Innovation Atlas

2026

Innovation
Atlas

BLOXHUB

2026

Innovation Atlas

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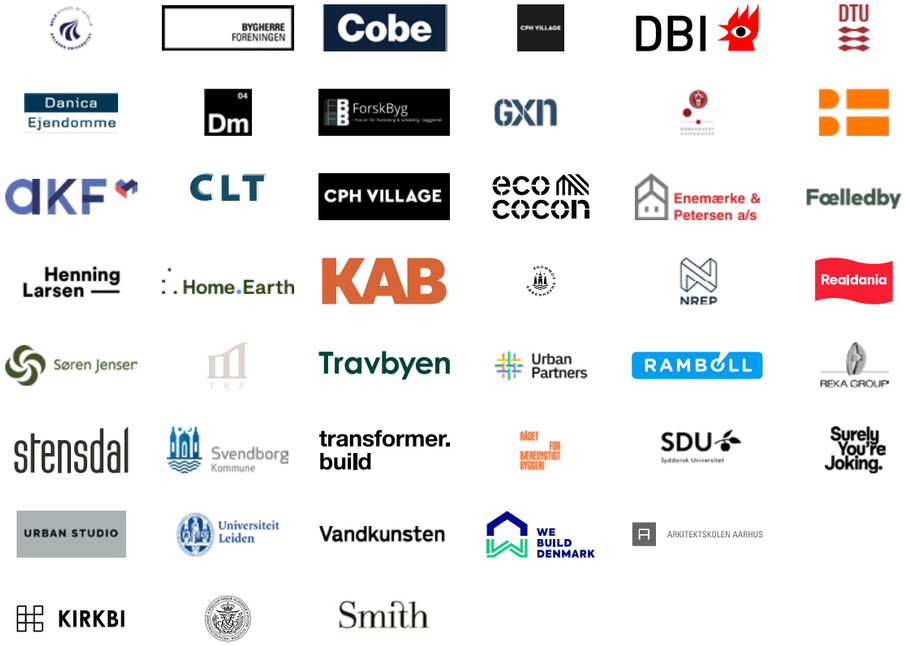
Our sincere thanks go to everyone who contributed to the Innovation Atlas, through interviews and insightful conversations, survey responses, and the preparation of case studies.



Part 1
The Society We Are Building

Foreword

The core task of the built environment is to create the physical conditions for a good life. It is where people live, work, and meet; where industry and nature must find ways to coexist; and where economic, social, and climate priorities must be brought together in practice. The built environment is therefore not simply one sector among many. It is the infrastructure through which society's development takes material form.

At the same time, the way we build has a profound impact on climate and resource consumption. The built environment is therefore both a precondition for the good life and a significant part of the explanation for the challenges society faces today. It is this dual role that makes it a central pivot point in the green transition and in securing a resilient future for our cities and communities.

Across Europe, the same pressures are converging. The climate, and affordability crises are deepening, as are the challenges of mental health and, in particular, loneliness. They share a common answer: our homes and the built environment that surrounds them. That is why we have written this Atlas.

Denmark is not where it needs to be. We are still far from keeping within the planetary boundaries and far from delivering the homes our societies need at a price people can afford. But we have made real progress and gained experiences worth sharing. Denmark has gone further than most in translating climate ambition into regulation, with specific, binding carbon requirements per square meter written into law, and several of our largest developers beginning to scale green innovation across their portfolios rather than treating it as a one-off.

This Atlas shares both sides of that experience. First, it shows how Denmark, through intentional collaboration and co-responsibility between public actors, industry, research, voluntary standards and, ultimately, lawmakers, has created the framework and regulation needed to move the sector toward innovation and lower climate impact, while building the critical mass that new solutions need in order to scale and become mainstream. Second, it shares the tangible experiences Danish developers have gained in practice. In Parts 2 and 3 of the Atlas, these are distilled into an actionable toolbox followed by in-depth cases that others can apply again and again.

One consistent insight runs through the Atlas: replication is the indispensable tool that allows innovation to move from individual projects into portfolios and, not least, into more strategic and co-responsible practice across the sector.

This is precisely the context in which the demands placed on the built environment have become both sharper and more interconnected. Carbon impact and resource consumption must be reduced, while simultaneously delivering housing and urban spaces that are economically accessible, resilient and functional for more people. This shifts the focus from volume to value creation, and raises the bar for prioritization, productivity, and organization. In practice, it means that renovation and transformation cannot be treated as secondary disciplines. They are decisive strategic instruments in the development of the built environment.

These demands do not translate into abstract targets. They translate into concrete choices about materials, processes, procurement, documentation, collaboration, and risk management. Those choices are made in a sector characterized by fragmentation, thin margins, and a pronounced project logic, in which change is often experienced as more expensive, slower, and more uncertain than it needs to be.

This structural reality is a significant part of the explanation for why innovation in the built environment struggles to move from potential to broad practice.

The Untapped Potential of European Construction
When the European Commission's strategy for Housing Construction identifies an innovation deficit in the sector, it names something the industry has lived with for a long time: solutions are developed, tested, and documented, but far too rarely do they travel from individual projects into established practice.

This fragmentation stands in sharp contrast to construction's weight in society. Across Europe, the built environment accounts for more than 30% of environmental impact, 42% of energy consumption, and roughly 35% of greenhouse gas emissions, yet construction is consistently under-represented in public and private research and innovation spending, and the share of innovative firms in the sector remains low relative to other industries. The result is a visible gap between the built environment's societal and environmental significance and the level of systematic research and innovation directed at transforming it.

The challenge is therefore not only a lack of knowledge. New research is still needed, but without stronger implementation capacity, new insight risks remaining unrealized. Knowledge and solutions are unevenly distributed, and too often depend on the courage and capacity of individual actors rather than on systems that make lower friction, repeatability, and scaling possible.

This is the starting point for the Innovation Atlas. The Atlas is structured as a practical toolkit that makes existing knowledge and solutions more comprehensible, applicable, and repeatable within the decision-making logic that shapes the built environment today. By reducing uncertainty and strengthening the basis for decisions, it makes it easier to act on what we already know, while also showing where current structures limit the sector's ability to deliver on its core task.

The Atlas shifts attention from what can be delivered in a single project to what should be demanded across projects, organizations, and portfolios. In so doing, it strengthens demand for innovation and helps connect individual examples to broader practice. In the Pathways section, researchers and innovators also point to where new knowledge, new models, and new forms of collaboration are still needed.

The ambition is to help the built environment function more fully as the societal infrastructure it is: creating the conditions for everyday life, shaping the development of our cities, and connecting economy, well-being, and climate in a more coherent practice. The Atlas is not a complete picture of innovation in construction. It is a perspective on selected structures and mechanisms with significant implications for what the sector can do.

The Innovation Atlas 2026 has been developed as part of a five-year program financed by the philanthropic association Realdania. Led by BLOXHUB, the program aims to strengthen the culture of innovation in construction by identifying emerging needs and trends, and by promoting knowledge exchange and collaboration between industry and research.

We extend our thanks to everyone who has shared knowledge, data, and experience: to those who contributed through interviews and conversations, to the developers who completed the survey, and to the many organizations that have supported the work by collecting data, providing input, and sharing knowledge. A particular thanks to those who allowed us to look closely at their buildings, processes, and collaborations, making it possible to present cases that can inspire lower carbon impact, reduced resource consumption, and more economically accessible, resilient, and functional housing and urban spaces.
We hope the Atlas contributes to the shared dialog on how innovation in construction can move from isolated examples to stronger, more repeatable practice.

- Ditte Lysgaard Vind, August Queitsch Frimann and Gertrud Marie Grabbert

Toolbox

Across the cases in this Atlas we see real progress in materials, contract forms, building systems, and digital tools. CLT, bio-based constructions, new production methods, and digital platforms are no longer future scenarios – they are tangible solutions already in use. But the cases that move innovation from pilot to practice share more than technology choices. They share structural choices. What makes innovation work is not a single solution; it is the way direction, risk, and scale are organized.
The analysis points to four principles: direction must be structural; risk must be structured early; scale must be designed, not hoped for; and strategic partnerships must be prioritized.
These four principles are operationalized through fifteen tools, described on the following pages.

The tools

Principle 1: Direction Must Be Structural

The strongest projects begin with a clear ambition. Climate, materials, community, affordability, and quality are not themes but deliberate priorities.

However, ambition only delivers value when it is embedded in structure. Priorities must be set early and translated into targets, strategies, and governance frameworks that guide decisions from brief to building. It must be translated into decision-making authority, financial logic, contracts, and organizational setup. Only then does it guide action.

This also requires a shift in the role of the developer. Direction is not only defined but actively upheld. The developer must hold both the mandate and the capability to engage as an informed counterpart to the market, able to challenge assumptions about feasibility, performance, and cost.

This principle is operationalized through four tools:

1. Active developer role

Direction and requirements are anchored with the developer and maintained across all project phases. The developer holds both the mandate and the capability to challenge advisors and contractors, based on knowledge of solutions, performance, and cost levels. This reduces interpretive drift and makes ambition operational.
What this changes: Decisions are not only aligned across phases but actively pushed forward, as the developer can challenge feasibility claims and cost assumptions rather than accept them.

2. Buildable principles

Ambition is translated into governing principles that can be directly traced in material choices, typologies, and collaboration models. These act as decision logic and ensure transparency on priorities throughout the process. **What this changes:** Trade-offs are guided by predefined priorities, not negotiated ad hoc. This makes ambition easier to maintain when pressure arises and gives project teams, advisors, and partners a shared basis for decision-making.

3. LCA as a steering mechanism

Climate performance is integrated into the core decision logic alongside cost and quality. LCA is used as a decision tool, not only as documentation. **What this changes:** Climate shifts from a reporting requirement to a parameter that actively shapes choices and drives innovation.

4. Innovation as a standard requirement

New solutions are formalized into requirements and agreements, enabling reuse across projects. Innovation becomes part of procurement practice rather than remaining project-specific. **What this changes:** Proven solutions are repeated by default instead of being reinvented or abandoned.

Principle 2: Risk Must Be Structured Early

The most consistent projects engage with uncertainty from the outset. Testing, clarification, and prototyping are integrated into early phases before decisions are locked.

Not all uncertainty can be eliminated, but it can be managed and reduced.

Uncertainty does not disappear on its own. It must be structured. When risks are identified early, broken down into concrete questions, and assigned organizational ownership, part of the uncertainty is resolved. The remaining uncertainty becomes manageable when alternative pathways are defined. This changes the decision space and turns innovation and solutions with lower climate impact into a deliberate forward movement rather than a late-stage correction.

This principle is operationalized through four tools:

5. Early testing and clarification

Knowledge, testing and prototypes are presented before design and financial commitments are fixed. **What this changes:** Reducible uncertainty is addressed early, lowering risk before it is locked into the project.

6. Dedicated innovation track

Innovation is organized with its own success criteria, timelines, and risk tolerance, preventing new solutions from being assessed on standard project terms. What this changes: Innovation is protected from being rejected due to mismatched evaluation criteria.

7. Challenging default assumptions

Established assumptions are actively tested rather than accepted. Research, international experience, and industry input replace perceived risk with documented knowledge. What this changes: Decisions shift from habit-based to evidence-based, reducing unnecessary uncertainty and opposition to innovation.

8. Internal financing mechanisms

Financial structures absorb development costs and integrate climate into economic decision-making. Internal carbon pricing or climate budgets shift incentives from add-ons to core parameters. What this changes: Financial risk is redistributed, making it possible to act despite remaining uncertainty.

Principle 3: Scale Must Be Designed, Not Hoped for

Innovation does not scale on its own. In fact, it rarely moves beyond the individual project unless it is deliberately structured to do so.

Innovation becomes transformative when it is repeatable, carried by the portfolio and organized as a system rather than a one-off intervention. Hence repetition is not a consequence of success. It is part of the design.

When solutions are developed with scale in mind, the economics change. Risk is reduced at the project level, learning accumulates across projects, and investments can be distributed over time. Innovation becomes embedded in the business model rather than dependent on individual ambition.

This principle is operationalized through three tools:

9. Portfolio logic

Development costs and learning are carried by the portfolio rather than a single project. Projects are strategically linked to create the volume required for innovation to be economically viable. What this changes: Innovation is no longer judged within a single business case but across a portfolio, making long-term value outweigh short-term constraints.

10. Repeatability by design

Solutions are developed to be replicated from the outset. Systems, components, and processes are structured to reduce complexity and enable iteration. The focus shifts from proving a solution once to improving it over time. What this changes: Innovation moves from isolated success to continuous improvement through repetition.

11. Product thinking

Construction is organized around a defined product logic. Stable elements are standardized as a platform, allowing variation and adaptation on top of a robust base. What this changes: Delivery shifts from bespoke projects to scalable systems with predictable performance and cost.

Principle 4: Strategic Partnerships Must Be Prioritized

Innovation in the built environment requires access to knowledge beyond the capacity of any single organization.

However, access alone is not enough. The strongest projects move beyond ad hoc collaboration to organize partnerships as a structural part of how projects are developed and delivered.

When knowledge from research, industry, and practice is integrated over time, it enables better decisions, reduces uncertainty and increases the likelihood that solutions can be improved and reused across projects. Partnerships are therefore not a nice-to-have support function, but a core mechanism for quality, risk reduction, and scale.

This principle is operationalized through four tools:

12. Long-term collaboration structures

Partnerships are organized as long-term structures rather than project-by-project arrangements, allowing relationships, responsibilities, and learning to accumulate over time. What this changes: Knowledge and collaboration capacity compound instead of resetting between projects.

13. Integration of applied research

Research is embedded as an innovation driver within projects, contributing to new solutions, methods, and decision frameworks in interaction with practice. What this changes: Research moves from external input to an integrated part of decision-making and knowledge sharing becomes a strategic capability, not a courtesy.

14. Cross-disciplinary development capacity

Capabilities across the value chain are brought together and organized to work in parallel, ensuring that technical, financial, and regulatory considerations evolve together. What this changes: Constraints are identified and resolved early instead of emerging as conflicts later in the process.

15. Institutional anchoring of knowledge

Experience and performance are translated into standards, principles, and decision frameworks, embedding knowledge as a permanent organizational capability. What this changes: Learning is retained, scaled, and reused instead of being lost after each project.

A Call to European Developers and the Wider Industry: Help Shape What Comes Next

The next decade of European construction will look very different from the last. Climate regulation is tightening. Capital is pricing carbon into its risk models. Tenants, employees, and public buyers are starting to ask harder questions. None of this is speculation; it is already happening, unevenly, across the continent.

The next decade of European construction will look very different from the last. Climate regulation is tightening. Capital is pricing carbon into its risk models. Tenants, employees, and public buyers are starting to ask harder questions. None of this is speculation; it is already happening, unevenly, across the continent.

This shift presents a choice: You can wait for the market and the rulebook to settle and then adjust. Or you can be one of the developers who decides what the new normal looks like. Not simply by arguing for it, but by building and transforming it. Because a new way of building is not conjured in white papers. It is delivered on-site, at scale, within real budgets, with real supply chains and real tenants. The most powerful source of inspiration for developers is other developers. This is why parts 2 and 3 of this Atlas take a closer look at a series of best-in-class projects in which developers have succeeded in using innovation to create value, reduce carbon emissions, and make the results repeatable.

Every project that succeeds redefines what is possible. That is the pattern behind the Danish journey. Years before carbon limits entered the building regulations, a first wave of developers had been delivering projects that showed lower-carbon construction was feasible at scale. None of them set out to shape policy. They set out to build better buildings. But the evidence accumulated through that work is what eventually led to requirements that were ambitious without being unrealistic, because the proof was already there. The cases in this Atlas sit inside that framework now and push what is possible even further. The same opportunity exists across Europe today. Build ambitiously, and share honestly; both what works and what is not yet ready. The developers who do so will define what European construction becomes.

From Developer Demand to Sector Delivery

While developers can play a driving role in the necessary transformation, there is, of course, a need for the entire industry to engage, providing a grand opportunity for those who choose to be innovators rather than dawdlers.

Insurers

Insurers set the conditions under which construction risk is taken. Standard practice still treats new and emerging solutions as higher risk by default, with higher premiums or outright exclusions. That default must change.

The shift required is from convention-based to performance-based underwriting: pricing risk on the basis of actual rather than perceived exposure, drawing on data from reference projects, technical calculations, trials, and forecasts. Buildings that demonstrate long-term resilience and a low carbon footprint must be rewarded, not penalized. For the insurers who grasp this opportunity and succeed in properly assessing and capturing risk pertaining to the new way of building, there are tremendous opportunities.

Financial Institutions

Banks shape the economics of most construction projects through loans and mortgages. In many markets, maximum loan amounts are calculated backwards from expected interest income or short-term returns on investments. Loans for climate-aligned, long-term resilient, lower-rent buildings are treated like loans for conventional, higher-carbon assets. Lower future energy and maintenance costs, whole-life carbon performance and the role of affordable housing as foundational urban infrastructure are largely invisible in the calculation. This locks in high rents and makes lower-carbon, affordable housing harder to finance, even when the long-term case is stronger.

The shift required is from income-based to performance-based lending: explicitly valuing long-term resilience and durability. Buildings and typologies that contribute to well-functioning cities, stay within planetary boundaries, and deliver affordability over time must be easier to finance, not harder.

Distributors and merchant chains

Suppliers and merchant chains hold a decisive but under-examined position. They decide which products sit on the shelf, how they are bundled and priced, and what is most accessible at the point of purchase, and thereby what reaches the contractor and construction site and the construction sector. and so determine in practice whether a lower-carbon option is convenient enough to choose at all.

Today's rebate and bonus structures work against that choice. The deepest discounts and the easiest access land on conventional, virgin, higher-carbon materials, while lower-carbon alternatives stay at list price. With the sector so fragmented, relying on the seamless interaction of thousands of subcontractors and procurement decisions, even a small shift between list and discounted price cascades across tens of thousands of purchasing decisions. The underlying commercial logic runs counter to decarbonisation, unless it is deliberately reversed.

That logic can be reversed. Suppliers and merchant chains can curate lower-carbon alternatives across every major product category and attach their most attractive terms to the products that genuinely help projects meet their carbon targets, making the low-carbon route the easy default.

Building quality-assessed inventories of verified reclaimed structural components, using their national distribution infrastructure to connect supply to demand across projects. Establishing take-back schemes and making reused and lower-carbon products easy to choose for contractors, who typically work on very low margins and tight timeframes.

This does not require subsidising lower margins. It requires realigning existing terms toward the products with the strongest long-term trajectory. That shift alone would reset the baseline for thousands of purchasing decisions every day and create the scale that innovative, lower-carbon products and components need to become commercially viable.

The larger opportunity is a shift in role: from passive logistics actor to active project partner. By co-designing delivery schemes with developers, consultants, and contractors, suppliers can ensure that key low-carbon systems are secured, sequenced, and delivered to reduce site risk and cut waste by supplying right-sized components, creating take-back schemes, and building inventories of quality-assessed reclaimed components.

Contractors

Contractors are one of the most overlooked levers for innovation in the value chain. They hold the decisive power over whether a solution is possible: if it does not work on site, it does not get built, and if a contractor can make it work, that proof of concept informs the rest of the value chain. The thousands of decisions they make every day, on material handling, waste routing, subcontractor selection, sequencing, problem-solving under pressure and the real-time substitution of specified products, can either reinforce or undermine a project's carbon ambitions. However well a project is designed, decarbonisation ultimately depends on what happens on site.

The change in the contractor's role is twofold: outward, in how they engage with the rest of the value chain, and inward, in the capabilities they build at home. Outwardly, the shift is from execution after design to delivering knowledge and expertise throughout the project. Contractors need to be engaged early and to move from receivers of products to active shapers of development, products and processes. Bringing them into design, logistical planning, product development and risk management from the start means they can test buildability, propose alternative solutions, optimise delivery and challenge unnecessary complexity before decisions are locked in.

If they are to take on this role, contractors inwardly need to build the capabilities that make innovation possible on site, that make new and less carbon-intensive products and processes deliverable. It means establishing work processes geared towards low-carbon solutions, internal guidelines for waste reduction and safe deconstruction, and supplier partnerships that hold across projects. It means investing in planning, digital tools and training so that crews know how to handle unfamiliar materials, and structures are in place so that what is learned on one project is captured and carried into the next rather than lost when it ends. Contractors need to be willing to build capabilities by engaging in pilot projects, R&D collaborations and product and project mock-ups, seeing this as an investment in the business. Because as regulations tighten and demand for new and emerging solutions grows, the contractors who can contribute knowledge, expertise and planning, and who know how to handle innovative solutions, will be at the forefront.

Technical advisors

Technical advisors shape what a project treats as technically possible. They translate ambition into the calculations, models and specifications on which a building is actually built , and in practice, their advice often decides whether a new solution is carried forward, redesigned, delayed or removed. This positions them as gatekeepers for new solutions. When an advisor flags uncertainty about a new material or system, the project usually defaults to the conventional alternative, not because the new solution is technically inferior, but because it lacks a documented evidence base the advisor feels comfortable defending. Since advisors carry professional liability, perceived risk blocks innovation even when the actual evidence is strong enough to proceed.

The shift required is from risk identification to innovation-enabling technical leadership. The decisive change is to base decisions on actual risk rather than perceived risk and habit. Technical advisors need to lean in, engage actively and learn how to work with new solutions. In practice, this means looking for evidence and documentation beyond the usual sources: reference projects, data and documentation found in international databases, and engaging with producers, suppliers and contractors who already have hands-on experience with the solution or similar ones. Drawing on that expertise across the value chain, advisors can ground their assessments, turn producers' new systems, suppliers' solution knowledge and contractors' delivery experience into credible new standards of practice rather than isolated exceptions, and provide safe pathways for new solutions. Technical advisors need to work with LCA as standard practice in early design, and to make climate risk, including future regulation, carbon pricing and physical risk, visible in their recommendations, so that the real cost of inaction becomes clearer when decisions are taken.

As carbon requirements move from voluntary to regulatory, this competency will move from a premium service to a baseline expectation. The advisors who lean in now, and who make new ways of building technically credible, financially understandable and practically deliverable, will be indispensable in moving innovation from concept into construction, and will avoid being left behind when the transition takes hold.

Producer & manufactures

Producers decide what the industry can actually specify, source and scale. They control the material base of construction through product development, documentation, warranties, pricing and production capacity. If low-carbon solutions remain niche products with incomplete documentation, long lead times or uncertain guarantees, they will remain difficult to choose even when everyone else in the value chain wants to move. Low-carbon products that do not come with clear EPDs, installation guidance, tested performance data and reliable volume are hard to specify, hard to insure and hard to commit to.

The shift required is from product supply to systems readiness. Producers need to make their low-carbon materials and components technically documented, insurable, cost-transparent and available at sufficient volume. That means investing in EPDs, third-party testing and verification, warranty models, standardised installation details, and digital, BIM-compatible product data that fits how design teams actually work.

And it means being willing to engage and collaborate directly with contractors, technical advisors, developers, distributors and architects on what conditions need to be met for a new product to be adopted into standard practice. It also means designing products for disassembly, reuse and repair from the outset, and establishing clear take-back schemes, so that circularity becomes part of the product logic rather than an afterthought.

Architects

Design is where the future performance of a building is first made possible or quietly made impossible. Architects are involved early, and they shape choices that carry long-term consequences. The structural logic, material strategy, spatial typology and adaptability of a building are all set at the design stage, and so is much of its lifetime carbon footprint. That is where their contribution matters most, and it is where the shift needs to happen.

The most immediate thing architects can do is design from well-proven systems, standardised structural approaches and tested material palettes that make low-carbon solutions the natural starting point rather than a special effort. Working with what already performs, and building repeatable design intelligence across projects rather than starting from scratch each time, makes it easier and cheaper for every other actor in the value chain to follow. And because architects are often engaged in multiple projects at once, and across different categories, they act as a powerful knowledge-sharing base between projects.

Architects who develop this kind of practice-level knowledge and embed it in how they work day to day make lower-carbon choices accessible across hundreds of projects, not only the ones where the client was already convinced. Architects also shape what clients believe is possible in the first place. A compelling, well-argued case for adaptive reuse, showing how an existing structure can be transformed rather than demolished, can change the direction of a project before anyone else has even been appointed. So can a design that demonstrates how a lower-carbon material strategy or a more flexible layout produces a better building, not just a more responsible one.

Close collaboration with contractors, technical advisors and producers makes architects more effective, not less. Contractors know what survives value engineering and what does not, so involving them early means a design can be developed to hold up through procurement rather than be dismantled after it. Technical advisors and producers can say what is genuinely buildable, insurable and available at scale, which makes specifications more robust and reduces the risk that an innovative solution is dropped the moment it meets a practical obstacle. Architects who build those relationships carry better knowledge into every project, and are far more likely to see their ambitions realised on site.

At its best, architecture does more than optimise a brief. It expands the imagination of what good development can be. The task ahead is to design buildings, neighbourhoods and business cases that create more value with fewer square metres, less material use and longer-lasting quality. That requires architects to help clients and partners see a new way of building before it becomes standard practice.

Municipalities

Municipalities hold a unique position in the construction sector: they are simultaneously planners, regulators, landowners, clients and community managers. Through zoning, planning requirements, land allocation and public procurement, they control the conditions under which a large share of new housing and urban development takes place. That gives them several levers to pull at once. As things stand, many regulations, however well intentioned, end up holding innovation back through costly and lengthy approval processes.

The shift required is from passive regulator to active co-creator and innovation demander. Municipalities can use their planning powers to make low-carbon, resilient and affordable solutions standard conditions for development permits rather than voluntary additions.
They can use public procurement, which in most markets represents a substantial share of total construction volume, to set performance requirements that create a reliable demand signal for the producers, distributors and contractors willing to invest in new capabilities. And they can use land allocation strategically, structuring development agreements and land leases to prioritise affordable, long-life, low-carbon housing typologies, and to reward developers who commit to whole-life performance rather than short-term returns.

This also makes municipalities important stewards of co-responsibility. Developers, architects, contractors, technical advisors, producers, utilities, housing organisations and residents all hold parts of the solution, but municipalities are often the actor with the mandate to bring them around the same table early enough for the outcome to change. Used well, that convening power can turn regulation from a late-stage control mechanism into an early framework for alignment, learning and delivery.

By prioritising innovation in regulatory frameworks, planning documents and building programmes, municipalities can reduce the risk and cost of innovation for every other actor in the market, and help new solutions become the default rather than the exception.

Beyond regulation and procurement, municipalities can act as convenors and knowledge hubs. They sit at the intersection of the whole value chain, working with developers, contractors, architects, technical advisors and residents, and are therefore uniquely positioned to facilitate the kind of cross-actor learning and standardisation that individual projects cannot generate on their own.

Reading Guide

The built environment is generating more innovation and development than ever before, alongside a growing body of research focusing on the green transition. Yet a fragmented knowledge landscape makes it difficult for decision-makers, developers, and businesses to prioritize, invest in, and scale solutions.

The Innovation Atlas differs from the market and trend analyses the sector typically uses. It combines a view of the need for change and the associated potential, the structural challenges and opportunities facing the built environment, and the concrete innovations already available.

This first edition has been developed to create a more precise basis for decisions in a field marked by high complexity and structural constraints. The Innovation Atlas is intended as an annual publication, aimed at the built environment's agents of change and decision-makers.

The Innovation Atlas is structured as an analysis that moves from framing through mapping to orientation, in three parts:

The Society we are building

This section begins with the built environment's core task and shows how the demands placed on it are shifting faster than the practices, structures, and decision-making logics that currently dominate the sector. It provides an overview of construction's footprint, its impact on society, and the transitions the sector faces, examining both internal and external barriers and potentials for changing practice. This section includes infographics and tables that support a view of the society we are building; how developers can function as facilitators and drivers of innovation; and how innovation in the built environment moves from idea to practice. It also includes an overview of the evolution of climate impact threshold values and a selected summary of the existing knowledge on which this publication builds.

A New Practice Takes Shape

This section presents a mapping of how innovation is currently moving through the built environment, with a particular focus on developers as drivers of demand across the value chain. The mapping identifies recurring patterns, barriers, and drivers. It is based on data from interviews, a survey, and desk research, examining how actors successfully implement research and innovation in practice, which tools recur, and which barriers prevent the sector from going further. This is illustrated through an analytical depiction of selected cases, developed in dialog with developers and supported by research, visualizing tangible tools and methods from industry that can serve as inspiration for changing practice.

New Pathways in Construction

I In this section, the Innovation Atlas looks forward, examining emerging solutions that can contribute to the necessary change on shorter or longer time horizons. It curates contributions from different professional disciplines – tools, research projects, methods, and processes – that indicate where the next steps can be taken to reduce carbon impact and resource consumption while delivering economically accessible, resilient, and functional housing and urban spaces. The section brings together the fault lines and potentials the analysis has identified and relates them to research trajectories and international experience.

Methodology

The Innovation Atlas draws on several types of data collected in the second half of 2025 and early 2026, combining desk research, interviews, and a survey conducted by BLOXHUB.

Interviews

The data collection included 18 interviews with one or more actors across the construction sector, covering the full value chain from materials manufacturers to developers and industry organizations. The interviews generated approximately 40 hours of data, used to identify relevant actors and cases that make tools and methods from the industry visible and that can serve as inspiration for changing practice.

Cases

The cases are constructed from the developer's perspective and portray collaborative models, financial structures, and approaches to navigating innovation that can serve as a source of inspiration and demonstrate how developers translate knowledge into action through innovative practice. The cases have been developed in close collaboration with developers and build on an extensive research process. They represent an analytical selection, not a comprehensive mapping of all innovation activity in the sector.

Survey of Danish Developers

To gather knowledge about how developers work with innovation, we developed a survey that was distributed broadly across the sector via BLOXHUB's network and through the Danish Association of Construction Clients' newsletter to its members. With 48 responses, the survey provides a useful empirical foundation with a relatively high response rate for an online study. Respondents are distributed evenly across Denmark geographically, across organization size and project scale, and broadly across public, private, and non-profit actors.

Glossary

Absolute sustainability
Absolute sustainability refers to an assessment of whether a building's total climate and environmental impact stays within planetary boundaries – that is, within nature's capacity to absorb human-made impacts and regenerate – rather than simply being less damaging than an alternative.

Affordability
In this Atlas, households that spend an excessive proportion of their disposable income on housing are described as overburdened.

Almene boliger (non-profit housing)
The Danish non-profit housing sector – known as almene boliger – is a distinctive model in which housing is owned and managed by democratic tenant organizations, broadly accessible across income groups and governed as a social good rather than a market commodity. It accounts for approximately 20% of the total Danish housing stock. The English term for this concept used throughout this Atlas "non-profit housing".

Biogenic and bio-based materials
Biogenic materials are minimally processed organic materials that can be used directly in construction. Bio-based materials are more extensively processed and may be combined with non-organic components.

BUILD (Aalborg University)
BUILD is the research institute for the built environment at Aalborg University. It conducts and publishes research on construction, housing, urban development, and sustainability, and has played a central role in developing the analytical and methodological foundation for Denmark's climate requirements for buildings.

The built environment
In this Atlas, the built environment refers to "all buildings, infrastructure, and human-made recreational areas, together with the industries that create, operate, and maintain them".[1]

CapEx
Capital expenditure (CapEx) refers to the costs a company incurs in acquiring and upgrading physical assets required to deliver its products and services – for example land, property, machinery, and technology.

Climate impact and CO_2 equivalents
This Atlas uses the Danish Building Regulations' definition: "Climate impacts are measured in kg CO_2 equivalents per m^2 per year. CO_2 equivalents are a collective term for the effect of all greenhouse gases, converted to a common unit." CO_2 equivalents are noted in this Atlas as CO_2 eq./m^2/year.

Cross laminated timber
Cross laminated timber (CLT) is a solid wood panel product made from layers of timber bonded at right angles to one another, delivering high rigidity, strength, and stability.

The Danish Building Regulations *(Bygningsreglement)*
Denmark's national building code, updated periodically. The most recent version, BR25, came into effect in 2025 and introduced tightened climate impact thresholds for new construction, including a maximum of 7.1 kg CO_2 eq./m^2/year for embodied and operational carbon, and 1.5 kg CO_2 eq./m^2/year for the construction process. The regulations set the minimum legal requirements that all construction in Denmark must meet.

DGNB
DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen – the German Sustainable Building Council) is a voluntary sustainability certification system for buildings widely used in Denmark and across Europe.
It assesses buildings across climate, environmental, economic, social, and technical criteria. In Denmark, DGNB certification – at Gold or Platinum level – has become a common market standard for demonstrating sustainability performance. DGNB Platinum represents the highest level of the certification.

Framework agreement
A framework agreement is a procurement contract established between a client and one or more suppliers that sets the terms for a series of future projects or deliveries over a defined period. In the Danish construction sector, framework agreements are used by both public and private clients to create continuity of collaboration, enable learning across projects, and reduce transaction costs. They are a central mechanism for achieving the repetition effects that make innovation scalable.

Innovation
In this Atlas, innovation is understood as the process by which an idea is brought into use, with the potential to create lasting change.

Life Cycle Assessment
A Life Cycle Assessment (LCA) is an analysis that quantifies a product or system's total impact across a range of environmental indicators throughout its full lifecycle. The Danish Building Regulations' requirements relate only to CO_2 equivalents.[2]

The low-emission class *(lavemissionsklasse)*
A voluntary Danish classification for new buildings that perform significantly below the mandatory climate impact thresholds set in the Danish Building Regulations. For the period 2025–2027, the low-emission class threshold is 5.0 kg CO_2 eq./m^2/year, compared with the mandatory limit of 7.1 kg CO_2 eq./m^2/year. Buildings in the low-emission class are increasingly used as reference points for what is achievable under current market and technological conditions.

Nordic Swan Ecolabel *(Svanemærket)* The Nordic Swan Ecolabel is the official Nordic sustainability certification program, established in 1989 by the Nordic Council of Ministers. It certifies products and services – including buildings and building products – against strict environmental criteria covering the full lifecycle. In this Atlas, buildings or materials described as "Swan labelled" carry this certification.

OpEx
Operating expenditure (OpEx) refers to the ongoing, recurring costs a company incurs in its day-to-day operations –e.g., salaries, interest, and utility costs – that are necessary to deliver its products and services.

Planetary boundaries
The planetary boundaries are nine biophysical limits that together define the Earth's "safe operating space" for human activity. Exceeding them increases the risk of sudden, self-reinforcing, and irreversible shifts in climate and ecosystems. Earth system science's most recent assessment (Planetary Health Check 2025) finds that 7 of the 9 boundaries have now been crossed.

Realdania
Realdania is a Danish philanthropic association that invests in projects that improve the built environment for the benefit of the common good. It is one of the primary funders of innovation initiatives in the Danish construction sector, including this Atlas.

1 Boligøkonomisk Videncenter. Det byggede Danmark – omfang, opbygning, værdi. Boligøkonomisk Videncenter, 2014. Set 23. februar 2026. https://bvc.dk/media/1215/bvc_detbyggededanmark_web.pdf

2 Social- og Boligstyrelsen. Bygningers klimapåvirkning – tekniske bestemmelser i bygningsreglementet (Energiforbrug og klimapåvirkning, § 250–§ 298). Set 23. februar 2026. https://www.bygningsreglementet.dk/tekniske-bestemmelser/11/brv/bygningers-klimapaavirkning-1-juli-2025/?Layout=ShowAll

The Society We Are Building

Construction and the build environment creates the physical setting for life and is the foundation for a functioning society. At the same time, the way we build has a significant impact on climate and resource use. Hence, construction is both essential to the good life and, as we practice it today, a direct threat to the well-being of people and the planet.

Across the European Union, the built environment accounts for more than 30% of total environmental impact, roughly 35% of greenhouse gas emissions, and 42% of energy consumption.[1] Housing alone is responsible for some 52% of the EU's material footprint.[2] The sector's weight in the economy is matched by its weight in the transition: no credible pathway to climate neutrality goes around it.

At the same time, European cities are facing a systemic affordability crisis. One in ten Europeans are unable to pay their rent or mortgage on time.[3] The shortage of affordable housing is undermining cities' ability to attract and retain both specialized labor and the welfare workers who keep daily urban life running.

When access to the city is increasingly determined by economic means rather than by contribution to society, the consequences extend beyond competitiveness and welfare: they touch the democratic foundations of cohesion, representation, and trust. The affordability crisis is therefore not a narrow housing issue, but a structural challenge that directly affects the democratic resilience and social fabric of our cities.

Scale and Impact of the Built Environment

Environmental Impact

The European Commission has identified construction as one of the three largest industrial sectors in the EU and one of those facing the greatest transition challenge. As the figures above show, the sector accounts for a major share of environmental impact, emissions, and energy use, produces roughly a third of Europe's waste, and has a material footprint that exceeds most other sectors.

In Denmark, where national reporting is more granular, construction is credited with 30% of national carbon emissions, 31% of resource consumption, 40% of energy use, and 40% of generated waste.[4]

At EU level, the complete building sector, including the full building lifecycle, accounts for between 30% and 40% of total greenhouse gas emissions, depending on the measurement method, making it the sector with the highest environmental impact in Europe. Construction alone, covering the processes involved in delivering buildings and infrastructure but not their subsequent use, generates over 35% of the EU's total waste, consumes 50% of all raw materials[5] and accounts for 33% of water consumption.[6] The weight and volume of building materials also means construction accounts for around 30% of all urban goods transport.[7] The lifecycle of buildings adds a further dimension. Buildings account for 42% of energy consumption across the EU, and 75% of the EU housing stock is classified as energy inefficient.[8]

Affordability

The affordability crisis is no longer a problem confined to a handful of capital cities, but is a growing concern across Europe. In a Euro Cities Pulse survey of mayors, 47% identified increasing the supply of affordable housing as their top priority and 98% listed it among their top three. Of the mayors surveyed, 39% reported that housing in their city is already unaffordable, while a further 47% described affordability as not yet an acute crisis but a growing concern.[9]

In the most acute cases, such as Amsterdam, purchasing a 70 m² apartment requires 15.4 average gross annual salaries. This pattern is widespread across European cities: Copenhagen, ranked 20th, still requires 9.3 average gross annual salaries to buy 70 m². For an average earner, homeownership has become effectively out of reach.[10] In 2024, 9% of Europeans lived in households with arrears on mortgage, rent, or utility bills, and in most large European cities the share of households spending more than 40% of disposable income on housing has been rising for a decade. In Denmark, 22.7% of the urban population now lives above the EU overburden threshold. Affordability is where climate ambition, regulation, investment logic, and collaboration models have to work concurrently – not in the premium segment, but in the everyday housing economy. It is the most honest stress test of whether the mechanisms set out in this Atlas can actually carry weight in practice.

The cost of not solving it is systemic. Cities that cannot house their teachers, nurses, bus drivers, and construction workers cannot deliver the services that underpin them. When access to the city is determined by wealth rather than by contribution, the consequences reach into competitiveness, welfare provision and, ultimately, democratic trust. Affordability is therefore treated throughout this Atlas not as a separate social track, but as one of the clearest indicators that the structures we describe actually work.

Health and Loneliness

How we build shapes how we live – and, increasingly, how alone we feel. Europe is in the midst of what the WHO has called an epidemic of loneliness. According to the first EU-wide survey on the issue, 13% of adults in the EU feel lonely most or all of the time, while 35% feel lonely at least some of the time. The problem is especially acute among young adults: 57% of Europeans aged 18–35 report moderate or severe loneliness, and 47% of older

The European construction sector's footprint

* Construction and materials companies accounted for just under 1% of R&D investment by EU-headquartered firms, 2.25 of 233.8 billion euros. Infograph by BLOXHUB.

adults experience at least moderate loneliness. Globally, around one in six people (16%) experience loneliness, according to the WHO Commission on Social Isolation and Loneliness. The built environment is not the only driver, but it is one of the most direct: the density and mix of our neighborhoods, the presence or absence of shared spaces, the walkability of streets, the relationship between private dwelling and public realm, and the design of common areas in housing all measurably affect the frequency and quality of social contact.

Loneliness is not only shaped by individual circumstances but also by the neighborhood-built environment. Research shows that built and social environment factors together explain 8.3% of the variation in loneliness scores. Key design features that reduce loneliness include accessible third places and passing spots, preserved informal meeting areas, walkable streets with mixed uses, and housing types that encourage neighbor interaction. Empirical evidence identifies housing satisfaction, housing type, and neighborhood cohesion as independent predictors of loneliness, confirming that the physical environment and the social connections it fosters are both linked to lower loneliness. Beyond social contact, daylight, indoor air quality, thermal comfort, acoustic conditions, access to green spaces, and the quality of the public realm translate directly into health outcomes and healthcare costs. Designing and regulating the built environment for health is therefore not an aesthetic concern but a public-health intervention.

Treating housing as infrastructure for health and cohesion – as well as a climate and affordability issue – changes what counts as a successful project. Poor housing conditions are linked to respiratory infections, asthma, lead poisoning, injuries, depression, and anxiety, while improving housing offers a powerful lever to address a key social determinant of health. The distinction between providing shelter and creating habitat matters more than semantics suggest: habitat means not just a roof and four walls, but access to stores, local businesses, healthcare, education, culture, leisure services, green spaces, and public spaces that support diverse populations. This perspective raises the bar for what developers and municipalities should be expected to deliver, and it opens a legitimate space for innovation in typologies, shared amenities, and governance models that most existing procurement frameworks do not yet reward. Cooperative housing models exemplify this potential: they provide shared amenities such as community gardens, laundry rooms, and common houses where residents meet, combined with democratic governance in which residents participate in decision-making, fostering ownership, accountability, and strong community bonds.

Loneliness is a widespread public-health crisis affecting millions across Europe, and the built environment plays a measurable role in either mitigating or worsening it. By reframing housing as health infrastructure, rather than merely shelter or investment, we create space for innovative solutions that prioritize social connection alongside climate resilience and affordability. The path forward requires policymakers, developers, and municipalities to recognize that design decisions have health consequences, and to reward governance models and typologies that foster the social fabric we so urgently need. This represents a shift from treating loneliness as a personal failing to understanding it as an environmental condition requiring spatial intervention, where the aggregation of micro-moves – pedestrian-level environmental modifications such as comfortable seating positioned for conversation, sight lines connecting activity, and walkable access to diverse services – can transform proximity into genuine belonging.

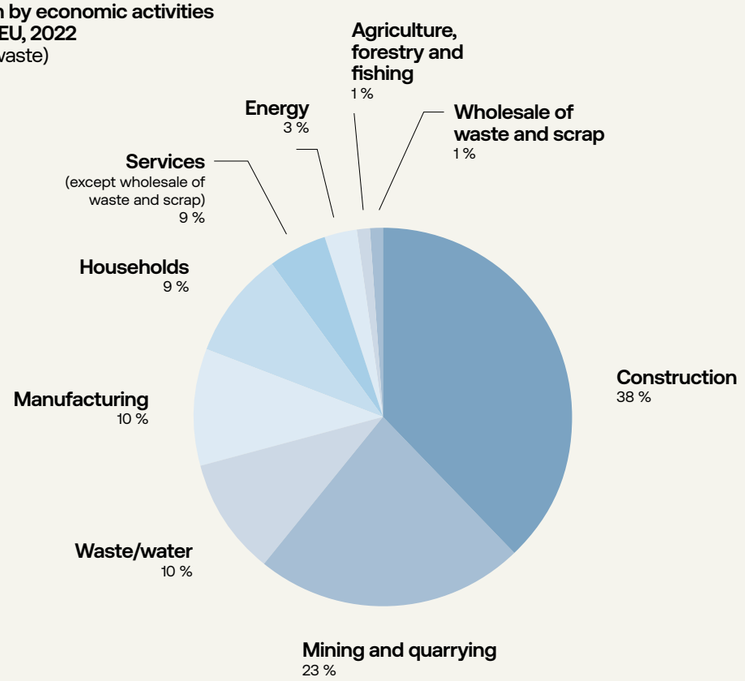
Waste in the Construction Sector

Construction and demolition waste is the single largest waste stream in the European Union, amounting to roughly 35% of all waste generated across member states each year[11]. The embedded material, resource, and time savings in reducing that waste are enormous. Research from Aalborg University shows that for some material groups delivered to a Danish building site – such as roofing felt, reinforcement steel, plasterboard, and insulation – up to a quarter ends up as waste, and packaging alone accounts for 28% of a site's climate impact. Targeted waste reduction, however, could cut the emissions associated with that waste by 50%[12].

> "Obviously, no one has any interest in throwing away usable materials, but in a busy industry it happens every day. We therefore need to factor in expected materials waste in the planning phase, because a great deal of waste can be avoided or reused."

Lea Hasselsteen, PhD fellow, BUILD, Aalborg University.

Waste generation by economic activities and households, EU, 2022
(% share of total waste)



Source: Eurostat (online data code: env_wasgen)

The single most impactful change that a developer, contractor, or consultant can make is strategic planning of the construction process. Designing spaces around standard material dimensions – plasterboard sizes, for example – eliminates the need for cuts and the resulting waste. In addition, a new tool from Aalborg University connects LCA and materials consumption, enabling data-driven decisions throughout the process.

Innovation Deficit in the Built Environment

Taken together, these figures sharpen the dual challenge the Atlas addresses: the sector that shapes the physical conditions of everyday life is also the sector most in need of transformation, and the one most exposed to the societal risk of lacking affordability.

Set against this footprint, the current collective investment in reshaping the sector is modest. Despite construction's central role in both climate impact and social provision, the built environment attracts a disproportionately small share of European research and innovation funding. Across EU programs, only a small fraction of grant volumes flow to construction and the built environment. According to the European Investment Bank, 75% of construction firms in Europe do not innovate, compared with 67% in other industries; only 55% of construction firms use advanced digital technologies, against 76% elsewhere.[13] The gap between the problem and the investment is one of the most telling structural features of the sector.

Both Danish and European data confirm the picture. In 2024, Denmark's main research and innovation funds allocated approximately 3.3% of their grants to construction-related research and innovation. In 2024, the EU-headquartered companies tracked in the European Commission's Industrial R&D Investment Scoreboard invested 233.8 billion euros in R&D. Construction and materials accounted for 2.25 billion euros of this, just under 1% of the total R&D Investment.[14] A figure that stands in stark contrast to a sector responsible for

roughly a third of national emissions, resource use, energy consumption, and waste.

The World's Greatest Asset Class

Real estate encompasses housing, commercial property, infrastructure, land, and the building stock worldwide, representing the single largest category of assets in the global economy.

This matters because it places cities and the built environment at the center of both economic stability and systemic risk. Small changes in regulation, financing, energy prices, or building culture affect very large sums of value. Working in the built environment is not working with construction, materials, and buildings. It is working in the backbone of global wealth and the physical economy.

We are effectively managing the world's primary store of wealth. That combination of resource use, essential functions, infrastructure, and its role as an asset class makes the built environment a central lever for addressing multiple crises simultaneously: climate risk, affordable housing, wealth and welfare distribution, and social cohesion. Ensuring a resilient, long-lived, and socially just built environment is not only fundamental to meeting climate targets and staying within planetary boundaries. It is essential to protecting the value and the equitable foundations on which economies and societies depend.

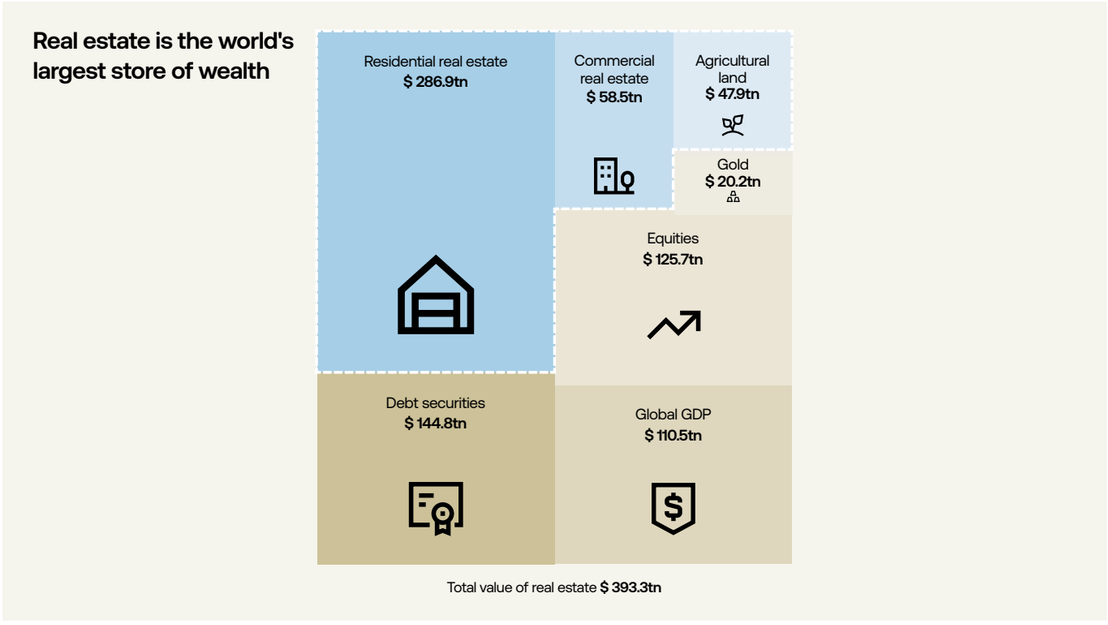
The Price of the Just Transition and the Price of Inaction

Europe's construction sector today performs below the EU average on productivity and value creation, particularly at the delivery and construction end of the value chain, and its structural weaknesses have become increasingly visible. Since 2019, construction has posted the largest productivity drop of any EU sector. Labor productivity per hour has fallen by around 8%, while costs have risen faster than inflation. Material costs and labor costs have risen. The European Commission's strategy, *The European Strategy for Housing Construction: A More Competitive and Productive Construction Industry*, points directly to the sector's innovation deficit – a deficit that drags productivity, inflates housing costs, and limits the sector's ability to deliver at the scale and quality that the environment and social needs require.

Construction is also one of the three largest industrial sectors in the EU, with a complex ecosystem that stretches from raw materials to operations. Its value chain is overwhelmingly composed of small and micro enterprises. This gives the sector agility, but also causes fragmentation and weak incentives for long-term investment in innovation and productivity improvement.

Against this backdrop, the transition requires substantial capital. Estimates for Denmark indicate that reaching climate neutrality by 2050 will require total investment of around EUR 202 billion, with roughly EUR 56 billion tied directly to buildings and a further EUR 129 billion to electricity, heating, and transport – all closely connected to cities, infrastructure, and construction.[15] At the European level, comparable estimates from the European Investment Bank suggest investment needs in the built environment running to several trillion euros across the next two decades.

The decisive question is not whether Europe can afford to transition the construction sector. It is whether Europe can afford not to. A sector that consistently delivers less, costs more, and wastes more imposes a growing burden on the rest of society: wasted resources, rising carbon emissions, unbuilt homes, stranded assets, and productivity lost across every industry that depends on the buildings it occupies. Delay is not a neutral choice. It is an accumulating liability.



Source: Savills Research, and Savills Research using IMF, Bank for International Settlements, World Federation of Exchanges, World Gold Council.

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Innovation in the Built Environment – From Idea to Practice

Innovation is a term used widely, imprecisely, and often normatively. In the built environment, it covers both minor adjustments to existing practice and more fundamental changes to the way we plan, build, own, and use our buildings and cities. In the Innovation Atlas, innovation is understood as the process by which an idea is brought into use and creates lasting change.

Operationalizing the Concept of Innovation

To make the concept analytically useful, it is necessary to distinguish between different levels and types of innovation. The distinction matters because innovation can be both incremental and radical, and because these forms carry different preconditions, risk profiles, and effects.

The foundational distinction is between *Little i* and *Big I*. Little i covers incremental innovation: continuous improvements to existing solutions and processes. In practice, this might be the optimization of design processes, adjustments in material choices, new collaborative arrangements, or better use of familiar technologies. This type of innovation is often quiet and less visible, but it forms the backbone of practice-based development in a project-oriented industry.

Big I covers more radical innovation. It covers fundamental changes in how value, the market, and the sector as a whole are organized and realized. This entails new business models, new ownership structures, altered incentive systems, and new roles for the developer. *Big I* is rarer, but necessary if structural challenges – climate, productivity, and affordability – are to be addressed. This type of innovation often builds on substantial and in-depth research and market understanding, but it is only realized when it gains a foothold in practice.

Both forms are treated as innovation in this analysis, provided they move from idea to practice. The difference is not whether something constitutes innovation, but what type it is, what conditions it requires, and what effect it can have when implemented at scale.

A related but often overlooked distinction runs between product innovation and strategic innovation. Product innovation is visible, tangible, and easier to communicate. Strategic innovation is more subtle. It concerns new ways of doing business, new organizational arrangements, or new applications or uses for familiar solutions. In construction, it is often this type of innovation that enables real change. However, it is also the easiest to overlook, because it does not present itself as a breakthrough. And because there is, quite simply, still very little of it.

To analyze further why some ideas become practice while others remain pilots, this Atlas draws on an innovation model developed at MIT that treats innovation as an interplay between three dimensions: technical feasibility, market, and implementation. Technical feasibility refers to the knowledge-based possibility of a solution, its maturity, documentation, and validation. Market refers to demand, willingness to pay, and the actors who can and will adopt the solution. Implementation covers organization, competencies, regulation, and institutional frameworks.

The point is: innovation only emerges when all three dimensions are present. Technological development without demand rarely translates into practice. Market need without implementation capacity rarely produces lasting change. And organizational ambition without a solid technical or knowledge base cannot stand alone.

Innovation does not, however, follow a linear path from idea to market. The process is iterative and technology, market´, and implementation develop and evolve in the interplay between the three dimensions. Innovation therefore involves repeated testing and recalibration rather than progression in a single direction. Actors continuously adjust solutions in response to new knowledge, unforeseen barriers, and changed behaviors. What can appear to be a disorderly process is, in reality, a mechanism for increasing innovation efficiency, reducing misallocated investment, and improving decision quality.

In the built environment, innovation also frequently unfolds across systems and sectors. Developments in mobility, energy, and material choices, for example, can mutually reinforce or impede one another. Thus, innovation cannot be understood in isolation within a single technological category. It must be analyzed as systemic connections between multiple simultaneous development tracks.

From Idea to Practice

Research on the built environment is heavily concentrated, both institutionally and disciplinarily. Across Europe it is dominated by engineering and architecture, with comparatively thin contributions from management, innovation, organization, and market studies. Seen through the lens of innovation models in which technology, market, and implementation are equally decisive dimensions, this skew is a structural explanation for why many solutions struggle to move from technical documentation into actual use. Significant technical knowledge is produced, but far less is produced about the organizational, market, and institutional conditions that determine whether a solution is implemented in practice.

Change in the built environment, therefore, moves at two simultaneous speeds. On the one hand, through continuous incremental improvement within projects and processes. On the other hand, through the slower, structural changes of framework conditions, institutions, and business models. Historically, construction has found incremental improvement easier to fund and legitimize within existing structures, whereas structural innovation is more fragile because it challenges established logics and requires protected spaces, clear responsibility, and structures that allow teams to learn from mistakes without being punished for them.

Innovation rarely fails for want of ideas. It fails because the translation from knowledge to use is the weakest link in the chain. An innovation effort focused only on the first speed risks optimizing inside frameworks that are themselves inadequate to the challenge. An effective effort must embody both speeds at once, and work deliberately with the structures, incentives, and forms of collaboration that determine whether innovation survives, evolves, and scales.

It is in this tension between idea and practice, between research and market, and between short and long horizons, that this Atlas takes its starting point.

A significant part of the innovation deficit is tied to the structure of the industry. Across the EU, construction is dominated by small and medium-sized firms: according to Eurostat, roughly 94% of construction firms have fewer than ten employees, and micro and small enterprises, together, account for the overwhelming majority of employment and value added in the sector.

Expenditure on innovation

Total expenditure per Danish company (DKK 1,000 Development in total expenditure (DKK 1,000) per Danish company: Expenditure on in-house R&D; Expenditure on purchased R&D; Expenditure on innovation excluding R&D; Expenditure on purchasing external rights.

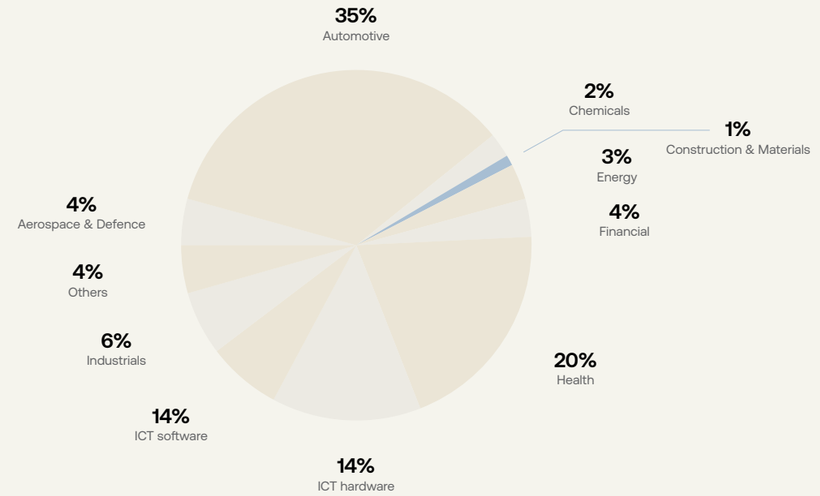
Source: Statistics Denmark. Data collected by SMITH Innovation.

Across industries, this size profile is consistently associated with lower innovation activity and fewer R&D full-time equivalents. Patent activity, a key output of innovation, is concentrated in large firms, and in construction, as in other sectors, it is the largest players that carry the bulk of registered inventions.

Read alongside the sector's SME dominance and project-based organization, this underscores the fact that the innovation challenge in construction is not primarily cultural but structural. Innovation is prioritized in words, but the conditions for investing in it, learning from it, and scaling it are weak. This is especially true for the more long-term and strategic innovation efforts, which cannot be carried by single projects or short-term budgets but, rather, require continuous investment and organizational anchoring.

For many smaller actors, innovation work carries high relative risk, limited resources, and short time horizons. This means innovation becomes person-dependent, project-bound, and hard to document or scale. The result is a sector that produces significant technical knowledge but has a weaker capacity to translate that knowledge into practice. This is reinforced by construction's other structural features – high fragmentation, project-based organization, limited repeatability, and long timelines from development to implementation. Knowledge is often created project by project and lost again when the project ends.

European Commission's Industrial R&D Investment Scoreboard



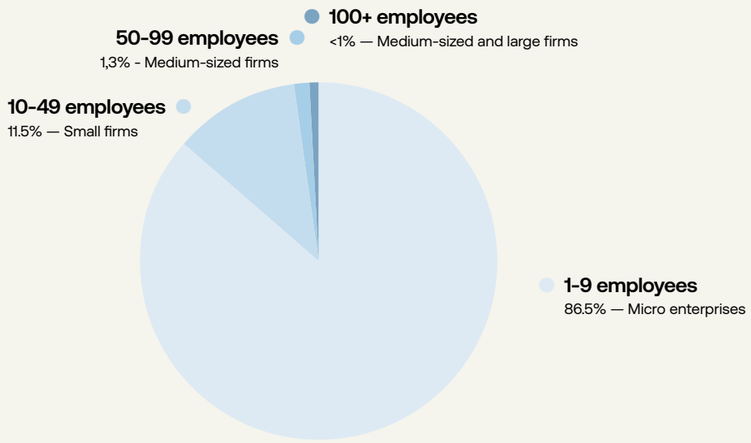
In 2024, the EU-headquartered companies tracked in the European Commission's Industrial R&D Investment Scoreboard invested 233.8 billion euros in R&D. Construction and materials accounted for 2.25 billion euros of this, just under 1% of the total R&D Investment
Source: European Commission, IRI. "2025 Industrial Research & Development Investment Scoreboard". Economics of Industrial Research and Innovation, European Commission, IRI. Seen 5. juni 2026. https://iri.jrc.ec.europa.eu/data.

