



Sustainability Industry Report

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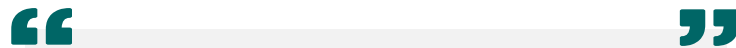
Overview: Green Urbanism



Rooted in a need for sustainable human living, green urbanism represents an essential avenue in achieving ambitious climate goals; implementing environmentally-minded strategies into cities offers substantial emissions improvements.

BACKGROUND

- Although sustainable urban design dates back centuries, the term **"green urbanism" began primarily in the 1990s** with increased attention on making post-industrial cities sustainable.
- Steffen Lehmann's chapter (2010), **"What is Green Urbanism? Holistic Principles to Transform Cities for Sustainability,"** introduces the 15 Principles of Green Urbanism, founded on three aims of **zero use of fossil fuels, zero waste, and zero emissions**
- Lehmann's principles have been widely recognized as **important guidelines in sustainable city development**, with three additional target areas of **energy and materials, water and biodiversity, and urban planning and transport**



Cities can and must become the most environmentally-friendly model for inhabiting our earth.

- Steffen Lehmann

[Enelx](#), [Health Policy-Watch](#), [Indovance](#), [Research Gate](#)

Energy and Materials

Renewable energies such as solar, wind, or biomass represent a critical element in achieving zero carbon emissions. Additionally, **utilizing local materials** to shorten building sector supply chains, **committing to zero-waste** through recycling and waste transformation, and **promoting local food** via in-city farming are key to meet goals.

Water and Biodiversity

Proper water management includes personal efforts like **rainwater collecting** to city-scale features, such as **stormwater and flood drainage systems**. Wastewater recycling convert contaminated water into useful forms and **exemplifies optimized water management**. Recycled water is used in areas from **irrigation and plumbing**.

Urban Planning and Transport

With 20% of emissions coming from transportation, making **eco-friendly transport options** like cycling, walking, and electric vehicles convenient is a primary goal for sustainable urban planning. Emissions can also be reduced by **preserving land through densification**, involving more **compact communities and living spaces**.

Health Ramifications

Experts have recently drawn **parallels between sustainable urban planning and the health of city inhabitants**, noting the **37% of heat-related deaths accounted for by climate change**. Research shows **cities with greater available green space have lower mortality rates** due to less emissions and urban heat island effect.

Key Takeaway

Prioritizing the key principles of green urbanism provides cities wide-ranging benefits, from greater efficiency and convenience to improved health conditions.

Categories of Green Urban Partnerships



Through the establishment of PPPs in green infrastructure, transportation, smart city technology, and renewable energy, cities around the globe have made significant investments to reduce emissions.

Green Infrastructure

- Cities will partner with private firms to establish **parks, green roofs, and sustainable drainage systems**, to help **manage stormwater, reduce urban heat, and improve air quality**.
- In 2021, **60%** of total private investments in infrastructure was in green projects.
- Example: In New York City, the **Green Infrastructure Plan** is a collaboration to install **green roots and bioswales** to reduce stormwater runoff.

Transportation

- Cities partner with private firms to introduce **electric buses, shared e-scooters, and bike sharing programs** to their communities to reduce traffic congestion and emissions.
- The electric bus market is expanding by over **25% monthly** and is expected to be worth **\$75 billion by 2030**.
- Example: Paris partnered with **RATP** to get electric buses to promote eco-friendly transport while Copenhagen partnered with **GoBike** to operate and maintain electric bikes in the city's bike sharing system.

Smart City Tech

- Smart city initiatives often involve private firms providing Internet of Things tech to monitor and **optimize energy use, traffic flows, and waste management**.
- The global smart cities market is excited to grow to **\$1.3 tril** by 2026, with a CAGR of **24%**.
- Example: Barcelona partnered with **Cisco** to deploy **smart sensors** across the city for **energy efficient lighting, parking management, and waste reduction**.

Renewable Energy Integration

- Cities collaborate with firms to build renewable energy infrastructure, such as **solar farms or wind power projects**. Projects that power urban areas are located both inside and outside of cities, depending on the location.
- In 2022, private companies invested over **\$114 bil** into smart city projects.
- Example: San Diego partnered with **San Diego Gas & Electric** to achieve to try to help achieve its goal of running entirely on renewable energy by 2035.

[GlobalEV](#), [GreenInfrastructure](#), [RenewableReport](#), [SmartCities](#)



Economic Benefits of Green Urbanism

Green urbanism provides significant economic benefits for private businesses through higher property values, reduced energy costs, and expanding market opportunities in sustainable products.

Increased Property Value and Occupancy Rates

- LEED-certified buildings tend to have **higher occupancy rates**, commanding up to **20% higher rent** compared to non-certified buildings. Tenants are willing to pay a premium for sustainable features.
- **The Empire State Building** underwent a **\$550 million retrofit** that earned it LEED Gold certification, reducing energy consumption by **38%**, leading to **annual savings of \$4.4 million**.

Energy Efficiency and Cost Savings

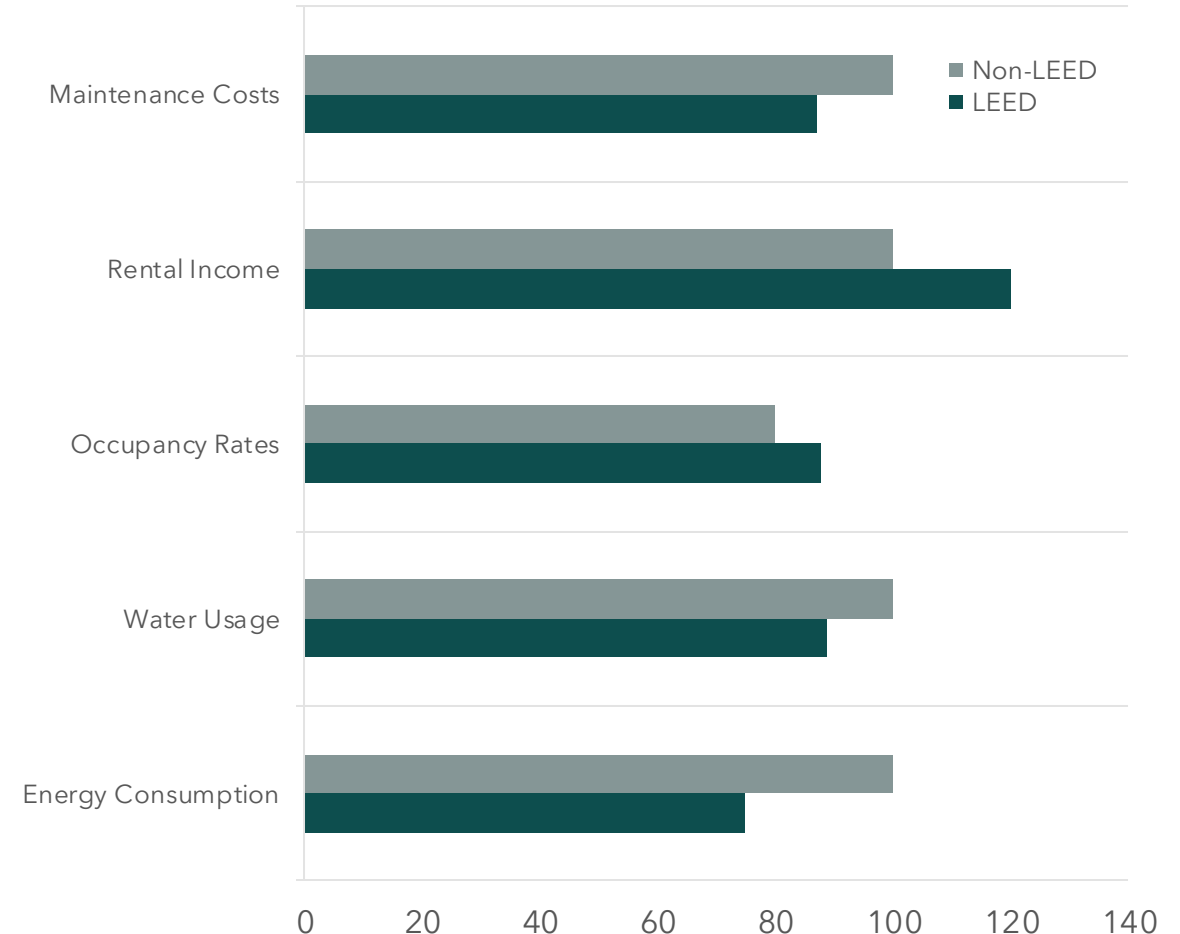
- LEED buildings typically consume **25% less energy** and **11% less water than traditional buildings**, cutting down on utility costs, benefiting businesses in the long run.
- **Adobe's San Jose headquarters** achieved LEED Platinum certification by reducing energy usage by **30%**. This equates to **substantial annual savings** on energy bills.

