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FROST & SULLIVAN

THE 2D'S SHAPING THE BUILDINGS INDUSTRY

DIGITALIZATION & DECARBONIZATION

Presented at

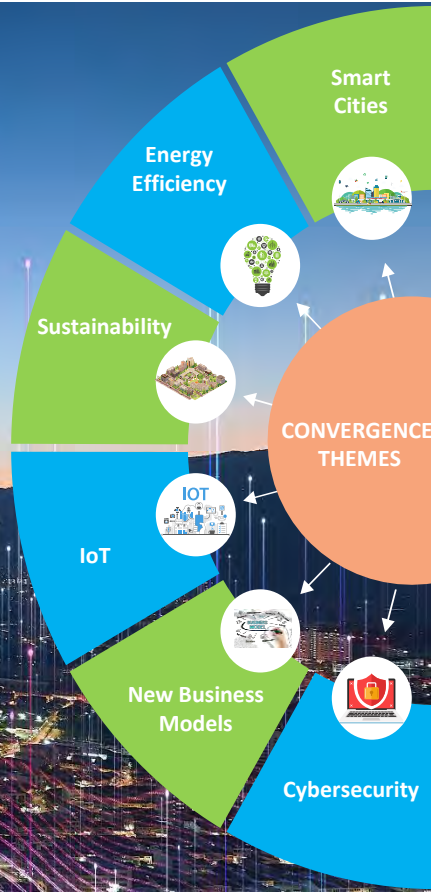
Smart Buildings Show 2023, London

ENERGY & ENVIRONMENT FOCUS AREAS FOR THOUGHT LEADERSHIP

Power generation equipment & services	Energy storage, critical power	Alternative & renewable energy	Grid technologies and services	**Energy**
Connected Living	Smart & Cognitive Buildings	Facility Management	Energy Management	**Homes & Buildings**
O&G Equipment	Oil Field Services	Unconventional O&G Opportunities	Digital Oil Fields	**Oil & Gas**
Circular Economy	Water Utilities & Smart Solutions	Industrial Water Services	Waste to Value	**Sustainability**
Innovation of technology and business models	IoT and data analytics	Digital transformation	Growth opportunities and market disruption	**Innovation & Transformation**

HOMES & BUILDINGS FOCUS

Facilities Management	• Facilities Management Services • Integrated Facilities Management • Energy Services • Co-working & Future of Workplace
Properties and Construction	• Property and Building Industry • Infrastructure • Construction Technology
Smart Homes & Buildings	• Building Management & Automation • Energy Management • Fire Detection & Suppression • Access Control
HVAC System	• Air-conditioning • Air Purifier • Thermostat & Controls • District Heating and Cooling
Building Mobility Solutions	• Elevator • Escalator • Moving walkway • Crowd Analytics
Lighting	• Conventional Lighting • LED Lighting • Smart Lighting • Luminaire and Fixture • Entrance Matting



DIGITAL SOLUTION ARCHITECTURE OF HOMES AND BUILDINGS INDUSTRY

Industry Segments

- Lighting
- Energy Management
- Building Automation
- Fire Safety and Security
- Facilities Management
- HVAC
- Elevators & Escalators

Digital Services

- Digital Twin
- Energy Optimization
- Fault Detection and Diagnostics
- Healthy Building Services
- Predictive Maintenance
- Remote Monitoring
- Workplace Optimization

Technologies and Post–Covid-19 Applications

- AI-based lighting control
- Voice-enabled lighting control
- Human-centric lighting
- Building energy performance optimization (BEPO)
- HVAC optimization
- Cloud-based remote services
- Digital twin
- Workplace analytics
- IAQ-based ventilation
- Predictive maintenance
- UV germicidal irradiation (UVGI)
- Occupancy detection (OD)-based social distancing
- High efficiency particulate air (HEPA) filters
- Indoor positioning (IP)-based contact tracing
- AI-based face mask detection
- Antimicrobial paints in washrooms
- Foot-operated elevators
- Touch-free washroom fixtures
- AI-based access control
- Thermal imaging
- Building health performance benchmarking
- Pathogen scanner
- Nanotechnology (NT)-based self-cleaning surfaces
- Touch-free toilet seat cover cleaning
- UV-C disinfection
- Power over ethernet (PoE)
- Narrowband communication
- Bluetooth low energy (BLE)
- Wi-Fi 6
- Light fidelity (Li-Fi)

CLIMATE CHANGE POLICIES FAVORING DECARBONIZATION OF BUILT ENVIRONMENT

Infrastructure Investments and Jobs Act

US Federal funding of $225 million through Department of Energy to update Building Energy Codes and implement energy efficiency measures.

