



Putting sustainability at the heart of building design

How innovative, user-friendly tools are helping architects drive sustainable change right from the earliest stages of design



The future is built on sustainability

83 percent of company decision-makers consider sustainability to be an important issue. 60 percent of companies already have a sustainability strategy, and the same percentage report that they have at least general environmental, social and governance standards (ESG), according to a PwC study published in February 2023¹. However, the good intentions indicated by these figures are not yet reflected in sustainability data within the building industry. In 2021, the buildings and construction sector accounted for around 37% of energy- and process-related CO₂ emissions and over 34% of energy demand globally.²

Today, players in the Architecture, Engineering and Construction (AEC) industry are facing various challenges arising from changes in society, the environment and technology. Sustainability is one of the greatest challenges for architects and the broader construction industry, but also one that has enormous potential for delivering innovative solutions that will lead to a more sustainable future. Therefore integrating sustainability considerations into the everyday practices of architects has a powerful effect.

Climate change will cause 6.9 trillion dollars' worth of damage annually by 2030, according to an estimate by the OECD³. It is imperative therefore that this huge problem be tackled proactively within the building industry. Sustainable design and construction worldwide is one of the most important levers for reducing greenhouse

gas emissions. Implementing material efficiency strategies in G7 countries and China alone, including the use of recycled materials, could reduce greenhouse gas emissions in the material cycle of residential buildings by over 80 percent in 2050.⁴ Since architects play a pivotal role in shaping the built environment they simply have to address this issue of sustainability.

Traditionally, the process of integrating sustainability aspects into building design has proven challenging for a variety of reasons. Thorough sustainability considerations are based on an extensive array of information, such as embodied carbon, predicted energy consumption and solar PV potential. Such information is often not readily available to architects in the early stages of planning – where design decisions have the largest impact on outcomes. Typically, the acquisition, analysis and evaluation of this information involves time-consuming and costly processes and collaboration with experts – elements which are rarely included in project timelines. As shown in this paper, the data essential for sustainability considerations in the early stages of planning is now accessible to architects. This marks a transformative time for the architectural planning process.

Another challenge for integrating sustainability in AEC processes is that the existing design process is often separate from any analysis of the sustainability needs of a building. Moving sustainability analysis to the start of the planning and design exploration phase would mean departing from existing workflows familiar to many stakeholders. While some architects have already been incorporating sustainability criteria into their concepts during the early stages of planning and design, they have found this a laborious task. Advancements in digital design tools and improved access to them is transforming this paradigm – with new applications such as Autodesk Forma making sustainability data and insights accessible to architects and planners from the outset.

1 Source: Die Bauindustrie in anspruchsvollen Zeiten: Geopolitik, Digitalisierung und Nachhaltigkeit. Eine PwC-Studie zum Umgang der Baubranche mit den aktuellen Herausforderungen, Februar 2023

2 2022 GLOBAL STATUS REPORT FOR BUILDINGS AND CONSTRUCTION

3 Source: Energy & Climate Intelligence Unit | Climate economics - costs and... (eciu.net)

4 <https://wedocs.unep.org/bitstream/handle/20.500.11822/31715/RECC.pdf?sequence=1&isAllowed=y>

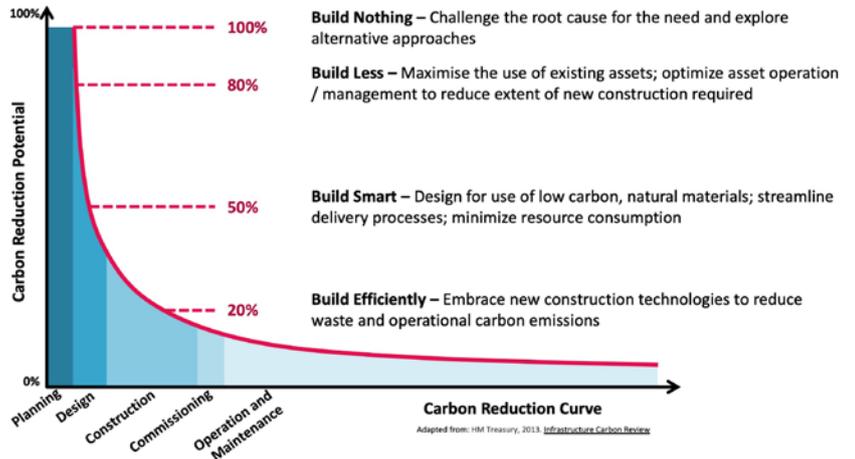


The future of planning

There is a need for a more integrated design process in which architects can seamlessly incorporate sustainability aspects and input from other stakeholders right from the start of the project, thereby making them an inherent part of the design process. To achieve long-term success, sustainability must be ingrained in the fabric of the design process. This approach establishes an iterative feedback loop that helps designers to balance the various trade-offs and promote positive sustainability and business results along the entire chain from the initial design phase to final handover.