To further specify where in the innovation process a solution exists, the analysis in this Atlas also uses Technology Readiness Levels (TRL). TRL is an internationally recognized and standardized scale that describes the maturity of an innovation, from early idea to full implementation in operation.

TRL divides the innovation process into nine levels. The first three cover fundamental research, concept development, and early validation in controlled environments. The middle three cover testing, demonstration, and trialing in relevant and partially real-world contexts. The final three cover full-scale implementation, market application, and stable operation. In the built environment, the challenge is rarely a shortage of ideas at the early TRL levels. On the contrary, significant volumes of knowledge, prototypes, and pilot projects are produced. The challenge typically arises in the transition from the middle levels to full implementation, where technical validation must be combined with market acceptance, organizational capacity, regulatory compliance, and financial viability.

Read alongside the MIT innovation model, TRL makes clear that technological maturity alone is not sufficient. A solution can be technically sound and well documented, yet still fail in practice if the market and implementation conditions are not in place. TRL is therefore used in this analysis not as an end in itself, but as an analytical tool for identifying where in the innovation chain barriers arise and which actors, competencies, and decisions are decisive for bringing solutions from idea to practice.

Distribution of construction firms in Denmark by size



Source: 2 March 2026, Statistics Denmark, © www.statbank.dk/ERHV4

Innovation, Research, and Practice

Innovation does not always involve research. Many improvements in construction arise through experience, repetition, and practice-based learning. But in a field marked by increasing complexity, tightening regulatory requirements, and high climate ambitions, research is playing an increasingly central role.

Applied research, in particular, holds significant potential as an innovation lever. Not as a parallel system separated from practice, but as an integrated part of development, testing, and decision-making. One area where applied research is already making a substantial contribution is documentation, validation, and systematization, thereby reducing the uncertainty that so often slows implementation and scaling.

This requires a broad understanding of research, in which knowledge production takes place in interaction between universities, research and technology organizations (RTOs), and practice-based actors. Firms cannot replace research institutions, but they can contribute data, test environments, and the systematic capture of experience. Innovation emerges from this interaction, not from separate silos.

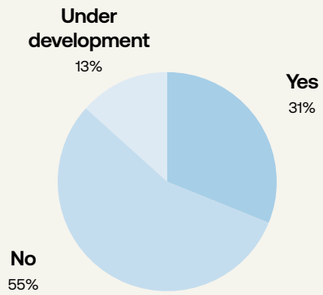
A Sector Falling Behind – Structural Change

Both in Denmark and across the EU, there are signs of a structural innovation deficit in the built environment. The European Commission's Housing Construction Strategy, published in December 2025, identifies this deficit explicitly.

Construction and materials is among the sectors with the lowest productivity growth and the lowest investment in R&D. Construction research is also heavily concentrated in a small number of technical disciplines, while knowledge about implementation, market mechanisms, and institutional change remains comparatively thin. Since 2014, the gap has widened further, indicating that the sector has not adapted in line with changing conditions: digitalization, tightening climate requirements, and increasing complexity.

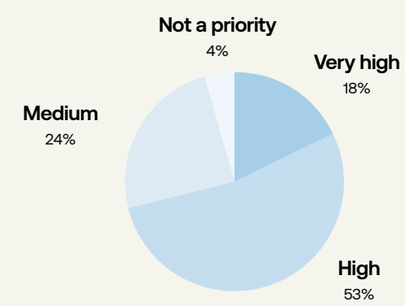
As the figure on page 32 shows, per company expenditure on innovation in Denmark has risen over time across the industry and across all firms combined. Construction, however, does not follow this pattern. The data show that construction, today, allocates relatively fewer innovation expenditures per company than it did previously, in both absolute terms and relative to other sectors.

Does your organisation have a formal innovation strategy?



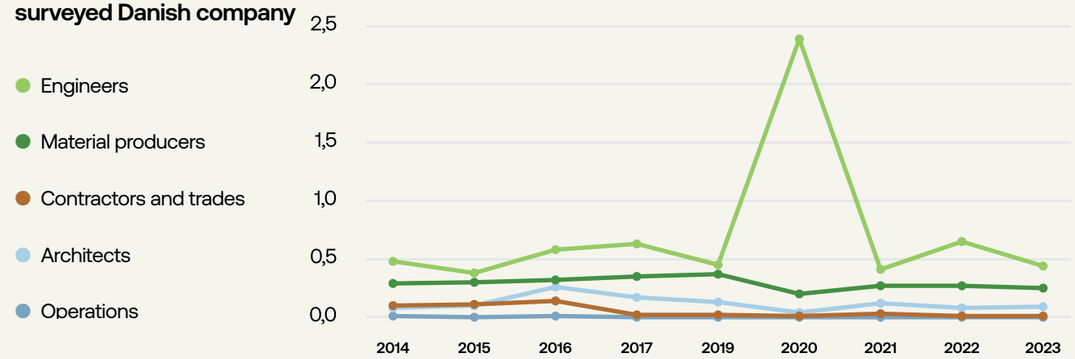
Source: Data collected by BLOXHUB in a survey of Danish developers

How high a priority is innovation in your organisation?



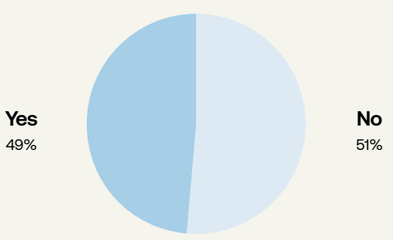
Source: Data collected by BLOXHUB in a survey of Danish developers

R&D full-time equivalents (FTEs) per surveyed Danish company



Source: Statistics Denmark. Data collected by SMITH Innovation.

Have you carried innovative solutions developed for one project over into other projects?



Source: Data collected by BLOXHUB in a survey of Danish developers

Patent scoreboard: the top 10 Danish actors in construction-related IPC categories

Actor	Number of applications	Share of all applications
VKR	450	16,8%
Rockwool	272	10,1%
Danfoss	132	4,9%
Siemens	102	3,8%
Grundfos	84	3,1%
FLSmidth	44	1,6%
DTU	24	0,9%
Hempel	21	0,8%
Dissing	15	0,6%
Leica Geosystems Tech	13	0,5%

Source: European Patent Office (https://www.epo.org/en/searching-for-patents/business/patstat)

This indicates that construction is not merely falling behind. It has struggled to adapt to the structural shifts in its operating conditions since the mid-2010s.

Why Innovation Remains Difficult to Scale

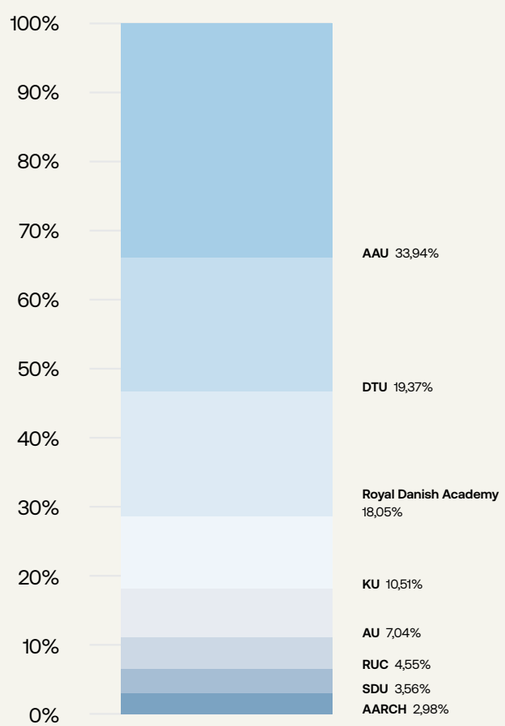
A significant part of the innovation deficit is tied to the structure of the industry. Across the EU, construction is dominated by very small firms: according to Eurostat, roughly 94% of construction firms have fewer than ten employees, and micro and small enterprises, together, account for the overwhelming majority of employment and value added in the sector.[11] Research consistently shows that smaller firms innovate less, invest less in R&D, and register fewer patents. In construction, as in other sectors, it is the largest players that represent the bulk of registered inventions – in a sector where large firms are the exception rather than the rule, this concentrates innovation capacity in a very small part of the industry.

For many smaller actors, with limited resources and short time horizons, innovation works with high relative risk. Innovation becomes person-dependent, project-bound, and hard to document or scale. The sector's SME dominance and project-based structure underlines the fact that the innovation challenge in construction is not primarily cultural but structural. Innovation is prioritized in words, but the conditions for investing in it, learning from it, and scaling it are weak. That is especially true for the more long-term and strategic innovation efforts, which cannot be carried by single projects or short-term budgets, but, rather, require continuous investment and organizational anchoring.

Construction research reflects the same pattern. Across Europe, research in the built environment is heavily concentrated in engineering and architecture, with comparatively little in the fields of management, innovation, organization, and market studies. This disciplinary skew has direct consequences: viewed through the lens of innovation models in which technology, market, and implementation are equal dimensions, the imbalance explains why many solutions struggle to progress from technical documentation to actual use. Substantial technical knowledge is produced, but there is far less knowledge available about the organizational, market-based, and institutional conditions that are decisive for implementation in practice.

The result is a sector that produces significant technical knowledge but has a weaker capacity to translate that knowledge into scalable practice. This is reinforced by construction's other structural features – high fragmentation, project-based organization, limited repeatability, and long timelines from development to implementation. Knowledge is often created project by project and lost again when the project ends.

Distribution of publications across universities



Source: Manual data collection carried out by SMITH Innovation

Research as a Lever for the Industry

Research and knowledge communities play a central role in realizing the transition of the built environment. They bring specialized expertise that the construction industry needs to navigate the complex challenges facing both the sector and society. Research contributes not only documentation and validation, but also new solutions, methods, and decision-supporting tools, often developed in direct interaction with practice.

For industry, collaboration with universities, RTOs, and university colleges provides cross-disciplinary insights and specialist knowledge, while introducing new technologies, models, perspectives, and tools. As our cases from the Danish construction sector highlight. This collaboration is essential if the industry and society are to realize genuine reductions in climate impact, meet continuously tightening requirements, and future-proof their organizations. Cross-disciplinary research collaboration therefore delivers value across multiple parameters.

Specialized knowledge can bring both expertise and tools to the table, ensuring that decisions and projects rest on a solid professional foundation. This might take the form of systematic documentation, analysis, measurement, and indicators, alongside a broad reference framework that makes it possible to assess performance across multiple parameters and make decisions accordingly.

Research competences, therefore, reduce the real risk, because solutions are not merely "possible", they are actually documented, tested, and benchmarked on a verified professional foundation. Research partners also open up new financing and risk-management logics. A wide range of funding and collaboration structures are available to both industry and research actors. This makes it possible to advance development activities that would otherwise be difficult to finance within a tight project budget, because costs, development, and testing can be distributed across multiple actors and partly covered through EU soft funding programs rather than being the responsibility of a single firm.

Collaboration also expands the innovation ecosystem for everyone involved. Anchoring in a broader, cross-disciplinary academic, and industrial network helps ensure that the right competences and resources are present and that tools and knowledge can be brought effectively into decision-making processes.

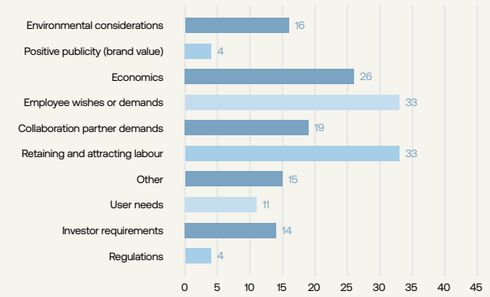
For research, collaboration provides access to real problems, data, and insight from actors across the construction sector, along with dialog with manufacturers, contractors, consultants, operators, suppliers, and other innovation actors. This allows research to be targeted at the sector's actual needs and the real barriers to implementation, and to be developed with integration across the value chain in mind. The likelihood that knowledge, ideas, and technologies are actually implemented and scaled in practice is thereby substantially increased.

Research-based documentation and practice examples can also form the basis for regulatory dialog and the further development of standards, enabling new solutions to be scaled on a more robust and verifiable foundation. This reduces the risk of innovation and increases the probability that practice can adopt solutions technically, organizationally, and commercially.

Finally, collaboration and the associated documentation and results provide the foundation for market maturation, practice change, and shifts in regulation and legislation. Firms engaged in research can stay ahead of developments by taking early ownership of new technologies, methods, and processes before they are widely integrated across the sector. This can deliver a clear competitive advantage, as the firm builds capacity and evidence that support future regulatory requirements, new standards, and emerging practice.

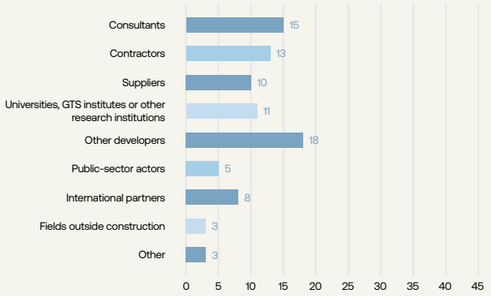
A concrete illustration of the connection between research and practice comes from PhD Julia Köhler's analysis of construction's project-based organization. She identifies how the project-based structure creates a barrier to scaling innovation and keeps solutions as one-off pilots. In the contribution that follows, she sets out how deliberate repetition across projects can make innovation more robust and operational.

What are the most important drivers of innovation in your organisation?



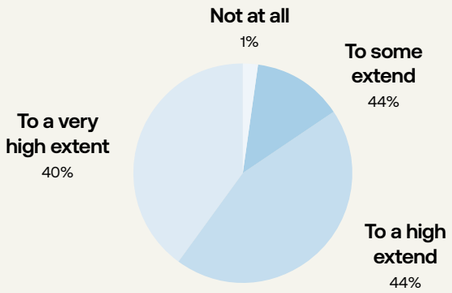
Source: Data collected by BLOXHUB in a survey of Danish developers (up to five options could be selected)

Where do you find inspiration for innovation?



Source: Data collected by BLOXHUB in a survey of Danish developers (multiple options could be selected)

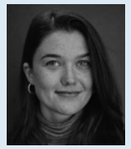
To what extent do you see reducing your climate impact as relevant / value-creating?



Source: Data collected by BLOXHUB in a survey of Danish developers

Are One-Off Projects Killing Innovation in Construction?

by Julia Köhler



Julia Köhler
PhD, CircOP and Technical University of Denmark

The construction industry is largely shaped by projects. This project-based organizing allows flexibility, tailored solutions, and delivery under changing conditions. But these strengths also produce a side effect that slows the industry's ability to innovate: an intensified fragmentation. Work is executed through temporary constellations, with supply chains being reconfigured for each project. Fragmentation manifests across supply chains, phases, and actors. The same problems are solved repeatedly by different teams under different contracts, and solutions are developed again and again. Learning remains siloed, productivity gains are hard to lock in, innovation diffusion is slow, and transaction costs stay high.

These conditions hinder the urgently needed green transformation in construction to achieve substantially lower environmental impacts[1,2] while maintaining competitiveness and social value[3]. This is where the circular economy comes into play: it offers a pathway to reduce primary material use, retain value through reuse and recirculation, and prevent waste. While the potential is high, the concept is difficult to scale in a project-based context. As a result, a multitude of circular solutions exist but remain "stuck" as pilots.

The Project Trap: Why Innovation Struggles to Scale

On paper, every project aims for predictability. In reality, project margins and timelines leave little room to absorb experimentation costs, resolve cross-organizational coordination issues, or carry learning beyond the project boundary. When something goes wrong, the response is to stabilize the project rather than redesign the system that caused the issue.

That makes innovation challenging, especially the kind of innovation that requires coordination across actors and phases. Innovations, such as digital workflows, industrialized methods, and circular solutions, are not plug-and-play; they demand contextual embeddedness, integration, and, most importantly, repeated practice. In a fragmented, projectified environment, like construction, these factors are rarely given: Complexity increases because a multitude of decisions is distributed across organizations. Agility decreases because changes need to ripple across the value chain, and resistance to change grows as perceived risks hinder innovative capacity. The industry is full of clever solutions, but it struggles to turn them into repeatable capabilities.

An Alternative: Fewer Projects?

The alternative is not to abandon projects, but to loosen the focus on *pure* projects and refocus on what can be repeated *across* projects. Recent research points to an actionable countermovement to the ongoing *projectification:* The deliberate repetition across projects to address fragmentation[4]. Instead of reinventing the wheel with each project, organizations can intentionally develop solutions that are repeated across projects. This is not about forcing standardization onto a sector that is supposed to produce unique buildings. It is about creating cost reductions and performance improvements achieved by repeatedly executing similar solutions across projects[5].

> "We build sustainably by repeating what works. So instead of starting over on each project, we start from the previous project that we built. And then we take all that learning with us to the next project. And that way we can systematically continue to refine, improve, but also make it more sustainable."[6]
>
> Dan Pham, co-founder of Home.Earth

How it works: 'Repetition' in Construction

Repetition in *Components:* Designing for Reuse

The most intuitive form of repetition is in *components*. This includes modularized construction, configuration of predefined parts, and standardized interfaces - the core of Home.Earth's Product platform (see case in this issue). For the circular economy, components matter because reuse depends on consistent quality, known interfaces, and predictable specifications. When components are repeatedly designed and specified in comparable ways, they become easier to procure, replace, and reintegrate into secondary markets.

Repetition in *Processes*: Turning Workflows into Assets

A less visible but no less impactful form of repetition lies in *processes*. This is where organizations design methodologies or workflows once and reapply them across projects. It can include processes inside and across organizations, such as having clear routines for who to collaborate with for a specific material, or how to run price negotiations and material processing decisions. Processes are where fragmentation typically manifests as miscommunications or coordination issues. Making processes repeatable enables an improvement loop: each project becomes a chance to refine the workflow rather than re-invent it.

Repetition in *Knowledge*: Iterative Improvement and Dissemination of Learnings

Construction creates enormous amounts of *knowledge* with each project, but when teams dissolve after project completion, important knowledge often gets lost. Repetition in knowledge means deliberately capturing learnings and making them usable for the next project. It also means sharing knowledge with partners, so optimization is collaborative rather than isolated. The more interoperable and accessible knowledge becomes across projects, the more it can reduce rework and accelerate innovation.

Repetition in *Partnerships*: Stabilizing Collaborations

Finally, repetition can be relational. Long-term *partnerships* enable collaboration with similar stakeholders across projects, allowing knowledge to accumulate within the partnership. The TRUST partnership (see case in this issue) illustrates how a portfolio-based framework agreement can create stable teams, shared processes, and practical pathways for repetition across projects. Contracting agreements that enable long-term collaboration increase predictability and reduce risk - preconditions for scaling innovation.

Shifting from reinvention per project to repetition across projects creates an important shift: instead of treating each project as a singular delivery challenge, organizations can build capabilities, making each project more efficient and innovative than the last.

Why Repetition Supports the Circular Economy to Scale

Rebuilding the circular "setup" from scratch per project - roles, documentation routines, liability discussions, reverse logistics – is a core barrier to scaling circularity. Embedding repetition across projects addresses this barrier. The Home.Earth and TRUST cases in this issue illustrate how repetition strengthens documentation and information flow, learning, efficiency, adaptability, and integration - benefits that directly address many circular economy barriers in construction. In practical terms, repetition helps circularity scale through four mechanisms:

Commercialization

Repeating solutions reduces time, cost, and error rates, improves reliability, and enables new business opportunities, making circular practices more competitive and easier to roll out beyond niche pilots.

Reuse

Standardization, modularization, and configuration, paired with systematic documentation links the end-of-life of one building with the design of another. Validating and documenting material properties supports traceability; predefinition reduces complexity, cost uncertainty, and logistical difficulties in deconstruction and reverse logistics, which is essential for secondary markets and reuse business models.

Derisking

By capturing and reapplying best practices, repetition reduces financial, planning, and market risks. Standardization increases predictability and supports a common knowledge base, so "going circular" feels less like a leap into the unknown.

Innovation

Repetition professionalizes circular practices: solutions and routines can be stored, reused, refined, and shared across projects and partners, creating conditions for experimentation and cumulative learning rather than isolated one-offs.

A Practical Guide to Repetition

Look at the pipeline of projects and analyze where friction keeps occurring. Is it the same interface problems between structure and façade? Is it the same late design changes that hit procurement? Is it the same uncertainty about material quality that hinders reuse? Then choose one thing to repeat. Start with components: which building parts do you specify again and again, and where do interfaces repeatedly create rework? Then shift to processes: which step consistently creates friction, and what workflow could you design once and reapply? Move to knowledge: which decisions do we keep re-evaluating from scratch, and what information do you always wish you had but never capture in a reusable way? Finalize your assessment with partnerships: which relationships would be worth stabilizing across projects, and what agreement structure would make that possible?

Thinking Beyond Projects

Projects will remain the way we build. But if we want innovation to scale and stick, we must think beyond them. The shift is subtle but powerful: from delivering isolated projects to building integrated capabilities across projects. That integration strengthens both economic performance and the environmental impact of construction. The industry has the talent and ambition; what it needs is a way of working that allows systemic innovation like circular economy practices to move beyond pilots and become a repeatable practice across projects.

1 European Commission. (2020, February 17). In focus: Energy efficiency in buildings. https://commission.europa.eu/news-and-media/news/focus-energy-efficiency-buildings-2020-02-17_en

2 Rambøll. (2025). Analysis of Life-Cycle Greenhouse Gas Emissions of EU Buildings and Construction. https://c.ramboll.com/life-cycle-emissions-of-eu-building-and-construction

3 United Nations Environment Programme. (2022). 2022 global status report for buildings and construction: Towards a zero-emission, efficient and resilient buildings and construction sector. https://www.unep.org/resources/publication/2022-global-status-report-buildings-and-construction

4 Köhler, J., Egerter, A. M., Hall, D. M., & Thuesen, C. (2025). Product platforms as enablers for the circular economy in construction: an integrative review. Computers & Industrial Engineering, 207, 111277. https://doi.org/10.1016/j.cie.2025.111277

5 Davies, A., & Brady, T. (2000). Organisational capabilities and learning in complex product systems: towards repeatable solutions. Research Policy, 29, 931–953. www.elsevier.nlrlocatereconbase

6 EjendomDanmark (2025, November 21). Fredriks Fordomme. Vimeo. https://vimeo.com/1139234581

Blueprint: Introducing Carbon Requirement's in Regulation through Co-responsibility

Europe has set the direction: the EPBD recast, the Construction Products Regulation, the Taxonomy, the CSRD and the European Commission's Housing Construction Strategy all point the same way – a built environment with a measurable, progressively shrinking climate footprint. What Europe does not yet have is a shared, operational answer to the hardest question: How do we translate that direction into a credible regulatory path that gives industry the certainty it needs to plan ahead and invest with confidence?

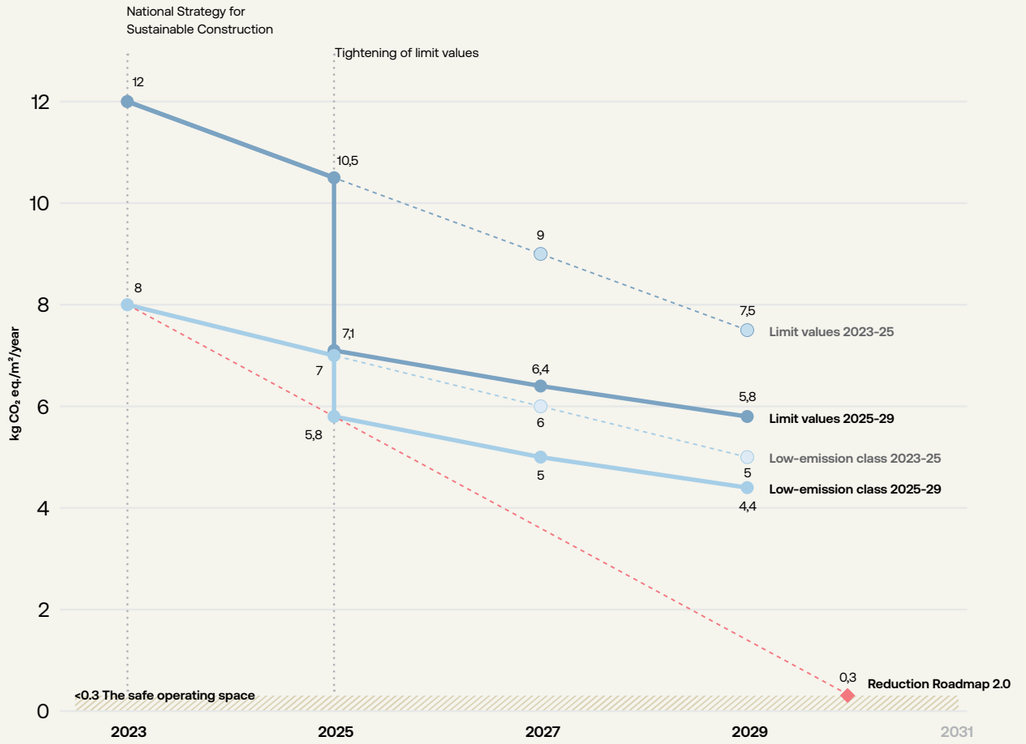
Denmark is not the only country experimenting with this, but it is among the few that has actually legislated concrete CO_2 limit values per square meter, tightened them on a published schedule, and done so in close dialog with the sector that has to deliver. The Danish experience is therefore not a model to be copied 1:1; national contexts differ, and Denmark's own framework is still a work in progress. However, it is a working blueprint for how to move from ambition to enforceable practice.

What makes the Danish path distinctive is not only the regulation itself, but the way it came about. The tightening of climate requirements was not a top-down imposition. It emerged from a co-responsible process in which industry actors tested and documented solutions in live projects, voluntary standards and research and colaborations with academia build shared methods and data, and lawmakers translated the resulting consensus into regulation at a pace the sector could absorb. Each step of regulation was preceded and enabled by practice.

The timeline on the following pages gives an overview of selected research and regulatory milestones from 2020 to 2025. It marks the breakthroughs in setting limit values for construction's environmental impact and, taken together, shows a growing consensus on both the possible and the necessary level of reduction. It also makes visible how, over time, documentation has informed and sharpened regulation through new emission and disclosure requirements.

The purpose of displaying these moments in time is to show that regulation does not emerge in a vacuum. It emerges from an interplay between research that supplies robust evidence and industry actors who test, implement, and document new solutions in practice. When common methods, data, and understandings are built across the sector, the ground is prepared for regulatory steps and for validated, repeatable actions that clients can apply in project and building processes today, reducing uncertainty and shifting demand. And this is the part of the Danish experience that is most readily transferable to the rest of Europe today.

Development in LCA-based limit values for building climate impact



- National Strategy for Sustainable Construction, incl. supplementary agreement
- Voluntary low-emission class
- Reduction Roadmap 2.0: Reduction pathway (50% probability)

Soruce: Indenrigs- og Boligministeriet. "National strategi for bæredygtigt byggeri". April 2021.
Social-, Bolig- og Ældreministeriet. "Tillægsaftale om national strategi for bæredygtigt byggeri." 30 May 2024.
Artelia, EFFEKT og CEBRA. "Baggrund for Reduction Roadmap 2.0 og oplæg til skærpet grænseværdi for bygningers klimapåvirkning." Reduction Roadmap, 15. December 2023.
Diagram produced by BLOXHUB

Timeline

Direct links

Research / industry initiative

Political action / regulation

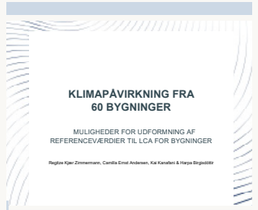
2020

Publication of "Recommendations to the Government"

Life cycle assessments and CO_2 accounting are named as one of five "green building blocks" in the recommendations from the government's climate partnership for the construction sector.

Proposed LCA limit value:
12 kg CO_2 eq./m²/year.

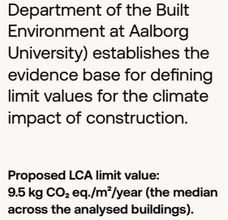
2021



Publication of "Climate Impact from 60 Buildings"

This study from BUILD (the Department of the Built Environment at Aalborg University) establishes the evidence base for defining limit values for the climate impact of construction.

Proposed LCA limit value:
9.5 kg CO_2 eq./m²/year (the median across the analysed buildings).



Launch of "the Voluntary Sustainability Class"

Denmark introduces a voluntary scheme that lets projects trial tougher sustainability requirements before they become law. For the first time, a life cycle assessment (LCA) is one of them.

2022

Launch of "the National Strategy for Sustainable Construction"

The government sets a clear timetable for phasing in climate-impact requirements, building step by step towards 2029.

LCA Limit value set: 12 kg CO_2 eq./ m²/year, for buildings over 1,000 m², from 2023.

Publication of "Reduction Roadmap 1.0"

Reduction Roadmap, a Danish science-based initiative, defines limit values for construction for the first time within Earth's safe planetary operating space, translating the Paris Agreement into concrete targets for new Danish construction.

Proposed LCA limit value:
6.75 kg CO_2 eq./m²/year
(2025, 50% scenario).

2023

Publication of "Reduction Roadmap 2.0"

With the remaining global CO_2 budget now halved, Reduction Roadmap tightens its planetary limit values for construction accordingly.

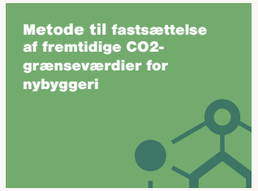
Proposed LCA limit value:
5.8 kg CO_2 eq./m²/year
(2025, 50% scenario).

The 2023 Building Regulations (BR23) take effect

Life cycle assessment becomes mandatory for every new building, and for the first time a binding carbon limit applies to anything over 1,000 m².

LCA Limit in force:
12 kg CO_2 eq./m²/year, for buildings over 1,000 m².

2024



Publication of "Method for Setting Future CO_2 Limit Values"

This strategy paper proposes including more life cycle modules, combining top-down and bottom-up approaches, differentiating limit values by building type, and applying them to all new construction.

Publication of "Analytical Basis for Establishing a New LCA-based Limit Value"

This proposal sets limit values on the principle that one third of construction should perform better than current practice, and that limit values should be differentiated by building type.

Proposed LCA limit value:
9.90 kg CO_2 eq./m²/year.

supplementary agreement tightens the limit

Parliament agrees to lower the limits from 2025. The calculation now covers more of the building's life cycle, the values vary by building type, and they apply to all new construction, not just the largest.

LCA Limit value set:
7.1 kg CO_2 eq./m²/year on average, from 2025.

2025

Publication of "Evaluation of the Voluntary Sustainability Class"

Lessons and experience from the test phase of the Voluntary Sustainability Class are shared.

The 2025 Building Regulations (BR25) take effect, 1 July 2025

The tighter carbon limit now applies to every new building in Denmark.

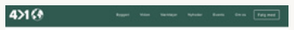
LCA Limit in force: 7.1 kg CO_2 eq./ m²/year.

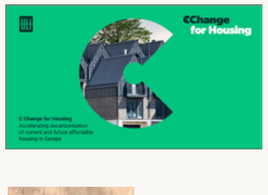
Future limit values already set:
6.4 kg CO_2 eq./m²/year in 2027
5.8 kg CO_2 eq./m²/year in 2029.

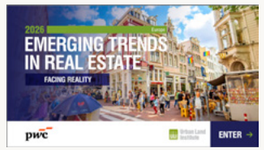
Standing on the shoulders of existing knowledge and contributions

Long before the Innovation Atlas came into being, numerous organisations and initiatives had investigated, described, analysed and recommended strategies and tools for driving innovation and lower-carbon measures in the built environment.

The Innovation Atlas acknowledges and stands on the shoulders of the knowledge that previous initiatives have generated. Seen in this light, it is a contribution that brings together and makes accessible the knowledge already available. A non-exhaustive list of the publications that have inspired and informed it:







Part 2
A New Practice Takes Shape

Principle 1: Direction Must Be Structural

Principle 2: Risk Must Be Structured Early

Principle 3: Scale Must Be Designed, Not Hoped for

Principle 4: Strategic Partnerships Must Be Prioritized

Not long ago, much of what is now being built was written off as technically, commercially, or practically unrealistic; innovative solutions confined to the drawing board, pilot projects, and prototypes. Today, we see many of those same solutions incorporated into commercial projects at scale. They are still exceptions, but they exist, and they offer something more valuable than yet another catalog of ideas: they reveal the choices and structures that explain why some projects succeed in shifting practice. The Innovation Atlas therefore does not ask: What is out there? It asks: What do successful developers and projects do differently when they manage to move climate impact, quality and economics together, while keeping delivery realistic in everyday practice? It is an analysis of the repeatable mechanisms: tools, principles, processes, and collaboration models that recur whenever ambition is translated into operable practice.

The mechanisms analyzed here are illustrated through Danish cases, but the patterns themselves are not uniquely Danish. They show how construction innovation begins to scale when ambition is supported by the right structures and can be read as a blueprint for developers across Europe.

A defining trend in 2026 is getting more out of what we already have. This is seen in the shift from greenfield to transformation, the growing emphasis on renovation over demolition and new build, and increasing pressure to use existing square meters better and reduce floor area per person. In a European context, a new analysis by C40, Arup, and Urban Partners points to almost 2 million hectares of brownfield ready for regeneration through transformation, which is enough to deliver 230 million European homes. On top of that, there is substantial demand and potential for renovating the existing building stock, both for energy performance and changed use: the same analysis shows that Europe holds some 20,000 hectares (200 million square meters) of unused retail and office space that could be converted into housing.[1]

This places new demands in relation to the quality of decision-making and replicability if solutions are to scale. It is at this intersection that we created the Innovation Atlas: between climate and affordability, between innovation and implementation, and between single projects and what can become broad practice.

1 C40 Cities, Arup, and Urban Partners. "Unlocking sustainable urban regeneration in Europe: A blueprint for cities, investors, developers, and communities". C40 Cities, 2026.

From Niche to Norm

If innovation is to shift practice, it must move from niche to norm. The question is therefore not only how new solutions are developed, but how they are repeated, reordered, and embedded as standard. The following analyzes the mechanisms that make this possible.

Designing Demand

A recurring argument is that innovation is not merely about new solutions for the existing market, it is about redesigning demand itself. In this way, innovation shifts from adapting to the market to actively shaping it: the question becomes not only how to demand innovation, but how a new form of demand can drive the necessary transition.

Projects such as **Travbyen**, a large-scale neighborhood development by KIRKBI, and the projects from **Home.Earth**, a mission-driven developer delivering low-carbon housing through a standardized, continuously improved product platform illustrate two different but strategically related ways of moving bio-based materials from niche to norm. What they share is that neither waits for the market to mature. Instead, both actively redefine the concept of standard construction through clear principles, systematic working methods, and repetition.

At **Home.Earth**, innovation happens internally and systematically. It is integrated into the core business and anchored in the organization as a continuous development process. Through targeted product development, fixed standards, and continuous technical and economic optimization, the company develops its solutions and embeds them directly in its projects, expanding the traditional developer role to include developing the solutions themselves and using its own projects as a platform for testing, learning, and scaling.

In the **Travbyen** project, KIRKBY expand the role of developer through a different mechanism. Clear governing principles and explicit requirements and mandates for materials, construction, and performance are established upfront, backed by a matching financial framework. The ambition is not to develop all solutions in-house, but to shift the incentive structure across the value chain so that consultants, contractors, and producers deliver the necessary innovations to meet the set mandates and requirements. Innovation happens externally, but is triggered by the developer's demand. The developer is buying innovation, but doing so in a way that systematically pushes the market in a new direction.

In both cases, the point is that bio-based building systems are treated as the organizing starting point rather than as experiments. The difference lies in the innovation logic. Either solutions are developed internally and implemented directly in the product, or requirements and incentive structures are established that demand the market

deliver them. Both approaches serve to shift innovative material choices and construction logic from exception to standard, showing how the developer can shape the market rather than merely adapt to it, and in doing so help create new demand.

The non-profit housing association **Boligselskabet Sjælland**'s use of framework agreements for the utilization of CLT (cross laminated timber) in housing construction since 2017 shows clearly how legal and procurement-related mechanisms can build a critical mass of demand and mature a domestic market, moving from dependence on foreign expertise to building Danish capacity through actors such as CLT Denmark.

Similarly, **AKF's** (Danish property developer and owner) use of EcoCocon, (a bio-based straw panel building system), **Travbyen**'s knowledge exchange with **Leralliancen** (rammed earth R&D partnership), and new frameworks in **Fælledby** (timber-built, nature-led neighborhood development in Copenhagen) show how targeted demand and curated cross-disciplinary collaborations can drive new solutions, smaller actors, and innovative materials into the mainstream.

The Developer's Unique Opportunity

A recurring pattern across the analyzed cases is that the developer wields an opportunity, and a corresponding responsibility. The developer has the capability to translate ambition and decision-making power into demand, investments, and project requirements. Developers who succeed in shifting practice do not see themselves as passive recipients of the market's solutions, but as actors who can and must influence how the market develops.

The approach is a deliberate top-down move: the developer uses their position to set precise requirements for processes, performance, and solutions. It is not about shifting responsibility away from the developer, but using power wisely by demanding new processes, stipulating clear environmental performance requirements, and simultaneously investing in solutions that enable other actors to deliver. The shift lies in recognizing that no single actor can own or control the entire value chain, and that open-source approaches and knowledge sharing are a precondition for achieving the necessary scale.

This pattern repeats across all the cases presented in the atlas. Developers do not drive innovation by inventing everything themselves, but by creating the conditions in which contractors, manufacturers, and consultants can invest and develop new solutions at a lower risk. When requirements are clear and repeatable, it becomes rational for the value chain to follow. As several actors across the value chain put it: when the developer demands, the market delivers.

From Niche to Norm

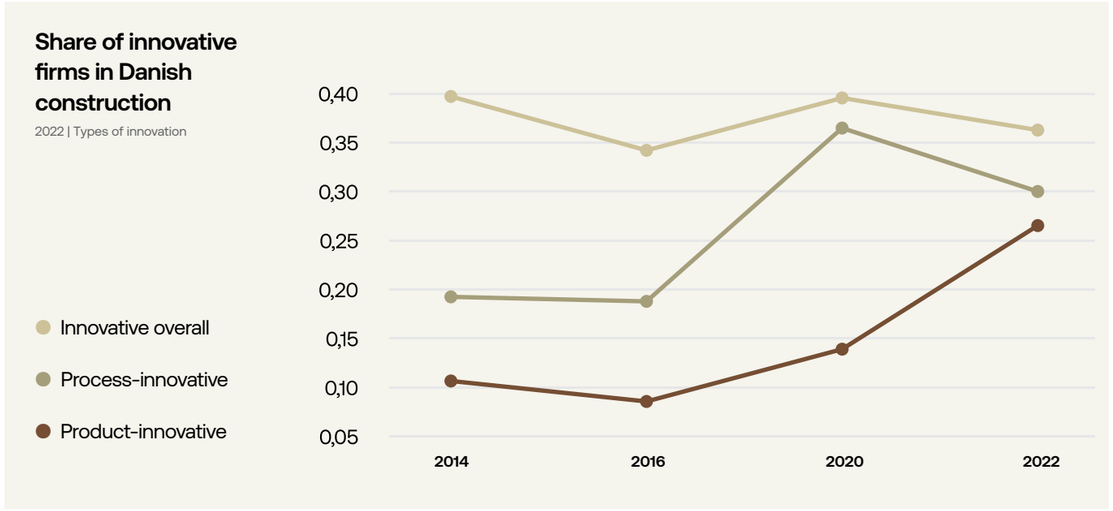
What Others Can Do

- Treat bio-based construction as the starting point, not as an experiment to be added later.
- Establish clear principles, fixed standards, and repeatable working methods to move new materials from exception to standard practice.
- Build demand either by developing solutions internally or by using requirements and incentives to compel the value chain to deliver.
- Use framework agreements, repeated procurement, and curated collaboration to mature new materials and build capabilities among the actors working with them.

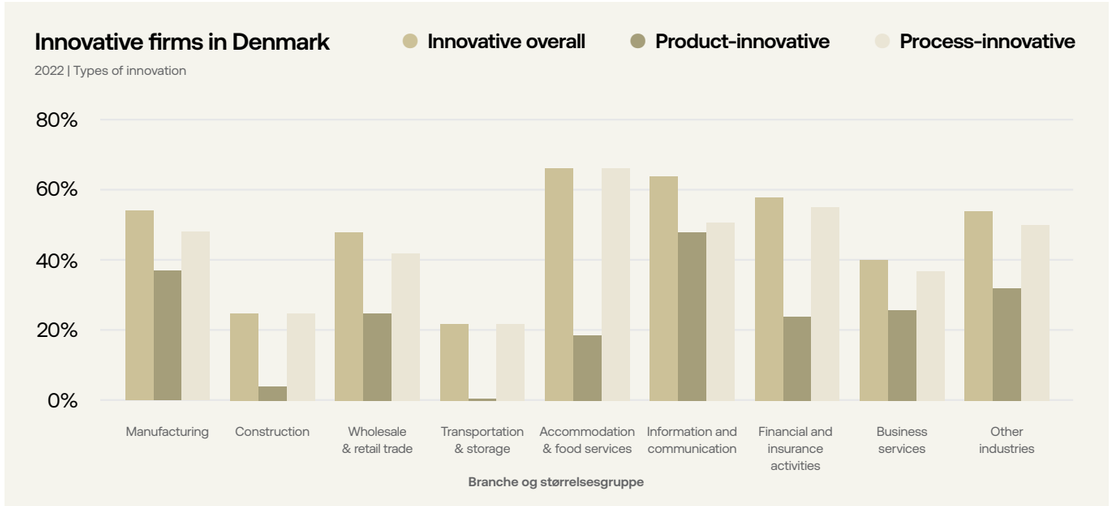
The Developer's Unique Opportunity

What Others Can Do

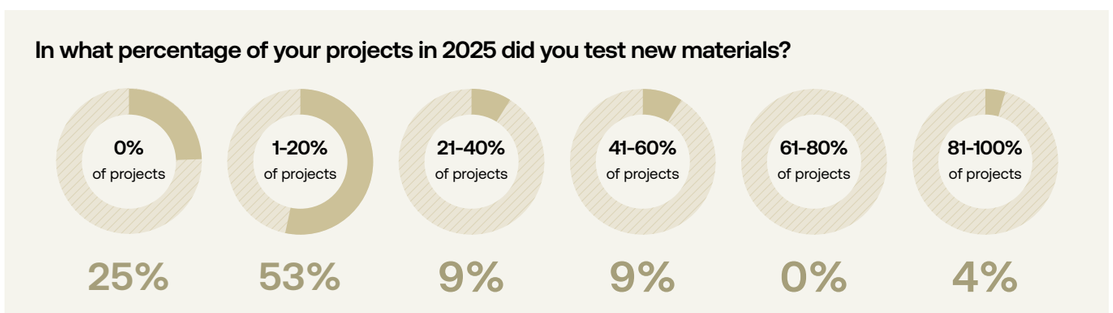
- Use the developer role actively to define clear, precise requirements for processes and performance.
- Shift focus from owning the entire value chain to creating conditions that enable others to invest.
- Prioritize open-source approaches and knowledge sharing, so solutions can scale beyond your own projects.
- Accept that leadership in the transition means shaping the market not merely responding to it.



Source: Statistics Denmark. Data collected by SMITH Innovation.



Source: Statistics Denmark, 2022.



Source: Data collected by BLOXHUB in a survey of Danish developers.

Regulation as a Driver

Regulation emerges as a central but indirect driver of innovation. Not because regulation, itself, creates new solutions, but because it shifts the minimum requirements and, in doing so, changes the conditions under which innovation operates. When requirements tighten, marginal optimization within familiar solutions becomes insufficient. The figure *Share of innovative firms in construction* points to the same development: a recent increase in Danish product innovation consistent with the tightening of carbon emission requirements across the sector.

The mechanism is clearest in the recent Danish climate requirements. Denmark was among the first countries in Europe to write mandatory CO_2 limits per m^2 directly into building regulations, with thresholds introduced in 2023 and stepwise tightening through 2030. As several developers have noted, these requirements have triggered a genuine shift in material choices, alongside a sharper focus on reducing waste and re-use existing materials. As part of the tightened carbon framework, reused materials count as zero in the carbon footprint calculations, and this has had an effect on the market by shifting attention from hoping that others will reuse your materials to taking them back yourself, with the risk and complexity that entails. Combined with requirements for selective demolition, this changes processes, responsibilities, and ultimately demand across the value chain.

Throughout our interviews, the climate requirements of the Danish Building Regulations were consistently identified as a key driver of innovation, as they compel the sector to pursue more ambitious solutions. Certification can play a similar but more incentive-based role: by defining how we measure performance, it creates a shared direction for all actors across the value chain and a clearer incentive to innovate. In this context, certification becomes a tool for capturing a green premium, aligning expectations, and creating demand. However, its effect depends on ambition levels being continually raised. When requirements are too easy to meet, innovation stops.

At the same time, a structural tension runs through the cases in the Innovation Atlas: regulation must set stricter and more consistent requirements if it is to continue to function as a driver. But it must also become more flexible and adaptive toward non-conventional solutions.

Today, large parts of the regulatory system are designed to ensure and reproduce precisely the practice we are trying to change. Documentation requirements, standards, and approval procedures are largely calibrated to familiar materials and well-tested systems.

If regulation is to function as a genuine engine of innovation, it must do more than raise the bar. It must also create a more responsive framework in which alternative structures, bio-based materials, and circular solutions can be approved and scaled without disproportionate complexity. In other words, regulation must not merely control existing practice, but be actively geared toward the practice we are trying to establish.

Regulation as a Driver
What Others Can Do

- Use regulation as a starting point for raising ambition, not as a minimum to be complied with.
- Prepare your organization and value chain for the requirements that are coming, not only what is already in force.
- Use certification strategically to document performance and create value.
- Accept that tightening requirements will change materials, processes, and responsibilities and plan accordingly

Public Procurement as a Driver

Public developers and public procurement play an important role because they can create volume, stability, and legitimacy around new solutions. When public actors demand innovation, it can trigger systemic change that extends far beyond the individual project.

The mechanism lies in using procurement and partnerships to enable repetition and scale. The City of Copenhagen's **TRUST** framework agreements, long-term strategic partnerships through which the city procures portfolios of similar projects via a small number of consortia over several years, are the clearest illustration of this in the Danish market. The model has since inspired framework agreements in Denmark's non-profit housing sector, showing how solutions can scale when a large public developer commits. It does, however, require significant in-house construction expertise and the ability to formulate clear, repeatable requirements.

Drawing on thinkers, including the British economist Mariana Mazzucato (UCL), the analysis points to the potential for a closer link between public demand and soft funding, so that investments in innovation are connected directly to implementation through procurement. This changes the risk profile and makes it more attractive for the market to invest in new solutions.[1]

Public Procurement as a Driver
What Others Can Do

- Use public procurement strategically to build volume and repetition.
- Couple innovation, funding, and procurement.
- Define clear and ambitious requirements that can be repeated across projects.
- Build in-house development expertise so that procurement becomes an active steering tool.

Knowledge that Shapes Practice

A significant share of the innovation that succeeds in practice is driven by knowledge that emerges close to the projects themselves. Much of the relevant knowledge production does not happen in isolated research environments, but in the interaction between developers, the value chain and researchers, you need a strong knowledge base to take informed decisions, and new solutions only succeeds if they are compatible across all links of the value chain.

The mechanism is the systematic capture, accumulation, and application of knowledge. BUILD (Department of the Built Environment, Aalborg University) has over time has curated a shared evidence base for the Danish construction sector through research, data, and knowledge based on completed construction projects.[2] This has strengthened both legislation and the sector's common frame of reference. Combined with the Reduction Roadmap, the Danish construction sector has a relatively clear picture of where it has come from, where it stands, and where it must go. The challenge is not a shortage of data, but that knowledge too often remains fragmented and locally anchored.

This is precisely the gap the Innovation Atlas is designed to address. Several actors point out that the primary barrier is not the lack of innovation, but that knowledge and insights are not being collected, curated and made accessible so that others can build on them and push the limits further.

Travbyen is an example of how technical insights, collaboration with BUILD, and working systemically with data can create a more robust shared knowledge base. Brandbanken[3] (a Danish knowledge portal that collects and publishes fire-test data and documentation for bio-based building materials), a private initiative developed by **Travbyen** and **Fælledby**, makes fire tests and technical documentation from the two projects openly available to the wider sector. In addition, Urban Partners' sharing of fire-test data from **Ripple Residence** points to the same larger issue: individual actors are already producing and sharing valuable knowledge, but the sector still lacks a coherent framework in which that knowledge is gathered, translated into practice, and repeated.

Knowledge that Shapes Practice
What Others Can Do

- Prioritize the systematic collection of knowledge from your own projects.
- Share documentation and test results so that others can reduce risk and help build the new market.
- Use existing databases and roadmaps actively in decision-making.
- Treat knowledge sharing as an investment in market maturation not as a loss of competitive advantage.

Contractors Respond

The analysis also shows that contractors are increasingly preparing for a shift in demand. When major contractors signal that the bulk of their future business is expected to lie in renovation rather than newbuild, it is a sign that the market is already in motion.

The mechanism is organizational adaptation in anticipation of future requirements. Contractors such as Enemærke & Petersen are positioning themselves by developing the skills, processes, and partnerships they will need to deliver once demand materializes. This reduces risk for developers, because the capacity is already being put in place.

A comparable example is seen in the **Fælledby** project, where bgb a.s. (main contractor) established its own production unit to manufacture prefabricated timber cassettes. This was not simply a matter of delivering on a specific brief, but of investing in production capacity and industrial organization capable of supporting a new construction logic. At the same time, the company entered into close collaboration with designers and consultants to develop a flexible standard that could be adapted to different projects without losing efficiency.

In both cases, contractors are not merely adapting to existing requirements; they are actively preparing for a structural shift in demand. They are investing before volume is fully documented, and in doing so are themselves helping to make the new practice deliverable at scale.

Contractors Respond
What Others Can Do

Choose contractors with a proven interest in, and track record for, innovative solutions.
Involve contractors early in the development process to incorporate hands-on knowledge and experience into early design decisions.
Use their market knowledge to test the realism of requirements and standards.
View contractors' transitions as an indicator of where the market is heading.
Set demands that make it rational for contractors to invest in capacity building.

1 https://www.ucl.ac.uk/bartlett/sites/bartlett/files/mission-oriented_public_procurement_international_examples_final.pdf

2 See BUILD's research portal and datasets, including Builddata in English (en.build.aau.dk/web/builddata) and the BUILD guidelines in Danish (anvisninger.dk).

3 https://brandbank.dk/

Scale is Created

Scale does not emerge on its own. It is designed. If innovation is to move from one-off projects into broader practice, it requires structures capable of sustaining repetition, distributing risk, and accumulating learning over time. This chapter analyzes the mechanisms that make scaling possible: across sites, organizations, and project cycles.

When Development Moves from Building Scale to Neighborhood Scale

A clear movement across the cases analyzed is that innovation is increasingly being designed at neighborhood scale rather than at building scale. When development is understood as a place in its entirety, it becomes possible to work with multiple systems and actors simultaneously and to make testing, learning, and documentation a part of the urban development logic.

The mechanism is that developing at neighborhood scale makes innovation deliverable. Scale creates greater room to invest in development and to manage the complexity that arises when construction is coupled with social, functional, and infrastructural targets and requirements. At the same time, risk can be distributed across multiple typologies, phases and square meters, and a broader network of actors can be drawn into a continuous development process in which learning and relevant expertise are embedded into the overall delivery.

Fælledby and **Travbyen** illustrate this logic. Both projects are anchored in an aligned vision for the development. Variation in typologies and volume is used actively as a means of spreading risk and creating structured spaces for learning. **Travbyen** is particularly significant because it combines neighborhood scale with phased delivery: learning from one construction phase is systematically carried forward into the next. As development moves from building to neighborhood, the relationship and partnership with the municipality also has the potential to shift, from primarily a regulatory authority to a strategic partner, because planning, infrastructure, and delivery must be thought through together from the outset.

When Development Moves from Building Scale to Neighborhood Scale
What Others Can Do

Design innovation at neighborhood scale. When the complexity demands more than a single building can bear.
Use a mix of building types and phased delivery to spread risk and structure learning.
Bring key actors in early and make collaboration part of the development design.
Engage the municipality as a strategic partner, not only as a regulatory authority.

From Plot to Portfolio

The analysis reveals a more linear but highly effective scaling logic, one in which innovation is borne not by a single project but by an entire portfolio over time. Testing, documentation, and development costs shift from the individual building to a continuous series of projects, where learning can be reused and improved.

In this mechanism, repetition over time reduces uncertainty and distributes the costs of innovation. When a project does not stand alone, learning ceases to be a one-off data point and becomes an active resource, one that feeds into future decisions and future deliveries. This builds an organizational knowledge structure that makes it possible to raise ambitions without starting from scratch every time.

Urban Partners illustrates this by carrying learning from UN17 forward into **Ripple Residence. Home.Earth** works with a related logic: internal standards and product development are continuously optimized, updated, and enriched with knowledge from previous projects to shape the next one.

Boligselskabet Sjælland's framework agreement for timber-based element construction shows how repetition and greater volume can translate into lower delivery complexity through standardization and modular principles.

What these three approaches have in common is that innovation becomes less risky because it no longer has to be financed and justified for each individual plot, but can be distributed across a shared investment horizon.

From Plot to Portfolio
What Others Can Do

- Design testing and documentation so that it can be reused across future projects.
- Build standards and processes that make learning operational in the next project.
- Distribute innovation costs over time rather than loading them onto a single project.
- Make investment and impact decisions at portfolio level, not only project by project.

Replicability as a Precondition

For developers who wants to spearhead a genuine shift in practice, repetition is essential. Solutions only achieve real impact when they can be repeated. Replicability is therefore not a by-product of success; it is a precondition for a new practice.

The mechanism is repetition across projects, typologies, and collaborations. When products, solutions, and processes are reused, they steadily improve, become more robust, and carry less risk. The cost of developing them is paid once, then recouped with every reuse. Standardization here is not a driver for homogenization; it is what creates a stable foundation on which variation and architectural quality can be built.

Home.Earth is a clear example of this logic of continuously building on experience across projects. Both **Travbyen** and **AKF** have used community buildings as small-scale test laboratories for new solutions, then drawn on what they learn from the test builds to optimize and replicate at scale. This shows how a building system can be developed from a small-scale project into multi-story construction and used across varying typologies. In **AKF**'s approach, the progression is tangible: solutions developed in one project are carried forward from community buildings to townhouses.

At **Travbyen**, the "sandbox projects" serve the same function. In construction phase 1, selected buildings are designated as dedicated innovation test builds, where solutions are systematically trialed with the intention to carry knowledge and solutions for implementation in construction phase 2. Testing is therefore not a separate track, it is an integrated part of the scaling and development process.

Boligselskabet Sjælland works with the same consistent logic of repetition through framework agreements, where each project improves the next, and accumulated knowledge from experience is translated directly into practice. This has enabled them to build with CLT, originally seen as carrying significant risk, and deliver faster and within budget.

Travbyen's work on bio-based building systems and its decision to publish fire-test data, along with general learnings and teachings from across the project, show how developers are increasingly driving knowledge sharing so others can repeat it and build further on the foundation. The point is not that everyone must build the same thing, but that knowledge, testing, and documentation should carry forward from one project to the next rather than being built up from scratch every time. Element and modular construction reinforce this, and have continuously delivered both quality and volume.

Replicability as a Precondition
What Others Can Do

- Develop solutions with repetition in mind not as unique project-specific solutions.
- Standardize knowledge and solutions to bear development costs once and improve solutions over time.
- Prioritize knowledge sharing so that learnings can benefit more than one organization and do not remain project-specific.
- Accept that repetition is the precondition for shifting practice from building scale to portfolio logic.

Framework Agreements and the Effect of Repeated Collaboration

The analysis shows that repetition is a decisive lever for moving innovation out of one-off projects and into broader practice. In projects run as isolated engagements, learning, relationships, and the willingness to take risks reset with each new project. In the successful cases, framework agreements and repeated collaborations are used actively to create continuity and predictability for everyone involved.

The mechanism is that legal and organizational structures make it possible to work with the same actors across multiple projects. When repeated collaboration is a deliberate choice, experience accumulates and solutions can be refined over time. In **ByK with TRUST** and **Boligselskabet Sjælland**, this repetition has been formalized through legal framework agreements that give both developer and suppliers room to invest in innovation and development, because volume and repetition are on the horizon. When partnerships extend beyond the individual project, it becomes possible to deliver on innovation, quality, time, and cost at the same time, rather than prioritizing one consideration at a time. Repeated collaboration also reduces transaction costs and uncertainty. The parties know each other, understand what it takes to drive development across all the actors involved, and can take risks on a more informed basis. This makes it easier to test new solutions while keeping control over budget and progress.

A new study from the University of Southern Denmark (SDU) and the Technical University of Denmark (DTU)[1] analyzing the experience of TRUST alongside a parallel strategic collaboration in the City of Copenhagen, reinforces this point.

The study finds that long-term partnerships do not merely reduce risk and uncertainty, they change the behavior of actors over time. When collaboration is organized as an ongoing partnership rather than a temporary contract, incentives emerge to invest in joint problem-solving, capability-building, and the development of solutions that extend beyond the individual project. The evidence shows that this structure makes it possible to turn learning into continuous improvement, while the involved supply chain maintains focus on economics, quality, and delivery.

Across the cases presented in the Innovation Atlas, the same pattern holds: strategic partnerships create an alternative to the project logic that dominates construction, where work is tendered and organized project by project. In a market made up of many small and medium-sized firms with limited capacity to invest and innovate, ongoing partnerships and framework

Framework Agreements and the Effect of Repeated Collaboration
What Others Can Do

- Use framework agreements to make repetition possible across projects.
- Give suppliers enough volume and continuity to invest in capacity building and innovation.
- Use repeated collaboration to reduce uncertainty, build capability, and turn learning into continuous improvement.

agreements overcome that barrier. They consolidate volume, reduce fragmentation, and make it possible to lift development efforts to a level where they become viable for the partners involved. Consequently, these partnerships tackle some of construction's fundamental structural challenges, rather than merely optimizing within the existing framework. It is this alternative organizational and legal structure that makes innovation possible in practice.

From Project to Product

A clear shift runs through the analysis: the move from project-based solutions to professionalized solutions that can be repeated and improved. When solutions remain project-specific, they become expensive, fragile, and hard to scale. In the words of Danish economic geographer Bent Flyvbjerg, construction risks falling into the "uniqueness trap", where every project is treated as so unique that learning, standardization, and repetition are actively undermined, with higher risk and poorer results as the consequence.

The mechanism is simple: development work moves out of the individual project and into the organization. Processes and components are developed with repetition in mind. Each project becomes an iteration rather than a special case. Development work shifts from a single project into systems, committees, catalogs and building kits that can be used again. In this way, each project is no longer an endpoint but a link in a chain of learning, where experience is systematically captured and carried into the next iteration.

Home.Earth, Enemærke & Petersen, EcoCocon, and Urban Partners illustrate this movement from different positions in the value chain, but with the same underlying logic: solutions must be repeatable before they deliver real impact.

From Project to Product
What Others Can Do

- Decide early whether solutions are to be project-specific or developed as products.
- Move development work out of individual projects and into systems.
- Accept that product logic is a precondition for scaling.

New Products Moving Closer to Market

Several solutions that were previously at pilot and prototype stage are now moving closer to market. This is happening not through technological breakthroughs alone, but through professionalization, systematization, and coupling with practice. The journey from idea to product is increasingly about integrating technology, market, and implementation simultaneously, not sequentially.