Inflation Reduction Act

This US Act will fund $1.2 billion to support deploying emerging & sustainable technologies in buildings and accelerate efforts on net-zero federal footprint.

US Climate Smart Buildings Initiative

Leverage public-private partnerships and attract $8 billion investments to improve energy efficiency of 300,000 federal buildings through performance contracts.

Defense Production Act

To expedite domestic production of five key energy technologies including heat pumps to strengthen energy security and lower energy costs for families.

European Green Deal

European Renovation Wave Strategy under the ‘Fit for 55’ package to accelerate the annual energy renovation rate of buildings in Europe.

REpowerEU

To double the rate of deployment of heat pumps and integrate geothermal and solar thermal energy in district and communal heating systems.

UK’s Heat and Buildings Strategy

To innovate heat pump sector via £60 million ‘Heat Pump Ready’ Programme and create a market to deploy 600,000 heat pumps per year by 2028.

Saudi Vision 2030 – NEOM Project

The NEOM project with 10 sub projects with a funding of $500 billion will deploy clean energy technologies and accommodate a million people by 2030.

BUILDING AUTOMATION TRENDS

Digital Twins

- Digital twins in the built environment will play a crucial role in O&M of connected and healthy workplaces
- Technology companies are teaming up with digital twin and smart building participants to create a virtual twin of connected and healthy workplaces, monitoring indoor air quality, optimizing space utilization, and increasing energy efficiency, thereby enhancing collaboration and productivity and reducing operating costs

AI-driven Building Solutions

- AI-driven building solutions will assist end customers to achieve sustainability goals and will drive the shift from a reactive to a prescriptive maintenance model
- Prescriptive maintenance uses advanced analytics to make predictions about maintenance
- Asset digitalization and the potential of producing actionable intelligence derived from the data opens opportunities for employing AI, resulting in prescriptive maintenance capabilities being the future of asset management.

Real-time Cloud Visualization

- The COVID-19 pandemic has pushed customers to invest aggressively in cloud-based remote services for critical building systems to respond to changing business and market needs
- Cloud, with its high degree of flexibility and scalability, is well suited to store and handle large volumes of generated data. This facilitates remote monitoring and controlling, resulting in reduced maintenance costs, lower down time, and overall better tenant comfort

Cyber-security

- The smarter a building becomes, the more susceptible it is to cyber attacks. With increasing convergence between IT/operational technology (OT) networks, the opportunity for attackers to place malware, steal data, or hack into systems increases several manifold
- The pandemic is enhancing the need for cybersecurity due to increased remote working and management, making cybersecurity top priority for building owners and facility managers

LIGHTING TRENDS

Health & Wellness

- Cross-industry applications are opening new avenues for lighting systems and providing more than lighting in buildings.
- For instance, demand will multiply for ultraviolet C (UV-C) LEDs capable of disinfecting air, surfaces, and water in buildings and public transport.
- Demand will grow for new applications, such as light therapy and human-centric lighting promoting health and wellness.

Smart Lighting

- COVID-19 has accelerated digitization, and as buildings get smarter, lighting will follow suit.
- Smart LED luminaires with sensors that track employee movement and optimize lighting needs will become commonplace.
- With the number of connected devices multiplying, light fidelity (LiFi) will gain demand and could succeed WiFi.
- Organic LED (OLED) and quantum dots will also find wide acceptance.

LaaS-based Digital Lighting Solutions

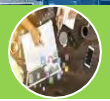
- Digital lighting solutions that the LaaS model supports has taken off after the pandemic.
- This will cause a market shift from a capital expenditure (CAPEX) to an operational expenditure (OPEX) model.
  A more circular business model will aim at balancing the shift away from product focus.
- Companies, such as Signify, OSRAM, and Acuity Brands, are early adopters in the LaaS space.

Sustainable Lighting

- The urgency to ensure sustainability throughout the lighting system's life cycle is growing.
- Through changes in factors, such as materials, manufacturing processes, and shipping practices, LEDs of the future will be more energy efficient than their predecessors.
- Sustainable practices will be vital to ensure circularity throughout product life cycles, including longer lifetimes, disassembly, and repurposing, to reduce landfill waste.

