

STATE OF GREEN

In-Flight Magazine

Explore Denmark's journey to decarbonise and energy optimise its buildings



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InFlight Magazine
Explore Denmark's journey to decarbonise and
energy optimise its buildings
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Forewords

Welcome to Denmark

Fluctuating energy prices and low energy performance in buildings are pushing energy poverty around the world. As approximately 85 percent of the buildings we will live in by 2050 already exist today, designing energy-efficient solutions for existing buildings is of particular importance. Thankfully, many of the solutions to relieve this societal pressure are already in place.

Construction and use of buildings are responsible for approximately 40 percent of Denmark's overall energy consumption and account for about 30 percent of our CO₂ emissions. While there is still a lot to be done, Danish learnings show that a firm focus on energy-efficient household buildings is one of the easiest and most cost-effective vehicles to combat the consequences of energy poverty. On top, energy efficiency contributes to widespread societal benefits, acting as a potential lever for just transition, job creation, and societal equality. Eyeing this potential, a steady focus on lowering the building sector's footprint through regulation, innovation, and partnerships is an embedded part of the Danish mindset.

As approximately 85% of the buildings we will live in by 2050 already exist today, designing energy-efficient solutions for existing buildings is of particular importance.



The Danish journey toward a more energy-efficient society started in the early 1970s. Since then, public and private players have worked in tandem to secure Denmark's position at the forefront of renewable energy, energy-efficient solutions, renovation of buildings, and sector integration through the likes of district heating systems.

Standing on the shoulder of more than five decades of dedicated efforts, I hope that Danish lessons as presented in this in-flight magazine will instigate an even greater appetite for energy-efficient measures before you visit Denmark.

**By Finn Mortensen
Executive Director, State of Green**





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A brief introduction to Denmark's green ambitions, policies and initiatives

What is Denmark aiming for?

By law, Denmark is committed to reduce its greenhouse gas emissions by 70 percent by 2030 compared to 1990 levels.

As the construction sector and use of existing buildings represents around 40 percent of Danish energy usage a significant restructuring of the building industry is necessary to meet this goal.

In comparison, numbers from IEA show that operation of buildings accounted for 30 percent of global final energy consumption in 2021.



Denmark's climate ambitions

- Net-zero by 2050
- Reduce greenhouse gas emissions by 50-54% by 2025 and 70% in 2030.

As such, realising energy savings by prioritising energy efficiency in new construction and renovation of existing buildings is at the heart of Danish energy policies.

To meet national climate goal, a public-private partnership has been established in Denmark with representation from 14 sectors of the Danish business community. The Danish construction sector has proposed 63 recommendations to cut its emissions to meet the national climate goal by 2030. Implementing these proposals could result in an annual reduction of 5,800,000 tonnes net reduction in CO₂e emissions per year by 2030.

While these are significant improvements, national goals are not enough. Denmark only accounts for 0.1 percent of global greenhouse gas emissions. Therefore, Denmark proactively looks outside its national borders with a goal to contribute to the global green transition, leading by example through developing and demonstrating replicable and scalable ways to protect the planet while maintaining a prosperous, socially cohesive and just society. One such thing is through energy efficient building solutions.

Where do we come from?

Denmark has a long history of promoting energy efficiency in buildings through the implementation of public policies and regulations.

Denmark was one of the most affected countries in the world when the oil crisis hit back in the early 1970s. With financial and security implications happening overnight, the crisis fostered government-led efforts to reduce energy consumption in buildings, by development of new building regulations, requiring buildings to have better insulation and heating systems.

In the 1980s, Denmark established an ambitious national energy plan with a goal of reducing the country's energy consumption even further. The plan included a specific focus on accelerating energy efficiency in buildings.

Reaching the 1990s, the Danish Government implemented a range of policies to promote energy-efficient buildings, including tax incentives for energy-efficient renovation and the establishment of a national energy labelling system for buildings.

The effort of promoting energy savings in buildings continued through the 2000s and the 2010s with policies and initiatives such as introducing the Energy Performance Certificate (EPC), implementing a Energy Saving Obligation, as well as updating its building codes and standards.

Where is Denmark today?

Today, Denmark has one of the most comprehensive regulatory frameworks for ensuring energy efficiency in buildings. Among its key components are a strict building code, energy labelling, targeted information campaigns and, crucially, involvement of relevant industries. Eyeing the potential of public-private partnerships, Denmark has presented a unique way to harness the strength of both public and private resources to support energy efficient buildings.

Standing on the shoulders of a 50 year old legacy, Danish companies provide world class solutions and technologies for insulation, windows, data control systems and architecture that make sustainable energy

renovation projects possible. These innovative solutions, developed by both the public and private sector, have made Denmark a frontrunner in the field.

But although Denmark has learned from 1970s crisis, the country, along with Europe and other regions of the world, is currently confronted with a new energy crisis. The current geopolitical situation has resulted in high energy prices, which in combination with low energy performance in buildings is pushing energy poverty all around the world.

Improving energy efficiency and performance of household buildings can very much act as the secret weapon to effectively combat the consequences of energy poverty, while accelerating a just, green transition along the way.

What did we learn along the way?

