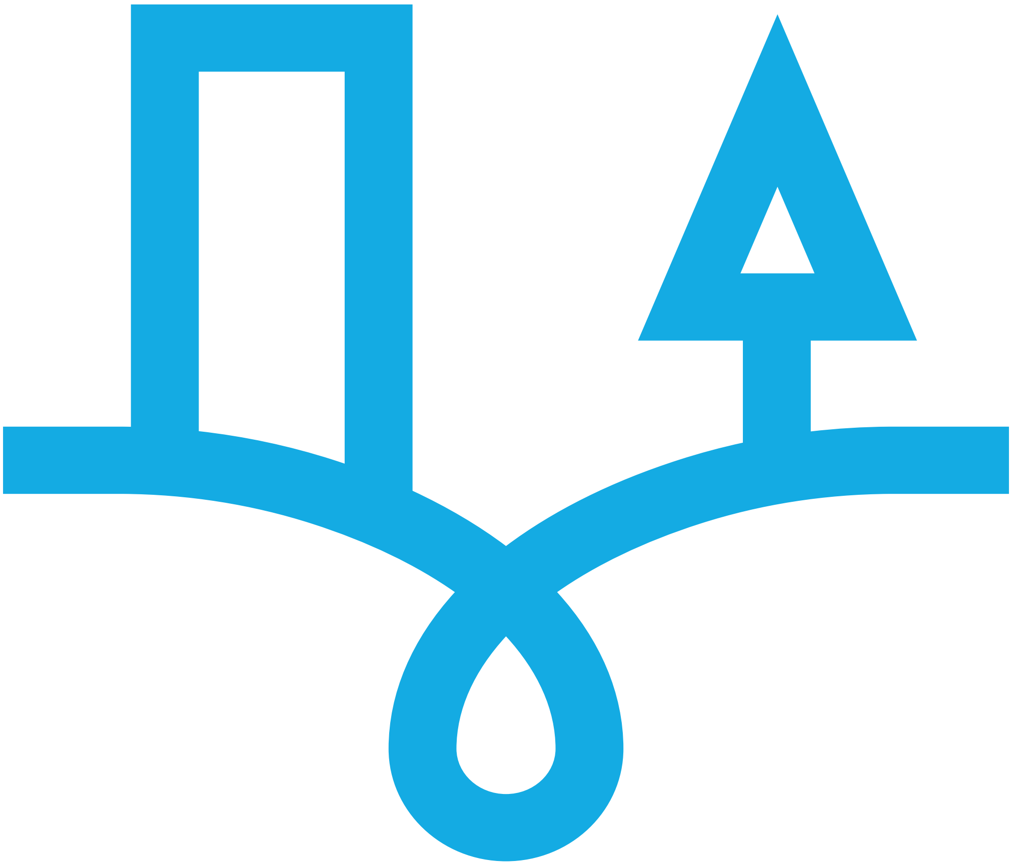
CIRCULAR
ECONOMY
IN CITIES



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DESIGNING BUILDINGS FOR ADAPTABLE USE, DURABILITY, AND POSITIVE IMPACT

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How buildings are designed is key to how they are used, the impact they have on their surroundings, and how long they are fit for purpose for. Design can either improve or impede building performance, longevity, use, and after-use management. Incorporating circular economy principles into the design of buildings is therefore an important action to improve the time they are fit for purpose, as well as optimising construction and disassembly.

CASE FOR CHANGE

Only **20–30%** of construction and demolition waste (CDW) is recycled or reused, which is often due to poor design and lack of information on building contents[1]

80%

More than **80%** of the total energy consumption in a building's life is consumed during its use[2]

US cities may be **1–3°C** warmer in the daytime and up to **12°C** warmer in the evening than surrounding areas due to the heat-island effect[3]

33% of people over 60 in the UK would like a smaller residence, but only **10%** actually downsize[4]

