The Building Playbook

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An Owner´s and Solution Provider´s Guide to Low Carbon Retrofit

Danish Industry

GXN

Danish Energy Agency

City of Austin

BLOXHUB

Colophon

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Preface

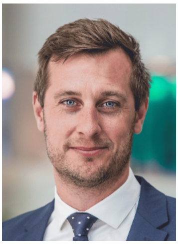
The pressing challenge of climate change necessitates innovative and ambitious approaches to decarbonizing the building sector, a critical component in achieving national and global climate targets. Denmark stands at the forefront of these efforts, dedicated to serving as a model for sustainable building practices and regulatory frameworks.

The Danish sustainable building framework includes stringent building codes and a robust energy labeling system that inform and guide consumer choices. Furthermore, Denmark has successfully implemented targeted information campaigns that raise awareness about energy efficiency, making the public and relevant industries key participants in the country's green transition.
A cornerstone of Denmark's success in this area is the collaborative approach. Denmark's model for climate partnerships and municipal engagement exemplifies how industry, local and state governments, as well as citizen groups, can work together to drive the climate agenda forward, demonstrating that sustainable progress is achievable through collective effort.

In the context of the United States, state and local engagement is equally vital for building decarbonization. Local governments and state authorities play a crucial role in implementing and enforcing energy efficiency measures, tailoring solutions to regional contexts, mobilizing community support and strengthening the business sector while fostering innovation to drive a green transition. The cases and guidelines highlighted in this playbook exemplify the importance of localized initiatives in achieving broader climate goals.

With support from the Danish Energy Agency's Energy Governance Partnership program Denmark's largest business and employer' organization, Danish Industry, and the Nordic Hub for Sustainable Urbanization, BLOXHUB, partnered with Austin Energy to foster collaboration between Danish institutions and their counterparts in the City of Austin, Texas.

By sharing knowledge and best practices, the program strengthens ties between Denmark and its partners, enhancing the capacity of both to address climate change effectively. The program has supported this playbook with the aim of providing valuable insights and practical guidance for building retrofit projects that can significantly contribute to decarbonizing the U.S. building sector. By learning from the highlighted cases and suggested guidelines, we can make substantial strides towards a sustainable, energy-efficient future.



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Introduction

The Danish Way of Building is a Green Way of Building
Decarbonizing the U.S. Building Sector to Achieve Climate Targets

Photo: Ditte Frisk Gidionsen

The Danish Way of Building is a Green Way of Building

Globally, buildings represent around 40% of the energy used. This makes targeting the energy consumption of buildings a key priority for any country or community striving to reduce CO_2 emissions. In Denmark, a wide range of public and private stakeholders have cooperated to develop sustainable and energy-efficient solutions for buildings to support a future green energy transition. Consequently, 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 labeling, targeted information campaigns, and, crucially, involvement of relevant industries.

Retrofitting existing buildings is an indispensable tool when greening the built environment as it provides a more sustainable alternative to demolition and, thus, an effective way of driving down carbon emissions from construction. According to the World Economic Forum's Transforming Energy Demand report, retrofitting existing buildings could reduce their energy intensity by almost 40%. Enhancing energy efficiency through retrofitting makes it possible to decrease energy consumption, positively impacting the climate while reducing the marginal cost of heating, production, and electricity. As such, it creates impactful paths to increased sustainability, not only environmentally but also economically and socially.

Renovations can range from simple and affordable modifications like changing lighting to LED bulbs to more comprehensive renovations such as fitting solar panels or installing clean heating and cooling technologies. This makes retrofitting applicable to any form of building. However, it is important that energy renovations are devised in a collective and holistic manner to reap the benefits. Addressing embodied carbon is therefore crucial for reducing the environmental footprint of buildings together with reducing operational carbon.

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 solutions entail retrofitting existing buildings, introducing intelligent components, implementing energy management, and carefully planning new buildings. For decades, Denmark has focused on energy efficiency in buildings, and energy-efficient solutions are widely implemented in newly built, renovated, and retrofitted housing, offices, and public institutions. Over the last decades, the Danish building industry has developed significantly, resulting in buildings constructed today having an energy consumption of about 30% of those built in 1995. These solutions, developed by both the public and private sectors, have made Denmark a frontrunner in the field of energy-efficient buildings.

Beyond Buildings

Denmark aims to go further in creating a sustainable building sector. In 2020, a public-private partnership has been established with representation from 14 sectors of the Danish business community. The Danish construction sector has proposed 63 recommendations to reduce emissions to meet the national climate goal by 2030. Implementing these proposals could result in an annual reduction of 5,800,000 tons net reduction in CO_2e emissions per year by 2030. Savings can especially be found through measures such as intelligent control and energy renovation, green heating systems, CO_2 budgets for buildings, and energy labeling for all buildings. The solutions and recommendations have great potential for scaling to the US.

Read more about the Climate Partnerships

State of Green is a not-for-profit, public-private partnership between The Danish Government and the country's three leading business associations (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.

Decarbonizing the U.S. Building Sector to Achieve Climate Targets

There are nearly 130 million existing buildings in the U.S., with 40 million new homes and 60 billion square feet of commercial floor space expected to be constructed between now and 2050. Buildings are responsible for more than a third of total U.S. greenhouse gas emissions and account for 74% of U.S. electricity use.[1] Consequently, the buildings sector will play a key role in achieving economy-wide net-zero emissions by 2050. In April 2024, the U.S. Department of Energy published a federal blueprint setting out a national strategy for decarbonizing the building sector. More specifically, it aims to reduce greenhouse gas emissions from U.S. buildings by 65% by 2035 and 90% by 2050 compared to 2005 while centering equity and benefits to communities.

Strategic Objectives

Increase building energy efficiency
Reduce on-site energy use intensity in buildings 35% by 2035 and 50% by 2050 vs. 2005.

Accelerate on-site emissions reductions
Reduce on-site GHG emissions in buildings 25% by 2030 and 75% by 2050 vs. 2005.

Transform the grid edge
Reduce electrical infrastructure costs by tripling demand flexibility potential by 2030 vs. 2020

Minimize embodied life cycle emissions
Reduce embodied emissions from building materials and construction 50% by 2030 vs. 2005.

[1] Decarbonizing the U.S. Economy by 2050: A National Blueprint for the Buildings Sector | Department of Energy

Austin as a national frontrunner for building decarbonization

Located in Central Texas, Austin is the capital of the state of Texas. Renowned for its vibrant culture, thriving economy, and commitment to sustainability, Austin embodies the spirit of modern urban development with a conscience. The city's economy, largely driven by exponential growth in the tech sector, ranks as the region's second-fastest growing. With an estimated population of 961,855, making it the 10th largest city in the U.S., Austin's metro area continues to experience rapid growth, adding an average of 155 new residents daily. Despite this fast-growing population, the city has reduced its greenhouse gas emissions from energy in buildings by nearly 20% in the last eight years, underscoring one of Austin's most notable attributes: its unwavering dedication to environmental stewardship and sustainable living. As a leader in the green movement, Austin has implemented progressive policies and initiatives aimed at reducing carbon emissions and mitigating climate change impacts. From renewable energy programs to ambitious sustainability goals, the city has positioned itself at the forefront of the global effort to combat environmental degradation. With 20,000 acres of green spaces, Austin ranks among the most ecological cities in the U.S. Moreover, as of 2019, Texas emerged as a leading investor in the construction sector nationwide, setting the stage for Austin to emerge as a frontier for Danish enterprises and collaborative governmental ventures, presenting ample opportunities for sustainable growth and partnership.

Austin climate equity goals

In 2021, the City Council of Austin adopted the Austin Climate Equity Plan, which introduced the bold and aggressive goal of equitably reaching net-zero community-wide greenhouse gas emissions by 2040, with a strong emphasis on cutting emissions by 2030. This makes Austin one of four major US cities that have adopted the most aggressive GHG reduction goal: Net Zero by 2040.

The City of Austin is the recipient of a $1 million grant funded through the IRA. The grant is part of the Climate Pollution Reduction Grants program, designed to support states, local governments, tribes, and territories in developing and implementing robust plans to reduce greenhouse gas emissions and harmful air pollution. The City of Austin plans to use these funds to collaborate with regional partners and neighboring cities, extending their climate planning and action beyond Austin's borders.

Cap 1
Achieve net-zero carbon for all new buildings and reduce emissions by 25% for existing buildings, while lowering all natural gas-related emissions by 30%

Cap 2
Reduce community-wide greenhouse gas emissions from refrigerant leakage by 25%

Cap 3
Reduce the embodied carbon footprint of building materials used in local construction by 40% form 2020 baseline.