Renovating and retrofitting existing buildings are impactful paths to increased sustainability – not only in an environmental sense, but also economically and socially.

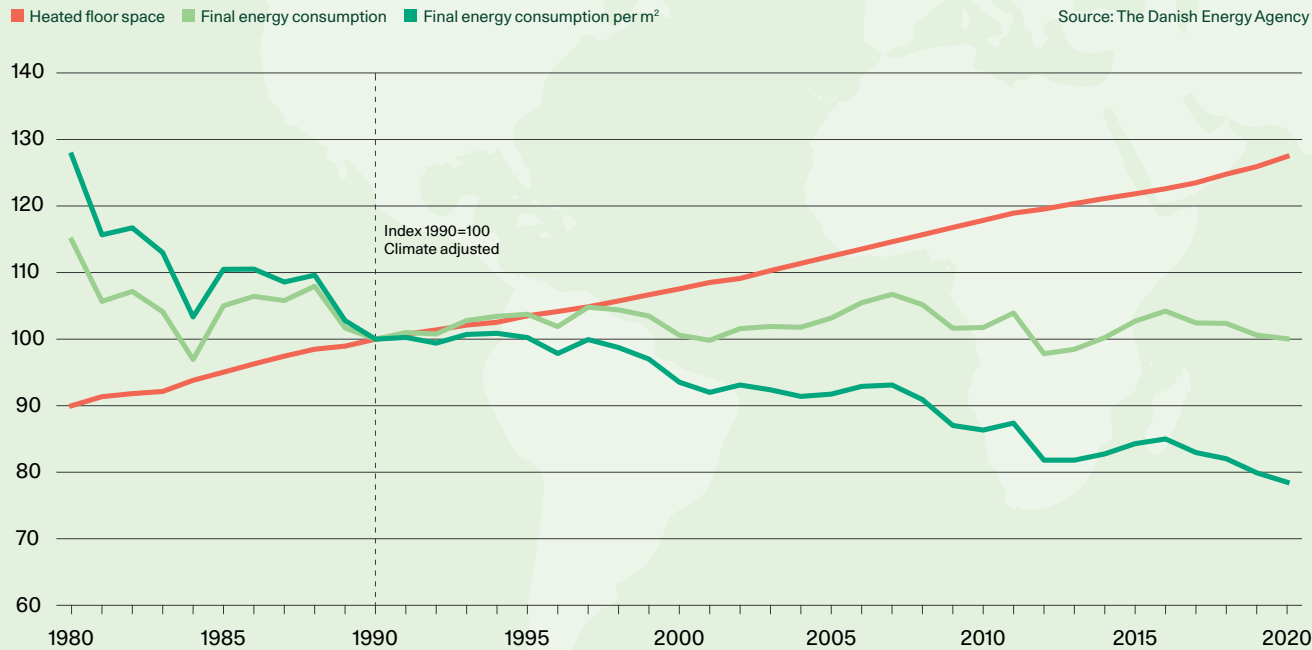
INFO

Why Energy Efficiency?

Energy efficiency in buildings is crucial for multiple reasons, including enhancing security, health, sustainability and economic prosperity:

- Improving energy supply security by reducing dependence on foreign energy sources, making space for renewable energy
- Reducing energy usage and greenhouse gas emissions, leading to a cleaner and more sustainable environment
- Providing health benefits by offering better indoor climate
- Offering significant economic benefits by lowering energy bills and operating costs, thereby contributing to the fight against energy poverty
- Promoting job creation in the construction and energy sectors

Energy consumption for space heating 1990-2020



Denmark witnessed a significant reduction in energy consumption for space heating per m² in households from the 1990s to the 2020s, thanks to improved insulation, the replacement of oil burners with efficient natural gas boilers and district heating systems, and stricter energy standards for new homes.

While renovating a building can result in lower CO₂ emissions, it can also lower heating and electricity costs as well as increase the value and lifespan of the building.

While renovating a building can result in lower CO₂ emissions, it can also lower heating and electricity costs as well as increase the value and lifespan of the building.

The business case for energy renovation becomes even stronger when considering benefits of an improved indoor climate and functionality can have for residents. Taking a broader view, pursuing energy renovation programmes can play a critical role in pushing our common energy systems towards a low-carbon future by reducing energy demand.

Denmark aims to lead the way in energy efficiency and renewable energy, demonstrating innovative solutions to increase energy efficiency and implementing district heating systems. These examples can act as inspiration for other countries to follow.



The Danish approach: Six ways to accelerate energy efficiency in buildings

From smart energy systems to holistic sustainability methods, the Danish approach to energy efficiency in buildings can serve as a source of inspiration for other countries.

Denmark has made significant strides in optimising energy efficiency in buildings over the past few decades, reducing energy consumption, and lowering carbon emissions. But work is still to be done, and new ambitious goals have been set to further improve and secure sustainability in the Danish build environment.

Explore six key areas that demonstrate why Denmark is well-positioned to continue to succeed in optimising energy efficiency in its buildings.

The building code as a driver for innovation

The Danish Building Code, BR18, drives innovation by regulating energy performance in major building renovations. It sets minimum standards for components like windows, ventilation systems, and roofs, ensuring continuous energy efficiency improvements in existing buildings. Owners are encouraged to save energy during renovations, and the code is regularly updated to incorporate technological advancements through industry consultation.

