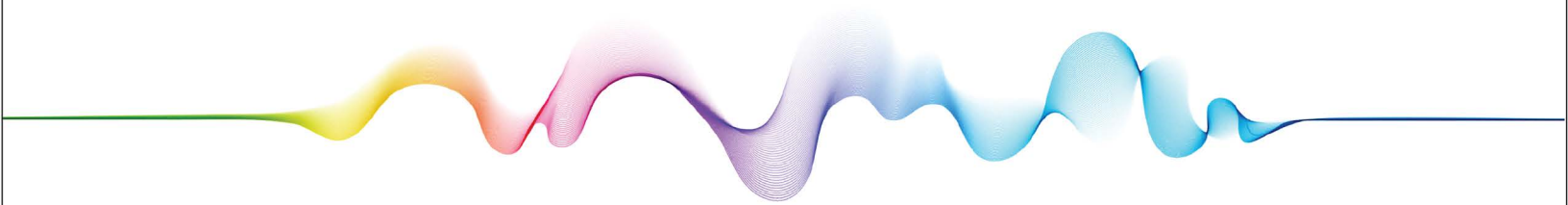


I N S I G H T R E P O R T

AN OVERVIEW OF GREEN BUILDING AND INFRASTRUCTURE



C L I M A T E S C I E N C E



TAG Insights Report: An Overview of Green Building and Infrastructure

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Introduction

This TAG Insights Report on *Green Building and Infrastructure* is intended to help companies, managers, practitioners, researchers, investors, and commercial vendors better understand current trends, issues, and market opportunities in this area. A list of representative commercial vendors working in various areas of green building and infrastructure is included. The five specific areas covered in this report include:

1. Sustainable Architecture and Design
2. Green Building Materials and Concrete
3. Zero-Emission Construction Equipment
4. Green Roofing and Insulation
5. Sustainable Urban Planning

This report is intended for general and unrestricted use, but interested readers are encouraged to connect with the TAG research and advisory team for more information on the private [TAG Research as a Service \(RaaS\)](#) community that covers, discusses, and shares information on these topics in more depth and includes a wider range of startups, vendors, and companies.

TAG Climate Taxonomy

Our advisory work at TAG is guided by our TAG Climate Taxonomy which includes twenty different market categories, with one hundred associated subcategories – all developed consistent with our research into emerging and existing commercial offerings. Subscribers to

TAG Research as a Service (RaaS) have access to the more detailed specifics of the taxonomy and the full set of companies working in each area.

The taxonomy is intended to be interpreted as a market guide for commercial (and in some cases, open source) platform, tools, products, and services. The day-to-day tasks of any practitioners focused on sustainability will include many considerations such as dealing with regulators, addressing compliance issues, and keeping up with legislation that will not typically be represented in our taxonomy. We focus here on products and services.

