INTESA SANPAOLO
INNOVATION CENTER

INDUSTRY TRENDS REPORT
SUSTAINABLE CITIES

FROST & SULLIVAN

CONTENTS

EXECUTIVE SUMMARY

With 2.5 billion (b) more people expected to live in urban areas globally by 2050, the development of smart and **sustainable cities** has become a necessity. Growth will be driven by public and private sector participation, greater commitment and awareness amongst inhabitants and technological advances and adoption.

Three themes – resilience, quality of life and productivity – will serve as the foundation for future cities, shaping both their design and utilization while the concept of the 15-minute city addresses each of these areas by providing residents with easy access to amenities.

Urban areas account for 70% of annual global emissions so "making it local" will become one of the key responses to climate change. Within this, buildings with 38% are the largest contributors. Innovations focused on the built environment will therefore be central to developing the smart and sustainable cities of tomorrow.

Reliable and verifiable carbon tracking and accounting is a prerequisite for enabling decarbonization across the built environment. Frost & Sullivan believes that the global market for **emission monitoring** technologies in cities was valued at $350 million (m) in 2022 and will reach $1.5b by 2030.

Monitoring stations and ***IoT sensors*** represent the most established approach with Dijon in France becoming one of the first city to track carbon dioxide (CO2) emissions in real time by deploying a network of ground-based probes. Earth observation (EO) ***satellite imagery*** to identify hotspots is an emerging solution. Here, Turin in Italy is amongst the cities exploring its potential to generate indicators that enable smart and sustainable urban development.

EO is largely being enabled by the emergence of small satellites which weigh less than 500kg and accounts for 32% of the revenue that they generate. Uptake is being driven by the declining cost-to-orbit which itself is enabled via recourse to reusable and modular launch vehicles as well as the emergence of advanced sensing technologies which include passive (e.g., hyperspectral) and active (e.g., microwave) systems.

In addition to carbon tracking, EO supports the growth of a "green" built environment more broadly as well as greater sustainability in other areas. Epidemiology, for example, is a key use case with satellite imagery able to contribute to an improved understanding of disease propagation across urban environments.

Whether using IoT sensors or satellite imagery, monitoring emissions on an open basis allows stakeholders to plan, prioritize and enact science-based environmentally friendly measures. In the future, the market is moving towards a platform approach, such as that offered by AIDash (US) which combines sensor and satellite data with artificial intelligence (AI).

"Making it local" is being joined by "**making it green**" as a priority for 20% of cities looking to boost climate change resilience. Chengu in China is, for example, experimenting with leveraging the outside of public and private buildings and balcony space to install trees and plants. This is part of a broader trend towards using urban areas not just for vertical planting but increasingly also for vertical farming.

Controlled environment agriculture (CEA) addresses consumers' demand for locally sourced produce as well as authorities' need to improve security of food supply. Furthermore, it offers a sustainable alternative to conventional farming techniques, enabling cities to reduce their water use and their carbon footprints.

From a technology point of view, hydroponics is the most widely used CEA system and offers simplicity and efficacy compared to aero- and aquaponics. AeroFarms (US) is perhaps the best know operator, but PlantLabs (NL) is one of many vertical urban farms attracting new funding. Overall, the success of vertical farming will depend in part on effective irrigation with countries in Asia and notably Korea proponents of rainwater harvesting. Netherlands-based Hydraloop Systems is taking the concept further with its greywater system recycling rain and residential wastewater for further use.

In addition to "making it green", the idea of using buildings as repositories of valuable resources is a further enabler of decarbonization across cities. Frost & Sullivan believes that the global market for buildings as material banks (BAMB) was valued at $438m in 2022 and will reach $3.6b by 2030.

BAMB has the potential to stimulate **circular construction** across the entire lifecycle of a building from design and use or reuse to its end-of-life and recycling. As such, it allows – and requires – the involvement of a broad base of city stakeholders including property owners as well as occupiers and local authorities.