Creating user-friendly EPCs

Energy Performance Certificates (EPCs) assign buildings in Denmark an energy rating and provide cost-effective recommendations for improving efficiency and savings. Half of Denmark's building stock has an EPC.

The layout of the Energy Labelling Report was redesigned in 2021 for easier comprehension, while a new funding requirement for EPCs has significantly increased the annual number of energy labels issued. The Danish Energy Agency (DEA) is responsible for implementing and overseeing the EPC scheme, with all certificates registered in a central database accessible to the public.

Implementing smart energy systems

Smart energy renovation considers the transformation of energy systems around buildings to unlock their full potential. By adopting an integrated Smart Energy System approach, synergies between savings, energy efficiencies, and interconnections across sectors can be leveraged, utilising existing infrastructure and storage.

Integrating heating, cooling, electricity, transport, and gas savings improves overall energy efficiency, allowing for the utilisation of waste heat and expanding district heating. Sector integration enables cost-effective thermal storage options and facilitates the integration of renewable energy sources like wind and solar power.

Sector integration enables cost-effective thermal storage options and facilitates the integration of renewable energy sources like wind and solar power.

Empowering and understanding needs of citizens

To empower citizens with energy efficiency information, targeted messaging is crucial, especially when building owners are seeking information during house transactions or major refurbishments. Recognising that

individuals have diverse motivations for reducing energy consumption, such as monthly savings, improved comfort, or environmental concerns, allows for more precise and impactful campaigns on the platform, catering to specific needs and goals.

DK2020: Denmark's Municipalities unite to achieve green energy

Denmark's municipalities are working together for energy savings in order to reach the targets under the Paris Agreement. Through the DK2020, tailored climate action plans address barriers, prioritise energy efficiency in municipal buildings, and encourage homeowners to follow. Smart climate strategies, optimised building activity, and data-driven energy management are all employed, while municipalities share knowledge to inform legislation, suppliers, and product development, facilitating effective local solutions.

A holistic approach to sustainability

A holistic approach is crucial for sustainable energy renovation, considering both environmental, economic, and social factors. The DGNB certification standard provides a benchmark for evaluating sustainability in buildings and urban areas, encompassing technical, process, and area quality criteria. With different phases and specific criteria for various building types, DGNB certification is applicable to new and existing buildings, renovations, and buildings in use, covering the entire life cycle.



FACTS

How to make existing Danish buildings energy efficient:

- Converting 400,000 gas boilers and 100,000 oil boilers to sustainable solutions such as individual heat pumps and district heating
- Upgrading the worst performing buildings; Around 30% of energy labelled buildings in Denmark currently possess energy labels from E-G
- Securing energy improvements such as energy efficient windows and improved insulation when buildings are being renovated
- Ensuring optimal operation and efficiency of technical systems such as heating, lighting and ventilation
- Energy efficiency requirements for new buildings and major renovations will be continually updated to cost optimal levels
- Life cycle assessment in new buildings has been mandatory from the beginning of 2023

Sound of Green: Designing for sustainability in buildings

Interested in learning more about the Danish approach to energy efficiency? Sound of Green, a podcast by State of Green, offers a unique perspective on the global challenge of reducing energy consumption and promoting sustainable development the Danish way.

In this episode of Sound of Green, we take a deep-dive on energy efficiency in the building stock. You will get a chance to hear the tale of the Danish approach to energy efficiency, the country's history, and how energy efficiency in Denmark is strongly connected to health and liveability.

With insights from the Danish Energy Agency, and Danish solution providers VELUX and COWI, this episode provides a view into how policy and regulatory frameworks, innovative technologies, and public-private partnerships can be used to promote energy efficiency and address global challenges.

“What we try to do is share experiences, both in terms of the do’s and the don’t’s. We have the advantage that we’ve worked with this for over 40 years. So we’ve learned quite a bit, both in terms of what works, but also in terms of what doesn’t work.”

Stine Leth Rasmussen, Deputy Director General at the Danish Energy Agency



LISTEN

The podcast 'Sound of Green'



Curious to unlock the potential of building a sustainable, energy efficient future?

You can now listen to State of Green's latest podcast episode [here](#) →



Green Walk: Discover Copenhagen's green buildings and Denmark's climate ambitions

While in Copenhagen, seize the opportunity to do some green sightseeing with State of Green. Our Green Walk is an interactive audiowalk talking you through the city's green urban development and presenting insights from Denmark's green transition, while you explore the streets of Copenhagen.

What measures has Copenhagen taken to address climate change? How can one save energy, money, and reduce their CO₂ footprint while maintaining architectural and aesthetic standards?

Find the answers by taking the 'Green Walk' of Copenhagen. Our interactive audiowalk guides you through the inner Copenhagen, from the City Hall Square with a tale of Copenhagen's green ambitions and climate adaptation, to the waterfront of Copenhagen, with a presentation of the city's transformation towards a sustainable and liveable city.

Discover energy efficient buildings, such as Industriens Hus, Axel Towers and Blox, while hearing about Denmark's climate partnerships at Christiansborg Palace.