TAG Climate Taxonomy V2.0 – 1Q2024

1 Renewable Energy 1.1 Solar and Wind Power Generation 1.2 Fission and Fusion 1.3 Hydropower Innovations 1.4 Geothermal Energy Technologies 1.5 Bioenergy and Biomass Systems	6 Water Management 6.1 Water Purification and Filtration 6.2 Smart Irrigation and Agriculture 6.3 Industrial Water Recycling 6.4 Stormwater Management 6.4 Desalination Technologies	11 Climate Data Analytics 11.1 Climate Modeling and Prediction 11.2 Weather Forecasting Technologies 11.3 Environmental Monitoring Services 11.4 Climate Risk Assessment Service 11.5 Carbon Footprint Assessment Tools	16 Eco-Friendly Consumer Products 16.1 Sustainable Fashion and Textiles 16.2 Eco-Friendly Personal Care Products 16.3 Biodegradable Packaging 16.4 Energy-Efficient Appliances 16.5 Sustainable Electronics
2 Energy Efficiency 2.1 Building Energy Management 2.2 Smart Grid and Energy Storage 2.3 LED Lights/Energy-Efficient Appliances 2.4 Industrial Process Optimization 2.5 HVAC and Cooling Solutions	7 Sustainable Agriculture 7.1 Precision Farming Technology 7.2 Organic Farming Solutions 7.3 Soil Health and Nutrient Management 7.4 Vertical Farming and Aquaponics 7.5 Crop Monitoring and AgTech	12 Sustainable Food and Beverage 12.1 Plant-Based and Lab Grown Meat 12.2 Sustainable Seafood Production 12.3 Food Waste Reduction Technologies 12.4 Eco-Friendly Food Packaging 12.5 Sustainable Ingredients and Oils	17 Clean Air and Pollution Control 17.1 Air Quality Monitoring Services 17.2 Air Purification Technologies 17.3 Pollution Source Tracking 17.4 Emission Control Systems 17.5 Indoor Air Quality Solutions
3 Sustainable Transportation 3.1 EV Charging Infrastructure 3.2 Sustainable Urban Mobility Solutions 3.3 Fleet Electrification Services 3.4 Alternative Fuel Technologies 3.5 EV Battery Recycling and Repurposing	8 Circular Economy 8.1 Recycling and Waste Management 8.2 Product Lifecycle Assessment 8.3 Sustainable Packaging Solutions 8.4 Reusable and Repairable Products 8.5 Upcycling and Repurposing Services	13 Eco-Tourism and Recreation 13.1 Eco-Friendly Accommodations 13.2 Sustainable Travel Booking Platforms 13.3 Adventure Tourism/Conservation Focus 13.4 Wildlife Monitoring/Conservation Tours 13.5 Eco-Friendly Outdoor Gear	18 Climate Education and Services 18.1 Climate Change Education workshops 18.2 Sustainability Training 18.3 Climate Industry Advisory 18.4 Climate Intelligence Software 18.5 Climate Insurance
4 Carbon Capture and Utilization (CCU) 4.1 Direct Air Capture incl. Point Source 4.2 Carbon Removal and Sequestration 4.3 Carbon Mineralization 4.4 Enhanced Oil Recovery (EOR) 4.5 Soil-Based Sequestration	9 Carbon Market and Trading Platforms 9.1 Emission Reduction Verification Services 9.2 Carbon Offset Project Development 9.3 Carbon Credit Exchange Program 9.4 Blockchain-Based Carbon Trading 9.5 Carbon Taxation Solutions	14 Green Energy Storage 14.1 Advanced Battery Technologies 14.2 Advanced Fuel Cells 14.3 Energy Storage for Electric Vehicles 14.4 Grid-Scale Energy Storage Solutions 14.5 Hydrogen Energy Storage	19 Sustainable Supply Chain 19.1 Sustainable Sourcing/Procurement 19.2 Supply Chain Transparency 19.3 Ethical Labor Practices 19.4 Circular Supply Chain Solutions 19.5 Eco-Friendly Transport in Supply Chain
5 Green Building and Infrastructure 5.1 Sustainable Architecture and Design 5.2 Green Building Materials and Concrete 5.3 Zero-Emission Construction Equipment 5.4 Green Roofing and Insulation 5.5 Sustainable Urban Planning	10 Sustainable Finance and Investment 10.1 Green Bonds and Sustainable invest. 10.2 ESG Analysis 10.3 Impact Investment Platforms 10.4 Carbon Disclosure and Reporting Tools 10.5 Sustainable Investment Advisory	15 Biodiversity and Conservation 15.1 Wildlife Habitat Restoration 15.2 Conservation Tech for Monitoring 15.3 Anti-Poaching Solutions 15.4 Sustainable Forestry Practices 15.5 Marine Conservation Initiatives	20 Green Technology Integration 20.1 IoT for Sustainability 20.2 Autonomous Electric Vehicles 20.3 Blockchain/Transparent Supply Chain 20.4 3D Printing for Sustainable Manufact. 20.5 Space Tech for Climate Monitoring

Figure 1. TAG Climate Taxonomy

Overview of Green Building and Infrastructure

The following emerging global commercial opportunities for green building and infrastructure are covered in this report, including the listing of several viable commercial entities providing solutions on the market today:

- Sustainable architecture focuses on minimizing environmental impact by integrating energy efficiency, renewable energy, and environmentally friendly materials into building design. Key issues include balancing aesthetic appeal with functionality and the use of innovative technologies to reduce a building's carbon footprint.
- The production of traditional concrete contributes significantly to CO2 emissions. Green building materials aim to reduce this impact by using recycled materials, reducing embodied energy, and enhancing durability and recyclability. The challenge lies in sourcing materials that are both eco-friendly and comparable to traditional options.