Building Playbook

Austin Case 1: Retrofit Commercial Building
Austin Case 2: School Building Modernization

Building Playbook

The construction sector stands as the largest single segment in the global advanced energy market, and as the demand for more sustainable and innovative construction solutions increases, the green building sector emerges as one of the fastest-growing industries. Therefore, this playbook seeks to develop a comprehensive guide that illuminates the concrete challenges and opportunities associated with the energy renovation of buildings for both building owners and solution providers. Focusing on Austin, one of the most progressive and rapidly growing cities in the U.S., this playbook expands local knowledge while extending the base for decision- making. It aims to support a green transition through collaboration and knowledge sharing between Danish and American peers.

To collect knowledge, expertise, and data for the recommendations outlined in this Building Playbook, two intensive-day workshops were conducted in the City of Austin. These workshops engaged City of Austin representatives, local stakeholders from the built industry, and Danish companies and organizations, addressing technical, social, and financial perspectives on decarbonization measures through two Austin-specific case studies. The first day's case centered on the transformation of an existing commercial building, while the second day focused on the modernization efforts of existing and newly constructed schools. The backdrop for the workshops stands the Austin Climate Equity Plan, which stipulates three overarching goals for decarbonizing buildings in Austin by 2030. The guidelines of this playbook are directly related to Austin's Climate Action Plan goals, thereby recognizing the complex nature of decarbonization spanning technical as well as social parameters.

The outcome of the workshops resulted in identifying cost-effective approaches for decarbonization efforts in both retrofitting and transforming existing buildings.

Austin Case 1: Retrofit Commercial Building

This project consists of an office tower and an attached parking garage located in North Austin completed in 2017. The tower is an 11-story Class-A Office with ground-level office and retail space, three levels of parking, and seven upper levels of office space. The attached parking garage has one below grade level and four above grades. Both structures were built with cast-in-place concrete construction. The office tower has a chilled water plant for cooling and electric heat. HVAC condensate is collected and reused as cooling tower makeup water.

This case study project was selected as an example of a building type that could seek future retrofits or redevelopment in the North Austin area, based on the height, age, and attached parking structure.

Austin Case 2: School Building Modernization

This project is a new public school building constructed to replace an existing school in East Austin. Construction was completed in 2020. The school serves pre-kindergarten to fifth grades with two stories and approximately 80,000 square feet of building area. It was designed to meet criteria established by the school district and campus leadership including preservation of existing trees, upgrading learning spaces, and the need to occupy the existing school until construction of the new building was complete.

This case study project was selected as a representative example of new school facilities planned for construction throughout Austin.

Guidelines for Cost-effective Decarbonization of Buildings

1 Acquire the Right Data

To effectively decarbonize building operations and enhance performance in the most cost-efficient way, acquiring accurate and comprehensive data is indispensable. Beyond technical specifications, understanding how buildings are utilized, the experiences of occupants, and the renewable energy potential of the site are crucial components. This chapter explores the strategic approach to systematizing and harmonizing data across various building typologies in Austin, focusing on energy profiles, operational emissions, and user dynamics to drive sustainable outcomes.

Understanding the actual building's energy consumption and operational emissions is the first step in the decarbonizing process of existing buildings. Technical data, such as energy usage patterns, HVAC system performance, and building envelope efficiency, provide a quantitative understanding of energy efficiency opportunities. Equally important is qualitative data, encompassing user behaviors, occupancy patterns, and comfort preferences, which influence energy consumption and occupant satisfaction. Additionally, assessing the renewable energy potential of a site informs opportunities for onsite generation and integration into building operations. Including a variety of data helps adapting the most cost-efficient and low-carbon technologies for building projects.

Strategic collaboration across building typologies

Systematizing and harmonizing data across different building typologies within Austin requires strategic collaboration among stakeholders, including building owners, operators, developers, city planners, and sustainability experts.

By establishing standardized data collection protocols and methodologies, consistent and comparable datasets can be generated across diverse building sectors, from residential and commercial to institutional and industrial. This collaborative approach ensures that data-driven insights are applicable and actionable across the city's built environment.

Analyzing energy profiles and operational emissions

Centralizing energy profiles and operational emissions data enables benchmarking and performance comparisons among buildings, identifying outliers and opportunities for improvement. The use of IoT-enabled sensors facilitates real-time monitoring of energy consumption and operational metrics, supporting proactive energy management strategies. The patterns of major energy end-use categories can be analyzed at various time scales. In the case of Austin, benchmarking the power usage effectiveness, which is the largest electricity consumer in commercial buildings, together with diagnosing HVAC equipment using detailed time-series operating data can support low carbon retrofits. Moreover, integrating renewable energy assessments into building data frameworks informs decision-making on investments in onsite solar, wind, or other renewable technologies, advancing sustainability goals while reducing dependency on fossil fuels.

User experience and engagement data

Capturing user experience and engagement data provides qualitative insights into occupant behaviors, preferences, and satisfaction levels. Surveys, feedback mechanisms, and occupancy sensors offer valuable information on comfort conditions, indoor air quality perceptions, and utilization patterns, guiding optimization strategies for building operations and management. Especially in use-specific buildings such as schools, the integration of staff and students can contribute to successful implementation efforts. By prioritizing occupant comfort and well-being alongside energy efficiency measures, buildings can enhance user satisfaction and productivity while minimizing environmental impact.

Case: Smart Building Management with Data Insights

Ubiqisense is pioneering the future of real estate management with cutting-edge technology designed to enhance energy efficiency and optimize space utilization. In collaboration with BLOXHUB, an innovation hub in central Copenhagen, they deployed our advanced footfall and occupancy sensors to tackle space management challenges and enhance sustainability.

BLOXHUB, home to 122 companies and over 800 daily visitors, faced challenges with meeting room availability and space utilization. By implementing Ubiqisense's technology, BLOXHUB gained access to real-time data on occupancy trends. This optimization led to a significant reduction in energy consumption, aligning perfectly with their environmental goals. An analytics dashboard provides continuous insights, enabling BLOXHUB to optimize meeting room usage and reduce energy.

The improved space utilization enhances operational efficiency and supports their sustainability objectives. Additionally, the solution supports BLOXHUB's flexible workspace model, allowing better management of hot desking and fixed desk arrangements. This adaptability ensures every square meter is used effectively, reducing unnecessary energy expenditure.

Ubiqisense's innovative technology empowers property managers to make data-driven decisions that promote sustainability and operational efficiency. By providing deep insights into how spaces are used, they help conserve energy and create healthier, more sustainable environments.

2 Utilize Renewable Solutions

The shift towards electrification of building operations plays a pivotal role in reducing greenhouse gas emissions and advancing climate goals. Austin is prioritizing a significant transition towards electrification of building operations while phasing out reliance on gas. By replacing gas-powered systems with electric alternatives for heating, cooling, cooking, and other functions, buildings can significantly reduce their carbon footprint. Electrification also aligns with the broader trend towards cleaner energy sources and enhances grid resilience by diversifying energy inputs. As 10% of greenhouse gas emissions in the US come from direct fossil fuel consumption by buildings burned in water heaters, furnaces, and other heating sources, electrification becomes a crucial shift in reaching net-zero emissions by 2040. Retrofitting existing buildings with upgraded electric systems and applications while ensuring newly built buildings are outfitted with super-efficient electric heat pumps, is an essential step in furthering the transition.

Shift towards renewable energy use in buildings

To support the electrification of buildings, Austin is dependent on a reliable and efficient electrical grid. As part of the Electric Reliability Council of Texas (ERCOT), Austin is connected to an organization that manages the flow of electric power to more than 27 million Texas customers, representing around 90 percent of the state's electric loads. From 2002 to 2022, Texas has increased its electricity generation from wind and solar from 0.7 percent to 26 percent. On a city level, Austin can further this progress by integrating technological solutions locally such as rooftop solar panels on residential, commercial, and government buildings or community solar projects that allow citizens to subscribe in return for credits on electric bills. Such initiatives allow Austin to enhance the positive impacts on the environment while reducing energy costs and increasing energy stability.

Integration of cost- and energy-efficient technologies

In addition to renewable energy integration, leveraging energy-efficient technologies further enhances building performance and sustainability. Advanced building envelope materials, high-efficiency HVAC systems, smart thermostats, LED lighting, and energy management systems (EMS) optimize energy use and operational efficiency. These technologies not only reduce energy consumption but also lower utility bills, improve occupant comfort, and extend equipment lifespan, demonstrating a compelling return on investment for building owners and operators.