The mechanism is that materials and solutions are developed in direct dialogue with construction practice, and with a clear understanding of their future market application. The transition from material to product happens when a solution is not merely technically feasible, but organized, documented, and adapted so that it can be delivered repeatedly within realistic economic and regulatory constraints.

EcoCocon is a clear example of this movement. The product has progressed from exploratory use in smaller community buildings to professionalized solutions in townhouses and larger construction projects. The material is the same, but the product has changed: documentation, detailing, assembly, and collaboration models have all been adapted to an industrial context. This is where the difference between an interesting solution and a market-ready product becomes clear.

The same pattern is seen with Enemærke & Petersen's **EP PRO**. What began as a Realdania-supported development project in Aarhus has been systematized and is now being rolled out across construction sites. Here, it is not a material that becomes a developed product, but the construction process itself. Learning, planning, and production management are standardized so that efficiency and quality can be repeated. The innovation lies not merely in the method, but in its ability to work in practice.

Similarly, the collaboration between **Leralliancen** and **Travbyen** shows how new materials can move to market through controlled experiments in practice. At **Travbyen**, three buildings were built under separate contracts to allow greater ambition in innovation, including one built using rammed earth blocks as a structural element. The learning from this process is that adding a small quantity of lime would allow the product to be used in the next test house. Adding lime is not the perfect ideal, but it is a compromise that makes the solution achievable within current regulatory requirements. It shows that market maturation often happens through negotiation between the ideal and the implementable, as a fit between technology, market, and implementation.

In **Fælledby**, a similar movement toward bio-based construction is underway. Here, the ambition is not only to demonstrate individual solutions, but to integrate them into a larger, deliverable development structure. Materials and systems are tested in relation to logistics, fire requirements, and contractor capacity, rather than in isolation.

What these cases have in common is innovators engaging in a continuous negotiation with industry. They confirm a decisive difference: between having a promising solution and having a finished product. Only when a solution can be specified, documented, insured, and delivered within current economic constraints does it genuinely move closer to market. It is in this interplay between technology, market, and implementation that the path to commercialization and lasting impact is shortened.

New Products Moving Closer to Market
What Others Can Do

- Develop materials and solutions in close contact with the value chain and the construction project from the outset.
- Turn technical feasibility into products that can be documented, insured, and delivered repeatedly.
- Use controlled practice experiments to move from ambition to implementation through iteration.
- Professionalize the process around the solution, not only the solution itself.

Platform Thinking as a Tool for Standardization and Scale

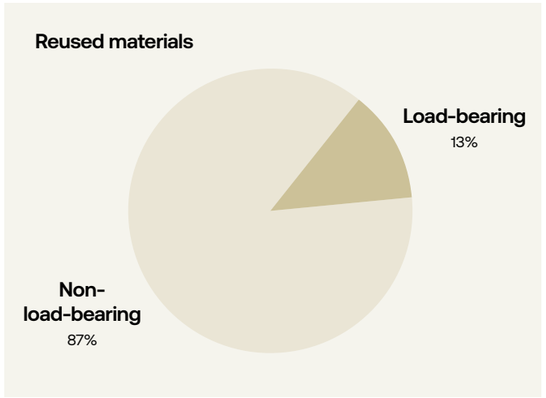
Platform thinking is used here as a deliberate approach to combining standardization and variation not to homogenize construction, but to create a stable foundation on which knowledge can accumulate. The concept is understood as an industrial approach to construction in which physical building systems, components, and processes are standardized for repeated use. Variation emerges in architecture and application, not in the underlying solutions. In this way, the platform becomes a tool for capturing learning, reducing risk, and making scale and repetition possible.

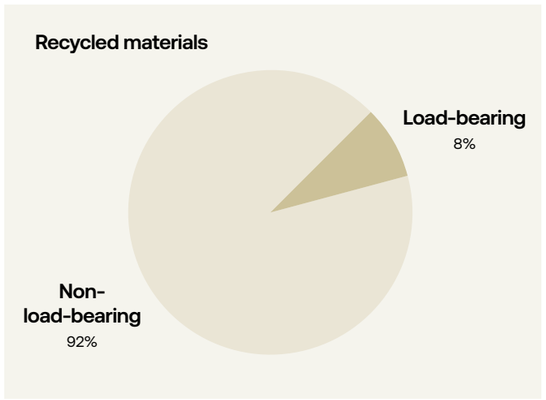
The mechanism is systematic standardization of components, knowledge, processes, and partnerships. **Home.Earth** has industrialized the construction process, drawing on inspiration from other sectors. Each project is used actively to identify errors and opportunities for improvement, which feed directly into the next iteration. The difference in LCA and implemented solutions, and procurement, between their two projects in Nærheden and Høje Taastrup C, respectively, demonstrates how this approach can translate into both a lower carbon footprint and a more robust business case.

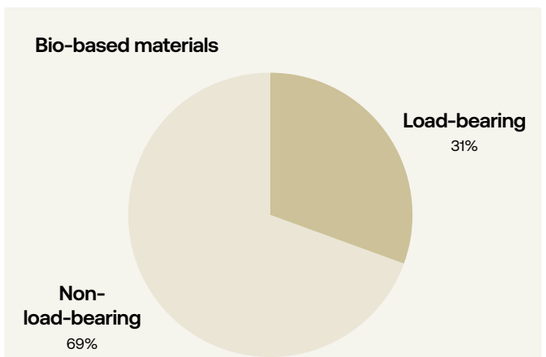
Urban Partners applies a related logic by shortening the value chain and going directly to major material producers such as Saint-Gobain and Holcim. Drawing on a leaner, Swedish-inspired approach, it sources knowledge where it is strongest and evaluates solutions on their scalability across the portfolio. Here, standardization is not a constraint but a precondition: it is what makes it possible to work with take-back programs, international application, and large volumes.

Platform Thinking as a Tool for Standardization and Scale
What Others Can Do

- Use standardization as a foundation for learning and improvement.
- Work with platforms rather than one-off solutions.
- Require scalability and portfolio relevance before solutions are selected.







Source: Data collected by BLOXHUB in a survey of Danish developers

When circularity meets scale

The previous sections described the structural mechanisms that make scale possible: the shift from pilot to portfolio through repetition and standardisation. To stress test these mechanisms, we need an innovation track where complexity, uncertainty and the need for collaboration are all essential. Circular and bio-based materials are exactly such a test. The technology is largely known and the potential well documented, but implementation lags, because it challenges existing structures and demands new processes.

The challenge lies not in the materials themselves, but in turning circular and bio-based concepts into scalable solutions that can change the logic of the market and processes. When reuse, recycling and bio-based solutions are applied consistently, the value chain adapts. Several actors point to several benefits, from better use of space on site to overall optimisation, when the value chain is integrated early, and can change the logic of the process.

Circularity is often described as "difficult", precisely because it challenges the familiar, and reuse is where developers often "burn their fingers". Even so, the actors who continue do so from a clear recognition: their overall impact is greater if they contribute to making circular ad bio-based solutions less risky. When knowledge are shared and solutions professionalised, cost and uncertainty fall across the market.

One central move is to shift complexity away from the individual project, and define processes according to bio-based and circular principles, so that working with these materials does not turn every project into an experiment. A related logic is to reverse the process: identify the materials first and design around them, rather than seeking circular alternatives to a fixed design.

This confirms the analysis's central point: without simultaneous innovation in market demand and implementation, circular and bio-based solutions stay trapped in the pilot phase, praised for their potential but limited in practice. The challenge is not only to develop better solutions, but to change the structures that determine what is demanded, financed and ultimately built. With the right link between core business, organisation and market, circularity and bio-based materials can move from exception to norm.

1 Gottlieb, Stefan Christoffer, og Christian Thuesen. "Strategiske partnerskabers effekter: kvantitativ evaluering af tid, pris og kvalitet". Aalborg Universitet / Danmarks Tekniske Universitet, December 2025. https://findresearcher.sdu.dk/ws/portalfiles/portal/301356955/Gottlieb_og_Thuesen_-_Kvantitativ_analyse_af_strategiske_partnerskaber.pdf

Strategic Partnerships
by Stefan Christoffer Gottlieb and Christian Thuesen

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What is the Vision?

The challenges facing the construction sector are well known. The industry is characterized by fragmentation, ad hoc collaborations, loss of knowledge between projects, high transaction costs, and significant variations in time, cost, and quality. Traditional procurement models do not systematically support learning and innovation because, in practice, each project begins “from scratch”.

Strategic partnerships have emerged as a response to these challenges. The purpose is to develop a coherent and learning-based construction practice where repetition effects, shared culture, and interdisciplinary integration create better quality, higher productivity, and greater budget certainty. The partnership model points toward a market in which relationships replace transactions, and where continuous knowledge exchange reduces inefficiencies and conflicts for the benefit of users, clients, and delivery teams. In practice, this means that clients move from tendering projects individually to tendering portfolios of relatively similar projects to be initiated over a four-year period.

Strategic partnerships therefore rethink the traditional way construction is organized and delivered. Their relevance is especially clear today, as society faces major climate challenges while simultaneously needing to deliver more and better buildings with fewer resources. This increases the need for robust processes, data, and collaborative models capable of creating continuous improvements across projects, portfolios, companies, and client organizations.

What is Needed for Success and Broader Implementation

Research shows that strategic partnerships can generate concrete improvements in quality, collaboration, and budget reliability, particularly in renovation projects. This is important because the renovation and transformation of existing buildings is playing an increasingly central role in the green transition of the built environment. Although the effects are not yet conclusively documented, partnerships appear to establish the structural conditions necessary for continuous improvement – even before full maturity or scaling has been achieved.

However, if partnerships are to scale, several conditions must be in place. Partnerships depend on repetition effects and continuity. Stop-start dynamics and uncertain capital funding undermine learning and capacity building. Broader implementation therefore requires clients to invest in multi-year programs rather than isolated projects in order to create the necessary stability and continuity. There is also a significant need for better documentation and sharing of results. More systematic, transparent, and comprehensive reporting is required if partnerships are to gain broad legitimacy. Without data, effects remain invisible and legitimacy becomes fragile.

What Conditions Must be Present for Partnerships to Have Societal Impact?

For strategic partnerships to have broad impact within the construction industry, attention must be given to three primary conditions.

First, regarding organizational and governance pre-conditions, municipalities and clients must be able to stabilize project portfolios and funding processes to support continuity and learning. This requires mature client capabilities related to establishing clear goals and participating effectively in relational contract models. In addition, shared processes, data structures, and standards must be established across projects.

Second, as examples of market and cultural pre-conditions, industry actors must accept a new shared partnership identity in which individual company interests are balanced against the objectives of the partnership as a whole. In this regard, competency development in interdisciplinary collaboration, process management, and cooperative practices is crucial.

And third, knowledge, documentation, and scaling mechanisms can be highlighted as key pre-conditions. However, there remains a need for more data to document effects related to time, cost, and total value. Methods are also lacking for transferring learning from individual partnerships to the broader industry without creating monopolistic structures. Finally, greater investment in research is needed to investigate how standardization, variation, and sustainability can best be balanced within a portfolio-based logic.

About the Research Project

In connection with The City of Copenhagen's procurement of two framework agreements for strategic partnerships in 2016, Realdania supported an independent evaluation aimed at assessing both the implementation process and the effects of this approach to procuring and delivering construction projects.

The project is documented in the following reports:

Gottlieb, S. C., & Thuesen, C. L. (2025). Strategiske partnerskabers effekter: Kvantitativ evaluering af tid, pris og kvalitet i Københavns Kommunes strategiske partnerskaber. SDU Sustainable Building 2025: 4, Institut for Teknologi og Innovation, Syddansk Universitet. https://findresearcher.sdu.dk/ws/portalfiles/portal/301356955/Gottlieb_og_Thuesen_-_Kvantitativ_analyse_af_strategiske_partnerskaber.pdf

Gottlieb, S. C., Thuesen, C., Frederiksen, N., & Berg, J. B. (2020). Strategiske partnerskaber i Københavns Kommune: Erfaringer og resultater 2017-2019. BUILD Rapport 2020:26, Institut for Byggeri, By og Miljø (BUILD), Aalborg Universitet. https://backend.orbit.dtu.dk/ws/portalfiles/portal/242449075/BUILD_Rapport_2020_26_1_.pdf

Grangaard, S., & Gottlieb, S. C. (2025). Arkitektonisk kvalitet i strategiske partnerskaber. BUILD Rapport 2025:15, Institut for Byggeri, By og Miljø (BUILD), Aalborg Universitet.https://vbn.aau.dk/files/804038523/Grangaard_og_Gottlieb_-_Arkitektonisk_kvalitet_i_strategiske_partnerskaber_web.pdf

Risk Must Be Structured

Innovation in construction is shaped by structures: who is allowed to assume risk, over what time horizon, at what scale, and against which success criteria. This chapter examines how organizational design, ownership structures, governance mandates, and investment logic can be deliberately configured to let new solutions develop and mature without losing their connection to the portfolio and to practice. It looks at how dedicated innovation formats, internal risk reserves, revised return expectations, and new relationships between developer and investor create the conditions for learning and scaling. And it shows how incentives, such as internal carbon pricing, move decision-making from intention to structure, turning ambition into something the organization is actually built to deliver.

Innovation Requires New Structures

Innovation is not determined by technical solutions alone. It is shaped by structural factors: time, risk, and decision-making power. The critical question is whether an organization has established dedicated structures for what writer and entrepreneur Safi Bahcall calls "loonshots": projects that must be given different conditions from the core business precisely because they are innovative and carry the potential to transform business as usual. When innovation is forced into a standard project format, where price and speed are the dominant logic, new solutions are either killed early or confined to one-off pilots.

The cases that succeed establish dedicated structures where innovation can develop under different conditions from the standard project, while keeping access to the competences needed for later implementation and scaling. In several cases, this is ultimately what allows solutions to be delivered within standard project conditions. At **Ripple Residence**, for instance, the project was defined from the outset as a distinct product category, the Earthshot format, under an explicit leadership mandate. This shifted the success criterion from maximizing IRR on the individual case to maximizing learning and scalability at portfolio scale.

This, then, introduced an alternative governance and investment logic: higher CapEx is accepted, the time horizon is extended, and a tolerance for failure is allowed, provided failures are converted into documented learning that can inform future solutions and are utilized across the portfolio.

The rationale is that Ripple Residence functions as a deliberate learning laboratory, one where a "code" is cracked that can then be standardized across the broader portfolio. That code is not only technologies, but decision frameworks, design principles, cost curves, supplier strategies, and the evidence base that makes solutions repeatable. The output is therefore not just a building, but transferable knowledge that informs decisions and solutions across the portfolio.

The approach also functions as an active risk management strategy. Rather than treating higher climate ambition as an additional cost isolated within a single project, it is treated as a means of preempting transitional risk at portfolio scale. Urban Partners is already addressing

anticipated tightening of regulations, rising carbon pricing, and the long term risk of stranded assets. By deliberately accepting controlled higher CapEx pressure and a lower short term return on selected Earth Shot projects, the risk of greater value erosion later is reduced. The investment functions as a structured shift of risk in time: absorbing a manageable cost now to protect and strengthen the portfolio's overall competitive position as market and regulatory requirements tighten.

The mechanism is that innovation is given space within a structure where risk can be absorbed, learning can be documented, and the transition from development to practice can be planned. In the **Travbyen** project, The Community House has been structured as part of an R&D pilot project and executed at a scale where risk is manageable, but with the underlying conviction and intention that the solution can eventually be scaled. **Travbyen** has also established dedicated financial pools, including an internal climate reserve and a community fund, as the financial basis for testing and early implementation of lower-carbon solutions. Innovation is therefore not carried by the economics of any single project alone, but by deliberately allocated risk capital.

The construction sequence is itself an active lever: it makes it possible to carry learning directly from the pilot build into subsequent buildings – including multi-story construction – within the same development project and phase. Rammed earth construction is being implemented in parallel with comparable typologies in other materials, so that performance can be monitored over time and benchmarked against conventional building practice. Throughout all development phases, work has been guided by a clear principle: solutions are only pursued when there is a realistic pathway to application and broader adoption in practice.

Across the private actors that succeed, there is, in practice, always an internal risk pool: a place within the organization where development risk can be borne without destabilizing individual projects and where the relevant technical and commercial competences are available when solutions need to be taken further.

A key structural mechanism is internal carbon pricing. When climate impact is treated as a real cost in investment and design decisions, priorities change fundamentally. The Urban Land Institute's C Change initiative has identified internal carbon pricing as a tool for moving decision-making from marginal to structural climate consideration.

Pricing carbon into the project calculations corrects the current situation in which the benefits of emissions are privatized while the costs are socialized. By embedding climate cost into a project's economics, and potentially coupling this with bonus structures for documented reductions, it is possible to create the right incentives within the governance model.

The analysis also points to the potential of new ownership structures and investor relationships. In the **Home.Earth** projects, the structure is built around long-term ownership, with the investor relationship supporting stability rather than quick exits. When the time horizon is extended, the decision logic changes: innovation is evaluated not only based on its immediate additional cost, but on its contribution to longevity, operational performance, risk profile, and future value. This makes it possible to prioritize solutions that would appear too expensive or too slow in a conventional project logic.

Innovation Requires New Structures

What Others Can Do

- Establish a moonshot structure with a distinct mandate, risk capital, and revised success criteria at portfolio scale.
- Structure the transition from moonshot to portfolio from the outset, so that learning, data, and decision models are systematically translated into standards for the next generation of projects.
- Work actively on ownership structure and investor relationships so innovation can be evaluated over time, not only based on the economics of a single project.
- Introduce internal carbon pricing or equivalent climate incentives so that carbon impact becomes an integrated part of investment and design decisions
- Use structures to protect innovations from short-term market logic, but ensure that the competences needed to realize their potential and to scale them are in place if and when innovation succeeds.

The Outcome is Largely Determined before Construction Begins

The projects that succeed invest time upfront, not because they have more of it, but because they know that uncertainty and cost overruns can almost always be traced back to insufficient planning. When the foundation is unclear, innovation becomes something you "try", and when the project comes under pressure, it is the first thing to go.

In the strongest cases, project management is not an administrative function but a strategic one: the process is designed before solutions are locked in. Program, direction, and decision logic are set before budget and design are fixed. Value programs, masterplans, and clear governing principles act as a shared compass rather than instruments of control. Knowledge is gathered early, and the critical choices are made while there is still room to act and adapt.

In the **Travbyen** project, the masterplan and value program are established around a set of core values and serve as a shared reference point between the actors involved. Governing principles are translated into construction principles that both enable the development of building systems and allow repetition across typologies. In the **Fælledby** project, a related approach is used: the ambition for bio-based construction and holistic development is anchored in the overarching development structure rather than handled building by building. Variations and experiments are embedded within an overall plan, so that learning can be transferred without compromising the whole.

EP PRO, by Enemærke & Petersen, shows the same principle at a different scale. Here, the lever is not new technical solutions, but a systematic up-front organization of the construction process, built on early involvement of subcontractors, clear leadership, and data-driven planning. The case underlines a critical lesson visible across the successful projects: when a project is planned in detail before work begins on site, uncertainty decreases, estimates are more precise, and financial risk is reduced for both contractor and developer.

For PFA and Kilden & Hindby, the foundation is an early decision to define TRÆ in Aarhus as a strategic lighthouse project for circular construction and knowledge sharing. The ambition was established as part of the portfolio strategy and the project's identity from the outset, not added on afterwards.

Several cases also show that what may look risky from the outside is, from the inside, highly professionalized and structured. When a project's foundations are well planned to the smallest detail, climate and environmental measures and innovation are not add-ons. They become a method for creating better processes. This is not about accepting higher risk. It is about restructuring the decision space so that reduced climate impact becomes the default rather than the exception.

The mechanism is straightforward: planning, clarification, and coordination are moved forward in the process to the stage where the latitude to act is greatest and changes are cheapest. When direction and decision logic are established early and anchored strategically, uncertainty later in the process is reduced. Innovation is not an addition to the project structure. It is the structure.

The Outcome is Largely Determined before Construction Begins

What Others Can Do

- Prioritize the development phase and allow time for thorough planning.
- Formulate a shared vision and guiding principles – in the form of a value program or equivalent guiding framework – that can withstand time and cost pressures.
- Move critical clarifications, testing, and coordination earlier in the process, where the latitude to act is greatest.
- Use project management actively to reduce risk.

Responsibility Organized across Actors

Once scale and structure are in place, the next question becomes: who bears responsibility for translating ambition into practice? Innovation in the built environment cannot be anchored with a single actor. It requires a deliberate organization of roles, risk, and decision-making power across the value chain and between public and private domains. This chapter examines how responsibility is organized and why the active developer role emerges as a central node in this movement.

The Active Developer Role

What works in the cases that succeed in shifting practice is not only higher ambitions, but also a more active developer role. Developers who manage to combine the green transition with manageable risk and strong economics do not behave as passive recipients of market solutions. They serve as directing actors engaging in the construction process, taking responsibility for direction, requirements, and delivery.

Whereas the developer has traditionally acted as a commissioning and contracting party, a new movement is emerging: developers who centralize control and take a more hands-on role in project management, actively assembling and steering the entire value chain from planning through to the construction site. This places sharper demands on the developer organization's competences, capacity, and active involvement.

The mechanism is that the developer moves closer to the technical and operational decisions while simultaneously centralizing direction and decision logic. Rather than merely formulating high-level ambitions, the developer uses its position to set precise and repeatable requirements for processes, materials, collaboration, and performance. Vision and internal targets function not as declarations but as governing principles for design decisions, partnerships, investments, and innovation.

This requires either strong in-house competences or deliberately built partnerships. In the successful cases, the conventional consultant structure is supplemented with direct dialogue with materials manufacturers, research environments, and other developers when the necessary knowledge is not available within the existing value chain.

The developer directs but does not dictate, ensuring shared ownership among the actors involved while providing direction centrally. This shifts the dynamic from sequential delivery to coordinated co-creation, in which ambitions can be maintained throughout the entire process. This is clearest in the cases where climate ambition, risk, quality, and economics are treated as part of the same management task.

Home.Earth is a clear example of this integrated approach. In their work, sustainability is not a parameter adjusted late in the process; it is a governing principle of the business model. They work with internal standards and a building system that is developed, tested, and improved across time and projects. Innovation is not outsourced to the consultant layer but anchored in the organization through product development, platform thinking, and continuous technical and economic optimization.

This means decision-making power remains close to the decisive choices about materials, details, and processes. When new solutions meet resistance or are assessed as too risky, the response is not to lower ambition, it is to adjust the design and organization to ensure both performance and the business case can be balanced. The active developer role becomes a professional management instrument in which climate, quality, and economics are developed together rather than sequentially.

What enables innovation is not taking on more risk, it is addressing risk earlier in the process and making it manageable. The method is for the developer to set clear, precise, and repeatable requirements while also having the competence to qualify and challenge the responses that come back. When consultants assess new solutions as disproportionately expensive or unrealistic, this is not accepted uncritically as a final answer. Instead, it becomes the starting point for exploring alternatives, adjusting the framework, or finding solutions that reduce cost and complexity. This is not about pressuring the value chain, it is about using the developer role structurally to avoid suboptimization and unnecessary safety margins.

Urban Partners' work on Ripple **Residence** illustrates this approach: an active developer role combined with clear requirements and strategic partnerships that translates ambitions into a strong commercial outcome. In the Fælledby project, a similar logic is at work, where joint project management and the early integration of competences from across the value chain reduce uncertainty and strengthen delivery. Across all the cases, the point is the same: the developers that succeed commercially are those who are close enough to the process to distinguish between genuine risk and assumptions that are simply the product of habit.

This is not a rejection of consultants; it is a rebalancing. Developers who deliver strong returns accept neither handing over the innovation task entirely to the market nor attempting to own the whole value chain themselves. Instead, they create conditions in which contractors, producers, and consultants can invest in new solutions at lower risk, because requirements are clear, repeatable, and commercially grounded. When the developer's demand are clear and consistent, it becomes rational for the value chain to deliver better solutions without increasing time or uncertainty.

The Active Developer Role

What Others Can Do

- Use the developer role actively to set clear and precise requirements for both process and performance.
- View the active developer role as a tool for strengthening value creation and returns not as an additional cost.
- Move risk management forward in the process by stipulating clear, precise, and repeatable requirements.
- Build in-house competences or strong partnerships so that requirements can be qualified and consultants' rejections and cost estimates can be challenged constructively.
- Use dialogue and alternative approaches to reduce unnecessary complexity rather than accepting standard solutions.
- Create conditions that make it rational and attractive for the value chain to invest in new solutions.

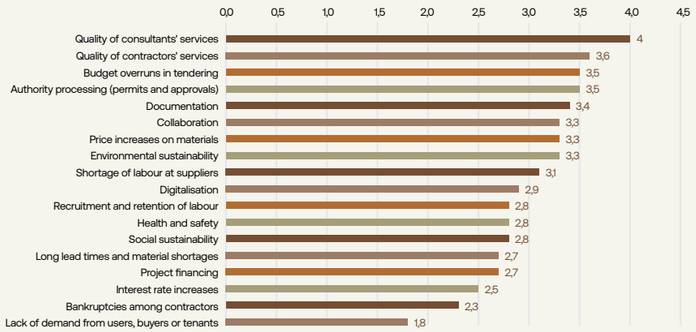
A Changing Consultant Role

Consultants continue to play a central role in the development of lower-carbon construction. But that role is under pressure. Across the cases, consultants are frequently identified as a source of friction in the transition, a pattern confirmed by the Danish Association of Construction Clients' 2025 Barometer

Danish developers' primary challenges in 2026 Survey

What do you expect your primary challenges to be over the next 12 month

The data comes from the second part of the Developer Barometer 2026, a trend analysis carried out among developers across Denmark. It examines developers' priorities and challenges now and in the year ahead, with a particular focus on sustainability. The data is based on a survey of the members of the Danish Association of Construction Clients (Bygherreforeningen), conducted in October 2025.



Results are shown as an average.

Source: Developer Barometer 2026: Trends and developments in construction over the next 12 months.
Published by the Danish Association of Construction Clients (Bygherreforeningen) in collaboration with Byggefakta, December 2025.

(*Bygherrebarometeret* – in Danish).[1] Developers point to gaps in knowledge about new materials and solutions as well as to structures and professional practices that make the approval of new solutions slow, risky, or disproportionately expensive. This does not place the responsibility with consultants, but it does reveal a growing mismatch between the demands facing the sector and the competences and incentives currently in place.

"There is a sorting process happening right now, where we as developers are choosing the innovative consultants. I also think that we as developers are partly paying for the consultants' education. There are scenarios they haven't encountered before, and they need extra hours to build knowledge in those areas. The consultant also need to invest their own time in learning something new. Some consultants are willing to do that, and that's why a sorting process is happening right now."

Jørgen Jensen, Senior Project Development Manager, AKF

In many cases, consultants' knowledge base and approach to risk management are tied to familiar, conventional solutions and existing standards. When alternative solutions are assessed against old reference points, they are quickly ruled out. Several developers also point to a reluctance in parts of the consultant community to invest in building new knowledge. The result is that developers are increasingly looking beyond the conventional consultant structure to access the expertise they need to make informed decisions.

In several cases, this means going directly to material producers, experienced contractors, and research environments to gain a proper understanding of materials, systems, and performance. This opens up new configurations within the value chain in which the consultant role does not disappear but changes character. Consultants who lean into this shift, invest in new knowledge, and engage in more open collaborations find their position strengthened. Those who hold on to a more defensive approach will gradually lose relevance in the most ambitious projects.

A Changing Consultant Role
What Others Can Do

- Recognize that the consultant role is changing and requires continuous investment in new knowledge.
- Create space for consultants to work more experimentally without bearing excessive risk alone.
- Supplement consultant expertise with direct dialogue with material producers and research, where knowledge is lacking.
- Pay attention to which consultants are leaning into the transition, and build long-term relationships with them.
- Accept that new configurations within the value chain can strengthen decision-making rather than weaken it.

Shortcutting the Value Chain

A clear pattern runs across the analysis: actors are deliberately shortening or reorganizing the existing value chain. Not as a rejection of established roles, but as a pragmatic move to access the knowledge, capacity, and decision-making power needed to realize new solutions in practice. When conventional processes become too slow, too expensive or too risky, some developers and contractors find other routes.

The mechanism is direct access. Actors go straight to those who actually hold the decisive knowledge or production capacity. Urban Partners, for instance, works directly with material producers, drawing on Swedish experience, moving dialogue closer to manufacturers to reduce complexity and accelerate the development of new solutions. **Travbyen** has increasingly turned to academia, including a formal collaboration with BUILD at Aalborg University, to access deeper insights when the necessary knowledge cannot be found in the consultant layer.

Enemærke & Petersen's acquisition of Genbyg shows how contractors integrate competences into the value chain to work more consistently with reuse in practice. CLT Denmark's experience points to cases where consultant design has made solutions unnecessarily expensive, while direct involvement of the producer can reduce both costs and barriers. JDH-Byg's role in relation to AKF shows, in a similar way, how contractors can demonstrate solutions in practice.

What these examples share is not a rejection of consultants, but a reprioritization of where knowledge and decision-making power are placed. By shortcutting the value chain, misunderstandings are reduced, safety margins are narrowed, logistical costs fall, and solutions can be evaluated more directly based on their actual potential.

Shortcutting the Value Chain
What Others Can Do

- Consider where in the value chain the decisive knowledge is actually found and go there directly.
- Supplement the consultant role with direct dialogue with producers and research when assessing new solutions.
- Be open to integrating new competences into the organization when they are essential to realizing ambitions.
- Accept that alternative routes through the value chain may be necessary to shift practice.

Co-responsibility as a Governance Model

The most robust and successful projects in this analysis share a common characteristic: responsibility for development does not rest on one actor alone. In these cases, the municipality does not function solely as a regulatory authority, but becomes an active partner in shaping and anchoring the project. This creates stronger coherence between urban development, architecture, and business logic, and proves to be a significant factor in commercial success.

Co-responsibility is understood here as an organized sharing of responsibility, risk, and decision-making power between public and private actors throughout the development process. It takes as its premise that private actors actively lean into the solution of society's structural challenges and complexities, while public actors step into a more strategic role in the design and anchoring of projects. Co-responsibility, in this sense, is about establishing shared ownership of problem definition, risk, and long term outcomes.

As such, co-responsibility emerges as an operational precondition for both societal impact and economic sustainability in complex urban development projects. The mechanism is a collaboration built around a shared vision for a place, rather than individual local plans or minimum requirements. When development is organized around a long-term direction for an area, the dialogue shifts from control to shared accountability.

The **TRÆ** project and the collaboration with Aarhus Municipality illustrate how municipalities are increasingly becoming strategic partners, particularly when a project's location and significance for the city are clear.

External pressure combined with clear ambitions makes it possible to move away from a controlling role and toward shared responsibility for quality and coherence. Place-based development literature points to this coupling of investment, planning, and value creation as a key factor in both urban quality and economic resilience. This analysis confirms it: when responsibility is organized around a place rather than a project, both delivery and long-term value are strengthened.

The same pattern is seen in **Home.Earth**'s collaboration with Høje-Taastrup Municipality, where the municipality engages early in the urban and architectural grounding of the project. When ambitions and premises are established jointly, a different decision space emerges, one in which degrees of freedom can be granted in exchange for early and qualified involvement.

The **Fælledby** project illustrates how co-responsibility can become a concrete organizational structure across multiple institutional levels. The joint venture between PensionDanmark and By & Havn brings together capital and urban development expertise, while dialogue with the City of Copenhagen and collaboration with the Danish Road Directorate on mobility planning show how infrastructure, planning, and investment can be bound together. Here, responsibility for the coherence of a place is shared across public and private actors.

Co-responsibility does not stop at municipality and developer. A significant shift occurs when material suppliers and financial actors are integrated earlier and are more committed to the development process. Suppliers hold specialized knowledge of performance, documentation, and production capacity that can reduce uncertainty and unnecessary safety margins in projects. When they are brought in early, risk moves from assumption to concrete knowledge.

Financial institutions are equally part of this structure. The increased premium on timber construction currently showing up in OpEx illustrates that risk assessment and incentive structures have not yet fully adapted to new construction logics. If co-responsibility is to function as a governance model, financing and insurance must also be organized as part of the shared responsibility. Without this, structural resistance emerges, even where the technology and the will are present.

Taken together, the cases show that co-responsibility is not a nice narrative about partnership. It is a concrete organization of responsibility, risk, and decision-making power across levels: government, municipality, developer, investor, supplier, and contractor. It is this structure, not intention alone, that makes it possible to manage complexity and create robust projects at scale.

Co-responsibility as a Governance Model

What Others Can Do

- Organize co-responsibility as a deliberate sharing of responsibility, risk, and decision-making power across public and private actors.
- Build collaborations around a shared vision for the place, not only around local plans and minimum requirements.
- Make broader societal goals part of the business logic, so private investment contributes to long-term urban value.
- Bring suppliers, financial actors, and insurers in early, so performance, risk, and incentives are aligned across the value chain.

Collaboration Across the Innovation Ecosystem

Innovation in construction does not emerge linearly or within a single type of actor. The most impactful solutions are developed in the interplay between different roles, each contributing something distinct: capital, risk appetite, volume, time, knowledge, and legitimacy. When these roles are clear and complementary, an innovation ecosystem forms in which solutions can be developed, tested, and delivered in practice.

The mechanism is that different actors bring different resources and competences, and take on different types of risk at different points in time. Expensive, high-profile sites, such as the Ripple Residence plot in Nordhavn, function as testbeds where greater complexity and ambition can be absorbed, because location value and market interest create room for experimentation. Public procurement contributes volume and stability that can pull solutions from niche to mainstream. In some cases, foundations and philanthropic organizations such as Realdania play an active role as developer, through programs such as the nationwide Vores Sted and the Mini-CO_2 Houses in Nyborg and at other times provide soft funding that enables innovation with a long-term perspective that markets rarely sustain alone.

Similarly, organizations such as WE BUILD DENMARK (Danish cluster organization for the construction sector) can function as catalysts, providing space for in-depth investigation, documentation, and the coupling of research with practice that is often difficult to finance within conventional projects. At the same time, the analysis shows that this type of funding is not a universal solution. If the connection to practice is too weak or the implementation perspective is absent, projects stall and the potential is not realized.

The same applies to research collaborations. What matters is not only the volume of research but the timing and format. In some cases, long-term arrangements such as industrial PhD programs are effective because they allow both disciplinary depth and organizational learning over time. Experience from Enemærke & Petersen and Henning Larsen Architects shows that this type of collaboration can strengthen an organization's capacity to translate research into practice when it is closely connected to concrete challenges and decisions.

Collaboration Across the Innovation Ecosystem

What Others Can Do

- Think of innovation as an ecosystem with multiple necessary roles, not as a single project.
- Use different types of actors strategically to enable different capabilities and bear different forms of risk.
- Connect soft funding and research closely to practice and implementation.
- Prepare your organization to work in new collaborative structures where responsibility, risk, and decision-making power are shared across actors, and where climate challenges like heat, water and urban resilience – are built in as fundamental preconditions for development

Taken together, the analysis shows that innovation does not rest any single actor. It emerges from an interplay between different functions, each contributing something distinct: direction, capital, regulation, development, production, testing, and implementation. Some actors formulate demand and set ambition. Others invest and bear financial risk. Some define the framework. Others translate it into concrete solutions. Knowledge is developed in one place, validated in another, and realized in a third.

When these functions are deliberately organized and connected, coherence emerges between development, testing, and scaling. When they are not, responsibility fragments and solutions remain one-off projects.

The capacity to structure this interplay is therefore not an organizational detail; it is a strategic competence. Actors who can bring together direction, risk, and knowledge across boundaries are better positioned to meet both climate uncertainty and increasing complexity. New collaborative structures are not a supplement to existing practice. They are a precondition for delivering robust and scalable solutions in a built environment that is changing.

Looking ahead, the need for new forms of collaboration and structure will only intensify. Climate challenges are deepening, with rising temperatures and urban heat island effects in cities, as well as increased

water volumes, flooding, and pressure on existing infrastructure. These challenges cannot be addressed through one-off projects, narrow sector logics, or conventional role distributions. They require solutions that cut across construction, urban development, infrastructure, and operations, and that depend on closer collaboration between public and private actors.

A defining characteristic of the innovations that succeed in shifting practice is their cross-disciplinary character. They do not emerge within a single discipline and then get implemented linearly. They are developed at the intersection of architecture, engineering, production, economics, regulation, and operations. When one dimension changes, the others are affected. A given innovation only becomes viable when it is integrated across the whole value chain. A new material solution requires adaptation in design, changed logistics on site, adjusted contract forms, and acceptance within the financing and insurance layer. A new process requires changes to roles, incentives, and forms of documentation. If innovation is anchored in only one place, it remains a prototype. When it is negotiated and adjusted across the value chain, it becomes implementable.

This explains why some technically mature solutions fail to scale, while others with apparently less technological novelty achieve broad adoption. The difference is not in the technology alone, but in the capacity to couple technology, market, and implementation. The cases that succeed work deliberately on this integration: they bring producers closer to the design phase, involve contractors early, connect financial actors, and adjust the organization so that the solution can function in operation.

In the **Fælledby** project, to ensure connection across the many actors, Fælledlab was established as a shared project office that brings together developer, consultants, and contractors on site, ensuring knowledge sharing and communication across the value chain. This enables continuous adjustment of solutions in collaboration with relevant actors and ensures a broad competence base in decision-making and design processes.

Cross-disciplinarity is therefore not an ideal. It is an operational necessity. Innovation in the built environment succeeds only when it is embedded in a value chain capable of carrying it.

1 Bygherreforeningen. "Halvdelen af alt byggeri udskydes". Bygherreforeningen, 15. december 2025. https://bygherreforeningen.dk/halvdelen-af-alt-byggeri-udskydes/

From Barrier to Value Creation

The preceding chapters have shown that innovation in construction is not held back by a shortage of solutions, but more by structures, organization and incentives. We have seen how roles can be rethought, how responsibility can be shared, and how risk can be repositioned and managed differently.

The next step is to examine what happens when these structural moves begin to shift practice more broadly: When does a solution move from isolated exception to becoming part of how the sector transforms in order to deliver more value with fewer resources?

The focus here shifts from individual mechanisms to patterns of movement – from barriers as explanation to the processes through which barriers are gradually transformed into capacity and value creation. This is how innovation begins to change markets, regulations, and practice over time.

Tipping Point: From Stranded asset to Value Creation

The analysis points to a sector approaching a tipping point, where risk is gradually shifting away from green solutions and toward inaction. For years, lower-carbon construction has been regarded as more expensive and more risky than conventional alternatives. However, several of the cases analyzed indicate that this logic is beginning to reverse. Actors with a documented track record in delivering green buildings are increasingly finding that the market rewards quality, robustness, and credibility with a premium, whether in the form of higher sale prices, more stable tenants, or lower long-term risk.

Lighthouse projects play a central role in this shift. They function as deliberate risk-bearing projects, making room for higher costs and uncertainty in the development phase, while the actual additional cost often turns out to be significantly lower than assumed. Experience from pioneer projects such as Ripple Residence shows that these buildings have had no difficulty finding buyers at a price level consistent with strong market returns. On the contrary, they have outperformed comparable projects commercially. The point is not that every project needs to be a lighthouse. It is that lighthouse projects reduce uncertainty for the rest of the portfolio and demonstrate that green solutions can function as value capture rather than cost drivers.

Lighthouse projects are also not only a business case. They are an organizational learning and development process. They are used actively to build in-house competences, mature collaborations with suppliers and contractors, and test new governance approaches that can later be scaled into more standardized projects. Investment in the most ambitious projects therefore becomes an investment in future execution capacity, and in making the rest of the portfolio more resilient to regulation, resource scarcity, and rising climate requirements.

Several actors are simultaneously working more explicitly to internalize climate risks within their business models.

Urban Partners' internal carbon tax is an example of how climate impact is made a governance parameter on par with economics. The ULI C Change initiative[1] shows how innovative developers across Europe are applying the same methodology. Combined with internal roadmaps and clear carbon budgets in dialogue with contractors, focus is shifting from individual solutions to systematic optimization, prioritizing the cheapest carbon reductions first and bringing in known solutions, such as green steel, when supplier dialogue makes them realistic.

The question is therefore not when climate and environmental impact will become a necessity for the core business, but how demand will shift from niche and brand value to a genuine market logic. The Atlas points to a persistent central barrier: insufficient demand. As long as the existing business model works and there are enough projects within familiar parameters, the risk of working differently appears unnecessary. In that situation, innovation is rationally hard to prioritize, regardless of strategies, tools, and ambitions.

This demand situation is what needs to change. Regulation plays an important role, but the analysis shows it is not sufficient on its own. In practice, it requires private actors to co-lead and bear the risk of developing and selling new solutions. There is therefore a need for an innovation push in which risk is reduced through targeted soft funding and structures that support collaboration and demand across the market.

Public actors can function as catalysts in this context, when public funds are linked directly to collaboration, procurement, and sales. This distributes the early market risk, as public procurement and tenders help to create a broader and more predictable market for the specific innovations being used in construction. This, in turn reduces uncertainty about subsequent sales and documentation, and makes it rational for private actors to invest in development and scaling.

Several actors also point to growing internal pressure within organizations. Employees, particularly younger generations, are increasingly demanding that companies translate ambitions into concrete practice. This internal drive is not in itself sufficient to bear financial risk, but it does function as a significant accelerator once the business case starts to hold water.

The tipping point, therefore, does not arise in a single place. It emerges from the interplay of three conditions: documented economics, reduced risk, and a demand that seeks to reward those who can deliver green solutions with quality and scale. When these conditions converge, the logic of the market changes. Sustainability is no longer treated as something that can be opted in or out of on an individual project basis. It becomes an integrated part of the core business: economics, risk management, and value creation.

At the same time, the analysis shows that this movement is not sufficient on its own. Several of the necessary changes cannot be accommodated solely within the current logic of the market. Market-based value creation must therefore be supplemented by a systemic effort in which regulation, standards, public frameworks and shared infrastructure are developed in parallel, so that the structural barriers to transition are reduced, including in areas where the market cannot bear the full change by itself.

Tipping Point: From Stranded asset to Value Creation
What Others Can Do

Work deliberately with both risk and opportunity. Reducing the risk of green solutions is not enough on its own. Those who succeed combine active risk management with a clear ambition to create added value through quality, credibility, and repeatability.

Create demand, not just solutions. Innovation only spreads when there is a market to absorb it. That requires collaborations, early customers, and mechanisms that make sales and documentation possible across projects.Brug fyrtårnsprojekter strategisk. lighthouse-projekter skal ikke ses som undtagelser, men som redskaber til at reducere usikkerhed, opbygge kompetencer og modne løsninger, som senere kan indgå i standardproduktion

Use lighthouse projects strategically. Lighthouse projects are not exceptions. They are tools for reducing uncertainty, building competences, and maturing solutions that can later enter standard production.

Work on the market and system in parallel. Market-based value capture is essential, but insufficient alone. The actors who move furthest combine commercial development with active work to change the structural conditions where the market cannot bear the change by itself.

The Barriers that Remain

This Atlas has focused on what has actually worked. That does not mean the barriers are absent. On the contrary, the analysis shows that a number of persistent challenges continue to make it difficult to work systematically with innovation in construction.

The purpose here is not to rehash familiar explanations, but to examine which barriers are genuinely shaping outcomes and which function in practice as reasons for maintaining the status quo. If we work based on the wrong assumptions about what is holding us back, we risk solving the wrong problems, even when those problems present themselves as fixed conditions in the industry. Many of the explanations that are repeated again and again function in practice as shared narratives that legitimize the status quo, even when they are no longer the primary reason change fails to materialize.

A critical first step is therefore to stress-test which barriers are genuinely operative and which simply mask the fact that new approaches require more time, more competences, and a different organizational form than the existing project logic can accommodate. The point is not to dismiss the barriers, but to ensure that effort is directed at the right problems rather than working based on explanations that no longer apply.

Fragmentation is a persistent barrier across the entire value chain and at every level of organization, from materials and components to projects and portfolios. It means that responsibility, risk, and learning are separated, and that improvements in one area rarely create incentive or capacity elsewhere. The actors that succeed, work deliberately to consolidate decision-making power, knowledge, and risk management across projects, so learning can accumulate and be carried forward rather than disappearing the moment a given project is completed.

Risk is the most pervasive and sensitive barrier. Construction involves large investments, and the consequences of failure can be significant, which makes caution rational. Here it is essential to distinguish between perceived and actual risk. Many new solutions are rejected because uncertainty arrives late in the process, often on the construction site or with an individual contractor or supplier. The actors that move forward reduce this uncertainty by shifting risk away from execution and into the organization, where testing, documentation, and approval are handled systematically before solutions are introduced into projects.

In this context, risk sharing becomes a central lever. When time, performance, responsibility, and any additional costs are addressed explicitly in collaboration with suppliers and partners, the tendency to reject new solutions out of caution is reduced. Risk is managed as a shared concern at system level rather than as an invisible extra layer of uncertainty pushed down through the value chain.

Taken together, the analysis points to a clear conclusion: innovation only genuinely takes hold when it is organized as a continuous and systemic concern rather than as a one-off project. This requires structures, decision-making forums, and competences that the industry recognizes and trusts and that make it possible to work with the development, learning, and maturing of solutions over time. Only when fragmentation is reduced, and perceived and actual risk are brought closer together, does it become realistic to shift practice at broad scale.

The Barriers that Remain
What Others Can Learn

Challenge the industry's barriers. Many barriers persist as shared narratives long after they have been overcome in practice. Distinguish between genuine structural barriers and assumptions that no longer apply.

Address fragmentation actively. Fragmentation in responsibility, risk, and learning is a persistent barrier. Consolidate decision-making power, knowledge, and risk management across projects and portfolios.

Move and share risk deliberately. Innovation rarely stalls on technical grounds alone, but on unresolved risk. Handle testing, documentation, and approval before execution, and make risk sharing explicit.

Organize innovation as a system. When innovation is treated as a project, it becomes vulnerable to cost and time pressures. The actors that succeed have established structures and decision-making forums that make innovation a continuous organizational concern.

Green Housing as Infrastructure

The preceding sections have described how innovation can be organized, scaled, and brought closer to the core business. A critical question, however, is whether these mechanisms also work in the part of the market where financial room for maneuver is limited, and where access and affordability are the governing concerns.

Green affordable housing is therefore a concrete test of the central arguments in this analysis. Climate ambitions, regulation, investment logic, and collaborative structures must work together, not in the premium segment, but across the broader housing economy. This section examines how the non-profit housing sector, private actors, and municipalities organize responsibility and risk when the goal is to deliver both lower carbon impact and economic accessibility. This should not be read as a separate social track. It is one of the clearest tests of whether the structures described in this Atlas actually work in practice.

Denmark has a strong starting point in its non-profit housing sector. It has historically secured access to affordable housing and functioned as institutional infrastructure for social stability. It is also a stable platform, capable of carrying long-term considerations and creating predictability in a housing economy otherwise driven by shorter-time horizons.

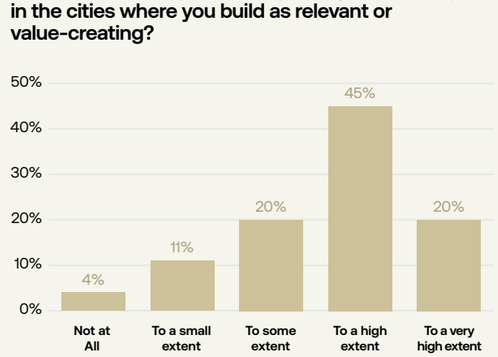
The pressure, however, is significant. The current system has produced an acute affordability crisis in almost every major European city. Today, more than 10.6% of the EU's urban population live in households spending over 40% of their disposable income on housing, the EU "overburden rate". In Danish cities, the situation is particularly acute: 22.7% of urban residents face this level of housing cost pressure. That means the share of overburdened households in Danish cities is more than double the European average.[2]

In Copenhagen, the requirement for 25% non-profit housing in new development areas has not been sufficient to meet demand and ease the pressure, partly because the cost framework for the non-profit sector has made it difficult to deliver that 25%. Long waiting lists and growing pressure on household finances point to a challenge that cannot be solved through regulation alone, but requires new forms of interaction and new roles.

The point is not that the non-profit housing sector does not work. The point is that even a strong foundation in non-profit housing cannot compensate for the combined effects of market dynamics, rising land prices, and a construction economy that makes affordability increasingly difficult to deliver at the scale required.

Research has so far devoted limited attention to green affordable housing as an integrated problem. Some of the relevant knowledge is likely found outside conventional urban and construction research and therefore falls outside bibliometric analyses. At the same time, there are strong Danish research communities, including at Aalborg University and the Royal Danish Academy, working at the intersection of climate and social sustainability, addressing housing, community, building systems, and economics. The practical challenge is often the connection between knowledge and the mechanisms that can make solutions investable and scalable without pushing rents and access out of balance.

To what extent do you see improving affordability in the cities where you build as relevant or value-creating?

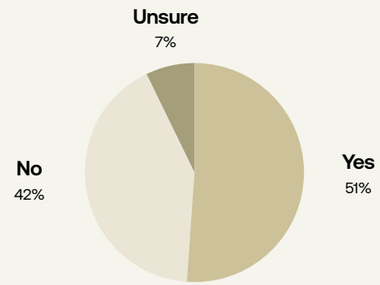


Source: Data collected by BLOXHUB in a survey of Danish developers

In parallel, there is growing interest from the private sector. Our survey indicates that 64% of developers see improving affordability in the cities where they build as value-creating to a high or very high degree.

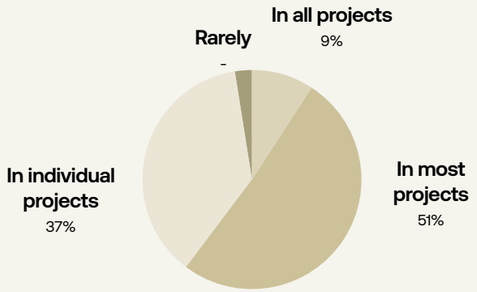
Several actors are actively engaging with the development of green and affordable housing. This is reflected in the emergence of a growing range of private initiatives focused on housing, working with new ownership models, tenures, partnerships, and business structures.

Has your organisation appointed people responsible for initiating and following up on innovation activities?



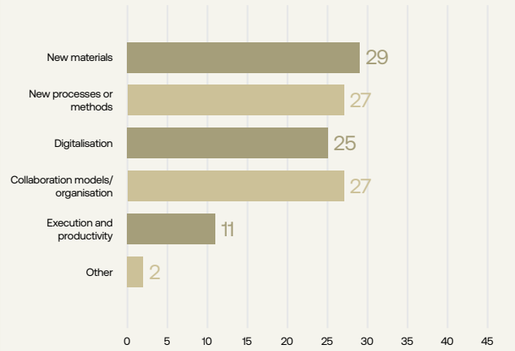
Source: Data collected by BLOXHUB in a survey of Danish developers

How often do you actively work with innovation in your construction projects?



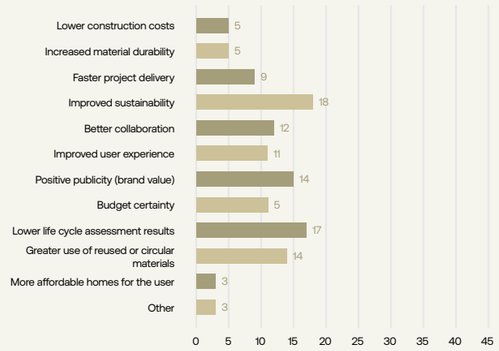
Source: Data collected by BLOXHUB in a survey of Danish developers

What types of innovation do you typically work with?



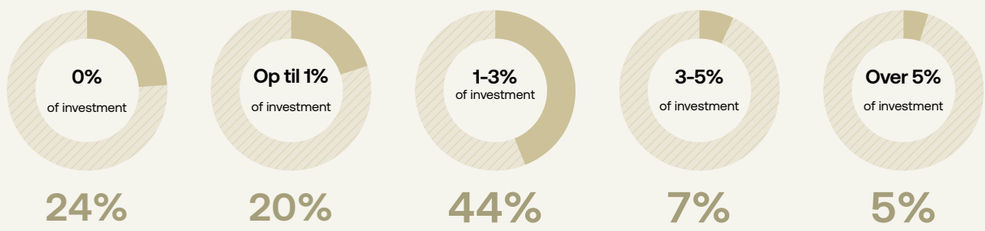
Source: Data collected by BLOXHUB in a survey of Danish developers (multiple options could be selected)

What effects has your innovation typically had?



Source: Data collected by BLOXHUB in a survey of Danish developers (multiple options could be selected)

What share of the investment per project in 2025 went to innovation?



Source: Data collected by BLOXHUB in a survey of Danish developers

This matters, because housing cannot be treated as a narrow sectoral responsibility when the challenge is systemic, and when it requires both public and private sectors to accept shared accountability.

The mechanism that recurs in practice is a structured interplay between municipality, state, research, and private actors: not ad hoc collaboration, but deliberately organized co-responsibility in which roles, risks, and incentives are clarified early rather than being pushed continuously between parties. This is expressed, for example, in the collaboration between **KAB and CPH Village**; in **Boligselskabet Sjælland**'s use of framework agreements for biogenic materials as a means of creating volume and predictability; and in **Home.Earth**'s collaboration with Høje-Taastrup Municipality. Across these cases, the non-profit housing sector functions as a stable long-term foundation, while private actors contribute mobility, pace, and willingness to experiment at smaller scale within clear parameters collectively increasing the sector's capacity to deliver green and affordable housing at scale.

This pattern is also visible in urban development projects such as Urban Partners' work in Tingbjerg, where urban transformation has been designed with a clear ambition to improve the area without displacing residents. The interplay between municipality, non-profit actors, and private investment is used actively to combine social stability with urban quality and long-term value creation.

What these examples demonstrate is that the non-profit housing sector functions as a stable foundation, providing access and continuity and capable of bearing a higher degree of societal commitment over time. Private actors can increase mobility, pace, and risk appetite, but only when the framework makes clear what is being delivered, for whom, and how value and return are distributed. In the most robust models, the municipality's role shifts from primarily regulating to also coordinating, enabling, and maintaining goals across time and changes in actors.

The underlying logic is closely aligned with Mariana Mazzucato and Leilani Farha's concept of co-responsibility[3], in which housing is understood not as an isolated market commodity but as social infrastructure, with responsibility and returns distributed across actors. The point is not to dissolve accountability, but to define it in a way that makes it possible to deliver both affordability and climate ambition within the same project logic.

Green Housing as Infrastructure

What Others Can Learn

Green affordable housing does not emerge through a single sector or a single intervention. Use the non-profit housing sector to be actively as a platform; invite private actors in with clear roles; and structure the interplay from the outset.

All actors are necessary, but only if they are brought into play in a coordinated and institutionally grounded way that matches the scale of the problem.

1 Urban Land Institute. C Change. U.å. Set 23. februar 2026. https://cchange.uli.org/

2 Eurostat. "Housing in Europe – 2024 edition." Set 24. februar 2026. https://ec.europa.eu/eurostat/web/interactive-publications/housing-2024

3 Mazzucato, Mariana, Rainer Kattel, & Kate Roll. "The right to housing: a mission-oriented and human rights-based approach". Institute for Innovation and Public Purpose, University College London, 2024. Set 23. februar 2026. https://www.ucl.ac.uk/bartlett/publications/2023/may/right-housing-mission-oriented-and-human-rights-based-approach

The Shortage of Affordable Housing
by Rikke Skovgaard Nielsen

Rikke Skovgaard Nielsen
Rikke Skovgaard Nielsen. Senior Researcher at Department of the Built Environment, Aalborg University, Member of EU's Housing Advisory Board

The Housing Crisis and New Construction as a Questionable Solution

Across Europe, demand for affordable housing is acute – particularly in cities with overheated property markets. Copenhagen is no exception. In the run-up to the municipal elections at the end of 2025, politicians competed to promise the most new homes, and in January 2026 Copenhagen's newly appointed Lord Mayor announced that more housing of all kinds would be built in the city (*Politiken*, January 25, 2026). At EU level, the European Commission presented, in late 20256, its plan to increase the supply of affordable housing – the European Affordable Housing Plan. It identifies a need for "a substantial increase in new homes" to be secured through, among other measures, improved productivity in the construction sector, faster planning permissions through simplified administrative procedures, and the mobilization of investment in new construction[1]. The Commission estimates that two million new homes must be built every year across the EU to meet current demand.

That we are in the midst of a housing crisis, with a shortage of affordable homes, is beyond serious dispute. It has been established by the working paper underlying the European Affordable Housing Plan[2]. From 2010 to 2025, housing prices rose by more than 60% across the EU, while average rents increased by almost 30%. Homelessness has risen, including among children. More people face the risk of being forced to move. Intergenerational inequality has widened. Young people struggle to enter the owner-occupied market. And key workers – nurses, police officers, teachers – cannot afford to live in the cities where they work, creating recruitment problems across a range of essential occupations.

From 2010 to 2025, housing prices rose by more than 60% across the EU, while average rents increased by almost 30%. Homelessness has risen, including among children. More people face the risk of being forced to move. Intergenerational inequality has widened. Young people struggle to enter the owner-occupied market. And key workers – nurses, police officers, teachers – cannot afford to live in the cities where they work, creating recruitment problems across a range of essential occupations."[3] The most environmentally responsible construction, in other words, is the construction we do not do. At the same time, the EU's own figures show that one fifth of all homes in the EU are unoccupied, and approximately one third are under-occupied – meaning they could accommodate more residents[4].

There is therefore substantial potential to make better use of the space we already have. A survey of all Danish municipalities' master plans and population projections also found that "municipalities are collectively planning almost the same volume of new construction as in the past ten years, even though projected population growth is significantly lower."[5] This creates a real risk of overbuilding and increasing land consumption. We may be building not only what is needed, but far more than we will ever require.

Second, further residential construction in cities risks worsening conditions elsewhere in the country. If more people can live in major cities, there will be fewer people to sustain life in smaller towns. Urbanization has already placed many of these communities under strain. We cannot ignore the risk that expanding our cities accelerates this process in ways that become self-reinforcing: as fewer people choose to live in smaller towns, the population base for schools, services, stores, and public transportation shrinks. Once closures begin, in-migration is likely to fall further. Homes become harder to sell and fall into disrepair, making the community less attractive still. Even those who want to move there may find it difficult, as banks become more cautious about lending on properties that, though cheap, may also prove hard to resell. This can intensify a spiral of depopulation.

The Hard Questions

In the period ahead, we need to turn over every stone in search of solutions to the housing crisis: solutions that can create more affordable homes without increasing new construction. Some of the difficult questions we need to ask are:

- How do we ensure housing turnover, making it attractive to leave a home that has become too large?
- How do we make sharing a home attractive?
- How do we ensure that cities do not become enclaves for the wealthy – that economics alone do not determine who has access to the homes we have in our cities?
- How do we ensure that homes remain homes, and do not become objects of speculation or short-term tourist rentals?
- How do we make it attractive and viable to live outside major cities while working within them? Could improved public transportation and greater flexibility in working hours help to relieve the housing crisis?
- How do we plan across cities and municipalities to avoid both worsening conditions elsewhere and the situation where every municipality builds in response to an overly optimistic population forecast?

These are genuinely difficult questions. There are no easy answers if we want to increase the supply of affordable housing without making new construction the only solution. The vision must be to explore and exhaust every other option before we build new. At the same time, we need to have the very difficult conversation about whether the goal of our urban development policy should be to ensure there there is room in our cities for everyone who wants to live there.

