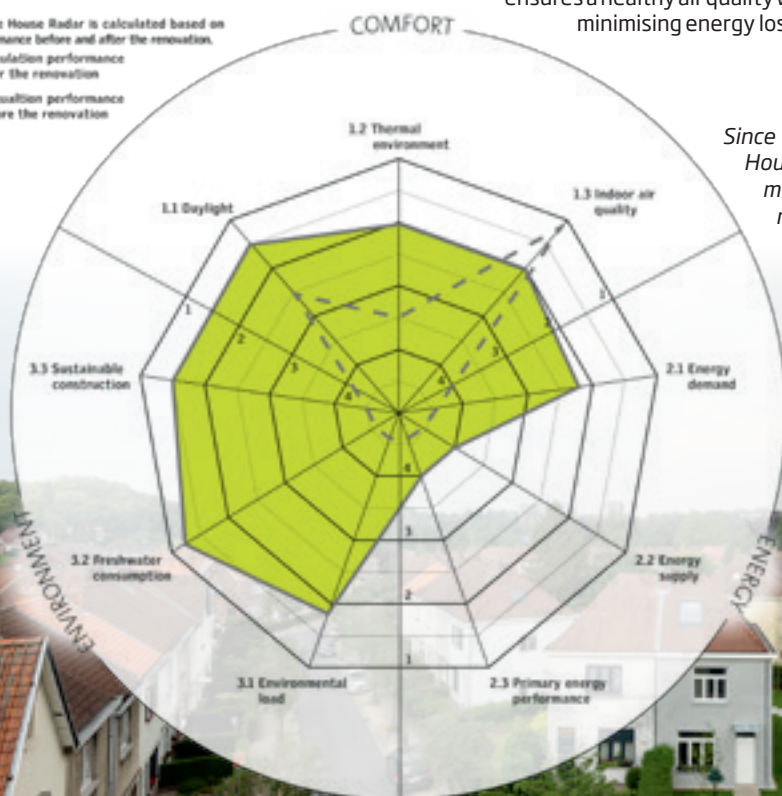
In Brussels, the public housing company decided to renovate further 86 homes due to the scalability of the concept. Amongst the many benefits gained by implementing the concept, homeowners now enjoy a significant improvement in access to natural light, thanks to use of strategically placed roof lights and a glazed extension. Automated natural ventilation is established through the controlled windows and the open staircase. The ventilation is energy efficient and is regulated according to humidity, temperature and CO2 levels, which ensures a healthy air quality while minimising energy loss.

A viable treatment for European society

Due to the increasing age of the European building stock, unhealthy buildings have become a public health issue. These unhealthy buildings do not only affect inhabitants physically, but also have an impact on the general economy. Every year European societies face a cost of EUR 82 billion to cover just a handful of the illnesses caused by unhealthy buildings. However, if just 2 per cent of European homes were renovated with an emphasis on health every year, by 2050 we could reduce the number of Europeans who live in a damp and unhealthy home by 50 per cent. The RenovActive project in Belgium proves that by exploiting a renovation concept that can be adapted to even the strictest of budgets, it is possible to solve one of the biggest health issues in European society.

The Active House Radar is calculated based on the performance before and after the renovation.

- Calculation performance after the renovation
- Calculation performance before the renovation



Since the RenovActive project was built on the Active House concept, the Active House radar was used to measure the success of climate renovations. The tool reflects the three main principles in active house renovation projects, which are comfort, energy and environment. Following the Active House principles means creating healthier and more comfortable homes without a negative impact on the climate.



RENOVATION AND CULTURAL HERITAGE

Unfolding potential heat and energy savings

Discovering methods to save energy in a heat demanding building whilst respecting the original architecture and cultural value.

Mari Brandl, Head of Renovation and Building Physics, Rambøll

The synagogue in Copenhagen was built in 1833 and is a listed building after being deemed worthy of preservation by the Danish Ministry of Culture. The building is used several times a day for religious gatherings, lectures and especially during the Jewish Sabbath each Saturday. For various purposes, an effective heating system is required in a cold climate like the Danish one, but as the building is almost 180 years old, the insulation level and structure do not enable a warm indoor climate. Therefore, to heat the 1225 m² in the synagogue, the Danish Jewish society saw the need for an energy reduction project to save both heat and energy as well as increase the functional heating features.

Architects and engineers from Rambøll initiated the renovation project of the old synagogue, which is constrained by the obligation to maintain original architectural, cultural and environmental aspects due

to its heritage-listed status. A special focus has been on the design of intelligent technical solutions within the framework of the restrictions of a listed building structure with a high level of sensitivity to the exquisite detailing of the interior. The Rambøll integrated design setup covers the entire scope of services required for the project and supports a lean, efficient and comprehensive take on the delicate transformation of an iconic building into an up-to-date setting and comfort requirements. The close in-house collaboration within Rambøll between expert disciplines - architects and engineers - supports the successful implementation of new technical standards in a delicate architectural setting.

The renovation process included the addition of adequate roof insulation, installation of removable windows with energy measures, a new heat-distribution installation, ventilation system and, lastly,

a replacement of existing light sources with LED lighting. The new heat installation enables energy savings through various measures, for example by making sure that the capacity equals the heating demand to alleviate the need to supplement demand with expensive electricity heating.

All initiatives are installed with the aim of saving heat as well as lowering energy demand in the old building. Consequently, energy reductions will influence operational costs and potentially reduce CO₂ emissions at the same time. Supporting the project business case, Rambøll has calculated the potential reduction of energy consumption for heating to be 100 MWh per year, which amounts to a 35 per cent reduction. In the end, the old synagogue can expect to reduce annual energy costs by DKK 117,000 (EUR 16,000), and simultaneously ensure an energy efficient building with a warm and comfortable indoor climate for the users.



SMART ENERGY SYSTEMS AND RENOVATION IN BUILDINGS

How to decarbonise the energy sector in an affordable way

Energy renovation of existing buildings will not only decrease energy demand but also lead to further efficiencies in energy supply as well as the integration of renewable energy.

Henrik Lund, Jakob Zinck Thelleuvsen and Brian Vad Mathiesen, Aalborg University

Approach to future energy systems

Denmark and many other countries and regions around the world are working on decarbonising the energy sector. There is growing recognition among the public, as well as in the building and energy sectors, that one must take an integrated approach in order to achieve this goal. Savings, heating, cooling, electricity, transport and gas cannot be seen as separate elements. In the future, these sectors need to be integrated. Here, energy efficiency in buildings plays an important role.