Policy support and incentives as decarbonization driver

Supportive policies, incentives, and regulatory frameworks are essential in accelerating the adoption of renewable solutions and energy-efficient technologies in buildings. In Austin, initiatives such as rebates for solar installations, energy performance standards, green building certifications, and expedited permitting processes could further encourage investment in sustainable building practices. Public-private partnerships and community engagement initiatives further promote awareness, collaboration, and shared responsibility for achieving climate resilience and equity objectives.

Case: Recycling Heat Waste with Water-source Heat Pumps

At 345 Hudson Street, a comprehensive retrofit is setting a new standard for decarbonizing heating and cooling in New York City. Upon completion, the 1930s building will use 25-40% less energy and reduce its annual CO_2 emissions by 90%. Before, 345 Hudson St. used separate systems for heating and cooling. Now, a vertical network of water-source heat pumps by Energy Machines™ integrates these functions into one system. Heat pumps on different floors reduce heating and cooling demands by recycling heat within the building and eventually between neighboring buildings.

The system is complemented by an efficient energy recovery ventilation system that minimizes energy waste. Waste heat, typically expelled outside, is recovered and redistributed throughout the building, drastically reducing the need for additional energy. During warmer months, this waste heat is stored in repurposed fire suppression tanks, enhancing efficiency and cost-effectiveness.

Recognized as one of the four Empire Building Challenge showcase projects by NYSERDA in 2022, this initiative exemplifies best practices in low-carbon retrofits and contributes to New York's goal of reducing greenhouse gas emissions by 85% by 2050. The significant emissions reductions will also exempt the 17-story property from the city's upcoming CO_2 taxes, saving Hudson Square Properties - a joint venture of Hines, Trinity Church Wall Street, and Norges Bank Investment Management - over $200,000 annually.

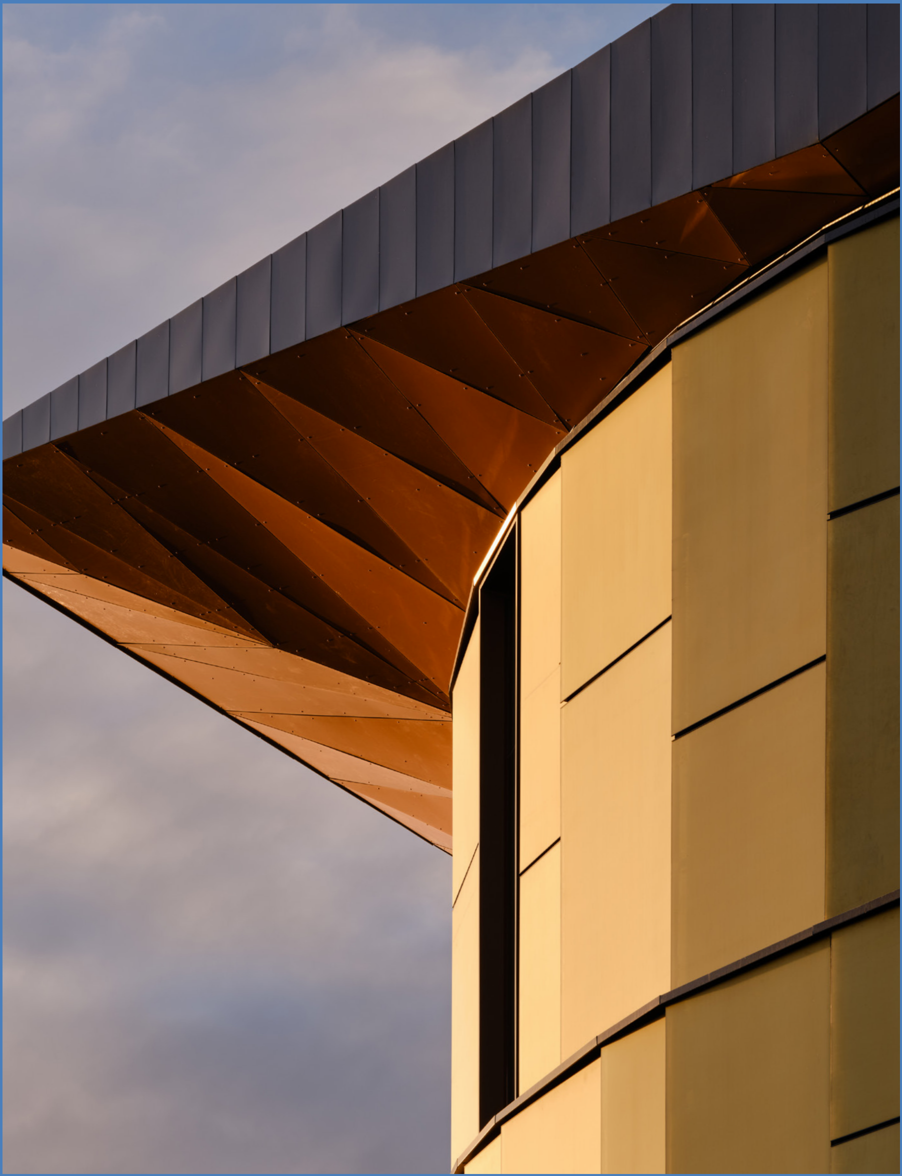
Case: Innovative Solar Facades Create A Sustainable Powerhouse

Introducing SolarLab, a pioneer in bespoke Building-Integrated Photovoltaic (BIPV) solar facades, revolutionizing the intersection of sustainable technology and architectural design.

SolarLab's pioneering BIPV solar facade at Red River College's Manitou a bi Bii daziigae exemplifies the perfect fusion of sustainability and architectural elegance. Designed in collaboration with Diamond Schmitt Architects and Number TEN architectural group, the project features a shingled solar Rain Screen that dynamically flows across multiple facades, including an iconic rounded corner.

This design not only offers architectural freedom and dynamism but also transforms the building into a sustainable powerhouse. With panel-level monitoring and rapid shutdown, the system ensures resilience, safety, and optimal production of carbon-free electricity throughout the day. Utilizing a variety of panel sizes and shapes in an interleaved pattern, the BIPV facade enhances the architectural experience with depth and texture. The tailor-made panels are combined in sections up to 4000 mm tall, with concealed, angled suspension systems for tool-free mounting, fire protection, and optimal ventilation. Financially, SolarLab's BIPV facades offer substantial economic and environmental payback. In the U.S., financial incentives such as federal tax credits and state-specific rebates further enhance the appeal, making SolarLab's sustainable solutions an attractive investment for forward-thinking architects and developers. The Manitou a bi Bii daziigae building is a testament to the potential of SolarLab's innovative approach, targeting zero energy consumption and minimal CO2 emissions.

The Manitou a bi Bii daziigae building is a testament to the potential of SolarLab's innovative approach, targeting zero energy consumption and minimal CO_2 emissions.



SolarLab

3 Stimulate Sustainable Behavior

Retrofitting and modernizing buildings is a paramount strategy for reasons stated earlier in the playbook. However, even with the most advanced technologies integrated into these structures, their true sustainability hinges largely on the behaviors of those who inhabit them. Understanding this, the focus must shift towards stimulating sustainable behaviors within retrofitted buildings. By empowering users to engage with and optimize building systems, a significant reduction in operational carbon emissions can be achieved.

Understanding the user-system interface

The operational carbon emissions of buildings are intrinsically tied to user behavior. Heating, cooling, lighting, and appliance usage are all influenced by occupants' actions. Therefore, altering these behaviors becomes the linchpin of reducing emissions effectively. To accomplish this, it is imperative to bridge the gap between users and building systems through education and engagement.

Education and training initiatives for a systemic behavioral change

One of the primary approaches to stimulate sustainable behavior in retrofitted buildings is through comprehensive education and training initiatives. Users must be made aware of the environmental impact of their actions and educated on how to interact with building systems optimally. Workshops, seminars, and online tutorials can impart knowledge about energy-efficient practices and the utilization of building technologies.

Gamification for sustainable engagement

Integrating gamification elements into building management can be a powerful tool for engaging users and fostering sustainable behavior. By incorporating game-like features such as challenges, rewards, and leaderboards, occupants are incentivized to participate in energy-saving activities actively. These methods can be successfully applied to school programs or in an office setting with the same group of users in the building.