Modern cloud-based digital design software gives architects the tools to do just that. By integrating these tools in their work practices, architects can effectively embed sustainability solutions directly into their designs from the project's inception and contribute to a more sustainable building sector.

Greatest Impact is Reducing Carbon Early



Carbon emissions in AEC

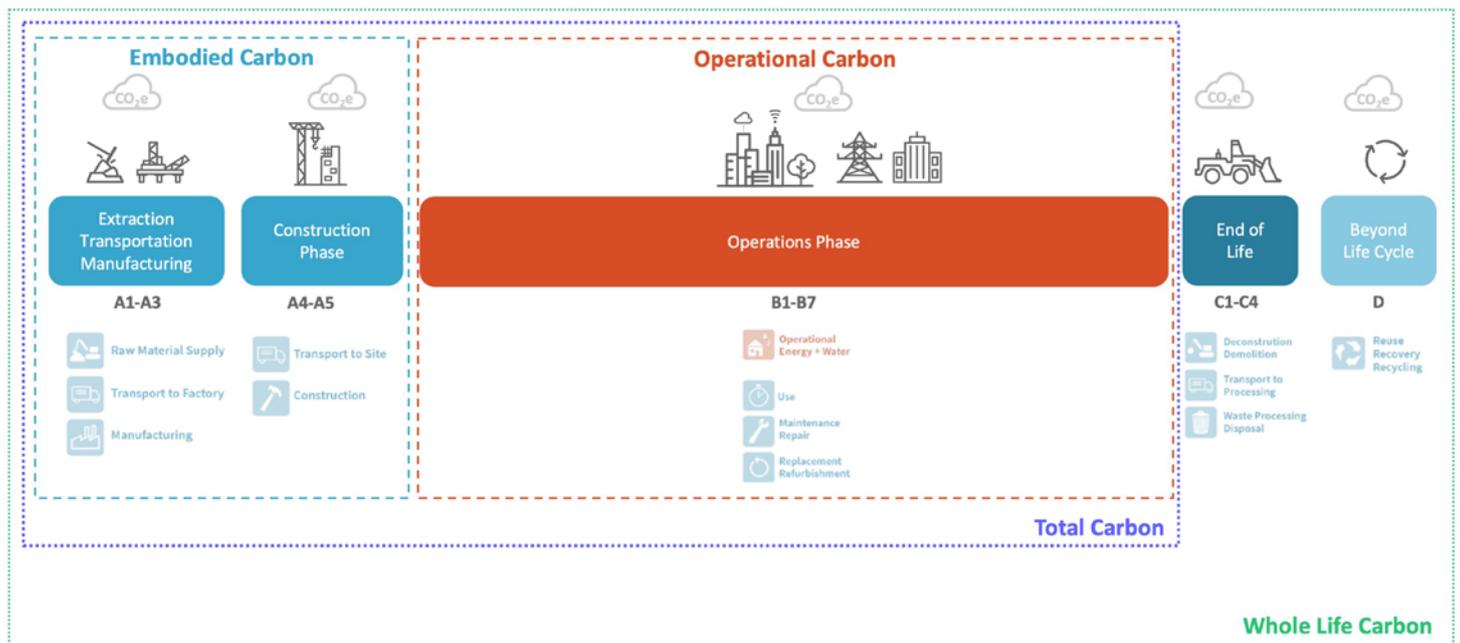
About 40 percent of global greenhouse gas emissions are due to the construction and the use of buildings.⁵ As the global economy continues to grow, global consumption of raw materials will almost double between 2022 and 2060.⁶

For architects, it is particularly important to investigate where carbon emissions originate within the AEC project lifecycle. Embodied carbon emissions are associated with the extraction, production, transport and disposal of the materials that make up a building. Operational carbon emissions are the emissions that result from the use of a building (energy, water, maintenance, repairs, etc.). Total carbon emissions are the sum of embodied carbon and operational carbon.