- Transitioning to zero-emission construction equipment involves electrification of machinery, which reduces reliance on fossil fuels and lowers greenhouse gas emissions. Issues include developing battery technologies to support heavy loads, ensuring equipment reliability, and creating infrastructure for charging or fueling equipment.
- Green roofing involves the use of vegetation on rooftops to improve insulation and reduce urban heat islands. Insulation plays a role in energy conservation within buildings. Issues include ensuring long-term viability of plant life on roofs, managing water usage, and selecting insulating materials that are efficient and sustainable.
- The design of urban spaces can support sustainable living, with a focus on reducing resource consumption. Key issues include integrating green spaces, promoting public transportation and walkability, managing urban sprawl, and ensuring that developments are resilient to changing climates and can support diverse ecosystems.

Focus Area: Sustainable Architecture and Design

Sustainable architecture and design represents an approach that seeks to minimize the negative environmental impact of buildings by enhancing efficiency and moderation in the use of materials, energy, and development space. This discipline often emphasizes the adherence to principles of economic, social, and ecological sustainability. Architects and designers use strategies to reduce energy needs, harness local ecological resources, and minimize waste.

Energy efficiency is at the core of sustainable architecture, with designs incorporating features such as passive solar building design where buildings are oriented to the sun to take advantage of natural heating and lighting. Active solar technology, including photovoltaic solar panels and solar water heaters, can also be integrated into the building design to generate energy. Other energy-efficient design elements include high-quality insulation, energy-efficient windows, and the use of energy management systems.

Materials used in sustainable architecture are chosen based on their lifecycle environmental impact. This includes sourcing from local, renewable, or recycled materials that are durable and can be reused or recycled at the end of their life. The use of rapidly renewable materials like bamboo and straw can reduce the depletion of resources. Additionally, water conservation is integrated into sustainable designs through the use of greywater systems and low-flow fixtures.

Sustainable architecture also extends to the building's interior, where designers focus on creating environments that improve air quality and natural light and use non-toxic or less polluting materials. Green buildings often incorporate indoor plants and green walls to enhance air quality and provide a connection to nature.

Overall, sustainable architecture and design not only focus on reducing the carbon footprint of buildings but also aim to create spaces that are healthful and comfortable for occupants, which is increasingly recognized as crucial for the well-being and productivity of those who live and work within these spaces.

Focus Area: Green Building Materials and Concrete

Green building materials and concrete represent a progressive approach to construction that emphasizes environmental responsibility and resource efficiency throughout a building's lifecycle. One of the primary goals of green building materials is to reduce the environmental impact associated with the extraction, processing, transport, installation, maintenance, and disposal of these materials.

Concrete is one of the most widely used building materials globally, and its production is both energy-intensive and a significant source of carbon dioxide emissions. Green concrete, however, is an innovative solution that involves the use of recycled materials such as fly ash, slag, and recycled aggregate. Fly ash, a byproduct of coal combustion in power plants, can replace a portion of cement in concrete, leading to significant reductions in carbon emissions. Slag, from iron and steel manufacturing, can also be used to replace cement, providing added strength and durability to the concrete while reducing the environmental footprint.

The development of alternative binding materials to traditional Portland cement is another area of innovation in green building materials. These alternative binders can significantly reduce CO2 emissions, as they require less energy to produce and can be made from industrial byproducts or natural materials.

Green building materials also extend beyond concrete, encompassing a wide range of products like bamboo, recycled metal, reclaimed wood, and bio-based materials. These materials are selected for their lower environmental impact, considering factors like renewability, recyclability, embodied energy, and emissions during manufacture.

The use of innovative concrete technologies such as high-performance concrete, self-healing concrete, and lightweight concrete contributes to sustainability. High-performance concrete offers superior strength and durability, reducing the need for repairs and maintenance. Self-healing concrete contains bacteria that produce limestone to fill cracks that develop, thereby extending the material's lifespan. Lightweight concrete reduces the overall weight of structures, leading to savings in materials and energy.

The advancement in concrete technology and the use of green building materials represent critical steps towards more sustainable construction practices. They not only provide environmental benefits but also can lead to economic advantages by reducing material costs, improving energy efficiency, and minimizing waste.

Focus Area: Zero-Emission Construction Equipment

The transition to zero-emission construction equipment is a critical component of sustainable business practices within the construction industry. This move towards zero-emission technology is driven by the need to reduce the considerable carbon footprint of construction activities, which traditionally rely on diesel-powered heavy machinery responsible for significant greenhouse gas emissions. Zero-emission construction equipment encompasses

electric and hydrogen fuel cell-powered machinery, including excavators, loaders, bulldozers, and cranes.

