OPPORTUNITY 28

SCOPE TRANSITIONAL

UNCERTAINTIES

Technology, Nature

MEGATRENDS

Boundless Multidimensional Data

TRENDS

Advanced computing
Advanced connectivity
Air pollution
Automation
Urban Design

SECTORS IMPACTED

Agriculture & Food
Data Science, AI & Machine Learning
Energy, Oil, Gas & Renewables
Health & Healthcare
Infrastructure & Construction
Materials & Biotechnology

What if smart buildings evolved into smart urban ecosystems?

WALLS THAT TALK

Connected, eco-intelligent buildings form biomimicking ecosystems that optimise resources and minimise environmental impact to support sustainable, affordable, and healthier cities.

WHY IT MATTERS TODAY

Half of the world's population live in cities and 2.5 billion more people are expected to join them over the next 30 years.[626] Although they occupy only a fraction of the Earth's surface, cities account for some 67% of global energy consumption and more than 70% of greenhouse gas emissions.[627] Poorly designed or legacy urban areas are prone to pollution and associated health risks. Buildings contribute 30%–40% of emissions from cities[628] and building emissions must be reduced by 80%–90% to meet COP targets.[629]

In 2019, the Coalition for Urban Transitions highlighted the potential to reduce city emissions by 90% by 2050 using existing technologies.[630] Green buildings are energy-efficient, environmentally friendly, and often energy self-sufficient as they use data and analysis to enhance energy efficiency.[631] Powered by 5G and 6G, efficiencies can be further enhanced by managing the water–energy nexus with the internet of things (IoT).

At the same time, architects around the world are already looking at biomimicry to strengthen, cool, or heat buildings.[632] A design movement is underway that explores the integration of living organisms into building materials and services, with bioluminescent algae or microbial fuel cells that can generate energy and improve air quality as examples.[633] Progress in synthetic biology could also contribute to buildings that can adapt to environmental changes and self-repair,[634] while sustainable organic building materials can absorb carbon dioxide.[635]

As of January 2024, 28 cities have committed to the World Green Building Council's Net Zero Carbon Buildings Commitment, aiming for net-zero carbon by 2050 for all buildings.[636] Global smart city projects focusing on building innovation are limited[637] and less than 1% of buildings have so far reached net zero.[638]

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OPPORTUNITY

Advanced connectivity, advanced computing, and the IoT facilitate citywide biomimicry, making cities themselves, like forests, an ecosystem. Buildings would actively track and share data on energy, water, emissions, and people flows. With an aim for collective response and impact, advanced machine intelligence could make cities net positive, as opposed to buildings being net zero, by 2050. For instance, a building with net-positive energy from solar and thermal energy can automatically assist others across the city. Similarly, if a building's water usage hits a critical level, it can seek others with surplus harvested water for redistribution. A building can offset another building's increased emission levels.

To transform the city into a living ecosystem, every building must be equipped with new infrastructure, including sensors, actuators, and enhanced connectivity. This will also necessitate the redesign of current municipal, water, and energy systems.

BENEFITS

Accelerated achievement of city-level net-zero targets, reducing the city's total energy and resource consumption while also reducing and capturing emissions enhancing urban sustainability. Additionally, managing the interplay between water and energy in cities is likely to become more cost-effective.

RISKS

Implementing and maintaining connected and closed systems may be costly over time. Organic materials on buildings may deteriorate or become contaminated, posing potential environmental or health hazards. Allocating costs to individual buildings could disadvantage some. Cybersecurity threats in IoT systems may lead to inaccurate data, compromising intended objectives.

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