⁵ Source: Embodied Carbon - World Green Building Council (worldgbc.org)

⁶ Source: Embodied Carbon - World Green Building Council (worldgbc.org)

Carbon in the AEC Lifecycle





Pressure is growing – so are incentives

In recent years, the pressure for architects to integrate sustainability into their designs has steadily increased. This pressure stems from both increasing societal and client expectations regarding the responsibility of architects and a regulatory shift driven by political initiatives aimed at achieving established climate goals. Consequently, architects are experiencing heightened economic pressure from owners, particularly since the financial implications of buildings will increasingly hinge on their sustainability. Integration of sustainability criteria is therefore evolving into an economic imperative.

Architectural firms unable to satisfy these criteria risk lagging behind their competitors and gaining a poor reputation. For this reason alone, architectural firms must proactively address this issue.

Governments are also increasing the pressure to promote sustainable designs. Many countries and regions have enacted laws and regulations that mandate sustainable building design and construction. These include requirements for energy efficiency, water conservation and the use of environmentally friendly materials. Decarbonization is often the focus of legislative initiatives as a key lever for reducing greenhouse gas emissions and achieving climate targets. Initiatives worth mentioning in this context are the

Inflation Reduction Act (IRA) in the USA, Specifications for Carbon Management from the UK, the globally applicable PAS 2080 and the European Green Deal with the goal of making Europe a climate-neutral continent by 2050 based on the Paris Climate Agreement with its commitment to limit global warming to below two degrees Celsius. The aim is not so much to build pressure but to create incentives. The IRA provides concrete incentives to reduce greenhouse gas emissions in the form of extensive subsidies for clean tech companies. PAS 2080 provides a global specification for regulating greenhouse gases from infrastructure, however the specification is not mandatory.

Finally, the greater prevalence of sustainability certifications such as LEED (Leadership in Energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Method), mandated by many clients, ensure the repositioning of the AEC industry in terms of sustainability. Another example is the revised EU Energy Performance of Buildings Directive (EPBD) which was adopted in spring 2023. Among other provisions, it mandates that as of 2028 all newly constructed buildings must be emission-free. If technically feasible and economically viable, all new buildings should incorporate solar systems by the same deadline.



Three ways to achieve sustainable design

Sustainability in AEC is comprised of a multitude of factors including decarbonization, the transition to sustainable materials, maximizing energy efficiency, reducing waste and cutting costs. In each of these areas, architects have various opportunities to realize sustainable buildings. Operational Carbon Savings, Annual Fuel Use and Renewable Energy Production are just a few of the choices available to them for managing sustainability.

There are numerous other measures and options for making buildings sustainable. Adopting a trial-and-error approach to determine which measures would be appropriate for a given case would be inefficient and time-consuming. The principle of “design first, analyze later” therefore has to evolve toward outcome-based design, incorporating frequent and repeated analysis of the anticipated performance of the design at each stage. This will ensure that design and performance are intricately linked.

Technology plays a crucial role here. Digital tools enable architects to visualize the impact of design decisions and to balance trade-offs in real time. As a result, environmental aspects can be more effectively assessed and implemented from the early design phase, pre-empting costly and challenging design changes. For example, designers can determine the ripple effect of an increase in the window-to-wall ratio on operational energy demands, or the impact of massing on wind flow and daylight. By equipping designers with the data and insights they need at every stage of the design process to make more informed, climate-smart decisions, digital tools are helping to maximize energy efficiency, reduce embodied carbon, reduce material usage, and optimize on-site renewable energy generation.

The use of these technologies not only makes data-driven decisions easier but also paves the way for a completely new and integrated form of collaboration with all stakeholders – one that meets the demands of our time. Digital tools that can be accessed by

all stakeholders from the early stages of the design process establish a framework for jointly defining goals, developing solutions, exchanging information and providing feedback. This collaborative design process ultimately enables architects to achieve the defined goals with a high degree of efficiency.

The practical benefits of this approach are presented in the following sections using three scenarios that highlight the use of specific software to support architects in the first stages of planning.

1. Sustainable design from the outset

At the start of every design process, architects need to consider how the different requirements of the building can be reconciled with the existing framework conditions. The client’s ideas, the budget, the spatial and technological requirements, the surroundings, and the purpose of the building all have to be balanced against each other. Since these factors serve as guidelines for the entire planning process and determine the final design, sustainability aspects need to be considered for each of the factors. Digital tools such as Autodesk Forma, the cloud-based planning and design software, make sustainable design more accessible.