Savings in heating demand make it possible to decrease the temperature of the heat supply, which benefits both district heating systems and individual heat pumps. Moreover, this result of energy savings and district heating will further the affordability of solar thermal, geothermal and waste-heat utilisation. Combined with sector integration, this leads to more affordable thermal storage options that can increase the integration of wind and solar energy.

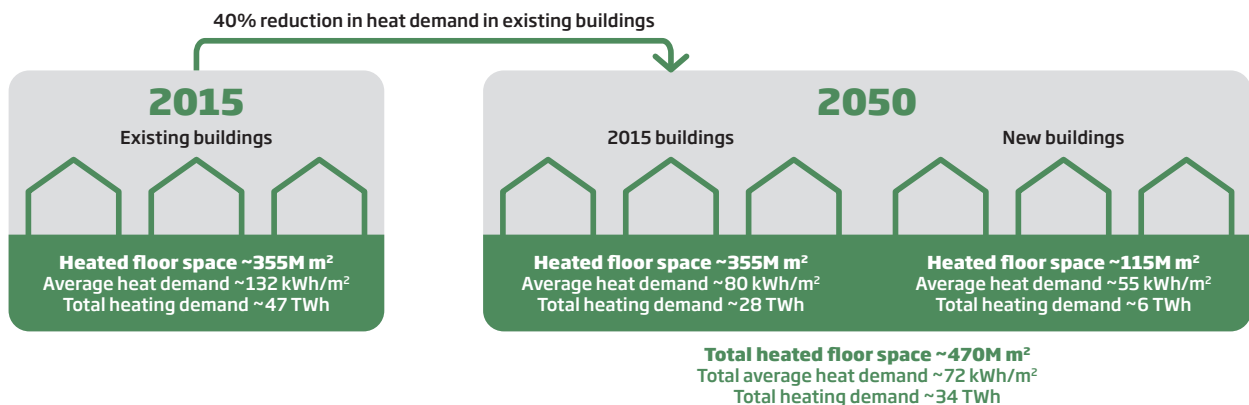
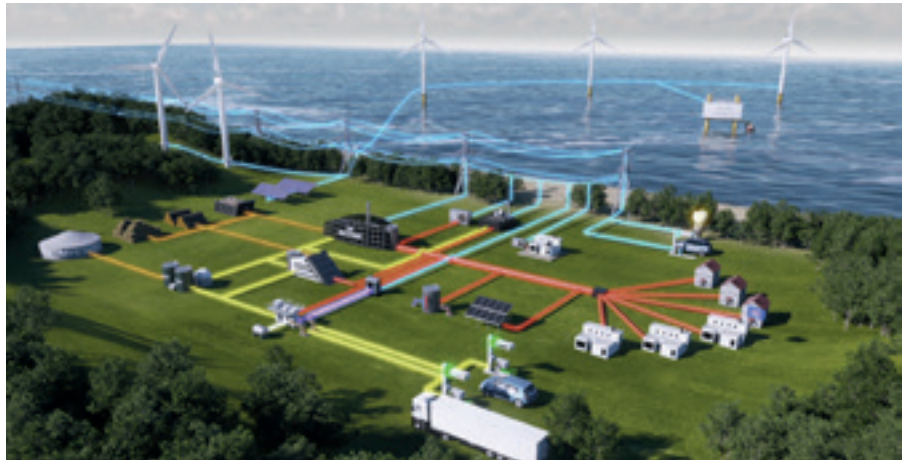
To realise the future role of existing and new buildings, one needs to understand the changes in the energy system around buildings. In this, when identifying affordable paths to decarbonisation, it is key to take an integrated Smart Energy System approach. This approach relies on the benefits from

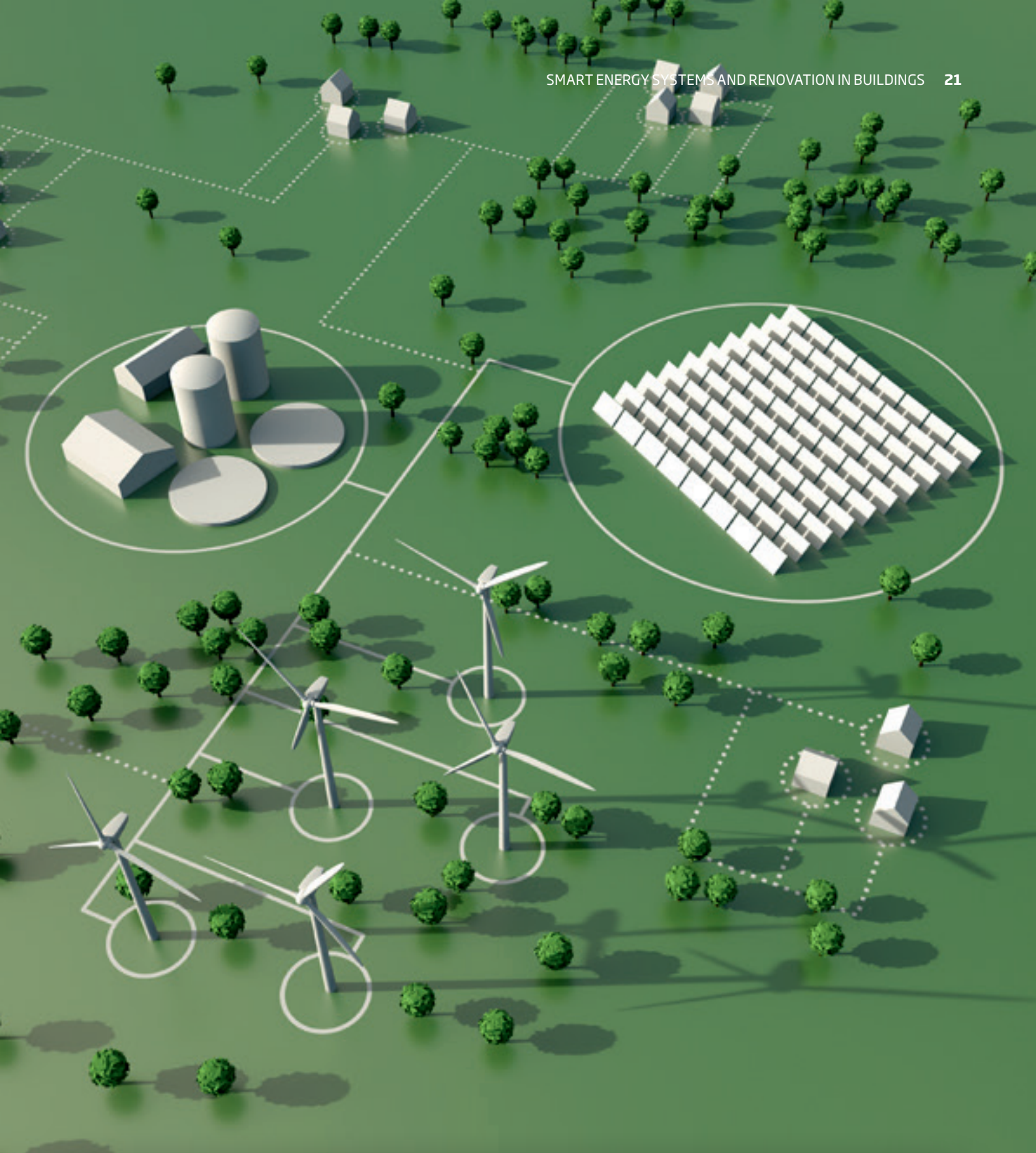
the synergies between savings, energy efficiency, and interactions between energy sectors, in combination with an integrated use of storages and existing infrastructures.