New Market Opportunities

- The green building materials market was valued at **\$238.91 billion in 2020** and is projected to reach **\$425.4 billion by 2027**. This growth reflects the **increasing demand** for sustainable construction products, offering businesses in this sector significant market opportunities.
- **Rockwool**, a top producer of sustainable stone wool insulation, saw over **10% annual revenue growth from 2020 to 2022**.

[Rockwool](#), [Runstad Center](#), [Ugreen](#), [US Green Building Council](#).

Comparison of Economic Benefits for LEED vs. Non-LEED



Challenges in Implementing Green Urbanism



Implementing green urbanism presents challenges for businesses due to high upfront costs, significant compliance expenses, and financial risks associated with failing to meet stringent environmental standards.

High Upfront Costs

- Achieving carbon-neutral standards in construction can result in a **cost premium of 6.2%** for **intermediate upgrades** and up to **17%** for more **advanced improvements**, such as integrating renewable energy systems and high-performance materials.
- These costs can **discourage smaller businesses** from adopting green standards **without financial incentives**.
- The **California Sustainable Building Task Force** found that green buildings generally have higher upfront costs due to the need for **specialized materials and technology**. However, they noted that these costs are often **recuperated over time** through operational savings in energy and water usage.

Compliance Costs

- According to the U.S. Census Bureau's Pollution Abatement Costs and Expenditures (PACE) survey, some pollution-intensive industries in the U.S. incur compliance costs that can exceed **\$5 billion annually**, largely driven by **pollution abatement requirements**. These costs are more substantial in sectors with older infrastructure, which may need **extensive retrofitting** to meet current standards.
- Companies in regions with stringent environmental laws, such as certain U.S. states and the EU, often face **higher compliance costs**, which include both **capital expenses** (like equipment upgrades) and **operational expenses** (such as monitoring and reporting), impacting profit margins and sometimes deterring investment in those areas.

Financial Risks

- The financial risks associated with failing to meet environmental standards are **significant**.
- In the EU, non-compliance with green regulations can lead to fines up to **€10 million or 5% of a company's annual revenue**, depending on the severity of the breach.
- In California, companies that fail to meet state environmental standards often face **costly retrofits** or **legal challenges**. Retrofits to align with green standards post-construction are **generally more expensive** than initial compliance, driving up **long-term costs**.



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Case Studies of Green Urbanism



Portland, Copenhagen, and Barcelona exemplify the potential of sustainable urban living, demonstrating how initiatives focused on water, transportation, and solar can balance reduced emissions with societal efficiency.

Portland, Oregon

Portland is a city dedicated to sustainability, with **renewable sources covering 50% of energy needs**. Portland has accomplished this feat partly through **robust water-saving initiatives**. The **Sustainable Stormwater Management Manual** details the utility of water through its entire interaction with the city, from when it falls on the roof, gets to the ground, and finally gathers under the surface. **Roof gardens, pervious pavement, and soakage trenches** are only a few examples of Portland's impressive optimization of precipitation.

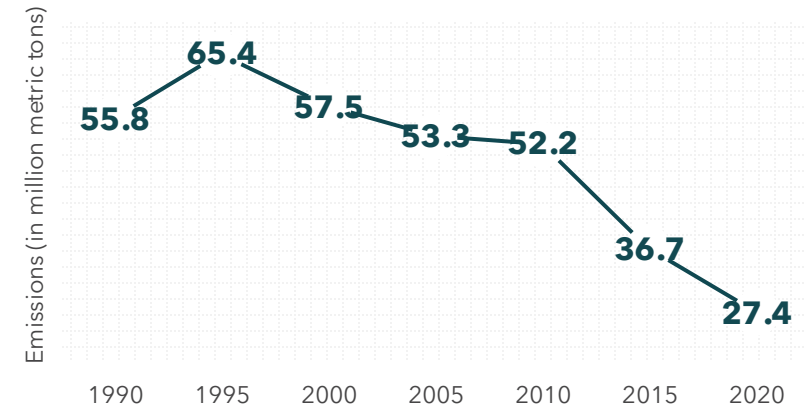
Copenhagen, Denmark

Copenhagen is known for **the Copenhagen Climate Plan**: an ambitious goal to become the **world's first carbon-neutral city** by 2025. To that end, Copenhagen has seen numerous initiatives promoting sustainable city-living, including the **Five Finger Plan**. The plan concentrates urban development along railroad lines and links suburban zones along paths to business districts and high interest areas. Copenhagen shows how **efficient transportation systems** and **environmentally-minded housing** can reduce emissions.

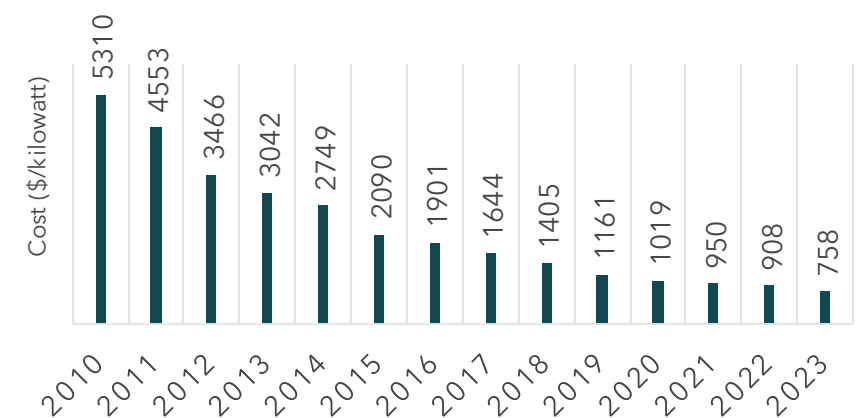
Barcelona, Spain

Barcelona has been especially effective at **incentivizing the implementation of renewable energy** applications. The **1999 Solar Thermal Ordinance (STO)**, requiring all new buildings and renovations to utilize solar power for **60% of their hot water**, has led to significant growth in the country's solar panel coverage, from **1,650 square meters in 2000 to 87,600 in 2010**. The private sector is responsible for all installation costs, which is made possible through a **4-year, 50% housing tax reduction** for private actors choosing solar technology.

Denmark Carbon Dioxide Emissions



Installation Cost for Solar PV Worldwide



[ICLEI](#), [Portland.gov](#), [City of Portland Environmental Services](#), [Spur](#), [Statista](#), [Statista \(II\)](#), [The Urbanist](#), [Urban Green Blue Grids](#), [USGS](#)

Cities with Extensive Public Private Partnerships



Both Singapore and Copenhagen have established PPPs to encourage innovation in sustainable urban development, data-based monitoring systems, and new renewable energy developments to reduce emissions.

Singapore and Copenhagen

Cities that created successful PPPs.

Singapore

- **Smart Nation Initiative**
 - Aims to transform Singapore into a smart city through the utilization of **digital technology** and IT solutions.
 - Partnered with tech companies like **Siemens, Microsoft, and Huawei** who provide expertise in **big data, cloud computing and AI** to help cities **monitor energy use, traffic flows, and environmental conditions.**
- **Energy Solutions for Sustainable Development**
 - Singapore's SolarNova program seeks to install **solar panels** on public housing and industrial buildings and partnered with private firms like **Sunseap** and **Sembcorp** to **install and maintain** these panels.
- **Water Sustainability and NEWater**
 - **Jacobs, Sembcorp** and **Hyflux** work to operate **desalination plants** and NEWater facilities, which are for Singapore's highly effective water recycling program.

Copenhagen

- **Copenhagen Cleantech Cluster**
 - The city of Copenhagen has established more than **200 partnerships** with private clean tech firms to help foster **collaborative innovation** in sustainable urban development.
- **Copenhill (Amager Bakke)**
 - Copenhill is a waste energy plant that was developed through a PPP with **Amager Resource Center** and Copenhagen. Copenhill **converts waste into energy** for **150,000 household** and reduces landfill waste.
- **Energy Lab Nordhavn**
 - A living lab for green energy solutions that has partnered with **Danfoss, ABB**, and other tech firms to **support energy efficiency** and **smart grids.**
- **Offshore Wind Farms**
 - **Ostred**, a Danish energy company, partnered with the city of Copenhagen to **construct offshore wind farms** that provide renewable energy to the city and are a key part of Copenhagen's strategy to achieve carbon neutrality by 2025.

[Copenhagenn \(I\)](#), [Copenhagen \(II\)](#), [Copenhagen \(III\)](#), [Singapore \(I\)](#), [Singapore \(II\)](#)



Section 1: Green Cities

Section 2: Canadian Initiatives

Vancouver Arbutus Greenway Program Analysis



Through persistent efforts from Vancouver, the city was able to develop a large greenway that enhanced biodiversity and promoted active transportation with the support of private partners for design.



