INTESA SANPAOLO
INNOVATION CENTER

INDUSTRY TRENDS REPORT
INFRASTRUCTURE & CONSTRUCTION

SMART BUILDINGS

FROST & SULLIVAN

CONTENTS

EXECUTIVE SUMMARY

In 2020, Frost & Sullivan valued the global **Homes & Buildings** industry at $1.3 trillion.

The space combines an unusual mix of traditional segments and high-growth niches with the penetration of the Internet of Things, the advent of the Cloud and the deployment of other advanced technologies continuing to rapidly and fundamentally reshape the ways in which buildings are operated and developed.

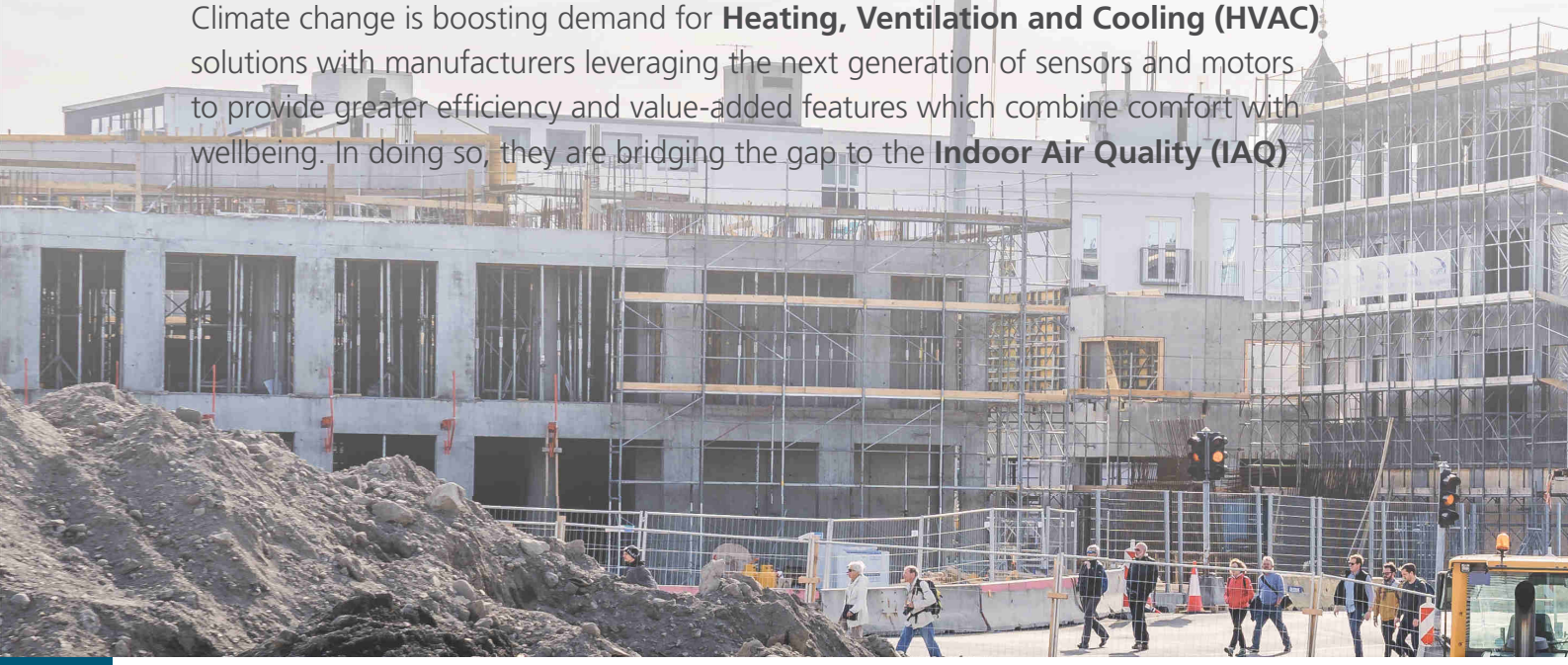
On the one hand, the conventional buildings of the past are being replaced by the **smart buildings** of today which in the future are expected to evolve into cognitive buildings. In this context, building operators and owners are focusing on delivering **automation** which is increasingly enabled by **Artificial Intelligence** and, in turn, improved **sustainability**, greater **comfort** and increased **wellbeing**.

Building Automation Systems (BAS) centralise the remote monitoring and control of a building's functions and promise cost savings to end-users. On the supply side, emerging communication protocols and IoT-enabled solutions are transforming business models and enabling the deployment of Platform-as-a-Service (PaaS) and horizontal architectures.