There is also a wide range of private companies stimulating the market with incumbents such as Rockwool (DK) setting themselves ambitious sustainability targets while start-ups like Loopfront (NO) are developing digital solutions that help other city participants to reduce their waste and emissions. Indeed, growth of the BAMB concept is expected to be driven by the launch of next-gen innovations like material passports and tagging sensors.

From a city perspective, Amsterdam in the Netherlands is leading the way with circular construction a core part of its "Circular Strategy 2020-2025". Authorities are also being helped to reduce footprint more broadly with new products allowing them to assess the impact of their city design plans. In the future, the data generated from physical infrastructure and assets will be leveraged to support the design of increasingly sustainable urban centers.

Source: Frost & Sullivan

Digital transformation is impacting the way in which the built environment is **heated and cooled** as well as constructed with the Internet of Things (IoT) shaping heating, ventilation and air-conditioning systems (HVAC).

HVAC can account for 40% of a building's energy requirement so market participants are notably looking to AI to improve efficiency and reduce emissions. BrainBox AI (CA), for example, automatically computes a range of internal and external factors to optimise HVAC performance and provide user comfort.

In parallel, the HVAC industry is seeking to harness "natural" methods of cooling, such as ice, and heating, notably including geothermal power sources.

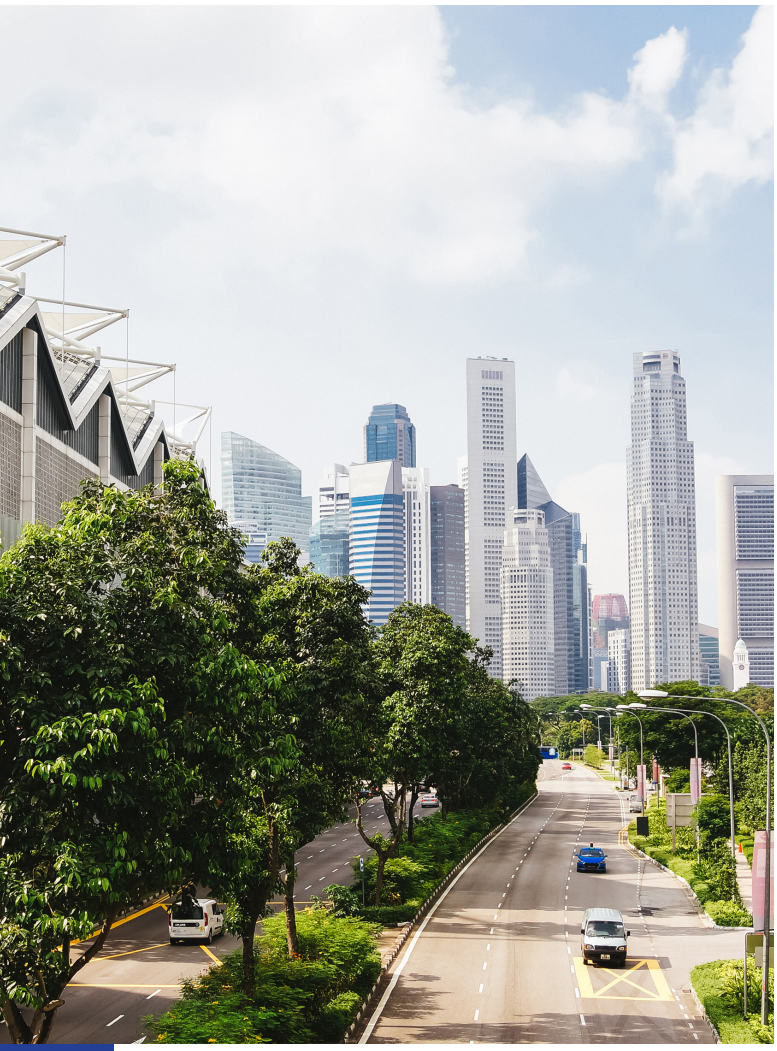
Geothermal energy is extracted from the earth's core and is therefore largely limited to specific geographical areas including Italy and Turkey in Europe. In addition to conventional HVAC, emerging applications for geothermal power include "closed-loop" heating and cooling systems for residential new builds as well as a low-carbon alternative to fossil fuels for the larger district heating schemes which are relatively widely used in Eastern Europe and the Nordics. Eavor Technologies (CA) is one of the companies building a position in these markets with its Eavoor Loop solution capable of serving about 16,000 homes. Meanwhile, the Italian firm Exergy International is working to develop a new and more efficient turbine for use in binary cycle geothermal power plants.