Summary of Arbutus Greenway

Arbus Greenway transformed a former railway corridor into a **nine-kilometer greenway** for walking, cycling, and future light rail transit. Vancouver awarded **\$2.5 mil to PWL Partnership Landscape Architects** to design the project. The project added **42 acres** of new greenspace to the city. The development enhances biodiversity, promotes **active transportation, and provides significant recreational areas.**



Challenges

Vancouver struggled to purchase the land from the Canadian Pacific Railway for over a decade, before purchasing the corridor for **\$55 million**, paying in phases to spread costs out over time. After this, Vancouver faced the challenge of designing the corridor to be satisfactory to different resident demands. Eventually, they created a **complex design with lanes for both cyclists and pedestrians.** They also created plenty of recreational spaces. Additionally, they implemented soil remediation efforts to prepare land for green space and remove contaminants.

Arbus (I), Arbus (II), Arbus (III)

Laneway Housing Initiative Analysis



The Laneway Housing Initiative utilized partnerships with private firms to address regulatory and compliance challenges and make building laneway housing more affordable and appealing.

Summary of The Program



Vancouver's Laneway Housing Initiative aims to **increase urban density** by enabling **secondary homes to be built on existing single-family lots**. The program encourages homeowners to build compact, eco-friendly units onto their properties, creating more housing options without urban sprawl. Since its launch in 2009, over **3,300 laneway homes** have been built.

Regulatory & Compliance Challenges



Vancouver's **complex zoning laws** and **permit regulations** led to building delays. In response, the city **revised zoning bylaws** and streamlined the permit process. Additionally, Vancouver set ambitious green building standards that made compliance challenging. **Lanefab Design/Build**, which specializes in solar laneway housing, offers support to homeowners to **design** quality and energy-efficient laneway homes.

Affordability & Engagement Challenges



Vancouver's high **land and construction costs** initially discouraged laneway home development. In response, the city partnered with **private builders** to offer affordable **modular and prefabricated options**. Vancouver also engaged companies like Smallworks to provide **consultations and showcase model homes**, highlighting the unseen benefits of laneway housing.

[Lanefab](#), [Laneway \(I\)](#), [Laneway \(II\)](#), [Laneway \(III\)](#), [Laneway \(IV\)](#), [Smallworks](#)

Canada Line Program Analysis



The Canada Line faced significant challenges in the form of funding the Canada Line in Vancouver and unexpected demand for the public transportation system. Vancouver utilized private partnerships to finance these challenges.

1 Canada Line Explained

- The Canada Line is a **rapid transit system** that was developed through a PPP with the Government of Canada, British Columbia, the airport authority, TransLink, and InTransitBC. This collaboration resulted in a projected completion both **on budget** and **ahead of schedule**.
- The project has significantly enhanced public transportation options and reduced traffic congestion. The Canada Line reached **100,000 daily riders** by 2010 and over **150,000 by 2019**. The line reduces **20,000 tons of CO2 emissions annually**.

2 Funding Challenges

- The Canada Line cost **\$2.05 bil**. In order to secure this funding, Vancouver partnered with **InTransitBC**, which covered part of the costs for operational rights. The line got additional support from **federal, provincial, and airport authorities**. These partnerships made clear performance standards necessary to ensure quality and accessibility as they had to balance public service goals with private profitability needs.
- Local business owners **won a lawsuit** against Translink, but the private partnerships helped cover the costs.

3 Overcrowding Challenges

- The Canada Line was initially designed with a **short train length and limited capacity** to reduce costs, but it became apparent that the demand for this public transportation was higher than suspected, so the line became **overcrowded**, especially during peak hours.
- To address this, TransLink **increased the frequency of trains** and tried to expand the train, but it wasn't possible due to increased costs because the original design was complete, but this is something to be aware of. It is easier to have a train that is too long than to extend a train that's too short.

[*The Canada Line \(I\), The Canada Line \(II\), The Canada Line \(III\)*](#)



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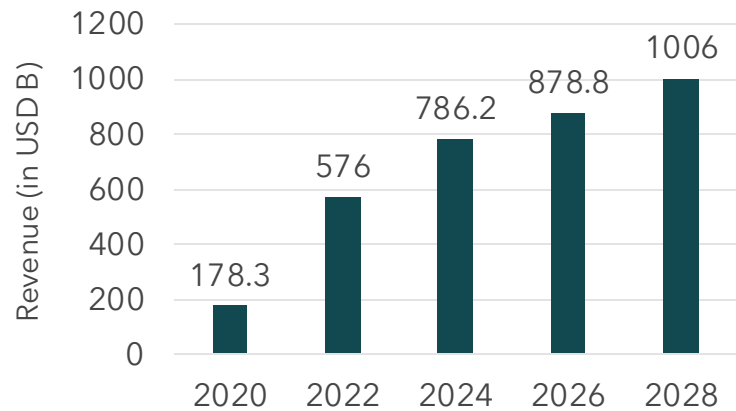
Section 3: Key Takeaway

Green Transportation Overview



Green transportation seeks to minimize emissions from the transportation sector by producing a wide range of approaches involving electric vehicle usage, walking, and cycling as primary focuses.

Expected Global Revenue of Electric Vehicles



-74%

In Europe, **medium-sized electric vehicles** registered in 2030 are **estimated to contribute 74% less in greenhouse gas emissions** than regular gasoline-powered cars of comparable size, expressing the **potential of properly implemented EV adoption**.

[Cyber Switching](#), [Modeshift](#), [Nature](#), [Science Direct](#), [Statista](#), [US News](#)

Electric Public Transport

The **electrification of public transport systems** are a high-potential avenue for minimizing emissions. Rather than prioritizing individual carbon factors, targeting **higher-capacity automotives** is more efficient for sustainability measures. From 2018 to 2021, US transit battery electric buses **increased in use by over 112 percent**.

EV Charging Networks

Electric vehicle charging stations are an attractive choice among environmentally-concerned politicians and society members seeking to minimize pollution. While the popularity of EV is promising, it is important stations are **powered by renewable energy sources** to avoid an adverse effect on transport carbon emissions.

Bike-Sharing

Bike-sharing may be an effective system to promote sustainable transport; however, ensuring the readiness of cities through **proper lane management and pedestrian space** is crucial prior to implementation. Additionally, **cultural preferences must be considered**, as actors must prefer bikes over cars in traveling short distances.

Social-Minded Infrastructure

Narrow streets, larger pedestrian zones, and separate bike and scooter lanes from sidewalks are all measures helpful to promoting a **social aspect in urban living**. Cultivating a **sense of community contributes greatly** to lessening a city's carbon footprint by encouraging walking and biking over automobiles among its residents.

Key Takeaway

Electrifying existing transport systems and encouraging the use of alternatives to emissions-contributing vehicles are the main methods of green transportation.

Green Transportation Implementation



Major incentives for green transport implementation include ESG requirements and financial bonuses, with many successful initiatives stemming from efforts supported both publicly and privately.

Corporate Sustainability Initiatives

ESG requirements push the adoption of innovative and sustainable methods in the corporate space, including green transportation. Major polluters like Amazon and Ikea have pledged to **dramatically reduce emissions by adopting EV vehicles** in deliveries and ensuring proper infrastructure such as charging stations at centers.

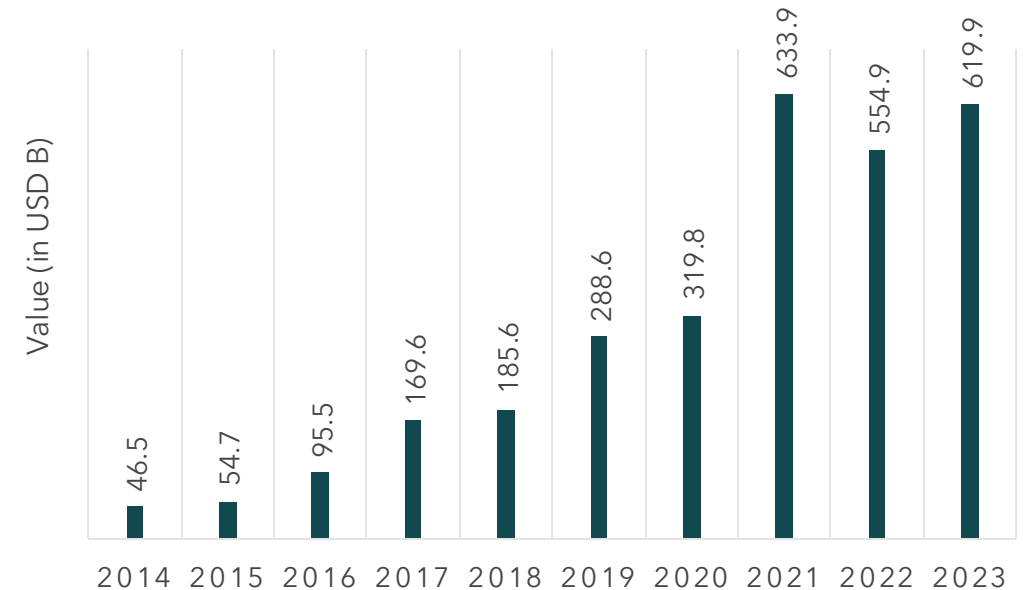
Green Fiscal Measures

Initiatives like the **US Inflation Reduction Act and Norway's VAT exemptions** for electric vehicle adoption have been successful in **incentivizing market growth for clean technologies**. 87% of Norway's new car sales are EVs. These examples support **green financing as an effective method** of achieving sustainable goals.