Supply level as enabler

The contribution of the building sector is essential to establish smart energy infrastructures and a 100 per cent renewable energy system. Recommendations to increase energy savings activities and support behavioural changes in the operation of buildings go hand in hand with supply level recommendation. It is essential that heat

savings in existing buildings are implemented together at the given moment of general renovation and refurbishment in a building. Otherwise, the cost of achieving demand savings is excessive and a renewable energy system by 2050 risks becoming more costly. For the building stock that exists today approximately 40 per cent savings can be recommended for space heating (including hot water). Although new buildings pose a smaller challenge overall, it is key that recommendations are made which facilitate savings to a level at which the supply of renewable energy becomes cheaper.





PROPOSAL FOR ENERGY SAVINGS IN DENMARK IN THE FUTURE

- District heating should be expanded further to replace individual boilers
- New supply systems with low temperature district heating from solar thermal
- Large-scale heat pumps, geothermal, waste incineration, and biogas should be supported outside district heating areas
- Efficient ground-source heat pumps supplemented with solar thermal

SMART CENTRAL HEATING CONTROL AND MAINTENANCE WITH AI

Cut heating costs by up to 20 percent and make buildings virtual power plants for the energy network

Implementing a smart heat control system in existing building stock can increase energy efficiency and indoor climate, whilst optimising the district heating network.

Jukka Aho, CEO, Leanheat Oy

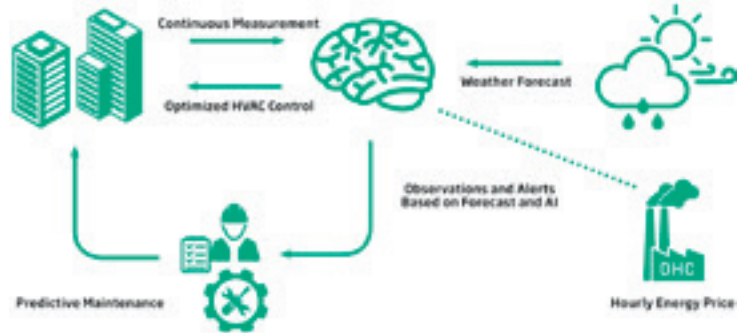
Traditional central heating systems fail to adjust to changing weather, living patterns and thermodynamic properties of the building. This results in overheating, inefficiency, high costs and poor indoor climate conditions. At the same time, heating systems are inadequately balanced in up to 75 per cent of multifamily buildings. The Danfoss partner, Leanheat, uses artificial intelligence to optimally control and monitor centrally heated buildings. The solution is scalable and retrofitable to existing building stock with wide integration to various controllers. Data from a heating room is combined with data collected from IoT(Internet of Things)-sensors placed in the building's apartments. By processing the collected data with AI, the central heating can be controlled in an optimal manner taking into account the thermodynamic behaviour of the building; weather, ventilation, inhabitant living patterns, etc. The heating control adapts to the changing environment making the system maintenance free.

In addition to better control, AI is used for predictive maintenance. Problems are

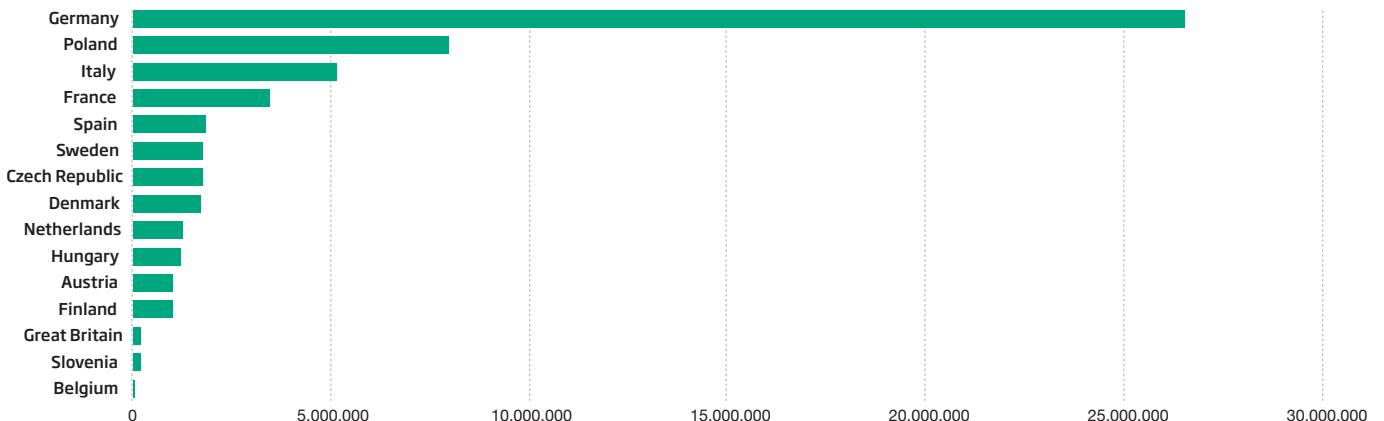
detected at an early phase with pinpointed accuracy that uncovers the root cause of the problems. For district heating companies, it provides an opportunity to optimise their energy production with demand response; buildings can be turned into virtual power plants that can be optimised like any other part of the production.