PHOTO: STORHUNT

DISCOVER

The interactive audiowalk 'Green Walk'



'Green Walk' is an interactive audiowalk made by State of Green, that takes you around inner Copenhagen presenting energy efficient buildings and the climate ambitions driving the Danish green transition.



Cases

Danish solutions – nationally and globally



CASE 1
VELUX: IMPROVING INDOOR AIR QUALITY AND LEARNING WITH ENERGY-EFFICIENT ROOFLIGHTS (UK)



CASE 2
RAMBOLL: THE EVO BUILDING: A BLUEPRINT FOR ULTRA-LOW CARBON WORKSPACES (UK)



CASE 3
ROCKWOOL: SECURING SAFETY AND COMFORT IN THE GRAND HOTEL EUROPEJSKI (POL)



CASE 4
VELUX: ENERGY-EFFICIENT WINDOW SOLUTIONS CREATES SUSTAINABLE HOMES (POL)



CASE 5
DANFOSS: SUPPLYING AFFORDABLE HEATING IN BROOKLYN (US)



CASE 10
RAMBOLL: THE MARBLE PIER: REDUCING CARBON EMISSIONS WITH THE USE OF TIMBER (DK)



CASE 9
REMONI: REDUCING ENERGY USAGE IN BUILDINGS THROUGH CLAMP-ON INTELLIGENCE (DK)



CASE 8
VELUX: LIVING PLACES: BUILDING LOW-CARBON AND MORE SUSTAINABLE BUILDINGS (DK)



CASE 7
LENDAGER: REUSING MATERIALS FOR THE RESOURCE ROWS (DK)



CASE 6
ROCKWOOL: REDUCING NYC'S EMISSIONS BY INSULATING THE WORLD'S LARGEST PASSIVE HOUSE (US)



CASE 1 VELUX
TAG INDOOR AIR QUALITY
LOCATION LONDON, ENGLAND

Improving indoor air quality and learning with energy-efficient rooflights

Challenge

The Thomas Buxton Primary School in Whitechapel, London was facing multiple challenges. Deteriorating rooflights were leaking, disrupting lessons, and failing to meet safety standards. The old rooflights could not manage the glare and heat and the school was relying more on artificial lighting. Furthermore, worsening thermal insulation was negatively affecting learning due to poor indoor temperatures



The project also aimed to lower energy consumption, which was successfully achieved.

Solution

The main contractor, Centaur Technologies, and installer, Central Roofing collaborated on a rooflight replacement project. They installed 100 dome Rooflights and three Specialist Continuous Rooflights, improving the school's thermal insulation and providing daylight throughout the school.

The larger domes incorporated bronzed polycarbonate glazing to manage glare and heat gains. A curved polycarbonate canopy now covers the reception entrance, offering optimal daylight as students and teachers enter the school. The project also aimed to lower energy consumption, which was successfully achieved.

Result

Students now benefit from optimal daylight in classrooms, corridors, the canteen, and kitchen, invigorating learning in a thriving primary school.

The triple skin Dome Rooflights improve thermal insulation and the durability of the solutions.

Interchangeable kerbs allowed a faster and simpler installation process, with the installation of all domes and Specialist Continuous Rooflights completed over a six-week period. This enabled the school to remain operational, with the added benefit of improved indoor air quality.



About VELUX Group

For more than 80 years, the VELUX Group has created better indoor environments by bringing daylight and fresh air into homes and other buildings all over the world. The VELUX Group was founded in Denmark and is today an international company with a presence in more than 40 countries.



Discover VELUX at
stateofgreen.com



CASE 2 RAMBOLL
TAG HOLISTIC BUILDING CONSULTING
LOCATION MANCHESTER, ENGLAND

The Ev0 Building: A blueprint for ultra-low carbon workspaces

Challenge

How do you design and construct a workspace building that meets the UK's net-zero carbon vision, with ultra-low carbon emissions, high energy efficiency and sustainability, and innovative architecture?

This was the challenge Ramboll was faced with upon being hired to provide sustainability, MEP, and structural design expertise to the Ev0 building project alongside



FACTS

The Ev0 building

- 94% of Ev0's energy demand will be generated on site
- Upfront carbon emissions circa 500 kgCO₂ e/m²
- Whole life carbon emissions 800-1000 kgCO₂ e/m²
- Extensive timber use stores 4000 tonnes CO₂ e of CO₂



local property providers Bruntwood Works. Located at the heart of Didsbury Technology Park in Greater Manchester, the 6-storey building is a £30m commercial development aimed to set the bar high for future workspaces.

Solution

Ramboll used a smart and green design approach that relied on the extensive use of timber and low-carbon concrete.

The building's facade design was optimised to minimise solar gain and overheating, and almost all the energy required for the building will be generated on-site (94 percent) through the use of solar panels and an ambient loop system. The remaining 6 percent of energy demand will be sourced from Bruntwood Works' co-operative owned wind farm in Ayrshire.

Result

The Ev0 building is expected to be the most operationally efficient office building in the UK and a model for future sustainable commercial developments. The building stores approximately 4000 tonnes CO₂e of CO₂ and has upfront carbon emissions of circa 500 kgCO₂e/m² and whole life carbon emissions of 800-1000 kg CO₂e/m².