Behind many of the debates about how many homes to build lies an implicit assumption that we can satisfy demand, that we can build enough homes for everyone who wants to live in the city. But this assumes that demand is a fixed and stable number. In practice, expanding affordable housing in cities can increase interest in urban living (pull) and reduce the attraction of living elsewhere (push). A mutually reinforcing push-pull effect can emerge, increasing demand in cities and creating the need for still more homes. We risk building ourselves deeper into the problem.

Finally, we need to consider the consequences for quality of life in cities: as more people share the available space, we need to ensure that there are sufficient facilities, services, and green areas, the very things that are often sacrificed to make room for new development.

We need to increase the supply of affordable housing. We need to ensure that this housing reaches those who are struggling most in overheated urban markets. But we need to do so responsibly: without worsening the climate crisis, widening the urban-rural divide, or degrading the quality of life in the cities we are trying to make more accessible.

1 European Affordable Housing Plan | Housing. https://housing.ec.europa.eu/document/756915b5-d1b1-4bde-ac82-03532d2d3d90_en

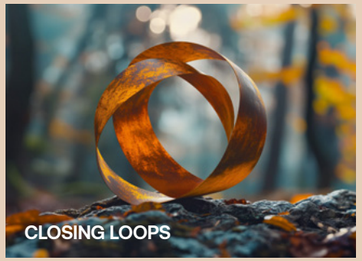
2 https://housing.ec.europa.eu/document/download/2ad4c9f2-602b-43ba-9ed9-ef2ee059cf97_en?filename=0_1.pdf

3 Addressing the environmental and climate footprint of buildings | Publications | European Environment Agency (EEA) pp. 13. https://docs.google.com/document/d/1QlzlCRdWAwrAy8NW7wKuwDgVHApRmzlp2I5u06RHBDs/edit?tab=t.93hhxpph7zvw#:~:text=8-,Addressing%20the%20environmental%20and%20climate%20footprint%20of%20buildings%20%7C%20Publications%20%7C%20European%20Environment%20Agency%20(EEA),-Addressing%20the%20environmental

4 European Affordable Housing Plan | Housing. https://housing.ec.europa.eu/document/756915b5-d1b1-4bde-ac82-03532d2d3d90_en

5 Danmarks planlagte boligudbygning - i et klimaperspektiv | Plan22+. https://plan22.dk/da/publikation/danmarks-planlagte-boligudbygning-i-et-klimaperspektiv

Cases



Cases

Construction today lacks a clear shared understanding of what is already achievable with the knowledge and technologies we have available – and what still cannot be solved without new research and development. This ambiguity slows both practical action and targeted investment in the solutions that remain necessary to deliver within planetary boundaries.

To make this distinction concrete and operational, the Innovation Atlas draws on fifteen detailed cases. These are not presented as ideal models, but as practice-grounded examples of how far it is possible to go today when existing knowledge, technologies and methods are applied consistently and in an integrated way across investment product, business model, material choices, collaborative structures, and construction process.

They can be read against the Atlas's two-part theory of change (see the foreword), in which the transition in construction cannot be realized at a single uniform pace, but perhaps at two parallel and mutually dependent speeds. The first speed is about expanding the space for action within existing decision-making and incentive logic: making innovation operational, competitive, and less risky on the terms under which decisions are actually made today. The concrete cases show how existing solutions can be brought into use in ways that deliver documented reductions and more robust outcomes within the current framework.

At the same time, the cases reveal the limits of this first speed. They show where the room for action of any individual actor runs out, and where further reductions cannot be achieved even when investment product, business model, material choices, collaborative structures, and construction process are all rethought and brought into alignment within the existing framework. It is precisely here that the need for the second speed becomes visible: the development of new knowledge, new materials, and new structural solutions that cannot be developed or implemented within existing market and decision-making logics.

Home.Earth - Nærheden and Høje Taastrup C

Project details

Scope: 158 homes + commercial units[1] (Nærheden), 163 homes[2] (Høje Taastrup C)

Floor area: Nærheden: 13,000 m². Høje Taastrup C: 11,000 m².

Construction/project period: started 2024, first move-in 2025, completion 2026 (Nærheden); construction start 2026, completion 2027-2028 (Høje Taastrup C)

Location: Hedehusene, Høje-Taastrup Municipality (Nærheden); Høje Taastrup city centre (Høje Taastrup C), Denmark

Developer: Home.Earth.

Architects: Vandkunsten and EFFEKT.

Consultants: Sweco.

Contractors: Scandi Byg, a:gain.

Subcontractor: Byens Tømrerentreprise.

Building services / MEP: Energy Machines™, Centrum Palæ A/S and Construction Pillars Company (CPC).

Municipality and spatial planning: Høje-Taastrup Kommune, Realdania

Management: Sjælsø Management ApS.

Image: Home.Earth ©

Home.Earth: A step toward responsible, affordable, scalable construction practice

"Our approach is about removing uncertainty through standardization, so that sustainability becomes predictable, scalable, and economically responsible."

Dan Pham, Co-founder, Home.Earth

A Concrete Example of Practice We Are Able to Deliver Today

Home.Earth is a relatively new company built by an experienced team drawn from development and building operations, with backgrounds in investment, consultancy, and innovative construction, including roots in NREP/Urban Partners (Nordic Real Estate Partners, now operating as Urban Partners, the Nordic region's largest commercial real estate investor) and Cobblestone (Danish full-service property management firm).

The company is designed from the outset to deliver on multiple bottom lines: lower carbon impact, durability, affordability, social value, and investor returns. This is the precondition for translating ambitions into realized projects and for creating an industrialized construction practice with a high level of innovation while maintaining a robust investment case. LCA calculations, long-term solutions, returns, affordability, and social value are built in as governance instruments, forming the foundation for rethinking both the design and construction process.

Home.Earth addresses one of the sector's primary barriers: the assumption that innovation and the implementation of new products and solutions carry high risk, which typically makes the business model vulnerable and causes new solutions to be rejected across the value chain. At Home.Earth, risk is reduced through the structures and mechanisms that form the organization's architecture. A large part of the complexity is moved away from the construction site by treating projects not as unique cases but as iterations of a product.
This is embodied in the company's product platform: a standardized and industrialized building system used across projects, continuously developed and updated on the basis of new knowledge, learning, and innovation. Each project functions as a laboratory that feeds new insights from across the value chain into a shared knowledge base, informing and shaping decisions.
This continuous updating is clearly visible across projects. Where the company's first project, Home.Earth Nærheden, achieved an LCA of 4.7 kg CO_2 eq./m²/year, an upcoming project in Høje Taastrup C is expected to come in at under 4.0 kg CO_2 eq./m²/year.

"For us, innovation is not about individual solutions – it is about building a system that can be repeated and improved over time. That is why we have chosen to develop a product that can be optimized and scaled through a shared product platform. Our pilot project in Nærheden shows that this approach makes it possible both to reduce the carbon footprint significantly and to maintain a robust and financially responsible investment case."

Dan Pham, Co-founder, Home.Earth

Home.Earth has established an internal innovation engine in the form of a product development team and a product committee that together navigate, analyze, and approve new solutions. As a rule, solutions are tested and qualified before they reach the construction site. Decisions about new products, procurement, or processes go through the product committee, where partners from across the value chain and senior management assess whether the risk is acceptable and whether solutions are compatible with the product platform and the project partners, including whether new solutions require longer installation time or changed workflows. Through these structures, risk is managed actively and collectively at system level, rather than arriving as an invisible layer of uncertainty for the individual contractor or supplier.

Beyond the internal innovation engine, Home.Earth makes strategic use of research collaborations, functioning as a central partner that both facilitates the work and ensures solutions are translated into practice with a focus on scaling. The aim is to develop methods and solutions that can subsequently be embedded into the product platform.

Home.Earth's risk profile is therefore not primarily tied to project execution itself, but to the way the company has organized its product development. A large part of the risk is addressed early, through systematic analysis of methods, processes, partnerships, and components before they are brought into construction. By applying only solutions that have been tested, approved and processed across the value chain during the design phase, the risk of unforeseen costs and conflicts between actors is substantially reduced.

Documented Results

- The institutional investor and pension fund Sampension is among the investors in Home.Earth.[3] (Sampension is one of Denmark's largest pension funds, with approximately DKK 354 billion under management, and their involvement signals that the Home.Earth business model has cleared institutional due diligence).
- In July 2023, Home.Earth received a loan and equity commitment of more than DKK 200 million from Denmark's Export and Investment Fund (EIFO).[4]
- LCA performance improves from project to project: from Home.Earth Nærheden (4.7 kg CO_2 eq./m²/year)[5] to Home.Earth Høje Taastrup C, the following year, calculated at under 4.0 kg CO_2 eq./m²/year.[6]
- Circularity is made measurable and integrated into practice through the organization's own Circularity Tool. New modules are developed according to design-for-disassembly principles, and 80% of new modules are circular.
- LCA is applied at five fixed project milestones and continues as ongoing monitoring after completion, keeping the building responsive to new knowledge and changing regulations throughout both development and operational life.

Key Learnings

- Home.Earth owns its buildings in perpetuity. Choosing long-term durable and less environmentally damaging solutions can therefore be both the cheapest and the best option over time. Other developers and owners with long holding periods, pension funds, public developers, and non-profit housing associations, can benefit from the same logic.
- Home.Earth treats its buildings as a product rather than a series of unique projects, built from standardized components and processes. This makes low-emission solutions repeatable and scalable within current financial and regulatory constraints, while freeing up resources and reducing risk over time.
- Home.Earth has structured itself, its investment product, business model, organization, and working methods with the explicit purpose of delivering green and affordable housing.
- Innovation becomes deliverable when risk is moved from the construction site to the organization through testing, validation, and committee decisions.
- A product committee functions as validation and control (similar to an investment committee), assessing risk and implementability before solutions are approved as part of the product standard.
- LCA can function as governance when it has ownership, continuity, and consistency.
- Circularity becomes operational when it can be quantified and connected to concrete choices.
- Standardization of processes, knowledge, components, and partnerships reduces risk, increases speed, and improves quality when all actors work from a shared foundation of co-created and repeated standards.

How They Do It

The Company is Structured to Deliver on the Mission
Home.Earth's success is not built on individual projects but on a mission-driven organizational architecture structured to simultaneously deliver lower carbon construction and operations, increased affordability, social value, and investor returns. Through deliberate alignment of ownership structure and governance with climate goals, social goals, and investment returns, the purpose of the company is embedded in its structure itself, and is fundamental to creating value across multiple bottom lines. While not all organizations share the same structural preconditions, this case offers concrete lessons in how Home.Earth approaches design, organization, and construction processes – lessons that can be translated and adopted by other organizations and practices.

The company is structured as an evergreen entity, distinguishing it from more conventional property funds through an indefinite time horizon and built-in safeguard mechanisms that prevent the company from being

Image: Home.Earth ©

repurposed.[7] This structure entails permanent ownership of its buildings and enables highly centralized control, as Home.Earth functions simultaneously as investor, developer, and operations partner.

This pushes decisions away from the short-term returns toward optimization across the actual lifetime of buildings, and across both CapEx, OpEx, and returns. It makes the implementation of durable, long-term, low-emission solutions not only possible but desirable. Having multiple projects in the pipeline under permanent ownership also means the organization can move from thinking about innovation at project level to thinking about it across the entire portfolio.

The organization also works to match housing stock and apartment sizes to societal needs, reducing floor areas by optimizing space use through shared functions. Fewer built square meters means a lower carbon footprint, and lower operating costs mean reduced rents.[8] Through the Mutual Benefit mechanism, this delivers a combined benefit for both climate and affordability.

Standardization, Industrialization, and Repetition as Principle

Through systematic standardization of components, knowledge, and processes, Home.Earth has created a culture of constant learning in the organization that contributes to scaling, risk reduction, and streamlined collaboration through industrialized and repetitive construction practice.

Home.Earth organizes the construction process according to principles more commonly seen outside the construction sector: platform thinking, in which standardization, scaling, and efficiency are rewarded with growth and value creation. Treating buildings as a standardized but dynamic product contributes directly to identifying opportunities for optimization: driving emissions as low as possible, streamlining the process to free up resources for innovation across teams, reducing risk by increasing familiarity with the process, and ultimately strengthening the business case. Processes, partnerships, and value chains are similarly standardized and repeated. Combined with deliberate logistics integration, this creates transparency and reduces supply chain risk. The process of continuous optimization means each project functions as both a lever for learning and a source of the next generation's standards.

An illustration of platform thinking in practice is Home. Earth's product platform: a predefined, industrialized, and modular building system covering housing units, communal areas, materials, MEP systems, ground-floor structure, structural systems, and balconies. It takes advantage of off-site production in controlled factory environments, enabling higher quality assurance and a significant reduction in on-site work and risk. According to EFFEKT (a Copenhagen-based architecture and research practice), this is one of the key reasons Home. Earth Nærheden (the company's first commercially built housing project) has achieved Denmark's lowest LCA for a multi-story building without additional cost, illustrating that industrialized construction methods combined with carefully considered material choices can be both environmentally and economically advantageous.[9]

The platform is continuously updated and developed as a collaboration between internal and external actors, drawing on in-depth knowledge of the entire value chain within Home.Earth's innovation and development infrastructure. At the same time, the product platform increases transparency and efficiency for all actors involved, enabling the repetition and scaling of less carbon-intensive solutions within the sector's own logic. Part of the platform's success is that decisions are taken in a forum where expertise from across the value chain and the construction process is present, ensuring that relevant technical and professional knowledge is available when decisions are made.

The system has a clear impact on the process, shifting the conventional development logic. It moves key decisions about solutions, material choices, and layouts to early in the development and design phase and establishes a design logic governed from the outset by LCA, CapEx, OpEx, and quality. When the same components and processes are repeated across projects, accumulated knowledge, and quality and delivery can be improved systematically over time.

To illustrate the depth of thinking made possible by the standardized product platform: floors are module-divided so that repair and sanding can be done locally at the point of tenant changeover rather than throughout the entire apartment. Skirting boards are specified in wood rather than painted finishes to reduce the need for ongoing surface treatment. The individual acts are small, but their effect is systemic: they reduce operating costs, tenant changeover costs, and resource consumption, and in doing so protect tenants from unnecessary expenses.

In response to Home.Earth's LCA reduction from 4.7 kg CO_2 eq./m²/year in Nærheden to under 4.0 kg CO_2 eq./m²/year in Høje Taastrup C, Dan Pham (Co-founder, Home. Earth) notes that the reduction was not driven by new or emerging components or materials from one project to the next, but by an in-depth knowledge of the product that enabled more precise procurement and a reduction in material volume. This underlines that meaningful carbon savings come from examining innovation across multiple angles, levels of detail, and stages of construction.

Mutual Benefit – Profit-sharing as an Affordability Instrument

Mutual benefit is one of the instruments through which Home.Earth delivers on its multiple bottom lines: lower carbon impact, affordability, social value, and investor returns within the same model.

A portion of each building's operating surplus is shared with tenants as a conditional rent rebate. The operating result is calculated as rental income minus operating costs, interest, and tax. Up to 30% of any positive surplus is set aside in a financial reserve and distributed as a monthly discount over the subsequent 12 months. In a normal year, this corresponds to roughly one month's rent.

The scheme is upside-only for tenants. To qualify, tenants must have lived in a Home.Earth property for at least 12 months. Tenants do not become co-owners, are not exposed to losses, and cannot be required to repay rebates already received. Mutual benefit is discretionary, not a contractual right. It is only granted in years when the building posts a positive overall result. Negative value adjustments can reduce or eliminate the rebate, even where day-to-day operations showed a surplus, ensuring that the program never places financial strain on the building.

Strategically, the model works on two levels. First, it is an affordability instrument: it reduces rent and increases access to more affordable housing. Second, it creates a sense of shared ownership without legal co-ownership, aligning tenant behavior with long-term asset performance. When the collective behavior of tenants contributes to lower operating costs, rents fall, renovation expenses decrease, the material lifespan of the building is prolonged, and the investment case becomes more resilient over time.

LCA as a Governance Principle on Par with Economics and Quality

LCA is a central decision-making tool across the company's design process, material choices, and collaborations. It is carried out at five project milestones and when major substantial design changes occur, and the results are used continuously to adjust the product, optimize CapEx, OpEx and quality, and carbon reduction.

The work is anchored with an LCA Lead: an external specialist who owns the overall LCA process throughout the project. The role involves gathering input from architects, engineers, and other project partners, testing design suggestions and changes, developing scenarios, and translating findings into concrete recommendations. Direction is maintained through continuous reporting and regular cross-disciplinary meetings. This ensures that LCA functions as a central governing principle for both the design and operation of the project, and that knowledge from project phases, tests, and the innovation department feeds back continuously into the company's product platform and standards.

The organization works continuously from a dual optimization principle: first, what delivers the greatest LCA savings; and second, what delivers the greatest economic savings in both the short and long terms. These are not stand-alone sustainability measures, but an integrated decision logic in which environmental and economic performance are evaluated simultaneously.

Product Development Team and Product Committee as Internal Innovation Engine

A central component of Home.Earth's innovation infrastructure is the product development team, which manages and further develops the product platform and standards. Its purpose is to ensure that the platform is continuously optimized through the integration of new and emerging components and solutions, delivering on the organization's objectives.

The team's role is to ensure continuous optimization of the product platform: identifying, analyzing, and assessing new knowledge, technologies, and improvement opportunities for implementation. The team operates cross-functionally and works systematically with

Image: Home.Earth ©

documentation and an evidence base, including gathering and assessing EPD data, desk research through relevant databases, and knowledge acquisition through networks and R&D collaborations. Learnings from previous projects are fed back into the organization through a structured, experience-based practice, translating experience into repeatable decision principles and scalable solutions.

This approach also challenges one of the sector's most recognized barriers to innovation: new solutions are rarely tested and documented before they are needed on site. By only adopting solutions that have already been tested, documented, and assessed as ready for use, the team reduces perceived risk and demonstrates what is achievable within a commercially viable project, and with already ready-to-use products and systems.

Thus, the product committee functions as a validation and control body with a decision logic similar to that of an investment committee. It is internally anchored with representatives from key functions across project development and operations: project development, the product platform, finance, technology, architecture, and sustainability. On the basis of the product development team's proposals and documentation, the committee assesses whether a solution is sound enough to implement before it can be adopted into the standard.

Implementation only proceeds if the solution is assessed as scalable, compatible with Home.Earth's business and delivery model, accepted by relevant partners, and approved by the committee. Overall, this structure moves risk management from the execution phase to the decision and design phase, by requiring documentation, responsibilities, and financial consequences to be clarified before implementation.

Strategic Partnerships and Collaborations as Risk Management and Process Optimization

Home.Earth's construction and design process is built on long-term, standardized partnerships, and close integration of partners across the value chain. Consultants, suppliers, municipalities, and contractors are involved from the earliest project phases, developing solutions jointly and embedded directly in the process.

The product platform is the precondition for this collaboration. All partners are expected to know and work from it as a shared point of reference for design and dialogue. This shared foundation is what makes the integration of the value chain a strategic tool for risk management and continuous product optimization: knowledge and competences from across disciplines are fully utilized, repeated collaboration builds familiarity, and co-created solutions mean that delivery can be achieved across all involved actors, replicated, and made less costly over time, improving both the process and the product with each iteration.

Beyond risk management, this way of working positions Home.Earth as an innovation facilitator. Through its combined role as investor, developer, operator, and innovation partner, it gives other actors across the value chain both the incentive and the opportunity to engage in innovative construction and operational practice. Home.Earth actively demands new solutions and products from its partners, creating the environment in which involved actors can develop and build capability in new approaches. Partners consistently identify this close collaboration and tight value chain integration as essential for making new practice possible.

Strategic Use of Knowledge Collaborations and Knowledge Sharing

Home.Earth occupies a role that is frequently absent in the translation from idea to practice: an actor capable of evaluating new solutions against economic and operational criteria and testing them through actual implementation in its own construction projects. The company operates within a cross-disciplinary innovation ecosystem spanning the value chain, research institutions, and the wider sector.

The effect is twofold. Knowledge and documentation produced through collaborations are shared openly with the sector, meaning that solutions created in collaboration are tested in a commercial product, and the findings and learnings become knowledge embedded in the industry. In addition, that same knowledge feeds directly back into Home.Earth's product platform and building practice. Knowledge sharing and R&D collaborations are therefore not a sidelined exercise. They are a structural element of the business and of its internal product development. External funding allows development costs and risk to be distributed across partners rather than carried by a single actor, while ensuring the work is anchored across disciplines.

Image: Home.Earth ©

One concrete example is the product platform itself, which draws on knowledge and principles developed and tested in the R&D partnership Closing Loops (a collaborative value chain R&D program aimed at developing circular building systems), in which Home. Earth works alongside a:gain (supplier of circular building products made from remanufactured materials), Scandi Byg (modular timber construction manufacturer), Nordic Wood Industries (producer of wood-based materials and prefabricated elements), and EFFEKT (architecture and research practice). The program is executed in collaboration with WE BUILD DENMARK (national cluster organization for the construction sector) and funded by the Danish Board for Business Development (Danmarks Erhvervsfremmebestyrelse), and the European Union.

Other examples include Circular Construction for Urban Development – a collaboration between researchers, architects, and consultants to develop a generalizable methodology for circular construction, with principles now embedded in Home.Earth's DNA, processes, and building system; and the Doughnut for Urban Development initiative – an open-source project that translates a multiple-bottom-line economic model into practical tools for the construction sector.

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Home.Earth's LCA Process

From early planning to construction, Home.Earth's LCA process defines the scope and distributes responsibility among the parties involved. It demonstrates how the product platform and LCA calculations function as central governing principles across actors and project milestones.

1. Feasibility study stage

Purpose: To calculate an initial LCA for the project.

Key activities:

- Delivering an initial concept design (as a BIM model), including the project's spatial layout, apartment configurations, and unit distribution, along with a preliminary material selection. All materials are delivered via BIM.
- The LCA Lead carries out the first calculation, including assumptions for all elements that fall outside the scope of the building system (foundations, basement where applicable, energy consumption, retained materials, etc.).

2. Planning stage

Purpose: To refine the LCA as the level of detail increases throughout the design process, and to run energy simulations and material optimization.

Key activities:

- The energy and MEP teams conduct energy simulations and indoor-climate studies to assess their impact on the LCA, for example considering the need for solar shading or insulation.
- All involved partners update the BIM information to reflect detailed design changes, energy simulations, and material optimizations, particularly for elements outside the building system (for example optimizing the external wall construction, replacing facade cladding, or incorporating new Environmental Product Declarations from EPD Danmark and EPD Norge).
- The LCA Lead incorporates design adjustments, recalibrates the LCA model to reflect the project's development, and produces an updated report.
- Working with the relevant consultants, the LCA Lead assesses the scope for incorporating reused materials into the project.
- The LCA Lead also presents low-emission material alternatives for the project. This process will be developed further alongside the NEFA and HTC processes, which began in November 2024.

3. Tender stage

Purpose: To refine the LCA with precise EPDs and confirm supplier availability so the project's carbon targets can be met while reducing procurement risk.

Key activities:

- Involved partners compile specifications and EPDs for all building components and ensure the project targets can be met.
- Assessment of the availability of each EPD and analysis of procurement risks, for example the risk of over-reliance on a single supplier. One example is an EPD with a very low carbon footprint that becomes a vulnerability if only one supplier exists, which can affect price, availability, and delivery times.
- For high-impact EPDs (those contributing more than 0.1 kg CO_2/m^2/year to the project's total impact), project partners are required to prepare a list of alternative EPDs with comparable carbon footprints. This reduces the risk of depending on a single product or supplier.
- The LCA Lead reviews and integrates verified EPD data for all materials into the LCA model and produces an updated report confirming compliance with the project's carbon targets.

4. Pre-Construction Validation Stage

Purpose: Purpose: to review the contractors' tenders to ensure they align with the LCA strategy, and to confirm compliance with LCA phases A4 (transport) and A5 (construction processes).

Key activities:

- The LCA Lead reviews the contractors' tenders to ensure they align with the LCA and the project's carbon targets, including EPDs, and then reports any potential issues to Home.Earth's representative.
- The LCA Lead validates the strategy for phases A4 and A5 and confirms that logistics and construction processes support the project's carbon targets.

5. Færdigt projekt

Purpose: To finalize the LCA report and submit it for compliance assessment against the requirements of BR25 and the DGNB certification standards.

Key activities:

- Advisors and contractors provide any final updates to the LCA Lead before submission.
- The LCA Lead prepares and submits the final LCA report, ensuring that all data is up to date and compliant with the requirements.

Doughnut for Urban Development – A Sector-Specific Framework

by Jacob Rask

Jacob Rask
Director, REGEN Network, BLOXHUB

Doughnut Economics in a Nutshell

Climate crisis, ecological collapse, pandemics, and geopolitical instability reveal how interconnected the systems underpinning our socio-economic structures have become. Yet we still measure progress using a single metric – Gross Domestic Product – while treating pressures on climate, nature, and people as "externalities". But complexity does not disappear simply because we ignore it.

The word *oikonomia*, from Ancient Greek, originally meant the art of household management – today, humanity's home in the Holocene depend on the stability of the entire planet. The art we now need to learn is *planetary economics*. And for that, we need a new compass: a measure of human well-being within planetary boundaries. Kate Raworth's Doughnut Model is our preferred proposal for such a compass, and it has gained traction across countries, cities, and sectors. In Denmark, the construction sector, in particular, has embraced it.

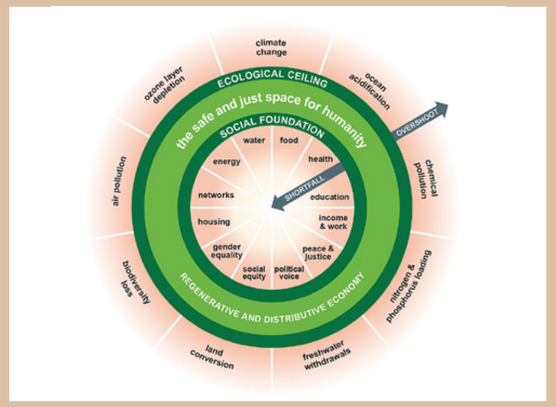

FIGURE 1: The Doughnut
A safe and just space between the social foundation and the ecological ceiling.

The Doughnut consists of two boundaries. The inner ring – *the social foundation* – identifies the minimum conditions required for a dignified life (defined through the social priorities of the United Nations Sustainable Development Goals). The outer ring – the *ecological ceiling* – represents Earth's nine planetary boundaries, which are dangerous if exceeded. Globally, humanity has already exceeded seven of the nine boundaries. The goal is to move the economy into the light green ring: well-being for all within Earth's ecological limits. Achieving this requires development that is both regenerative – rebuilding and restoring nature's inherent capacity to create conditions conducive to life – and distributive – sharing value and resources more fairly.

The Doughnut Unrolled

Since 2012, this model has been adopted by cities, companies, and civil society organizations. In 2020, The City of Copenhagen decided to use the Doughnut as a guiding framework and has worked to translate global goals into local contexts while building data overviews to inform political priorities. Kate Raworth, who created the model and co-founded Doughnut Economics Action Lab (DEAL), collaborated with city practitioners to develop the tool: *The Doughnut Unrolled.* The tool helps municipalities operationalize the model by creating a shared conceptual framework, data portraits, and cross-sector collaboration structures, allowing social and ecological concerns to be integrated into planning and decision-making.

When Construction Met the Doughnut

Construction shapes our cities, resource consumption, and waste streams – and therefore impacts both the social foundation and the ecological ceiling. In 2023, the model was translated into The Doughnut for Urban Development, supported by Realdania through

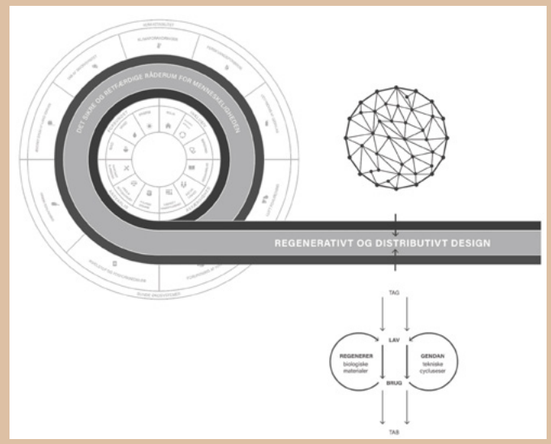

FIGURE 2: The Doughnut for Urban Development Unrolled

collaboration across the industry and an international network of researchers. The purpose was to provide developers, clients, and consultants in the construction sector with guidance for applying Doughnut principles in practice. The Doughnut for Urban Development is the result of two years of collaboration involving a multidisciplinary team with many perspectives – sometimes conflicting, because transformation requires new ways of working together. The Doughnut for Urban Development is not a certification system nor an extensive checklist. It is a sector-specific framework.

Three Insights that can Transform the Industry

- Two planetary systems: climate stability and healthy ecosystems. Innovation in construction should focus on staying within carbon budgets while simultaneously protecting, supporting, and regenerating nature and biodiversity.
- Allocation of resources and energy is political. Distributing planetary boundaries down to sector and project levels is not merely a mathematical exercise. Choices about allocation principles can either preserve business as usual or open new possibilities. The Doughnut for Urban Development points toward a principle of sharing based on sufficiency: fulfilling fundamental human needs as the guiding benchmark.
- Social impact cannot be reduced to a single number. Instead, the framework works with context-sensitive impact areas, both local and global, and with four social categories for urban development: connectedness, inclusivity, equality, and responsibility.

From Planetary Targets to Practical Methods

The construction sector's impact on the climate system is relatively well-defined, but translating it to building level requires clear decisions about system boundaries and allocation principles. For biodiversity, the model emphasizes regeneration – inspired by Biodiversity Net Gain approaches – and an off-site perspective that highlights indirect impacts in global value chains. This makes it possible to move from general ambitions toward evidence-based targets and measurements, including through Life Cycle Assessment (LCA) and biodiversity assessment tools. These methods can help create net-positive outcomes over time.

In-depth Business Design

Whether a "doughnut economy in practice" can be realized depends not only on indicators, but equally on business models – indeed, on the very design of companies themselves. When businesses are structured and optimized for revenue growth and short-term returns, this limits transformational potential. Existing companies therefore need to be redesigned if they are to deliver regenerative outcomes. The *Doughnut Design for Business* tool identifies five layers that are crucial to organizational capacity for action: purpose, networks, governance, ownership, and financing. New ownership models, such as foundation ownership, employee ownership, and democratic enterprises. can shift incentives toward long-term quality rather than volume.

The First Step

An important first step is mapping social and ecological outcomes – creating a "data portrait" of a place – and actively using it to inform priorities. The next step is integrating the Doughnut model as a strategic compass across planning and management processes, ensuring that social and ecological impacts are systematically weighted in decision-making.
The Doughnut for Urban Development does not provide one single recipe. It provides a shared language, new tools, and a realistic framework for navigating the difficult priorities that absolute sustainability demands from individual homes, citizens, cities, and developers. The key question is: Does this project contribute to enabling people to thrive – without passing the cost on to other people, other places, or future generations?

Closing Loops

Home.Earth is part of the value chain partnership, Closing Loops, together with EFFEKT, Scandi Byg, Nordic Wood Industries, and a:gain, working to develop a Circular Bio-based Building System (CBB). The CBB is to be constructed from prefabricated modules made of bio-based materials. The partnership's ambition is to develop a system that can be built up to six stories high, has a carbon footprint below 4 kg CO_2 eq./m²/year, and in which 90% of the materials can be reused.

The partnership will deliver full-scale mockups of building elements, structural shell, facade solutions, fit-out, and insulation. These will be tested and optimized for circularity and bio-based materials, ensuring the system can be used in the construction of a planned Home.Earth building of at least 15,000 m² by mid-2026. The building system is expected to deliver a reduction in climate impact of 7,125 tons CO_2 equivalents over a 50-year period, alongside waste savings of 260 tons.[1]

This partnership is one of many within the Closing Loops project, which focuses on advancing circular economy and sustainability across a range of industries, including construction and civil engineering. Supported by the Danish Board for Business Development and co-financed by the European Union, the project received total funding of approximately DKK 229 million in 2023.[2]

It is run by Denmark's five regional business hubs and four cluster organizations, including WE BUILD DENMARK, which received DKK 35 million[3] and took responsibility for maturing, assembling, and facilitating value chain partnerships in construction and civil engineering, including the partnership Home.Earth is part of. In November 2025, the Danish Business Authority announced a further investment of DKK 272 million[4] in the project with effect from 2026, of which DKK 93.5 million[5] is earmarked for strengthening circular value chains and innovation in construction and civil engineering.

CLOSING LOOPS
sammen om cirkulære løsninger

Project details

Scope: A value-chain collaboration to develop a Circular Bio-based Building System, with the ambition of reducing the climate impact of construction and the construction waste generated by the building process.

Floor area: Target of at least 15,000 m²

Project / construction period: 2023-2026.

Facilitator: WE BUILD DENMARK.

Partners: EFFEKT, Scandi Byg, Nordic Wood Industries, a:gain.

Funding: Co-financed by the European Union and the Danish Board of Business Development.

Documented Results

- **Clearly defined targets.** The CBB partnership is developing and testing a full-scale Circular Biogenic Building System, prefabricated as modular elements made of bio-based materials. The partnership's specific targets are: develop a building system that can be built up to six stories high; develop a system that maintains a carbon footprint below 4 kg CO_2 eq./m²/year; develop a system in which 90% of the materials can be reused; produce full-scale mockups of the structural shell, facade, fit-out, and insulation; ensure the system can be used to construct a commercial Home.Earth building scheduled for mid-2026.
- **Significant CO_2 savings expected.** Compared to conventional construction, the building system is expected to save 7,125 tons of CO_2 equivalents over a 50-year period and to avoid 260 ton of production waste. The partnership's goal is to realize a full-scale 15,000 m² building by mid-2026.
- **Principles anchored across the value chain from the start.** The partnership allows participating companies to share specialist insights from the earliest development phase. This ensures that principles such as design for disassembly, take-back solutions, and upcycling, along with tools such as material passports and bio-based materials, are embedded from the outset, ensuring that product and process are compatible across the value chain.
- **Specialist expertise used to anchor responsibility across the lifecycle.** The partnership builds on the idea that innovation is achieved when the necessary knowledge is embedded from the start, and draws on the specialist competences of each individual partner, with every collaborator filling a unique role. for example, architecture and design firm EFFEKT contributes experience and expertise in design for disassembly, while a:gain, experts in circular building elements, contributes expertise in industrial upcycling. Involving multiple layers of the value chain in development is an advantage because it ensures that responsibility for each phase of the product lifecycle is clearly delegated: the system can be built, can be taken apart again, and has buyers for the materials at the end-of-life stage. This increases the likelihood of developing optimized, durable solutions that ensure the system is genuinely circular.
- **Development projects create value from day one.** Even though the building system is not yet fully developed, the partnership is already generating value. Home.Earth has already applied a number of insights and solutions from the partnership in other projects across its portfolio.

Key Learnings

- **Creating ripples: Applying learning in other projects.** Through Closing Loops, the partners have generated experience and solutions that introduce circular construction principles to the wider industry. These solutions can be carried forward into projects beyond the partnership. In this way, Closing Loops primes the sector for broader change.
- **Funding collaborations and central facilitation reduce risk for industrial partners.** The Closing Loops project is financed through national and international funding programs and facilitated by four cluster organizations – Food & Bio Cluster Denmark, Lifestyle & Design Cluster, WE BUILD DENMARK. and CLEAN – with the five regional business hubs. This means companies do not have to spend resources establishing partnerships or setting aside development funding. Risk is therefore reduced across the value chain, increasing the incentive to take part.
- **Defining concrete targets creates momentum.** The CBB partnership has set concrete targets for the building system to be developed. This gives the partnership a shared direction and creates the incentive and motivation to drive innovation and create new solutions.

How They Do It

- **Integrated value chain collaboration.** The CBB is developed across the value chain, ensuring responsible development and the integration of optimized solutions in both the sourcing and decommissioning processes.
- **New materials and modular thinking.** The CBB is a modular building system that can be easily assembled and disassembled. The use of innovative bio-based and waste-based materials drastically reduces climate impact compared to conventional building practice.
- **Centralized facilitation and funding.** The Danish Board for Business Development and the EU have co-financed both the Closing Loops project and the cluster organizations that run the value chain partnerships. This demonstrates that centralized, ambitious public organizations are a fundamental driver of innovation and sustainability in construction.

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KIRKBI – Travbyen, Construction Phase 1, Building Plots 01–04

Visualisation: Loop Architects

Project details

Scope: Neighbourhood-scale innovation project: approximately 550-600 homes plus small businesses, a daycare centre, shared facilities, multi-storey car parks and a "Playline".

Construction period: The first phase, plots 01-04 (171 homes / 17,000 m²), will be completed in late 2026. The rest of the neighbourhood is being developed in stages, with expected completion around mid-2030. KIRKBI bought the site from Billund Trav and took over the area on 1 January 2022.[1]

Location: Billund, Denmark

Developer: KIRKBI Invest A/S.

Value programme and masterplan: Gehl Architects og Andel.

Architects: Tegnestuen Vandkunsten, CEBRA, ReVærk, LOOP, Tegnestuen LOKAL, AART.

Landscape: BOGL.

Engineers: Artelia.

Contractors: Nordstern, Jorton, Kirkegaard, Winther Trolle

Client advisers: Transform, NIRAS, Henning Larsen Architects, Ingeniør'ne og Designskolen Kolding.

Visualisation: GEHL Architects

"The technology exists
– it's still just too expensive."[2]

Christian Nørgaard, Head of Travbyen, KIRKBI

Travbyen is a rare example of a development project deploying innovation at this scale. The results include an exceptionally low carbon footprint and resource use across a wide range of housing typologies and associated infrastructure.

Development at neighborhood-scale makes the task substantially more complex than delivering individual buildings. It requires coordinating across multiple actors, systems, and phases; balancing a range of considerations as scope grows in square meters, typologies, and time; and taking on the responsibility of creating a thriving community, with all the social, functional, and infrastructural dimensions that entails.

KIRKBI's solution has been an integrated value program, a masterplan, and a strategic municipal partnership. Particularly central is the inclusion and integration into the existing context required when a new neighborhood is established within an existing city, a process that requires both physical and social coherence between the new and the existing.

KIRKBI has turned this complexity into an advantage, treating neighborhood-scale as an opportunity to work with multiple governance logics within a larger, integrated system. Through deliberate partnerships, clearly defined governing principles/dogmas, innovative processes, and risk management, the visions for bio-based solutions, play, integration with the surrounding city, and landscaping quality have been translated into specified delivery packages, action plans, requirements, and systems.

The development of Travbyen functions as a strategic practice laboratory. Through systematic testing and documentation, previously non-pre-accepted materials and structures have been implemented and approved for construction, establishing precedent for alternative solutions within the existing regulatory framework. Through cross-disciplinary collaboration, these solutions have been anchored in systems and standards applicable across residential, recreational, and institutional typologies, achieving scalability that extends far beyond any single project.

Documentation, process learning, and test results are shared openly with the sector to challenge established practice. Other actors can now build with comparable materials and systems without repeating the same resource-intensive approval processes. Travbyen functions not only as a development project, but as a platform for market maturation and sectoral transformation.

Documented Results

- **Low calculated LCA climate impact.** BR25 (Denmark's national building regulations) has tightened the threshold for climate impact to 7.1 kg CO_2 eq./m²/year, with a process-related threshold of 1.5 kg CO_2 eq./m²/year.[3] Although the requirements for Travbyen were set before BR25 took effect, the results fall below the tightened thresholds. In phase 1, Travbyen achieves an LCA of 4 kg CO_2 eq./m²/year from materials; 0.5 kg CO_2 eq./m²/year from operations; and 1 kg CO_2 eq./m²/year from the construction process.[4] Indicative LCA calculations for site preparation and landscaping are being developed, not for benchmarking, but to establish a data foundation for areas where the sector has as yet no standards. The data is being anchored at BUILD (Aalborg University's research institute for the built environment).

- **Significantly reduced resource consumption and a substantially higher proportion of bio-based materials than the sector norm.** Typical sector resource consumption in the Danish construction sector hovers around 760–1,060 kg/m², with bio-based materials accounting for 5–6 %. In Travbyen Phase 1 (building plots 01–04), resource consumption has been reduced to 570–750 kg/m², with bio-based materials accounting for 24–31%. In addition, 89% of above-ground insulation is bio-based.[5]
- **Reduced climate impact and architectural quality are not in conflict.** Travbyen achieves both an exceptionally low LCA and minimal resource consumption while delivering high architectural quality and diversity. Sustainability is pursued not in isolation, but integrated with equally high ambitions for architecture and urban life.
- **Fewer square meters per person than average in newbuilds.**Apartments range from 41 to 151 m², with an average of 95 m² – relatively low for comparable locations in Denmark. To compensate for smaller private units, communal buildings, shared guest rooms, shared workshops, and shared workspaces have been provided. This delivers lower embodied carbon per person and improves everyday quality of life through more shared functions.

Key Learnings

- Vision is translated into reality through centralized governance, a defined program hierarchy, and close collaboration with experts. Clear, accessible governing principles translate vision into clear and manageable construction, material, and architectural requirements.
- Financial reserves have been established. A Climate Reserve and a Community Fund serve as the basis for experiments, testing, and early implementation of lower-carbon solutions.
- From plot to portfolio: By treating construction as a continuous portfolio rather than one-off projects, Travbyen has been able to spread risk and manage uncertainty across a much larger number of square meters.
- The construction sequence has made it possible to establish the project as a living laboratory, scaling learning from smaller test builds to larger projects in later construction phases and into the wider market.
- Process innovation has moved key decisions about knowledge and material choices to an early development phase, making bio-based materials, reuse, and other innovative solutions governing design principles from the outset rather than optional additions later.
- A standardized modular building system with a high proportion of bio-based materials, applicable across typologies: townhouses, urban villas, and multi-story buildings, was produced in phase 1.
- Through extensive documentation, evaluation, knowledge sharing, and process transparency, Travbyen establishes precedent for industrial transformation and contributes to both legislative development and market maturation.
- Share-friendly programs and functions have contributed to smaller apartment sizes and a reduced total floor area.
- Travbyen is not developed on market-rate financial terms. It accepts a lower return in exchange for a higher quality of neighborhood experience, social sustainability, and a positive impact on construction's carbon footprint – and not only within Travbyen itself, but by sharing knowledge so that others can replicate the solutions and build to a comparable standard on market terms.

How They Do It

Specific Tools that Translate Vision into Reality
The developer, KIRKBI, has set a high level of ambition for Travbyen from the very earliest phases. This is clearly evident in the fact that, very early in the process, they have consistently worked to establish a solid foundation for the individual sub-projects within the new urban district.

The foundation is defined through a series of hierarchically organized programs and plans which together constitute the developer's overall vision for the area, including the overarching value program and masterplan.

The value program defines four core values: 1) *Play for Everyone*, placing play at the center of neighborhood development; 2) *Everyday Life in Balance*, addressing environmental and climate sustainability; 3) *Community for You*, addressing social sustainability; and 4) *We Meet in Billund*, supporting the identity of Billund Municipality (the home of Lego) as "The Capital of Children".

The program does not function as a detailed manual. It is a shared starting point that creates a coherent foundation for collaboration between residents, institutions, and professional actors, with social and climate ambitions as the governing compass. The masterplan translates this into a location-specific and spatial plan that describes what happens where and defines the overarching approach that underpins the development.

To make the visions operational, they are translated into governing principles, requirements, and parameters across three thematic programs: Program for Quality, Program for Sustainability, and Program for Play. These govern all subsequent planning, design, and development work by every actor involved. This clear program hierarchy, along with the systematic translation from vision into operational requirements developed in collaboration with relevant professional experts, is what has made delivery possible.

A second crucial factor in making this possible and in ensuring the value programs are realizable and achieve the intended effect is thorough preparation, careful consideration, and early involvement of professional expertise. By bringing specialists in at early decision-making stages, potential problems can be identified before they become costly ones, and solutions can be verified as both technically and economically realizable. This ensures that ambitions do not remain at vision level, but are realized through operational frameworks with the capacity to deliver.

To support implementation, the construction project has been categorized as an innovation and development project, thus ensuring greater freedom to pursue and test innovative solutions with a lower carbon footprint, including where they involve higher initial investment.[6]

Value Program and Masterplan
The masterplan and value program are the unifying narrative of the visions and development of the new neighborhood. They contain the outlines of the vision, clarify the goals, and establish the foundation of what the development must achieve.

The value program builds on four core values: *Play for Everyone, Everyday life in Balance, Community for You*, and *We Meet in Billund.* All supported by concrete initiatives, activities, programs, and tools, as well as financial mechanisms to help translate visions into practice.

As preparatory work for the value program, interviews were conducted with a selection of the city's stakeholders, along with a larger survey among the city's residents, with a high participation rate of approximately 1,100 out of 7,500 respondents. A vision day was also held earlier in the process to ensure input from residents and other relevant stakeholders.

Value Program: Play for Everyone
Play for Everyone is one of the four pillars of Travbyen. This value program ensures that play becomes a central design parameter for the development. This is supported through the extension of the existing *Playline in Billund*, creating physical connection and making the culture of play visible. To operationalize play as an integrated planning element, Travbyen entered a strategic collaboration with the Kolding School of Design[7] and its LAB for Play Design. The collaboration has contributed expertise through the involvement of specialist knowledge holders in workshops and dialogue with relevant actors throughout the process, strengthening the integration of play as a core design principle.

Value Program. Everyday Life in Balance
Everyday Life in Balance defines the value program's ambitions for construction with a reduced environmental footprint. The program establishes that the carbon footprint of construction must be significantly below current Danish regulatory requirements and that space for nature must be embedded as a governing principle in all decisions relating to Travbyen. The green agenda is not an isolated measure. It is an essential element in the overall development of the neighborhood. Among the concrete ambitions, the developer set a requirement to double the biofactor (a Danish planning metric that quantifies the proportion of green and biologically active surface area on a site or within a neighborhood), with a sharp focus on circularity and bio-based materials as fundamental design parameters.

Value Program: Community for You
Community for You is the social foundation of the value program, setting a clear ambition to develop a diverse neighborhood with high resident diversity and a strong and cohesive community life. Shared activities are embedded as a governing principle, and the neighborhood is composed of a wide spectrum of housing types so that residents at different life stages can live side by side, achieving a demographic composition that reflects the existing diversity of Billund Municipality. The physical design of the area consistently prioritizes people, outdoor life, and activity. A community building serves as the central hub. And a dedicated Community Life Fund *(Bylivspuljen)* finances initiatives developed by the shared neighborhood association, ensuring that community is not only an ambition in planning but actively realized once the neighborhood is in use.

Value Program: We Meet in Billund
We Meet in Billund focuses on integrating Travbyen with the rest of the city. It builds on Billund Municipality's city vision as "The Capital of Children" and ensures that Travbyen becomes unified with the existing Billund, connecting everyday life, visitors, and communities across Travbyen and the rest of the city. The ambition is coherence between the city vision and the new neighborhood. Travbyen should be an integrated part of Billund while elevating the experience of catering to the child in everyone, both spatially and culturally. The ambition is that the neighborhood does not become an isolated enclave, but an active contribution to the city's overall identity and function.

Mandates and Requirements as Operational Management Tools

From Masterplan and Value Program → Thematic Programs
Building on the value program and masterplan, three thematic programs translate intentions into concrete mandates, requirements, and conditions. The masterplan and value program are publicly available for anyone to read and engage with. The three thematic programs are the translated core values and governing principles found in the plans. These are formulated into concrete requirements, mandates, and guidance for the professional partners who must follow them in all design, consultation, construction, and related work.

The three programs are: 1) *Program for Quality*, describing the overall ambitions for the nature and quality level of the built environment in Travbyen; 2) *Program for Sustainability* (climate, social, and economic), describing the strategic focus areas that set the direction for sustainability in Travbyen; and 3) *Program for Play*, describing how play can be supported and incorporated in the development of Travbyen. The programs are not separate tracks. They form an integrated framework in which solutions are developed by balancing quality, sustainability, and play. The mandates and requirements have been developed in collaboration with expertise from across the value chain and from research institutions, ensuring that the necessary knowledge is present when the framework is established and that it can be operationalized in practice.

Program for Play
Travbyen operates with an expanded understanding of play that extends far beyond the conventional playground. Play in this context encompasses social encounters, communal cooking, movement, events, and community projects. Play is regarded as a fundamental way of life in the city, manifested at the level of activity and functioning as a strategic compass for the decision-making of all actors involved in the development.

Program for Play is therefore one of the central frameworks setting the direction for Travbyen's development. Significant resources have been invested in ensuring that play is implemented as a pervasive design element across public spaces, architecture, and programing. The ambition is that play should be experienced in the physical urban realm through architectural qualities that appeal to curiosity, creativity, social interaction, cognitive stimulation, and joy.

A central collaborative partner in this process has been the Kolding School of Design and its LAB for Play Design. Particularly in the design phase, the LAB has served as an essential "dialogue partner" for the project partners through workshops and structured dialogue, incorporating play design thinking as an integrated design principle across both urban and building scale. In parallel, the local daycare and the international school have been engaged in the design of public space elements such as manhole covers and utility cabinets.

Program for Sustainability and Quality: Mandates and Requirements as Management Tools
Travbyen stands out for its use of project-specific mandates and requirements that translate overarching visions into concrete management and design principles for the development. Central to this is a project-specific climate requirement: a maximum carbon footprint of 8 kg CO_2 eq./m²/year in accordance with BR18 (Denmark's national building regulations as updated in 2018), covering lifecycle modules A1–A3 (production phase), A4–A5 (construction process), B4 (replacement), B6 (operations), and C3–C4 (end of life). A sub-requirement for upfront emissions (A1–A3) of 3.5 kg CO_2 eq./m²/year has been set to maintain focus on emissions generated now.[8]


Image: Travbyen©

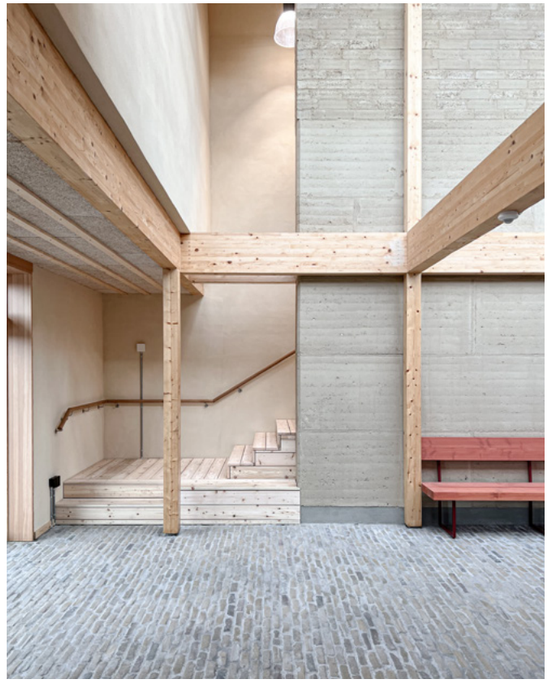
Image: Travbyen©


Image: Helene Høyer Mikkelsen


Image: Helene Høyer Mikkelsen

Beyond the carbon footprint of buildings, an indicative LCA calculations is being developed for site servicing and landscaping. The purpose is not to benchmark against existing standards, but to establish a robust data foundation for future development and modeling across the sector: data that can help move the industry toward genuine, systemic sustainability in construction.

Through the Program for Sustainability, the developer works with an ecocentric perspective, while building something deliverable to a commercial market. With a clear awareness that this cannot fully be achieved, given current market and technological conditions, this stance nonetheless represents the position from which decisions are made. The result is a stronger focus on genuinely less damaging solutions, even where these cannot be credited in an LCA or DGNB certification. The program contains a range of requirements and mandates that fall outside what the current calculation methods and certification systems can capture or reward, but that together seek to lay the foundation for a new building practice.

This reflects a deliberate strategic recognition: existing calculation models are insufficient to capture all relevant dimensions of sustainability. Travbyen therefore operates with an expanded sustainability concept, placing constraints on material hierarchies, material processing time, procurement, and materials that do not achieve a low LCA through compensation. Furthermore, it adds resource consumption, circular design strategy, local ecology, and social robustness, all as equal design parameters even when their effects cannot immediately be quantified with existing calculation methods. This positions the project as a strategic experiment: not only optimizing within the given framework, but challenging and expanding the very definition of what more sustainable construction can look like.

Beyond climate, resource, material, and technical requirements, architectural mandates have been developed that concretize ambitions in shape, form, and function, ensuring urban, landscape and architectural quality and character integrity with the overall vision for Travbyen. The mandates are designed to balance the varying needs of sustainable development: reducing carbon footprint, decreasing resource use and promoting materials with less energy-intensive processing, shorter transport distances, fewer extractive processes, and more favorable longevity and end-of-life conditions, while simultaneously creating the conditions for a thriving neighborhood, pushing beyond the status quo, leaving room for experimentation, variation, and quality, and in so doing defining a new practice.

The mandates function as a shared management tool that maintains ambitions across sub-projects and all involved partners. They set a clear standard without fully constraining the project: they define direction and minimum thresholds while leaving genuine professional room for maneuver in the subsequent design process. This balance between rigor and flexibility have proved crucial to both the project's progress and its quality.

The mandates and their associated requirements are formulated ambitiously enough to require the parties involved to actively seek new solutions in order to realize the project. This creates demand for innovation across the entire value chain as a for the project's realization. The mandates therefore function as direct drivers of innovation, pushing actors to think differently and develop alternative solutions.

The mandates were formulated by the developer with input and advice from selected professional experts. Operationalization, however, is based on a collaborative approach in which solutions are developed largely across the value chain, in close dialogue between developer, consultants, and contractors. This ensures that operationalization is compatible with the capacity and competences of the actors who must ultimately realize the project.

A significant element in this model is the systematic sharing of developed solutions, both internally across projects and externally to the sector in general. Travbyen therefore functions not only as a development project for KIRKBI, but as a platform for knowledge creation, market maturation, and scaling of innovation. This strategy underpins the project's long-term value by contributing to and guiding the sector's overall transformation.

This approach has required financial compensation from the developer. The economic framework for the parties involved has been expanded, while at the same time the requirement is that all parties must meet all three thematic programs and their underlying mandates and requirements within the given financial framework.

The developer also bears the cost of necessary testing, documentation, and prototyping. An internal financial reserve has been established to fund particularly innovative solutions, with the explicit requirement that solutions have genuine potential for scaling within the sector. This model ensures that innovation is not merely an ambition on paper, but a realizable element of project development with documented value for both project and market.

Front-Loading Knowledge, Testing Strategically, and Preparing Alternatives

The mandate's ambitious targets frequently exceed what can be met with pre-accepted materials and solutions under the current building regulations. This has necessitated working with alternative solutions and materials requiring material-specific documentation. In the absence of established knowledge about these materials' properties, it has been necessary to create, establish, and qualify knowledge and technologies in the early project phases, anchoring this capacity directly within the project and organization in order to establish a shared direction and knowledge base, reduce risk, and ensure compatibility across multiple disciplines.

To achieve this, early cross-disciplinary partnerships have been established to draw on relevant expertise and carry out indicative analyses from the outset, including LCA, LCC, fire, acoustics, and structural calculations.

The use of new solutions and materials has required systematic testing and documentation. In Travbyen, testing is approached strategically: drawing on expertise across disciplines, incorporating results from existing tests and past experiments with comparable materials, and conducting indicative tests at smaller scale to identify performance and compatibility early in the process before conducting large-scale testing.

In Travbyen, testing, learning, and documentation are organized not around a single plot, but for application across all the buildings in the portfolio. So that tested materials and results can inform the assessment of other building components and future projects. This shifts both costs and risk from project level to portfolio level, distributing the cost of testing across multiple projects rather than loading it onto a single building.

At the same time, the project adheres to the principle of designing with a Plan B. When a new material or structural build-up is tested, an alternative solution and its implementation route are defined in advance, in case Plan A does not deliver the desired result. A similar approach is applied when testing new materials directly in construction. When experiments are carried out in non-load-bearing structures, risk can be reduced by deliberately selecting areas where the material can be replaced relatively simply and cost-effectively. This allows valuable practical learning to be gathered without putting the project's critical elements at risk.

A key learning from the first construction phase is: when working with new solutions and materials, the properties and availability of those materials must be brought into the process early and treated as a core precondition. Buildings must increasingly be designed around what materials are available and how they perform, rather than adapting materials to a design that has already been set.

Construction Sequence and Typological Variation as Testing Tools and Risk Management

Travbyen is being developed in phases. The key advantage is that learning from one phase can be carried directly into the next. The construction sequence is therefore a deliberate management tool: it ensures that learnings and knowledge from previous experience can be utilized directly into the next project phase and that solutions are scaled systematically.

Within each phase, a number of designated test buildings are identified as sandbox projects where a more experimental approach is taken and a higher level of risk is accepted. The purpose is to identify and mature new solutions that can be scaled in the next phase, while filtering out what does not work in practice. The logic is to create a test environment that generates real learning, but with manageable consequences if something fails. In phase one, three buildings are classified as sandbox projects. This specific construction typology and financial logic makes it possible to test and develop solutions in practice and across project partners. Because the experiments are designed with scalability in mind from the outset, successful learning can be carried forward into the next phase of Travbyen and, in time, contribute to market maturation more broadly.

Visualisation: Travbyen©

The first sandbox project was the Green Community House *(Det Grønne Fælleshus)*, which has functioned as a platform for testing a range of alternative construction methods, including various biogenic materials and reuse materials. During the development phase, a number of experimental solutions were investigated, including the use of mussel shells as insulation in the ground slab. This solution was rejected after thorough assessment showed that it had no realistic potential for scaling and that the harvesting method (bottom trawling) was associated with negative environmental consequences.

This decision process illustrates a central principle of sandbox projects: not only must innovation be technically feasible, it must also be sustainable in a broader systemic sense and implementable beyond the individual project. Other methods were integrated and further developed with scaling in mind. The primary load-bearing wall is built from rammed earth elements, and the facades are predominantly made of earth, hemp, and timber. The building is also designed for disassembly and reuse, ensuring that materials can enter future cycles without loss of value. The ambition with these materials and methods was to investigate how resource consumption and climate impact can be brought to an exceptionally low level, while building a documented knowledge foundation for broader implementation in the next construction phase.

The key learning from the work with rammed earth in the Green Community House was a challenge with moisture ingress. This finding led directly to product development: the solution was adjusted through the addition of a limited quantity of lime. The updated solution has already been scaled and used as wall elements in the next test building, The Clay House *(Lerhuset)*, a multi-story building in an adjacent plot. When The Clay House is complete, it can be monitored, contributing further learning to both the overall development and the sector in general.

The work with rammed earth ran in parallel as a sister project to Leralliancen (the “rammed earth” alliance, an R&D project presented in this Atlas). The original intention was for Leralliancen to provide academic knowledge for the design and construction of The Green Community House in Travbyen. Instead, the two projects unfolded simultaneously, with the result that academia and practice cross-pollinated each other, creating a higher level of innovation than either would have achieved alone.

The Green Community House stands as an example of a strategic and coordinated progression of a new material: from research and development, through pilot, to implementation in practice. It illustrates a systematic knowledge-building process in which theoretical insight, experimental testing, and practical implementation are integrated in a coherent development sequence.

Strategic Partnerships as a Method for Knowledge Building and Risk Management

In Travbyen, the establishment of strategic partnerships has ensured that relevant expertise is present when key decisions are made and they have been an essential driver in moving the project from ambition to realization. Partners are selected on the basis of the visions for Travbyen, and this is visible in the way each partner’s professional expertise and values connect directly to the project’s goals.

GEHL and Andel developed the masterplan, contributing expertise on the human scale, civil engagement, and urban life studies, in direct alignment with the project’s visions. The Kolding School of Design contributed expertise in play as a design element through the LAB for Play Design and research into how play can be integrated as an active design principle.