Electric construction equipment operates using battery power, significantly reducing emissions at the point of use. The efficiency of these machines continues to improve with advances in battery technology, which are increasing energy storage capacity and reducing charging times. Electrification also offers the benefit of lower operating noise levels, which can reduce noise pollution on construction sites, particularly in urban areas.

Hydrogen fuel cell-powered equipment is another avenue being explored, with water vapor as the only emission. Fuel cells convert hydrogen gas into electricity, providing the necessary power for heavy machinery. While the technology is promising, the challenge lies in developing a more robust hydrogen fueling infrastructure and ensuring the production of hydrogen is itself sustainable, preferably through green methods like electrolysis using renewable energy.

The adoption of zero-emission construction equipment is also encouraged by policy changes, where emissions regulations are becoming increasingly stringent. Moreover, there is a growing market demand for sustainable construction practices, which includes the use of environmentally friendly machinery.

Focus Area: Green Roofing and Insulation

Green roofing and insulation are strategic elements in sustainable architecture that enhance a building's energy performance and reduce its environmental impact. Green roofs are part of an integrated building design which includes a layer of vegetation placed on a rooftop. They serve multiple purposes: improving thermal insulation, managing stormwater runoff, reducing urban heat island effects, and creating habitats for urban wildlife.

The layers of a green roof typically include a waterproof membrane, root barrier, drainage system, growing medium, and vegetation, which are selected for their hardiness and low maintenance needs. When implemented correctly, green roofs can significantly reduce the need for heating and cooling in a building, leading to energy savings and a reduction in greenhouse gas emissions.

In parallel, sustainable insulation options such as cellulose, wool, and advanced foam materials improve the energy efficiency of buildings. These materials are chosen for their low environmental impact over their entire lifecycle, from production through to disposal or recycling. Effective insulation reduces the energy demand for temperature control, lessens the building's carbon footprint, and can improve indoor environmental quality.

Focus Area: Sustainable Urban Planning

Sustainable urban planning is the practice of designing and developing urban areas that are environmentally responsible, socially equitable, and economically viable. It considers long-term

impacts on the environment and promotes a better quality of life by integrating development with natural features, public transport, and community amenities.

Key principles include the reduction of sprawl, promotion of mixed-use neighborhoods, and the development of green spaces. Sustainable urban planning prioritizes pedestrian-friendly and bike-friendly infrastructure, public transport systems, and the use of renewable energy sources. It also focuses on the resilience of urban areas to climate change, including the integration of climate adaptation strategies such as permeable surfaces for improved stormwater management and urban greening to mitigate heat.

The field also incorporates the principles of smart growth, which emphasizes the efficient use of land and resources. It encourages compact, transit-oriented development, and the preservation of open space and critical environmental areas. Additionally, sustainable urban planning uses tools such as zoning reforms and building codes to promote sustainable practices, like requiring green building certifications and incentivizing the preservation of natural landscapes.

By focusing on these sustainable practices, businesses and communities can contribute to the creation of urban environments that are not only environmentally friendly but also conducive to the health and well-being of their inhabitants. The overarching goal is to achieve a balance between growth and sustainability for the long-term prosperity of urban areas.

Companies and Contributions

The companies listed below emerged as part of our research at TAG Climate. Our goal in listing these fine firms is to provide a starting point for buyers, advocates, stakeholders, and researchers trying to make sense of the commercial landscape for green building and architecture as a means for driving toward a more sustainable energy future.

Sustainable Architecture and Design Vendors

1. [3DReid](#) - Designed 1 Angel Square in Manchester, an office building with the highest BREEAM rating in the UK, featuring innovative energy control and efficiency measures.
2. [Ecosistema Urbano](#) A Madrid-based group of architects and urban designers operating in urbanism, architecture, engineering and sociology.
3. [Exploration Architecture](#) - Specializes in biomimicry and regenerative design, with projects like The Sahara Forest Project that focus on sustainable solutions.
4. [Michael Green Architecture](#) - A leader in mass timber innovation, creating sustainable and innovative wooden structures.
5. [Rethinking The Future \(RTF\)](#) - Provides insights into climate-resilient design, promoting sustainable development practices such as green roofs and solar panel usage.
6. [RRMM Architects](#) - Offers comprehensive services from master planning to interior design, focusing on sustainable features and community-sensitive solutions.
7. [Studio505](#) - Recognized for designing the Pixel building in Melbourne, a 6-Star Greenstar Carbon Neutral Development office with integrated environmental systems for superior performance.