The building's design and construction make it one of the lowest carbon workspaces in the UK, helping businesses to take affirmative action to reduce their carbon footprint.

**About Ramboll**

Ramboll is a leading engineering, design and consultancy company founded in Denmark in 1945. With 300 offices in 35 countries, Ramboll combines local experience with a global knowledge base constantly striving to achieve inspiring and exacting solutions that make a genuine difference to clients and society at large.



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stateofgreen.com



CASE 3 ROCKWOOL
TAG INSULATION IN BUILDINGS
LOCATION WARSAW, POLAND

Securing safety and comfort in the grand Hotel Europejski

Challenge

The renovation of Raffles Europejski Warsaw, also known as Hotel Europejski, was a massive undertaking aimed at restoring the historic building to its former glory while ensuring the ultimate safety and comfort of guests. The challenge was to find the perfect insulation material that could meet the building's unique requirements and protect against fire, noise, and energy loss.



Solution

SUD Architects opted for ROCKWOOL Superrock, Toprock Super and Rockfon insulation materials to insulate the roof and ceilings of the building. These materials were chosen because they are made of stone wool, which can withstand temperatures above 1000°C, preventing fire from spreading onto subsequent floors and increasing the time available for evacuating guests while also protecting the building.

Additionally, stone wool provides perfect insulation against interior sounds and exterior traffic noise, contributing to the overall feeling of luxury in the hotel. The inherent insulation properties of ROCKWOOL products also ensure energy savings for decades to come, retaining their thermal properties for at least 60 years and having excellent dimensional stability.

Results

Hotel Europejski now boasts restored 109,000m² of space, including 106 hotel rooms, 3,000m² of luxurious retail space, and 7,000m² of offices.

The stone wool insulation materials used in the renovation provide a peaceful and luxurious atmosphere for guests and employees, while also ensuring their safety in the event of a fire. The insulation materials will also provide energy savings for decades to come, making the renovation a smart and sustainable investment for the future.



About ROCKWOOL

ROCKWOOL transforms volcanic rock into stone wool and its products contribute to address many of society's biggest climate change challenges, creating new opportunities to enrich modern living and build safer, healthier, and more climate resilient communities.



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stateofgreen.com



CASE 4 VELUX
TAG INDOOR AIR QUALITY
LOCATION WROCLAW, POLAND

Energy-efficient window solutions creates sustainable homes

Challenge

The owners of a newly-constructed house in Wrocław, Poland, bought a plot of land adjacent to a large park area near the Grabiszyński Park. The house is perfectly located among lush natural scenery, but yet a demanding plot of land in terms of constructing a house.

The plot presented a number of challenges for building a house, such as small area, location in the second line of buildings, and the need to complete more formalities than usual in this type of construction projects.



Solution

The architects from the local Polish design studio Wytwórnia Pracownia Projektowa created a solution that allowed the plot's advantages to be fully exploited while minimising its limitations. The house was designed to use daylight as its starting point and included a strip of glass along the centre of the building to allow warm light to enter the living area while maintaining privacy.

Eight electrically-operated VELUX GGL roof windows and seven VELUX VFE elbow windows were used in the glazed strip to ensure maximum illumination of the interior and bring in daylight from the south and west. In total, 15 VELUX solutions were used in the building, including VELUX electric blackout blinds and VELUX solar blackout blinds.

Result

The VELUX solutions allowed the investors to control the amount of incoming light and protect the interior from overheating. The VELUX electrical control system was integrated with smart home systems, making it possible to program the blinds to go up in the morning at sunrise and down in the evening at sunset. The implementation of roof windows above the staircase also provided light on the ground floor and made it possible to efficiently ventilate the interior using the so-called 'chimney effect'.

Because of these solutions, the house is filled with light and has low energy consumption, while also providing beautiful views of the park.



Design studio: Wytwórnia Pracownia Projektowa,
www.wytworniapp.com
Design authors: Patrycja Zarzycka, Piotr Zarzycki
Photos: Maciej Lulko, foto-ml.pl

About VELUX

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CASE 5 DANFOSS
TAG HEATING IN BUILDINGS
LOCATION BROOKLYN, NEW YORK CITY, UNITED STATES

Supplying affordable heating in Brooklyn

Challenge

Buildings account for a significant amount of all global energy-related emissions. According to reports from the Global Alliance for Buildings and Construction, it is estimated that the world will add approximately 230 billion square metres of new construction by 2060, the equivalent to adding a city the size of Paris to the planet every single week.

PHOTO: UNSPLASH



To achieve the International Energy Agency's net zero scenario, we need to ramp up improvements in energy efficiency and make a complete shift away from fossil fuels in the construction and operation of buildings. To succeed in today's society, every new building must not only be constructed to be energy efficient, but also be economically affordable.

It was the first mid-sized apartment building in the US to be certified to the Passive House Standard.

Solution

In recent years, the average rent for a one-bedroom apartment in Brooklyn's Bushwick neighbourhood has skyrocketed to more than \$3,000 a month, excluding utilities.

90%

This has resulted in 90 percent lower energy consumption than comparable buildings, and heating costs below \$50 per apartment per year.