The smart control of central heating combine data science talent with the best HVAC specialists and software developers. This mix has proven successful - the solutions are already installed in 35,000

apartments all over the world, including Finland, China, Sweden, Germany and Denmark. The business model is based on a one-time investment in the sensors and the software setup fee combined with an annual service fee. The benefits to the heat providers and consumers are clear, with a potential saving in energy consumption of 10-20 per cent. Furthermore, the maintenance costs potentially decrease by 5 per cent, the peak capacity can be reduced by 15-30 per cent, the indoor climate improves, and lastly, district heating companies can optimise their production and network.



MARKET POTENTIAL: AMOUNT OF CENTRALLY HEATED APARTMENTS IN DIFFERENT COUNTRIES



SCANDINAVIA'S LARGEST RENOVATION FOR CERTIFIED PASSIVE HOUSE

A renovation project with a strong business case increasing the building value for owner and tenant

The 123 Vester Voldgade renovation project in Copenhagen reduced operating costs by 76 per cent, whilst increasing overall value via reduced energy and water consumption and improved indoor climate.

Lars Ørtoft, Director, Ørtoft

Renovation project components

The project went from an intended renovation of windows and concrete damages to an extensive energy efficiency renovation process. This included a thorough renovation of the building envelope, establishment of an efficient mechanical ventilation system, recycling rain water to use in toilets, changing existing lighting to daylight controlled LED lighting, establishment of natural preheating and cooling of ventilating air through vertical wells as deep as 25 meters. The indoor climate was improved with an efficient mechanical ventilation solution with natural cooling using the ground water and exterior solar shading in combination with additional natural ventilation. The primary solution towards the improvements was the solar storage under the building, which reduced heat loss by approximately 50 per cent through existing floors. Furthermore, waterless toilets as

well as rainwater collection and recycling, helped reduce water consumption and flooding problems. Negotiation with the district heating supply company HOFOR has resulted in a reduction of fixed taxes due to the fact that the property does not use solar heating for hot water production and that district heating can be interrupted on weekdays during the peak hours.

Strong business case

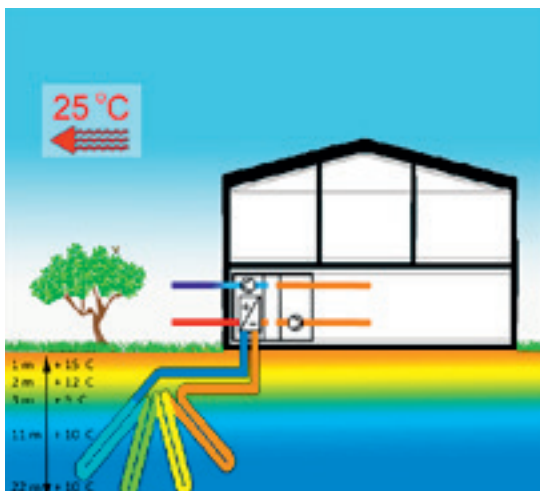
The project also demonstrates a strong business case via the return on investment from the different elements. Originally envisaged as a EUR 1.5 million project, its scope was expanded to encompass renovations to alter the building into a low-energy property with a budget of 3.1 million EU. This proved to be profitable by recognising future and planned maintenance and increased payments from tenants. The investment resulted in a direct payback time

for the window elements of 6 years and the LED lighting with daylight management of 10 years. Furthermore, the project reduced the building's energy consumption by 86 per cent; improving the Energy Label from F to A1. Lastly, through the recycling of rainwater the building has ensured 1,090 m³/year in water savings adding to the total value of the project and the building.

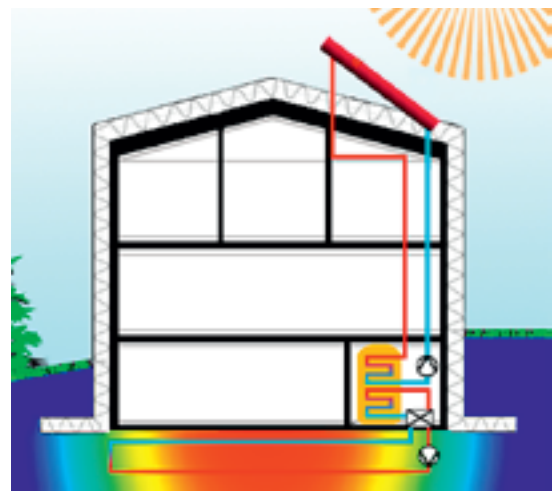
FACTS

Construction period: **2011-2012**
 Building Owner: **Danish Building and Property Agency**
 Consulting engineer energy and sustainability: **Ørtoft**
 Area: **7.000 m²**

Ground drilling for preheating and cooling of air intakes for ventilation



Solar heat storage under the basement floor halves heat loss, the solution is patented by Lars Ørtoft



A HOMEOWNER CENTRIC ONE-STOP-SHOP MODEL FOR ENERGY RENOVATION

Energy renovation with the aim to create comfortable and healthy living conditions

BetterHome creates a burden-free experience for the building owner and offers a service that goes beyond replacing building components.

*Niels Kåre Bruun, Managing Director, BetterHome, www.betterhome.today
 Susanne Dyrbøl, Director, Group Public Affairs, ROCKWOOL Group*

Europe faces a profound challenge - to triple the current renovation rate in order to meet its climate and energy goals. The urgency is stressed by the reality of inadequate and poor housing, causing high energy bills and health issues. At the same time, energy renovation of the building stock represents an exceptional investment opportunity, with the capacity to boost the economy and generate local jobs whilst creating comfortable and healthy living conditions.

For building owners, the renovation process can be a hassle, shaped by the ambiguity of the measures to implement. Uncertainty is one of the reasons why the renovation rate continues to linger around 1 per cent and private investments remain limited. Achieving the full market potential of renovation calls for a paradigm shift, where a more service-oriented supply-side together with a deeper awareness on the demand-side play a key role.