BOGL designed the landscaping project, bringing an approach in which play and nature function as structuring elements in urban development. The practice has solid experience with nature-based solutions and rainwater management as recreational elements in public space. NIRAS provided engineering consulting for site development, with a focus on water management and biodiversity.

Tegnestuen Vandkunsten, CEBRA, LOOP, AART, Lokal, and ReVærk worked on building plots 01–04, alongside Artelia as the coordinating cross-disciplinary engineer. JaJa Arkitekter and Tegnestuen Vandkunsten are the architects for the following two plots, 06 and 11, in collaboration with Artelia and Søren Jensen Rådgivende Ingeniører, respectively. On the test buildings, several of the above-mentioned collaborators are joined by consultants from Rambøll and Ingeniør'ne.

All partners are active across a broad range of innovative projects in Denmark, contributing with extensive experience in alternative housing forms, integrated community functions, and nature-based design solutions.

Smaller architectural practices were invited into the process through targeted workshops and a development day held in collaboration with the Danish Association of Architects, where they were given the opportunity to contribute with sketches and ideas.

The aim was to bring the next generation of practices into the project and ensure broader professional diversity in the solution space. The winners, ReVærk, were subsequently invited to participate as project-specific architects. They were chosen for their capacity to engage in democratic dialogue with others, for their focus on materials and holistic thinking, and because they presented not a finished product but an approach aligned with the project's visions. This illustrates a deliberate strategy of opening the innovation process to new perspectives while maintaining clear curatorial control over the project's direction and ambition level.

In addition, several civic and commercial actors have been involved to bring supplementary knowledge into the process. The development days established at the project's outset gave residents and local businesses a role in decision-making and created the opportunity to incorporate their needs and perspectives into the project. The collaboration with the municipality is notable as a productive working relationship throughout.

Building System and Construction Program

The project's mandates cover multiple parameters: DGNB certification, material choices, a low carbon footprint, and an ambition to create vibrant public spaces through playful architecture.

A central learning from the project is the necessity of truly working differently from the industry norm. The result of this realization was the creation of a shared building system for building plots 01–04, developed in partnership with a number of involved actors. The system provides a modular, consistent structural framework that can be applied across typologies while still allowing variation and architectural differentiation within individual buildings.

The building system changed the conventional design process through a deliberate shift: from Design-to-System to System-to-Design. The defined building system moves material choices and structural layouts, derived from the requirements and mandates set out in in the thematic programs, ahead of the classical design phase, bringing sustainability and efficiency decisions to the forefront and operationalizing them directly in the building system from the outset rather than adding them to a finished design. The result is a standard that reduces delays and repeated iterations, and a building system with a high proportion of bio-based materials above ground, including timber as structural frame, party walls, and floor slabs and 89% bio-based insulation.

Another requirement was the integration of circularity into the building system through design for disassembly with a view to future reuse. This proved more challenging than initially anticipated and has led to redesigns and the replacement of built-in material components.

Rethinking Apartment Size and Reducing Built Square Meters through Integrated Shared Functions

Apartments range from 41 to 151 m², with an average of 95 m², relatively low floorage compared to typical newbuilds in comparable locations. To compensate for the smaller private units, communal buildings, shared guest rooms, shared workshops, and shared workspaces have been provided for residents.

The result is twofold: lower embodied carbon per person and improved everyday quality of life through more shared functions.

Strategic and Transparent Knowledge Sharing as a Catalyst for Industrial Transformation and Market Maturation

Travbyen is designed as a learning project. Its scale and complexity make its findings, learnings, and insights directly relevant to the rest of the construction sector. Through Travbyen's knowledge bank, KIRKBI and its partners have released the report "Construction Insights 01" as well as LCA calculations and fire test results via Brandbanken (a Danish knowledge portal that collects and shares fire test documentation for biogenic building materials), enabling other actors to gain knowledge and insights from the project and further accelerate innovation by building on documented solutions rather than starting from scratch. This strategic knowledge sharing has the potential to accelerate standardization, initiate dialogues about regulation, support market maturation, and drive changed behavior across the value chain, and in so doing, inform new practice.

A collaboration has also been initiated with BUILD at Aalborg University with the aim of actively bringing research into a broad range of projects and ensuring that the knowledge and experience generated along the way is anchored in university research.

The developer intends to publish further material as experience accumulates and knowledge relevant to the sector is generated throughout the project.

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Leralliancen

Image: Oscar Uhrskov Mikkelsen

Project details

Scope: Development, production, testing and use of building modules made from rammed earth

Project period: 2023-2025.

Developers: PensionDanmark, KIRKBI, CPH Village.

Consultant team: Juul Frost Arkitekter, ReVærk, MEE Studio.

Additional partners: Én Jord, Gantio Robotics

Funding: The project is supported by Realdania

Leralliancen is a research and development partnership initiated by a group of developers and consultants focusing on the use of rammed earth in construction. A broad range of actors have contributed to its knowledge network, including KIRKBI, PensionDanmark, CPH Village, Juul Frost Arkitekter, ReVærk, MEE Studio, Engel Architects, Robots at Work, én jord, the Technical University of Denmark (DTU), and the Danish Technological Institute.[1,2] Supported by Realdania, the alliance works to develop rammed earth into a documented, standardized, and scalable building material.[3] The aim is clear: to create a genuine alternative to concrete and cement-heavy construction, and to deliver low-emission, bio-based buildings in practice. Lifecycle calculations show that combining timber and rammed earth can reduce a building's climate impact by up to 75% compared to conventional construction.[4]

Beyond its lower carbon footprint, rammed earth offers several additional advantages as a construction material.[5]

The documented benefits identified by Leralliancen include:

- The material requires no firing or chemical treatment in the manufacturing process.
- It can be locally sourced and returned to the local environment after use.
- It has good moisture-regulating and thermal properties and can absorb airborne particles.
- It requires no surface covering and can be used in load-bearing structures.
- The manufacturing process can potentially be automated through new technology.

Documented Results

- **From idea to building element.** Leralliancen has succeeded in developing and producing a rammed earth element suitable for both load-bearing and non-load-bearing structures. Throughout the process, Leralliancen has tested and documented its properties, production techniques, and applications, building an evidence base for both the material and the element itself.
- **Mapping the process from material extraction to building element.** Leralliancen has investigated clay deposits in Denmark and analyzed which types are best suited for the production of building modules. They then mapped the critical factors in the manufacturing process: degree of compaction, layer bonding, and drying times.
- **A building element that takes the whole value chain into account.** Actors from across the value chain have participated actively in Leralliancen, and this has been decisive in shaping the design parameters for the clay elements, ensuring compatibility across the building process. Key parameters include: elements must be stackable on pallets to facilitate transport; weight must be below 500 kg so they can be handled with standard site equipment; and elements must stack with high precision to ensure buildability.
- **Iterative industrialization and automation of the manufacturing process.** Although rammed earth is an ancient material with almost no established use in Danish construction, Leralliancen has succeeded in moving from a manual stamping process to demonstrating that an efficient, automated, and robot-controlled manufacturing process for rammed earth structural elements is feasible.
- **Development of quality control principles and practices.** To systematically ensure and document the buildability and strength of the elements, Leralliancen has developed a range of control principles and practices. Quality control focuses primarily on ensuring optimal moisture content in the elements, which is critical for resistance to shrinkage and cracking. The process starts with visual inspection of the clay before production, followed by weighing of the produced elements throughout the drying period, and concludes with geometric precision checking to verify that elements are produced within accepted tolerances.
- **Developing new test methods by drawing on knowledge from abroad.** To systematically ensure and document the buildability and strength of the elements, Leralliancen has developed a range of control principles and practices. Quality control focuses primarily on ensuring optimal moisture content in the elements, which is critical for resistance to shrinkage and cracking.

The process starts with visual inspection of the clay before production, followed by weighing of the produced elements throughout the drying period, and concludes with geometric precision checking to verify that elements are produced within accepted tolerances.

- **Creating the foundation for new standards and a new industry.** Leralliancen has taken an ancient material and qualified it for today's practice: demonstrating its durability, developing a scalable manufacturing process, and proving compatibility across a value chain. Leralliancen has optimized production and designed a buildable rammed earth element for use in commercial industrial construction projects. In so doing, it has created the foundation to scale in practice.

Key Learnings

- **Further development is needed.** Despite the quantum leap Leralliancen has made in clay construction, further development is required. Inherent limitations still prevent full integration of clay elements into modern construction, including vulnerability to impact during transport and inadequate weather resistance. These vulnerabilities can be critical for the material's integrity and durability. Danish standards and testing and quality requirements also still need to be developed.
- **Principles for handling clay as a raw material:**
  - *Time:* If surplus excavation soil is to be used, all raw materials must be processed within approximately one week. Topsoil from gravel pits is recommended as the primary resource, as it is the most stable source.
  - *Movement:* Raw materials should be moved as little as possible, as each additional move increases cost and complexity.
  - *Season:* Weather conditions affect production potential, as wet weather produces wet soil that is not optimal for manufacturing clay elements.
  - *Contamination:* The contamination level of the soil must be tested early to determine whether the raw material is suitable.
- **Proof of the value of value-chain collaboration and integration of research, consultancy, and industry.** Leralliancen demonstrates how effective lower-carbon solutions and materials can be developed when multiple actors collaborate across disciplines and communities of practice. The combination of expertise in materials, manufacturing, testing, and documentation, alongside a specific demand from developers, has been essential to developing usable clay elements in a field where no national standards, practice, or norms previously existed.

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ByK with TRUST – Strategic Partnerships across a Framework Agreement

Copenhagen is experiencing significant population growth, which is increasing pressure on Byggeri København (ByK) – the City of Copenhagen's in-house developer, responsible for developing and managing public buildings such as the municipality's schools and daycare institutions – to improve the efficiency of its construction program.

In November 2016, ByK entered into a framework agreement with the strategic partnership TRUST, known as ByK with TRUST.[1] TRUST brings together a range of actors from across the sector: Enemærke & Petersen (main contractor), KANT Arkitekter and Nøhr & Sigsgaard (architects), Dominia and Norconsult (engineering and design consultants), GHB Landskab (landscape architects), and Rekommanderet (fixed consultant). The partnership was tasked with developing and delivering school and institutional buildings and renovations over a four-year period. In a subsequent procurement round, TRUST won a new framework agreement for the period 2022–2025.[2,3] The partnership represents a fundamentally different way of working compared to conventional project-by-project tendering, one built on trust, integrated consultancy, and shared value creation over multiple years.

"In far too many projects, collaboration happens by chance in the wake of pre-qualification and tendering processes rather than as a deliberate choice. Today, we can document that deliberate choices and repetition are not just nice to have. They are a precondition for developing construction projects efficiently and handling the requirements bearing down on us: the green transition, renovation and transformation rather than newbuild, data-driven documentation, and a political expectation of cost certainty under pressured construction budgets – which often fail to keep pace with construction inflation and evolving legislation, including lower CO_2 requirements."

Uffe Bay-Smidt, Architect and Commercial Director, Sweco Denmark, to byrummonitor.dk[4]

ByK med TRUST

Project details

Scope: Renovations, conversions, modernisation, extensions, schools, daycare centres, after-school centres, supported housing and more, in the City of Copenhagen.

Framework agreement: 2016-2020 (first round), 2022-2025 (second round)

Location: City of Copenhagen, Denmark

Developer: the City of Copenhagen's construction unit (ByK)

Contractor: Enemærke & Petersen.

Architects: Sweco Danmark/KANT Arkitekter, Nøhr & Sigsgaard, LYTT Architecture/GHB Landskab.

Consultants: Dominia, Norconsult.

Additional partner: REKOMMANDERET.

Documented Results

- **Over 60 projects delivered on time, on budget, and to quality.** ByK with TRUST has completed over 60 construction projects of varying typology, size, and complexity without costly disputes between client and supplier. These projects have met cost, time, and quality targets through continuous optimization of the relationship between development, quality, and cost through the repetition and knowledge accumulated across projects.[5]
- **Strategic partnerships break from the traditional collaboration culture and process.** ByK with TRUST has established a shared culture and sense of accountability that has secured long-term, trust-based, and effective collaboration from the outset.[6]This has been achieved by submitting a joint bid for the framework agreement, selecting partners deliberately in advance, and aligning shared interests before the work began. The framework agreement is therefore both innovative and culturally disruptive in a sector where individual projects and tasks have traditionally been tendered separately, and where collaboration has typically emerged only after project start and depended on winning individual sub-contracts.
- **Costly disputes and construction conflicts eliminated.** The model has broken from the traditional culture of conflict in the construction sector. The partnership has built a trust- and dialogue-based collaboration in which no money has been spent on lawyers, disputes, or arbitration.
- **The partnership and model has gained professional recognition.** ByK with TRUST has received sector recognition for its innovative collaboration process, including the Industry Role Model of the Year 2018 award and the Process Prize at the 2019 Building Awards. This recognition confirms that the model sets new standards for process and collaboration culture.[7]
- **Stronger professional dialogue and co-created solutions.** When partners, client, contractor, architect, and engineer work in the same office and attend shared meetings, close professional dialogue develops naturally. This
- establishes a broader knowledge foundation on which to make decisions and produces better and faster co-created solutions that collectively contribute to more efficient project delivery.[8]
- **Created a reference model for the sector.** The ByK with TRUST success story demonstrates that integrated consultancy, contractors, and design-and-build contracts can deliver projects on time and to budget. It has inspired other organizations in the construction sector to attempt strategic partnerships. KAB (Danish non-profit housing association) and Enemærke & Petersen, together with a consultancy team, formed the construction partnership "&os" in 2019.[9] FSB (Danish non-profit housing association), Civica (Danish non-profit housing association), and Hørsholm Municipality have also entered into partnerships with multiple suppliers.[10]
- **Shared sustainability ambitions in a new partnership.** When the parties entered a new partnership agreement for the period 2021–2025, focus shifted from merely changing the traditional way of working to achieving sustainability through resource minimization and reuse, as well as attaining DGNB certification.[11]
- **Material reuse across different projects.** ByK with TRUST has exploited the significant potential for reusing materials across projects that the framework enables. The partnership has launched several initiatives to increase reuse, including the use of 3D cameras to build digital models of buildings approaching demolition or renovation. These models map reuse potential internally and can be shared with partners, who can then bid on materials and fittings to reuse in their own projects.[12] In one example, 350,000 bricks from a school were reused in another project.[13]
- **Research integrated into practice and knowledge sharing.** The framework agreement's procurement model and the TRUST partnership offered a unique research opportunity: to gain insight into what happens in practice when multiple organizations enter a long-term collaboration. An industrial PhD fellow was therefore attached to ByK with TRUST, supported by Innovation Fund Denmark and Realdania. The research examined how the new procurement and collaboration model can drive innovation and embed it within construction practice.[14] Following the three-year project, the researcher, in collaboration with Enemærke & Petersen, published a freely available book: *Experiences and acts about the strategic partnership – told by practitioners*.[15] The partnership has therefore not only benefited from research in practice, but has contributed to improving the knowledge base across the sector.

Key Learnings

- **Framework agreements turn repetition into capability.** Framework agreements allow cross-disciplinary partnerships to build a shared knowledge and practice base in which solutions and processes can be standardized and transferred systematically from project to project.[16] This strengthens both individual and organizational capability and contributes to incremental innovation and improvement between projects. Through the repetition effect, standards and knowhow are established that can deliver higher quality and greater certainty in individual projects.
- **Flexible organization and standardized execution.** This type of partnership establishes a flexible framework that enables repetition and smooth processes, increasing efficiency and reducing delivery times. This is possible because the partnership can steer and prioritize resources across a broader portfolio while working from a shared, aligned logic and standardized processes. The combination allows the partnership to adapt to shifting needs and deliver fast, effective results.
- **The repetition effect works best with a stable and continuous portfolio.** Evaluation shows that the partnership model delivers the greatest benefit when the project portfolio is stable and consistent. There are also indications that a larger portfolio generates more repetition effects than a smaller one, because it enables greater economies of scale. Large fluctuations in projects and plans make it difficult to capture the full benefits of repetition and synergy, whether in financial terms or in the accumulation of organizational and individual learning.
- **Early involvement contributes to adherence to schedules and quality requirements.** Crucial to the partnership delivering results is the early involvement of broad professional expertise in planning. By bringing the architect, engineer, contractor, and installer into the same room from the outset, problems are examined from multiple disciplinary perspectives. This helps clarify dependencies and uncertainties and produces optimized project plans and technical solutions that are compatible across the whole value chain from the outset.
- **Framework agreements reduce hard transaction costs.** Pooling procurement into framework agreements reduces costs for both clients and suppliers. Clients save time and money in processing procurement documentation, while suppliers save time and resources in preparing bid materials. The close, integrated collaboration between the parties also reduces expenditure on legal assistance and arbitration.
- **A successful collaborative culture requires deliberate effort.** Building a trust-based collaboration and shared sense of accountability requires the active and conscious establishment of a shared culture. The parties must deliberately adapt their individual working cultures, norms, and practices into a more streamlined collective approach. This can be motivated by formulating and realizing shared goals and ambitions. It is worth noting that the process can potentially affect employee stress levels, because people are required to deliver under significant pressure while simultaneously changing their work routines
- **Shift from project to portfolio approach removes barriers to reuse.** The ByK with TRUST partnership shows that it became easier to identify and coordinate reuse potential and overcome some of the usual barriers. Because the framework agreement means that multiple projects have the same client, contractor, architect, and consultant attached to multiple construction sites, the critical mass of material reuse increases. This addresses some of the problems with conventional public procurement, which creates procedural and timing barriers to reuse: short tendering periods, complex coordination of demolition contractors, uncertainty about ownership and the uptake of materials, and logistical challenges.
- **No evidence that framework agreements have a negative impact on radical innovation or architectural expression** When the partnerships were established, concerns were raised that standardization and repetition within framework agreements would produce monotonous architecture and low levels of innovation. The evaluation concludes that the architectural discipline and its methods are respected and prioritized within the partnership. The evaluation does note, however, that maintaining architectural freedom requires deliberate effort and continuous strategic work. It also finds that the partnerships do not inhibit radical innovation, citing the implementation of digital tools for developing circular material systems as an example.
- **Researchers create value and strategic advantage** Establishing connections and collaborations with researchers generates value for a project by providing insights across projects, prompting reflection, learning, and changed practice, as well as increasing the potential for repetition effects. It also produces unique insights into new areas of knowledge not yet widely integrated in the sector. This allows industry organizations to gain strategic advantage and build experience with new technologies and processes, staying ahead in a highly competitive industry.

“Value creation happens the moment the researcher walks through the door. Every construction project has a kind of blank-slate quality about it, and in the construction industry we aren’t great about taking what we learn from one project forward into the next. Research can add something by looking across projects, and suddenly we had a level of reflection and some powerful feedback loops that we couldn’t have created ourselves. And I can confidently say that Nicolaj [Frederiksen] (Industrial PhD at E&P) is a large part of the reason that strategic partnerships today is an area where we stand very strongly as a company.”

Anders Sørensen, Head of Sustainability, Enemærke & Petersen, in Realdania’s Annual Magazine 2025.[17]

- **Established precedent for an industrial research symbiosis.** Following the ByK with TRUST PhD project, Enemærke & Petersen has participated in multiple further research projects and has several PhD students attached to the company.[18] [19] [20] The first research project embedded in practice thus established a foundation for how research and the construction industry can bring out the best in each other and drive new initiatives, solutions, processes, and innovation in both construction technology and sustainability.

“It was an eye-opener for our organization when we invited the first industry PhD to join us. And today I simply cannot imagine not continuing to have PhDs attached. I no longer need to make the argument for it, and across the organization there is broad recognition of the value it delivers.”

Anders Sørensen, Head of Sustainability, Enemærke & Petersen, in Realdania’s Annual Magazine 2025.[21]

How They Do It

- **Close physical co-location in a shared office.** The client and all suppliers work together in a single shared office, with joint meetings, professional dialogue, and shared activities such as knowledge-sharing days and Friday socials. This is a decisive factor in building trust, as it creates conditions for both formal and informal interaction and relationship-building.
- **Close physical co-location in a shared office.** The client and all suppliers work together in a single shared office, with joint meetings, professional dialogue, and shared activities such as knowledge-sharing days and Friday socials. This is a decisive factor in building trust, as it creates conditions for both formal and informal interaction and relationship-building.
- **Integrated consultancy and a shared project team.** The partnership has established a project team which pools all disciplines and knowledge from architecture, construction, project management, technical consultancy. and specialist advice, allowing rapid reprioritization and reorganization of capacity as needed.
- **Long-term shared interests and goals**. The collaboration within TRUST is the result of a deliberate choice: the actors formed their partnership before winning the tender. This deliberate selection of partners, combined with a multi-year framework agreement, created a shared long-term foundation of interest and commitment. From that foundation, the focus has been on finding shared solutions rather than assigning contractual blame. The mutual interdependence between parties has significantly reduced the number of conflicts and established shared goals for delivering quality projects on time and within budget.
- **Shared processes and methodology with a focus on learning and optimization.** ByK with TRUST has developed common internal processes, workshops, and methods through which they systematically address process challenges and technical problems. This enables economies of scale and the continuous optimization and standardization of learning between projects.
- **An active and strategically strong client function.** The client has been an active catalyst in launching the strategic partnerships. ByK has been willing to invest in the new collaborative model and has continuously managed expectations. This is essential for delivering a change of this magnitude.
- **Upskilling sustainability competencies.** The entire TRUST leadership team, together with 30 employees at Enemærke & Petersen, have completed DGNB certification training. The aim is to spread understanding of sustainability throughout the organization and processes so that knowledge is not limited to a single specialist.
- **Mapping potential reuse materials.** Cameras and 3D models have been used to map materials with reuse potential. This creates an overview of reuse opportunities across the portfolio and opens the possibility of entering into collaborations with third parties who can take over reusable fittings and building materials.
- **Research collaboration.** Enemærke & Petersen employed industrial PhD researcher Nicolaj Frederiksen with the aim of further developing the partnership model through collaboration with ByK with TRUST from the shared office. The PhD is funded by Realdania’s innovation campaign, Innovation Fund Denmark, and the Knud Højgaard Foundation, and is attached to the industrial PhD networks the *Smart City Research Network*[22] and Circular Built Environment[23] under the auspices of the BLOXHUB Science Forum. Enemærke & Petersen also participates in BLOXHUB’s new industrial PhD network, *Toward a regenerative built environment.*
- **On-site research in practice.** The attached industrial PhD researcher shared an office with the other parties in ByK with TRUST. This both increased practitioners’ accessibility to the researcher and gave unique research insight into practice. It also reduced the distance from theoretical insight to practical action.
- **Connection to wider R&D.** Enemærke & Petersen has several additional industrial PhD projects on circularity, reuse, and construction site optimization, which relate to a number of the sustainability themes being tested within TRUST.

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EP PRO – A Platform for Actor and Knowledge Integration

EP PRO is an award-winning production system developed by Enemærke & Petersen in collaboration with PricewaterhouseCoopers (PwC) and Aarhus University, with the aim of increasing productivity on the construction site.[1] It began in 2022 as a test case for a concept developed by PwC, Aarhus University, and Værdibyg, funded by Realdania through the Effektiv Byggeproduktion (Effective Construction) project, also known as Byggeledelse 2.0.[2] Since then, EP PRO has been applied across multiple Enemærke & Petersen projects and has earned the firm the Process Prize at the 2024 Building Awards.

The development project found that productive work accounted for only 27% of the time spent on construction projects, due to challenges in planning, execution, and management structure. The implementation of EP PRO was therefore motivated by the potential to increase productivity by focusing on three core elements: Leadership, Flow, and Value. The concept has also been tested in collaboration with Adserballe & Knudsen (Danish contractor) and NCC (Nordic construction group.[3, 4]

EP PRO increases productivity by integrating established approaches, including Lean Construction and the Last Planner System, alongside knowledge and experience drawn from manufacturing. By systematically involving actors from across the value chain early in the process with clearly defined responsibilities and roles, it creates the conditions for stronger leadership, more detailed planning, and improved availability of information and data. The system creates value by establishing a clear structure for communication between project actors, enabling data-driven decision making and anchoring accountability within the project.

Project details

Scope: Development and implementation of a new "production system"

Project period: From 2022

Contractor: Enemærke & Petersen

Consultant: PricewaterhouseCoopers (PwC)

Knowledge partner: Aarhus University

Others: Værdibyg, supported by Realdania

Documented Results

- **Increased productivity.** With EP PRO, Enemærke & Petersen has succeeded, in some cases running nine months ahead of original project plans. PwC estimates that Byggeledelse 2.0 can increase productivity by 10% to 20%.[5] This is supported by an Aarhus University report finding a 10% productivity increase with implementation of the framework.[6]
- **Early involvement, data-driven decisions, and improved flow.** EP PRO has enabled Enemærke & Petersen to increase transparency through structured communication and leadership across actors and processes on construction projects. The system works because it applies an up-front approach to construction production rather than an ad hoc one. Subcontractors and suppliers are involved before construction begins, enabling transparent dialogue between disciplines and realistic planning with adequate time allocated for specific tasks. The increased transparency has provided better access to data and embedded knowledge from project actors, and made it possible to make decisions based on evidence rather than intuition. This is essential for achieving better planning, execution, and productivity optimization.
- **A scalable system that can be adapted.** The underlying principles of EP PRO – Leadership, Flow and Value – leverage the advantages of a systematic, logical, and structured approach to construction production and early stakeholder involvement. EP PRO is therefore a production system that can be adapted and transferred to other projects.
- **More precise estimates and reduced financial risk.** While additional work can still arise, data-driven decisions and increased transparency enable subcontractors to produce more precise project estimates. This has helped reduce the risk to the overall contract sum, which is typically between 8% and 15%.[7] As a result, Enemærke & Petersen has been able to offer more precise and stable pricing to clients.

Key Learnings

- **Planning is the heart of the project.** To achieve an efficient construction process and capture the benefits of EP PRO, it is essential to recognize that planning is the foundation of every successful construction project. Planning must be prioritized. It is the precondition for successfully distributing responsibility, executing efficiently, and thereby achieving Leadership, Flow, and Value.
- **Implementation requires facilitation and adjustment.** Involving many actors early, as EP PRO requires, reverses conventional working practice. Implementation can therefore be resource-intensive, as involvement, detailed planning, and data collection require significant internal or external facilitation. As the system is applied across more projects, experience with it grows and the need for facilitation can be expected to decrease as a new norm becomes established.
- **Local adaptation produces results.** No two projects are identical. Each tool and method available in EP PRO must therefore be adapted to the individual project and site. The adaptation of the Last Planner System is one example. Where adaptation to the local context succeeds, productivity increases.[8]
- **Greater satisfaction leads to higher efficiency.** The increased involvement of actors that EP PRO brings about, and the transparency that follows from it, increases employee satisfaction, which in turn increases efficiency.

How They Do It

- **Early involvement and strict prioritization.** Enemærke & Petersen has realized EP PRO's benefits by involving subcontractors early. This has required strict prioritization of planning, leadership, and knowledge facilitation from the outset. Setting clear priorities and involving actors early creates the conditions for good, considerate collaboration. And healthy collaboration is the precondition for the smooth flow of data, materials, and information between actors that drives value creation.
- **Collaboration with consultants and universities creates value and innovation.** EP PRO has been adapted and implemented in Enemærke & Petersen's processes in collaboration with consultants from PwC and researchers from Aarhus University, a collaboration crucial to the success of the production system. It also reflects Enemærke & Petersen's willingness to use research directly in projects and demonstrates how this creates both research value and industrial returns. EP PRO is an example of how research can identify a potential, develop theoretical solutions and, through industrial collaboration, produce real industrial innovation.

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7 Enemærke & Petersen. "Projektchef: "Jeg sidder allerede nu og planlægger afleveringen af renoveringen – og der er et år til"". 2024. https://eogp.dk/nyheder/ep-pro/.

8 Wandahl, S., Salling, S. & Pérez, C.T. "Case 2: Bartholin. Serietitel Effektiv Byggeproduktion". Aarhus Universitet, Institut for Byggeri og Bygningsdesign, 2023. Redaktion afsluttet Juni 2023.

Urban Partners - Ripple Residence

Visualiseringer: Dimension Design

Project details

Scope: Multi-storey timber housing, comprising 115 owner-occupied homes

Floor area: 13.100 m².

Construction period: 2024-2026.

Contractor: 5E.

Architect: Henning Larsen Architects.

Consultant: Søren Jensen Rådgivende Ingeniørfirma.

Additional partners: CLT Denmark, Rambøll, DBI, Taasinge, Riis Akustik.

Ripple Residence was developed by Urban Partners (founded as Nrep in 2005, now a pan-European private investment platform), operating under the full commercial requirements of a private equity platform: return expectations, cost pressures, and delivery constraints. The significance of this case is precisely that: they are fully exposed to market conditions. They are working within them, systematically delivering innovation at scale, and demonstrating how decarbonization and innovation can be integrated into a conventional investment model, proving that the transition in construction and commercial performance can go hand in hand. With a substantial portfolio, they also have the capacity to scale new solutions and create real impact on market practice.

Central to this is an explicit distinction between perceived and actual risk when evaluating new materials and solutions. The purpose is to move risk management away from habit and systemic inertia toward decisions based on documentation and cross-project learning. This is supported by early integration of the value chain, ensuring relevant knowledge is brought in during the project's initial phases and innovation is actively demanded from contractors and producers. In some cases, Urban Partners goes further and deliberately shortcuts the supply chain, engaging directly with major material producers on volume, specifications, and climate requirements. This creates real demand for lower-carbon materials and builds capability among the actors responsible for delivery.

Central to Urban Partners' innovation engine are the Earthshot projects, of which Ripple Residence is one. These projects operate under an alternative investment logic: rather than maximizing short-term return on investment, the success criterion is generating learning that can be scaled across the portfolio. They function as test laboratories where new solutions are tested and documented before being implemented across the portfolio. Ripple Residence is part of a series of innovation projects that includes UN17 in Copenhagen and the Bålsta logistics center in Sweden. What is key is that Ripple Residence is not an isolated innovation project. It is a product of an integrated system of financial incentives, organizational structures, strategic partnerships, and documented performance – a self-reinforcing dynamic in which decarbonization and commercial performance increase concurrently.

Documented Results

- **Innovation does not compromise the business case:** The project has been sold and stands as a robust commercial case in which the level and cost of innovation has not undermined returns. As the Ripple Residence team puts it: "For us, this is a super solid business case."[1]
- **Technical breakthroughs and documented performance in practice:** Virtually every element above the foundations: load-bearing structures, walls, staircase cores, elevator shafts, and parts of the facades have all been delivered in timber (CLT and glulam).[2] At the same time, technical solutions have been developed and adapted to ensure the building meets the Danish Building Regulations' acoustic requirements. This is significant because acoustics consistently stand as one of the primary barriers to multi-story timber construction. Solving that issue within a commercially robust business case, at this scale, establishes documented precedent for the broader use of timber in construction.
- **Reduced climate impact in operation and across the full lifecycle:** The expected LCA is approximately 5 kg CO_2 eq./m²/year, indicating a low overall footprint across the building's lifecycle. Operational emissions are 1.1 kg CO_2 eq./m²/year, pointing to an operational set-up with a relatively low climate impact.

Key Learnings

- **The Earthshot format enables high levels of innovation by shifting the mandate.** Moving the success criterion from maximum short-term ROI to learning and scaling new solutions at portfolio level, with a longer return horizon, paves the way for innovation. Without this mandate, the level of innovation in this project would not have been possible.
- **Early integration of contractors, other actors, and material suppliers reduces risk and ensures solutions are implementable in practice**. Early inclusion of relevant knowledge and expertise in decision-making and design processes is not a nice-to-have. It is the mechanism that moves innovation from concept to deliverable solutions with managed risk.
- **Risk can be transferred from the construction site to early testing and development phases.** Working directly with material suppliers and testing foreseeable complications early in the process de-risks new solutions and makes them ready for scaled application.

- **Prime locations as innovation financing mechanism.** Prime locations can carry green premiums, making it possible to fund lighthouse projects and turning location value into an innovation financing mechanism.
- **Innovation must be coupled with the portfolio, not isolated at project level.** Learnings from earlier projects must be operationalized, standardized, and scaled across the construction portfolio.
- **Internal LCA targets and decarbonization roadmaps make carbon impact a structural factor in decision-making.** It is not a secondary consideration.[3] When carbon is priced into decisions from the outset, the portfolio moves in a consistent direction and creates a demand for innovation.
- **Developers can create innovation demand through supply chain shortcuts.** By going directly to producers and bypassing the usual intermediary layers, developers can use the combined purchasing power of a large portfolio and clear requirements to force suppliers to innovate.
- **Distinguish perceived risk from actual risk.** Use alternative test standards, technical approvals, and material data packages from other countries, such as ETA, CE marking, and EPDs, as objective risk indicators when implementing new materials and solutions. This allows perceived risk to be distinguished from actual risk, and enables decision-making based on evidence rather than on the constraints of the systemic inertia of regulatory frameworks.
- **Bang for the buck: Go after the highest CO_2 reduction per unit invested.** Approach decarbonization systematically, always prioritizing the interventions that deliver the most climate impact for the investment made.

"Sustainability actions are most powerful when they are taken early on and are at the core of a business. Putting a price on carbon is a great motivator. To reduce the carbon tax as much as possible, teams are now doing a deep carbon analysis on every building within NREP's portfolio. Our internal carbon tax is a means to an end. It puts us one step ahead in adjusting our business for a greener future, with regulations tightening every year. As such, it reduces risk and drives business value. We see a surge in demand for sustainable real estate, from customers, banks, and investors alike. I firmly believe that decarbonizing now will equate to a future advantage."[4]

Claus Mathisen, CEO, Urban Partners

Mistakes as Valuable Innovation Data – Learning across Projects

Urban Partners has accumulated knowledge in timber construction through a continuous development process across its innovation projects, characterized by a progressive learning curve: start small, test under controlled conditions, monitor feedback from project to project, and scale up gradually.

A clear example of this approach is the learning carried forward from a previous Urban Partners Earthshot project, UN17 (a 35,000 m² residential development in Ørestad, Copenhagen, a hybrid construction combining timber and concrete elements and designed around all 17 UN Sustainable Development Goals).

A decisive lesson was the necessity of resolving critical issues in timber construction early in the design phases. Late decisions in these areas generated additional development work and time pressure, experiences that directly shaped how a later building, Ripple Residence, was designed and managed.

To meet the Danish Building Regulations' acoustic requirements, Urban Partners developed a layered solution without the use of concrete, in collaboration with Søren Jensen Engineers and acoustic specialists. Rather than relying solely on theoretical calculations, the solution was validated through full-scale 1:1 mockups before the 13,000 m² building was constructed. This de-risked Ripple Residence significantly and ensured solutions were developed to be integrated from the outset.

UN17 also revealed a practical barrier: Moisture and Danish weather conditions created challenges when working with timber. SiteCover was therefore implemented on Ripple Residence as a risk management measure, maintaining dry conditions throughout construction and reducing uncertainty in the execution phase.

The comparison between UN17 and Ripple Residence traces a stepwise progression: from a hybrid model to a 100% timber building. This progression became possible because the experience and documentation from UN17 reduced perceived risk and made the solutions more robust. This is the mechanism: Problems encountered become data; data becomes learning; learning becomes a reduction in perceived risk for the next project; and reduced risk enables a higher ambition level.

Section A-A
1:500

Plan, 3rd floor
1:500

Illustrations: Henning Larsen Architects ©

At a more fundamental level, the experience points to a governing design principle: The material's logic and properties are brought forward, and the design and construction process are adapted to its conditions rather than forcing timber into a logic developed for other materials. To operationalize this early, learning from previous innovation projects is combined with testing, analysis, and collaboration, ensuring that solutions are qualified before they are integrated into the final design. This increases project certainty and strengthens the ability to scale documented solutions across the portfolio.

Supply Chain Shortcut

Urban Partners uses its position as a market-defining actor to actively demand innovation across the value chain. The scale of their portfolio means they can go directly to suppliers with requirements for lower-carbon solutions, and in some cases collaborate with the supplier to develop production systems that bring new materials to scale.

A third project, Bålsta, illustrates this clearly. Urban Partners demanded carbon-reduced paving materials and, working with the producer, developed a manufacturing system that is now commercially available.[5]

At Ripple Residence, the developer's LCA requirements required CLT Denmark to rethink their procurement and change supplier. CLT Denmark normally works with KLH, but for this project they had to switch to Södra, because KLH's EPD could not perform within the agreed LCA framework. Only Södra could deliver timber elements with a low enough climate impact to meet the requirement.

This demonstrates a direct mechanism: Stringent LCA requirements actively favor suppliers with strong EPDs and low carbon impact. When only a small number of suppliers can help the developer meet its target, the EPD becomes a strategically competitive instrument, and documented low climate impact becomes a commercial advantage.

The effect cascades across the value chain. First, innovation is demanded from the producer . Then contractors, consultants, and the rest of the supply chain are required to work with these new materials. The entire chain is pushed in a deliberate direction. Additional requirements to suppliers can also include take-back programs, making circularity a condition of collaboration rather than an optional extra.

Value Chain Integration

In the conventional project development model, consultants, in particular structural engineers with their personal liability, frequently become a barrier to new solutions. Bound by national standards and cautious about unfamiliar materials and methods, they filter out innovation before it can be tested. Urban Partners reframes the question: What is the actual risk? This shift from perceived to actual risk means innovation no longer needs to pass through traditional consultant hierarchies. Knowledge, experience, and dialogue can be sourced directly from producers, suppliers, and contractors.

The collaboration with CLT Denmark on Ripple Residence demonstrates the value of bringing specialist knowledge from contractors and producers into process stages where it is rarely present. The consultant's original structural approach was cost-intensive. Urban Partners brought CLT Denmark in alongside the contractor, drawing on their practical experience to contribute structural principles and construction methodology. Building on expertise from previous projects, CLT Denmark reduced the cost of the original solution while maintaining both technical robustness and financial certainty. The collaboration also demonstrated the importance of an agile main contractor: 5E Byg developed working methods that made the new approaches operable in practice.

This approach places suppliers in a role they rarely occupy in the conventional value chain. CLT Denmark has been involved as a consultant in both the design and engineering phases, and is now responsible for constructing the structural shell in collaboration with 5E Byg as main contractor. The shell is built almost entirely in CLT, supplied in partnership with Södra.

Innovation Across Borders

Shortcutting the value chain and sourcing knowledge directly from material suppliers is connected to Urban Partners' systematic practice of distinguishing perceived from actual risk. New materials and methods are identified and developed within an ecosystem of partners, networks, and project references, often from other countries, supported by objective documentation: EPDs, ETA approvals, and CE marking.

These are cross-referenced against reference projects already functioning in comparable markets and geographies. Risk profiles are therefore built on both

Image: Urban Partners ©

Facade East
1:500

Illustration: Henning Larsen Architects ©

documentation and experience, not only from Denmark but across borders.

Use High-end Developments as Scaling Engines

"As a sustainability-driven, long-term investor and responsible landlord, Ripple Residence represents exactly the type of asset we seek to own and operate in the coming decades: high-quality housing with a genuinely low carbon footprint."

Benjamin Kurmulis, Head of Transactions, Proteus.[6]

Ripple Residence proves that innovation can be a solid business case. By strategically using high-end developments in prime locations as lighthouse projects, the premium value generated can finance innovation and scale new solutions.

Construction costs for Ripple Residence are higher than for a conventional project. However, the combined effect of green financing, a more efficient construction site, and the high-end sales potential of the apartments means the commercial case is now as strong as it would have been with a conventional building on the same site.[7] Urban Partners sees a market of both buyers and investors who want to be associated with this type of development. That demand makes it possible to charge a green premium, which in turn can carry a higher innovation and cost profile.

The mechanism is straightforward. High-end developments on prime sites can be used strategically as scaling engines for solutions that will later be deployed across the rest of the portfolio. They can carry the high up-front costs of building through new and innovative methods.

Standardize Process and Production

Ripple Residence is not conceived as a one-off project. It is a step toward a new construction practice: developing solutions and standards that can scale across the portfolio. This entails not just a standardized building system, but a standardization of the entire value chain with prefabrication, partnerships, modularity and circular principles working as a single integrated logic. This reflects their strategy that Earthshot projects must develop new practices applicable across the portfolio and scalable to the whole market.

The building is constructed as a CLT-based system. Load-bearing walls, floor slabs, staircase cores, and elevator shafts are delivered as prefabricated solid timber elements from CLT Denmark and Södra, produced in a factory and assembled as modules on site. Beyond the CLT structure, a number of other components are also prefabricated, including the bathrooms, which are delivered as complete timber-based elements that have achieved the same guarantees and technical performance as a conventional concrete solution.

All primary building components are designed for prefabrication, modularity, and future disassembly. They are assembled with mechanical connections and can, in principle, be broken down and reused as whole elements or materials later in the building's lifecycle. This makes the building system more than a technical solution. It is also a value chain strategy. By working directly with key suppliers on logistics, process, and design, and by establishing this supply chain, deploying the system on future projects becomes substantially easier.

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Boligselskabet Sjælland – Framework Agreements for Timber Construction in Non-profit Housing

Project details

Scope: Framework agreements for the construction of 300-500 non-profit homes (almene boliger) built in timber
Construction period: 2017-2028/2029
Location: Roskilde, Glumsø, Viby Sjælland, Hvalsø, Mørkøv. Denmark
Developer: Boligselskabet Sjælland

Consortium (Framework agreement 1: "Bolig-træ")
Contractor: Adserballe & Knudsen
Architects: Vilhelm Lauritzen Arkitekter, Thing Brandt Landskab
Consultant: Holmsgaard Rådgivende Ingeniører
Additional partner: CLT Denmark

Consortium (Framework agreement 2: "Boligrækkerne")
Contractor: Adserballe & Knudsen
Architects: We Architecture, Mangor & Nagel
Consultant: Holmsgaard Rådgivende Ingeniører
Additional partner: BRAV Rådgivende Ingeniører

Image: Boligselskabet Sjælland

In 2017, Boligselskabet Sjælland (a non-profit housing association based in the Zealand region of Denmark) made a major commitment to timber construction, tendering a framework agreement for up to 400 affordable, sustainable, and flexible non-profit housing units.[1] [2] The initiative was called Bolig-træ (literally "housing timber").

"Even though we aren't a large non-profit housing association, we believe it is important to grab the baton and lead the way in offering standardized sustainable housing with a unique indoor climate. And timber was an obvious choice."

Tommy Novland, Boligselskabet Sjælland, to bygtek.dk, June 25, 2019

The four-to-five-year framework agreement was won by a consortium consisting of Vilhelm Lauritzen Arkitekter (architects), Adserballe & Knudsen (contractor, timber and renovation specialist), Holmsgaard Rådgivende Ingeniører (consulting engineers), and Thing Brandt Landskab (landscape architects), who had developed the building concept CLT-Flex: a modular CLT system whose innovative use of the material makes it possible to use timber as a load-bearing structural material. The system works from 3D models that are sent to producers who then manufacture finished CLT modules for assembly on site.[3]

At the outset, Denmark had no CLT suppliers and the elements were produced abroad. However, by the time Skousbo II, the fourth project under the agreement, was under construction, CLT Denmark (Danish CLT producer) had been established and joined the consortium[4] as a CLT supplier. CLT-Flex has been used in the projects Skademosen, Toppen, Skousbo I and II, and Søgården. The first project was delivered in 2019.

Following the first framework agreement, Boligselskabet Sjælland experienced high demand for townhouses and tendered a new framework agreement for a minimum of 250 units.[5] This agreement, known as Boligrækkerne,[6] was won by a consortium including Mangor & Nagel (architects), WE Architecture (architects), and Holmsgaard Rådgivende Ingeniører (consulting engineers). For this project, the consortium developed a new building system, a timber assembly kit in which the load-bearing structure consists of a timber frame. The frame can be prefabricated indoors, simplifying the construction process on site. The projects Tofteengen, Elverbakken, Alkes Have, and Sømmes Vænge have all been delivered under this agreement.[7]

For the construction of Sømmes Vænge, Adserballe & Knudsen joined the consortium as main contractor.[8] This collaboration led to the development of yet another new modular timber frame building system, using the digital 3D modeling tool Carpent (a digital design and production tool created by Brav Rådgivende Ingeniører).[9] Carpent produces structural, cost, and quantity calculations that help reduce material use and optimize the design, production, and construction processes. Once the 3D model is complete, it is sent directly to a supplier, where a robot cuts the timber beams to size. The frames are then packed and delivered to the construction site, where they can be erected when weather conditions are optimal.[10] The new technology, combined with the framework agreement's conditions, directly contributed to the project being delivered ahead of schedule.

"On the next project, our building system and experience from the other builds will really pay off. So much repeats itself that we can utilize many of the standard details we have developed along the way. The whole concept, details, documentation, and work descriptions already exist, they just need a little adapting here and there."[11]

Lasse Skov Viborg, building designer, Vilhelm Lauritzen Arkitekter, to Konstruktøren, 2019

Documented Results

- **Design and construction of new timber building systems.** The consortia behind the projects have designed the CLT-Flex system[12] [13] [14] and a timber frame system, both of which have proved scalable, flexible, and fast to build through the framework agreements.
- **Digital 3D modelling put to full use.** Both building systems are designed using digital 3D programs, including Carpent, developed by Brav Rådgivende Ingeniører. 3D models are used for cost calculations, early buildability assessment, and direct transfer to production. This produces highly precise components that are straightforward to assemble on site.

- **Large housing projects delivered at speed.** The consortia have successfully delivered large timber construction projects. CLT modules and timber frames are manufactured with high precision, and timber elements weigh substantially less than conventional structural materials such as steel and concrete. This has enabled fast assembly and installation, keeping project costs down. Several projects have been delivered ahead of schedule.
- **Challenges conventional practice and proves innovation is possible in the non-profit housing sector.** As the first large-scale non-profit timber housing project in Denmark, the projects enabled the consortia and Boligselskabet Sjælland to develop knowledge and expertise in designing and constructing timber buildings. In doing so, they challenge conventional building practice by proving that Danish technical requirements for floor separation, fire safety, and moisture can all be met in timber construction. They also demonstrate that even non-profit housing associations operating on tight budgets can innovate.
- **Better indoor climate delivered.** The timber buildings measurably improved indoor climate quality. Timber has a scientifically documented positive effect on human well-being, and certain types of timber have antibacterial properties and good moisture-regulating qualities.[15]
- **Lower carbon housing delivered.** The projects reduced construction's carbon footprint by using timber rather than conventional materials. Timber is a bio-based material that stores CO_2, and its manufacturing process generates significantly lower emissions than many conventional building materials.[16]

Key Learnings

- **Flexible yet standardized timber modules.** CLT-Flex consists of a series of CLT modules – a set of building blocks that can be combined in different configurations to achieve varied architectural expression according to the client's wishes. The structural principle is standardized, which generates repetition effects. Most of these advantages apply equally to timber frame systems.
- **Current Danish regulations are barriers to innovative practices.** Danish standards and norms are not configured for timber, which creates challenges in areas such as fire safety requirements.[17] This is a systemic barrier that projects must work around rather than with.
- **Thorough preparation is decisive.** No large-scale non-profit housing using CLT had previously been built in Denmark. Success required substantial upfront work: designing new building systems, planning, procurement, and investigating how to comply with Danish standards. The investment in preparation paid for itself in execution, making the actual construction process relatively problem-free.
- **Limited sector experience places demands on the process.** Experience with CLT and timber construction in Denmark remains limited. This means actors have to adapt multiple elements of their process: identifying new suppliers, establishing new collaborations, and overcoming caution among consultants unfamiliar with the material.
- **Framework agreements create a positive repetition effect.** By delivering projects under a framework agreement with the same team, experience and solutions are transferred directly from one project to the next. The framework agreement is the mechanism that converts learning into efficiency. This saves both time and money.
- **Partnerships that build knowledge and expertise.** Through accumulated experience across the projects, the partners develop work descriptions and technical documentation that enable compliance with Danish standards. Combined with the repetition effect the framework agreement creates, the consortia can build a unique community of practice, establish reference projects, and create best practices for timber construction in Denmark.
- **Planning and logistics management is critical during installation.** Timber construction offers many advantages in the assembly process, but moisture and rain during construction must be carefully managed to prevent staining and cracking at element ends. This requires the capacity to build efficiently when weather conditions allow, and it demands optimized logistics for transport and storage of timber components.
- **Low-carbon construction can become a strategic business area.** At Adserballe & Knudsen, low-emission construction became a strategic development area in 2025. Their CLT experience and participation in R&D projects are highlighted in their strategy.[18] Developer demand for lower-carbon solutions can therefore generate incentives for research, competitive advantage, and brand value simultaneously.
- **Non-profit housing can lead the way.** Boligselskabet Sjælland's commitment to non-profit timber housing proved that timber construction can be delivered efficiently at large scale, on time, and within budget.

How They Do It

- **The framework agreement created the conditions for close collaboration.** Multiple actors have noted that it generated close, trust-based working relationships, enabling challenges to be addressed early. The long-term structure and the continuity of the same team created a genuine incentive to engage from the outset and to develop solutions that were both sustainable and compatible across the project.
- **Workshops kept challenges from becoming problems.** Regular workshops throughout the construction process enabled issues to be addressed early in the process. This created a project culture with capacity and good momentum rather than reactive fire-fighting.
- **Platform thinking in the modular building system.** Modul-The modular building system served as a platform that made it possible to keep the core structural elements fixed while making it easy for the architectural expression, such as cladding, to be varied from project to project, so that the same underlying structure could support a range of different designs. The platform also increased efficiency, because the fundamental construction processes remained consistent across every project in the framework agreement portfolio.
- **A clear-sighted and committed client.** Boligselskabet Sjælland had a clear vision from the start: to create a lower-carbon, affordable, and flexible housing system. This set a clear direction for the framework agreements and generated demand for new solutions. It required a determined and bold client, one willing to take risks and believe in solutions rather than be deterred by the challenges.
- **3D modeling software as an effective production tool.** The consortia used 3D modeling software, including Carpent, to design the new buildings as modular, platform-based systems. This made it possible to prefabricate modules off-site at factories in Denmark and abroad with high precision, which in turn enabled fast assembly and construction on site. Because the 3D models feed directly into the manufacturing process, elements can also be adjusted quickly and straightforwardly when needed.

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Fælledby P/S – Fælledby

Visualisation: Henning Larsen Architects ©

Project details

Scope: Approximately 2,000 homes (including 25% non-profit homes / almene boliger), two daycare centres, a public school, a care home, local shops, neighbourhood / community houses, multi-storey car parks and a nature centre

Floor area: Approximately 219,000 m²

Construction period: 2022 - 2032.

First move-in: Expected 2026; fully built out around 2032

Locaation: Copenhagen, Denmark

Developer: Fælledby P/S - et 50/50 joint venture between By & Havn I/S og PensionDanmark Ejendomme Holding[1].

Masterplan: Henning Larsen Architects.

Landsacape and urban spaces: Henning Larsen Architects, 1:1 Landskab.

Mobilty plan: Beta Mobility og Ramboll.

Biodiversity plan: Sweco.

Architects on the housing plots under development: ONV Arkitekter and Holscher Nordberg Architecture and Planning (first housing blocks, C4 and C6). Vandkunsten (timber housing on bgb a.s.'s plots C2, C3, C5). Tegnestuen LOKAL (including C4, the "Biohus"). Norland Arkitekter (C6 courtyard house).

Consulting engineers: Ramboll, Nordiq Group, Sweco, Artelia, OVBE, Fjord Rådgivende Ingeniører, C&C m.fl.

Contractors: Scandi Byg (first main contractor on the initial plots), bgb a.s. (design-and-build contract for approximately 205 timber homes on C2, C3, C5), JDH-BYG (bio-based terraced houses on C4 using EcoCocon/Roust, and C6 in CLT elements).

Additional partners: Visibuilt, Sustain, GoMore, Harry vs Larry, VidaLocal, Heynabo!, Digital Estates.

Fælledby is a neighborhood for 5,000 to 6,000 people, currently under construction and designed around a core narrative of coexistence between city, nature, and community. Biodiversity and the relationship between people and nature are the neighborhood's structural foundations. The project attempts to establish an alternative model for construction and urban development.

From the outset, Fælledby has been conceived as more than a new neighborhood and solid investment case. The ambition is to establish a living laboratory: a scaling engine for innovation in construction and urban development, a place for testing, implementing, and scaling visions, ideas, and new solutions.

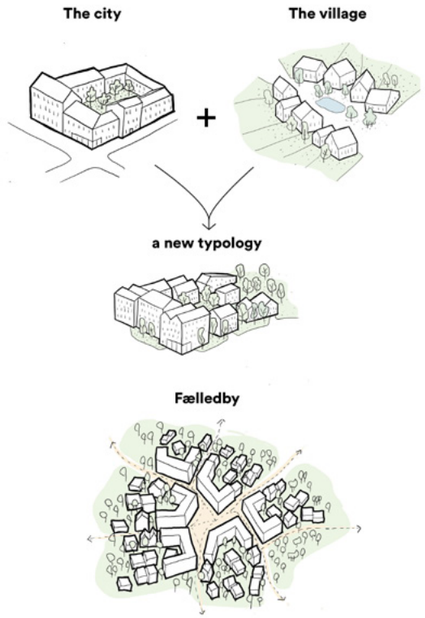

Diagram: Henning Larsen Architects ©

Fælledby is also a project that has generated significant public debate. Its location on a previously undeveloped former camping ground on Amager Fælled commons, a protected 223-hectare nature reserve close to the city center, has raised important questions about how cities balance the need for housing with the protection of nature. That debate places a particular burden on the project, but also acts as a driver. The tension forces the developer to prove that these competing demands can be reconciled and makes it necessary for Fælledby to demonstrate that urban development does not have to come at the expense of surrounding nature, but can take place in dialogue with it.

The vision and success criteria is that the project must demonstrate that construction with a lower carbon footprint is possible. The neighborhood is to be built primarily from timber and a combination of bio-based materials, recycled materials, and innovative use of conventional materials, while simultaneously providing the framework for a thriving neighborhood and coexistence with nature. Not as a compromise between ambition and feasibility, but as proof that the two are compatible.

The ambition level and the timing of decisions are crucial. The vision for the neighborhood was established as early as the ideas competition and has been continuously concretized into criteria that provide the governing framework on which Fælledby is being built. Fulfilling these criteria is what defines success, rather than simply being supplementary ambitions added to a conventional project. They are the foundation.

When carbon impact, nature, and human well-being define the success criteria from the outset, they drive every decision that follows: building components, on-site choices, collaboration structures, the selection of project partners, etc. They also function as a shared narrative that both internal and external partners can align with.

These ambitions have since been further realized in architectural firm Henning Larsen's masterplan, in which nature and local biodiversity are positioned as foundational structures in the cities of the future, while simultaneously supporting human well-being in the city.

Henning Larsen's masterplan gives this complexity a clear direction by positioning Fælledby explicitly as both a nature city and a timber city. Taking the village as a

reference point, the neighborhood is organized around nature corridors and green wedges that create an integrated weaving of built environment and nature.

To underline Fælledby P/S's level of ambition, plans and proposals that depart from conventional frameworks and standards for mobility and parking have been agreed upon. It is precisely this willingness to challenge the status quo that makes the project more than a demonstration: it is a continuous justification for new practice. The project offers a compelling case for how new practices can be implemented, while simultaneously integrating the city's many layers of infrastructure, hierarchies, and functional relationships. In so doing, Fælledby demonstrates an understanding of the inherent complexity of urban development and delivers concrete solutions to navigate it.

Documented Results

- **High proportion of bio-based materials:** Fælledby is being built with a share of bio-based materials that is significantly above the sector norm.
- **DGNB Platinum at both building and neighborhood scale:** The first properties have been certified or pre-certified to DGNB Platinum or Gold, with the ambition that the entire neighborhood of Fælledby achieves Platinum level.[2]
- **Low carbon footprint (LCA):** Fælledby's climate strategy targets a carbon footprint within the low-emission class: a maximum of 6.1 kg CO_2 eq./m²/year from 2026.[3]
- **Energy community at neighborhood scale:** Fælledby has established Denmark's first neighborhood-scale energy community, which is designed to cover up to 35% of the neighborhood's total electricity consumption through local solar panels, batteries, and intelligent management systems.
- **Expected increase in biodiversity:** A targeted biodiversity strategy means Fælledby is working toward a net positive contribution to biodiversity by 2030, at the latest.
- **Proof that the market demands new construction and urban development practices:** Fælledby has generated research collaborations between academia and practice and is being used as a case study by a range of actors across the sector.
- **The project functions as a scaling engine:** Fælledby has been awarded public funding from, among others, the Danish Energy Agency and the Danish Ministry of Transport for its innovation projects in areas of energy and mobility, and participates in EU projects in these fields. It is generating knowledge and tested models that regulators, investors, and developers elsewhere can build on.

Key Learnings

- **Centralized and Hands-on Project Management**
  The developer organization, Fællebyen P/S, is structured to include capacities that span the entire value chain through to the construction site, drawing on strong competences across design-and-build contracting, architecture, engineering, crafts, communication, urban life, and administration. Fælledby P/S operates as an active project organization: present on site, coordinating advisers and contractors, and able to take over construction management directly when needed – as it did when the main contractor suddenly filed for bankruptcy.
- **The Narrative as a Management Tool, Not Just Storytelling**
  The core narratives of nature city, timber construction, and village with a strong community function as a strategic compass, aligning the parties and attracting and filtering collaborators who want and are able to contribute to the project"s profile. This narrative is embedded in governance documents such as Fælledby's Design Manual and Value Program, which underpin the work of every collaborator on the project. It has made it easier to obtain dispensations and support for new solutions, such as reduced parking standards and an energy community, and it connects vision, lower carbon impact, and business case into a single coherent argument.
- **Vision Translated into Requirements and Design Drivers**
  The ambition is not only declared, it is operationalized, anchored in stringent, measurable requirements: DGNB certification, documented CO_2 reduction overarching strategies, and plans including a biodiversity strategy that defines baseline conditions, habitat types, and monitoring.
- **Select Partnerships Based on Competences and Set Explicit Requirements**
  The developer sets explicit requirements for suppliers before they enter the project, including take-back programs for kitchens and installations. Contractors and producers are selected primarily based on their ability to deliver timber construction and hybrid solutions, and on documented LCA and DGNB performance, not solely on price.
- **SMEs as an Agile Innovation Engine**
  A significant share of specialist contracts and key deliveries are supplied by small and medium-sized enterprises capable of working in an agile way and developing new solutions in close collaboration with the developer. Examples include JDH-Byg, bgb a.s., Sustain, and other suppliers of prefabricated timber and bio-based elements, all of which are building new capacity and new value chains through the project.
- **Shared Project Office and *Fælledlab***
  Bringing together the developer, advisors, and contractors in a shared project office and laboratory – *Fælledlab* – makes it easier to maintain an overview, catch conflicts early, and adjust solutions as the project progresses. The Fælledlab building laboratory is a physical space for testing structures, materials, and courtyard designs with natural habitats, generating learning that feeds back into the project continuously. Day-to-day working is characterized by continuous knowledge sharing and cross-disciplinary dialogue.
- **Standardization and Building Systems Serve as Scaling Engine**
  The project deliberately works with standardized timber and bio-based building systems, modular construction, concrete-timber hybrids, prefabricated timber cassettes, and elements in bio-based materials. Repeatable systems and a shared design framework improve construction efficiency and make solutions easier to reuse across plots.
- **Innovation Happens at the Intersection of Disciplines**
  Different professional fields complemented each other in the innovation process. The energy and mobility plan, for example, were developed in close collaboration so that new energy solutions could also use emerging technologies such as vehicle-to-grid systems for electric vehicles.
- **Co-financing and Partnerships for Risk Sharing**
  Collaborations with the municipality, foundations, and national and EU programs, including the City of Copenhagen, Realdania, the Danish Energy Agency, the Danish Ministry of Transport, and the energy programs behind the Fælledby Energy Community distribute risk across multiple collaborators. This makes it possible to go further on bio-based materials, energy communities, and new mobility solutions than any single budget could sustain alone.