Investment in **Artificial Intelligence (AI)** is relatively low in the smart buildings space but interest is growing. AI is seen as a means with which to provide owners and occupiers with sustainability, comfort and wellbeing and its application in Homes & Buildings is attracting attention from tech giants and start-ups.

Zero Energy Buildings (ZEBs) in many ways represent the final goal in the gradual move towards improved sustainability. Energy self-sufficient units currently represent less than 1% of the global stock but industry commitments and stringent legislation are driving the deployment of solutions such as building enveloping material and solar PV systems.

Climate change is boosting demand for **Heating, Ventilation and Cooling (HVAC)** solutions with manufacturers leveraging the next generation of sensors and motors to provide greater efficiency and value-added features which combine comfort with wellbeing. In doing so, they are bridging the gap to the **Indoor Air Quality (IAQ)**



market where Covid-19 has heightened concern about airborne disease and prompted vendors to innovate, pivoting their products to detect pollutants as well as pathogens.

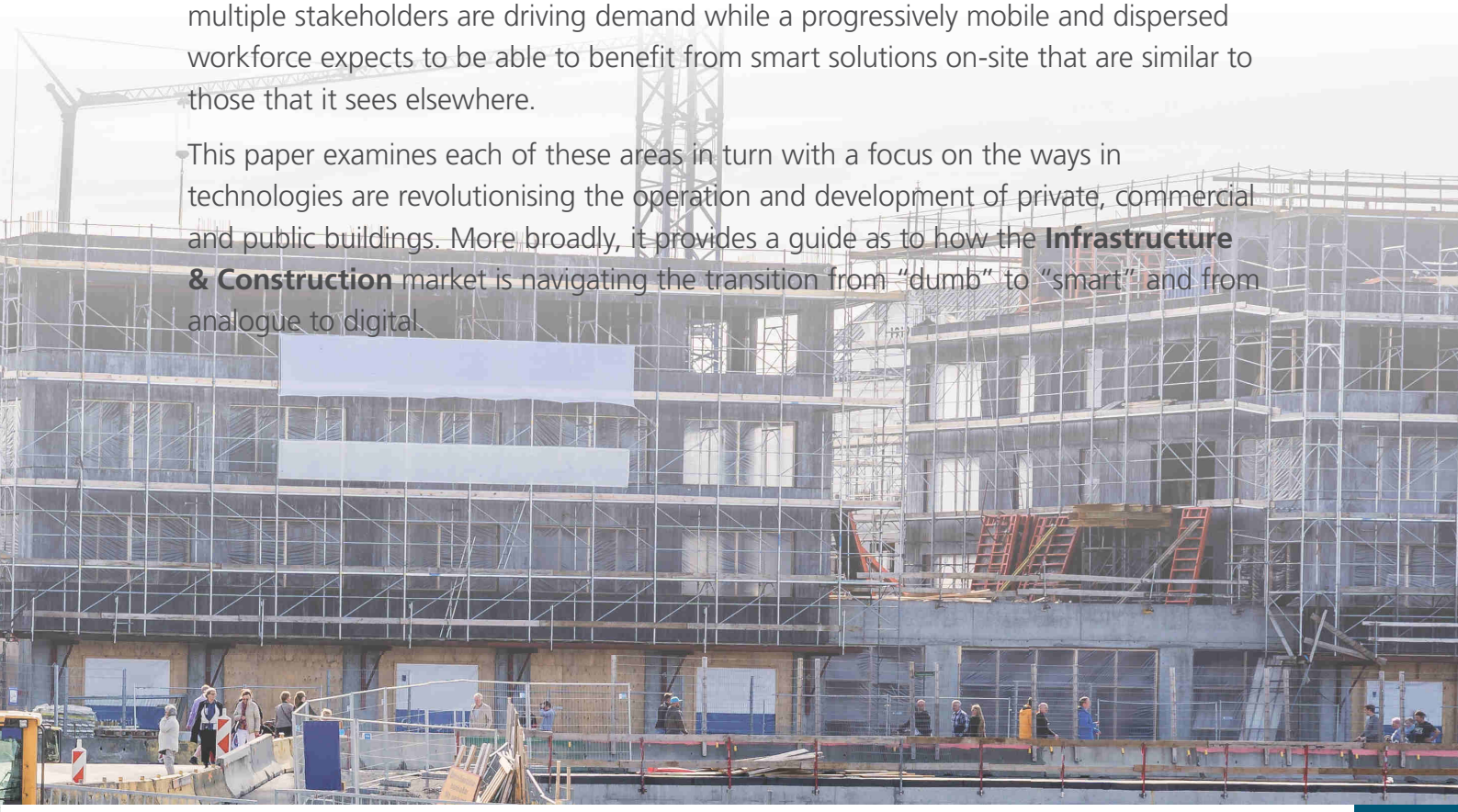
On the other hand, buildings are not only becoming smarter in the way that they are operated but also in the way in which they are built with **digital construction** coming to the fore and market participants leveraging emerging systems such as **Information modelling**, **Robotics** and **Management solutions**.