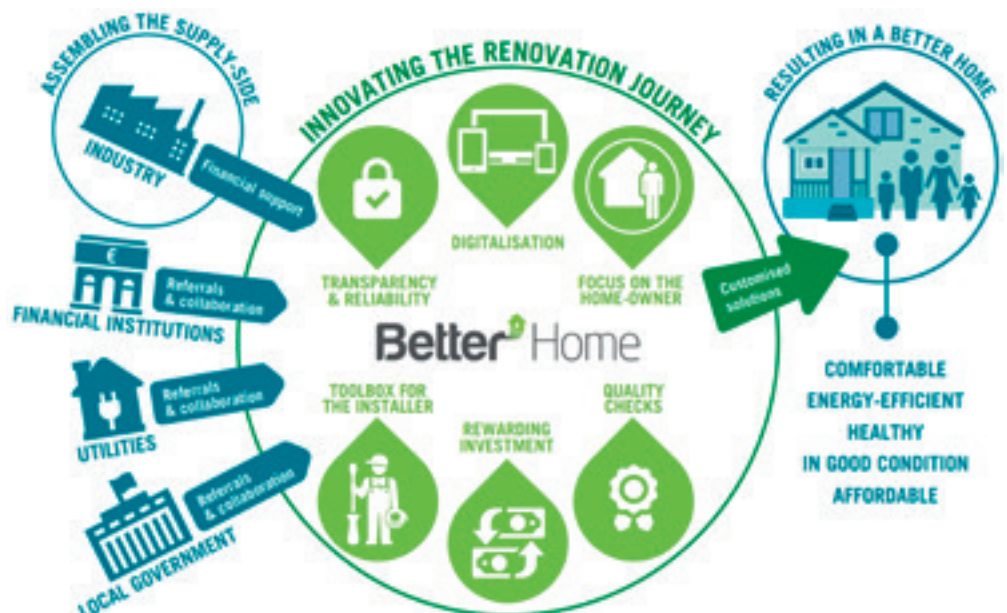
Facilitating a simple renovation process

BetterHome delivers a comprehensive digital one-stop-shop solution in partnership with key players in the construction value chain, including banks. Homeowners are offered tailor-made solutions based on his/her specific preferences, covering energy improvements in the building envelope, heating, cooling, ventilation and hot water systems. The process utilises holistic planning, optimising the value chain by minimising efficiency losses, miscommunication and avoiding lock-in effects.

The real innovation of the model is the transformation of the installers' work to better meet the demands and concerns of the homeowner. BetterHome is structuring the entire renovation for the installers, including guidance, training, support and clear deadlines.

As facilitator, BetterHome is transforming a complex and fragmented renovation process into a simple and straightforward procedure for the homeowner. For the installers, BetterHome clusters suitable projects and helps them to better structure the renovation process.

The figures show the success of the model. BetterHome started in Denmark in 2014 and was already profitable after 3 years. Today, they have a network of more than 3,500 installers, five banks and four utilities. The main target is deep renovation projects of single-family houses. The average project investment is EUR 70,000 with energy savings of approximately 30-70 per cent. Indirect turnover was in 2017 was EUR 13 million with 334 projects and a rapidly growing demand.



PRESERVING THE PAST AND SHAPING THE FUTURE

Siemens modernises the locations of Australia's largest museum organisation

Museums Victoria in Melbourne, the largest public museum organisation in Australia, collaborates with Siemens to improve resource efficiency across its building stock.

Lars Nielsen, Sales Director in Building Technologies Division, Siemens

Museums Victoria in Melbourne attracts approximately 2.5 million visitors each year, and its six locations have recently been upgraded for a more climate friendly future. The Victorian Government's Greener Government Buildings program selected global engineering company Siemens to bring state of the art energy and environmental efficiency technology to Melbourne Museum, the World-Heritage listed Royal Exhibition Building (built in 1880), Scienceworks, the Immigration Museum and two storage facilities.

The project comprises of a total upgrade of the building management, lighting, water and cooling systems. The Victorian Government has financed the up-front cost of \$A11 million (EUR 7 million). The savings are expected to repay the costs within seven years.

Cloud-based energy and sustainability platform opens up new perspectives

As part of the energy performance contract, Siemens also installed the Navigator energy and sustainability platform, which is based on Siemens' open industry cloud, MindSphere. Here, valuable information supplied by sensors, actuators and other devices is essential. This software enables intelligent analysis of the massive amounts of data collected and generates key performance indicators in real time. This is the basis for displaying and generating detailed trends, reports and evaluations for utility bill management and CO₂ reporting.

The data collected by Museums Victoria's Navigator platform is sent to Siemens where teams of engineers continually review it to further optimise energy consumption. Navigator allows proven services that used to be the purview of on-site management to be combined with remote services.

Investments in modernisation pay back

The success of the modernisation concept is already tangible: CO₂ emissions have been reduced by 35 per cent. Siemens anticipates a savings of 4,590 tons of CO₂ by the end of the contract term. Water consumption has dropped by six per cent. The utility costs have been reduced by 32 per cent, an amount equivalent to the electricity consumption of 1,264 average households.

Today, operating costs comprise 71 per cent of a building's total cost of ownership, with approximately 30 per cent of that going toward energy costs. For this reason, investment in comprehensive building technology modernisation makes sense, both in environmental and financial terms, as exemplified by Museums Victoria.

"We all know that museums help us to learn from the past so we can work towards preserving the future. It's important that we continue to play a leading role to educate and inform our communities and audiences about a range of topics and issues, such as environmental sustainability."

*Ms Lynley Marshall
CEO, Museums Victoria's*



The Royal Exhibition Building in Melbourne, Australia is a World Heritage listed museum building from 1880 recently upgraded to contemporary energy and climate standards. Photo: Musuems Victoria

NON-PROFIT HOUSING AND CLIMATE CHANGE

Renovating the non-profit housing sector in Denmark

It will be a large challenge for non-profit housing to reduce energy consumption in buildings - this case illustrates the methods to reduce consumption whilst generating energy locally.

Mikkel Jungshoved, Technical Consultant, BL - Danish Social Housing

Recently introduced construction regulations (BR18) entail significant energy savings both in new-builds and in the renovation of older building stock in the coming years. Danish non-profit housing is subject to construction cost limits. Furthermore, current residents are unable to pay high rents. Meeting the stringent new energy requirements requires creativity and careful consideration. Nevertheless, there are many examples of innovative new-builds and renovation projects in which the non-profit sector has taken the lead in relation to energy efficient housing.