How They Do It

"It is in the development of our projects that we can really move the sustainability agenda forward – which is why it must be embedded from the very beginning. As a developer, that is an obligation we have a responsibility to fulfill."[4]

Martin Baltser, Director of Project Development, Fælledby

Co-responsibility as Organizational Design
Fælledby P/S is organized as an independent project company, a joint venture owned 50/50 by PensionDanmark Ejendomme Holding K/S and By & Havn I/S (Copenhagen's publicly owned urban development corporation). The company has its own board, management and staff, and functions as a single, unified professional developer on behalf of both owners.

The joint venture structure is a fundamental precondition for Fælledby's realization. The partnership brings together By & Havn's urban development mandate, experience with large and complex urban projects, public legitimacy, and long-term investment horizons, alongside PensionDanmark's long-term capital, sustainability requirements for its property portfolio and biodiversity strategy.

The 50/50 ownership creates a strategic platform in which public and private interests are unified. When both owners share returns and risk equally, potential conflicts of interest are transformed into shared strategic priorities. Long-term qualities, focus on nature and biodiversity, and innovative energy and mobility solutions can be adopted as joint strategic choices rather than contested trade-offs. The joint venture structure therefore internalizes innovation and learning as a legitimate part of the strategy: not as risk to be minimized, but as value to be realized.

A Strong Narrative Builds a Strategic Asset and Functions as a Compass for Decision Making
"Fælledby is built on a narrative so strong and specific that you can only be a partner if you buy into the premise. The narrative therefore functions as a kind of management tool for the entire project: It makes it easier to sustain ambitions throughout the process, and it gives architects, engineers, researchers, contractors, foundations, and the municipality a sense of shared ownership of the vision."

Signe Kongebro, Global Director, Future Resilient Design, Architecture & Landscape, Ramboll

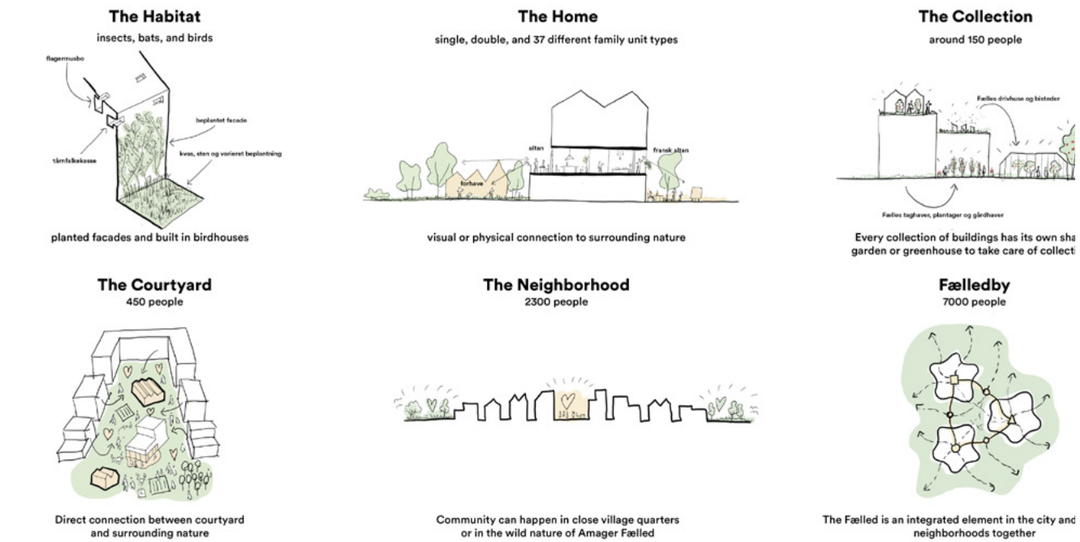

Diagram: Henning Larsen Architects ©

By insisting that the project must exemplify an alternative future for urban development, Fælledby takes on a role that differs from conventional development practice. It must fulfill its basic functions as a new neighborhood with new housing, and it must be a sound business case. But a new, ambitious strategic compass is overlaid on the construction through the narrative of timber, nature, and community, which are then defined as the project's foundation, while construction, mobility and infrastructure are designed to support this baseline without compromising the neighborhood's core functions. This is not construction with nature subsequently integrated into it. It is an inverted order of priorities, in which nature and timber constitute the governing starting point.

The carefully developed narrative therefore establishes an informal mandate for the project. Not in a legal sense, but it changes the basis on which decisions are assessed and shifts the order of priorities. It functions as a management instrument and a strategic tool creating a shared compass and assessment framework across actors, establishing a clear governing line while leaving enough agility to explore and trial innovative solutions compatible with the project's core values. Solutions, collaborations, materials, and processes are evaluated based on their ability to support the project's core vision. This means that familiar strategies, conventional solutions, and established regulations must give way if the overarching vision is to be realized.

The story of an innovative neighborhood built in timber and in coherence with nature also works as a knowledge magnet. It attracts suppliers, contractors, producers, researchers, and other innovative collaborators who share the vision of a changed development practice and who see Fælledby as a practice laboratory and scaling engine for solutions, knowledge, and products. In doing so, it builds a foundation for the broader maturation of new practice. The narrative also carries a clear financial dimension: It strengthens the project by creating demand and a potential green premium among future residents, and by making it easier to attract external innovation funding from foundations and public programs.

The core narrative is therefore not a layer on top of the project. It is a strategic and economic instrument that drives decisions, collaborations, and implementation.

This narrative can be realized because it is reflected throughout the value chain and supported by the fact that the partners' profiles are configured for exactly this type of development. Both owners describe Fælledby as a visionary model city project, designed to test new solutions and serve as a reference point for future urban development. The joint venture structure makes it easier to use Fælledby as a laboratory for bio-based construction, energy community, and low-car mobility, because both the public and the private partner have accepted innovation and learning as part of the strategy, as opposed to focusing solely on short-term optimization.

The separate mandate and organizational autonomy of Fælledby P/S are a precondition for a project with this level of complexity, this number of collaborators, and this degree of new-solution implementation. It reduces the risk of the project being overwhelmed by bureaucracy and ensures focused, agile management of an ambitious innovation project operating within interfaces and regulation that are in constant flux.

Early Anchoring Values, Strategies, and Requirements

"Design decisions made in the early phases paved the way for partnerships, investments, and technological innovation that are now delivering results in ways no one could have predicted, but which were made possible by the project's original design framework."[5]

Signe Kongebro, Robert Joseph Martin, Simon Madsen, in Ramboll post.

Before the masterplan was defined, the developer established a set of central values and requirements in the competition brief: all housing in the neighborhood must be sustainability-certified, timber must be the prevailing construction material, nature must play a central role in the urban structure, and solutions must address climate, biodiversity and urban quality. A concrete area framework was set: only approximately 11.8 hectares can be built on, while at least 6.3 hectares must be designated as nature and open space. The brief also requires approximately 2,000 homes, of which a minimum of 25% must be non-profit housing.[6]

At this point, the decision has been made politically and by the developer to build densely with a lower carbon footprint and a nature-oriented approach before the precise solution is defined. Henning Larsen's masterplan then interprets and sharpens these parameters by adding a series of new, ambitious choices. Fælledby is positioned explicitly as Copenhagen's first all-timber neighborhood, with timber as the prevailing structural principle, and car traffic is reduced through a low-car structure and reduced parking standards.

The plan introduces three "villages" rather than one compact urban block, separated by wide nature corridors. Around 40% of the project area is kept free as nature, substantially more than the minimum requirement proposed in the competition brief.

After the masterplan was adopted, the framework was tightened further through the developer's own requirements: The construction must be designed to DGNB Platinum, with concrete, low CO_2 ceilings of 6.1 to 8 kg CO_2 eq./m²/year.[7] PensionDanmark's overarching biodiversity strategy adds a further commitment: All investments in urban areas and new construction must deliver a net positive contribution to on-site biodiversity by 2030, at the latest.[8]

When the developer makes these choices early in the project, they are not aspirational statements, but fundamental design decisions made in the opening phase of the process. The high ambitions for lower-carbon construction, biodiversity, and mobility force the project and all its collaborators to operate innovatively: through their own targets and plans, seeking unconventional and previously untested solutions, and departing from the building regulations to seek dispensations where needed. This has required a mobility plan developed in collaboration with BETA Mobility and Rambøll, and a biodiversity plan developed by Sweco, both to obtain regulatory approval and to produce a document providing guidance on how to work with biodiversity at this specific geographical location.

Curating, Orchestrating and Integrating Knowledge and Competences

The project's high complexity and ambition have required assembling collaborations in which the right partners provide a professionally qualified basis for decisions and the competences needed to deliver on the targets. Equally important has been maintaining coherence between plans, strategies, and construction, and ensuring that new initiatives can be realized across the entire value chain.

This allows plans, strategies, and processes to be developed concurrently rather than in sequence.

The developer plays an unusually active and orchestrating role in assembling the project partners. Fælledby P/S has not simply commissioned individual services from experts. It has functioned as curator and conductor for parallel strategy tracks covering biodiversity, mobility, energy, materials, and housing typologies, insisting that all of these must form part of the same system and complement one another. Significant emphasis is also placed on supporting productive day-to-day collaboration among all involved partners and on ensuring that sufficient expertise is present when decisions and solutions are being discussed.

A central element of this is FælledLab, the shared project office established as an on-site laboratory and co-working space where knowledge communities, partners, the developer, contractors, and consultants are located together and can develop solutions jointly. FælledLab therefore functions as both an innovation platform and an archive for learning and insight gathering across the project's many tracks.

This integrated working structure results in shorter decision chains, increased cross-disciplinary coordination, and complex challenges being resolved quickly and collectively, with relevant knowledge present while production is running. This is an essential capability when operating in uncharted territory. When looking across the plans and strategies that have been produced, it is clear they have not been developed in silos. They are integrated and complement each other across disciplines and subject areas.

"When you have such a large area to develop from scratch, it creates enormous value to bring people together in a shared, neutral office."[9]

Rasmus Overgaard Bertelsen, Project and Design Manager, OVBE Ingeniører

It is precisely this cross-disciplinary process that has been decisive in ensuring the strategies do not end up as appendices or side projects, but become real working instruments for design, construction, and operation. The plans have also been developed in close collaboration with other consultants, meaning that new strategies are built on top of existing plans, which are continuously adapted and developed. Involving the value chain from the outset ensures solutions are deliverable in practice.

An important lesson also emerges here about assembling different knowledge competences and cultivating innovation by integrating solutions across disciplines. Rather than inviting experts to solve specific tasks within their own field, the project creates space for innovation to happen at the intersection of different professional areas. The cross-disciplinary space between mobility, biodiversity and energy, for example, becomes a source of innovation rather than a coordination problem.

One example is Mobility Plaza, later renamed Fælledtorv, created in partnership between Fælledby P/S, BETA Mobility, and the Danish Road Directorate, with input from energy and mobility experts. The car-sharing scheme here functions as an integrated element of Fælledby's energy community, demonstrating how mobility, energy, and everyday life can be woven together in complementary plans and systems in new neighborhoods.
The same applies to the biodiversity strategy. Sweco notes that the strategy builds on the structure developed through the landscape projects.[10] This ensures that professional strategies are operationalized on an existing foundation prepared by architects and designers.

Centralized and Hands-on Project Management

"Fælledby P/S, with their strong design expertise and construction competences, has made it possible to function as a kind of 'site foreman' across the different professional disciplines. They have orchestrated and directed the collaboration between the many partners, ensuring that competences are fully utilized and that the project stays on track."

Signe Kongebro, Global Director, Future Resilient Design, Architecture & Landscape, Rambøll

Fælledby P/S occupies a role and competences that extend beyond the conventional developer. The organization acts as an active coordinator across building plots and phases, with a constant presence on site and through FælledLab. In practice, the developer functions as day-to-day manager across the project area's many construction sites while simultaneously developing

Illustration: Henning Larsen Architects ©

Visualisations: Henning Larsen Architects ©

the overarching implementation plan for the strategies and establishing external partnerships that accelerate and contribute to project development. This expanded role rests on the organization's inherent professional profile and in-house expertise. The team composition is anchored with a broad range of skills from across the value chain: from experience with large design-and-build contracts, through craft backgrounds and building design expertise, to architectural and engineering competences and experience launching co-housing communities.[11]

These inherent competences proved to be not only a strong management tool but also a source of resilience. This became clear when the main contractor for the first building plots suddenly filed for bankruptcy. Fælledby P/S took over project management directly and completed the first phase as a series of separate trades contracts.[12] In so doing, the developer confirmed its capacity to internalize management and coordination when needed, while delivery and completion proceed in collaboration with a newly assembled team and previously involved parties.

Competencies as a Competitive Parameter

Fælledby P/S's vision, requirements, and range of competences are expressed not only internally, but also in the strategic selection of partners. The phasing system of construction across different building plots with different contractors and methods creates the conditions for systematic testing of a wide range of new solutions. The construction is designed to work as a scaling laboratory in which different actors, products, and processes can be tested in parallel, with the aim of developing solutions that can be scaled and implemented in future projects.

Three design-and-build contracts form the backbone of the first phase (building plots C2 to C6, including associated townhouses): Scandi Byg (modular timber construction manufacturer) was responsible for 172 homes on C6 until their bankruptcy, after which the developer completed their portion of the construction through separate trades contracts.[13] bgb a.s. (carpentry and timber construction contractor) is responsible for a separate design-and-build contract for 205 homes across C2, C3, and C5, while JDH-Byg (contractor with extensive knowledge in bio-based construction) is delivering the townhouses on C4 and C6. All were selected based on specific competences and their ability to deliver on Fælledby's demanding requirements and targets, but with different approaches.

All three work with prefabricated systems, integrating production, delivery, and assembly within the same organization or in close collaboration with other project partners. Scandi Byg was selected on the basis of documented expertise in reduced carbon impact, experience with DGNB certification, Swan-labelled (the Nordic Swan Ecolabel) production, and the ability to deliver a complete proprietary modular timber system.

bgb a.s. was subsequently selected for the new design-and-build contract on C2, C3 and C5,[14] bringing a somewhat different profile: an established joinery and contracting firm with long experience in timber construction and moisture control.[15] They could meet Fælledby's climate and material requirements, but had not previously had production capacity to prefabricate elements at scale. With the Fælledby project, they established a dedicated production unit to manufacture timber cassettes.[16] Fælledby P/S has, in this way, acted as a lever for transforming bgb a.s. from a traditional joinery and contracting profile into also being a manufacturer of prefabricated timber elements at industrial scale.

In contrast to Scandi Byg's proprietary system, bgb a.s. works with a more flexible, standardized cassette principle designed in collaboration with consultants, architects, and the developer,[17] allowing it to be optimized and rethought for new purposes based on experience or new innovative solutions. Establishing production within the same organization shortcuts the supply chain: production, delivery, coordination, and assembly take place within a single company, eliminating complexity at the interfaces between separate collaborators.

JDH-Byg is responsible for the townhouses on C4, with design-and-build responsibility based on their expertise in biogenic construction materials, particularly EcoCocon. They deliver the project through their own partner ecosystem and consultancy, with full-height walls and floor slabs in straw elements from EcoCocon produced at Roust Element's factory. In addition to the large contractors and advisers, the developer has made a deliberate strategic choice to bring in a number of small and medium-sized enterprises with specific expertise in building innovation, new products, and processes, contributing directly to the project's scaling laboratory function. The aim is to bring more ideas, products, and solutions to the table so that as many innovative approaches as possible can be tested and scaled.

The extensive collaboration is managed by Fælledby P/S and supported by FælledLab, and includes, among others, Fjord Rådgivende Ingeniører, OVBE Rådgivende Ingeniører, C&C Rådgivende Ingeniører, visiBUILT, Tegnestuen LOKAL, Zero Engineering, Nordiq Group, and Digital Estates.

The developer has also embedded explicit requirements into agreements with various suppliers. Take-back programs with Stykka Køkkener, Miele, and Grohe have been established as a condition of contract, securing circular material flows.

Strategic Knowledge and Innovation Alliances
Fælledby P/S has built an extensive knowledge and innovation network through collaborations with partner foundations and initiatives. These alliances serve as active platforms for knowledge development, legitimization, and the scaling of innovative solutions.

A central example is Fælledby's participation in Realdania's initiative, Pathways to Bio-based Construction (Veje til biobaseret byggeri). This collaboration serves as a test and documentation case for bio-based building solutions and generates multiple strategic benefits.

First, it establishes formal knowledge sharing forums in which project teams from the participating projects share experiences systematically across cases, strengthening the foundational knowledge between cases and increasing the likelihood that solutions can be repeated and scaled in future projects.

Second, the alliance provides a critical knowledge-bridge function with a broad network of relevant actors across the value chain. This makes it possible to connect developers with suppliers, understand the industries that enable construction, production and supply, and build less environmentally damaging value chains and bridges between knowledge and market.

The Danish Road Directorate has supported Fælledby's mobility work both financially and strategically by designating it as a pilot project with the potential to form the basis for a new approach to mobility in future urban development projects.[18] This legitimizes deviation from standard practice and regulatory frameworks and provides access to public co-financing. The mobility solutions are deliberately integrated into the area's energy strategy, illustrating the cross-disciplinary coordination that characterizes the project.

Informal knowledge sharing also takes place through the involvement of actors engaged in other innovative construction projects. Henning Larsen is one of the most prominent strategic partners in the development of Fælledby and simultaneously serves as architect on Ripple Residence and as consultant for Travbyen.
The overlaps create opportunities for the systematic transfer and qualification of experience and solutions across projects. This knowledge bridge reduces risk and development costs for all partners involved and creates the conditions for faster maturation of new approaches.

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Pathways to Bio-based Construction – an R&D Collaboration

Pathways to Bio-based Construction (Veje til biobaseret byggeri) is an R&D collaboration that aims to collectively investigate and establish a how-to guide for integrating less carbon-intensive models and the use of bio-based materials in construction. Its scope runs the full length of the value chain: from which crops are grown in the fields, to how value chains should be assembled, to the properties of bio-based materials and the technical details on how to build with them. The initiative was launched by Realdania in 2023 with a budget of DKK 46 million, in collaboration with several organizations, including Aarhus University, University of Copenhagen, DTU, Royal Danish Academy, Smith Innovation, Artelia, and JAJA, who have contributed expertise, insights, and knowledge sharing to raise the level of understanding. To translate theory into practice, Realdania has offered financial support for bio-based building products, reference buildings, and demonstration projects through two open calls.
An additional call is planned in the near future, supporting developers who want to establishing a closer connection between agriculture, production, and construction.[1]

Project details

Scope: Holistic knowledge development and sharing on the value chain for bio-based building products and construction

Project period: 2023-2026

Project owner: Realdania

Contributors (academic institutions): Aarhus University, the University of Copenhagen, Aalborg University, and the Royal Danish Academy's School of Architecture

Contributors (industry actors): Smith Innovation, Artelia Rådgivende Ingeniører and JAJA Architects

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Documented Results

- **Raising the level of knowledge through publications.** The project has resulted in a total of 16 publications. The publications address crops and land use, value chains, material properties, and brings together all the others to give a broad overview of the collective knowledge.
- **Coordinated knowledge-building on bio-based materials.** On Realdania's initiative, a range of private actors and public knowledge institutions have been brought together in cross-disciplinary collaborations with the aim of developing new knowledge, documenting the properties of bio-based materials, and strengthening their value chains.

Key Learnings

- **There is still some way to go before bio-based construction is mainstream.** The publications indicate that significant challenges remain in integrating bio-based materials in practice, including how to protect the materials against external influences such as moisture. In addition, the absence of established standards, norms, experiences, and guidelines makes it less attractive to introduce bio-based materials into construction projects.
- **Bio-based construction is an opportunity that demands systems thinking.** Bio-based construction is an opportunity to rethink the entire building industry, from material extraction to end-of-life processes. The project illustrates that there are several areas across the value chain to address if we want to shift practice in a more bio-based direction, and that realizing the potential of bio-based building materials requires systems thinking.

How They Do It

- **Setting strategic direction and activating the field.** Throughout this project, Realdania has taken active leadership with the ambition of driving a shift in construction sector practice. Starting from a recognition of construction's significant carbon footprint, Realdania has formulated a clear vision to promote bio-based building materials as a strategic priority.
- **More than support: a deliberate lever.** By deliberately making funding available for research and development, the initiative generates new knowledge and documentation and shines a light on the potential of shifting to bio-based solutions. At the same time, the funding functions as risk-mitigating capital, making it possible for researchers and practitioners alike to test, qualify, and mature solutions that would otherwise struggle to find their way into the market. The effort is therefore not merely financial support, but a deliberate means of accelerating demand, reducing barriers, and shifting practice.

TRÆ - PFA Ejendomme, Kilden & Hindby

Image: Rasmus Hjortshøj

Project details

Scope: Building Denmark's tallest timber building, at 78 metres, while demonstrating new, lower-carbon materials and sharing knowledge and insights from the process to the industry

Floor area: 20 storeys across approximately 14,000 m² of floor slabs

Construction period: 2022-2025.

First move-in: 2024.

Location: Sydhavnen, Aarhus, Denmark

Developer: PFA Ejendomme, Kilden & Hindby.

Contractor: Kaj Ove Madsen A/S, Aarhus.

Architect: Lendager.

Consultant: Artelia.

Additional partners: Realdania and City of Aarhus's Climate Fund.

TRÆ is a 78-meter-high, 20-story office building constructed in timber in the Sydhavn district of Aarhus, Denmark's second-largest city. Beyond the load-bearing timber structure, a wide range of recycled materials have been incorporated, including decommissioned wind turbine blades, reclaimed double-glazed units, and facade panels. TRÆ has been realized a a collaboration between PFA (pension fund and developer), Kilden & Hindby (urban development firm), Lendager (architects), Artelia (consulting engineers), and Kaj Ove Madsen (main contractor), with Aarhus Municipality and Realdania as central knowledge and dialogue partners.

Documented Results

- **Proven demand for a high-innovation project.** The developer was able to raise rents by 25% on the basis of strong tenant demand. This is evidence of a market that actively wants to identify with what TRÆ represents.[1]
- **Reclaimed timber and other materials reused at scale in new construction.** TRÆ has successfully incorporated a broad range of reclaimed and recycled materials: recycled metal panels, decommissioned wind turbine blades, reclaimed windows used for both glazing and internal glass walls, reclaimed lighting fixtures, recycled PET in acoustic panels, and reclaimed timber. In total, 1,827 tons of timber were used, of which 179 tons were reclaimed.[2 3]

Key Learnings

- **Set clear ambitions early and anchor it in a direct and concrete strategy.** PFA and Kilden & Hindby had a clear intention from the outset: to build Denmark's tallest timber office building with extensive use of reclaimed materials. That intention makes TRÆ a lighthouse project for circular construction, not a conventional low-risk office development.

> "The client's ambition was clear: Create a building that accelerates a movement toward circular construction. If we can do things differently, we can help accelerate a movement. This is what we are trying to accomplish with this project. We are all in. We truly believe there is a demand for this type of building from businesses. This type of building and living sustainably will become a part of their DNA."
>
> Michael Bruhn, Director of PFA Real Estate."[4]

- **Involve knowledge and collaboration partners across the value chain early.** Public authorities, philanthropic foundations, contractors, and other actors were involved early and continuously throughout the construction process. This generated shared ownership among participating actors, contributing to positive framing of the project, a more efficient construction process, and more flexible approval processes, thereby substantially reducing risk. This early value chain integration was foundational to the success of the project. The involvement of CLT Denmark (CLT producer) and a:gain (supplier of circular building products) led to optimization of material choices, delivery logistics, and the assembly process.[5]
- **Use specialist expertise to simplify timber construction.** A decisive factor in successfully implementing bio-based and reclaimed materials was the involvement of specialist experts from CLT Denmark, a:gain, and GreenDozer (digital marketplace for surplus and reclaimed building materials). According to the suppliers, involving their expertise gave them shared responsibility for design, prefabrication, and pre-assembly. Expert involvement therefore drew know-how into the heart of the project and process design, simplified the process, and produced optimization in planning, logistics, assembly sequences, and moisture management strategy.[6]
- **Exploit the advantages of prefabricated timber.** CLT and glulam elements can be prefabricated with high precision, with brackets and other components pre-assembled, eliminating the need for on-site adaptation. Timber elements also weigh substantially less than conventional materials. Large parts of the assembly process were moved to the factory, and logistics were coordinated so materials arrived on site exactly when needed rather than being stored there over time. Together, these factors deliver a more predictable and reliable construction and assembly process. The weight and size of the elements also enable compact packing, reducing the number of trucks required to transport materials to the site. The result: cost savings, reduced congestion on site, and a lower carbon footprint from transport.
- **Use the narrative as a strategic asset.** Create an identity and a narrative that builds value, and leverage the premium location for a high-innovation project. TRÆ is described extensively as part of something larger: a landmark and gathering point for the city and the area. Aarhus Municipality refers to the project as a "climate office building".[7] The positive narrative reflects the shared commitment of the municipality and all actors involved, while the prominent site makes TRÆ a landmark that tenants want to be part of. This enables a green premium that has been decisive for the project's success and its commercial performance.

Image: Rasmus Hjortshøj

- **A test laboratory for portfolio-wide climate goals.** PFA has set a target of approximately 35% CO_2 reduction across its property portfolio and an ambition to meet EU taxonomy requirements. PFA regards TRÆ as a project in which solutions are developed for application across the rest of the portfolio.[8] TRÆ therefore plays an important role as a laboratory for anchoring PFA's portfolio goals and ambitions.
- **Test incrementally: Living Lab as a controlled experiment.** Three floors in TRÆ have been designated as a controlled testing environment for innovative solutions not implemented on the other floors. The three floors, called "Living Lab", enable deliberate testing of higher-risk solutions across three themes – reclaimed, bio-based, and upcycled materials – at a smaller scale with manageable risk.[9]
- **Operate innovation-seeking, but rethink the open call process.** In connection with Living Lab, open calls were initiated in which producers could submit new products and solutions for real-scale testing on the three floors. The aim was to bridge the gap between innovative producers and large-scale construction and to give the broader construction sector a showcase of existing solutions ready for direct use. Fewer producers submitted proposals than expected, which points to the need to rethink engagement processes.[10]
- **Use foundations and knowledge partnerships strategically for risk management.** Fonde og Aarhus Municipality's Climate Fund and Realdania finance and frame the knowledge track and Living Lab so that the investor /PFA) does do bear the entire development risk relating to testing, use, and documentation of new materials alone.[11]
- **Build flexibility into the design to absorb ongoing material flows.** TRÆ successfully designed its facades and interiors around the reclaimed materials available, treating the materials and stock on hand as design preconditions and keeping design solutions flexible enough to absorb incoming materials. This was made possible by a deliberate early decision to keep non-load-bearing elements open for adjustment as construction progressed.

"Last but not least is the importance of partnerships and collaborations, which can also happen while a project is under way, as Living Lab demonstrates. It is essential to develop new collaborative models during the process itself, in order to make innovation happen."[12]

Anders Lendager, to VCØB (Danish Knowledge Centre for Circular Economy in Construction)

How They Do It

- **Optimized processes through specialist involvement.** Suppliers and producers were given active responsibility for the planning and execution of parts of the construction from the outset. By drawing on their specialist expertise with new materials from the start, and by giving them ownership through dialogue with contractors and other partners, the planning, logistics, prefabrication, and assembly processes were all optimized and made compatible across the value chain.
- **Making the municipality a partner, not just a regulator.** In TRÆ, Aarhus Municipality is simultaneously co-funder, planning authority, and knowledge partner for both the TRÆ building and the entire Sydhavn district. Both the municipality and the developer highlight that this model gives the municipality a flexible, solution-oriented role that generates constructive dialogue rather than a blocking function.
- *"TRÆ has been realized through close collaboration with Aarhus Municipality, which demonstrated trust and enabled flexibility throughout the process."* [13] Henrik Kjærgaard-Phillipsen, Director and Partner, Kilden & Hindby.
- *"The municipality's support and ongoing workshops were decisive, but similar projects could face difficulties if authorities are not willing to engage in constructive dialogue"* [14] Henrik Kjærgaard-Phillipsen, Director and Partner, Kilden & Hindby.
- *"If Aarhus Municipality had acted in a purely conventional way, the project would have stalled. Without the necessary flexibility, projects can be put on hold while we secure materials and seek approvals, and that creates a great deal of uncertainty that very few developers are willing to accept"* Henrik Kjærgaard-Phillipsen, Director and Partner, Kilden & Hindby, to the Danish Forestry Association (November 12, 2024).[15]
- **Strategic use of public and philanthropic partners.** The Climate Fund (Aarhus Municipality's fund for climate initiatives), Realdania (philanthropic association investing in the built environment), the Danish Knowledge Centre for Circular Economy in Construction (VCØB), Aarhus Municipality, and WE BUILD DENMARK (national cluster organization for the construction sector) all contributed both funding and frameworks for knowledge sharing, making TRÆ a shared development project for developer, municipality, and foundations rather than a purely private investment. Strategic partners reduce financial risk and uncertainty, strengthen the positive narrative and branding through shared ownership, increase flexibility, and simplify approval processes.
- **Let form follow availability.** TRÆ exemplifies this principle directly. Facades, interiors, and parts of Living Lab are designed around available reclaimed materials. In this way, reclaimed materials become a design logic that defines the building's expression, not a sustainability add-on applied after the fact.[16]

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AKF – Halmrækkehusene in Kirkebjerg Søpark (Søbredden)

Project details

Scope: Construction of 13 terraced houses, with a focus on natural ventilation, passive design, and foundation and ground slab, with post-completion monitoring feeding into the project's knowledge base

Floor area: 1502 m^2.

Construction period: 2023-2025.

First move-in: 2025.

Location: Brøndbyvester, Denmark.

Developer: AKF.

Architect: Danielsen Architecture.

landscape: Danielsen Urban Landscape.

Consultant: Artelia.

Contractor: JDH-BYG.

Additional partners: EcoCocon Danmark, Ekolab, Norconsult, Notech, DTU, and BARK Rådgivning, Roust.

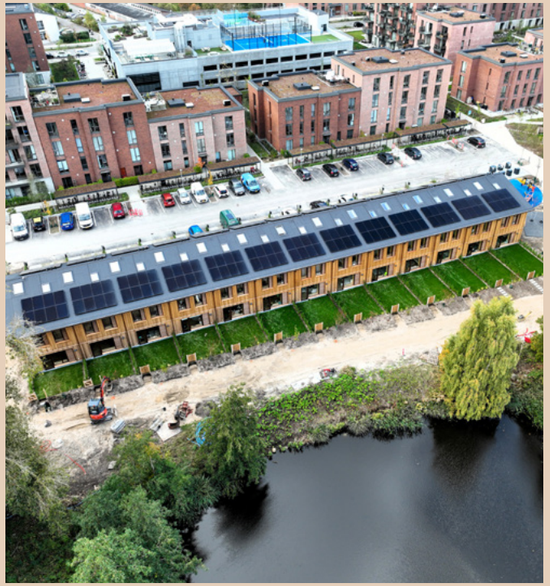

Image: AKF©

AKF has delivered 13 straw townhouses as part of the Housing Construction from 4 to 1 Planet initiative by the VILLUM FOUNDATION and Realdania, which is aimed at reducing the carbon footprint of new housing by 75%.

The townhouses are situated within a larger urban development in Kirkebjerg Søpark in Brøndby, west of Copenhagen, a new residential area comprising housing, shared facilities, and public spaces developed and operated by AKF (non-profit housing association).

With two community buildings, the townhouses form the innovation front of the project, demonstrating how a product such as EcoCocon elements can be integrated into a professional development set-up and scaled through the construction sequence. The project has been realized as a collaboration between EcoCocon Denmark, JDH-Byg (contractor), and Roust (manufacturer). The EcoCocon product has been developed and scaled across the value chain, establishing a shared biogenic building system used in both the straw townhouses and the two community buildings.

AKF's approach to innovation in construction is driven by a fundamental assumption: the transition to lower carbon impact is not only a responsibility, but also a sound business strategy. As a company, they operate across multiple bottom lines: economic, social, and climate and LCA, and they regard working proactively, and if possible ahead of legislation, as a precondition for building a future-proof business and reducing the risk of stranded assets. This is expressed in their decision to sell off properties that do not align with their strategic direction and reflects what AKF describes as "common sense" combined with a willingness for calculated risk-taking.

AKF works with an environmental consciousness that goes beyond what current metrics can calculate. Solutions are sometimes chosen that do not necessarily produce the best LCA score on paper, but which are assessed as less carbon-intensive in practice. Examples include choices relating to indoor climate, robustness, and material selection that do not register as gains in current LCA calculation models.

For AKF, the straw townhouses are not a one-off experiment. They are a deliberate, strategic step toward developing bio-based solutions that can scale across their portfolio. Construction projects are therefore used actively to make new knowledge applicable, including creating practical frameworks for translating research into buildable solutions. From this perspective, testing and trialing are not side activities but part of how projects are developed. The goal is to build reference projects that can document both the benefits and the challenges of bio-based materials, making it easier to repeat and scale.

Documented Results

- The project is designed and built with natural ventilation, a measure that may prove genuinely less carbon-intensive than mechanical ventilation, even though it scores less favorably in current LCA calculation models.
- Scaling and further development of the EcoCocon product in collaboration with producer, supplier, and contractor: from a standard box to prefabricated building modules.
- The straw terraced houses have been insured in the same insurance class as the rest of Kirkebjerg Søpark.

Key Learnings

- **Establish an internal ambition and organize to make delivery possible.** AKF's Vision 2030 is "to be recognized as one of Denmark's most sustainable property and investment companies". The ambition is anchored organizationally through a dedicated sustainability department, project developers with a focus on sustainability, and internal training and knowledge sharing through innovation meetings and innovation days that communicate new solutions across teams.
- **A dedicated innovation reserve for construction.** During the development of Søbredden, the organization maintained a dedicated financial reserve to absorb any elevated risk associated with innovation.
- **Start small and scale incrementally.** The system, process, and competences of the straw townhouses were first tested and developed through the construction of two community buildings. Each step was used deliberately to test buildability, logistics, and confidence before moving to the next scale. The causal chain is clear: test in the community buildings, learn what works, optimize the system, then replicate in the townhouses. This process enables EcoCocon to progress from individual building blocks to more standardized elements and processes that JDH-Byg can repeat and improve across projects.
- **Work actively with the difference between perceived and actual risk.** EcoCocon is approved and used across multiple countries, and solutions can be documented through project references and delivery documentation from

contractors and suppliers. This means that even where a consultant may be reluctant to “take responsibility” for a solution that feels new or atypical, the actual technical and execution risk is not necessarily greater. It has been tested, documented, and is traceable.

- **Build knowledge alliances to establish professional confidence.** When consultants and insurers cannot take responsibility for a new solution or product, the developer, supplier, contractor, and academia share data and experience across the group and build a shared knowledge community. This curated circle of actors builds a solid shared knowledge base through experience, analysis, and collaborative development, giving developers and contractors the foundation they need to take a calculated risk on new solutions.
- **The developer must accept the innovation responsibility.** The developer must often take on the innovation responsibility and a greater share of the risk, because consultants may be cautious for reasons of insurance, liability, and established workflows. Without a willingness to absorb some of that risk, new solutions typically do not get realized in practice.
- **Bring the contractor into the process earlier.** Involve the contractor early in the process. Their practical knowledge about implementing new systems and experience from previous projects must be brought in from the start, as it directly informs design and decisions. Early involvement functions as a supply chain shortcut: knowledge from production and construction feeds directly into design before choices are locked in.
- **Long-term ownership makes it possible to choose more sustainable solutions.** When the developer operates from an ownership perspective, it becomes possible to prioritize the right solutions rather than those that primarily generate short-term returns. Decisions can be made from a whole-life cost perspective: not only construction costs (CapEx), but also operational and maintenance costs (OpEx), service life, replacements, energy consumption, indoor climate, and residual value.
- **Work proactively with innovation to future-proof the portfolio.** Use investments in new materials and solutions such as EcoCocon and natural ventilation as a strategic instrument to make the portfolio more resilient against future regulation and tightening CO_2 requirements.
- **Strategic use of development partnerships, funding, and academic knowledge.** Partnerships and external funding are used strategically to mature and qualify new solutions. The Housing Construction from 4 to 1 Planet initiative contributes financing for testing, consultant hours, and the capture of learning that AKF can subsequently apply in scaling. Research institutions, including DTU and relevant researchers, can professionally qualify solutions, where conventional consultants may be reluctant to take responsibility or current calculation models do not fully reflect reality.
- **AKF insures the straw townhouses on normal insurance terms.** This may be connected to the fact that risk is “diluted” across a larger total portfolio, where individual projects are not assessed in isolation but contribute to a broader risk profile.
- **EcoCocon as a Trojan horse for biogenic materials.** EcoCocon is a new biogenic material packaged inside a standardized module that the construction industry already knows and can work with.

How They Do It

Organize to Deliver on Ambitions

AKF has set an ambitious vision: to be recognized as one of Denmark’s most sustainable property and investment companies. This ambition is not merely a long-term aspiration, it is embedded in the company’s organizational structure, staffing, and decision-making. The company considers it a societal responsibility to reduce construction’s environmental impact, but also treats working proactively as a precondition for building a future-proof business.

A central point is that AKF primarily builds for a long-term ownership horizon, developing and operating the portfolio itself. This enables the company to choose solutions that may be more complex or cost-intensive up front, but that deliver better results over time across operations, renovation, rental, user quality, LCA performance, and future regulatory compliance. This consolidates a broader accountability for construction in-house and creates a more nuanced basis for decision-making.

Long-term ownership and the view of construction as a long-term investment mean AKF accepts a calculated risk now in order to ensure the portfolio performs under future regulation. This priority is systematically weighed against the alternative: the risk of holding a portfolio that fails to meet future requirements and consequently loses value. In practice, this shapes decisions in new construction and drives the continuous energy-renovation of existing properties to reduce environmental impact and risk of stranded assets.

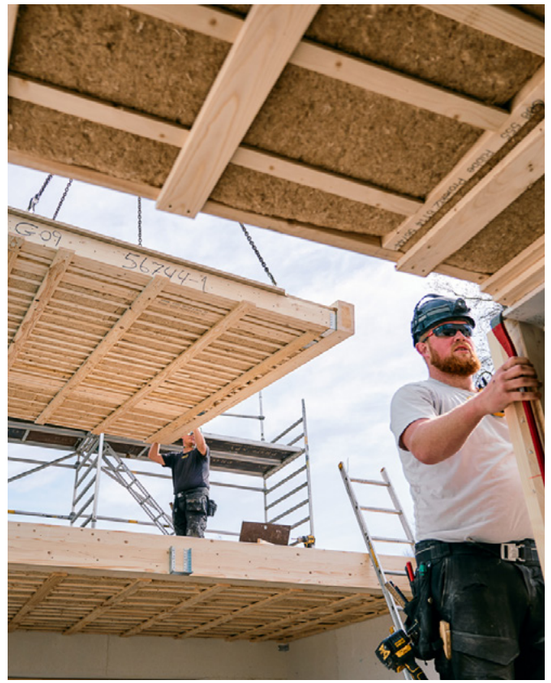

Image: AKF©

AKF's approach to sustainable urban development relies on a deliberate organization of competences and roles. The company has established a project development department with selected developers who carry specific responsibility for identifying and implementing lower-carbon solutions. New knowledge and ideas are supported through dialogue with external experts and internal inspiration days, where internal and external actors contribute new knowledge and learning, ensuring relevant knowledge circulates effectively throughout the organization.

Employees with a strong commitment to the transitions of the industry play a central role in identifying innovation opportunities: proactively finding new solutions and establishing contact with relevant partners. When the organization successfully connects employee ideas and knowledge with management decision-making, it creates an environment in which new knowledge can circulate and be embedded in projects.

The straw townhouses illustrate this dynamic. EcoCocon was first identified by a student assistant and subsequently developed into a collaboration spanning multiple construction projects. During construction of the townhouses, a dedicated innovation reserve was established for risk management and testing new solutions.

Scaling Solutions in Partnership with the Value Chain
Prior to the construction of the straw townhouses, two community buildings were constructed. Each was built using different EcoCocon solutions, allowing the team to compare what worked best in practice and build a solid knowledge base at a financially manageable scale and with limited risk, before scaling up to the 13 straw townhouses.

The process generated learning across all involved actors: supplier, contractor, and other parties, particularly regarding materials handling on site, assembly efficiency, moisture conditions, and delivery and logistics strategies. The two community buildings were therefore a targeted investment in knowledge-building with scaling in mind, presenting a lower risk and a great learning value.

The community buildings confirmed that the product worked technically, but revealed a long assembly due to the original EcoCocon cube format. This was both costly and problematic: more time on site increased moisture risk through prolonged material exposure and slowed overall completion. The developer therefore required larger, prefabricated elements and entered into dialogue with the supplier, EcoCocon, and contractor, JDH-byg, to work together to optimize the product for a more efficient building practice.

The product evolved from the original EcoCocon building block to full-height wall modules with integrated windows and doors. This created a more streamlined construction process reducing complexity on site, shorter exposure time, and a new production rhythm that together reduced both risk and labor hours, bringing assembly time for a two-story structural shell down to a single day.

Central to the process was the establishment of a new production link. EcoCocon Denmark does not manufacture elements itself, and products are usually shipped from a production facility in Latvia. To meet the needs of the new construction process, Roust (a Danish producer of prefabricated timber-based and bio-based building elements) established production capacity in Denmark, in collaboration with JDH-Byg and EcoCocon, ensuring that prefabricated modules could be produced locally and specifically for the project. By moving a substantial part of the process into a factory, it became possible to work systematically on quality, logistics, and repeatability.

The process demonstrates the success of a value chain collaboration with agile actors leaning in to co-develop solutions in uncharted territory. The iterative approach allows knowledge to be created and fed back into the process, and continuous product updates – grounded in experience, documentation, and reference projects – make the solution progressively more robust and easier to repeat at scale.

Alternative Approaches to Risk Assessment
AKF views lower-carbon construction an attractive business case in which innovative practice future-proofs the company. However, this requires a rethinking of how the organization works with risk: how risk is calculated, what is genuinely risky, and which methods are used for risk classification. By combining knowledge alliances, systematic testing, strategic use of external partners, and process innovation, risk assessment can be shifted from defensive skepticism to a more knowledge-based foundation. Both perceived and actual risk can then be reduced progressively.

> "One of the biggest challenges right now is that the models and metrics we are required to document and calculate against are not configured to accommodate the emerging sustainable solutions. A good example is natural ventilation: in the energy framework calculation, we are penalized when we choose natural solutions over mechanical ventilation, even though our consultants expect the same low energy consumption and at the same time an indoor climate with a more natural moisture balance."[1]
>
> Anders Borg, Head of Project Development, AKF

When developers work with bio-based materials, they encounter a fundamental challenge: rules, calculation models, and industry standards have been developed for conventional building materials and processes. The standard tools cannot be directly applied to quantify the actual risk of newer or emerging components or building systems.

The result is that perceived risk often appears higher, not because the solution is more risky, but because the system lacks documentation. At the same time, continuing business as usual with carbon-intensive building systems poses a real and much greater risk, both in climate terms and economically, as environmental requirements continue to tighten, buildings constructed through conventional means might be at risk of becoming stranded assets.

In the development of the straw townhouses, specialized professional expertise is brought in to assist with risk assessment and performance evaluation of solutions that are not yet fully tested. Academic partners, including an associate professor and graduate students from DTU, have contributed calculations, scenario analyses, and assessments of performance in areas such as ventilation. These analyses provide an important basis for making informed decisions under uncertainty and deliver alternative risk calculations when conventional models do not suffice.
Knowledge-sharing and development programs play an important role. In Søbredden, participation in a knowledge-sharing project, such as the Housing Construction from 4 to 1 Planet initiative, provides both professional dialogue and access to a financial pool for additional consultant hours and testing in relation to non-negotiable standards, such as fire safety. This makes it possible to carry out indicative analyses and clarifying tests that would otherwise be difficult to finance within a conventional project budget.

Taken together, the case points to a clear conclusion: risk cannot be managed through standard services and procedures alone. Risk must be distributed, qualified, and reduced through new collaborative models and a deliberate choice of partners with the right competencies, expertise, and experience.

If alternative building materials are to be adopted at scale, they must be used as widely as possible, even where standards and guidelines do not yet fully support them. This is how reference projects are created and precedents established: projects that communicate both the benefits and the challenges, inform regulation, influence insurance frameworks, and challenge the metrics by which we measure performance, while gradually building a knowledge base, and products that are more robust and easier to repeat scale.

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Realdania By & Byg – MiniCO2 Etagehusene

Image: Claus Fisker

Image: Claus Fisker

Project details

Scope: Construction of six demonstration buildings, aimed at reducing waste, streamlining the construction process and comparing the climate impact of different materials.

Project period: From 2020.

Location: Fredericia, Denmark.

Developer: Realdania By & Byg.

How do you build with the lowest possible carbon footprint? That question can only be answered through practical experience. In a street in Kanalbyen in the Danish city of Fredericia, Realdania is running the project MiniCO2 Etagehusene (literally "The Multi-Story Buildings"). The project is driven by Realdania By & Byg, and its purpose is to investigate how CO_2 emissions can be reduced by optimizing material choices and construction processes.

The method is a controlled experiment. Six unique apartment buildings are being constructed at the same size, with the same budget, on the same site and at approximately the same time, with currently available materials and methods. The only variables distinguishing the buildings are material choices and construction processes. This enables detailed comparison across all six. The buildings are assessed based on resource consumption, waste, time, defects, cost, and CO_2 emissions.[1]

The project's six buildings comprise two process buildings, focused on optimizing the construction process; three material buildings, focused on optimizing material choices; and one hybrid building, to be constructed on the basis of learnings from the first five.

Two buildings, MiniCO2 DIGITAL and MiniCO2 TRÆ, have already been delivered, in 2023 and 2024, respectively. The three remaining buildings, BETON, TEGL, and PRÆFAB, are under construction and expected to be delivered progressively during 2026. All six buildings are targeted for DGNB Gold certification.

The Process Buildings: DIGITAL and PRÆFAB
The two process buildings are motivated by the fact that construction and civil engineering projects average 10% waste, and that significant potential exists for improvement in construction processes.[2]

In MiniCO2 DIGITAL, the goal was to improve planning, increasing collaboration and transparency across the value chain through shared digital tools and processes, as well as to streamline construction processes and minimize defects, thereby saving materials, time, and costs.[3]

In MiniCO2 PRÆFAB, the aim is to reduce both waste and construction time by 50%, to avoid unforeseen costs, and to deliver a defect-free building.[4] This will be achieved by prefabricating building components in industrial environments to the greatest extent possible. MiniCO2 PRÆFAB also challenges the prevailing assumption in Denmark that prefabrication limits architectural freedom.

The Material Buildings: TRÆ (timber), TEGL (brick), and BETON (concrete)
The three material buildings are designed to comparatively investigate and methodically clarify which materials perform best, not only in climate terms, but also from an economic, functional, and comfort perspective.[5] Each is built using its primary named material in as many building components as possible, and all three are compared across the same parameters: CO_2 emissions, construction time, cost, material functionality in individual components, and comfort in use.

In MiniCO2 TRÆ (timber), the aim is to build experience with timber construction, a material relatively well established in construction abroad, but not traditionally used in Denmark.[6] In MiniCO2 TEGL (brick), new solutions have been required, including so-called hollow clay blocks fired at lower temperatures than conventional bricks and consequently emitting less CO_2.[7] In MiniCO2 BETON (concrete), the significant carbon footprint associated with concrete production is the central challenge. The response is to maximize design for disassembly and reuse, use low-carbon concrete, and incorporate recycled concrete.[8]

The Synthesis Building: HYBRID
The final building, MiniCO_2 HYBRID, will be constructed on the basis of the processes and learnings accumulated across the five preceding buildings. The target is to erect a multi-story building with a material footprint of no more than 5 kg CO_2 eq./m²/year and a process footprint of no more than 1.2 kg CO_2 eq./m²/year. The building is intended to function as a demonstration project.[9]

Documented Results

- **Delivered a building without defects, ahead of schedule, with minimal unforeseen costs and low waste.** MiniCO_2 DIGITAL was completed in December 2023, two months ahead of schedule. The building was delivered without a single defect, compared with a typical average of 80 to 100 defects for a building of this size. Unforeseen costs from waste, additional work, and similar were limited to 1.2%, compared with a sector norm of 10% or more. Material waste was 0.6 kg CO_2 eq./m²/year, equivalent to 5%, half the sector average of 10%.[10]

- **Buildings with a relatively low carbon footprint.** The purpose of the MiniCO_2 project is to reduce CO_2 emissions associated with new construction. For the two completed buildings, DIGITAL and TRÆ (timber), emissions were 7.4 and 5.1 kg CO_2 eq./m²/year, respectively. Both buildings were built well below the regulatory limits in place at the time (BR18), and at around or well below the current threshold of 7.1 kg CO_2 eq./m²/year, which came into effect in 2025 (BR25). Material waste during construction of the DIGITAL building amounted to 0.6 kg CO_2 eq./m²/year, a significant proportion of the total process emissions. The TRÆ building's construction process emitted 1.5 kg CO_2 eq./m²/year, meaning it met the 2025 (BR25) process requirement (construction process below 1.5 kg CO_2 eq./m²/year) a year early.
- **Certifications (DGNB) and awards.** Both MiniCO2 DIGITAL and MiniCO2 TRÆ (timber) have received DGNB Gold certification. MiniCO2 TRÆ also received recognition as Low-Emission Timber Building of the Year at the Build In Wood conference in 2023.[11]
- **New material tested and new solutions developed on site.** MiniCO_2 TEGL (brick) is built on the principle of using clay as the primary material in as many building components as possible. The central material is the hollow clay block (*teglhulblok*), used for both load-bearing walls and floor decks.[12] While brick has a long tradition in Danish construction, these monolithic hollow clay blocks are common across much of Europe but rare in Denmark, and therefore fall outside the country's pre-accepted solutions. This required fire testing of the hollow clay blocks at DBI – The Danish Institute of Fire and Security Technology, as Denmark lacks the intermediate fire classification used in Germany and several other European countries, as well as the development of mechanized lifting systems to comply with manual handling requirements on site.
- **Prefabricated modules greatly reduced time on site.** In MiniCO2 PRÆFAB, building modules were manufactured off-site and transported to the construction site. Using this process, five stories of the PRÆFAB building were erected in just two days.

Key Learnings

- **Digitalization creates transparency and reduces waste.** MiniCO2 DIGITAL placed consistent focus on applying digital tools throughout the process and across actors. This produced a transparent overview, up-to-date information, and precise tracking of material quantities. While some waste still occurred, the digital tools were a decisive factor in achieving waste levels far below the sector norm.
- **Focus on planning and process drives efficiency.** Delivering MiniCO2 DIGITAL two months ahead of schedule can be attributed directly to intensive focus on planning and process. By prioritizing transparent processes and careful tracking, the construction process was streamlined and ambiguity was reduced.
- **Danish requirements create barriers for new materials.** In MiniCO2 TEGL (brick), the project is working extensively with use of new materials. Even though the material has been tested and used abroad, it has required retesting to comply with Denmark's particularly stringent fire regulations.

How They Do It

- **An incremental process lets each building inform the next.** The MiniCO_2 buildings are being built in sequence, and this is a significant advantage in a development project of this kind: learnings can be carried forward from one building to the next. The sequential approach allows accumulated knowledge to inform and shape the upcoming projects, incrementally reducing environmental impact, improving efficiency, and lowering risk with each subsequent building. DIGITAL was completed first and, unsurprisingly, the process was the focus at the start. Getting the process right first means the lessons can be carried into all subsequent buildings.
- **An active, visionary developer.** Realdania By & Byg has maintained a clear vision and purpose from the outset. This has allowed them to set requirements for suppliers and drive innovation by accepting calculated risk and finding new pathways to lower-carbon construction. Each MiniCO_2 building uses a different combination of contractors, consultants and architects, but the same developer throughout. This confirms that a determined developer is essential for creating demand and maintaining momentum.

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CPH Village

Image: CPH Village

Project details

Scope: Construction of temporary 980 student homes on unused urban sites in Copenhagen, as a new business model for developers

Location: Copenhagen, Denmark

Developer: CPH Village

Project period: From 2014

Landowners: By & Havn, DSB

Additional partners: Realdania, the City of Copenhagen, the Hjem til Alle alliance, KAB, Boligforeningen 3B and AKB

Image: CPH Village

CPH Village is a private developer and housing operator that has specialized since 2014 in leasing underutilized urban sites to establish temporary, flexible, relocatable and community-driven student housing in Copenhagen. CPH Village's mission is to increase the supply of affordable housing and to make the most efficient use of vacant or temporary urban spaces. Its buildings are therefore constructed primarily from upcycled and bio-based materials, using as few resources as possible.

Documented Results

- **A new business model for developers and a flexible building concept.** CPH Village has succeeded with a new business model in which it leases a site from public authorities or companies such as By & Havn (Copenhagen's publicly owned urban development corporation) or DSB (Denmark's state-owned railway company) for an agreed period. When the lease expires, the housing must be removed and the landowner resumes use of the site. This model has driven the development and shaped the design logic to deliver a very specific concept, in which flexibility, modularity, and relocatability enable the housing to be moved from site to site.
- **Flexible housing with high reuse potential.** Through an iterative process across multiple projects, CPH Village has developed a building concept with a fully flexible floor plan and residential modules that can be transformed and adapted to new uses over time. CPH Village's Co-CEO describes this further in the following section: From Linear to Learning Infrastructure – Flexible Construction as a New Urban Development Model.
- **Villages built across Copenhagen's neighborhoods.** CPH Village has built villages in five different neighborhoods in Copenhagen. The first was built in 2018 in the Refshaleøen district, housing 164 students. Since then, CPH Village has built in the districts of Vesterbro (184 students), Amagerbro (88 students), Nørrebro (352 students), and Østerbro (192 students).[1]
- **Low-carbon construction delivered.** Form the outset, CPH Village has to build with minimal consumption of natural resources and a low climate impact. The first village in Refshaleøen was built from upcycled shipping containers; the second in Vesterbro was constructed in timber. CPH Village has also developed, tested, and obtained approval for a so-called Biowall that contains no mineral wool insulation and no plastic vapor barrier. To reduce carbon impact further, solar panels have been installed across the entire roof of the newest village in Østerbro.[2]
- **A developer that takes social responsibility and builds resident-driven housing communities.** Countering social segregation and creating thriving communities are the founding principles on which CPH Village is built.[3] The villages are designed to include a diverse group of residents and to involve them in the development and operation of the area, and the design places a strong focus on establishing quality shared spaces and facilities to support social interaction. As part of this strategy, CPH Village has an ambition for rents to remain 15% below the market average.[4] The most recent initiative is an agreement with By & Havn, the City of Copenhagen, the Hjem til Alle Alliance (a Danish alliance working to end homelessness), and Realdania to reserve six homes for young homeless people in the new CPH Village in the Nordhavn district, expected to be built in 2027.[5] This is the first agreement in which the City of Copenhagen has been granted nomination rights to youth housing in a private development.

Key Learnings

- **New models require new frameworks.** When CPH Village started, regulations hindered the placement of temporary housing on leased sites. CPH Village was therefore compelled to take the initiative to have the Planning Act amended to obtain dispensation for temporary construction within local plans. This makes CPH Village an example of a case in which a new, lower-carbon, socially responsible, and economically viable model required systemic change to succeed. In doing so, CPH Village positioned itself as an active facilitator of innovation.
- **Strong values and ambitions drive market positioning.** CPH Village's ambitions to reduce carbon impact and increase access to affordable housing, combined with concrete strategies and plans for achieving them, have positioned the company as a successful and widely recognized mission-driven developer. In 2022, CPH Village won the Developer of the Year award in recognition of its approach to lower-carbon and socially responsible urban and property development.[6]
- **Design for flexibility and relocatability from the outset.** Designing a relocatable building system has always been central to CPH Village's DNA. Flexibility and relocatability was therefore built into the residential modules from the start. The result is a building concept whose function can be transformed from temporary to permanent, or from single unit to open-plan.[7] The learning is clear: flexible housing modules open new possibilities for urban development through reuse, precisely because the developer accepted from the beginning that needs change over time and designed accordingly.[8]

How They Do It

- **An iterative and data-driven process.** CPH Village's iterative approach to developing both its housing modules and its villages has made it possible to carry learning from project to project and progressively improve construction solutions. CPH Village also continuously collects feedback from residents and involves them in the development of shared spaces. This adds a social dimension to the development and also functions as a source of knowledge, providing valuable insights.

> "In Refshaleøen, for example, we used old shipping containers, but that turned out to be very cumbersome. The floors had to be replaced, the walls were bowed, it took an enormous amount of work to turn them into housing. So now all our construction is in timber, in some places clad with a thin layer of metal."
>
> Frederik Noltenius Busck, Co-CEO, CPH Village, to oicc.dk, September 13, 2022.[9]

- **A mission-driven developer.** CPH Village is founded on clear values: build fewer square meters, build with lower carbon impact, and take social responsibility as a developer. The vision came first; the solution followed: temporary and relocatable structures and villages. These clear values have given the company a sharp sense of purpose, which it has used actively to drive changes in legislation, to challenge the minimum number of square meters a person actually needs, and to establish a distinct market position.

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From Linear to Learning Infrastructure – Flexible Construction as a New Urban Development Model

by Frederik Noltenius Busck

Frederik Noltenius Busck
CO-CEO, CPH Village

CPH Village and KAB – Transformation of Timber Modules from Student Housing to Social Housing

What is the Vision?

Cities have historically been developed around fixed building typologies, linear development trajectories, and assumptions of predictable needs. In practice, however, cities evolve under significant uncertainty: demographics, housing demand, climate requirements, and economic conditions change far more rapidly than the lifespan of buildings. CPH Village therefore works with flexibility as a fundamental design and planning principle. The vision is to create buildings and urban areas that function as learning infrastructures: physical frameworks where new construction methods, housing typologies, and urban development strategies can be tested, evaluated, and adjusted without losing value or materials. Flexibility thus becomes an active tool for innovation, resource conservation, and societal resilience.

Flexibility functions as a strategic urban development tool: a means of developing urban areas more rapidly, managing uncertainty about future needs, and preventing buildings and sites from being locked into a single function. This approach rethinks existing practice by planning for change rather than attempting to predict the future. CPH Village's most recent work on flexibility is a major collaboration with the non-profit housing association KAB, supported by, among others, Realdania, shedding light on how modular timber buildings can be transformed over time. The project demonstrates how the housing units are initially used as student housing and later transformed into affordable social family housing through unit consolidation, densification, and technical upgrades, without demolition and with maximum utilization of existing resources.

What Results Could this Generate?

The collaboration between CPH Village and KAB functions as an applied innovation process in which flexible construction is translated into concrete projects within real urban contexts.

The project creates, among other things:

- Methods for transforming between housing typologies without demolition
- Construction principles for flexible urban development and densification
- Documentation of resource savings and transformation economics
- Insights into new forms of collaboration and financing

At the same time, the projects demonstrate how flexible construction can function as a driver for phased urban development, where areas are activated early and continuously upgraded through iterative learning rather than waiting for fully completed masterplans.

The results provide a practice-oriented knowledge base for municipalities, housing associations, developers, consultants, manufacturers, and investors working with sustainable urban development under conditions of uncertainty.