Forma enables architects not only to take sustainability into consideration but to make it a key factor from day one by offering numerous relevant functions. Its predictive analysis feature, for example, can provide real-time insights into the building’s impact on its surroundings, terrain and other such elements. Even before the first stone has been laid, important environmental factors such as sunlight, daylight potential, wind and microclimate can be taken into account and optimized, and the design easily adapted accordingly. As the workflow advances, designs developed in Forma can be seamlessly transferred to Revit for a more detailed design phase. Within Revit, architects can access detailed



predictive analytics to comprehend the implications of specific design decisions on both embodied and operational carbon. The open and extensible nature of Revit allows architects to seamlessly integrate a wide array of solutions. These solutions include ones native to Revit as well as third-party applications so that architects can easily incorporate external data sources to optimize their design approach. Tools that help architects with their sustainability analyses include **Autodesk Insight** (Carbon Insights

tech preview), **tallyLCA**, **tallyCAT** (beta), and **One Click LCA**. More options can therefore be explored in a shorter time, and concepts that best fit the design requirements can be found more easily.

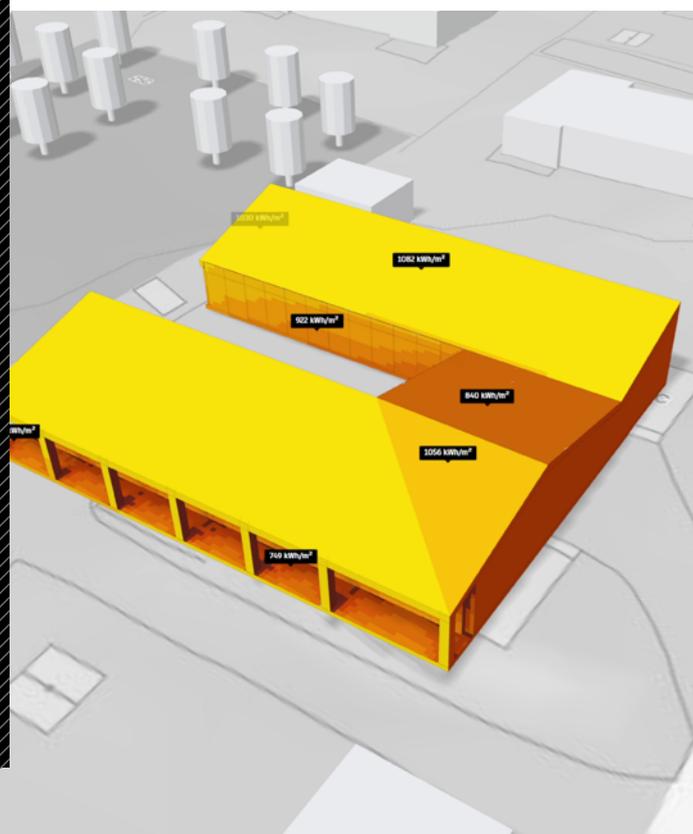
Specific factors such as usability, living quality, economics, durability and performance can be investigated to help architects and planners improve the resilience and sustainability of a site over its lifetime, which in turn will lead to a lower environmental impact in the long term. This fundamentally changes the design process and creates new possibilities for sustainable buildings by design. It allows for fast and smart decision-making throughout the design process, and harnesses the power of data-driven insights to make, test and streamline ideas, concepts and everyday choices. The premise is simple yet impactful – better inputs result in better outcomes. For people and for the planet.

One AEC company that is already using the potential of Forma in the early planning phase is Arcadis. An architecture team at Arcadis established a multi-step workflow using Autodesk Forma's environmental analyses to help integrate sustainability in their design processes from the early planning stages. Addressing these topics early makes sense, the architects at Arcadis feel, because that's when it's easiest and most cost effective. Forma not only aids in achieving sustainability targets by providing information about factors such as daylight, operational energy and solar energy, but also improves and streamlines communication between architects and sustainability experts, creating better collaborative solutions and improved outcomes.

"We believe sustainable design is a necessity, not an option. For example, Forma's operational energy analysis tool makes this easier as it allows our designers to better understand the implications of their design decisions at the onset of projects. Tools like this help make sustainable design more accessible." Pablo La Roche, Principal, Architecture and Urbanism at Arcadis

[Read the story](#)

[Learn more about Autodesk Forma](#)



2. Adaptive reuse

Often, a more sustainable option is to use what is already there and adapt it to what it needs to be. This is also true for buildings. The lifespan of buildings can be prolonged through adaptive reuse.