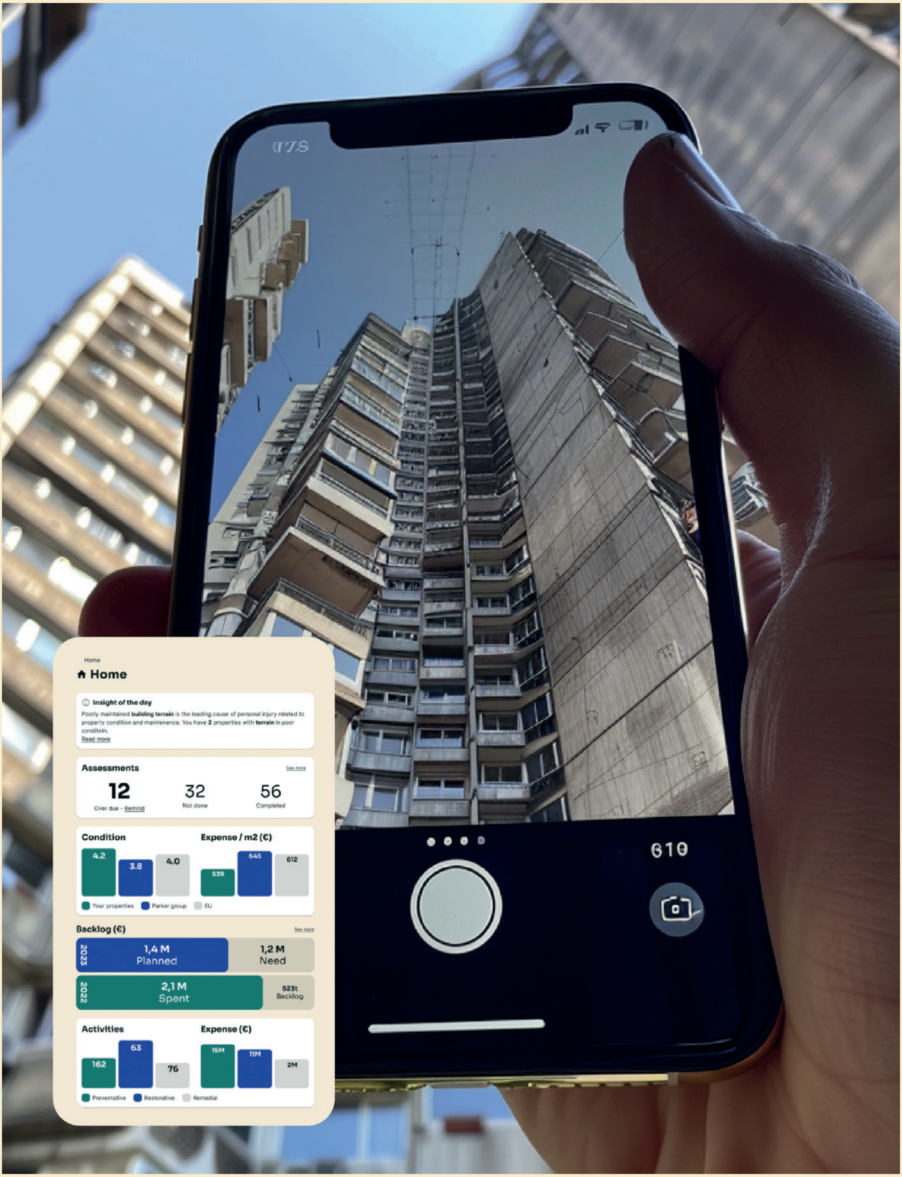
Whether reducing energy consumption during peak hours or optimizing thermostat settings, gamification can transform sustainable practices into an enjoyable and rewarding experience.

Utilizing online databases for visualization

Visualizing energy consumption data in real time can provide users with valuable insights into their environmental footprint. Online databases and user-friendly interfaces allow occupants to monitor and analyze their energy usage patterns, empowering them to make informed decisions about resource utilization. By visualizing the immediate impact of their actions, users are motivated to adopt more sustainable behaviors and contribute to overall emission reduction efforts. These efforts can be implemented in already existing technologies that are present in most commercial and school buildings such as screens and visualization boards for low effort-high impact results.

Community engagement and collaboration

Beyond individual efforts, fostering a sense of community and collaboration among building occupants can further enhance sustainability initiatives. Platforms for sharing tips, experiences, and success stories can inspire collective action and create a culture of environmental stewardship. Additionally, collaborative projects such as community gardens or composting programs can strengthen social bonds while promoting sustainable living practices.



Home
Home
Insight of the day
Poorly maintained building terrain is the leading cause of personal injury related to property condition and maintenance. You have 2 properties with terrain in poor conditoin.
Read more
Assessments
See more
12
Over due - Remind
32
Not done
56
Completed
Condition
4.2
3.8
4.0
Expense / m2 (€)
539
645
612
Your properties
Parker group
EU
Backlog (€)
See more
2023
1,4 M
Planned
1,2 M
Need
2022
2,1 M
Spent
523t
Backlog
Activities
162
63
76
Expense (€)
15M
11M
2M
Preventative
Restorative
Remedial
610

proprty.ai

Case: Efficient Property Maintenance Planning with AI

Efficient property maintenance is essential for ensuring predictable cash flow and sustainable buildings. Traditional maintenance processes are labor-intensive, relying heavily on scarce technical resources, leading to a lack of control over property conditions and resulting in significant reactive and unplanned maintenance expenses. Studies show reactive maintenance is 4x more expensive than preventive maintenance, impacting both business and the environment negatively. proprty.ai is AI that automates property maintenance planning. Trained on data from 12 million sqm, it predicts the condition and remaining lifespan of all building components. It provides a detailed preventive maintenance plan, specifying the starting year and frequency of maintenance, along with the predicted restoration year and associated costs.

By utilizing proprty.ai, property owners can optimize the lifespan of building components, deferring renovations to the end of their useful life and maximizing the use of embedded CO_2. This is crucial as the EU estimates renovation costs at 125-200 kg CO_2 per sqm. Extending the lifespan of building components reduces renovation cycles, significantly saving CO_2 emissions in an industry responsible for nearly 30% of all greenhouse gases. Proprty.ai ensures optimal renovation planning, contributing to the EU's renovation wave of reducing CO_2 emissions by 10 billion tons across the European Union.

Case: SparEnergi.dk - High-quality Information for Building Owners

A key measure to achieving Denmark's climate goals is easy-to-understand, high-quality information about the energy renovation of buildings to both building owners and craftsmen. For this, the Danish Energy Agency (DEA) has created several platforms, including SparEnergi.dk. This platform serves as a one-point entry to all information from the DEA regarding energy renovations and retrofitting buildings.

Hosted by the DEA, SparEnergi.dk offers a free, open-access platform providing guidance on how to renovate buildings and save energy. It caters to building owners in residential, commercial, and public buildings, providing detailed information on upgrading heating systems, enhancing insulation, replacing windows, and much more. The platform features examples, case studies, guides, and calculation tools to assist users in their renovation efforts.

Moreover, SpargEnergi.dk provides information on energy labeling and integrates all the DEA's campaigns and initiatives aimed at end users. The purpose is to create synergies between the various initiatives, making it easy for the users to find cohesive and comprehensive content. By consolidating resources and making them readily accessible, SparEnergi.dk plays a crucial role in promoting energy-efficient building practices in Denmark, supporting the nation's climate objectives.

4 Enhance Passive Design Measures

Increasing the reliance on passive design measures in construction and retrofitting is a key strategy for promoting sustainable building practices and reducing carbon emissions. Passive design strategies involve careful design considerations aimed at maximizing natural light, minimizing heat gain, and optimizing a building's location and orientation to create comfortable indoor environments without relying heavily on mechanical systems. Therefore, taking a holistic approach in the early design stages and utilizing simulation tools to estimate energy balances can help enhance the benefits of passive design strategies.

Key principles of passive design measures

Passive design relies on harnessing natural elements such as sunlight, airflow, and thermal mass. Here, taking into consideration climate and environmental factors in the given geographical location is important to yield the most cost- and energy-effective retrofit strategies:

Optimal Building Orientation: Proper orientation of buildings relative to the sun's path maximizes solar gain in winter and minimizes it in summer, reducing the need for heating and cooling.

Daylighting: Designing spaces to maximize natural light penetration reduces reliance on artificial lighting and can significantly influence building energy consumption and occupant well-being. Ways to enhance daylight entail optimizing window placement to capture natural light while minimizing solar heat gain. By using clerestory windows and skylights, natural light can penetrate deeper into the building, and with light shelves, glare can be reduced and daylight distribution enhanced.

Natural Ventilation: Strategically locating openings and utilizing cross-ventilation patterns enhances airflow, improves indoor air quality, and reduces the need for mechanical ventilation.

This contributes further to minimizing heat gain, including installing overhangs, awnings, and vegetation to shade windows and minimize direct solar radiation. To enhance cross-ventilation, winds often come from the south in Austin, so placing windows on the north and south sides can be effective.