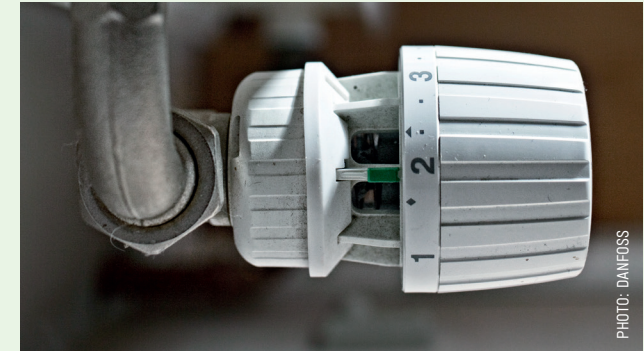
That is why New York City's Department of Housing Preservation and Development (HPD) and Ridgewood Bushwick Senior Citizens Council (RBSCC) came together to develop Knickerbocker Commons, a six-story, 24-unit, affordable multifamily building.

RBSCC wanted to cut tenant utility costs radically without compromising comfort, so they asked architects and engineers to design an ultra-low energy building.

Results

The Knickerbocker Commons features continuous exterior insulation, energy recovery ventilators, sealed combustion boilers, and individual room thermostat controls, including Danfoss thermostatic radiator valves (TRVs). This has resulted in 90 percent lower energy consumption than comparable buildings, and heating costs below \$50 per apartment per year.

It was the first mid-sized apartment building in the US to be certified to the Passive House Standard and was recognized in New York City Mayor Bill de Blasio's One City: Built to Last program as an innovative approach to reducing the city's carbon footprint.



About Danfoss

In the world's growing cities, Danfoss technologies ensure the supply of fresh food and optimal comfort in our homes and offices, while meeting the need for energy efficient infrastructure, connected systems and integrated renewable energy. Danfoss solutions are used in areas such as refrigeration, air conditioning, heating, motor control and mobile machinery.



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CASE 6 ROCKWOOL
TAG INSULATION IN BUILDINGS
LOCATION ROOSEVELT ISLAND, NEW YORK CITY, UNITED STATES

Reducing NYC's emissions by insulating the world's largest Passive House

Challenge

New York City has set itself some ambitious environmental goals. The city is aiming for a 50 percent cut in lower Manhattan's CO₂ emissions by 2030, and a city-wide 80 percent reduction by 2050. In a densely packed metropolis where the built environment creates 70–75 percent of greenhouse gas emissions, nearly all generated by heating and cooling systems, better buildings are the solution.



High-quality insulation is central to passive construction, creating an optimal indoor climate by minimising the need for active heating and cooling.

Solution

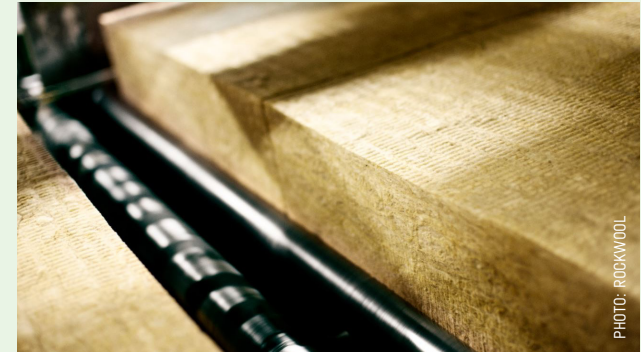
The House at Cornell Tech is showing what is possible. Standing tall at 26 storeys, this residential facility for students, staff and faculty is the largest and tallest building ever built to the demanding Passive House standard. This approach to building, which was pioneered in Germany, maximises the use of passive measures (or solutions) to reduce the energy needed using insulation in the design of the building. Strict limits on energy use for heating, cooling and thermal comfort are applied as criteria, in order to place the focus on efficiency first.

High-quality insulation is central to passive construction, creating an optimal indoor climate by minimising the need for active heating and cooling. In The House, architects exclusively used ROCKWOOL stone wool products.

A 280mm thickness of CAVITYROCK® semi-rigid insulation boards as well as AFB® and ROCKBOARD® are used to wrap the building in an insulated blanket. And as well as helping The House meet the Passive House standard, non-combustible stone wool provides the acoustic insulation and fire safety that is essential in multi-storey residential buildings.

Results

It is estimated that The House will save 882 tonnes of CO₂ emissions per year – the equivalent of planting 5,300 new trees – helping New York City in its quest to lighten its environmental footprint.



About ROCKWOOL

ROCKWOOL transforms volcanic rock into stone wool and its products contribute to addressing many of society's biggest climate change challenges, creating new opportunities to enrich modern living and build safer, healthier, and more climate resilient communities.



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CASE 7 LENDAGER
TAG CIRCULAR BUILDING MATERIALS
LOCATION ØRESTAD, COPENHAGEN, DENMARK

Reusing materials for The Resource Rows

Challenge

The construction industry in Denmark accounts for approximately 30 percent of the country's total CO₂ emissions and one-third of the country's waste generation. Thus, it is imperative to enhance sustainability in the built environment. One crucial way to do so is to ensure that building materials are circulated and kept at their highest possible value at all times in their life cycle benefiting the individual project, people and planet.