CO₂-neutral residential building – an example

New youth housing units in Herning's student accommodation centre in Birk. H2 College is one of the first housing complex to be constructed to passive housing standards. The residences in question are all 43 m² and most face south in order to fully utilise

the sun's energy. They do not receive any heat from external supplies. Instead, heat energy from air that has already been used is re-cycled. H2 College produces hot water and electricity in its own hydrogen plant. Electricity is used to generate hydrogen at night when wind power generates excess electricity and electricity prices are low. The hydrogen is then re-used to generate electricity via fuel cells during the day when electricity prices are higher. Excess heat generated by hydrogen production and fuel cell use is used to heat water whilst the electricity generated goes to heating and general household use.

CO₂-neutral renovations for more than DKK 100 billion

Over the last 10 - 12 years, the non-profit housing sector in Denmark has renovated buildings for more than DKK 100 billion (EUR 13.5 billion). The sector renovates according to the highest legal standards, which at

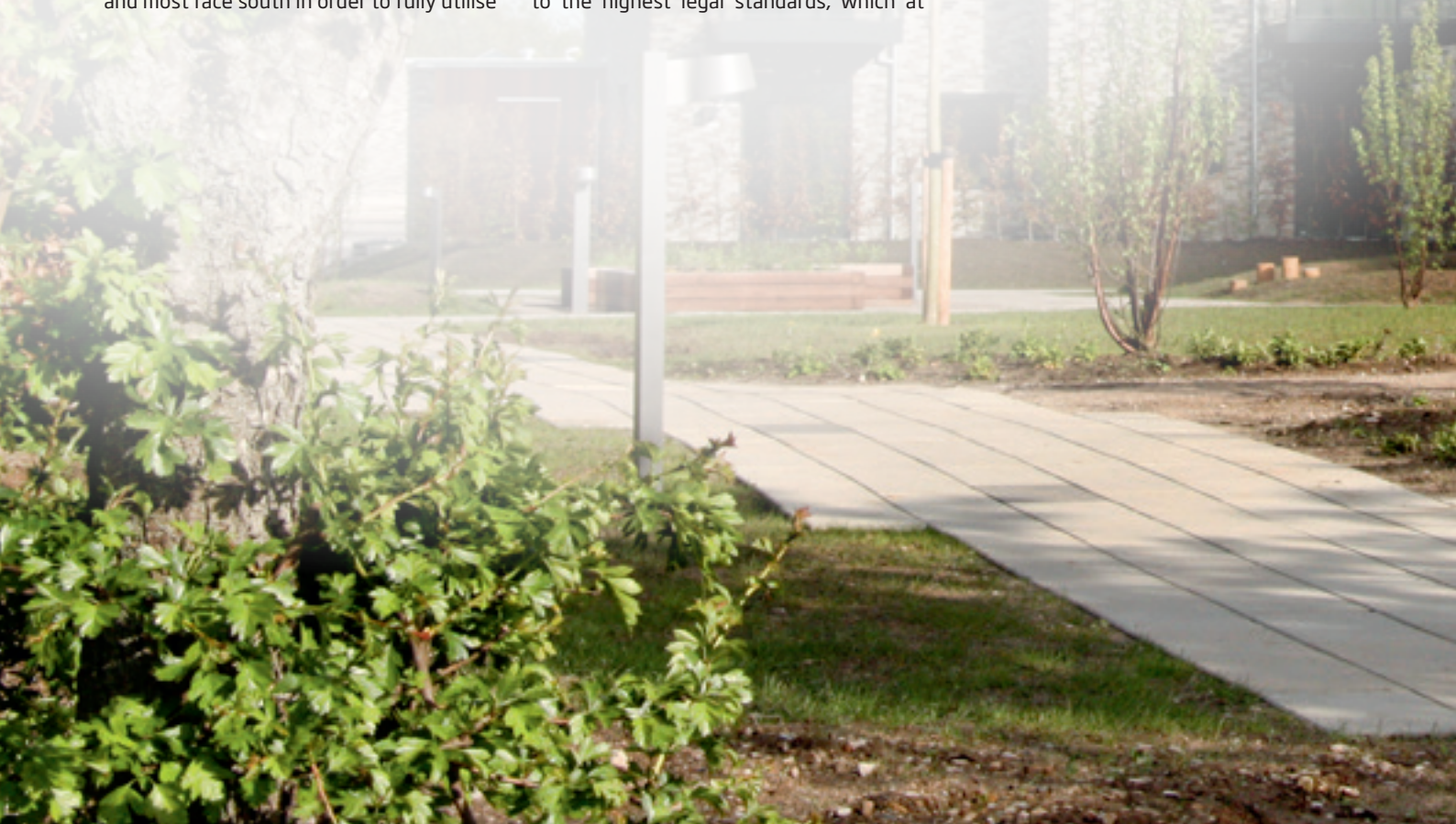
the moment is the BR18. There are also a number of examples where renovation is according to the BR20 - 2020 standard, where buildings are characterised by zero energy consumption. Thus, this sector has made a significant contribution to CO₂ reductions in Denmark the last decade.

The Federation of Non-Profit Housing Associations in Denmark (BL)

The Federation of Non-Profit Housing Associations in Denmark is an industry association covering approximately 700 non-profit housing associations administering more than 530,000 homes - almost one fifth of Danish housing stock. These homes are located in approximately 7,000 residential areas known as housing "divisions".

Contributors:

Aarhus Arkitekterne and Niras





The 840 flats in New Rosenhøj have been transformed from an isolated residential area into an integral part of the Viby Syd district of Aarhus in Jutland. The two main objectives have been to open the residential area towards the district as well as to create identity and community.



Photo:
Photographic Nordic

30 per cent of the total floor area

Buildings from the 60's and 70's make up 30 per cent of the total floor area built in Denmark

40 per cent of the total staff

Approximately 60,000 of the 150,000 employees employed within the Danish building industry are working within the renovation market (Danish Construction Association, 2016).

EUR 21 billion (est.) maintenance from 2006-2026

(The Landowners Investment Foundation, 2016)

Housing accounts for 85 per cent of the renovation market

(EUROCONSTRUCT, 2015)

Structural equality = Export possibilities

Export opportunities for structural equality with the international building stock

1 out of 5 lives in a social housing complex in Denmark

(BL - Social Housing in Denmark)

Potential for a holistic improvement

Major benefits for society are reductions in energy consumption and resources, health improvements due to improved indoor environment and comfort, improved functionality, and an overall improved quality of our buildings.