Building Information Modelling (BIM) and, increasingly, digital twins have succeeded Computer Assisted Design (CAD) as the construction industry's solution of choice for creating building models. Augmented Reality, big data analytics and AI are taking BIM capabilities to the next level and aiding the development of mega infrastructure projects.

On-site, cheaper, quicker and safer construction is being enabled by **Robotics**. Here, drones are the most common category with unmanned aerial and ground vehicles key to inspection and surveying activities. Emerging use-case include specific tasks such as bricklaying, demolition and welding.

Construction Management Systems (CMSs) allow developers to manage construction projects' financials, quality, safety and productivity. Continued increases in the volume of information available and the growing need for collaboration between multiple stakeholders are driving demand while a progressively mobile and dispersed workforce expects to be able to benefit from smart solutions on-site that are similar to those that it sees elsewhere.

This paper examines each of these areas in turn with a focus on the ways in technologies are revolutionising the operation and development of private, commercial and public buildings. More broadly, it provides a guide as to how the **Infrastructure & Construction** market is navigating the transition from "dumb" to "smart" and from analogue to digital.



Source: Frost & Sullivan

SMART BUILDINGS: **INTRODUCTION**

Traditional buildings of the past are being replaced by smart buildings today which in the future are expected to evolve into cognitive buildings

In **traditional** buildings, automation systems were focused on building management and control and leveraged historical data, included centralised remote control functions and provided users with alerts. They were primarily intended to enable interaction between buildings (as well as between buildings and people) and were centred on the delivery of space optimisation solutions.

In **smart** buildings, which are under development today, automation systems are designed to use real-time analytics, connected components and pervasive networks. Their purpose is to ensure the seamless integration of sensors as well as smart meters, devices and assets. They leverage wireless technologies, smart controls and analytics platforms based on the Internet of Things (IoT) including diagnostic and descriptive analytics. In smart buildings, the convergence of systems – and their integration into the construction – allows the provision of energy management solutions.

In **cognitive** buildings, automation systems are expected to enable forecasting and planning through tools such as predictive analytics and ubiquitous computing. The will be centred around the provision and use of;

— Information, including on metrics such as energy flow and building occupancy via the evaluation, integration and implementation of Big Data

— Intelligence, for example, artificial intelligence and scenario planning

Frost & Sullivan finds that the global "core" smart building market, comprising of hard- and software solutions, was valued at $5.9b in 2019 and growing at 3.1%

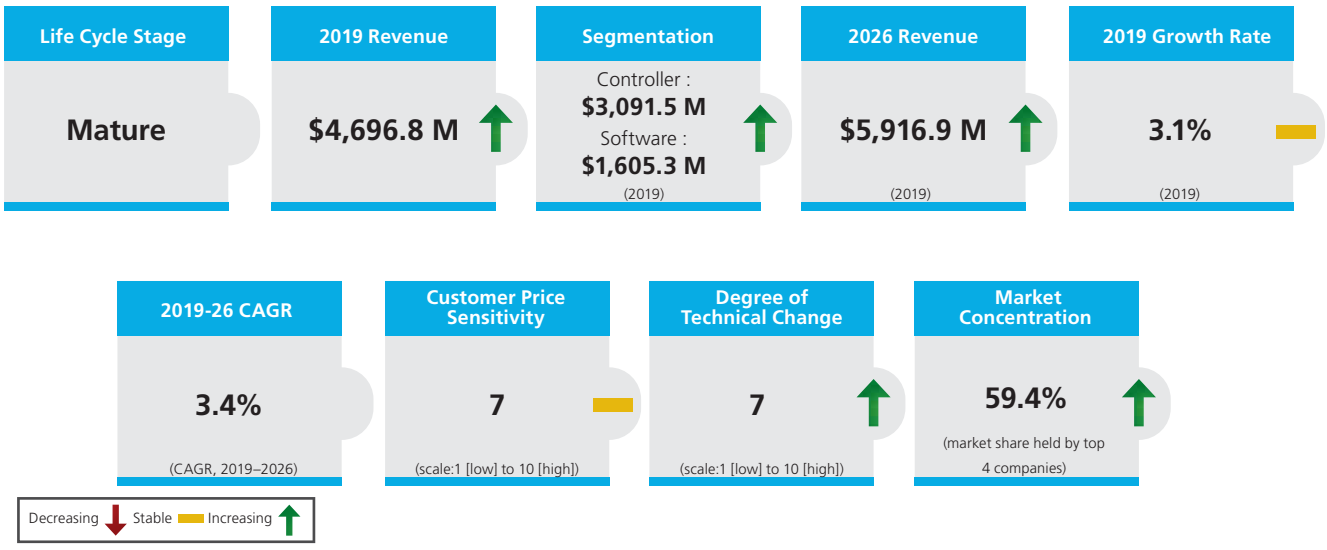
The advent of the cloud is a key enabler of smart buildings …