HVAC TRENDS

IAQ



- IAQ-based ventilation has become the core element of healthy buildings in the post–COVID-19 environment. The pandemic has cast concerns over airborne transmission through ventilation ducts.
- Healthy IAQ has proven to significantly increase occupant health and productivity.
- IAQ will continue to gain preference in the smart building market. Smart systems that handle air quality issues will be the way forward.

HVACaaS

- HVACaaS is a subscription-based model for HVAC equipment that could prove to be a game changer and a chance for equipment manufacturers to be more than just a product seller.
- With growing demand for remote monitored HVAC systems, the HVACaaS market could attract large buildings that plan to upgrade their existing HVAC systems. By 2026, an estimated 7%–8% of revenues will come from subscription-based services.

AI in HVAC

- Digital transformation of HVAC equipment and services is the backbone of achieving various energy-related targets.
- Data collected from HVAC systems can provide insights that, along with BAS, will lead to higher energy efficiency and open new revenue streams. Self-diagnosing buildings are an application of AI in the HVAC industry that could identify problems, diagnose, and auto-order replacement parts as necessary.

Sustainable HVAC

- Stakeholders in the HVAC industry, including power generation entities and HVAC equipment manufacturers are taking the initiative to lower their carbon footprint throughout the product life cycle chain.
- The increase in global warming, green building certifications, and climate control measures will lead providers to design, manufacture, install, and operate HVAC systems in the most sustainable way possible.

FACILITIES MANAGEMENT TRENDS

Sustainability

- Renewed focus on a low-carbon future.
- Promotion of the circular economy in all supply chains.
- Expanded opportunities for energy management.
- Improved working conditions for all (e.g., fair wages, safety, and support tools).

Healthy & Safe Buildings

- New cleaning, hygiene, and disinfection standards.
- IAQ monitoring (benchmarking, sampling, and continuous real-time analysis).
- New workplace norms and revised standard operating procedures.
- Robots and drones for cleaning and other uses.

Augmented Operations

- Operations using augmented and virtual reality (AR and VR) to enhance technician performance and optimize costs.
- Use of AI and machine learning (ML) to gain insights across the organization from the augmented workforce.

Contactless Services

- Automated supply and contactless delivery of products and services.
- Reduced risk of contaminated surfaces through sensor-based interfaces.
- Predictive demand planning/tracking, enabling contactless remote delivery, payment, and maintenance.

Energy Management

- A vital growth business model for energy performance contracting.
- Opportunity to compete with energy utilities and energy savings companies in the industrial and commercial segments.
- XaaS, real-time reporting, and sophisticated data analytics for energy.

ELEVATORS & ESCALATORS TRENDS

Health and Wellness

- Vertical transportation has become a focal point in the post-pandemic scenario. As enclosed spaces, elevators carry a significant risk of virus transmission.
- The mitigation of this risk witnessed incorporation of offerings, such as escalator handrail sanitization, thermal cameras to detect infected passengers, and UV-based air purification.

Contactless Operation

- Millions of people use elevators/escalators every day, and these transportation modes must remain comfortable, efficient, and secure, making contactless operations imperative.
- Passengers can operate elevators using smartphone apps or call for one using a foot pedal or kick button. Other options include facial recognition, voice command controls, or buttons that appear as holograms.

Crowd Flow Analytics

- Traffic monitoring solutions are essential to limit or control passenger amounts.
- Solutions that balance the risks of elevator/escalator congestion with social distancing needs and reduce wait times will be of prime interest.
- Technology must collect, analyze, and incorporate the elevator/escalator daily operation data, including passenger movement, traffic changes, passengers' body temperatures, and usage

Remote Monitoring

- A consequence of the COVID-19 pandemic is the need for remote monitoring and maintenance which has gained in demand and adoption in recent times.
- A step-up from this demand will be predictive maintenance of elevators/escalators that could extend machinery life and reduce maintenance costs by 40%, equipment downtime by 50%, and equipment costs by 3% to 5%.

KEY TAKEAWAYS

Sustainability to Drive Decarbonization of Buildings

- Need for **decarbonization of buildings** is accelerating. This trend could accelerate with the stronger push for smart cities

Digitalization to Facilitate better Building Management

- Push for **digitalization of buildings** now more than ever. AI, remote monitoring, cloud-based services to further grow in demand

New and Resilient Business Models are the need of the hour

- Technology-enabled and outcome-based **circular business models,** such as XaaS or performance contracting will open new and diverse opportunities

Focus on Health & Wellness of occupants will take center stage

- **Healthy buildings** that integrate the health and wellness of occupants in design and operation will hold key to future potential

THANK YOU!

Q&A

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We look forward to seeing you in 2024