Public Private Partnerships

In lieu of working separately, **public and private actors may collaborate directly** to promote green transportation efforts. Before 2022, a PPP between Copenhagen and Bycyklen utilized **tax revenue to manage CityBikes**, the city's predominant bikeshare. This system contributed to **Copenhagen's robust cycling culture**.

Growth of Green Bonds Value Over Time



Key Takeaway

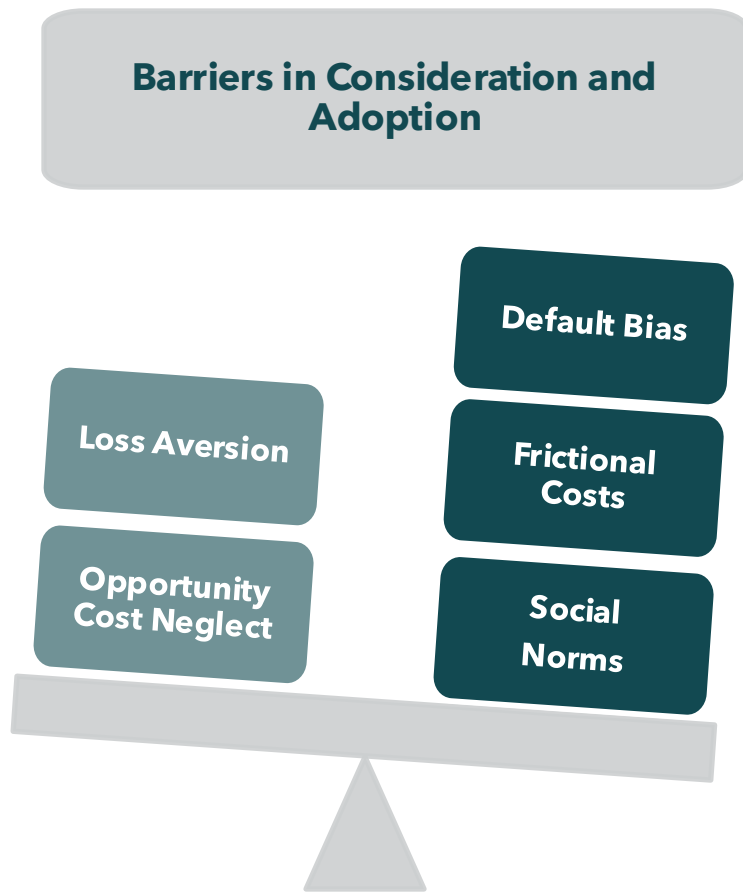
The most effective methods to implement green transport initiatives involve some degree of government involvement working in synergy with private actors, particularly in the use of public funding.

[Amazon](#), [Civitas](#), [Ikea](#), [PWC](#), [Statista](#)

Social and Psychological Barriers in Green Transport



Across relevant scientific literature, the most compelling behavioral explanations for opposing green transportation can be broken down into hindrances in considering solutions versus adopting solutions.



Loss Aversion

People are biased to **weigh losses heavier over equivalent gains**, resulting in an **avoidance of risk and potentially beneficial actions**. When choosing between modes of transport, an individual may prefer the control of driving over the **unpredictability and dependence of public transport**.

Opportunity Cost Neglect

Individuals often neglect to consider the **hidden sacrifices of choosing an option** when comparing choices. In the **context of single-occupancy vehicles**, these neglected sacrifices could include invisible costs such as **electronic toll collection or parking fees deducted from a paycheck**.

Default Bias

A **tendency to stick with defaults over taking extra actions** also relates to green transport. For example, a company offering free parking as a default and requiring paperwork to receive rebates for public transport **implicitly encourages the seemingly easier option** of parking without cost.

Frictional Costs

In general, people are likely to do **whatever is most convenient and requires the least amount of effort**. Unless a sustainable option aligns with convenience and ease of use, **potentialities like unpredictability and bad weather** will effectively **discourage individuals from choosing green**.

Social Norms

People are highly influenced by the perceptions of those around them; **identifying social factors is crucial to understanding patterns** in green transport usage. In America, modes of transport other than driving may possess a **negative social stigma for being associated with a lower income** class.

Behavioral Science and Policy Association

Private Sector Engagement and Key Findings



The private sector is relevant in the areas of public-private partnerships, private investments, and compliance with sustainability goals; urban living, convenience, and educational efforts appear key for effective green transportation.

Public Private Partnerships

- Public Private Partnerships are integral to the growth of green initiatives, with **funding from the government and private expertise** each being necessary for successful interventions.
- Creating a good PPP contract requires **heavy consideration of risk allocation** between the parties and includes an **organized process for unforeseeable circumstances** for added flexibility.

ESG and Private Equity

- ESG has become **increasingly important in investment decisions** over recent years; private equity firms, in overseeing portfolio companies, have an avenue to bolster ESG investing.
- With **ESG becoming a competitive differentiator**, PE firms have **optimal leverage to promote sustainability** compared to public market investors, who comparatively lack information.

Market Integrity

- The Roadmap for a Sustainable Financial System from the World Bank and UNFP claims **private financial markets must change to adopt sustainability standards**.
- Prompting **private sector behavior aligned with reducing emissions and environmental targets** is a priority for ensuring the success of long-term efforts to meet climate goals.

Holistic Consideration of Urban Living

- **Considering walkability and people centers** are needed in encouraging sustainable transport.
- **Simultaneous interventions are most effective**, such as bike-sharing with pedestrian zones.

Convenient Alternatives to SOVs

- **Making green options convenient** is essential for **positive support and widespread usage**.
- Major psychological obstacles to sustainable transportation **centered around frictional costs**.

Advocacy and Public Perception

- Social norms and public perception are **integral considerations** in promoting green transport.
- Behavioral nudges **informing individuals of emissions levels** were found successful.

Key Takeaway

Private actors engage with green transportation through PPPs, financing, and sustainability standards.

[Earth.org](#), [Harvard Business Review](#), [Medium](#), [Sustainable Development.un](#), [UNEP](#), [World Bank.blogs](#), [World Economic Forum](#)

Emerging Interventions and Future Trends



Prominent technologies in green transportation include renewable-powered transit, autonomous vehicles, and smart traffic management; wide legislation, robust EV infrastructure, and a prominent ride-sharing culture appear imminent.

Renewable-Powered Transit

Biofuel and hydrogen vehicles are two renewable options in powering vehicles; these options are promising avenues in **long-haul transport**, such as shipping and aviation. Additionally, **hydrogen-powered buses and trains** have begun working internationally, with fuel-cell buses in Washington and a zero-emission train in Berlin.

Autonomous Vehicles

Experts claim autonomous vehicles (AVs) will eventually dominate the transportation sector; AVs are a promising measure for **increased safety in society and reduced emissions** from replaced single occupancy vehicles. However, like EVs, the **source of power for AV batteries** is a key consideration for judging environmental effects.

Smart Traffic Management System

Smart traffic management systems improve emissions by **reducing congestion and traffic**. The intelligent traffic management system market is expected to grow to **\$19.91B by 2028 at a CAGR of 10.1%**, and estimates predict the technology could **cut emissions by 205MMT by 2027**, demonstrating tremendous promise.

WIDE LEGISLATION

Legislation determines the success of sector improvement. **Mobility interfaces on the communal level to infrastructure projects on the state and national level** may prompt widespread reductions.

EV INFRASTRUCTURE

EV charging networks are predicted to expand significantly. Since 2020, the **number of publicly available charging stations has doubled**; significant public funding will continue this trend.

RIDE-SHARING

Ride-sharing platforms **reduce congestion and the number of single occupancy vehicles (SOVs)**. By providing an option for non-car owners, ride-sharing systems effectively cut emissions.