Cloud networking will speed up time-to-market and reduce costs for owners by extending a type of clone or duplicating service that directly connects a building with network services. This improves the value proposition of service providers whilst benefiting occupiers.

For **vendors**, it will enable the provision of solutions encompassing areas such as safety and security, energy management, automation and control, health and wellness and home entertainment

For **end-users**, it will facilitate the deployment of new consumer devices which address each of these areas.

MAXIMUM ALLOWANCE OF CO2 EMISSIONS MEASURED IN G/KM, SELECTED COUNTRIES, 2015-2030



Source: Frost & Sullivan

… which require ever more robust cybersecurity measures

The smarter buildings become, the more susceptible they are to attacks. With increasing convergence between IT and Operational Technology (OT) networks, the opportunity for attackers to place malware, steal data or hack into systems increases several fold.

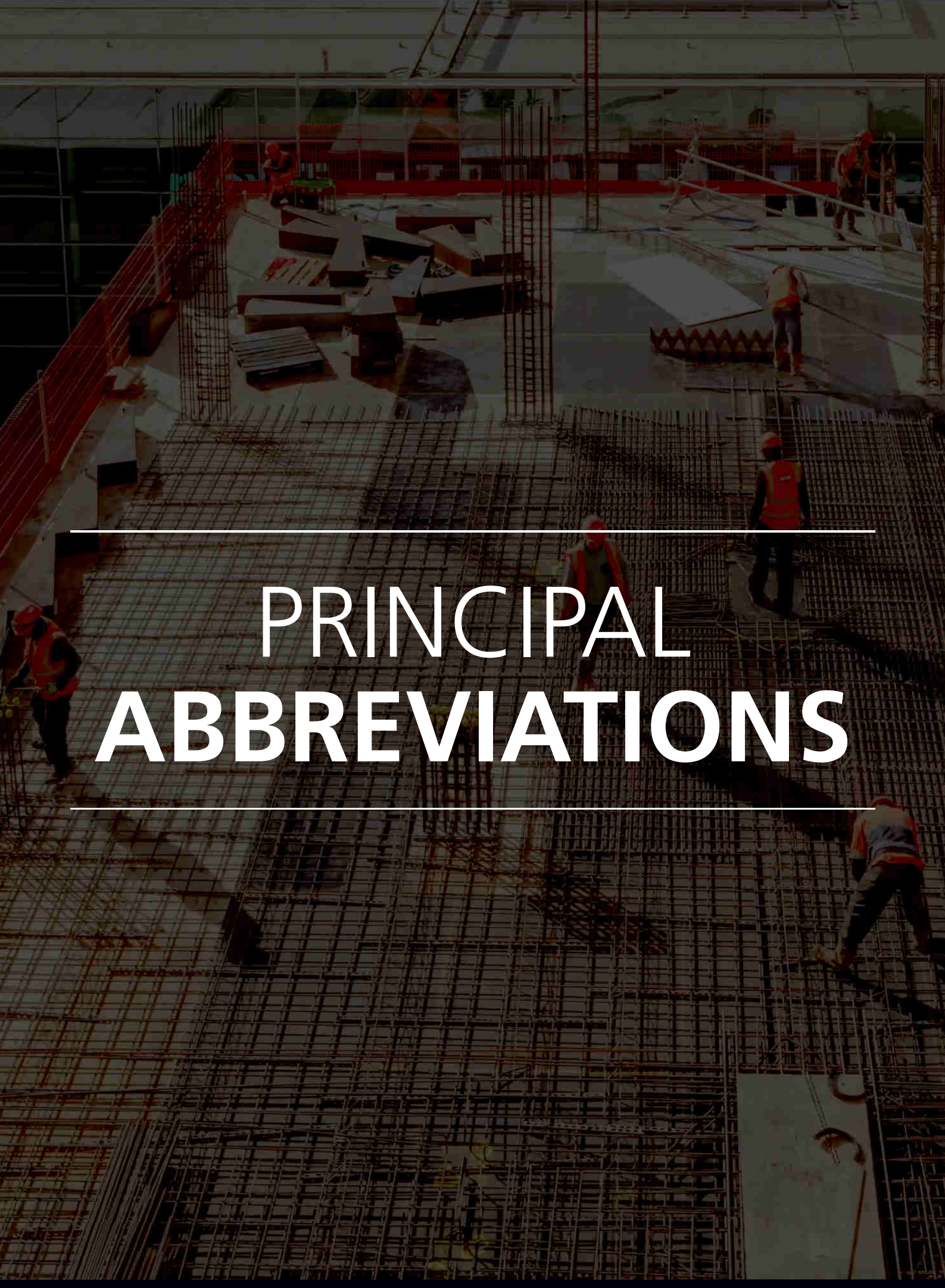
The Covid-19 pandemic is enhancing the need for cybersecurity solutions due to the sudden surge in remote working. Most building protocols, such as BACnet, KNX and Modbus, lack built-in security features, making attacks difficult to detect and mitigate.