REBUS – RENOVATING BUILDINGS SUSTAINABLY

Paving the way for world class renovations

As many multistorey buildings and housing complexes are aging, the need for renovations is urgent. How do we ensure high quality and cost-efficient renovations that take the environment and residents' health seriously?

Martha Katrine Sørensen, Senior Project Manager, Danish Technological Institute, REBUS

Renovation, the big rebus of the construction industry

Multistorey buildings from the 1960s and 70s make up 30 per cent of the overall floor area in Denmark and many of them face large renovation needs. Very often, buildings from the 1960s and 70s also face issues of low comfort and condensation. Furthermore, many renovations end in exceeded budgets and overdue deadlines, due to a fragmented value chain and the absence of incentives to collaborate. These many challenges create a new market for efficient quality renovations with new procedures, new methods and new products, all based on the latest R&D in construction and management.

Challenging business as usual

REBUS is a widely supported partnership seeking to radically change the renovation process and demonstrate fruitful solutions. It is a societal partnership with the vision to improve the building stock and boost business for the partners, as well as the

economy of the building industry. The partners focus on solving the multiple challenges in parallel, but intertwining, processes. REBUS runs from 2016 to 2020 and during that time, the partners develop cross-disciplinary solutions built on three foundational pillars:

- **Long-term projects and repetition**

REBUS seeks to establish a new tender and cooperation model for long-term strategic partnerships across the construction industry, focusing on the many advantages of transferring knowledge from one project to the next.

- **Total value and indoor climate**

REBUS develops a model to estimate the long-term return of deep renovation to support the decision-making and dialogues between investor, builder and residents. This includes measuring the thermal, visual, atmospheric and acoustic aspects of indoor climate.

- **Product before project**

REBUS develops configurable facade elements that can be tailored to the individual building, where some measures are fixed, but with a great possibility for variation. This opens up for better industrial planning, which eventually means shorter rehousing periods and less construction sites.

- **Demonstration in full-scale**

New ways to collaborate and technical solutions will be demonstrated in full scale with social housing buildings as a case. In close collaboration with building owners, REBUS showcases how the overall goals to reduce energy-consumption with 50 per cent, reduce use of resources with 30 per cent and increase productivity with 20 per cent are reached. Based on development within this segment of the renovation market, REBUS will deliver tested and documented solutions that can be applied in other building types and exported to other markets.

Partners

COWI, Danish Technological Institute, Frederikshavn Housing Association, Henning Larsen, Himmerland Housing Association, NCC Denmark, Saint-Gobain, Technical University of Denmark, Aalborg University/SBi.

Budget and investors

The budget is app. DKK 81 million (EUR 11 million). Hereof The Innovation Fund Denmark invested DKK 35 million (EUR 4.7 million), Realdania DKK 8 million (EUR 1.1 million) and The Landowners Investment Foundation DKK 6 million (EUR 800,000). The remaining DKK 32 million (EUR 4.3 million) are invested by the partners themselves.

HOW DO CITIES WORK WITH RENOVATIONS?

Free energy savings, new models and innovation

Municipalities are concerned about reducing greenhouse gas emissions from publicly and privately owned buildings. Retrofitting buildings is a key method to fulfil climate goals.

Morten M. Westergaard, Head of Climate and Energy at the Municipality of Middelfart

Middelfart municipality is located on the Island of Fyn, Denmark. Here, multiple initiatives have been launched in order to increase energy efficiency across both public and privately owned buildings. The keywords in the initiatives are awareness and mobilising citizens as the main driver for changes, which will have a real impact towards a climate-neutral future.

Municipality buildings in the cloud

A new approach at the municipality of Middelfart is based upon being a first mover in the usage of new tools and models. The municipality is the first to introduce "Building Analytics" based upon a co-operation with Schneider Electric.

The approach, using big data and analyses, bridges the gap between analysis of building performance and decision-making. The tool gives an overview at two levels: First, it demonstrates which actions could be initiated in an economic perspective and

secondly, it is possible to get a prioritised list of actions if building operations take health and comfort perspectives into account. Parameters such as humidity, CO₂ concentration, and temperature are put in front position, whilst optimising building performance by an average of 7 per cent.

Energy Coaching - putting home owners in control

Homeowners are a natural group to turn to when you want to spur interest and drive the green transition towards a low carbon society. Citizens are key players in several ways, as they provide the votes that enable politicians to transform systems and cities into low carbon societies, but most of all they have the power to transform their own homes into efficient energy buildings. The typical consultant approach towards the homeowner is technical, rational and based on natural sciences. Energy coaching is turning it around. To put it simply: The model consists of a combination of classic energy

consulting and a conversation with the house owner based on an anthropological and holistic approach. It is thus a model and decision-making platform which enables the homeowner to make climate intelligent decisions today and in the future.

Education of citizens

Instead of traditional energy saving campaigns, the municipality of Middelfart and a local evening school started the "Evening School" based on non-formal education for adult learning. The theme was retrofitting and renewable energy options for homes. The house owners paid a small amount to participate and local engineers and companies contributed as teachers in the modules. The evaluation showed that the participating citizens had made investments cumulating to almost DKK 2 million (EUR 268,000), showing the importance of knowledge-sharing as a lever for increased investments in renovation.





Photo: City of Middelfart

ENERGY DATA ENSURE BETTER BUILDINGS

Data based building operation lead to savings in economic and environmental terms

Energy Leap is a partnership where knowledge and data sharing is key to achieving a reduction in energy consumption, saving money and providing better buildings for the users.

Pil Damgaard Hasselager, Specialist Consultant, Energy Leap, City of Copenhagen

Focus on optimising operations and energy retrofitting

Energy Leap is a growing partnership in the property industry working to improve energy efficiency in buildings. Efficient operation of buildings is a prerequisite for retrofitting and there is a large potential for cost-savings in this field.

Energy Leap has a three-step approach to energy efficient buildings. Firstly, focus on data and screening of the energy consumption in the partners' property portfolio. Secondly, focus on optimising the operations of energy-consuming systems in buildings, and thirdly energy retrofitting based on insights from the data. The partners share data on their energy consumption in a benchmark. In the first year, the partners saved 2.6 per cent of the total energy consumption in the shared building portfolio.