Key Takeaway

While legislative efforts, greater support for EVs, and ride-sharing platforms appear on the horizon, renewable-powered transit, autonomous vehicles, and smart traffic management are emerging technologies in the status quo.

Climate Foresight, Earth.org, Environmental and Energy Study Institute, Federal Highway Administration, Lithon, Oliver Wyman, Symmetry Electronics, The Urbanist



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Case Studies: Green Transportation



Green initiatives have transformed the cities of Melbourne, Boston, and Barcelona to promote innovative and effective transportation, enhancing public life while contributing to climate goals.

“Places for People”

Melbourne, Australia

- Since the implementation of the 1985 Strategic Plan, the “Places for People” report has highlighted **key trends in Melbourne’s urban environment and transportation**.
- With the addition of **widened footpaths and promenades**, Melbourne saw a **39% increase in positive pedestrian traffic** daytime and 98% nighttime between 1993 and 2004.
- Additional **measures of convenience**, such as public restrooms in central mediums, lunchtime street closures, and accessible seating planters, have **further improved walkability**.
- Melbourne exemplifies how seemingly small urban developments can have **lasting, positive returns on lifestyle**.

The “Big Dig”

Boston, Massachusetts

- The “Big Dig,” America’s grandest highway project, exemplifies how **effective transportation can radically improve carbon emission levels and quality of life** in urban areas.
- Rerouting the Central Artery highway into an underground tunnel resulted in a **62% decrease in total vehicle hours** and **12% drop in carbon monoxide levels** across Boston.
- Freed land previously devoted to the interstate was used to create a **plethora of parks and green spaces** and **restore shoreline projects** such as the Charles River Basin and Fort Point Channel.
- Boston underscores the importance of **large-scale transportation evaluation**.

“Superblocks”

Barcelona, Spain

- By **limiting roads for through traffic**, Barcelona creates superblocks, urban spaces **bigger than normal blocks but smaller than neighborhoods**, which serve as social centers and green zones.
- **Structurally differentiating traffic and pedestrian areas** allows greater optimization of sustainability solutions to **ensure maximum effectiveness** without concerns of walkability.
- Utilizing **superblocks to control for transportation**, Barcelona **improved in achieving permeability goals** and initiative-focused **green area requirements**.
- Barcelona proves how creative measures can strike a **balance between sustainability goals and functionality**.

Case Studies: Nudging for Green Transport



Analyzing examples of financial, social, and informative nudging underscores a seemingly small motivating factor provided in interventions to successfully encourage the use of green transport options.

Weekly Bus Lottery



- The city of Durham, NC, rewarded city employees **choosing the bus over driving alone** the chance to win a **weekly cash prize**.
- Surveys of employees taking the bus showed **increased happiness and lower stress levels** during the intervention testing period.
- The bus lottery resulted in a **19% increase among employees commuting by alternative transport** than by car; this result was so promising, Durham was awarded **\$1 million in funding to implement** these interventions over time.

Personalized Travel Plan



- A study that investigated the **extent to which social norms impacted green transportation** found that **personalized travel plans** encouraged greater usage.
- The plan **presented alternatives to car travel** in addition to a persuasive message regarding sustainable transport. It then **required individuals to report their choice** between a car or sustainable alternative.
- Results found that **awareness of ecological harms** along with a **sense of responsibility** were conducive to green transport.

Enterprise



- The San Francisco Municipal Transportation Agency sent **targeted messages to employees encouraging sign-ups** for a public transportation benefits program.
- The intervention was designed to **combat opportunity cost neglect** by emphasizing **underrecognized benefits of public transportation**.
- There was a **statistically significant 23% increase in likelihood** for employees who learned about the **benefits such as financial savings and time savings** through the agency's postcards.

Case Studies: Digital Initiatives to Promote Green Transit



Digital interventions have been successful at incentivizing heightened usage of green transportation systems in a variety of ways; increasing convenience appears to be a common and critical attribute in achieving results.



Carpool Program Auto-Enrollment

- The Oregon Department of Transportation encouraged usage for a new carpooling tool by **auto-enrolling citizens to maximize ease of use**.
 - Since people would **automatically possess an account**, usage would increase.
 - Results showed a statistically-significant **improvement from 3.9% to 5.9%** in usage; those who created an account themselves were more likely to use the app long-term.
-



Mobile Navigation Applications

- “Mobility-as-a-Service” is a **digital platform serving as an accessible travel planning and payment system** encouraging the use of bikes and public transport.
 - In Beijing, the platform has reduced carbon by nearly **400K metric tons** in five years.
 - While countries around the world have taken to mobile navigating hubs, integrating **walking, bike-sharing, and public transit** is critical to progress usage goals.
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Email Notifications

- A southern university assigned a **personalized route tool** to approximately 4,000 residents in and around campus to improve usage of sustainable transport systems.
 - The tool shared **benefits to alternative measures** to public transport, such as **money, calories, and emissions saved** by opting out of conventional measures.
 - The tool itself was found ineffective; however, **combined with email notifications**, there was a **7.2% decrease in single driving**, suggesting effective email notices.
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[Behavioral Science and Policy Association](#), [Nature](#), [World Resources Institute](#)



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Key Takeaways: Green Transportation



Green transportation aims to reduce emissions from the transportation sector, while improving public quality of life as shown in case studies and providing corporate ESG benefits for private companies.



TRENDING MODES OF GREEN TRANSPORTATION

- Currently, **electric public transport, EV charging network stations, bike-sharing systems, and social-minded infrastructures** are being implemented with the rise of green transportation.
- Green transportation is **primarily being implemented in urban areas where traffic and air quality are prevalent concerns**, and cleaner transportation has the potential to greatly improve public quality of life compared to the use of emissions-heavy vehicles.



CASE STUDY FINDINGS

- Green initiatives have revolutionized **transportation in cities like Melbourne, Boston, and Barcelona**, fostering innovation and efficiency, improving public life, and advancing climate goals.
- Studies show that the quality of life in these cities improved in terms of **footpaths and traffic, restored shorelines, nicer parks and outdoor spaces, surface permeability, and improved air quality**.



PRIVATE IMPLEMENTATION

- The most effective ways to implement green transport initiatives require a **collaborative effort between the government and private sector**, with a particular focus on leveraging public funding.
- Private companies can benefit from implementing green transportation initiatives by **reducing operational costs through energy efficiency, enhancing brand reputation, attracting environmentally conscious customers, and gaining government bonuses**.

[Cyber Switching](#), [Modeshift](#), [Nature](#), [Science Direct](#), [Statista](#), [US News](#)



Section 1: Green Urbanism Overview

Section 2: Case Studies

Section 3: Green Transportation

Section 4: Private Sector

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Innovative Sustainable Design Projects



Lendlease has worked on nearly 500 development projects since its founding in 1958, with some recent highlights incorporating geothermal heat exchange systems, rooftop gardens, recycled water, solar panels, and living shorelines.

Key Projects

1 Java Street

- The residential building project includes over **800 apartments**, with 30% designated as affordable housing under the New York Housing Program.
- The all-electric property will be the **largest residential project in New York State to use a geothermal heat exchange system**.
- The building is projected to **reduce annual carbon emissions from heating and cooling by 53%** compared with typical residential systems.

CLIENT

Equity Partner

LOCATION

New York, United States

VALUE

\$865 mil USD

COMPLETION

Estimated 2026

Barangaroo Precinct

- The waterfront precinct is commercial and residential, incorporating **rooftop gardens and bees to support biodiversity and air quality**.
- The commercial development utilizes **cross laminated timber buildings** as well as renewable energy sources to create a carbon neutral precinct.
- Also, **on-site water recycling, centralized cooling using water from Sydney Harbour, and 6,000 square meters of solar panels** offset energy usage in the public domain.

CLIENT

NSW Government

LOCATION

Sydney, Australia

VALUE

\$6.7 bil USD

COMPLETION

2024

Clipperside Wharf

- The masterplan includes both apartments and condominiums, with **478 residential units** and restaurant and recreational uses at the ground level.
- The development has a **living shoreline with salt marsh terraces, bracketing the tides**, and a **wetland community** for flora and fauna.
- Residential units earned **LEED Platinum certification and ENERGY STAR certification** in 2022 due to its energy and water use reduction.