The market for IT/OT security services in smart buildings is predicted to hit $897.6 million by 2022, reaching a high Compound Annual Growth Rate (CAGR) of 24.6% from 2019.

To succeed in the post-pandemic era, building technology providers will need to rethink their strategies and offerings to accommodate new security requirements in the "new normal". Equipment manufacturers must incorporate cyber-security into the design of their products and provide secure default settings in all devices while building operators or managers will need to take steps to bolster their cybersecurity measures, such as improving authorisation controls, installing firewalls and implementing stronger end-to-end data encryption.

On their side, businesses and building occupiers can try to integrate Machine Learning (ML) and Deep Learning (DL) algorithms to monitor threat prevention.

Overall, building operators and owners are focused on automation which is increasingly enabled by Artificial Intelligence (AI) and in turn delivering improved sustainability, greater comfort and increased wellbeing



PRINCIPAL ABBREVIATIONS

AI	*Artificial Intelligence*
APAC	*Asia Pacific*
AR	*Augmented Reality*
B	*Billion*
BAS	*Building Automation System*
BEMS	*Building Energy Management System*
BIM	*Building Information Modelling*
BMS	*Building Management System*
BYOD	*Bring Your Own Device*
CaaS	*Cooling as a Service*
CAD	*Computer Assisted Design*
CAGR	*Compound Annual Growth Rate*
CMS	*Construction Management System*
CO2	*Carbon Dioxide*
DER	*Distributed Energy Resource*
DL	*Deep Learning*
DR	*Demand Response*
EED	*Energy Efficiency Directive*
EPBD	*Energy Performance of Buildings Directive*
EPC	*Engineering, Procurement and Construction*
ERP	*Enterprise Resource Planning*
ESAS	*Emergency Security and Automation System*
EU	*European Union*
GC	*General Contractor*
GHG	*Greenhouse Gas*
HaaS	*Heat as a Service*
HVAC	*Heating Ventilation and Air-conditioning*
HVACaaS	*HVAC as a Service*
IAQ	*Indoor Air Quality*
IoT	*Internet of Things*
IP	*Internet Protocol*
M	*Million*
ML	*Machine Learning*
MoU	*Memorandum of Understanding*
NOx	*Nitrogen Oxide*
OT	*Operational Technology*
PaaS	*Platform-as-a-Service*
PM	*Particulate Matter*
R&D	*Research & Development*
RoI	*Return on Investment*
RoW	*Rest of the World*
SC	*Specialty Contractor*
SRM	*Switched Reluctance Motor*
UAV	*Unmanned Aerial Vehicle*
UGV	*Unmanned Ground Vehicle*
UK	*United Kingdom*
US	*United States*
USP	*Unique Selling Point*
UV	*Ultraviolet*
UVGI	*Ultraviolet Germicidal Irradiation*
VOC	*Volatile Organic Compound*
VR	*Virtual Reality*
VRF	*Variable Refrigerant Flow*
ZEB	*Zero Energy Building*

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.

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Published: June 2021