Early simulation tools and energy balance

Advancements in building simulation tools enable designers to assess the energy performance of passive design strategies early in the design process. It is also becoming more common to consider energy and carbon thresholds to guide design teams. These thresholds serve as benchmarks or limits that aim to minimize the environmental and economic impact of a building throughout its lifecycle, from construction through operation and eventual demolition or reuse. Tools to simulate building performance are based on factors such as climate data, building orientation, envelope properties, and occupancy patterns. By conducting energy balance simulations, designers can optimize passive elements—such as insulation levels, window sizes, and shading configurations—to achieve desired energy efficiency targets thermal comfort conditions and, ultimately leading to substantial reductions in both operational and embodied carbon.

Integration and implementation

Implementing passive design measures successfully requires collaboration among architects, engineers, and sustainability consultants from the start. Integrating these principles into building codes, standards, and green certifications promotes adoption and ensures consistent performance across various building types. Continuous post-occupancy evaluations and performance monitoring validate design assumptions, guide future designs, and optimize operations for long-term energy efficiency and occupant comfort.

Case: Retrofit with Sustainable Stone Wool Insulation

This 160-unit residential co-op, constructed in 1961 in NYC's Upper East Side, was an early example of the white-glazed brick buildings typical of that era. The original design prioritized comfortable units with large, spacious rooms, but the façade was purely functional due to limited resources. Over time, inspections uncovered structural and masonry failures, requiring costly repairs. By 2018, a full façade recladding was needed which included upgrading the envelope with a high-performing rain-screen system that would improve thermal performance, acoustics, and comfort and safety for the residents. Stone wool insulation was selected as material for the new envelope due to its superior fire-resilient properties, thermal performance, and comfort. ROCKWOOL Cavityrock® Black and original Cavityrock were specified. The new façade used an open-joint system, requiring materials to meet aesthetic, durability, and energy efficiency needs. The matte black layer on Cavityrock Black was aesthetically suitable, and both stone wool products provided exceptional moisture resistance and drying properties. Metal framing for the new cladding was bolted into the repaired and sealed original concrete block backing, with stone wool boards installed behind the framing. Stone wool's ease of cutting allowed crews to fit the material around original and newer window installations. The porcelain tiles were attached with an innovative clip system, contributing to the fire-resilient design.

ROCKWOOL stone wool insulation products not only help in creating sustainable buildings; they are made from a natural fire-safe and durable material with no added flame retardants or blowing agents. Stone wool building insulation saves more than 100 times the energy consumed, and CO_2 emitted in its production in its lifetime of over 65 years.

Rockwool

Case: The Ev0 Building: A Blueprint for Ultra-low Carbon Workspaces

The international leading architecture, engineering, and consultancy company Ramboll was hired to provide sustainability, MEP, and structural design expertise to a building project that meets the UK's net-zero carbon vision.

The solution was to use a smart and green design approach that relied on the extensive use of timber and low-carbon concrete. The building's façade design was optimized to minimize solar gain and overheating, and almost all the energy required for the building will be generated on-site (94%) through the use of solar panels and an ambient loop system.

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 tons CO_2e of CO_2 and has upfront carbon emissions of circa 500 $kgCO_2e/m2$ and whole life carbon emissions of 800-1000 $kgCO_2e/m2$.

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.


LATTE
CORTADO
MACCHIATO
CAPPUCCINO
MASALA CHAI
TEA

5 Stimulate Healthy Indoor Climates

The need for cooling, heating, and ventilation within buildings is not only to maintain comfort but also to ensure the well-being of occupants. However, achieving this goal doesn't have to rely solely on traditional methods involving refrigerants. By leveraging natural ventilation, thermo-active constructions, referring to building systems that utilize the thermal mass of a building's structural elements and thoughtful daylight design, buildings can foster healthy indoor climates while minimizing environmental impact. In this chapter, the focus is on low-carbon efforts that minimize energy consumption and environmental impact while also creating a building design through thoughtful integration, optimization, and ongoing evaluation to provide occupants with sustainable buildings with comfortable, healthy, and inspiring spaces to live, learn, work, and thrive.

Natural ventilation to optimize health in buildings

Natural ventilation offers a sustainable alternative to mechanical systems, utilizing natural airflow to regulate indoor temperatures and air quality. By strategically positioning windows, vents, and louvers, buildings can capitalize on prevailing winds and temperature differentials to facilitate passive cooling and ventilation. Incorporating design elements such as atria, courtyards, and operable facades further enhances airflow and promotes natural ventilation, optimizing indoor health for occupants. Natural ventilation is most effective in climates with significant temperature differences between night and day. In regions with high humidity and temperature, natural ventilation is particularly beneficial during the winter season.

Thermo-active constructions

Thermo-active constructions harness the thermal mass of building materials to regulate indoor temperatures efficiently. Over the last decade, solutions have been reinvented and created to contribute to a green building environment. Materials such as sustainable concrete, brick, and rammed earth possess high thermal inertia, allowing them to absorb, store, and release heat gradually.

By integrating these materials into building structures, fluctuations in external temperatures can be mitigated, maintaining a stable and comfortable indoor climate year-round. Additionally, utilizing earth-coupled heat exchangers or geothermal systems further enhances thermal performance of buildings, reducing energy consumption and environmental impact.

Illuminating spaces naturally

Thoughtful daylight design reduces the need for artificial lighting and enhances indoor comfort and well-being. Maximizing natural daylight penetration through strategic fenestration, light shelves, and reflective surfaces creates visually stimulating and inviting interior spaces. Beyond aesthetic benefits, exposure to natural light has been shown to positively impact mood, productivity, and circadian rhythms, promoting overall health and wellness. Incorporating shading devices and glazing technologies minimizes solar heat gain and glare, ensuring optimal thermal and visual comfort throughout the day.

Integration, optimization, and feedback mechanisms

Achieving a healthy indoor climate requires a holistic approach that synergistically integrates natural ventilation, thermo-active constructions, and daylight design. By considering building orientation, site characteristics, and occupant behavior during the design phase, architects and engineers can optimize passive strategies to maximize comfort and efficiency. Building performance simulation tools enable designers to evaluate various design scenarios and assess the impact of different strategies on indoor environmental quality. Additionally, post-occupancy evaluations provide valuable feedback for fine-tuning building performance and occupant satisfaction over time.


RZR

Case: Saving Energy with High-efficiency Ventilation in Buildings

The Keppel Bay Tower is more than a tower far away. It is, most remarkably, the first commercial building in Singapore to achieve the Singapore Green Mark Platinum (Zero Energy). In a design competition for green-tech innovation and technologies, the Green Buildings Innovation Cluster (GBIC) competition called for the implementation of emerging energy-efficient technologies to reduce energy consumption by another 20% at the Keppel Bay Tower. Out of 50 applicants, five technology partners were chosen for trials.

NOVENCO® Building & Industry entered with a proposal to retrofit an existing centrifugal fan in an air handling unit with a high-efficiency NOVENCO ZerAx® axial fan. The committee accepted the proposal due to the significant energy reduction potential indicated by probing measurements and verification techniques. The ease of retrofitting contributed further to the selection of the proven and most efficient fan in the world, the ZerAx®.

The retrofit work went very smooth and was completed in less than 10 hours. The energy savings of 43% achieved through use of the ZerAx fans was verified by the independent adjudicators Nanyang Technological University (NTU). The impact the ZerAx fans have on the annual energy building consumption resulted in 2020 in a 22.3% reduction and well above the set target of 20%


Before


After

Case: Creating an Optimal Learning Environment with Energy-efficient Technology

Rebuilding two preschool classrooms at the Endrup School in Fredensborg, Denmark offered an opportunity to create healthy indoor environments for children and implement new, energy-efficient technologies. In so doing, the design team also hoped to create a better space for learning and teaching.

The objective of the transformation of Endrup School's preschool area was to improve air quality, reduce temperatures in classrooms to create a more pleasant indoor environment, and supply the area with abundant daylight. Until recently, the Endrup School's two preschool classrooms were severely lacking in both daylight and fresh air - two factors proven to enhance well-being, concentration, and the ability to learn. The classrooms were dark, vertical windows created unpleasant temperature changes, and the teachers and students suffered from poor air quality that caused discomfort and fatigue.

In collaboration with the VELUX Group, roof windows equipped with software that enable automatic control and pulse ventilation were installed in the classrooms. The optimized use of daylight has cut the use of electric lighting in the renovated classrooms down by 30%. The ample sunlight also provides useful solar gains during the winter period, significantly helping to reduce the building's energy consumption.

6 Use Nature as Climate Support

Every year, people, plants, and animals are increasingly challenged by the impact of climate change. While efforts to mitigate these challenges are essential, it is important to consider these realities in construction and retrofitting. By the end of this decade, Austin is expected to experience over 60 days annually with temperatures exceeding 37.7 Celsius degrees / 100 Fahrenheit.