This approach provides social, financial and sustainability benefits and will make up 90% of real-estate development over the next decade, experts predict.⁷

Repurposing preserves our architectural and cultural heritage, avoids wasteful demolition and addresses the deterioration of urban environments in an extremely effective way. Architects can decrease the embodied carbon of their projects by reducing the use of new materials and optimizing buildings for energy efficiency. The embodied carbon associated with a renovation and reuse project is typically 50 to 75% less than that for constructing a new building.⁸

⁷ Source: Adaptive reuse of commercial real estate – QuickLook blog | Deloitte US

⁸ Source: <https://www.aia.org/articles/70446-ten-steps-to-reducing-embodied-carbon>

With ReCap Pro, architects can precisely capture the attributes of existing structures and materials and reuse them adaptively, thereby reducing the demand for new building materials and conserving resources. The software facilitates reality capture and 3D scanning, allowing architects and engineers to create realistic 3D models of existing buildings and infrastructures. By integrating various data sources such as photographs, laser scans and drone imagery, they can generate comprehensive and precise digital models of actual structures. These models provide a nuanced understanding and validation of a building's current condition, leading to more informed design decisions in projects involving adaptive reuse. ReCap Pro also supports the BIM process and seamlessly integrates with other design tools like Revit. Adaptive reuse of materials and structures through ReCap Pro contributes significantly to a reduction in the carbon footprint associated with construction projects. ReCap Pro therefore promotes and facilitates sustainable building practices.

The requirements for the Vigentina9 project were clear: a historic building in a charming alley in Milan was to be repurposed but still had to fit visually in its unique surroundings. The team had to ensure not only that the interior was demolished safely but also that in renovating the façade they struck the right balance between preserving the structure of the original building and modernizing it. Using ReCap Pro and Revit allowed the team from Lombardini22 S.p.A. to overcome these challenges and secure the AEC Excellence Award.

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3. Taking collaboration to the next level

Collaboration is key in architectural projects. Creating and implementing a building design is only possible by involving a wide range of stakeholders. The modern approach to design therefore brings all the necessary trades together and invites input from all sides in order to achieve the best possible result. Approaching projects with the help of digital tools such as Forma, Revit and ReCap Pro fosters better collaboration and coordination. All stakeholders have access to the same digital model and can therefore check from their different perspectives whether or not the design needs to be adapted. Giving

all parties access to essential information early in the planning process minimizes the risk of reworking and helps projects to be completed on time. Digital planning and design software enables different analyses to be conducted simultaneously as they are correlated with other available data points and information at the same time as the users are making their design decisions. This provides the basis for informed discussions about the quality of the design and its performance throughout the whole team and enables project management to be streamlined. To make this process even more seamless and adaptable, the Forma API allows extensions to be created, which enables teams to tailor Forma to their needs and workflows.

When municipalities are looking to densify existing neighbourhoods, adaptive reuse is often the way to go. This is also the case with BPD: the largest real estate developer in the Netherlands and Germany prepared a design competition for a new housing project in Nuremberg, Germany, repurposing an existing tower and neighboring buildings. By using Forma, they were able to simplify communication with the municipalities and contestants, identify the opportunities and risks of their projects and check the concepts for their impact on sustainability and climate conditions. They could also revise the concepts at the click of a button.

“All in all, Forma helped us spend a lot less time on the site assessment and discussions and concentrate on the most important part of the project, which is to create sustainable, high-quality homes for people to live happy, healthy, and fulfilling lives”, Fabian Kuusik, project developer at BPD.

[Read the story](#)

Whenever sustainability issues need to be addressed, this approach significantly improves collaboration with sustainability consultants. Such consultants still have a vital role to play in the design process so digital models of the project can and should be made available to them. They in turn benefit from receiving designs that have been conceived with sustainability in mind, rather than as an afterthought, and have been included in the design process early on. They are therefore in a much better position to focus on more creative and impactful design recommendations.



A glimpse into the future

The world is undergoing a shift toward a more sustainable economic paradigm, demanding a corresponding commitment from the field of architecture. Architects are tasked with the responsibility of envisioning, constructing, operating and ultimately dismantling buildings and infrastructures in a sustainable manner. This entails a collective obligation for architects and planners to actively contribute to the reduction of carbon dioxide emissions within the building sector, judiciously conserve finite resources and engage in the construction of sustainable structures that will yield significant positive impacts for the future.

Architects and planners can now play their part in minimizing CO₂ emissions within the building sector, conserving resources and building sustainably with positive implications for the future. Using the functions and features of digital technologies in the early stages of planning and design, architects can proactively include sustainability aspects in their designs from the outset. By connecting the right products in smooth workflows they can bring stakeholders, information and ideas together – and create a new integrated way of working.

Whether starting from scratch or revitalizing an existing space, Autodesk delivers a wide range of solutions that help architects create designs with sustainable outcomes from day one.

Find out more about the opportunities to drive sustainability in AEC