CLIENT

Aware Super

LOCATION

Boston, United States

VALUE

\$270 mil USD

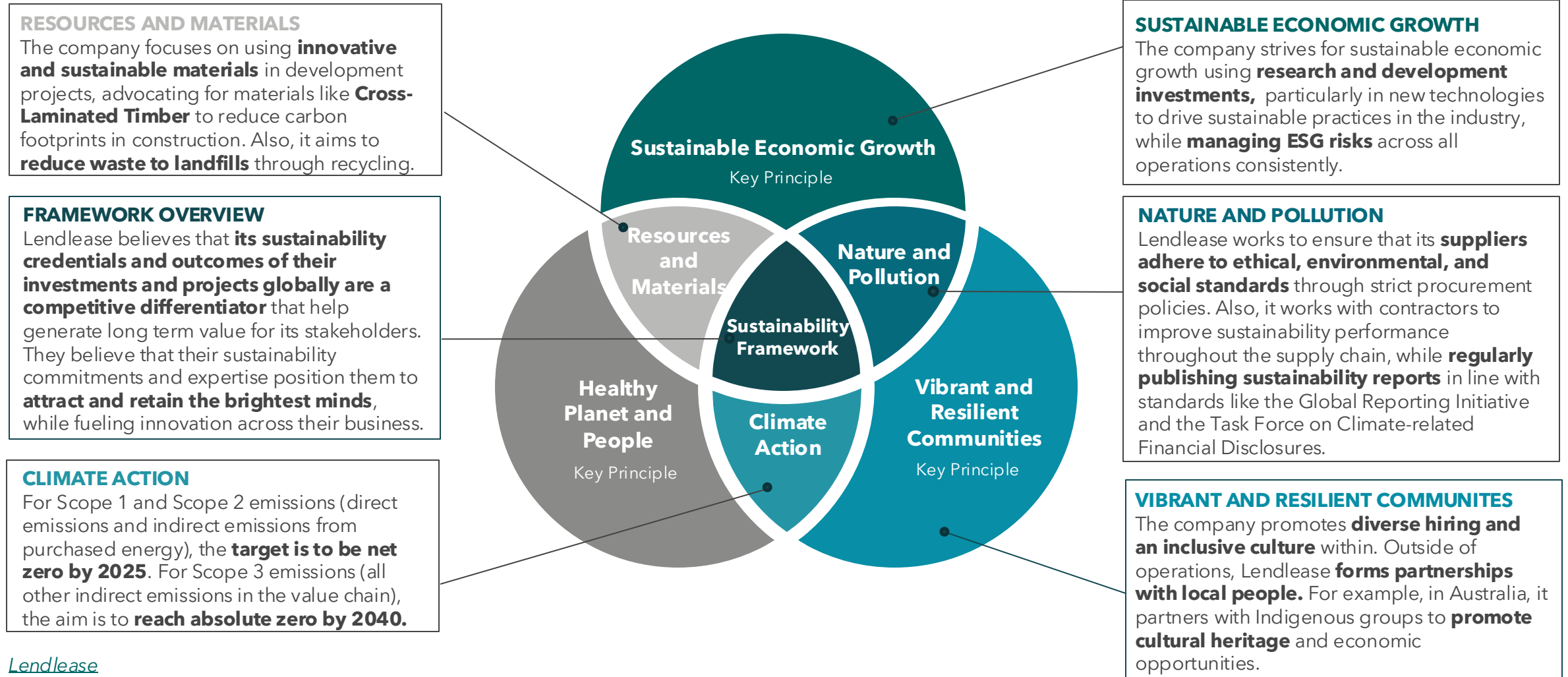
COMPLETION

2021

Sustainability Framework Breakdown



Sustainability at Lendlease is guided by a multi-faceted Sustainability Framework involving economic growth, resilient communities, and a healthy planet, with the aim of creating \$250 million of social value by 2025.



[Lendlease](#)

Challenges in Sustainable Private Development



While striving for environmentally-friendly private development, Lendlease faces challenges of navigating diverse environmental policies globally, weighing the cost of sustainable investments, and balancing societal differences.

Diverse Regulatory Policy

- Each country or region where Lendlease operates has its own **environmental laws, building codes, and sustainability standards**.
- These **standards can differ significantly in terms of stringency, focus areas, and enforcement**.
- Also, uncertainty about potential future policy changes and political instability can lead to **abrupt shifts in environmental regulations, affecting long-term projects**.
- Lendlease can find it challenging to apply a consistent sustainability framework globally, leading to **variations in environmental performance across projects**.
- Finally, legal complexities increase operational risks, which must be carefully managed to avoid **repercussions like fees and project delays**.

Costly Investments

- Sustainable materials and technologies often have **higher initial costs compared to traditional options**.
- These costs include expenses for **energy-efficient systems, renewable energy installations, and sustainable building materials**.
- The financial benefits of sustainability measures, such as energy savings or increased property values, may be realized over a longer term, which can be a **deterrent for investors focused on short-term gains**.
- **Convincing investors, clients, and shareholders of the long-term value** of sustainability can be challenging, especially if they prioritize immediate financial returns.

Societal Differences

- **Sustainability may not be a top priority in all regions** due to cultural, economic, or social factors, so some markets may have limited awareness or interest in environmental issues.
- In some areas, there may be a **shortage of skilled professionals or suppliers** who understand and can deliver sustainable solutions, so Lendlease appears to mostly focus developments in some countries.
- Though Lendlease can invest in **educating and engaging with local communities** and stakeholders to build support for sustainable initiatives, this is an additional investment for the company.
- Ultimately, **lack of demand for sustainable buildings can make it difficult to justify the additional costs** associated with green design and construction.

[Lendlease](#), [Science Direct](#), [University of Chicago](#)



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Hammarby Sjöstad Project



The Hammarby Sjöstad Project successfully reduced energy use by 50% and created an almost completely renewable energy district through establishing a complex, well-structured network of partnerships.

Program Summary

- Hammarby Sjöstad is a **large-scale urban redevelopment initiative** that transformed a former industrial zone into a **sustainable residential area**.
- The City of Stockholm led the strategic development of the area, dividing it into 12 sub-neighborhoods developed in phases to **facilitate coordinated planning and implementation**.
- Over 30 developers and 30 architectural firms were involved in this project. Notable developers include Skanska, which focused on **innovating green construction methods**, and JM AB, which delivered energy-efficient residential buildings.

Measurable Impact

- The program **reduced energy use by 50%** compared to typical 1990s neighborhoods, with **90% of household waste being recycled** or used for energy production.
- Fortum was responsible for developing a district heating and cooling system that utilized renewable energy sources like biofuel and waste-to-energy plants and integrated solar panels and fuel cells into the energy grid.
- **40% of stormwater from the area is reused** or treated through green infrastructure. Stockholm Vatten was responsible for the efficient management of water resources in the project.

Challenges

- To address the challenge of coordinating the involvement of over 30 developers, architects, and utility companies, the city established a **central project management team** to oversee planning and ensure alignment with sustainability goals across projects.
- To address the challenge of addressing energy, water, and waste to maximize sustainability and minimize environmental impact with one project, Stockholm created the **Hammarby Model**, an **integrated circular system** that closed the resource loop ensuring that waste and **by-products from one system became inputs for another**.

[The Nature of Cities](#), [Urban Design](#), [Urban Green](#)

Stockholm Royal Seaport



The Stockholm Royal Seaport established a number of partnerships with different organizations for a variety of purposes that helped the city build and maintain the Seaport.



The Program

- The Stockholm Royal Seaport transformed a former industrial and port area into a **sustainable mixed-use neighborhood**.
 - The area incorporates green buildings, renewable energy systems, and smart transportation infrastructure with a goal of creating a **fossil-fuel-free district** by 2030.
 - The area has created **housing for 12,000 residents** and **workspaces for 35,000 people**. Additionally, 16% of car parking spaces in garages have charging facilities.
-



Private Partnerships

- Stockholm partners with private real estate developers who are responsible for constructing residential and commercial buildings to meet environmental standards.
 - Partners like Skaanska and VasaKronan created **green office spaces** and innovation in sustainable building materials.
 - Technological companies like **Ericsson** and **ABB** provide **smart city technologies** for energy management and storage and grid optimization. In 2023, the district produced **664 MWh of solar energy**.
-



Challenges

- The project had **extremely high development costs** due to the sustainable infrastructure, energy systems, and green technologies.
 - To address this challenge, the city utilized **public-private partnerships** to **share financial risks** and attract private investments.
 - Stockholm struggled with getting the residents and businesses in the district to adopt sustainable practices. Through **public education campaigns**, waste collection systems, and extensive public transport infrastructure, the issue was addressed.
-

[Norrad \(I\)](#), [Norrad \(II\)](#), [Norrad \(III\)](#), [Norrad \(IV\)](#), [Norrad \(V\)](#), [Norrad \(VI\)](#), [Norrad \(VII\)](#), [Stockholm](#)



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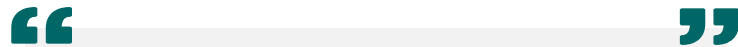
Sustainability Profile



Adobe demonstrates strong sustainability leadership by reducing environmental impacts through innovation, achieving renewable energy goals, fostering transparency, and supporting community initiatives.