Integrating nature into building design

Nature-based solutions (NBS) offer innovative redesign options that can integrate ecological, social, and technological factors into the performance of buildings. As such, NBS promotes adaptation and resilience by weaving natural features or processes into building design and operations. Instead of thinking of buildings as separate from nature, NBS encourages buildings as part of nature and in that way contribute to healthier environments while mitigating environmental impacts. Utilizing natural materials with a high thermal mass or strategically planting trees can help naturally regulate indoor temperatures by reducing heat buildup through evaporative cooling. Furthermore, strategically selecting trees and plants can help purify the air, reducing the harmful particles inhaled in the urban environment, thus improving air quality. Nature can thereby come to play an active role in improving the performance and enjoyment of buildings.

Well-designed city-nature contributes with ecosystem services that make cities more sustainable and keep them safe during heavy rainfall and flooding, as well as lowering temperatures during heatwaves and retaining warmth during cold winters. However, the implementation strategies for NBS are diverse; one size does not fit all. It is always important to consider the contextual climate challenges and apply and utilize native crops and plants accordingly.

Evaporative Cooling and Transpiration

Trees and plants contribute to cooling through evaporative processes. During transpiration, plants release water vapor into the air, which cools the surrounding environment, similar to a natural air conditioning system. This process helps mitigate urban heat island effects and improves thermal comfort in outdoor spaces adjacent to buildings. Incorporating green roofs and living walls further enhances evaporative cooling, insulates buildings, and reduces energy needs for cooling during hot weather. Besides the positive environmental effects, NBS often requires less maintenance and are cost-efficient alternatives considering mechanical cooling technologies.

Psychological benefits of enhanced aesthetics

Beyond their functional benefits, green spaces contribute to the aesthetic appeal and psychological well-being of building occupants. Integrating biophilic design principles, which emphasize connections to nature, can reduce stress, enhance mood, and increase productivity. Access to natural views, indoor plants, and landscaped outdoor areas fosters a sense of connection with the natural environment, creating healthier and more enjoyable living and working environments.

Case: Strengthening Climate Resilience with Nature Solutions

SUND Nature Park in Copenhagen is a new type of modern campus park designed in connection with a new 19-storey healthcare research complex, The Maersk Tower.

The 37,000 m2 SUND Nature Park provides optimal research and study opportunities for students and researchers: Outdoor study places, green hangout spaces, and integrated bicycle parking create an informal social gathering place for users, guests, and residents alike.

SUND Nature Park, designed by SLA, is state-of-the-art in terms of and climate adaptation and sustainability. The park is designed to absorb severe torrential rains without flooding the surrounding buildings or infrastructure. Biodiversity is strengthened by a varied and lush native planting scheme. Extensive public green roofs gather and reuse all rainwater as greywater in the building and irrigation for the park. The green roofs also naturally cool down the building while providing green and lush places to stay and socialize.

Large trees are planted strategically close to the tower to shield from down-winds and to help with the building's indoor climate and energy consumption - providing shade from the sun in the summer, and shelter from the cold winds during winter.

All in all, SUND Nature Park strengthens the climate resiliency of buildings and neighborhoods while adding a host of social values for all.

SLA

7 Implementing Carbon Budgets in Building Design

Decarbonizing buildings is imperative to reaching U.S. city climate goals and in the fight against climate change. Therefore, it is important to recognize that early design decisions significantly affect a building's embodied carbon emissions, prompting architects, engineers, and developers to adopt innovative strategies to minimize environmental impact, here among carbon budgets. By setting clear targets and conducting iterative carbon analysis alongside financial budgeting, carbon budgets offer a powerful and proactive tool to drive down embodied carbon and advance sustainable building practices.

Understanding embodied carbon

Unlike operational carbon emissions, which result from energy consumption during a building's operational phase, embodied carbon is emitted upfront. It accounts for a significant portion of a building's total carbon footprint over its lifecycle. Therefore, mitigating embodied carbon through thoughtful material selection and design decisions is crucial for achieving carbon neutrality in the built environment.

Introducing carbon budget methodology

Carbon budget methodology involves setting a predetermined limit on the amount of CO_2 equivalent emissions allowed for a specific project or building. Like financial budgets, carbon budgets establish constraints that guide decision- making throughout the design process. By allocating a finite carbon budget to different building elements and systems, designers can prioritize low-carbon materials and construction methods while minimizing waste and inefficiency. Furthermore, the carbon budget can be divided by percentage for the main building packages such as facade, MEP, structure based on typical carbon allocations. Dividing the carbon budget by percentage for main building packages results in enhanced clarity, accountability, and efficiency in achieving sustainable building goals. It encourages a holistic approach to carbon reduction across all facets of building design and construction, fostering collaboration and innovation among diverse disciplines involved in the project.

Setting clear targets and benchmarks

Central to the success of carbon budgets is the establishment of clear targets and benchmarks that align with broader sustainability objectives. Here, the city of Austin can play a vital role in promoting and setting standards for carbon budget guidelines. These targets can be inspired by other industry standards, regulatory requirements, or project-specific goals for carbon reduction, yet should be context-specific to the local setting of Austin. By quantifying allowable carbon emissions per square meter of building area or per unit of functional performance, stakeholders can track progress and measure success in meeting sustainability targets. This local baseline can be informed by local material sourcing and supply chains, along with climate-specific design strategies.
In collaboration with the local academic institutions and local specific knowledge, clear targets can be defined.

Conducting carbon analysis

Carbon analysis throughout the design process is necessary to evaluate the environmental impact of different design options and material choices. Life cycle assessment (LCA) tools enable designers to quantify embodied carbon emissions associated with various building elements and assemblies. By comparing alternative designs and materials against the established carbon budget, designers can identify opportunities for carbon reduction and make informed decisions that optimize environmental performance.

Integrating carbon budgeting into design practices

Implementing carbon budgets requires a shift in design practices to prioritize environmental sustainability alongside economic considerations. Collaboration among architects, engineers, contractors, and clients is essential to ensure that carbon reduction strategies are effectively integrated into all phases of the design and construction process. Building information modeling (BIM) platforms facilitates data-driven decision-making and enables real-time analysis of carbon impacts, enhancing the transparency and efficacy of carbon budgeting initiatives.

Case: Embodied Carbon Goal: Hot Spots and Easy Wins

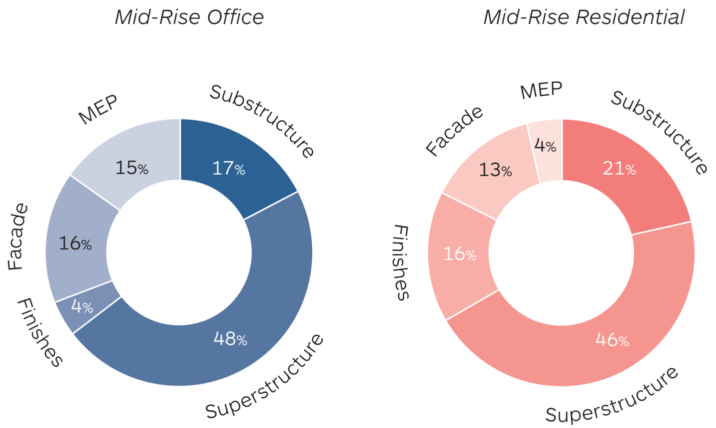
GXN uses carbon budgets as a tool to set individual goals for different building components, or upfront vs whole life carbon. It assists in highlighting what parts of the building are potential carbon 'hot spots' and likewise potential 'easy wins' to achieve an embodied carbon goal. It can also be used to assign each package/discipline a 'fair share' of the overall carbon goal to give designers and engineers a figure to check against when comparing options that are within their individual sphere of influence.

In the case of London, UK, the budget is set by:

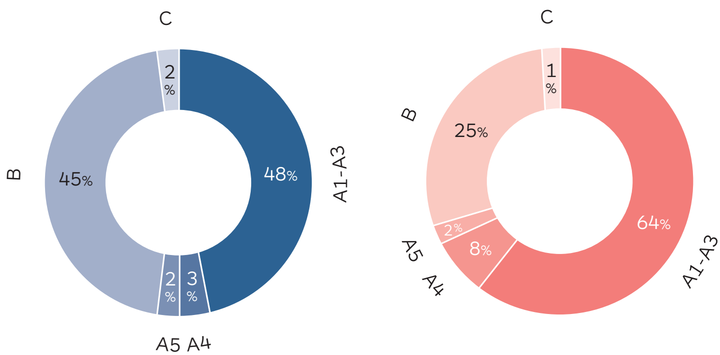
1. Looking at industry averages of carbon calculations and the typical split within a particular typology across building components. For example, London.
   Energy Transition Initative (LETI), Greater London Authority (GLA), or the Carbon Leadership Forum (CFL) could be a source to start.
2. Hosting a carbon workshop with the design team to discuss what opportunities/constraints different disciplines might face to meet their allocated budget.
3. Adjusting the carbon budget to reflect the project-specific context.