EXAMPLES OF CIRCULAR ECONOMY OPPORTUNITIES

Designing for adaptable and flexible use

New concepts and techniques, such as modular units and moveable interior walls, are bringing greater flexibility and resource-efficiency into residential and commercial buildings. These methods support the efficient and effective use of a building during its lifetime, such as repurposing a commercial building into housing, using modularity to downsize a home or an office, or supporting sharing and mixed functionality.[5] Flexible design also supports incremental and participatory housing; to begin with, only the essential parts of the building are completed, allowing the residents to expand and adapt the building as they need and can afford. This also opens up a way for low-income groups to access better-quality housing while contributing to building longevity.[6]

Using collaborative design processes

Using collaborative, multi-stakeholder processes supported by Building Information Modelling (BIM)[7] in the design phase, allows designers to coordinate with other stakeholders (clients, engineers, developers, deconstruction companies). BIM platforms can bring together the entire supply chain, and enable the end-customer to know what is in the building, and what the building and its components have been used for. This transparency facilitates reuse and recycling of building components and materials. Open-source design platforms, such as WikiHouse, Paperhouses, and Abari, allow architects to share blueprints with end-users so that they can customise and construct buildings to their own needs. These blueprints inherently support adaptable and modular design. Open-source solutions can accelerate design innovation, as the platforms learn from their users, and offer another way to scale the uptake of best-practice circular economy building approaches.[8]

Integrating material choices into design

Building materials used today can be unsuitable for high-value reuse if they contain toxic or harmful elements. Selecting safe and healthy materials to be used in buildings can result in healthier living and working environments for residents, as well as encourage the looping of materials at the end of their use. Adapting a building's design to incorporate locally available materials could also then actively support a local economy that sources, uses, and reuses materials locally. (See *City Case Study: Venlo*)

Taking design inspiration from nature

Nature-inspired design can create effective building solutions. Using a building's exterior for energy production (for example by integrating solar panels in roofs, windows or façades) is widely applied and the technology continues to develop. Low-tech solutions, such as bioclimatic and passive design, make use of natural conditions to cool, heat, light, and ventilate buildings. These increase a building's performance, and minimise energy consumption.[9] Biophilic design, i.e. greening of building exteriors, façades and roofs, reduces air pollution, noise, flooding and the urban heat-island effect.

RELEVANT CASE EXAMPLES

Modular and flexible meeting rooms

A modular meeting room unit, called Jack, has been developed to meet Google's rapidly changing needs for meeting spaces. The unit can easily be assembled, reassembled, and reconfigured in a variety of ways to create differently sized, fully or partially enclosed spaces in Google's open-plan London office, which improves the work environment, use of the building, and increases productivity.[10]

Incremental social housing

The Iquique project in Chile is an incremental and participatory housing concept, developed by the company Elemental. With a budget of USD 7,500 per home (including land), buildings are designed for low-income households but with middle-class needs in mind. This ensures that the building's shell will be useful for longer and limits the need for reconstruction. Initially, only half of the building is constructed, including three floors with the essential elements such as a kitchen, bedroom, roof, and sanitary installations. This makes the house fully habitable, but with the anticipation of additional rooms being added as and when residents can afford the expansion.[11]

Low-energy building with flexible interior

White Collar Factory is a 16-storey building in London designed to reduce occupational carbon emissions by 25% and offer a 10–33% annual reduction in operational energy costs. It contains commercial, residential and public spaces, and has been designed using adaptable floor plates and internal fittings to allow for easy subdivision, interactivity and flexibility over time, which facilitate the prolonging of the building's lifespan. Integrated smart services including concrete core cooling, passive systems that maximise natural daylighting and ventilation, and power and data systems in raised access floors also help with repairs, maintenance, and longevity.[12]

Using the local climate and ancient design

Pearl Academy of Fashion in Jaipur mixes modern architecture with local ancient Rajasthani building technology to deal with a hot desert climate without artificial cooling. A 1,500-year-old cooling system (a pool of water in the base of the building) creates a comfortable microclimate that keeps the building 20 degrees Celsius cooler inside than the outdoor temperature. Other elements, such as latticed clay screens, absorb heat while decorating and enhancing cultural aesthetics.[13]