- Adobe Headquarters in San Jose is the **first all-electric building** of its scale in Silicon Valley powered entirely by **renewable energy**.
- Adobe publishes annual **CSR reports** detailing its sustainability efforts and progress.
 - The **2022 report** highlights **achievements** in renewable energy usage, waste reduction, and community investments.
- Adobe has been named to the **Dow Jones Sustainability Index (DJSI) World** for multiple years, reflecting its **leadership in corporate responsibility**.
- Adobe **collaborates** with organizations to advocate for **sustainable practices & transparency**.



At Adobe, we believe that we have an obligation – to our employees, our communities, our investors, our customers, our partners and the environment – to operate our business sustainably.

[Adobe \(I\)](#), [Adobe \(II\)](#)

Product Innovation

Adobe's tools enable customers to **minimize environmental impacts** by **reducing paper usage** and **facilitating digital workflows**. **Adobe Document Cloud** helps avoid significant water consumption, waste, and CO₂ emissions associated with traditional paper-based processes.

Operational Efficiency

Adobe has committed to powering its global operations with **100% renewable electricity by 2025** and achieving **net-zero carbon emissions by 2050**. The company has set targets to reduce absolute **Scope 1 and 2** greenhouse gas (GHG) emissions by **42%** and **Scope 3** GHG emissions per unit of value added by **52% by 2030**.

Collaborative Partnerships

Adobe collaborates with organizations like the **Clean Energy Buyers Association** and **Ceres** to **advocate for sustainable policies** and practices across industries. The company also **encourages its suppliers** to set science-based climate targets and **improve transparency** in environmental disclosures.

Community Engagement

Adobe actively engages in local communities through **employee-led programs** and **partnerships with nonprofit organizations**. In 2023, Adobe employees contributed over **200,000 volunteer hours** to various causes, including environmental sustainability initiatives aimed at making cities greener.

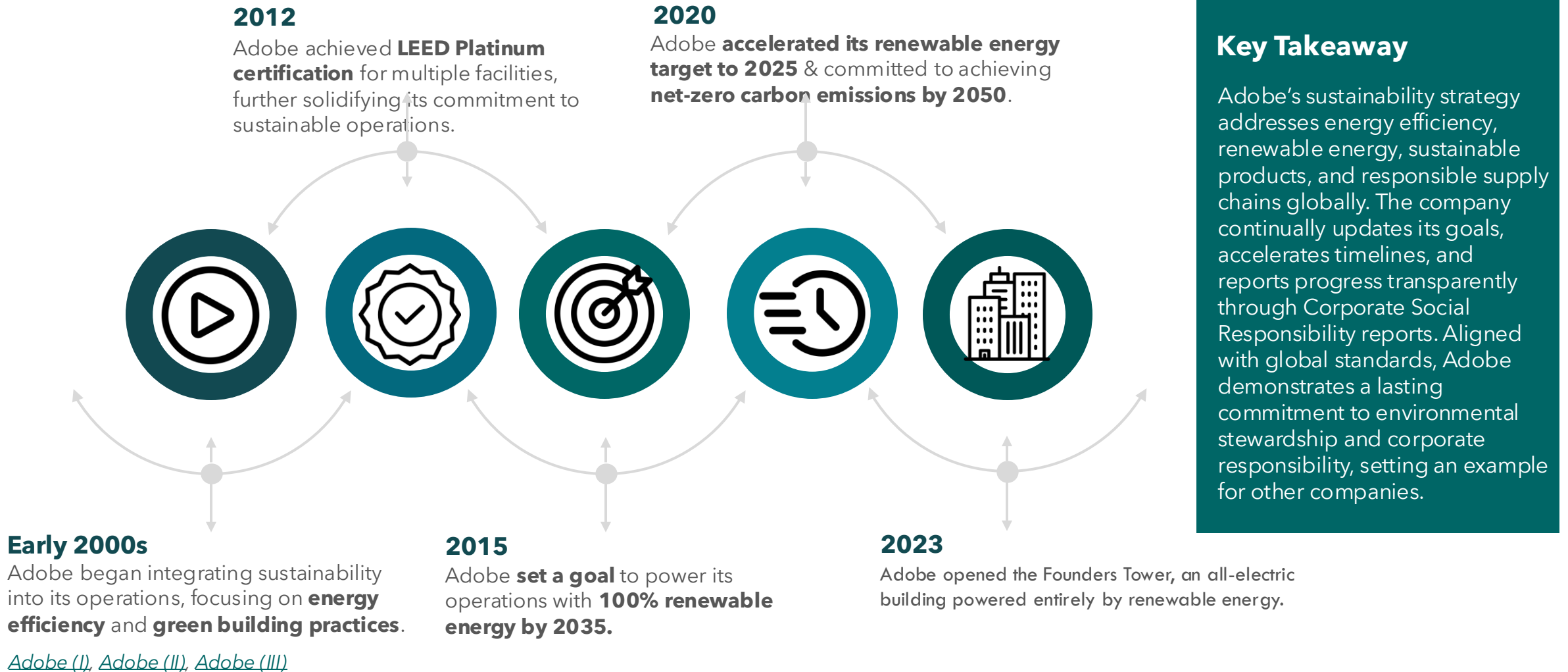
Key Takeaway

Adobe advances sustainability through digital innovation, operational goals for renewable energy and emissions reduction, partnerships for transparent environmental practices, and active community engagement focused on green initiatives.

Sustainability Timeline



Adobe's sustainability journey has progression demonstrates a long-term dedication to sustainable operations, setting an example for other companies, especially those in the Silicon Valley.



Key Takeaway

Adobe's sustainability strategy addresses energy efficiency, renewable energy, sustainable products, and responsible supply chains globally. The company continually updates its goals, accelerates timelines, and reports progress transparently through Corporate Social Responsibility reports. Aligned with global standards, Adobe demonstrates a lasting commitment to environmental stewardship and corporate responsibility, setting an example for other companies.

Sustainability Strategies



Adobe's seven sustainability strategies demonstrates a comprehensive commitment to environmental and social responsibility, organizing a structured approach to their sustainability goals.



Adobe (I), Adobe (II), Adobe (III)



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Sustainability Plans



Microsoft is committed to sustainability through innovative solutions, goals to reduce environmental impacts, and long-term efforts to achieve carbon negativity, water positivity, and zero waste.

19.8 GW

Microsoft increased its contracted portfolio of renewable energy assets to more than **19.8 gigawatts (GW)** across **21** countries, including a landmark agreement with Brookfield Asset Management to develop over **10.5 GW of new renewable energy capacity**, marking **one of the largest corporate renewable energy deals**.

\$200 million

In September 2023, Microsoft announced a **\$200 million purchase of carbon credits** from Heirloom Carbon, a company specializing in direct air capture and carbon sequestration. This initiative is expected to **offset 315,000 metric tons of carbon dioxide over ten years**.

\$1 billion

Microsoft established a **\$1 billion Climate Innovation Fund** to accelerate the **development and deployment of new climate technologies**. The fund focuses on investments in areas such as carbon reduction, water, waste, and ecosystems.

2025: Protecting Ecosystems

Microsoft is committed to **protecting more land than it uses by 2025** and is developing a Planetary Computer to provide environmental data and insights to support ecosystem preservation.

2030: Carbon Negative

The company aims to remove **more carbon from the atmosphere than it emits**, addressing direct, indirect emissions from purchased electricity, and broader value chain emissions.

2030: Water Positive

The goal is to **replenish more water than the company consumes globally**, focusing on reducing water use intensity and investing in replenishment projects in water-stressed regions.

2030: Zero Waste

Microsoft plans to achieve **zero waste** across its direct operations, products, and packaging, emphasizing waste reduction, material reuse, and improved recycling processes.

2050: Historical Carbon Removal

Microsoft has pledged to **eliminate all carbon emissions** it has **produced** since its founding in 1975, emitting **net negative** carbon emissions.

[Microsoft \(I\)](#), [Microsoft \(II\)](#), [The Onion](#)

Sustainable Innovations



Microsoft drives sustainability with tools like the Cloud for Sustainability and AI-driven solutions such as AI for Earth and the Planetary Computer, helping organizations reduce impacts and improve decision-making.