The central insight is how flexibility can be structurally integrated into construction, planning, and finance – thereby making transformation possible at real scale.

What is Needed for Success and Broader Implementation?

Flexibility opens the door to new business models and cross-sector partnerships.

The collaboration between CPH Village and KAB has led to the development of models in which private actors initiate flexible building projects during early phases, while social housing organizations later take over and further develop the buildings as permanent housing. Municipalities contribute through planning frameworks and strategic land development, while financial actors can invest in phased value creation rather than isolated projects.

Consequently, buildings function not as one-time products, but as circular assets generating value across multiple life phases, turning residual lifespan and flexibility into key economic parameters.

These hybrid models enable:

- Risk-sharing between private and public actors
- Ongoing capital release through transformation phases
- Long-term value creation instead of short-term project optimization
- Faster activation and maturation of urban areas

The greatest challenges lie in the lack of valuation of residual lifespan and flexibility within the financial sector, as well as the tendency among authorities and landowners to lock projects into detailed planning frameworks.

Perspective

Flexible construction as learning infrastructure represents a fundamental shift in how we develop cities. By combining applied innovation, concrete pilot projects, and new partnership and business models, CPH Village and KAB demonstrate how urban development can experiment, adapt, and create greater value with fewer resources. This "new path in construction" points toward a central transition strategy for the built environment from static structures and linear projects toward flexible systems capable of evolving alongside society's changing needs.

Part 3
Pathways

Through our work on the Innovation Atlas, we have met actors with both the courage and the capability to demonstrate that the sector can move toward a less carbon-intensive, more socially just, and more holistic practice. They offer hope for the future, showing that it is possible to translate ideas into action, scale them to the market, and deliver them in practice.

Yet we are still far from ensuring that the industry can deliver both green and affordable housing that stays within planetary boundaries. Getting there requires the courage to think differently, to move away from the conventional and out onto uncharted territory, to investigate new pathways and build bridges between sectors.

Much of what we see and analyze through the cases would have been unthinkable only a few years ago. Neighborhoods and multi-story buildings constructed primarily from bio-based materials were inconceivable. Reclaimed components used as load-bearing structures were an impossibility. Rammed earth as a substitute for concrete in multi-story buildings belonged in utopian visions of a different practice. Yet today, we stand somewhere else entirely. Industrialized and prefabricated construction processes using bio-based materials, from straw insulation to mycelium-based building components, are commercially available products. Integrated shared functions are making it possible to reduce the number of square meters needed per person and may even help counter some of the mental health challenges that current society suffers from. And new ownership structures are challenging the market-driven housing model, delivering returns to tenants and contributing to mobility in the housing market.

This change requires people willing to think big and act ambitiously. What is gaining traction in mainstream practice today existed first as ideas, theories, models and startups, often years before the industry employed them. The task now is to shorten that gap. That means building bridges between dedicated pioneers and established industry, between theoretical and hands-on expertise, and between research and practice, so that promising ideas are adopted across the value chain and put to work in real projects.

In the foreword, we described change as a movement at two speeds. One speed improves, optimizes, and professionalizes existing structures. The other develops new logics, materials, and ownership models that challenge the status quo. Both are necessary. Without the first, we never reach scale. Without the second, we never shift direction.

We therefore close the Innovation Atlas with the chapter New Pathways in Construction, a collection of ideas, models, and tools developed by researchers and other visionary pioneers. These are still at an early stage, but we believe they may become part of the next generation of innovation. This is by no means an exhaustive map. It is merely a selection of promising crests on an ocean of possibility, pointing toward a less carbon-intensive and more affordable future for construction.

District LCA

by Simon Sjökvist, Harpa Birgisdottir, Jacob Blak

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COBE

Project Purpose and Methodology

This project develops and applies Life Cycle Assessment (LCA) at the district scale as part of a PhD project. The purpose is to create a more precise understanding of the environmental impacts of urban development at neighborhood and district level, and thereby also a clearer understanding of the climate impacts of planning practices. The ambition is to qualify urban development decisions so they can increasingly be based on knowledge of embodied emissions, material flows, and long-term climate effects. The vision, meanwhile, is to develop concrete methods for calculating climate impacts at city and district scale and integrate these into general planning practice.

The specific climate impacts are calculated using the Århusgade neighborhood of Copenhagen's Nordhavn district as a case study. The case was selected based on a broader analysis of urban development areas in Copenhagen, particularly areas covered by the sequencing plan. A methodology has been developed to calculate climate impacts at district scale for the purpose of identifying hotspots – that is, where the climate impact is greatest and where the greatest reduction potentials exist. As part of this work, a series of building and landscape archetypes are being developed. The results from the case study also provide an indication of climate impacts at city scale.

Urgent Need for Knowledge about Climate Footprint of Planning

The project addresses a fundamental challenge: the construction sector accounts for a significant share of carbon emissions and resource consumption, and an increasing proportion of this impact is linked to embodied emissions in materials and constructions. If international and national climate targets are to be achieved, it is necessary to significantly reduce the total climate impact of the built environment. The project challenges existing practice by shifting the focus from the individual building to the district as the unit of analysis. Discussions on embodied emissions and reuse have so far largely been conducted at building scale, while discussions and research within urban development and planning have focused more on operational energy, transport, and mobility. At the same time, the vast majority of LCA research and existing tools have been developed for buildings. There is therefore a need for methods capable of addressing climate impacts and potentials at district scale.

Applicable Knowledge and New Methods for Planning

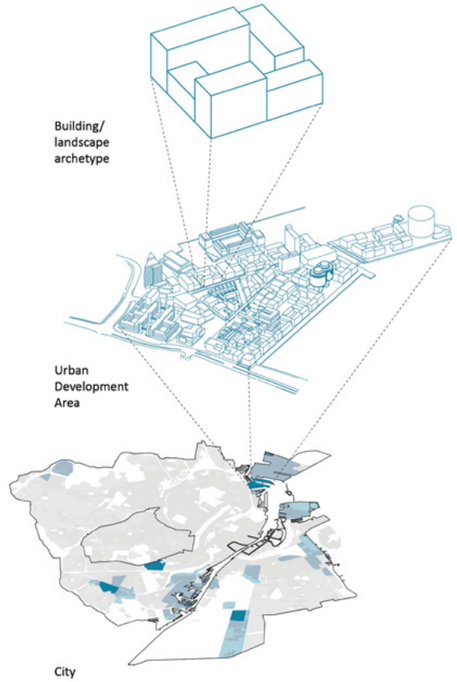
The project generates situated knowledge about climate impacts in the selected case study. By demonstrating how climate impacts are distributed across an urban development area, where the largest emissions arise, and where reduction potentials can be found, the project creates a more qualified basis for future planning. The results can provide municipalities, property developers, and consultants involved in planning processes with a stronger decision-making basis for organizing urban development with a lower climate footprint.

At the same time, the project has relevance beyond the individual district, as many urban development areas are structurally similar. The developed calculation method can be further refined into more operational tools and potentially integrated into everyday planning practice. The work with archetypes is particularly central, as it makes it possible to manage complexity systematically, and the archetypes can be reused across projects. The method can also be applied and further developed by other actors, including consultants and researchers. As such, the method may be regarded as a first step toward more integrated models that could eventually include additional parameters, such as operational energy. In a broader societal context, the project contributes to a discussion about the climate consequences of urban development. It highlights potential discrepancies between political climate targets and actual practice, thereby pointing to the need for a closer connection between climate ambitions and planning tools. At the same time, the project aligns with growing attention to the climate impacts of construction and contributes knowledge that can strengthen this debate.

Implementation, Barriers, and Further Development

The analysis identifies a number of hotspots indicating where climate impacts can be reduced, for example through material choices and increased reuse. However, implementation is associated with barriers. Some barriers are material and linked to existing building structures and technical systems, while others are institutional and procedural. Key actors include municipalities, political decision-makers, developers, and consultants. Broader implementation requires institutional and political support. The developed LCA method combines analyses across multiple scales, including city, district, and building, as illustrated in the figure. The analyzed urban development area functions here as a representative example of recent urban development. Although the developed method is applicable, there are also barriers to broader implementation of LCA calculations in urban planning. The calculations are complex and labor-intensive, and there is a need to investigate how LCA can be integrated into early planning phases, how methods can be standardized, and how results can be translated into concrete decision-making parameters.

Before this knowledge is further consolidated and operationalized, it will be difficult for other actors to adopt the method on a broader scale. Despite these barriers, the project contributes new knowledge about the climate impacts of urban development at district scale. It points to both the potentials and limitations of working with LCA in planning and forms part of an ongoing development toward more operational tools and methods for a more climate-conscious planning practice.



The developed LCA method combines analyses across multiple scales, including city, district, and building, as illustrated in the figure. The analyzed urban development area functions here as a representative example of recent urban development.

Your Nature-Positive project has impact and creates value. How much and for who?
by Ming Fricke

Ming Fricke
Industrial PhD Fellow — Henning Larsen & Leiden University

The Business and Biodiversity Report by the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES 2026) confirms that all businesses depend on and impact nature, yet <1% of publicly reporting companies mention biodiversity impacts in their disclosures.
A paradox or growing trend with long-term competitive advantage for those that do? - Once there was the first company to assess and report their impact on carbon emissions. Now, Denmark´s built environment industry, assesses and regulates carbon across the lifecycle of projects, all the way to the sourcing and embodied emissions of construction materials, leading globally by example. Thus, what could happen if the industry were to assess and disclose nature´s benefits, so called Ecosystem Services, protected and generated by its actions?

Ecosystem services are the measurable contributions of ecological systems to human health, economic security, and social wellbeing: temperature regulation that prevents heat death, stormwater retention that prevents flooding, air purification that prevents respiratory disease, habitat provision that supports biodiversity, and the psychological restoration that sustained urban living requires. **Every construction either inhibits or supports their delivery *(Figure 1)*. Making this measurable makes it designable, aligning what is profitable for business with what is beneficial for biodiversity and people.**

From Resilience to Measurable Regeneration

Flourishing people and nature are a professional pursuit and responsibility. Built environments are required that sustain society and acknowledge their significant role in our societal challenges, such as resource depletion, land degradation, carbon emissions, affecting socio-economic vulnerabilities and inequalities. Nature-based solutions can effectively address urban challenges including urban heat island, biodiversity loss and health outcomes (Li et al. 2025). However, are project performances addressing and closing the gaps? A study across 708 European cities found an average 50% supply-demand gap in the ecosystem services delivery of carbon sequestration, heat stress mitigation, flood control, accessibility to green space and habitat for species (Veerkamp et al. 2024), meaning cities and practitioners are systematically failing to provide the infrastructure for human livability, resilience and the increasing needs of their residents. **How are cities designed that produce ecosystem services at the scale of the ecological deficit they create and their populations demand?** Despite the science (i.e. Cortinovis & Geneletti 2020) and tools (i.e. Remme et al. 2025), the profession has never been challenged to answer this question – in project brief, zoning regulation, professional education, certification scheme or performance review.

A future pathway begins the moment the profession systematically creates wellbeing, supports biodiversity and establishes sustainable economies by protecting and designing functional (urban) ecosystems with a generous beneficiary and systems perspective. It controls physical environments off- and onsite through site decisions, material selections, construction sequences, drainage designs, and landscape strategies that determine the ecological function of extraction sites and the urban fabric for decades. Therefore, the built environment industry holds agency to, project by project, regenerate the foundations of our life on earth, and positively affect the livelihoods of people and species from where we live to where goods and materials come from. Such transformation requires a new professional instrument: a way of understanding, measuring, and designing for ecosystem services provision as indicator for regenerative urban design (Bartov & Fricke 2025) that is as embedded in standard practice as structural calculations, energy modelling or lifecycle assessments.

Method, Case Study Database and Best Practice

Benchmark Standardized Assessment Approach: no single measurement approach works for all business types, sectors, or decisions, but appropriate methods and tools exist, and must be selected for coverage, accuracy, and responsiveness to specific goals. Yet, industry agreed upon standardization is key to shared knowledge, broad uptake and fast-tracking best practice improvement, which can only be found in constructive discourse and shared interest. Nature-based solutions are the only climate adaptation strategy that simultaneously addresses heat, flood, drought, air quality, biodiversity loss, and human health while generating economic co-benefits. Built environment professionals who can quantify, communicate, and contractually guarantee ecosystem services (ES) delivery are positioned to unlock a fundamentally different category of investment — one that climate finance, impact investors, and municipal governments are actively seeking.

Open-Source Demonstration Collection: Case study documentation demonstrating successful standardized ES assessment integration across varying contexts and scales provides practical precedent for replication. These collections show: how assessments were performed, what ES performance levels projects delivered relative to baselines and benchmarks ***(Figure 2)***, who benefited, and how projects were financed, providing practical examples for replication and inspiration. Evidence of measurable performance unlocks new funding mechanisms by identifying diverse stakeholder interests: municipal stormwater savings, private healthcare investments, insurance premium reductions, property value increases, and climate adaptation co-financing.

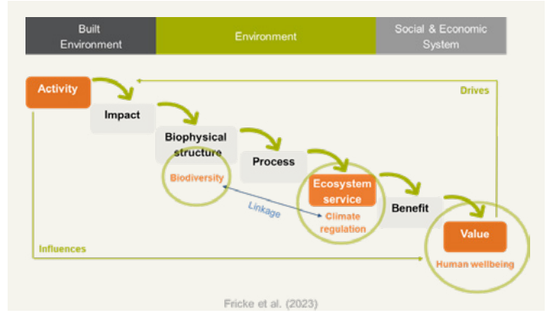


FIGURE 1
Ecosystem Services Assessment Framework connecting built environment actions to environmental impacts and socio-economic outcomes (Fricke et al. 2023)

FIGURE 2
Schematic differentiating Ecosystem Services performance levels. Relations between scenarios can deviate (Fricke, 2026)

Quantitative Industry Benchmark and Market Validation: A database of standardized assessments enables identification of peer comparison, best-practice performance, and performance drivers — creating competitive pressure for ES provision improvement. This mirrors the embodied carbon precedent established through platforms like deQo (de Wolf), where voluntary performance disclosure and transparent benchmarking elevated industry discussion, standards and informed progressive policy development. Such evidence creates regulatory confidence for targeted nature benefit

requirements in procurement frameworks, ecological risk assessment in development portfolios, and extension of policy criteria, as well as international curiosity and shared learnings in other countries.

What this looks like in practice

A city's planning department uses a supply-demand mapping tool to identify ecosystem services (ES) shortfall zones, then writes these into zoning requirements and developer obligations, quantified against a pre-development baseline and industry performance benchmark.

A developer's design brief includes a minimum ES provision target: the project must deliver measurable improvements in i.e. local temperature regulation, stormwater retention, and access to nature, but gets rewarded with cheaper loans or payments when delivering best practice performance and benefits.

A design and planning practice integrates ES performance assessments seamlessly into its standard workflow — selecting, choosing and deciding on scenarios based on modelled ES delivery and outcome experience collected through post-occupancy monitoring and reviews alongside energy and comfort metrics.

A third-party certification body validates service delivery for beneficiaries: financial institutions, the city, the healthcare system—that can in turn reward genuine ecological performance and societal impact through risk mitigation, climate adaptation or hospitalization savings at a fraction of their initial cost.

Success Environment: Converging Momentum

Regulatory and Financial Alignment:
Target 15 of the Kunming-Montreal Global Biodiversity Framework requires businesses to assess, disclose, and reduce biodiversity impacts. The EU Nature Restoration Law Article 8, UK Biodiversity Net Gain, TNFD reporting requirements, and EU Taxonomy expansion create mandatory disclosure architecture. Built environment actors integrating ES assessment into core workflows before regulatory enforcement gain competitive advantage through auditable, comparable performance data competitors lack. Near-term policy levers include municipal procurement specifying ecological outcomes not area coverage, finance instruments pricing biodiversity risk, and planning frameworks governing ES at ecosystem rather than plot scale.

Broad Consortium Legitimacy:
Standard credibility depends on co-creator breadth spanning scientific validation (research institutions providing ES methodology and peer review), practice application (design firms providing project portfolios for benchmarking and workflow co-design), governance integration (municipal and certification bodies providing regulatory alignment and procurement integration), and funding stewardship (philanthropic partners supporting 1-year open platform development with subsequent self-sustainability through institutional licensing). Such consortium can shape the industry standards by which it will be measured.

The scientific work is underway with a representative study at Henning Larsen under supervision of Roy Remme (Leiden University), Koos Biesmeijer (Naturalis), Davide Geneletti (Trento University), Kritika Kharbanda and Jakob Strømann-Andersen (Henning Larsen). Collaborators in design firms, academia, governance and philanthropy worldwide are encouraged to get involved in creating the growing interactive database and industry benchmark.
Contact: m.m.fricke@cml.leidenuniv.nl

Sources: IPBES (2026). Summary for Policymakers of the Methodological Assessment Report on the Impact and Dependence of Business on Biodiversity and Nature's Contributions to People. Jones M., Polasky S., Rueda X., Brooks S., Carter Ingram J., Egoh B. N., von Hase A., Kohsaka R., Kulak M., Leach K., Loyola R., Mandle L., Rodriguez-Osuna V., Schaafsma M. and Sonter L. J. (eds.). IPBES secretariat, Bonn, Germany. DOI: https://doi.org/10.5281/zenodo.15369060 · Meng Li, Roy P. Remme, Peter M. van Bodegom, Alexander P.E. van Oudenhoven (2025).Solution to what? Global assessment of nature-based solutions, urban challenges, and outcomes.Landscape and Urban Planning.Volume 256, ISSN 0169-2046, https://doi.org/10.1016/j.landurbplan.2025.105294 · Clara Johanna Veerkamp, Frank van Rijn, Martijn Spoon, Milan Loreti, Roy Paco Remme, Ton Dassen & Aafke Margaretha Schipper (2024) Assessing multiple ecosystem services in 708 European urban areas, Ecosystems and People, 20:1, 2387006, DOI:10.1080/26395916.2024.2387006 · Chiara Cortinovis, Davide Geneletti (2020). A performance-based planning approach integrating supply and demand of urban ecosystem services. Landscape and Urban Planning. Volume 201. ISSN 0169-2046. https://doi.org/10.1016/j.landurbplan.2020.103842 · Remme, R., Paling, N., Bruen, A., De Vreese, R., Deserti, A. et al., Handbook of tools for informing and monitoring urban greening strategies and nature plans, Cortinovis, C.(editor), Orta-Ortiz, M.(editor), Vasilakopoulos, P.(editor) and Velasco Gomez, M.(editor), Publications Office of the European Union, 2025, https://data.europa.eu/doi/10.2760/8493055 · Nitsan Bartov, Ming Fricke. Regenerative Urban Design across Academia and Practice: Mixed-Method Analysis of Conceptual Alignment and Implementation Barriers, 10 December 2025, PREPRINT (Version 1) available at Research Square. https://doi.org/10.21203/rs.3.rs-8186820/v1 · de Wolf, C. (n.d.). Database of embodied Quantity outputs. carbondeqo.com · Fricke, M.M., Hecht, K., Vollmer, M., Lang, W. (2023). Ecosystem Services Guiding Built Environment Design—Understanding the Impacts of Building Practice on Ecosystems and Their Fundamental Contribution to Human Wellbeing. In: Faircloth, B., Pedersen Zari, M., Thomsen, M.R., Tamke, M. (eds) Design for Climate Adaptation. UIA 2023. Sustainable Development Goals Series. Springer, Cham. https://doi.org/10.1007/978-3-031-36320-7_24

Affordability as a Measurable Metric in the Built Environment

by Frederik Møller Jensen and Mathias Nordby

Frederik Møller Jensen
Founder of Surely You're Joking

Mathias Nordby
Founder of Urban Studio

The vision is a housing market with a shared, measurable language for affordability – as transparent and operationalizable as Life Cycle Assessment (LCA) is today.

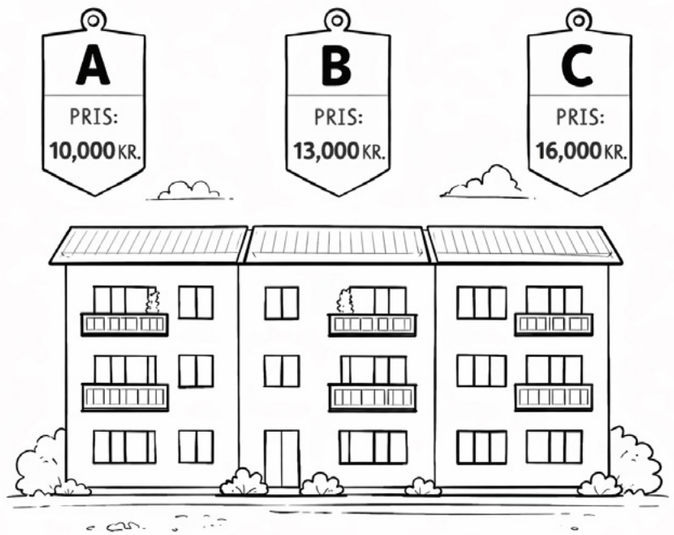
The real estate sector has developed a well-functioning common language for climate impact (LCA), with transparency, comparability, and incentives for improvement. For social impact – and specifically for affordability – no equivalent standard exists. This is despite the fact that housing prices and rents, particularly in the world's major cities like the Copenhagen metropolitan area, are rising faster than household incomes, pushing growing population groups out of the market: not only the economically marginalized, but also teachers, nurses, and young people with moderate incomes. Affordability was the most important issue in the latest Copenhagen municipal election campaign.

The problem transcends municipal and national borders, but without a shared definition, we lack the foundation for systematic action. At the same time, the sector faces a paradox: we must both solve the housing shortage AND reduce construction activity by 80% in order to meet the Paris Agreement climate targets. This requires new strategies and solutions. Before solutions can be found, however, transparency must be created in the debate, along with a shared basis for discussion across stakeholders and sectors.

By identifying and qualifying a common definition of affordability relative to different family types and income levels, the debate on affordability can be elevated from "newspaper articles about rising owner-occupied housing prices and the lack of cooperative housing" to an informed debate based on facts. This transparency creates the foundation for developing models that can ensure affordable housing for population groups currently excluded from the housing market.

What Results Could this Generate?

This project aims to deliver an operational, Danish definition of affordability with concrete benchmarks (for example, a maximum of 30% of disposable income) based on income and household type. Based on this definition, there will be a mapping of how large a share of Copenhagen's housing stock is affordable for different target groups today, distributed geographically and demographically.



In addition, an attempt to certify 10 dwellings across different housing typologies will test how the affordability definition works in practice and whether it can be scaled into a certification system.

Initially, the project will benefit stakeholders working with housing: Municipalities will gain a fact-based foundation for housing policy. Developers and investors, meanwhile, will gain clear frameworks for what is required to deliver affordable housing, as well as examples of what constitutes an affordable dwelling, which can inspire future developments.

What is Needed for Success and Broader Implementation?

The decisive factor for the success of this project is broad support among the key stakeholders in the sector. The project therefore also focuses primarily on bringing the industry together, so that a platform can be established from which a shared language for affordability can be defined.

This platform should help break down silos between stakeholders, enabling systematic collaboration among municipalities, the state, developers, investors, non-profit housing actors, and professional experts. The aim is to ensure that the framework becomes widespread and operational, while also initiating a process through which new knowledge can systematically be developed and new housing categories explored – with particular focus on financing mechanisms that channel private capital toward affordable housing.

A Sustainable Construction Industry: From Efficient Green New-builds to Absolute Sustainability

by Lise Horup Koch-Søfeldt

Lise Horup Koch-Søfeldt
DTU & Rambøll

The following contribution is based on the research behind the article:

Horup, L., Bruhn, S., Hoxha, E., Birgisdottir, H., Secher, A. Q., Ohms, P. & Hauschild, M (2025). Absolute sustainability assessment of the Danish building sector through prospective LCA. Science of the Total Environment.

1. What is the Vision?

The research article “Absolute Sustainability Assessment of the Danish Building Sector through Prospective LCA” presents a vision for a fundamental shift in the understanding of “sustainability” in the built environment. The vision is to move the understanding of sustainable construction away from reducing emissions per square meter toward an absolute sustainability approach, where the total environmental impact of construction is assessed in relation to the planet’s carrying capacity. This is particularly relevant in Denmark right now because the country is experiencing a major construction boom while climate targets and biodiversity crises are intensifying demands for reducing environmental impacts.[1]

The research applies a prospective life cycle assessment (pLCA) combined with absolute sustainability assessment and analyses the environmental impacts of new construction toward 2050 across 16 environmental impact categories. A key challenge addressed in the article is that even significant technological improvements and material substitutions will not bring the construction sector within an environmentally safe operating space if the overall volume of construction continues to increase. In other words: efficiency improvements are not enough.

The opportunity lies in rethinking the sector’s role – from a driver of growth to a steward of limited resources. More specifically, the article presents a scenario in which current construction trends must be reduced by 80%, and of the remaining 20%, half must be built using bio-based materials to not exceed the environmentally safe operating space.

In this way, the article challenges a core assumption in current practice: that sustainability can be achieved through more efficient new construction. Instead, the vision points toward a structural transition in which reducing new construction, extending building lifespans, and prioritizing renovation become key strategies.

2. What Results Could this Produce?

The research quantifies the environmental impact of the construction sector through a prospective LCA analysis and compares the results against the planet's carrying capacity. The outputs of the research include:

- Projected scenarios for new construction up to 2050.
- A method for linking prospective LCA with absolute sustainability assessment at sector level.
- Quantification of the environmental impacts of new construction across 16 impact categories up to 2050.
- An assessment of whether different technological and material transitions can bring the sector within the allocated share of the safe operating space.

This knowledge may benefit several stakeholders: Policymakers can use the results as a basis for regulation that addresses volume and resource consumption – not only carbon emissions per square meter. Planning authorities and municipalities can apply the insights in strategic urban development. Consultants and engineers may be inspired to work with absolute targets rather than relative improvements. Finally, the article provides the research community with a methodological contribution showing how absolute sustainability can be operationalized at sector level.

Although the analyses are situated in a Danish context, the project demonstrates an approach that can be transferred to other countries and sectors.

3. What is Needed for Success and Broader Implementation?

For this type of research to have practical impact, changes in framework conditions are required. Today, several barriers stand in the way. The construction sector is economically and politically tied to growth logics, where new construction functions as a driver of investment and employment. At the same time, regulation primarily focuses on energy efficiency and carbon limit values rather than overall resource consumption and absolute environmental impact.

Key actors are the state and municipalities, which can adjust building regulations, planning legislation, and procurement practices so that absolute sustainability is integrated as a guiding principle. Major developers – both public housing organizations and private actors – also play a central role in prioritizing transformation over new construction. Finally, it is essential that the consultancy sector and educational institutions build competences to a much greater extent around transforming and renovating the existing building stock rather than constructing new buildings.

The article therefore does not present a finished solution, but rather a crucial knowledge base. It shifts the discussion from how we can build slightly greener to how much we can allow ourselves to build at all – and thereby toward a more fundamental transformation of the built environment.

1 https://www.information.dk/indland/2026/01/byggeboom-paa-kollisionskurs-baeredygtigheden?kupon=eyJpYXQiOjE3Njg5NDEwNzcsInN1YiI6IjMzOTc4OTo4MzY1NjUifQ.gkeJ1VTekjugOBRHC80Kow?

BioFireAssess: Assessing the fire risks of bio-based insulation materials

by Dr.-Ing. Patrick Sudhoff

Dr.-Ing. Patrick Sudhoff

Bio-based insulation materials play a pivotal role in reducing the embodied CO_2 footprint of the built environment.

Materials such as cellulose, wood fiber, hemp, and straw-based products offer substantial climate benefits compared to conventional mineral or petrochemical-based insulation. Despite this potential, their broader implementation remains constrained by unresolved questions about fire behavior, particularly their tendency to smoldering combustion.

The industrial postdoc project "BioFireAssess" at the Danish Institute of Fire and Security Technology (DBI) aims to address this challenge directly. Supported by Innovation Fund Denmark and carried out in collaboration with Lund University and insulation manufacturers, the project aims to develop practical, scientifically sound methods for assessing smoldering in bio-based insulation materials. The goal is not only to better understand the materials, but also to create reliable ways to evaluate and manage the risks so they can be used safely and confidently.

Smoldering ("Ulmebrand") is different from an ordinary fire. It is a flameless, slow-burning process that can occur within porous materials, such as bio-based insulation. Because smoldering burns at lower temperatures and spreads much more slowly than a typical flaming fire, it can go unnoticed for a long time and cause severe damage. It can continue even when very little oxygen is available, and it is difficult to extinguish. If fresh air suddenly reaches the smoldering area, it can reignite into open flames and spread more rapidly.

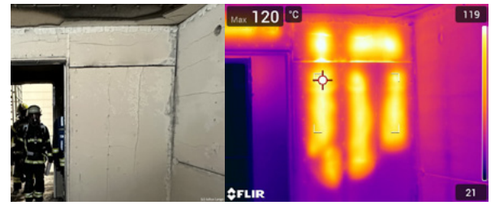


FIGURE 1:
Smoldering insulation inside a timber-framed wall, only visible through thermal imaging

Today's fire testing methods are not designed to properly evaluate this type of hidden burning. Standard fire tests primarily assess how materials behave when exposed to open flames or how building elements perform in a fully developed fire. Smoldering does not fit neatly into either category. As a result, it is not well covered by existing regulations and testing standards, creating uncertainty. Designers, fire safety consultants, authorities, and insurers lack clear tools to assess smoldering risks in a transparent, measurable way. Because of this uncertainty, bio-based insulation materials are often viewed with caution.
This slows down their wider use, even though they offer clear climate benefits. At a time when the construction sector must reduce its carbon footprint, this gap between sustainability goals and fire safety assessment becomes a barrier to innovation.

To bridge this gap, BioFireAssess combines established fire testing methods with advanced experimental and analytical tools specifically designed to study smoldering. Small- and intermediate-scale experiments are used to isolate and investigate key mechanisms, including ignition conditions, oxygen availability, heat generation, and propagation speed, within porous insulation materials.

A central experimental tool in the project is CASPR — the Controlled-Atmosphere Smoldering Propagation Reactor. The development of CASPR enables the study of smoldering under precisely controlled oxygen concentrations, airflow conditions, and boundary constraints. This is critical because smoldering is highly sensitive to oxygen supply and material permeability. By systematically varying atmospheric conditions, CASPR allows the identification of threshold conditions for ignition, sustained propagation, extinction, and potential transition to flaming combustion. In other words, it enables quantifying when smoldering starts, how it spreads, and under what circumstances it stops.

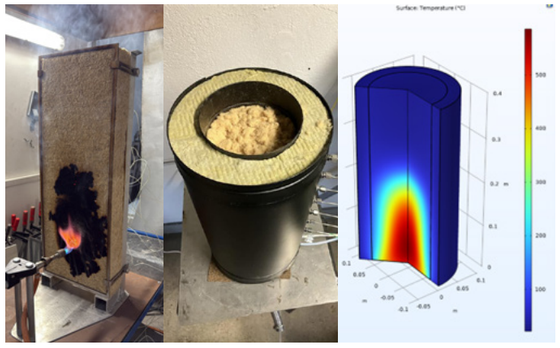


FIGURE 2:
Advanced smoldering tests in combination with numerical modelling.

These controlled experiments are complemented by advanced numerical modelling. Computational models simulate heat transfer, oxygen transport, and the thermochemical degradation processes occurring within the insulation. By calibrating the models with CASPR data, researchers can extend findings beyond laboratory-scale samples and predict behavior in realistic wall, roof, or floor assemblies. This integration of controlled experimentation and predictive modelling provides a far more comprehensive understanding than either approach alone.

Together, CASPR testing and numerical modelling form the foundation for a quantitative, risk-based assessment framework. This framework supports performance-based fire-safety design and provides consultants, authorities, and insurers with clearer, more transparent tools for evaluating smoldering risks in bio-based insulation systems.

By addressing smoldering as a distinct and measurable fire safety phenomenon, BioFireAssess contributes to removing a critical bottleneck in the green transition of the built environment. The project demonstrates how targeted research, controlled experimentation, and advanced modelling can translate complex material behavior into practical decision-making tools. In doing so, it not only strengthens confidence in bio-based insulation materials, but also provides a replicable approach for assessing emerging risks associated with innovative, low-carbon construction solutions.

Architecture of Disassembly – Materials, Construction, and Aesthetics
by Thorbjørn Lønberg Petersen

Thorbjørn Lønberg Petersen
Postdoctoral Researcher, Enemærke & Petersen, and The Royal Danish Academy, Institute of Architecture & Technology, CINARK – Center for Industrialized Architecture

The project's main assumption is that this can be realized through the implementation of circular and reversible building principles in prefabricated building systems, as well as through the substitution of climate-intensive construction materials with biogenic, reused, and recycled materials.

First and foremost, the implementation of such principles will enable non-destructive disassembly into pure material fractions and thereby allow direct reuse and material recycling. The vision is, thus, to challenge the linear material logics and algorithmic processes that currently promote an understanding of the built environment as compositions of static, permanent, and inseparable construction material assemblies – a tendency which counteracts circular principles and leads to the degradation of the values and resources embedded in our buildings.

Instead, the project aims to introduce a systemic approach to circularity in Enemærke & Petersen's in-house production, working toward the implementation of circular principles early in project development – not merely as optional add-ons or certification strategies, but as an integrated part of the production process and as a structural prerequisite for the creation of buildings. Finally, the project seeks to contribute to a cultural shift in which the built environment is increasingly understood as a living environment, maintained and operated through continuous care, maintenance, and repair. A related ambition is therefore to open new perspectives for the understanding and implementation of technical building solutions and tectonic principles that allow continuous maintenance through the use of biogenic materials and reversible construction principles. This challenges conventional construction, habitation, and operational practices, where maintenance-free solutions are often considered the ideal in modern construction, despite the climate and resource-related consequences associated with maintenance-free material composites and building systems. In this way, the project contributes to a broader societal discussion about practices of care and responsibility for the built and natural environments we inhabit and depend upon.

What Results Could this Produce?

The results of the project's various work packages range from identifying practical and organizational potentials/challenges in implementing circular strategies through case studies of existing projects and processes within Enemærke & Petersen's portfolio to the development of circular principles through building experiments and physical demonstrators of prefabricated elements. Based on this, the project's overall objective is to generate knowledge that can support the implementation of circular principles and biogenic materials on two levels:

- Concretely, through its investigations, the project aims to support Enemærke & Petersen's development of circular building elements and systems as deliverables that can become part of the company's strategic sustainability and circularity initiatives. This is achieved by reducing the costs of producing building elements and increasing competitiveness within the circular material economy through the reuse and recycling of materials from renovation projects and through the use of reversible building solutions. By strengthening processes and production systems, as well as integrating renovation processes with element production, the project will equip

the company to meet growing market demands, EU Taxonomy requirements, and certification standards, and specifically move Enemærke & Petersen toward a more circular practice.

- On a broader scale, the project will contribute to a deeper understanding of how constructions can be integrated with the industrial and natural ecosystems of which they are part and upon which they depend. This will benefit not only Enemærke & Petersen, but also the construction industry and society more generally. While the knowledge and experience generated through the project's various work packages will strengthen Enemærke & Petersen's position, these insights will also be disseminated to professional and industry peers, thereby supporting the generalizability of the developed circular principles and solutions despite their grounding in Enemærke & Petersen's specific organizational structure and production processes. Through this dissemination of knowledge, the project seeks to contribute to a broader cultural shift toward increased circularity in the built environment, through the implementation of materials and tectonic principles that enable and support continuous practices of care, maintenance, and repair.

What is Needed for Success and Broader Implementation?

The project's ambition to increase the use of biogenic materials in construction is linked to knowledge about natural resource foundations, sustainable land use, raw material potentials, and biodiversity. Increased use of already existing materials through reuse and recycling is connected to knowledge about material flows, application possibilities, technology, and chemistry. Because the project considers both material groups necessary for reuse within a circular material economy, there is a need for fundamental knowledge about the ecosystems from which the materials originate and in which they will subsequently participate.

At an organizational level within Enemærke & Petersen, important experience and competences are created in every project. Unfortunately, preliminary studies have shown that much knowledge is lost from one project to another on a project-to-project basis. To address this barrier, it is necessary to establish methods and systems for knowledge collection, experience exchange, and dissemination so that rather than reinventing circular initiatives and strategies within Enemærke & Petersen's workflows at the beginning of each project, each project can build upon previous experience and competences.

This issue spans workflows and organizational roles, as well as materials-related and tectonic strategies concerning construction processes and the production of prefabricated elements. It is this latter theme that forms the main emphasis of the project.

More generally, significant barriers exist throughout all stages of the construction value chain, which it is important what we identify and address in the transition towards a circular material economy. In working with the implementation of reused, recycled, and biogenic materials, issues of ongoing responsibility, guarantees, and operational processes are particularly obstructive. Overall, this issue points toward a broader cultural change concerning the built environment: within construction processes, in ongoing maintenance, and in everyday habitation practices. More specifically, it is a challenge that requires comprehensive understanding of the collaboration and division of responsibilities taking place among the different actors and processes within construction. In addition to the project's broader contribution to cultural change, the project seeks to gather compile and organize knowledge within Enemærke & Petersen's organization and project portfolio that is specifically capable of addressing these questions of ongoing responsibility and operational processes guarantees through accumulated experience, material practices, and various strategic collaborations.

The project "Det Biogene Montagebyggeri" (The Biogenic Prefabricated Construction) is led by CINARK, the Centre for Industrialised Architecture at the Royal Danish Academy, in collaboration with DBI (the Danish Institute of Fire and Security Technology), EcoCocon Danmark, Tækkefirmaet Horneby, Hemmed Tækkefirma and Enemærke & Petersen. The project is supported by MUDP (the Environmental Technology Development and Demonstration Programme) under the Ministry of the Environment. Image credits: The Royal Danish Academy & Karina Tengberg

"Rightsizing" of the Single-Family House
by Mette Mechlenborg

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Rightsizing of the Single-Family House

The single-family house, with its large floorage and high resource consumption, is a major contributor to the climate footprint. At the same time, it remains one of the most popular housing types – in Denmark and internationally – and most people value living in a house with a garden. This makes the single-family house a Gordian knot in the sustainable transformation of our housing system. The underlying premise is that if we can make the single-family house sustainable, other housing types will follow. And there is reason for optimism. Across Europe, Australia, North America, and elsewhere, initiatives, campaigns, and regulatory measures have already been introduced to promote more efficient use of existing houses and gardens, thereby reducing the need for further land subdivision and new construction.

BUILD's report (2026) presents international experiences with improving the use of single-family housing. The publication includes descriptions of more than 15 international examples of rightsizing, organized into three strategies: re-union (home sharing), re-location (residential mobility), and re-structuring (soft densification). In addition, it contains an introduction to rightsizing, a synthesis of experiences, key considerations, and recommendations. The publication concludes with a list of links to relevant websites, publications, and further resources. The overall aim is to provide municipalities, advisors, developers, and other actors in the housing sector, in Denmark and internationally, with inspiration for how the detached single-family house can be made fit for the future.

What is Rightsizing?

Rightsizing refers to the vision of adapting the housing stock – in this case, single-family homes – to a level that better aligns with current needs and resources, both in terms of operational demands and land use. It involves tailoring solutions to the local context and to the specific circumstances of individual residents. The concept thus points to the relationship between household and dwelling and, unlike approaches such as downsizing, transformation, or optimization, is grounded in the premise that adapting housing for the future is as much about understanding which housing qualities should be added to lived experience as it is about what should be reduced.

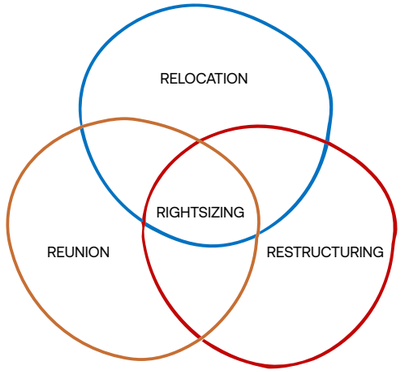

FIGURE 1:

Rightsizing refers to initiatives aimed at achieving a better match between household and dwelling.

Three overlapping approaches can be distinguished: re-union (home sharing), re-location (relocation pathways), and re-structuring (soft densification at the plot level). Source: BUILD.

- *Re-union:* Re-union refers to the social densification of underutilized homes and encompasses a range of approaches aimed at enabling residents to live more closely together. In many cases, this involves empty nesters who rent out rooms or parts of a family home after their children have moved out. Internationally, re-union is associated with two main concepts. One is kangaroo dwellings, an Australian term for intergenerational housing arrangements in which two or more generations live on the same plot – typically in the form of a main house with an attached unit, partially integrated into the primary dwelling. The Australian trend of kangaroo housing forms part of a broader international trend involving housing solutions that address both the shortage of affordable, smaller dwellings for students and young people and a strategic focus on the well-being of older adults. These approaches are often referred to as "intergenerational home sharing" or "solidarity-based housing". Across Europe, there are several nonprofit and municipal initiatives that combine efforts to support the well-being of older adults with the provision of housing for younger people, including in the United Kingdom, Germany, Spain, Austria, France, and Belgium.
- *Relocation:* Re-location refers to initiatives and campaigns aimed at encouraging people to move from homes that are either too large or no longer suited to their needs into more future-proof housing that better aligns with their current circumstances. The vision is to increase residential mobility within the housing market and thereby activate relocation pathways, leading to a better match between individual dwellings and the households that occupy them. Re-location strategies are (still) primarily initiated at the local level by municipalities, organizations, or social housing providers. However, recent developments indicate growing interest in coordinating such initiatives at the national level. For example, the Irish government has established a committee to develop a comprehensive national strategy for age-friendly housing, which also includes a focus on residential mobility. In Australia and in the US state of California, financial incentives have already been introduced to make it more attractive for empty nesters to move out of larger homes.
- *Restructuring:* Re-structuring focuses on localized restructuring of the conventional single-family house and its associated parcel. This may involve the physical and legal subdivision of an existing house into multiple dwelling units or the addition of smaller, detached units in the backyard or as extensions to the main building. The aim of re-structuring is to make more efficient use of space, both within the dwelling and on the associated parcel, thereby optimizing overall land use. Re-structuring is often combined with new planning instruments and/or state incentives, as well as broader municipal strategies for soft densification. Although international experiences remain largely theoretical or are based on pilot projects without documented large-scale impact, the sustainable transition has generated renewed interest in these approaches. For example, the Dutch organization Platform31 – an independent knowledge and network organization funded by national, municipal, and private sources – is working to develop strategies for sustainable housing transformation, including approaches to home sharing and subdivision. These range from relatively simple arrangements involving multiple occupants in a single dwelling to full woningsplitsing, in which a house is converted into two or more independent units with separate addresses and facilities.

International Knowledge: What Can We Learn?

The examples collected show that a range of approaches are used internationally to promote more efficient use of single-family housing, including support for voluntary relocation, home sharing, densification, and the restructuring of single-family neighborhoods. These approaches can also contribute to the preservation of single-family homes and help avoid demolition. Danish municipalities can draw inspiration from such initiatives and support more flexible use and adaptation of single-family housing. This, however, requires adjustments to planning legislation and, ideally, targeted support schemes and cross-sector collaboration. At the same time, international experience shows a need to develop local models that integrate social, economic, and physical interventions, and that interdisciplinary collaboration and citizen involvement are key to successful implementation.

1. The Role of Municipalities and the State in Optimizing the Use of Single-Family Housing

Municipalities and the state can promote more efficient use of single-family housing by developing regulations, incentive schemes, and planning strategies that support rightsizing. This involves aligning the size and use of dwellings with the actual needs of residents. A number of countries have introduced legislation and support programs that enable the sharing, subdivision, or conversion of single-family homes. For example, in 2019 Minneapolis abolished single-family zoning rules and allowed up to three housing units on a single lot, while California, through Senate Bill 9 (2021), has introduced statewide provisions that override certain aspects of municipal planning authority.

In Denmark, the state and municipalities have traditionally prioritized new land subdivision, but more recent municipal tools – such as the *OptiWohn* model in Göttingen, Germany – demonstrate opportunities to promote relocation pathways and residential mobility through advisory services and targeted relocation subsidies. Municipalities also play a role in reducing the demolition of existing housing stock by encouraging renovation and flexible reuse.

2. Business Models and the Role of Commercial Actors

Commercial actors are involved in several rightsizing models, particularly in relation to home sharing and subdivision. These models range from social enterprises to real estate developers offering turnkey solutions for conversion or shared use. In the Netherlands and Germany, partnerships can be observed between municipalities and such actors, where private advisors facilitate and implement housing conversions. In Steinfurt, the municipality collaborates with actors who inform and advise homeowners on sharing and conversion; a similar approach is seen in the BIMBY-BUNTI initiative in France. In Australia, the market promotes so-called granny flats (accessory dwelling units), where construction companies offer modular homes as additional dwellings on existing single-family plots. Experience shows that financial viability and standardized solutions are crucial for the participation of commercial actors. However, successful scaling depends on alignment with public regulation, as well as ensuring architectural coherence with the surrounding neighborhood.

3. Engaging Homeowners

Many homeowners, particularly older adults, exhibit low residential mobility and a strong attachment to their homes. It is therefore necessary to combine financial, social, and practical incentives to encourage changes in housing behavior. Information campaigns, personalized advisory services, and financial subsidies have proven effective in Göttingen and Steinfurt, Germany, and in Dublin, Ireland, where outreach-based advisory services have helped older residents consider relocation or home conversion.

At the same time, social programs play an important role. In Belgium and Germany, intergenerational housing schemes such as *1toit2âges* and *Wohnen für Hilfe* and have encouraged older adults to rent out spare rooms to younger people in exchange for practical assistance. However, this requires mediation and trust-building support from local organizations.

This project is supported by Bevar Mere – an initiative led by the Danish Landowners' Investment Fund, the Danish Building Foundation, Dreyer's Fond, and Realdania. For more information, see www.bevar-mere.dk.

Download here: https://vbn.aau.dk/en/publications/rightsizing-of-the-single-family-home-international-experiences-w/

The Blended City as Spatial Imaginary and Practice

by Deane Simpson, Nina Stener Jørgensen

Deane Simpson

Nina Stener Jørgensen

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The international research network “The Blended City as Spatial Imaginary and Practice” – running from 2025–2027 – addresses one of the most persistent and powerful urban ideals: that cities thrive when social difference coexists in shared space. **This proposition draws on a substantial normative tradition in urban thought.** From Jane Jacobs’ celebration of dense, mixed-use neighborhoods as engines of democratic vitality, to Richard Sennett’s advocacy for the “open city” shaped by encounter and incompleteness, to Hartmut Häussermann’s characterization of the city as an “integration machine,” heterogeneity has been framed not merely as an empirical condition but as a civic virtue. The Blended City addresses this lineage, identifying mixture as both descriptive of urban life and a long-running prescriptive of what the “good city” ought to be.

Today, the Blended City operates as a dominant spatial imaginary across architecture, urban planning, and housing policy in Denmark and internationally. Deployed by politicians, planners, and architects, it carries significant spatial and societal consequences. Like the smart city or the livable city, the Blended City functions as a spatial imaginary: a deeply held, collective understanding of socio-spatial relations that gives coherence to planning processes while remaining contingent, dynamic, and contested. Its power lies in this dual quality— simultaneously unifying and vague. It unites actors around the aspiration of social mixture, even as its meaning, metrics, and spatial translation vary widely.

In Denmark, the Blended City has assumed multiple and often contradictory forms. It has been framed as an antidote to concentrations of socio-economic disadvantage through the so-called “Ghetto List” and the 2018 Parallel Society Act (PSA); as an alibi for state-led gentrification through processes of territorial stigmatization; as a political initiative to expand non-profit housing access in urban centers through the 2021 Tættere På II program; as a response to concentrations of affluence; and as a conceptual framework for socially inclusive neighborhoods and public space. The ambiguity of the Blended City is evident in ongoing disputes over how mixture should be defined and measured: questions of composition, concentration, and scale remain highly contested. Yet despite this vagueness, enormous public resources have been mobilized in its name. The PSA alone dedicates approximately 12 billion DKK through 2026 and involves the demolition or private sale of several thousand non-profit housing units and the displacement of several thousand residents. Conversely, the Tættere På II initiative allocates 10 billion DKK toward constructing 22,000 non-profit housing units by 2035. The Blended City thus oscillates between demolition and construction, between dispersal and densification— revealing a gap between the conceptual vagueness of the imaginary and its material consequences.

The Blended City network addresses this gap. Its intention is not simply to critique the spatial practices deployed under the banner of urban social blending, but to clarify and qualify the spatial imaginary and its impact. The network seeks to analyze consistencies and inconsistencies across four dimensions: (a) theoretical traditions underpinning the Blended City; (b) qualitative practices enacted by planners, architects, and policymakers; (c) quantitative measurement frameworks that define and assess mixture/blending; and (d) the concrete spatial practices through which blending is implemented. By bringing these dimensions into dialogue across Danish and international cases, the network aims to examine where normative ideals align—or misalign—with spatial outcomes. This integrative approach is particularly urgent at a time when blending policies are deployed to justify large-scale restructuring, yet lack shared definitions or evaluation criteria.

The network’s potential contributions are both analytical and transformative. It intends to generate a clearer understanding of which forms of segregation are “seen” and reacted to—and which remain invisible. It will examine how metrics privilege certain variables (e.g., income thresholds or ethnic proportions) while neglecting others (e.g., labor market discrimination or housing affordability). It aims to contribute to mapping how different actors— state, market, housing associations, and civil society— translate blending into divergent spatial strategies. In doing so, the network challenges prevailing planning practices that treat mixture as an unquestioned good and demolition or relocation as neutral instruments. Instead, it foregrounds blending as a contested socio-spatial process embedded in political economies and cultural narratives.

For the spatial imaginary of the Blended City to evolve toward more nuanced and constructive practices, the early work of the Network begins to suggest that several conditions are necessary.

- First, blending must move beyond the asymmetrical obligations currently imposed primarily on disadvantaged neighborhoods. In many contexts, “mixing” is framed as a corrective measure for areas marked by poverty or ethnic concentration, while affluent and socially homogeneous districts remain untouched. A genuinely reciprocal approach would address concentrations of privilege alongside concentrations of disadvantage, deploying inclusionary housing tools, tenure diversification, and planning mechanisms across the entire urban territory rather than targeting only stigmatized zones.
- Second, integration must be linked to structural reform. Spatial redistribution alone cannot overcome labor market exclusion, educational inequality, or discriminatory practices. Without coordinated policies addressing employment access, school segregation, and anti-discrimination enforcement, housing interventions risk relocating inequality rather than reducing it.
- Third, robust participatory mechanisms are required to ensure that residents actively shape transformation processes. Meaningful consultation, co-design practices, and strengthened housing democracy can shift blending from a technocratic mandate to a collectively negotiated project.
- Finally, measurement frameworks must be refined. Evaluations should move beyond static indicators of demographic composition to include long-term affordability, tenure security, social mobility trajectories, and lived experiences of belonging and stability. Only through such multi-dimensional assessment can blending be evaluated as a social outcome rather than a numerical adjustment.

Ultimately, the Danish case demonstrates both the generative and destabilizing power of spatial imaginaries. The Blended City remains a compelling urban horizon—an aspiration toward pluralism and shared belonging. But without conceptual clarity, empirical grounding, and democratic legitimacy, it risks becoming a vehicle for exclusion and market restructuring. By interrogating its theoretical foundations, rhetorical mobilizations, metrics, and spatial translations, the Blended City network seeks to reposition mixture as a democratic and spatial justice issue rather than a disciplinary tool. In doing so, it aims to provide a more informed basis for reformulating policies and future planning proposals—ensuring that the substantial resources mobilized in the name of blending contribute to durable social cohesion rather than unintended fragmentation.

[About the international research network “The Blended City as Spatial Imaginary and Practice”: The network is supported by a DFF Explorative Network in the Humanities Grant, and is led by Deane Simpson and Nina Stener Jørgensen at the Royal Danish Academy in collaboration with Marie Stender and Elise Stenholt Lange at Aalborg University BUILD.

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X0 – Copenhagen Outcome Accelerator

by Dark Matter Labs: Ivana Stancic, Fabian Lecker, Indy Johar & Robyn Bennett


Ivana Stancic


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Copenhagen Outcome Accelerator

Why Is Current Innovation Insufficient?
As we are living through ecological, social, and economic breakdown, both the current configuration of the built environment as well as what we call “innovation” today largely operate inside a failing logic: We optimize an extractive system with incremental and siloed solutions, incompatible with planetary limits. At the same time, we underestimate the urgency: climate and ecosystem collapse are not distant risks - they are our current lived reality.

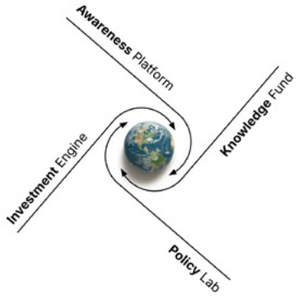
This is no longer speculative. Countries are starting to acknowledge this, such as the British Government now assessing that “every critical ecosystem is on a pathway to collapse”[1]. The Danish Reduction Roadmap states that national carbon emissions must be reduced by 97% to reach the safe operating space[2].

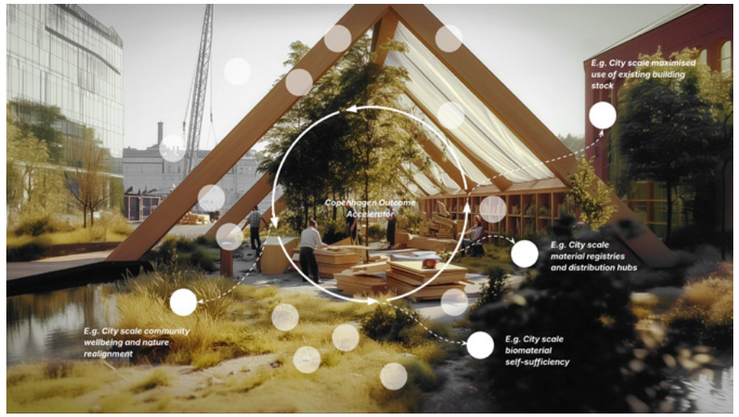
And WWF’s recent report goes even further, concluding that Denmark must reduce its deforestation impact by 100% as soon as possible[3]. This is not a question of swapping one building material for another, achieving marginal efficiency gains, or pilot projects. A 97% reduction in emissions and a 100% reduction in deforestation are not incremental adjustments to a system. They demand an entirely new system.

Such a system's transition will inevitably happen, either by coordinated design or imposed by collapse through material, energy, and food shortages, and resulting social resistance. Consequently, if innovation continues to mean making the existing systems slightly less harmful, rather than questioning the foundations, it will keep taking us nowhere.

The Copenhagen Outcome Accelerator: An Engine for the Built Environment Transition
Countries, cities, institutions, and communities lack the connective tissue to perceive and absorb risk, to sense-make collectively, and to respond in a coordinated manner. It’s not the absence of scientific insight that limits us; it’s the failure to translate it into outcomes at the pace the crises demand.

Rather than waiting for mandates or markets to align to create isolated innovation projects or reactive adjustments, we are responding to this challenge by building The Copenhagen Outcome Accelerator: a pathway for managing risk over time. It is not a project or a platform, but a structured transition





engine. It demonstrates a new infrastructure that connects awareness, knowledge, policy, and finance. Its purpose is to organise mass multi-actor transitions under conditions of distributed agency, contested legitimacy, and accelerating risk.

The Copenhagen Outcome Accelerator combines the four nodes of Awareness, Knowledge, Policy, and Investment into a single operating model:

- **The Awareness Platform** – builds shared understanding and acts as an interface between experts, industry and societal uptake, aiming for visibility and engagement.
- **The Knowledge Fund** – conducts research, produces evidence and analysis, and builds the required legitimacy.
- **The Policy Lab** – engages with institutional and legal conditions, and provides guidance for local, national, and European regulatory adoption.
- **The Investment Engine** – mobilises resources, aligns capital flows, and develops innovative financing models.

This combined approach matters because each layer on its own fails: campaigning without authorisation becomes noise; authorisation without delivery capacity becomes theatre; capital without regulatory pathways becomes stranded; and regulatory experimentation without legitimacy triggers social backlash. The four-node structure prevents the Copenhagen Outcome Accelerator from becoming disconnected projects or slow institutional drift.

Alliance is critical

Many of the actors needed for systemic change already exist, but in silos. The Copenhagen Outcome Accelerator creates the connective tissue across the industry: media and awareness platforms, knowledge institutions, planners, city leaders, policy makers and politicians, developers, contractors and insurers, communities and civic organisations, craftsmen, pension funds and public and private investors.

The result is a large-scale, multi-actor engine capable of driving new solutions in the building industry at a depth and the speed that this crisis demands.

1 Dept for Environment, Food & Rural Affairs, Government of the U.K. - Global biodiversity loss, ecosystem collapse and national security - 2026

2 Petersen, Walbech Ryberg, Birkved - The safe operating space for greenhouse gas emissions - 2022

3 WWF Denmark - Denmark's Footprint Challenge: From nature decline to a more sustainable future for all - 2025

Care Architect, Building Heritage, and Storytelling
by Tenna Doktor Olsen Tvedebrink

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Care Architect, Building Heritage, and Storytelling

At the Department of Architecture, Design & Media Technology, Aalborg University, we are working with a research track entitled Architecture as an Act of Care, which renews focus on the architect's role, ethical responsibility, design norms, and design empathy. The overarching vision of the research track is to strengthen the architect's ability to move between expert and facilitator – in dialogue and collaboration with a broad range of stakeholders: clients, users, local communities, and the many collaborators within the construction industry. This takes place with particular attention to topics like social sustainability, social resilience, universal design, and human diversity.

The central hypothesis is that when architects are attentive to interdisciplinary collaboration, integrating the stories of a place and the narratives of local communities, the understanding of architectural value changes from a primarily aesthetic form to a care-oriented process.

This perspective of care is particularly relevant at a time when the Danish construction industry is undergoing a comprehensive green transition. We are looking toward a future in which new generations of architects must increasingly address climate change, resource scarcity, and rising energy consumption. Among other things, this means that transformation projects will become more significant than new construction. At the same time, the profession is characterized by the rapidly growing use of digital technologies such as building information modeling (BIM) and AI. These trends challenge both professional identity and design competences.

Throughout the twentieth century, the architectural profession evolved out of a strong artistic tradition in which creativity, originality, and the (star) architect's personal signature was central. Transformation projects primarily concerned valuing cultural heritage, protecting identity, and preserving craft traditions. Today, and increasingly in the future, transformation is becoming a matter of valuing building heritage, safeguarding material consumption, and preserving planetary resources.

At the same time, it is evident that both the green transition and issues of building heritage are experienced differently across local communities and among individuals. These differences may be decisive for the sustainability choices people make in everyday life – and in the long-term impact on their health and well-being. The question is how architects can incorporate care, not only for resourceful citizens but also for socially vulnerable and marginalized groups.

Although both the construction sector and political parties express ambitious goals for the green transition, these goals often fail to recognize the consequences such transitions may have for the social resilience and life situations of socially vulnerable and marginalized groups (for example neurodivergent children and young people, elderly with functional variations, people experiencing homelessness, refugees, etc.). At the same time,

the knowledge and perspectives that these groups can contribute – both to the green transition and to building heritage – are often overlooked. A research gap has emerged as attention to environment, climate, nature, and technology has grown. There is a need to correct the instrumental and technical understanding of sustainability with an approach that views the residents of the city as essential resources.

In the tension between today's sustainability requirements and the increasing use of digital technologies, a new role for the architect is emerging. Here, the need for a care architect becomes evident: a professional capable of combining knowledge of social resilience, well-being, and human diversity with complex requirements related to life cycle assessments and energy calculations. This entails a deeper understanding of how architecture affects our bodies, senses, emotions, behavior, social relations, and interactions – and how these personal experiences and stories are central elements in the narrative of building heritage.