8. [Think Architecture](#) - A LEED-accredited firm specializing in passive houses and sustainable communities, employing modern energy-saving innovations.

Green Building Materials and Concrete Vendors

1. [CEMEX USA](#) - A global building materials company that provides high-quality products and reliable service, including cement, ready-mix concrete, aggregates, and related building materials.
2. [Civiconcepts](#) - Focuses on green concrete, a more environmentally friendly concrete made with waste and recycled materials like fly ash and GGBS, contributing to reduced CO2 emissions.
3. [Concrete Network](#) - Provides insights into decorative concrete flooring options that are environmentally friendly and contribute to sustainable building practices.
4. [Creative Materials Corporation](#) - A supplier of commercial tile and surface materials, offering a wide range of products with a strong focus on sustainability and American craftsmanship.
5. [Green Building Supply](#) - Specializes in eco-friendly building products, offering a wide range of non-toxic materials suitable for those with chemical sensitivities and anyone looking to create a healthier living environment.

Zero-Emission Construction Equipment Vendors

1. [Cleantech Group](#) - Highlights the emerging challenge and opportunity in decarbonizing off-road vehicles, mentioning companies like John Deere and Agco in the low- and zero-emission equipment sector.
2. [Gardenland Power Equipment](#) - Specializes in a selection of STIHL AP Series Battery-Powered Equipment designed for professional daily use, contributing to zero-emission landscaping solutions.
3. [JCB](#) - Offers a range of zero-emission construction equipment including the 19C-1 E-TEC electric mini excavator and the 1TE electric dumper.
4. [Knikmops](#) - Manufactures the KM130e electric wheel loader, contributing to the sustainable machinery market.
5. [Kobelco](#) - Offers the SK17SR mini excavator with electric capabilities, launched in the EU market.
6. [Komatsu](#) - Features the eDumper, known as the biggest electric vehicle globally, as part of its zero-emission lineup.
7. [Kramer](#) - Provides the 5055e electric wheel loader, designed for zero-emission operations.
8. [Liebherr](#) - Offers zero-emission construction machinery including the LB16 electric drilling rig and the ETM-Series electric cement truck mixers.
9. [United Rentals](#) - Offers a variety of zero-emission equipment options powered by battery, electric, or solar power, suitable for reducing carbon emissions in construction.
10. [Zero Emission-](#) Provides a range of electric excavators retrofitted by NULLUTSLIPP AS, suitable for a variety of climates and conditions.

Green Roofing and Insulation Vendors

1. [CentiMark](#) - Specializes in eco-roofing solutions including garden roofs and photovoltaics to enhance energy efficiency.
2. [GAF](#) - Known for sustainable roofing products that contribute to energy-efficient buildings.
3. [Green Roof Technology](#) - Focuses on sustainable roofing with layered green roof systems designed for efficiency.
4. [Holcim Elevate](#) - Provides roofing insulation with high energy efficiency using materials like polyiso.
5. [Insulfoam](#) - Offers a wide range of insulation products including EPS and HD composite for commercial roofing.
6. [Johns Manville](#) - Offers commercial roofing products, including insulation solutions for improved building energy performance.
7. [ROCKWOOL](#) - Offers stone wool insulation solutions with excellent thermal and acoustic performance, ideal for green buildings.
8. [Showalter Roofing](#) - Provides comprehensive green roofing services and roof maintenance expertise.
9. [Siplast](#) - Offers a variety of insulation options to meet different roofing goals, such as lightweight insulating concrete systems.

Sustainable Urban Planning Vendors

1. [American Planning Association](#) - Provides resources, strategies, and guidance for urban planning, including commercial corridor redevelopment to enhance community sustainability.
2. [Commercial Architecture Magazine](#) - Discusses essential elements of urban planning to create sustainable and livable cities.
3. [UN-Habitat](#) - Works with cities around the world using participatory planning methodologies to foster sustainable urbanization.

About TAG

TAG is a trusted next generation research and advisory company that utilizes an AI-powered SaaS platform to deliver on-demand insights, guidance, and recommendations in cybersecurity, artificial intelligence, and sustainability to enterprise teams, government agencies, and commercial vendors.

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