This report explores the ways in which the built environment is evolving in the context of the emergence of smart and sustainable cities. In particular, it examines the role of technology in monitoring, "greening", constructing, heating and cooling urban areas which will be more resilient and productive while also offering city-dwellers improved quality of life.

INTRODUCTION

With 2.5b more people expected to live in urban areas globally by 2050, the development of smart and sustainable cities has become a necessity

Smart cities are still evolving as a concept with different cities adopting different strategies. While the aim of smart city development is to enhance and enrich the lives of the citizens, from the perspective of a government there is a strong need for smart cities to be sustainable and self-sustainable. The end goal of a smart city is to become tenable not only in an ecofriendly way but also in a way that works toward solving future critical issues with ready solutions, without facing the challenges of securing funding and developing appropriate technology. A sustainable and self-sustainable smart city stands out from other so-called smart cities by being proactive and not fragmented or reactive. Sustainability and self-sustainability will help cities become truly smart and resilient in the future.



Growth will be driven by public and private sector participation, greater commitment and awareness among stakeholders, and technology advances and adoption

Public and private sector participation

Visionary leadership from governments and greater collaboration between the public and private sectors will be required for smart and city development. Smart cities will materialize from roadmap and strategy conceptualization and implementation. Such partnerships allow for participation from diverse companies across the industry value chain.

On the downside, unproven smart city solutions are impeding the active participation of some stakeholders. Although gaining a first-mover advantage may be of interest, some private sector players prefer to adopt "early follower" status and to learn from others while continuing to innovate. The public sector is unclear on how to develop sustainable business models in partnership with the private sector.

Commitment and awareness development

Dedicated task forces are driving the creation of successful smart city ecosystems. Such teams are crucial for coordinating efforts and collaboration among stakeholders. Personnel in the task forces may include government agencies, technology companies, consulting companies, academia and public figures that represent communities in a city.

On the other hand, little information exists on the costs, potential benefits and challenges that arise with smart city implementation. The advantages of advanced technologies may only become apparent after a smart city ecosystem has fully integrated them while the required investment and complexity of involved networks make it difficult for an organization to take the lead and coordinate all the activities.

Source: Frost & Sullivan

Technology advances and adoption

The creation of technology Innovation Hubs (IHs) and the availability of funding, tax rebates and other financial support mechanisms are creating dynamic platforms for stakeholders to advance the development and implementation of smart cities. This trend drives business model innovation and technology advances that smart cities need to evolve.

On the flip side, cybersecurity and smart city network safety will remain a concern for stakeholders, including citizens and business owners in the short term. Using more digital solutions or applications increases the risk of unauthorized data use and criminal access to systems or deliberate disruption by hackers. Assuring users of data security is imperative for wider uptake of smart city solutions or technologies.

Three themes – resilience, quality of life and productivity – will serve as the foundation for future cities, shaping both their design and utilization …

Greater **resilience** can stem from the idea of *making it green* and *making it local*, both of which are examined later in this report. The former leverages green energy which is gaining importance as cities work to become more climate resilient by preventing hazards and planning green spaces. The latter refers to increasingly popular circular approaches to production that promote local manufacturing, sharing and resource reuse.

Improved **quality of life** is based on the notions of *citizen health* and *citizen participation*. For the first of these areas, many cities are deploying digital technologies to promote healthiness through increased direct intervention and preventive measures. For the second, cities are involving citizens in city design by promoting active participation and collaboration between city planners and city residents.