Singapore aims to be the greenest city in the world

Since the early 1960s, Singapore has had a strong ambition to green itself in order to become a highly liveable and competitive city. Sky-rise greenery has increasingly become an essential component of the city's development plan, in part due to the limited amount of land. The city's 72 hectares of rooftop gardens and green walls are set to triple by 2030. These, combined with 4,172 hectare of green space (parks and park connectors), reduce the city's heat-island effect, improve air quality, reduce noise, help absorb stormwater, and increase urban biodiversity.[14]

EXAMPLES OF WHAT URBAN POLICYMAKERS CAN DO

Through **convening** and consulting with industry stakeholders, incorporating circular economy criteria in **public procurement** tenders, and via **asset management**, city governments can incentivise circular economy practices in the built environment. **Capacity building** and training for professionals (such as designers, procurers or suppliers, and manufacturers) can also help change commercial practices. **Regulatory** specifications on building standards and materials can level the playing field in the market.

To explore further see **Policy Levers**

EXAMPLES OF LINKS TO OTHER SYSTEMS AND PHASES

Buildings: Making The design and construction of buildings are strongly linked and overlap. In a circular economy, decisions made at the design phase will work to support appropriate material sourcing and new construction methods during construction.

Buildings: Operating and Maintaining The design of buildings will also have a significant impact on the operational efficiency of the buildings and how easy they are to maintain or adapt.

EXAMPLES OF BENEFITS:

ECONOMIC PRODUCTIVITY

Reducing operation and maintenance costs

Implementation of circular economy design opportunities in Chinese cities, such as green and smart buildings, would reduce operation and maintenance costs by 10% in 2030 and 28% in 2040, compared with the current development path.[15]

Increasing workforce performance

Designing for better indoor air quality (low concentrations of CO_2 and pollutants, and high ventilation rates) in offices can lead to improvements in workforce performance of up to 8%.[16]

Increasing the value of buildings

Building owners report that green buildings – whether new or renovated – command a 7% increase in asset value over traditional buildings.[17]

HEALTH AND ENVIRONMENT

Reducing the need for air conditioning and heating

Trees in urban areas can cool the air by between 2 and 8 degrees Celsius, reduce air conditioning needs by 30%, and save energy used for heating by 20–50%.[18]

Reducing air pollution

Green façades can lead to a reduction in concentrations of particulate matter by 10–20% in the immediate surroundings.[19]

Reducing noise

Green façades can reduce sound levels from emergent and traffic noise sources by up to 10 dB(A).[20]

Supporting better health

Spending time near trees improves physical and mental health, while decreasing blood pressure and stress.[21]

Improving cognitive ability

People working in green, well-ventilated offices record a 101% increase in their cognitive scores (brain function).[22] Employees in offices with windows slept an average of 46 minutes more per night.[23]

COMMUNITY AND SOCIAL PROSPERITY

Improving living conditions

Green rooftops can facilitate social and recreational activities or be used for urban agriculture, which brings a broad range of societal benefits such as improved neighbourhood relations, worker creativity and productivity, or supporting learning and food production to increase self-sufficiency.[24]

RESOURCE USE

Reducing resource consumption and prolonging the building's lifespan

Modular design typically reuses 80% of the components in a building's exterior, coupling modularity with durability.[25]

Reducing material costs

Locally appropriate materials can be more affordable. In China, the cost of a bamboo façade could be 60% lower than that of a concrete one and can be built in a modular fashion, strongly supporting adaptable use.[26]

Reducing embodied energy

A bio-composite building façade panel could reduce the embodied energy in façade systems by up to 50% compared to conventional construction.[27]

Increasing resource-efficiency

Engineered clay can offer an alternative to concrete, and uses up to 15% less material, requires less energy to produce, and can be recycled after use.[28]

Reducing energy consumption

Insulated walls and efficient glazing can reduce energy consumption twofold or more.[29] Compared to traditional houses, buildings built to passive house standards save 80% of heating energy and 50% of energy for cooling and dehumidification.[30]

ENDNOTES

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