Energy management in public buildings

A key partner is the administrator of the municipal building mass, Copenhagen City

Properties and Procurement, who offer their experience and know-how from their own energy projects. They manage the entire municipal property portfolio of 2.2 million m².

The City of Copenhagen is the first city in the world to have a completely centralised building monitoring system. Monitoring energy usage by collecting remote data from heat, water, and electricity meters on an hourly basis has made it possible for Copenhagen City Properties and Procurement to be able to identify areas with the highest energy usage and potential problem areas. In one instance, data collected by the building monitoring system indicated that there was a broken water pipe that would have otherwise gone unnoticed. In addition to flagging problem areas, detailed consumption data enables precise and reliable business intelligence to senior management and politicians. Furthermore, the system will be used in the planning process of retrofitting and to allow for more informed proposals for projects.

Business cases and new building standards

The initiative is anchored in a strong business cases with a projected payback period of six years, and a total investment sum of more than DKK160 million (EUR21.5million). This comprehensive building monitoring system is easily replicated and financially feasible for both public and private sector organisations. Due to the short payback time, it has been largely possible to use an efficiency agenda to pave the way for large-scale energy reduction projects.

Copenhagen has also created new standards for construction to make hardware installation streamlined and remotely accessible, which demonstrates the holistic and long-term thinking that has gone into this plan. By making formalised changes to building standards, Copenhagen sets a precedent for other cities and demonstrates the importance of collecting data.



22 founding partners with a signed partnership agreement at Copenhagen City Hall June 2016. By signing the agreement, partners are committing to 7 collaborative principles: 1. We share knowledge and data with the other partners, 2. We transform words into action, 3. We think long term, 4. We help residents and tenants - We inform them about energy-efficient behavior, 5. We benchmark the performance of our property portfolio with other comparable properties in partnership, 6. We act as ambassadors for the partnership, 7. We actively participate.





State of Green

State of Green is a not-for-profit, public-private partnership from Denmark. We foster relations with international stakeholders interested in discussing their challenges and bring into play relevant Danish competencies and technologies that enable the green transition.

As your one-point entry to more than 600 Danish businesses, governmental and academic institutions, experts, and researchers, State of Green connects you with all leading Danish players working to drive the global transition to a sustainable, low-carbon, resource-efficient society. Whether it be within renewable energy, energy efficiency, water management, waste management, climate adaption or integrated urban solutions, we can match you with the partners and solutions you need. Our goal is to support your role in the global green transition in the most optimal way.

State of Green is funded by the Danish Government and Denmark's four leading business associations: Confederation of Danish Industry, the Danish Energy Association, the Danish Agriculture & Food Council and the Danish Wind Industry Association. His Royal Highness, Crown Prince Frederik of Denmark, is the patron of State of Green.

If you are looking for inspiration, dialogue or partnership, State of Green welcomes you. We promise to connect, inspire and share.

The Danish Energy Agency

The Danish Energy Agency is responsible for the entire energy sector's value chain from energy production and energy supply to energy consumption, energy efficiency and savings as well as energy economy, energy administration and technology monitoring. The Agency is also responsible for supporting the economic efficiency of the supply sector, which, in addition to energy, includes water, waste and telecommunications, including usage, supply obligation and statistics on telecommunications, as well as regulation of water supply and waste management.

The Danish Energy Agency is thus responsible for the Danish energy and supply legislation supporting the desired development and implements for this purpose ongoing analyses and assessments of developments nationally and internationally.

The Agency undertakes a number of support schemes for renewable energy and takes part in representing Denmark's energy and supply interests in the EU. The Danish Energy Agency seeks to share the Danish experience with the energy conversion and also learn from other countries experiences through close cooperation with individual countries and international institutions.

The Danish Energy Agency was established in 1976, and is an agency under the Ministry of Energy, Utilities and Climate. The Agency employs approximately 410 people.



Confederation of Danish Industry

FRI (the Danish Association of Consulting Engineers)

FRI is a trade association of Danish consulting firms providing independent consulting services, planning and project management primarily on a technical-scientific basis on market terms. In addition, member firms provide services in economic as well as non-technical fields.

FRI is a business and market oriented organisation. FRI has strong relations to public authorities and other partners, and FRI is often consulted in matters relating to the preparation of legislation, which affects the market conditions of the industry.

FRI actively participate in various committees appointed by for instance the Ministry of Energy, Utilities and Climate; Ministry of Transport, Building and Housing and the Ministry of Foreign Affairs to discuss important issues relating to the general conditions of the industry.

FRI represents the majority of businesses in the technical consulting industry in Denmark. FRI member firms employ approximately 13,000 staff in Denmark (majority are engineers) and approximately 15,000 abroad.

Confederation of Danish Industry

The Confederation of Danish Industry (DI) is the largest private business organisation in Denmark - the voice of corporate Denmark. A number of sectoral federations work under the umbrella of DI:

The Danish Energy Industries Federation organises the Danish energy industry across all energy technologies and the total value chain. From exploration and production of energy to development and manufacturing of modern energy technologies to engineering of whole solutions and systems.

The Federation of Danish Building Industries organises companies within or related to the building sector. The aim of the federation is to promote the competitiveness, reputation and market conditions for the building industry in Denmark.

Both federations work to promote favourable political and regulatory framework conditions for their respective industries. Further, they strive to develop Denmark as the base for a building sector and energy industry with significant international outreach and impact in terms of exports and partnerships. This has contributed to the industry in Denmark today, which is home to strong clusters of innovation and manufacturing. These clusters enable the export of sustainable, durable and energy-efficient building and energy solutions.

DI supports policies at Danish, European and Global level that enable the transition towards higher energy and resource efficiency, more circular economy and a green transition, while improving economic competitiveness.

Learn more about Danish sustainable building solutions, find more cases from around the world and connect with Danish expertise at:
stateofgreen.com/buildings

State of Green facilitates relations between Danish and international stakeholders seeking to drive the global transition to a sustainable, low-carbon, resource-efficient society. We are a not-for-profit, public-private partnership founded by:



Confederation of Danish Industry

 DANISH ENERGY ASSOCIATION



Danish Agriculture & Food Council



DANISH WIND INDUSTRY ASSOCIATION



Ministry of Environment and Food of Denmark



MINISTRY OF FOREIGN AFFAIRS OF DENMARK