Increased **productivity** centers on the deployment of artificial intelligence (AI). Data-driven decision-making is improving efficiency in cities through process automation.

… with the concept of the 15-minute city addressing each of these areas by providing residents with easy access to all of the essential amenities

Globally, the proportion of people living close to amenities varies. Most cities report that residents typically wish to be able to access various facilities in 15 minutes.

Arup conducted a survey in 2021 that used the **15-minute city** concept to roughly assess a number of cities' "livability" by asking respondents how much time they needed to travel to reach essential services. European cities are among the most amenity-dense in the world, offering good and rapid accessibility.

Cities that provide amenities within 15-20-minute walking or cycling distances are creating greater resilience and improved quality of life as well as increased productivity.

Use Case

Melbourne, Australia, introduced *Plan Melbourne 2017-2050* to drive city growth and solve the issue of urban sprawl. The plan comprises a range of elements from the 15-minute city concept, including introducing new bike lanes and developing 20-minute neighborhoods. Similarly, **Chengdu** has launched its *Great City* plan as a model for how China could rethink and redesign its suburbs. This notably includes the development of areas around the city's periphery that can provide essential services in a 15 minute walking distance.

Source: Frost & Sullivan

PRINCIPAL ABBREVIATIONS

3D	*Three-dimensional*
AI	*Artificial Intelligence*
B	*Billion*
BAMB	*Buildings as Material Bank*
CA	*Canada*
CEA	*Controlled Environment Agriculture*
CO2	*Carbon Dioxide*
DE	*Germany*
DK	*Denmark*
DWC	*Deep Water Culture*
EO	*Earth Observation*
EU	*European Union*
GHG	*Greenhouse Gas*
GIS	*Geographic Information System*
HVAC	*Heating, Ventilation, Air Conditioning*
IoT	*Internet of Things*
KM	*Kilometre*
LEO	*Low-earth Orbit*
LST	*Land Surface Temperature*
LT	*Lithuania*
LULC	*Land Use/Land Cover*
M	*Million*
M2M	*Machine to Machine*
METRO	*Measure, Enhance, Track, Report and Offset*
ML	*Machine Learning*
MW	*Megawatt*
NFT	*Nutrient Film Technology*
NL	*Netherlands*
NO	*Norway*
ORC	*Organic Rankine Cycle*
RAR	*Real Aperture Radar*
RoI	*Return on Investment*
ROT	*Radial Outflow Turbine*
SAR	*Synthetic-Aperture Radar*
UK	*United Kingdom*
US	*United States*

Source: Frost & Sullivan

ABOUT INTESA SANPAOLO INNOVATION CENTER:

Intesa Sanpaolo Innovation Center is the company of Intesa Sanpaolo Group dedicated to innovation: it explores and learns new business and research models and acts as a stimulus and engine for the new economy in Italy. The company invests in applied research projects and high potential start-ups, to foster the competitiveness of the Group and its customers and accelerate the development of the circular economy in Italy.

Based in the Turin skyscraper designed by Renzo Piano, with its national and international network of hubs and laboratories, the Innovation Center is an enabler of relations with other stakeholders of the innovation ecosystem - such as tech companies, start-ups, incubators, research centres and universities - and a promoter of new forms of entrepreneurship in accessing venture capital. Intesa Sanpaolo Innovation Center focuses mainly on circular economy, development of the most promising start-ups, venture capital investments of the management company Neva SGR and applied research

For further detail on Intesa Sanpaolo Innovation Center products and services, please contact

businessdevelopment@intesasanpaoloinnovationcenter.com

ABOUT FROST & SULLIVAN:

For over five decades, Frost & Sullivan has become world-renowned for its role in helping investors, corporate leaders and governments navigate economic changes and identify disruptive technologies, Mega Trends, new business models and companies to action, resulting in a continuous flow of growth opportunities to drive future success.

For further details on Frost & Sullivan's coverage and services, please contact

LIVIO VANINETTI
Director of Frost & Sullivan's Italian operations;
livio.vaninetti@frost.com

Published: April 2023