Throughout the project, the budgets are used to compare different design options of individual building components, if a building component exceeds its allocated budget, savings will have to be made elsewhere to stay within the goal.

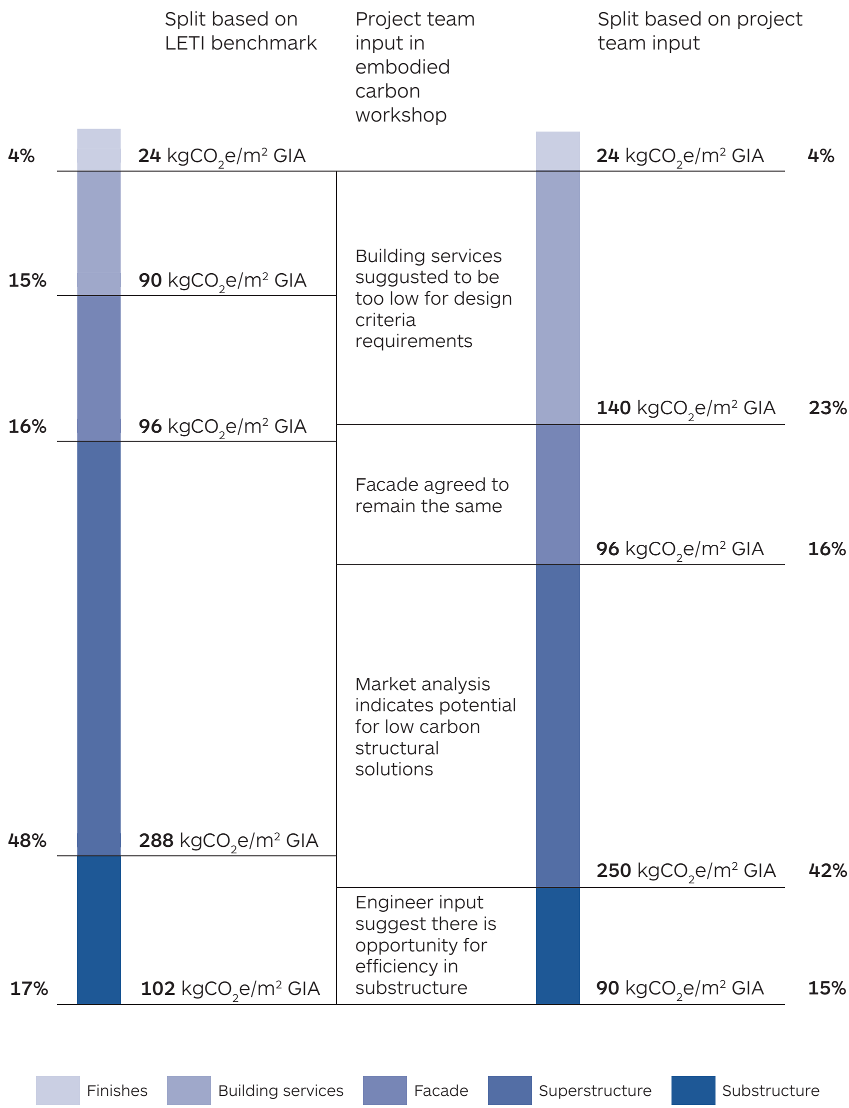
LETI - Building category (Cradle to Gate A1-A3)



LETI - Life Cycle Stages



Example of typical budget split based on average data.



Example of carbon budget discussion.
Carbon budget example: OfficeGoal: 600 $kgCO_2e$/m2 GIA (A1-A5).

	Target ($kgCO_2/m^2$)	Stage 2 ($kgCO_2/m^2$)	Mid Stage 3 ($kgCO_2/m^2$)	End Stage 3 ($kgCO_2/m^2$)
LETI Office 2020 Target **Total Upfront Carbon** (A1-A5)	**500**	**574**	**578**	**523**
Substructure	95	99	105	95
Superstructure	180	216	221	212
Facade	85	52	58	57
Internal Finishes	80	40	40	5
Building Services	70	138	124	124
Site Emissions	-	30	30	30

Within target or improved   Exceeds target or worsened

Example of tracking carbon budget throughout the design stages.

Legacy
Photo: Adrian Cuj, Unsplash

Case: ATP Ejendomme - Legacy Carbon Accounting Software

ATP Ejendomme, Denmark's largest pension fund and a leading real estate investor, faced several obstacles in its carbon accounting processes. Collecting consumption data was tedious and time-consuming, with significant gaps that needed addressing. Ensuring compliance and auditability in carbon reporting was crucial, alongside the need for transparent, up-to-date emission factors with both location-based and supplier-specific emissions. Understanding asset performance and customizing data views further complicated the process.

Legacy's implementation transformed ATP Ejendomme's approach to carbon accounting and utility data. Automated data collection through API integration streamlined processes and reduced costs by 80% compared to the previous semi-manual process. Data diagnostics identified low-hanging initiatives in 20% of the portfolio, and the data matching algorithm helped fill data gaps across the portfolio, achieving 100% data coverage. The system, ISAE 3000 certified, provided fully auditable CO_2e accounts and standardized reports with transparent calculations into ESG, GHG, CRREM, and other formats. Various benchmarks based on Legacy's access to metered data on 32 million buildings helped assess performance and indicate buildings with optimization potential. A custom Power BI integration enhanced data visualization from asset managers to C-level executives, ensuring that everyone was looking at the same data. API access allowed seamless data feed into internal tools at no additional cost.

The results were remarkable. ATP Ejendomme published fully auditable CO_2 accounts, increased its PCAF score, and made informed decisions on asset retention. Costs were significantly reduced, and comprehensive data coverage was achieved, ensuring compliance and transparency.

8 Advancing Circularity

Stimulating a circular economy to reduce carbon and resource use in the built environments is linked to how existing buildings are treated. The circular economy is a paradigm shift, and the transformation of how existing buildings are treated is central. By understanding material quantities in existing buildings and adopting circular principles, stakeholders can unlock significant environmental and economic benefits while paving the way for a more sustainable future.

Maximizing material reuse and recycling

A key strategy for enhancing circularity in buildings is to maximize the reuse and recycling of materials from existing structures. Through careful deconstruction and salvage operations, building materials such as timber, brick, concrete, and steel can be reclaimed and repurposed in new construction projects. Additionally, implementing policies and incentives to incentivize material recovery and recycling further promotes resource conservation and reduces the demand for virgin materials.

Embracing upcycling and repurposing

Upcycling involves transforming waste materials or products into new, higher-value materials or products, thereby extending their lifespan and diverting them from landfills. By embracing upcycling techniques such as refurbishment, renovation, and adaptive reuse, buildings can be revitalized and repurposed to meet evolving needs while preserving embodied energy and reducing environmental impact. From converting shipping containers into modular housing units to repurposing industrial artifacts as architectural features, upcycling offers innovative solutions that combine creativity with sustainability.

Shifting towards a new material paradigm

A fundamental aspect of advancing circularity in building design is shifting towards a new material paradigm that values the reuse and longevity of materials over single- use consumption. By assigning equal importance to second-hand materials as to new materials, designers, and developers can challenge conventional notions of value and embrace the principles of resource efficiency and waste reduction. This shift not only conserves valuable resources but also fosters innovation in material sourcing, manufacturing, and design.

Collaboration and innovation

Achieving enhanced circularity in building design requires collaboration and innovation across the entire construction value chain. Architects, engineers, contractors, manufacturers, policymakers, and communities must work together to develop and implement strategies that prioritize circular principles and drive systemic change. From designing buildings for disassembly to implementing material passports that track the provenance and lifecycle of materials, collective action is essential to realize the full potential of the circular economy in the built environment.

Case: Symbiose Houses Creating a True Sustainable Community

Many business areas around larger cities are usually deserted after dawn. The empty business premises occupy valuable space in often densely populated cities. This experimental transformation project supported by Realdania and the Danish Arts Foundation shows a completely new way for these types of areas to develop. A traditional commercial building is transformed, and a symbiosis between business, housing, and roof agriculture emerges. Different users can share facilities and utilize each other's resources – creating a truly sustainable community.

This will become a completely new way of living, combining the qualities of a village's close community with the mixed functions of the dense city. An integrated roof farm will provide offices and housing with fresh vegetables and a great recreational area and become a possible attraction for the neighborhood. In addition, the "village" and the office building below will form a strong symbiosis and benefit from each other. Food, water, heat, energy, parking meeting spaces, etc., are shared and utilized by different users at different times of the day and year – making much better use of all local resources.