A significant barrier today is that the UN ideal of "leave no one behind" remains difficult to translate into professional practice. This applies both to people with physical and psychological bodily variations. There is still a lack of knowledge, concrete methods, techniques, technologies, and a nuanced professional language that make it possible to integrate greater human diversity and theoretical perspectives, such as universal design, into architectural design processes. In particular, there is untapped potential not only in involving perspectives from marginalized groups, but also in rethinking the design process so that these people can genuinely participate in co-creative projects and gain ownership in the narrative of building heritage.

The research track therefore works to rethink methods for involving marginalized groups. We call this "Caring Sensibilities", and it is rooted in the need for a professional transformation within architecture; a transformation in which the architect's role is reformulated and space is created for a new language concerning the value of architecture. This reformulation simultaneously requires confronting parts of the profession's normative legacy and the myths upon which architecture has historically been built. This includes notions of "neurotypical people" and the building as a "work of art", which have shaped architectural history and theory for generations.

Photograph of six architecture students walking with a representative from the Danish Association of the Blind in the Sydhavn district of Aarhus. Photo copyright: Tenna D.O. Tvedebrink

Unique to this research track is the use of narrative methods such as storytelling, scenarios, and storyboards through text, images, models, and film – in combination with digital technologies such as XR, VR, and AI. This "storytelling toolbox" enables exploration of different personal narratives, norms, and historical layers across time and place. Among other things, it creates opportunities to revisit architectural history and explore cases historically highlighted for their architectural qualities – but which often lacked attention to human diversity and accessibility. The result of the research track is therefore the collection of empirical data and the development of co-creative design methods capable of updating the design process and our design tools.

This vision forms part of a significant paradigm shift that will take time to implement and require collaboration across professional disciplines and educational institutions. However, the intention behind these revisits of building heritage and these new narratives is, in the long term, that researchers, practitioners and educational institutions can use these results, for example, to understand how people with physical and psychological bodily variations experience architecture differently. In this way, the research track may contribute to a rewriting of architectural history and help create a building heritage that, going forward, places greater emphasis on social responsibility, human diversity, and care as central values within architecture.

Scaling the temporal
by Heidi Merrild, PhD.

Heidi Merrild, PhD.

Illustrations assisted by research assistant Anna-Lena Müller.

Background

This article draws on in-depth interviews with key actors involved in the development of several case projects: LKR Innovation House in Østbirk, Denmark; the transformation of Alcobaça Monastery in Portugal; the hybrid wood and rammed-earth ERDEN factory and office building in Austria; the rammed-earth construction Ofen Turm at the Ziegelei Museum in Cham, Switzerland; and the transformation of Hedensted Schoolyard in Denmark. The research is further supported by on-site visits to all of the projects. The empirical insights are situated within a broader investigation of international lighthouse projects.

The work forms part of a larger research collaboration at Aarhus School of Architecture (AARCH) and the Aarhus Center for Regenerative Buildings (ACRB).

The first part of this research has already been published; *Regenerative Architecture*,[1] a second publication, including more detailed analyses of several of the projects referenced here, will follow. The broader study investigates regenerative potentials and barriers through selected lighthouse case studies and interviews. Rather than revisiting each project in detail, this article distils a set of architectural pathways that emerge across the research.

The study explores future pathways emerging from both transformation and new-build projects, examining how architectural practice can move beyond conventional sustainability toward regenerative modes of building – strategies that actively restore, enhance, and cultivate ecological and social systems. By combining empirical engagement with critical analysis, the research remains grounded in the realities of practice while addressing broader architectural, ecological, and societal challenges.

The investigation is approached through a sedimentological lens, attentive to layers – in construction details and facades, in transitions between interior and exterior, and in the reciprocal relationships between

human and non-human actors. At every scale, the building is understood as a layered condition: an accumulation of materials, climates, uses, and temporalities.

Framed in this way, architecture appears not as a fixed and finished object, but as a natural and evolving system. Circularity is therefore reconsidered not merely as a technical strategy of reuse, but as an architectural principle embedded in assembly, sequencing, and long-term transformation. The future pathways of the built environment demand new research formats and collaborative processes capable of engaging this complexity. The aim is not to present resolved solutions, but to identify emerging trajectories that expand architectural imaginaries and professional practice.

The concept of "reversible tectonics" was developed in the author's PhD research conducted in collaboration with architecture firm Friis & Moltke.[2] The research engages construction traditions in which tectonic principles remain legible, in contrast to much contemporary building culture where assemblies, adhesives, and concealed joining methods often obscure how buildings are made. Drawing on Friis & Moltke's practice, the research explores the notion of "thickness" as a strategy for translating modernism's historically "heavy" architectural language into a lighter, materially layered, and articulated expression.

The work further proposes an expanded architectural vocabulary – one that acknowledges both human and more-than-human actors in the built environment. This constitutes a linguistic and conceptual investigation aimed at opening alternative ways of understanding the relationship between humans, materials, and environment. In the author's postdoctoral research, this exploration continues as a central component in articulating a new ecological mode of thinking and identifying regenerative pathways, grounded in empirical studies of contemporary national and international lighthouse projects.

LKR Innovation House is VELUX's living innovation platform, accommodating approximately 500 employees. Conceived as a large-scale transformation rather than a replacement project, it operates as a spatial and material reworking of the existing warehouse from 1995. The project demonstrates how an open-ended design framework – developed through comprehensive user involvement – can guide architectural transformation as a regenerative process, extending from early conception through construction and into occupation.

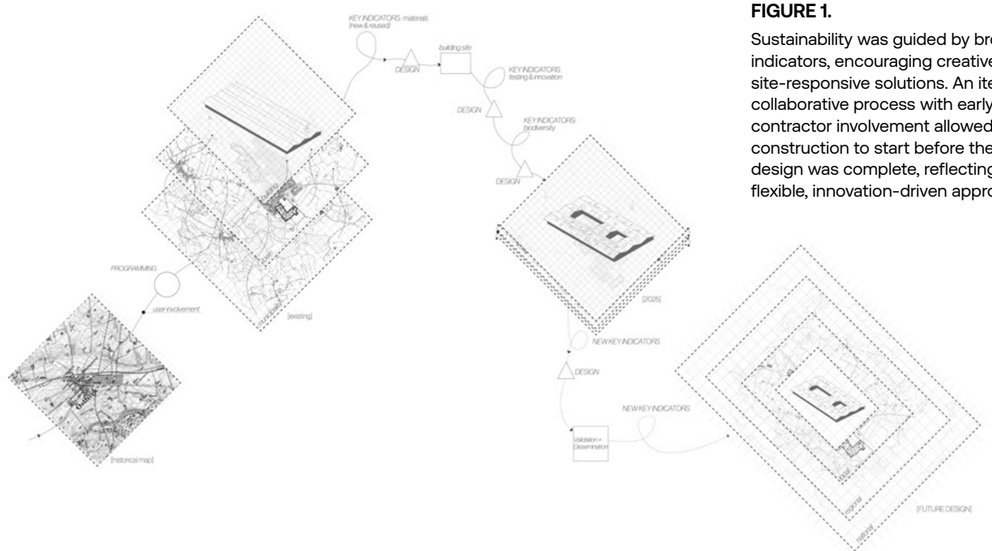

FIGURE 1.
Sustainability was guided by broad indicators, encouraging creative, site-responsive solutions. An iterative, collaborative process with early contractor involvement allowed construction to start before the final design was complete, reflecting a flexible, innovation-driven approach.

Architecturally, innovation emerges through the careful cultivation of what is already present. Existing structures are retained, exposed, and reprogrammed, while material reuse is made explicit through direct one-to-one applications in floors, facades, and interior elements. Reclaimed components are integrated as active architectural agents rather than concealed substitutions, allowing material history to remain visible and operative within the design.

The research underpinning the project unfolds through ten key points, presented in the article "Learnings from a Transformation". The present discussion focuses on selected themes: *Freedom to Innovate*, *Nature and Biodiversity*, *Breaking Point*, *New Depth/Thickness*, *'New' Materials*, and the notion of a *World of Light and Air*, which frames the inquiry and is immediately tangible in the spatial experience of visiting LKR Innovation House.

Reframing Ventilation and Comfort

The transformation appears deceptively simple: the introduction of light. By bringing daylight deep into the building through skylights, spatial perception is fundamentally altered. Historically, VELUX has worked intensively with this strategy, transforming former attic spaces and residual areas into inhabitable rooms. As a result, light does not merely illuminate the interior; it redefines it.

At LKR Innovation House, the interplay between light and air generates new spatial qualities and produces livable environments both inside and outside. Openings, ventilation paths, and layered thresholds establish a dialogue between interior climates and exterior conditions. Rather than isolating the building from its surroundings, the project enables exchange.

In contemporary practice, mechanical ventilation has become the default solution because it promises control, predictability, and measurable performance. Reliance on natural forces is often perceived as risky – subject to fluctuation and seasonal change. Yet it is precisely this variability that creates vitality. Variations in temperature, air movement, and light conditions foster awareness and sensory engagement, allowing the building to feel responsive rather than sealed and neutralized.

This suggests an important future research trajectory: how to combine qualitative spatial values with quantitative performance data. Materials, spatial configurations, thermal mass, orientation, and climate cannot be treated as isolated factors; they interact dynamically, from interior to exterior layers, as part of natural ventilation strategies. In this framework, comfort is not an absolute technical standard but a culturally mediated concept shaped by expectations and routines. Viewed through the lens of light and air, architecture shifts from being a controlled container to a responsive environment that engages both human and non-human processes.

Embroidering as Continuation

We appear to be at a turning point in how architecture is understood – no longer as a static object but as an evolving condition. Rather than something fixed and complete, architecture is increasingly seen as part of an ongoing material and cultural process. The city may be understood as a fabric onto which we continue to embroider: inherited, temporarily managed, and ideally improved before being passed on. Historically, architecture was often conceived as a Gesamtkunstwerk – a total work of art, self-contained and resistant to alteration. As canonical icons, such works were designed down to the smallest detail and intended to remain unchanged. Yet this completeness makes adaptation without compromising integrity difficult.

Today, a different understanding is emerging. Buildings must be conceived as capable of transformation – not isolated masterpieces, but elements within a larger material continuum. They form part of the urban fabric, continuously repaired, extended, reinterpreted, and sometimes carefully dismantled within broader circular flows. This shift is inseparable from growing material responsibility. Across contemporary practice, architects are increasingly concerned with conserving and reactivating materials already in circulation. Innovation, in this sense, does not imply replacement but continuation. LKR Innovation House exemplifies this position. Here, the intuitive and experiential approach of the architect aligns with the engineer's quantitative and performance-based methods. From the outset, Praksis Arkitekter operated from the premise that new architectural frameworks could emerge by activating and intensifying the latent qualities of the existing structure.

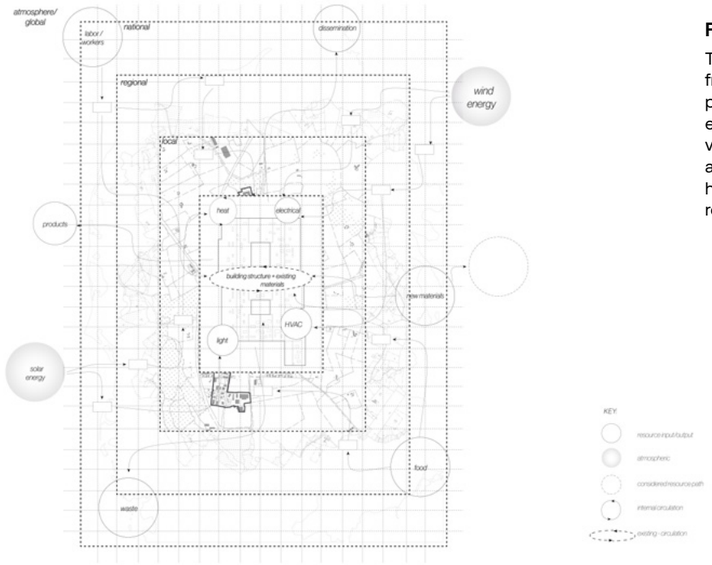

FIGURE 2.

The resources connected to a building span from local reuse and everyday consumption practices to national and international energy transfer networks. We can no longer view these in isolation; instead, we must adopt a broader perspective that maps how systemic building practices are re-emerging today.

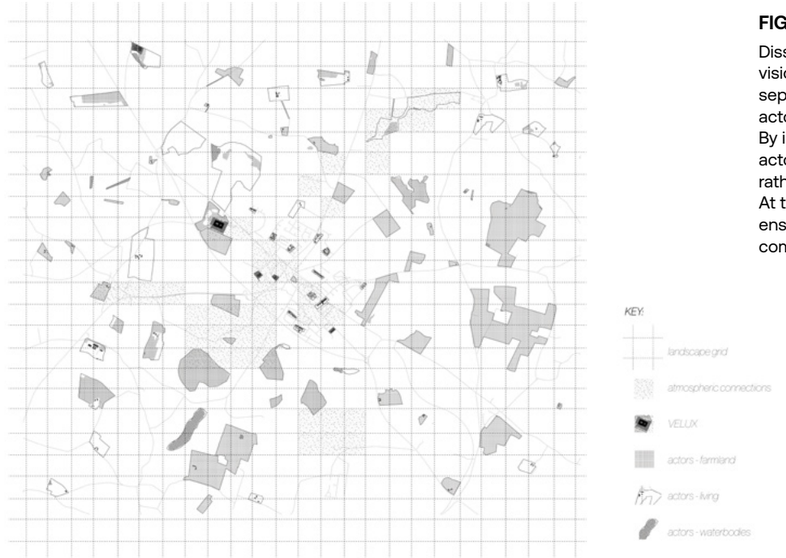

FIGURE 3:

Dissolved thresholds reflect Bruno Latour's vision of networks: spaces are not rigidly separated, and the connections between actors matter as much as fixed boundaries. By including both human and non-human actors, the map emphasizes interactions rather than merely static geography.
At the same time, the underlying grid ensures navigability, preventing the relational complexity from becoming disorienting.

Enabling Alternative Materials

This approach of continuing what already exists aligns with using as few additional materials as possible. When new materials are introduced, they should contribute positively to biodiversity and indoor environmental quality. Resource- and process-intensive materials must gradually be phased out, while testing and certification of emerging biogenic materials need to become more accessible. Currently, evaluation processes for bio-based materials are time-consuming and costly. Certification often carries limited weight for large corporations yet remains crucial for smaller start-ups. Alternative testing methodologies, knowledge exchange across countries, and more flexible regulatory frameworks are needed to support broader implementation.

In Denmark, regulatory and market barriers restrict the use of alternative insulation materials. Fire safety requirements and insurance conditions can be costly and complex, and this proved a challenge for LKA Innovation House, where it was ultimately not possible to implement bio-based insulation. Other European countries – including France, the Netherlands, and Germany – are advancing the adoption of biogenic materials. Germany's Building Type E, for example, enables experimentation in non-safety-critical areas within an evolving legal framework, thereby reducing regulatory barriers.[3]

Nature and Biodiversity

Transformation is inherently linked to biodiversity. Soil and earth must be recognized as valuable resources, and atmospheric and ground conditions must remain connected to sustain plant life. Re-opening sealed surfaces and breaking down rigid thresholds can reconnect ecological systems and networks within urban contexts.

Transformation projects can create new forms of openness within existing cities, linking built structures to surrounding landscapes. By dissolving hard boundaries, new networks emerge, fostering species diversity and expanding ecological connections. Soil should be valued not merely as displaced matter but as a living resource.

Experiential and sensory mapping must complement technical analysis to understand real ecological impact. At LKR Innovation House, unsealing surfaces and introducing permeable landscapes establish new ecological continuities. Architecture becomes an evolving spatial, material, and ecological system in which human and non-human actors coexist.

New Depth and Thickness

Listening to a site means recognizing its latent stories and ecological potentials. Work must be localized yet holistic, treating areas as interconnected systems rather than segregated zones of production, housing, or industry. Human and non-human resources are woven together; the richness of these interconnections corresponds directly to the depth and thickness of the ecological and spatial network.

Renovation and transformation inevitably reveal unforeseen conditions. Adaptability is therefore essential. Rather than imposing predetermined plans, architects must learn from what emerges when buildings are opened and materials are examined closely. This hands-on engagement fosters deeper understanding and expands creative possibilities beyond fixed sustainability metrics.

LKR Innovation House exemplifies this approach. As a sustainability landmark and workplace in the Danish town of Østbirk, the project impacts local infrastructure, community life, and regional economy. Such influence demands responsibility toward both resources and culture. The present moment calls for a fluid concept of nature[4] – one that dissolves rigid separations between suburban zones, industrial districts, and monocultural landscapes, and restores connections between earth and atmosphere.

Østbirk and LKR Innovation House are situated within an industrial landscape characterized by sealed surfaces – asphalt, concrete, and closed envelopes. By reopening these spaces and reconnecting them to ecological systems, new habitats and networks can emerge. Mapping biodiversity and integrating it into planning processes creates opportunities for both human and non-human life.

Alcobaça Monastery – Restoring a historic building is not an act of authorship, but of listening. This conviction runs through the work and reflections of the architect behind the long-term transformation of one of Portugal's most significant monastic complexes – a project that has unfolded over more than a decade and spans archeology, craft, politics, and pedagogy. The monastery, founded at the end of the 11th century, is deeply intertwined with the formation of Portugal as a nation. Its architecture embodies centuries of layered history: cloisters added and transformed across eras, walls thickened and repaired, colors applied, erased, and reapplied. The building is not a fixed object but a living accumulation of time.[5]

Learning before building

When work began, the architect describes arriving without certainty, and with little desire for control. The first task was not design, but diagnosis. Like medicine, restoration begins by understanding what already exists: which walls belong to which century, which construction techniques were used, which materials have proven resilient. Archeologists, historians, craftspeople, and

engineers worked side by side, mapping the building's stratigraphy and learning from its logic.

This was a process requiring humility. The ambition was never to "improve" the building, but to understand how it had survived for nearly a millennium. Medieval construction techniques – thick stone walls, lime-based mortars, breathable structures – were not primitive solutions, but sophisticated environmental strategies. In many cases, they performed better than contemporary systems when judged over centuries rather than decades.

Craft, replication, and teaching the eye

A central challenge of the project was the loss of traditional craft knowledge. Many of the techniques used by medieval builders are no longer part of standard construction practice. To address this, the architect spent long periods on site with stoneworkers and carpenters, studying existing details and, where necessary, reconstructing elements not as replicas for display, but as tools for understanding. Replication, in this sense, is not about copying appearances but about rediscovering processes. How was this joint made? Why is this column slightly irregular? What happens structurally when materials are allowed to age rather than be replaced? Teaching workers – and architects – to see these questions is part of the project's legacy.

Beauty

A recurring theme in the architect's reflections is beauty, not as perfection, but as continuity. Just as a human face gains character with age, historic buildings derive their beauty from traces of use, repair, and imperfection. Cleaning too much, replacing too thoroughly, or smoothing away irregularities risks erasing the very qualities that give the building meaning. In several instances, the easiest technical solution was deliberately rejected. Damaged windows were not replaced, but retained as framed memories of labor and time. New concrete elements were introduced sparingly and left visible, clearly distinguishable from the historic fabric without mimicking it. The goal was not seamlessness, but honesty.

Long before sustainability became a policy requirement, the monastery functioned as a self-sufficient system. Gardens were productive rather than decorative, water was carefully channeled for kitchens and fish ponds, and spatial organization responded to climate, ritual, and labor. In restoring the site, these logics were studied and, where possible, reactivated. The redesign of the monastic garden illustrates this approach. Rather than a manicured public park, it will remain a productive landscape with fruit trees, water systems, and seasonal variation. This has proven difficult to explain to politicians and administrators accustomed to conventional ideas of public space. Yet the project insists that sustainability is not an aesthetic choice, but a cultural one – rooted in long-term thinking and collective memory.

Being a small part of a long story

Perhaps the most important lesson drawn from the project is one of scale, not spatial, but temporal. A human life spans decades; the building spans centuries. Architects, therefore, are only temporary participants in a much longer narrative. The task is not to finish the building, but to keep it alive, allowing future generations to continue the work. In this sense, the project embraces incompleteness. Some spaces remain unfinished, not as failures, but as invitations. Like a film that ends with "to be continued," the architecture acknowledges that its story does not belong to a single author or moment in time. Working in silence, the architect suggests, may be the most respectful form of intervention.

Erden Factory and Erden Studios are the result of long-term experimentation with earth construction, integrating regenerative materials and prioritizing earth and wood as primary resources. The project explores simple rammed earth and hybrid wood-clay systems, prefabrication, renewable energy, and strategies for circularity and reversibility, rather than relying on standardized industrial components. They work with locally available resources, positioning architecture as a process of material engendering that is embedded in place, yet connected to the shared atmosphere.

The project resonates with ecological and contextual worldviews, yet it is driven by an art-craft innovation model supported by specialized networks of material knowledge. In this sense, it aligns with Bruno Latour's notion of a geo-social class, situating architecture within intertwined ecological and material conditions and advancing a terrestrial mindset grounded in the earth as substance and process[6]. The terrestrial, as Emanuele Coccia describes it, implies living within continuous material interdependence – soil, climate, and atmosphere – framing architecture as part of planetary life cycles.[7]

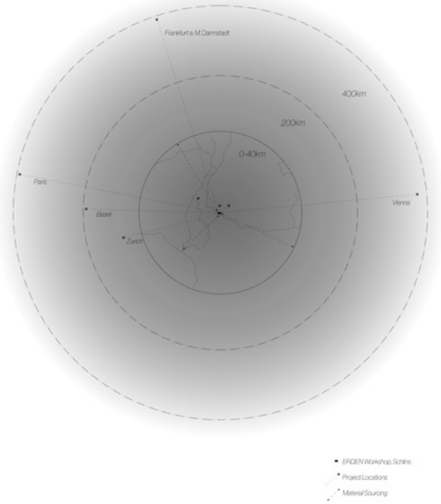

FIGURE 4:

The studio and factory illustrate how prefabrication can function within a local relational context. Instead of relying on standardized components and global supply chains, it represents a regional integration of local community, craft, industry, and site-specific materials.

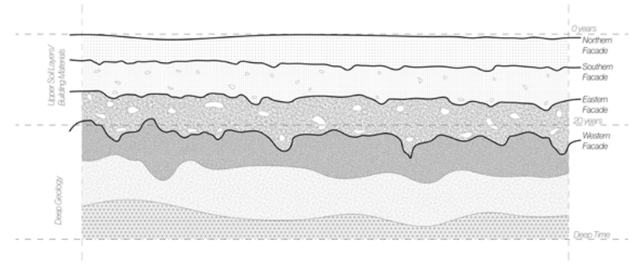

FIGURE 5:

Earth mixtures vary widely across regions and are adapted differently to climate and orientation. Their strength, erosion resistance, and thermal mass depend on the balance of aggregates, clay, and loam, as well as exposure to sun, wind, and rain.

The studio and factory demonstrate how prefabrication can be scaled within a local and regional relational context. This approach offers an alternative to conventional mass production and globalized construction logics, which are often characterized by overproduction and the long-distance transportation of materials and products. Rather than beginning with already standardized components, production at Erden starts from a given world of locally available resources.

Industrialising Rammed Earth

Erden's work demonstrates how regionally anchored prefabrication can overcome the economic, social, and quality constraints of temporary, project-based production models. Moving from on-site, ad hoc facilities to a permanent production setup has reduced weather-related risks, improved cost predictability, and enabled systematic quality control. The social dimension is equally significant. Consolidating production locally supports continuous employment, retains skilled workers, and strengthens regional knowledge networks. Embedding production within the community ensures that expertise is maintained and that the material culture of the region continues to evolve.

Materially, the project is closely tied to local resource cycles. Clay and earth used for production are sourced almost entirely from excavation material within a defined regional corridor, where availability far exceeds demand. This establishes a scalable, regionally grounded model that industrializes rammed-earth construction while maintaining connections to local resources and craftsmanship.

Unique Material Characteristics

Earth construction requires careful adaptation to local raw materials. In Erden's case, the mixture is comparatively soft, with smoother stone particles enhancing clay binding. As with historical rammed-earth structures worldwide, properties such as strength, erosion resistance, and thermal storage vary depending on the balance between aggregate and clay fractions.

Where specific technical performance is required, flexibility in sourcing becomes essential. Relying solely on immediately available materials can limit optimization.

Experiential Knowledge versus Quantification

A central challenge in Erden's work is society's growing demand for reliable, quantifiable metrics, such as energy consumption, return on investment, and performance optimization. In the process, confidence in sensory perception and experiential judgement has often been eroded. People who have lived in an earth-built house for an extended period tend to rely less on numerical indicators and more on lived experience. Metrics such as U-values or annual energy consumption remain useful, but creating genuinely comfortable, healthy interior climates requires considering factors that extend beyond standardized performance measures.

The construction industry's trajectory toward total quantification raises a fundamental question: How can qualities that are primarily experiential be communicated convincingly to clients? This challenge extends beyond architects and earth-building practitioners, reflecting broader structural imbalances. Established materials industries are deeply embedded in regulatory frameworks, supported by financial incentives and lobbying power. Their products become standardized within building codes, reinforcing dominance. By contrast, earth-based construction lacks comparable advocacy, leaving small-scale producers at a structural disadvantage. The responsibility therefore often shifts to clients.

In Erden's experience, choosing earth construction requires a willingness to question conventions and accept a degree of uncertainty Clients must decide whether they are willing to experience a rammed-earth building firsthand and form an independent judgement or rely solely on technical values and recommendations. Most clients have only a limited understanding of what such a process entails. Architects can communicate complexities, yet it is the occupants who will live with the materials long after the construction team has left. Decision-making rests on trust, but also on personal conviction. If society is unwilling to reconsider material choices within the building industry or rethink how interior climates are perceived, architects and alternative building practices will remain largely powerless unless legal frameworks actively evolve to support them.

Prefabrication

Erden is currently working on a one-and-a-half-story residential building constructed from prefabricated rammed-earth elements. According to the team, the raw structure can be erected in just one and a half weeks – a process comparable to that of a prefabricated timber house. By contrast, if the same building were constructed on site using traditional rammed-earth techniques, the construction period would likely extend to at least three months. This project exemplifies how innovation in materials, processes, and production methods can reconcile local resources, ecological responsibility, and industrial efficiency, while keeping the experiential qualities of earth construction central to design.

Ofen Turm by the Ziegelei Museum in Cham have been using clay from the Kellenmattgraben for brickmaking since 1645. The site later became today's Ziegelei Museum, founded in 1873 and preserved since 1982 as Switzerland's only brickworks museum. In 2021, the rammed earth "Ofen Turm" was added as a contemporary kiln tower and viewing platform – an experimental exploration of earthen construction designed by Studio Boltshauser in collaboration with ETH Zurich and the Technical University of Munich.

The project *Ofen Turm* by the Ziegelei Museum in Cham raises fundamental questions about the scalability of rammed earth construction. A central challenge is the absence of reinforcement, which traditionally limits both structural height and stability. The key question, therefore, is whether earth construction can be realized at a larger scale. In *Ofen Turm*, stability is achieved through a system of prestressed cables integrated into an open tower structure. These cables transfer forces downward, stabilizing the building through tension rather than relying solely on mass. The building also served as a test structure – a mock-up exploring the feasibility of constructing earth buildings in larger dimensions.[8]

From an architectural standpoint, rammed earth is among the most efficient earth-based structural systems due to its compressive strength and monolithic character. The critical challenge today is not aesthetics but scale. Earth construction has largely been relegated to small, isolated projects, limiting its relevance within contemporary urban contexts. The research conducted by Boltshauser therefore shifts focus from a preservation to transformation approach: how earth construction can be upscaled, hybridized, and structurally intensified. Experiments with pre-stressed earth construction explore this potential, testing how controlled compression can counteract material shrinkage and enable larger spans and greater heights. These investigations position earth not as a nostalgic material, but as a robust, architecturally operative construction system capable of engaging contemporary demands.

The project investigates how tensile logic can be integrated into earth construction to overcome inherent limitations of scale. While tension elements in concrete can be activated within days, earth requires extended stabilization. This temporal difference became a productive architectural constraint rather than a technical obstacle.

In the "*Ofen Turm*", tensile springs were introduced at the top of the structure, allowing structural forces to be regulated from the outset. This recalibration enabled consistent load distribution and demonstrated the feasibility of earth buildings reaching heights.

Re-calculating history (Image historical)

Historically, such dimensions existed in vernacular earth architecture, notably in Yemen historical cities, yet current structural regulations render these typologies unbuildable today. Projects such as *Haus Rauch*, which operate without tensile reinforcement, mark the upper limit of compression-only earth construction; beyond this point, architectural form becomes increasingly determined by excessive wall thickness and material mass.

By introducing tension as an architectural principle rather than an applied reinforcement, the project redefines the relationship between material, structure, and height. The work synthesizes research, teaching, and practice, using built experiments as instruments for knowledge production. Within this trajectory, the tower project functions as a pivotal project – translating historical intelligence into a forward-looking architectural system capable of operating at an urban scale.

Architecturally, working with earth presents a unique challenge: the material from each site is always different, meaning every project starts at "point zero". To design responsibly, architects need reliable data on the material's properties– its strength, stability, and how it can shape space. At ETH Zurich, mock-ups and material analyses, alongside experiments with bio-based stabilizers, expand earth's possibilities as a contemporary building material. Through close ties between ETH and Studio Boltshauser, it contributes to publicly funded research, where generated knowledge remains open and accessible. At the same time, collaborations with industry partners, such as Martin Rauch and Lehmann, connect research to built projects, forming a productive triangle between academia, industry, and practice.

Earth and beyond

Boltshauser approaches materials – earth and beyond – with openness, seeking creative ways to work with them. This approach opens up a space of freedom, because many questions remain unanswered. That uncertainty is precisely where architectural innovation emerges – it feels like navigating a new, uncharted territory. Architects exploring similar trajectories, and this spirit of experimentation may define the creative freedom of the next generation of architecture.

Students often ask, "What should the architecture of the future be?" Such questions can feel overwhelming, or even frustrating, but they are essential. Architecture must be thoughtful and enduring: ecological, resilient, and built to last, not destined for demolition after sixty years. As educators, our role is to guide students toward optimism and possibility, showing that multiple answers exist beyond standard solutions. Boltshauser's research reconnects with traditional earth construction across Morocco, Spain, and Europe, while also reflecting influences from China. By tracing these lines of continuity and adaptation, we explore how heritage techniques can be reinterpreted for contemporary architecture, expanding both scale and ambition.

Transformation of Hedensted Schoolyard may be one of the clearest examples of a project that operates as a true negotiation between human and non-human activities. All layers are carefully cultivated with the ambition of doing better with less – reusing materials where possible and, at times, deliberately leaving elements untouched.

In Hege Havnes' practice, landscape is not a surface to be shaped at will, but a living system to be negotiated with. Soil, plants, materials, and people participate in interdependent cycles in which every intervention initiates long-term processes, often beyond the architect's control. Landscape architecture cannot be reduced to form,

program, or image; it must be understood as an ongoing practice of observation, adjustment, and responsibility.

A central strategy is the division of each project into two parallel programs. One addresses conventional concerns like functions, users, recreation, play, and accessibility. The other is dynamic and unstable, encompassing biodiversity, soil biology, carbon cycles, and material life cycles. While the first is often treated as fixed, the second remains in constant transformation, from initial analysis to the realized – yet never finished – landscape.

Each project begins with a comprehensive baseline analysis mapping existing conditions alongside geology, past biodiversity, soil composition, carbon content, and traces of previous interventions. The baseline functions not merely as documentation, but as an operative framework defining the limits and potentials of intervention. Design emerges not from a predetermined form, but from the question: How far can we go without degrading the system?

Such an approach challenges conventional budgets and timelines. Continuous monitoring disrupts the linear project model, requiring iteration and adaptation to new knowledge, shifting material flows, and ecological responses. Projects become slower and more complex, while existing procurement and construction frameworks remain insufficiently aligned with regenerative practice.

By increasing soil depth, varying terrain, and treating soil as a living material, the conditions for long-term biodiversity – rather than mere visual greening – can be established. A key realization within this practice is that landscape projects can never fully offset the impacts of construction. Every excavation releases stored carbon. Even the most ambitious strategies can only mitigate or rebalance an intervention, not eliminate its effects. Offset areas therefore become an integral component of such projects: additional land, often larger than the project site itself, where ecological systems can be restored and function as a counterweight to the disturbance.

Case studies and interviews behind the research:

- **LKR innovation house** by Lone Feifer, Director of Sustainable Buildings, VELUX Group; Esben Lundsgaard Haubjerg, Senior Project and Program Manager (Velux); Martin Lyskjær Nielsen, Facility Manager (Velux); Mette Tony and Jakob Lind Hansen, Architects and Partners (Praksis Arkitekter); Mathilde B. Lauersen, Engineer (Søren Jensen)
- **Alcobaça Monastery in Portugal** by Eduardo Souto de Moura and Luís Peixoto
- **Erden Factory and Erden Studios** by Martin Rauch and Jomo Zeil
- **Ofen Turm** by Roger Boltshauser
- **Transformation of Hedensted Schoolyard and Surrounding Landscape** by Hege Havnes at Green Sustainable Landscapes.

1 https://aarch.dk/en/regenerative-building-publications/

2 Merrild, Heidi. Reversible Tectonic, PhD Dissertation, Aarhus School of Architecture, 2024.

3 Detroy, Sarah Eileen; Rathgens, Julius; Ilvonen, Outi; Becken, Katja. "The barriers and drivers of building refurbishments: an investigation of attitudes and perceptions among German architectural designers". Discover Sustainability. 19. May 2025. Article.

4 Coccia, Emanuele. The Life of Plants: A Metaphysics of Mixture. Cambridge UK: Polity Press, 2019

5 Borges, Nuno Miguel. Rachadouro Cloister, Monastery of Alcobaca, Eduardo Souto de Moura and Luís Peixoto. Wilco Art Books 2023.

6 (Latour, Down to Earth: Politics in the New Climatic Regime, 2018, pp. 2–3).

7 (Coccia, The Life of Plants: A Metaphysics of Mixture, 2019, pp. 48–49).

8 Boltshauser, Roger., Veillon Cyril., Maillard Nadja. Pisé. Rammed Earth – Tradition and Potential. Zürich: Triest Verlag, 2019.

REGEN Network
by Jacob Rask

Jacob Rask
Director of
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BLOXHUB

REGEN is a Danish cross-sector industrial research program that translates necessity and high ambitions into action while bridging research and practice. It is funded by Innovation Fund Denmark and Realdania, and facilitated by BLOXHUB in Copenhagen, Denmark.

Why?

The time has come for a regenerative transformation. We have inherited a built environment industry fueled by fossil energy, carbon heavy processes, and rapidly depleting mineral materials – while simultaneously pushing Earth's systems further toward climate destabilization and ecological collapse. We are also witnessing rising inequality, increasing housing burdens, and a lack of affordable housing in the places where people are moving to. This inequality erodes social cohesion, mobility, and sense of belonging. It is a paradox. On the one hand, the core purpose of building is to create shelter for a safe and fulfilling life: housing, public spaces, workplaces, and everyday infrastructure. On the other hand, the environmental burden of construction has become so severe that it destabilizes the continued habitability of Earth and contributes to spreading insecurity and volatility across our shared home. The built environment urgently requires a distributive and regenerative systemic retrofit – a deep transformation that promotes human well-being through thriving sufficiency strategies on a stabilized living planet. A series of initiatives to raise ambitions to meet the scale of the challenge has emerged from the Danish built environment, among them the Doughnut for Urban Development and Reduction Roadmap. The Regenerative Built Environment Network at BLOXHUB builds and expands on these, to create cross-disciplinary collaboration and bridge science and practice.

How?

Today, the construction, urban development, and infrastructure sectors are trapped in a perpetual growth paradigm: low profit margins, extreme speed, fragmented value chains, project-by-project risk management, short-term investment horizons, and incentive structures that reward repeating existing solutions, all without sufficient regard for ecological and social consequences. With REGEN, we aim to bridge what science tells us we **should** do, what we already know we **could** do, and the systemic changes that **would** unlock innovative and creative capacities in time. The aim is to develop future-proof regenerative practices and bioregional supply and value chains.

That is why Innovation Fund Denmark, Realdania, and BLOXHUB have jointly established the industrial PhD research program *Towards a Regenerative Built Environment* (REGEN). Over a three-year period, researchers working in collaboration with companies will develop new knowledge, new technologies, and new business models that can pave the way for widespread bioregional supply chains, regenerative landscape practices, higher sustainability ambitions within construction, and the transition from resource-intensive fossil-based construction to biogenic, renewable, and potentially even regenerative construction –although the latter still remains an ambitious and yet to be seen point on the horizon. The ambition is to move beyond optimizing the gears of an irrational system that is fundamentally unsustainable and, instead, develop and test practices capable of bringing construction into a "safe and just space".

What?

REGEN supports applied research in regenerative design, architecture, planning, policy, and business models within the built environment. This happens through practice-oriented research positions (industrial PhDs and postdoctoral fellows) working closely with companies and academic supervisors. The network builds bridges and strengthens pioneers, policies, and projects that are leading the way and demonstrating new paths forward.

REGEN is designed as a systemic learning network with a transformative agenda:

- We embed research within the operational realities of companies (technical, organizational, regulatory, and financial).
- We connect disciplines and projects through shared learning, synthesis, and feedback.
- We reduce friction in implementation by making new choices clearer, safer, and easier to replicate.
- We create practice-oriented outputs: methods, evidence, tools, publications, and events.

We make impacts visible by measuring, tracking, assessing, and prioritizing through biodiversity and ecosystem metrics beyond carbon, life-cycle and supply-chain tracing, as well as assessment, mapping, and valuation of ecosystem services. The purpose is to transform previously invisible impacts into evidence-based decision-making tools.

We translate knowledge about regenerative processes into applicable design and planning practices by interpreting, framing, designing, and testing in real-world contexts. This includes landscape design, typologies, and place-based strategies, as well as participation and co-creation processes that anchor methods in actual landscapes and communities.

We reduce risk and scale biogenic construction and renovation solutions by standardizing, industrializing, documenting performance, and replicating approaches. This includes responsible scaling of biogenic materials, fire-risk testing and modeling, circular renovation platforms, skills development and demonstrators for design-for-disassembly in industrialized construction. The goal is to make new solutions competitive in response to increasing restrictions on virgin materials.

We challenge and reshape the rules of the game through innovation in governance and business models by creating incentives, financing structures, and organizational mechanisms. This happens through procurement tools and decision-support systems, municipal client organizations, public procurement strategies, sufficiency strategies, transformation principles ("preserve or explain"), absolute sustainability targets, land sufficiency strategies and demand-reduction approaches. The aim is to shift incentives and economic/organizational logic, so regenerative choices become the standard – moving from niche to norm.

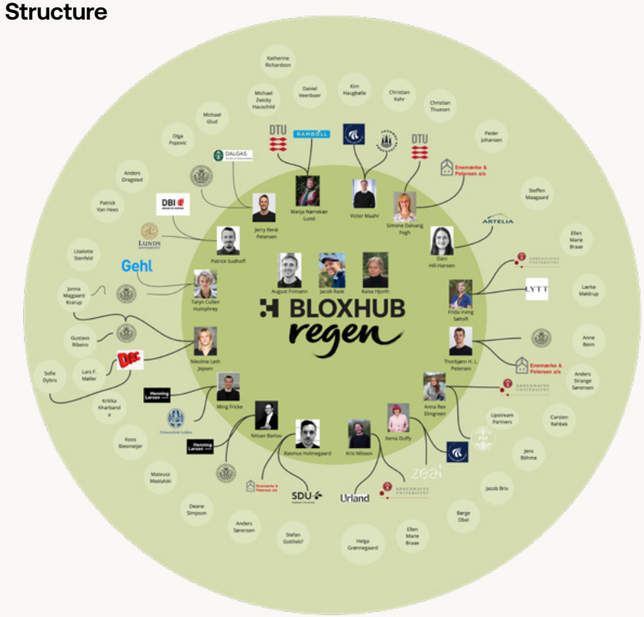
REGEN's Network Structure – Researchers, Companies, and Community

- **Layer 1 – The Research Program *(industrial PhDs + postdocs).*** This layer focuses on deep disciplinary expertise, interdisciplinary dialogue, analyses, conceptual development, case studies and both individual and collective research dissemination. Activities include team sessions, writing groups, expert lectures, and shared platforms.
- **Layer 2 – The Network: Bridge to Practice *(companies + industrial researchers + supervisors).*** This layer focuses on applied research, translating findings into company and industry perspectives, using research as an innovation tool and for organizational learning and transformation. Activities include company visits, joint activities, and industry events.
- **Layer 3 – The Forum: A Long-Term Community** *(alumni and younger researchers working within the built environment).* The forum hosts presentations, social events, and discussions extending beyond individual projects, where new ideas and concepts related to applied research in the built environment are presented and debated. The purpose is to support a vibrant research environment that continues long after individual projects conclude. The network is structured this way because the transition toward systemic and regenerative approaches requires not only **technical innovation**, but also **cultural, political, economic**, **and professional transformation,** as well as processes capable of being embedded into industrial and regulatory frameworks.

Regeneration

Regenerative processes are still a relatively new concept in a Danish context, especially within the built environment. They are therefore constantly subject

REGEN's Network Structure



to negotiation, shifting definitions, and competing interpretations. On the one hand, this diversity is a natural and productive part of developing a new field. On the other hand, it is important to avoid dilution – or outright greenwashing.

Regenerative design aspires to develop processes in which the built environment actively contributes to regenerating the ecosystems upon which it depends. Ecological design is an empowering approach to the built environment that returns us to the natural cycles where we belong and designs for health and well-being across scales, systems, and places.

Earth system science today recognizes what many indigenous cultures have always known: that "life creates the conditions conducive to life". This new paradigm validates new narratives in which the role played by the web of life is fully appreciated. As ecological designers, we understand the web of life as a dynamic system of relationships and interactions that regulate the climate, the winds, the water cycles, the carbon, nitrogen and nutrient cycles, as well as the oxygen we breath.

We can work with life's regenerative processes to meet human needs by designing symbiotic relationships into agriculture, sanitation, water management, natural building techniques, and low-impact energy. Focusing on bioregional resources, we can create edible ecosystems, construct wetlands, stabilize the hydrological cycle and the soil food web, reduce dependence on energy through passive heating and ventilation, and much more. We can mimic natural cycles and rhythms by including natural feed-back loops and closed-loop systems in our designs.

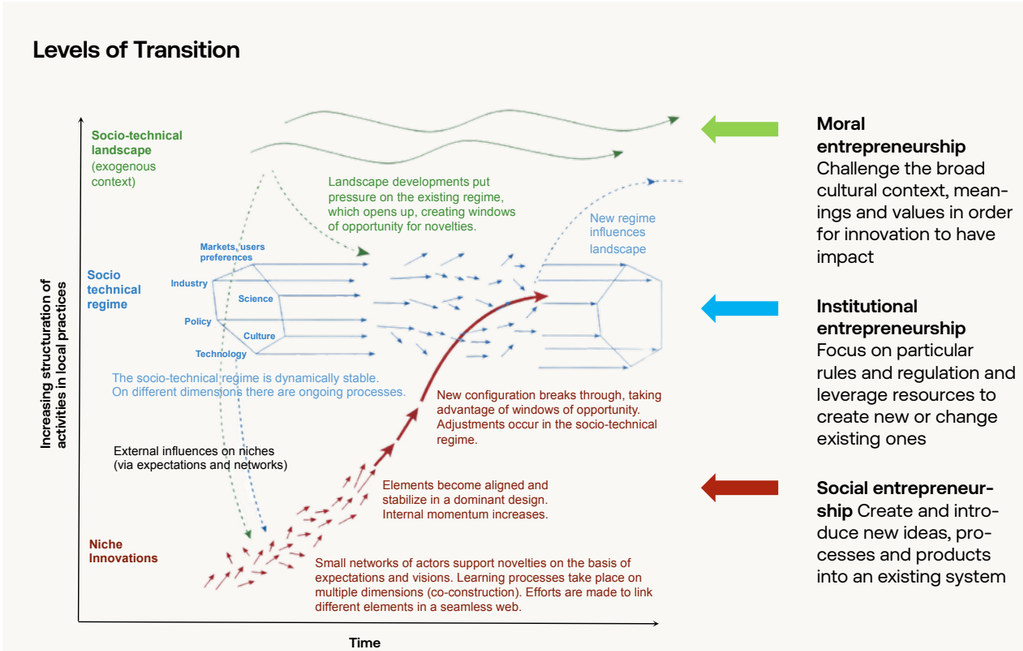
Social economic and ecological systems must be understood together. The decisive shift is: Regeneration is not primarily about doing "less bad". It is about designing and transforming the built environment so that its processes and products support **life's inherent capacity for regeneration**. This also requires significant reductions in our levels of production and consumption, so they remain within planetary boundaries and biophysical limits. The regenerative concept risks becoming an empty synonym for sustainability unless it remains grounded in scientific understandings of ecosystem functioning, absolute sustainability, and socio-ecological systems.

Rising demands create both pressure and opportunities for innovation. The pressures facing construction are not isolated challenges but intertwined crises that cannot be solved with a single silver bullet. Addressing the complex challenges often referred to as the “polycrisis” resembles solving a Rubix Cube: focusing narrowly on only one side at a time – for example, through carbon tunnel vision – is insufficient.

If the construction sector’s total activity grows faster than its environmental footprint declines, any efficiency gains will simply be consumed by continued growth. Returning to a safe planetary operating space therefore requires reduced construction-related pressures across **all** resources, not only CO_2, measured according to **consumption** (including imports), and rapidly enough to align with climate budgets and ecological boundaries. Because action has been delayed for so long, the scale of the task may now seem overwhelming.

Construction cannot merely “solve one side of the cube” at a time. If we focus only on carbon reductions, problems may simply shift to affordability, quality, materials, energy, land use, or biodiversity. This is where applied research becomes crucial as a bridge between what we know we ought to do, what we already know is possible, and what is actually done in practice.

What makes the REGEN network distinctive is that multiple projects are initiated simultaneously and developed in interaction with one another, with the ambition of creating a shared research and knowledge environment across sectors and disciplines. BLOXHUB facilitates knowledge sharing, peer exchange, and collaboration so results do not remain isolated one-off projects but can, instead, be shared, tested, and matured collectively.



Levels of Transition

Inspired by Frank Geels’ multi-level perspective, we describe the transformation process facing construction, and the role of industrial research within it, as movements across three levels:

- **Niches:** Small protected incubators where radical innovations can emerge, develop, and mature through iterative learning processes.
- **Regimes:** The established socio-technical order – standards, routines, markets, culture, regulations, and infrastructure – that stabilizes business as usual.
- **Landscape:** Broader external developments and shocks such as geopolitics, resource crises, climate change, biodiversity collapse, and changing societal values that pressure regimes and open windows for change.

Geels and colleagues describe four transition phases: niche experimentation, niche stabilization, diffusion/disruption, and institutionalization. The central insight is that niches become norms when they can: build internal learning processes and robust designs, attract resources and legitimacy, and align with moments when landscape pressures open windows the regime can no longer close. Within REGEN, we work not only to support industrial researchers in scaling existing approaches capable of competing under current market conditions, but also to create favorable **niche conditions**: protected learning spaces, documentation, shared language, and bridges to regime actors such as companies, consultants, developers, and authorities.

The Embedded Economy of Construction

The built environment provides us with homes, offices, parks, bridges, roads, and the entirety of physical infrastructure through four economic domains:
The market (companies, pricing, supply, and demand),
The state (regulation, planning, and investments),
The household (care, daily maintenance, repair, and rest),
and **The commons** (shared resources, civil society, cooperatives, and associations).

At the same time, construction practices and decisions are embedded in social, legal, and cultural norms – notions about what is lawful, high quality, low risk, and “the right thing”. Beneath and surrounding all of this lies the hardest bottom line of all: Construction is completely dependent on **nature’s raw materials and**

energy flows, biodiversity, healthy soils, water, air, and the regenerative capacities that stabilize the climate and absorb and purify waste. These are the planetary boundaries that define the biogeophysical limits of what can be built and maintained over time.

Social Tipping Points and the Leverage Principle

Another lens we use to understand transformation comes from systems thinker Donella Meadows and her essay "Leverage Points: Places to Intervene in a System". Her insight is deceptively simple: When attempting to change complex systems, we often push hardest in the places where we achieve the least effect. She outlines intervention points of increasing effectiveness – from parameters (numbers and standards) to rules, information flows, goals, and paradigms. For REGEN, three leverage levels are especially important:

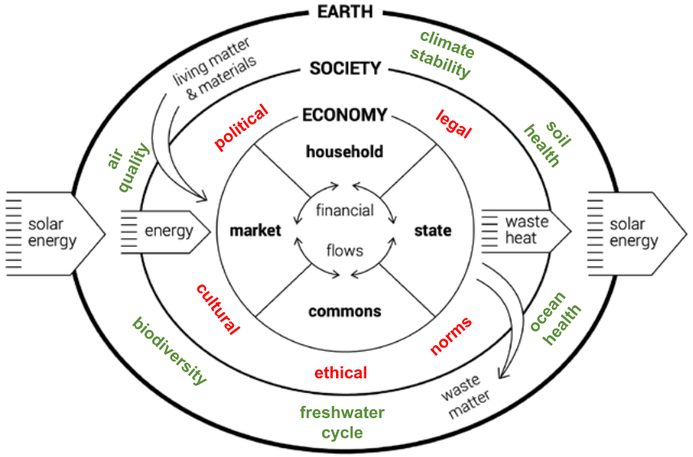
System Goals: If the practical goal is "lowest risk and stable profit in the next project cycle", one type of construction emerges. If the goal becomes "affordable well-being for all within planetary boundaries", an entirely different set of questions and objectives follows.
The introduction of Kate Raworth's Doughnut model is one such proposal to redefine the metric of success for the 21st century.

System Goals: Meadows also argues that paradigms – our underlying worldviews – shape our goals, rules, and behavior. In this context, the paradigm shift involves moving from isolated building-level performance toward a construction sector that does not undermine the living systems upon which it entirely depends.

Rules and Incentives: In Denmark, we are already seeing movements toward aligning climate goals with the sector's regulatory and incentive structures. Examples include Life Cycle Assessment (LCA) requirements in the building regulations and the Reduction Roadmap, which translates climate targets into concrete reduction pathways.

REGEN brings research and industry together in a shared learning space because successful transformation in construction requires coordination and integration more than isolated technical fixes. Using the Planetary boundaries as a benchmark, understanding multi-level transition dynamics, and identifying positive tipping points, the network works both to mature niches and to influence the goals, rules, and worldviews shaping decisions within companies and across the industry.

The aim is to make regenerative choices more repeatable, less risky, and more attractive in practice – so that what is currently the niche can become the new norm.



Mission Lab for Regenerative Building
by Karen Grønneberg

Karen Grønneberg
External Project Manager for Mission Lab for Regenerative Building – ATV, Funding Lead, BLOXHUB

The Danish Academy of Technical Sciences (ATV)'s Mission Lab for Regenerative Building

The Mission Lab has explored how the building sector can be transformed to operate within planetary boundaries while promoting human well-being in harmony with Earth's ecosystems.

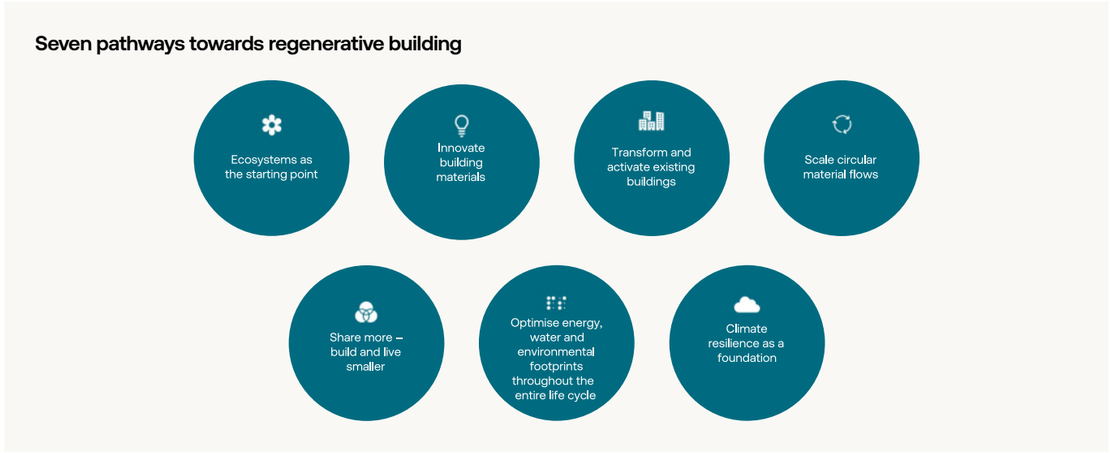
The work is based on the recognition that a paradigm shift is needed. A building sector that contributes to a society operating within planetary boundaries requires more than efficiency improvements and incremental change. It demands a fundamental shift in purpose, understanding of value, and practice. Regenerative approaches embody this shift by promoting ways of building that actively give back to and support healthy surrounding ecosystems. This ambition goes far beyond merely reducing the sector's negative impacts. It requires a systemic perspective that integrates climate, environment, biodiversity, economy, human well-being, and communities.

The Mission Lab has brought together stakeholders from across the entire building value chain – including researchers, advisory services, public authorities, developers, and practitioners – to identify barriers, dilemmas, and concrete pathways for action. The work has been guided by a mission-oriented approach: placing ourselves in the year 2075 and asking what it will take for the building sector to remain within planetary boundaries. The Mission Lab is part of ATV's broader initiative, Guide to a Resilient Denmark, which comprises 10 Mission Labs. Each lab addresses a complex societal challenge that, if solved, can contribute to a more resilient Denmark and inspire action globally. The Mission Lab for Regenerative Building has been carried out in collaboration with the Aarhus Center for Regenerative Building, with a core group from Arup, Rambøll, and NXT.

The Mission Lab has identified seven pathways and five cross-cutting recommendations for advancing regenerative building. These pathways are not independent areas of focus; rather, they are closely interconnected, with strong interdependencies between initiatives and goals across the different tracks.

Seven Pathways for Regenerative Building

Ecosystems as the Starting Point
The built environment must be shaped with living ecosystems as its foundation. Ecosystems are place-based systems of life, where organisms (plants, animals, microorganisms) interact with one another and with their physical surroundings (soil, water, air). Soil conditions, water cycles, biodiversity, and the functions of the landscape must guide where and how we build. This means planning and designing in ways that actively support and work with natural processes, cycles, and habitats. The aim is a built environment that strengthens the resilience, connectivity, and regenerative capacity



of ecosystems. It is about creating living connections between people, other species and the surrounding system, and integrating solutions that enhance ecological function and biodiversity.

Innovate Building Materials
Materials used in buildings and the built environment play a decisive role in the sector's overall climate, resource, and ecological footprint.

Advancing regenerative building therefore requires innovation in the materials we build with. This involves both developing new material types and improving existing ones to significantly reduce resource use, enhance carbon storage, and better align materials with natural cycles. At the same time, material innovation can unlock new regional value chains and architectural expressions, where buildings better reflect local resources, ecosystems, and craft traditions. In this way, materials become an active driver of the transition.

Transform and Activate Existing Buildings
The existing building stock must form the foundation of the future regenerative built environment. Instead of constructing new buildings, the focus must shift to transforming, reusing, and activating existing buildings and spaces that have already required significant resources to create. By preserving, transforming, and reactivating existing buildings, the need for new materials, raw materials, and energy is reduced. Moreover, the values embedded in the buildings – expressed through materials, cultural heritage, craftsmanship, and local identity – are maintained and further developed. This also involves adapting buildings to evolving needs over time. Through retrofitting, renovation and changes in use, existing buildings can continue to support new forms of living and activity, while gradually improving their performance in terms of climate, resource efficiency, and environmental impact.

Scaling Up Circular Material Flows
A large share of the building sector's impact stems from the linear approach to material use: raw materials are extracted, used once, and end up as waste. To move toward a regenerative approach, materials must be kept in circulation and retain their value over time. Today, only around 0.17% of building materials are directly reused. While innovation in building materials often focuses on developing and using better materials, this action pathway is about ensuring that materials are used again and again in closed, value-preserving loops. This will reduce resource use, waste and emissions, ease pressure on nature and raw materials, and help build a more robust building sector that is less dependent on global supply chains and less vulnerable to geopolitical risks and price volatility.

Share More – Build and Live Smaller
How much we build and how much space we use per person significantly impact the climate, resource, and environmental footprint of the building sector. To stay within planetary boundaries, we need to reduce the demand for new floor space and make better use of what we have already build. By increasing space efficiency, sharing more functions and designing multifunctional buildings, we can reduce the need for private space without compromising quality of life. At the same time, shared facilities and outdoor spaces can strengthen communities, improve health, and deepen the connection to nature.

Optimize Energy, Water, and Environmental Footprints throughout the Life Cycle
Buildings and the built environment impact climate, resources, and the environment throughout their entire life cycle. To operate within planetary boundaries, energy use, water resources and environmental impact must be optimized across the entire life cycle. This action pathway focuses on developing buildings and urban environments that go beyond reducing their footprint to actively contributing to the systems they are part of. Buildings and neighborhoods can generate, store, and share renewable energy, manage water as a valuable resource and, through smart design and operational solutions, minimize their overall environmental impact.

Climate Resilience as a Foundation
Climate change reshapes the conditions of the built environment. Climate resilience must therefore be incorporated as a fundamental design parameter.
A resilient built environment works with, rather than against, nature's dynamics. This action pathway focuses on planning and building based on the systems of the landscape and the natural environment. Through risk assessments, and integrated blue-green solutions, we can develop buildings and built environments that not only withstand climate change, but strengthen the overall resilience of the landscape and society.

Seven Pathways for Regenerative Building

A paradigm shift in building requires a new approach to how we plan, build, and use our buildings and the built environment. Many stakeholders, including legislators and authorities, researchers and educational institutions, developers, consultants and architects, investors, the building industry, materials manufacturers, as well as civil society and residents, play a role in this transformation. Across the identified seven pathways, we therefore highlight five recommendations designed to ensure that efforts are aligned and collectively support the development of a built environment that contributes positively to both nature and human well-being within planetary boundaries.

Five Recommendations for the Ecosystem

A paradigm shift in building requires a new approach to how we plan, build, and use our buildings and the built environment. Many stakeholders, including legislators and authorities, researchers and educational institutions, developers, consultants and architects, investors, the building industry, materials manufacturers, as well as civil society and residents, play a role in this transformation. Across the identified seven pathways, we therefore highlight five recommendations designed to ensure that efforts are aligned and collectively support the development of a built environment that contributes positively to both nature and human well-being within planetary boundaries.

Processen bestod af fire nedslag med fokus på:

- Use regulation as a catalyst
- Develop new competencies
- Develop new business models with distributed risk
- Establish cross-sectoral collaboration models
- Strengthen practice-oriented research and innovation

The Mission Lab resulted in a guide describing the seven pathways and recommendations. Read it here (in Danish): https://atv.dk/udgivelser-viden/regenerativt-byggeri

BLOXHUB is an international hub for innovation in construction and urban development, based in Copenhagen.

BLOXHUB brings together companies, research institutions and public bodies in the work of developing the built environment towards lower-carbon and affordable solutions.

Home to more than 400 member organisations, BLOXHUB acts as a platform for knowledge-sharing, innovation and partnership across the entire construction value chain.

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A mapping of where and how innovation takes place in Danish construction and urban development, the mechanisms that drive it, and what it takes for new solutions to be repeated and scaled.

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