PHOTO: LENDAGER GROUP



Solution

The Resource Rows, a housing project consisting of 92 flats, demonstrate a radical reuse approach to materials that significantly reduce the construction carbon footprint. The flats are arranged around a shared courtyard and roofscape with 29 greenhouses made from reused wood and windows.

The walls are built using upcycled bricks taken from a demolished Carlsberg brewery. As the brewery bricks were cement mortared and difficult to disassemble, Lendager developed a method whereby large squares would be cut from the old facades.

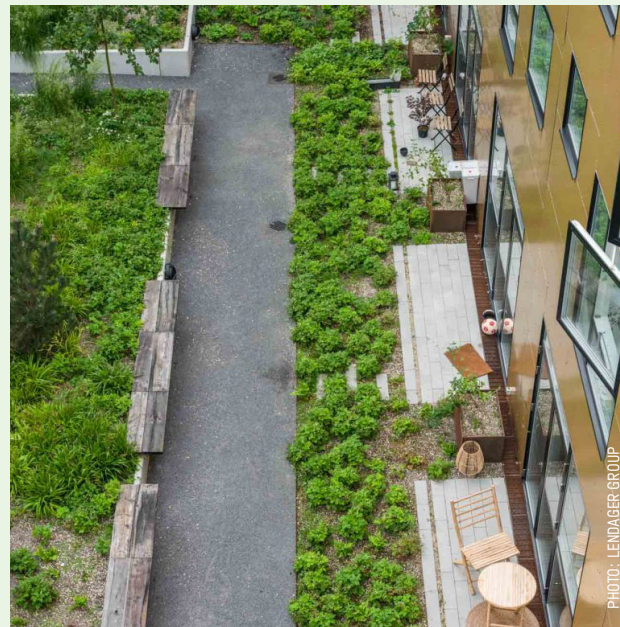
Brick modules in different colours were then assembled in new designs, giving the building a patchwork-like facade. All internal floors were made of waste wood from the flooring manufacturer Dinesen, which would otherwise have been burned.

29%

When building the Resource Rows, 10 percent of the materials are upcycled waste materials, while the overall CO₂ reduction is 29 percent compared to benchmark reductions.

Result

When building the Resource Rows, 10 percent of the materials are upcycled waste materials, while the overall CO₂ reduction is 29 percent compared to benchmark reductions. Around 300 tonnes of wood waste were sourced from the construction of the city's new metro and used externally for terraces. Each reused brick represents a CO₂ saving of 500g and the wood has a CO₂ saving of 77 percent.



About Lendager

Lendager was founded with the purpose of accelerating sustainable architecture. We enable the green transition in and around the built environment through architecture, urban planning, strategic and material innovation.



Discover Lendager Group at
stateofgreen.com



CASE 8 VELUX
TAG INDOOR AIR QUALITY
LOCATION VESTERBRO, COPENHAGEN, DENMARK

Living Places: Building low-carbon and more sustainable buildings

Challenge

Living Places is a new way of thinking about how to build in the future. The project by VELUX explores how the building industry can support the health of the people and the planet through building design that is scalable, affordable and commercially viable. It arose by looking at the most common Danish home, and asking how materials, construction, utilities, and architecture could be rethought towards building homes with less impact on the planet. The goal is to build within the Science Based Targets Initiative limit of 1.5 degree rise in global temperatures.



Solution

To document the environmental impact of a building's life cycle from design, manufacturing, use and maintenance, to renovation and demolition, The Compass Model, a Life Cycle Assessments calculator, was developed, enabling an assessment of materials already in the design phase.

“Living Places seeks to create a housing typology that is affordable to build at scale and healthy to live in, with an ultra-low carbon footprint – using only current technology and materials. It aims to lead the way within the building industry and show how rethinking buildings can help solve some global climate and health challenges.”

Seven building prototypes have been produced, built of materials with low or positive CO₂ impact and a focus on design for disassembly, reuse, and recycling of materials such as wood fibre insulation material and screw pile foundations. The prototypes hold the lowest CO₂ emissions in Denmark.

Result

The blueprint for Living Places considers the elements of sustainable living in a holistic manner; daylight, biorhythms, acoustics, air quality, thermal environment and the relation to the surrounding nature are all interwoven and incorporated in the design.

Living Places Copenhagen has a CO₂ footprint that is three times smaller than the average Danish one-family house. The project has been awarded a best-in-class indoor climate for its use of daylight and fresh air and demonstrates that we do not have to wait for future technology to build more sustainably now.

The first manifestation of Living Places will be displayed at the World Capital of Architecture 2023 at Jernbanebyen, the old Danish rail district in Copenhagen.

Owner: VELUX Group
Architects: EFFEKT
Engineers: Artelia
Contractors: Enemærke & Petersen
Landowners: DSB



About VELUX

For more than 80 years, the VELUX Group has created better indoor environments by bringing daylight and fresh air into homes and other buildings all over the world. The VELUX Group was founded in Denmark and is today an international company with a presence in more than 40 countries.