The existing office building has undergone a light renovation, reusing all existing concrete slabs and only minor things in the existing structure. New programs like a kindergarten and a health care center have been included to obtain a more diverse building. This alternative transformation has given the building a unique identity and brought extra value to both the owner and the community.

Urban Power

Case: Creating Functional Spaces with a Circular Approach

a:gain is a company dedicated to revolutionizing the construction industry through upcycling waste materials into new high-quality building elements and interior products. Their 'Tystø' partitioning wall system is a prime example of this innovative approach, utilizing reclaimed glass and discarded wood to create stylish, sustainable office partitions.

The Tystø system has been successfully implemented in many reference projects, with Ikano Bolig as a first large-scale reference. Ikano Bolig is committed to minimizing the environmental impact of its real estate developments. At their office in Copenhagen area, Ikano Bolig chose Tystø partitions for their aesthetic appeal and proven substantial environmental benefits. These partitions are made from glass units salvaged from demolished buildings, significantly reducing CO_2 emissions compared to conventional glass production.

The collaboration between a:gain, DEKO, and various demolition companies ensures that Tystø walls are sustainable and reliable, with full product warranties and scalable deliveries. This project has received positive feedback for both its environmental impact and the enhanced office ambiance it provides. a:gain's work with Tystø at Ikano Bolig showcases how functional spaces are created while promoting circular economy principles.

9 Stimulate Transformation of Existing Buildings

The most sustainable building is the one already built. Therefore, retrofitting existing buildings represents a cornerstone in reducing carbon and maximizing the longevity of urban infrastructure. It avoids the environmental impacts associated with demolition, such as waste generation, energy consumption, and disruption to the urban landscape. Transforming an existing building is usually just as ambitious as building a new one. Creativity and ingenuity in transforming tired buildings from one life cycle to the next is therefore greatly encouraged.

Reducing embodied carbon

Embodied carbon accounts for about 11% of global emissions from buildings, and most of the embodied carbon is found in the foundation, structure, and envelope. Austin, therefore, must consider the existing building stock as it is impossible to solely build a way into sustainability, even with the use of environmentally friendly materials and renewable energy. Transformation of sites can reduce embodied energy by capitalizing on the organized energy expended in constructing them. This approach not only avoids the extensive energy use and environmental impact involved in creating new building materials and constructing from scratch, thus conserving energy on a large scale but is also able to increase the value and lifespan of buildings. Additionally, adaptive reuse preserves the historical, cultural, and/or architectural significance of structures.

Economic and social benefits

Beyond environmental considerations, adaptive reuse of buildings preserves neighborhood character, promotes social cohesion, and revitalizes underutilized spaces, contributing to vibrant and inclusive urban environments. It is not overlooked that retrofitting buildings presents unique challenges, including addressing structural integrity, complying with building codes and regulations, and managing financial constraints.

However, these challenges can be overcome through strategic planning, interdisciplinary collaboration, and leveraging incentives or grants for historic preservation and sustainable development.

Policy support and incentives

Supportive policies and incentives play a crucial role in promoting retrofitting and adaptive reuse initiatives. The city of Austin can provide tax incentives, grants, expedited permitting processes, and regulatory flexibility to encourage investment in sustainable building practices. Public awareness campaigns and education initiatives raise appreciation for the environmental and cultural benefits of preserving existing buildings and promote community engagement in revitalization efforts. Through collaborative efforts and forward-thinking strategies, cities can harness the transformative power of retrofitting to create resilient, low-carbon urban landscapes that benefit present and future generations alike.

Henning Larsen

Case: A Vibrant New Space that Supports Industry and Culture

Located on the traditional territory of the Mississaugas of the Credit First Nation and the historic homeland of the Huron Wendat and Haudenosaunee people, Downsview, and its surrounding lands have a long history central to the region's ecological and social life. Downsview today, is home to over 35,000 residents but is divided by roads, rail lines, and the former Downsview Airport/Bombardier Airbase. With the airbase ending its operations, the 520-acre site – roughly the same size as Toronto's downtown – offers an immense opportunity for the rapidly growing city. Mindfully maintaining the site's heritage and allowing its previous life to inform its future, our design reimagines the runway as a green spine; a vibrant space for people, rather than planes.

Planned for completion in 2051, the project demands careful consideration of current and future social and environmental challenges. Rooted in principles of circularity, decarbonization, and natural systems, the area's urban infrastructure systems are designed to mitigate and adapt to the effects of climate change while supporting flexible and evolving uses. The Depot in Downsview West District and the Hangars in Taxiway West District may be repurposed into vibrant new spaces that support industry and culture.

Schmidt Hammer Lassen

Case: Superstructure Transformation at Boston waterfront

Boston Commonwealth Pier, constructed in 1901, originally served as a maritime cargo handling facility and passenger terminal. It was the largest pier building in the world, and a significant feature of Boston's industrial history.

In an invited competition, Schmidt Hammer Lassen architects proposed to preserve the original structures in a surgical approach to transformation with astute interventions that create enhanced spatial qualities for occupants and the public realm. SHL used precise subtractions in the seaport pavilions to deliver daylight and an ensemble of courtyard spaces to the otherwise deep floorplates, and created new public square at the water's edge, thereby extending the public promenade into the site. The industrial superstructure was resuscitated and reconditioned, exposed after half a century hidden under acoustic ceilings. The resulting cathedral-like spaces could never have been built new under today's construction budgets. A considered investigation of feasibility and modelled options accompanied cost calculations in the design and delivery of the project, set to open to the public this year.

Schmidt Hammer Lassen continue to develop tools, methodologies, and processes that unlock the complexities of assessment for architectural and urban transformation, hosting PhD research with AI scientists, architects, cost consultants, and engineers and focusing specifically on this topic.

Executive Summary

Decarbonizing the building sector effectively means recognizing that the most sustainable building is the one already built. Against the backdrop of a two-day workshop with City of Austin representatives, local stakeholders, and Danish companies and organizations focused on the retrofitting of commercial buildings and modernization of schools, this Playbook offers 9 guidelines aimed at assisting Austin in achieving its Climate Equity Plan and decarbonizing the American building sector.

Holistic approach

The guidelines emphasize how a holistic approach to low-carbon retrofits can help ensure comprehensive and integrated solutions that maximize energy efficiency and sustainability. Addressing the entire lifecycle of a building, including materials, energy sources, and passive design measures, helps ensure that retrofit measures are both cost-effective and future-proof, aligning with broader sustainability goals and regulatory requirements. A holistic approach incorporating innovative solutions and methods helps ensure that we are building for a better future.

Sustainable living and quality of Llife

Focusing on sustainable living and quality of life is vital, as it ensures that energy-efficient upgrades not only reduce carbon footprints but also enhance the overall well-being of occupants. By prioritizing sustainable materials, renewable energy sources, and efficient design, retrofitting projects can improve indoor air quality, thermal comfort, and acoustics, thereby contributing to healthier and more comfortable living environments. Additionally, integrating sustainability into retrofitting helps to lower utility costs, reduce maintenance, and increase property values, providing long-term economic benefits. This holistic focus aligns environmental goals with human-centric outcomes, ensuring that retrofitting efforts contribute to broader sustainability objectives while directly improving the daily lives of individuals and communities.

Collaboration

Additionally, collaboration across actors within the built industry is crucial for effective low-carbon retrofitting. Interdisciplinary cooperation integrates diverse expertise and perspectives into the planning and execution of retrofit projects. Architects, engineers, contractors, policymakers, and building owners must work together to identify the most efficient and sustainable solutions, address technical challenges, and comply with regulatory standards. Collaborative efforts enhance innovation, streamline processes, and facilitate the sharing of best practices and resources. By working together, these stakeholders can overcome barriers, optimize the use of materials and technologies, and ensure that retrofitting projects are both economically viable and environmentally impactful, ultimately driving the transition toward a low-carbon future.

Economic Benefits

Low-carbon retrofitting offers substantial economic benefits by significantly reducing energy costs, increasing property values, and lowering operational expenses through enhanced energy efficiency. Financial incentives and subsidies offset initial investment costs, while healthier indoor environments can boost occupant productivity and reduce healthcare expenses. By ensuring compliance with regulatory requirements and preparing for future resource scarcities, low-carbon retrofitting mitigates risks and enhances market competitiveness. Ultimately, this approach aligns economic growth with sustainability, fostering a resilient and prosperous economy.

Project Partners
Danish Industry (DI) / Danish Cleantech Hub
GXN
The Danish Energy Agency
City of Austin / Austin Energy
BLOXHUB