Discover VELUX at
stateofgreen.com

CASE 9 REMONI
TAG SMART ENERGY SYSTEMS IN BUILDINGS
LOCATION DENMARK

Reducing energy usage in buildings through clamp-on intelligence

Challenge

The world's buildings account for around 40 percent of the total energy consumption and around 36 percent of the world's CO₂ emission according to EU data – the majority of this is when the buildings are in use.

This calls for massive action to reduce both the energy usage and CO₂ emission. When talking about energy efficiency, most still think about renovating buildings. However, the potential in exploiting the existing systems in the buildings without making large investments in new systems or installations is huge.



Solution

At a large Danish municipality, ReMoni deployed the service Predictive Heating Optimization in the winter of 2022 in several buildings.

The service is basically an intelligent control of the heating system in the buildings. Here ReMoni installed a clamp-on intelligent solution, which monitors the water and heating consumption in the building. This is then sent to ReMoni's cloud Microservices, which combines it with data on weather forecast and other relevant data. The AI algorithm builds a digital model of the building ensuring a continuously updated model of the thermal characteristics of the building, heating needs etc.

The ReMoni algorithm then determines when heating is needed in the municipality's buildings and controls the heating systems based on this.

30%

The buildings vary in thermal characteristics and year of construction/renovation, however the measured savings are around 30 percent in all cases.

Result

At the Danish municipality actual measured savings range from 25,3 percent to 34,9 percent on heating consumption, meaning that the savings have been correlated with the metre data from the building – and the indoor comfort temperature has not been impacted or changed.

The buildings vary in thermal characteristics and year of construction/renovation, however the measured savings are around 30 percent in all cases. This shows that it can be worthwhile to both renovate a building to optimise thermal characteristics but at the same time ensure efficient usage of the existing systems and installations.

It is also assumed that CO₂ emissions have been reduced by approximately 25-30 percent.



About ReMoni

ReMoni specialises in clamp-on intelligence maximising energy efficiency and optimising energy usage in non-residential buildings. With market-proven services, such as the Predictive Energy Optimization, ReMoni ensures on average a 30 percent energy reduction in non-residential buildings.



Discover ReMoni at
stateofgreen.com

CASE 10 RAMBOLL
TAG HOLISTIC BUILDING CONSULTING
LOCATION NORDHAVN, COPENHAGEN, DENMARK

The Marble Pier: Reducing carbon emissions with the use of timber



Challenge

Conceiving ways to design and construct more sustainable buildings are imperative. One way to challenge old building traditions is by choosing more sustainable building materials. In Nordhavn, Copenhagen, Ramboll and **Henning Larsen Architects** are working on one of Denmark's largest timber structures to date, The Marble Pier.



Solution

At eight storeys and 36 metres tall, and covering 28,000 m², the Marble Pier will be one of the largest timber buildings ever constructed in Denmark and home to some of the most sustainable offices built with existing technology.

As the case against concrete construction gains more evidence, solid timber is emerging as a leader in the list of sustainable alternatives. Timber, in stark contrast to concrete, stores embodied carbon. Thus, by swapping out the structural concrete with timber, the structure will embed tons of carbon instead of emitting tonnes.

The building's multi-users profile, the diversity of extroverted programs and publicly accessible ground floor – outside and inside – makes Marmormolen the antithesis of a traditional and introverted domicile. With a transparent, open and inviting ground floor, Marmormolen will be a sustainable setting for a vibrant marketplace.

Inside, the ground level will hold amenities for the tenants such as a large cantina and auditorium, which will double as a public eatery and venue for theatres, flea markets etc. respectively. On upper levels, workplaces enjoy views of uninterrupted skies, the sea and the skyline of Copenhagen. In the centre there is access to a large courtyard with greenery and good exposure to sunlight. In other words, the building project also gives back to the environment surrounding it, adding to its social sustainability.

Result

Construction of the Marble Pier began in 2021 and is expected to be completed by 2024.

The building will save 9,500 tonnes of carbon emissions, as compared with a similar building made of concrete. Of that, 3,000 tonnes are avoided emissions by using timber instead of concrete, and 6,500 tonnes emissions are sequestered by the timber.

The Marble Pier is expected to receive the highest possible sustainability accreditations for buildings, namely, LEED, DGNB Platinum and Diamond; and the well-being certification WELL Platinum.

The 36 metre wooden building intends to be a prototype for future timber structures, inspiring awareness that it is possible to make more sustainable design and construction choices.



9,500

The building will save 9,500 tonnes of carbon emissions, as compared with a similar building made of concrete.

About Ramboll

Ramboll is a leading engineering, design and consultancy company founded in Denmark in 1945. With 300 offices in 35 countries, Ramboll combines local experience with a global knowledgebase constantly striving to achieve inspiring and exacting solutions that make a genuine difference to clients and society at large.



Discover Ramboll at
stateofgreen.com

About State of Green

State of Green is a not-for-profit, public-private partnership between the Danish government and the country's three leading business associations (Confederation of Danish Industry, Green Power Denmark, and the Danish Agriculture and Food Council). State of Green is your one-stop-shop to more than 600 Danish businesses, agencies, academic institutions, experts and researchers. State of Green connects you with leading Danish players working to drive the global transition to a sustainable, low-carbon, resource-efficient society.

Learn more: <https://stateofgreen.com/en/about/about-state-of-green/what-we-do/>