Development of Environmental Strategies

- 1. Microsoft Cloud for Sustainability:** This platform enables organizations to **record, report, and reduce their carbon emissions**. It integrates environmental, social, and governance (ESG) capabilities across Microsoft's cloud portfolio, providing a **unified view of sustainability data** to inform decision-making. The platform includes features such as the Sustainability Manager, which offers dashboards and analytics to track sustainability metrics, and the Emissions Impact Dashboard, which estimates carbon emissions associated with the use of Microsoft cloud services like Azure and Microsoft 365.
- 2. Microsoft Sustainability Manager:** A component of the Cloud for Sustainability, this tool allows organizations to **unify data intelligence, build sustainable IT infrastructure, reduce the environmental impact of operations, and create sustainable value chains**. It provides capabilities for data collection, calculation, and reporting of emissions, facilitating compliance with regulatory requirements and supporting sustainability goals.

AI-Driven Environmental Solutions

- 1. AI for Earth:** Launched in 2017, this program **applies AI to global environmental challenges** in areas such as agriculture, water, biodiversity, and climate change. AI for Earth provides grants to support projects that use AI to monitor, model, and manage Earth's natural systems. To date, it has **awarded over 850 grants to projects in more than 110 countries**, fostering a global community of grantees working on innovative solutions.
- 2. Planetary Computer:** As part of the AI for Earth initiative, Microsoft is developing the Planetary Computer, a platform that **combines a multi-petabyte catalog of global environmental data** with intuitive APIs and a flexible scientific environment. This platform enables users to **answer global questions about environmental data** and supports applications that put those answers in the hands of conservation stakeholders. The Planetary Computer aims to **support sustainability decision-making** with the power of the cloud, providing access to vast datasets and computational resources.

Key Takeaway

By leveraging AI and cloud technology, these solutions provide actionable insights to drive efficiency, conserve resources, and align with global ESG goals, empowering businesses of all sizes to transition toward sustainable practices, fostering innovation and systemic change across industries.

[Microsoft \(I\)](#), [Microsoft \(II\)](#), [Microsoft \(III\)](#), [Planetary Computer](#)

Challenges in Achieving Sustainability Goals



Microsoft faces challenges in achieving its sustainability goals, including rising emissions and the high energy demands of AI operations, but it is addressing these issues through various strategies.

Rising Emissions

Microsoft's total greenhouse gas emissions have **increased notably** in recent years. In its 2024 Environmental Sustainability Report, the company disclosed a **29% rise in emissions** from 2020 to 2023, primarily attributed to the **rapid expansion of data centers** to support growing AI and cloud computing demands. While Microsoft's direct emissions (Scope 1) and indirect emissions from purchased electricity (Scope 2) **decreased by 6.3%** from the 2020 baseline, indirect emissions from the supply chain and product usage (Scope 3) **increased by 30.9%**, now **constituting over 96% of the company's total emissions**.

Energy Consumption of AI

The deployment and operation of AI technologies are **energy-intensive**, leading to **increased environmental impacts**. Training large AI models require **substantial computational power**, resulting in **higher electricity consumption** and **associated carbon emissions**. Microsoft's AI data centers, which supports OpenAI's GPT, have **significantly increased energy and water demands**, contributing to a rise in Scope 2 emissions and requiring millions of liters of water annually for cooling.

Microsoft, The Atlantic, The Verge

Strategies to Mitigate Challenges

Optimizing Data Center Efficiency

The company is investing in technologies to enhance the energy and water efficiency of its data centers. This includes designing facilities with advanced cooling systems, utilizing renewable energy sources, and exploring low-carbon materials for construction.

Advancing AI Sustainability

Microsoft is developing AI models and algorithms that are more energy-efficient, aiming to reduce the computational resources required for training and deployment. Collaborations with research institutions focus the balance between performance with environmental considerations.

Supplier Engagement

Recognizing that a significant portion of emissions originates from its supply chain, Microsoft is working with suppliers to reduce their carbon footprints. The company has set expectations for suppliers to adopt renewable energy and improve energy efficiency, aligning with Microsoft's sustainability goals.

Innovative Energy Solutions

Exploring alternative energy sources, Microsoft has entered into agreements to procure nuclear energy to power its data centers. The company plans to purchase power from the reopening of the Three Mile Island nuclear plant.



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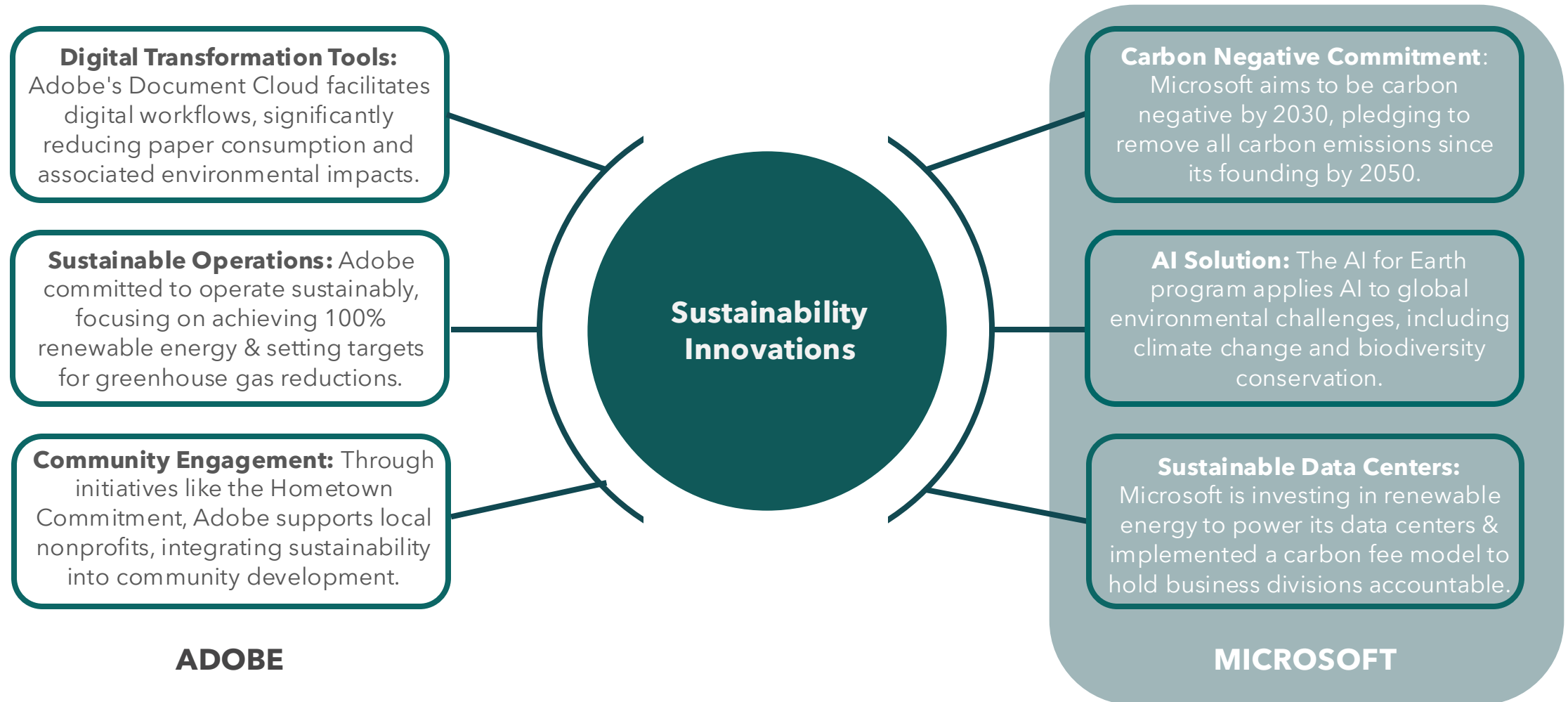
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Comparative Analysis



Both Adobe & Microsoft demonstrate sustainability through innovative solutions, with Adobe excelling in operational efficiency & community engagement, while Microsoft leverages AI & renewable energy investments for global impact.



Adobe (I), Adobe (II), Adobe (III), Microsoft

Recommendations for Adobe & Microsoft



These actionable recommendations for Adobe and Microsoft will help both companies enhance their sustainability efforts, focusing on supplier engagement, operational efficiency, and leveraging AI for environmental impact.

Adobe

- 1. Creation of certification program:** Requires suppliers to meet sustainability benchmarks, including **achieving 50% renewable energy usage in operations by 2030** and providing annual Scope 1, Scope 2, and Scope 3 **emissions reports**. This program would formalize the process of **monitoring** and **verifying** supplier compliance with Adobe's sustainability goals.
- 2. Allowing supplies access to Document Cloud and digital tools:** Helps reduce **paper use**, increase **operational efficiency**, and optimize **resource management** in alignment with sustainability goals.
- 3. Establishment of annual review process:** Evaluates **supplier performance** against certification benchmarks, rewarding suppliers who meet or exceed goals with incentives like **reduced contract fees** or **preferred vendor status**.

Microsoft

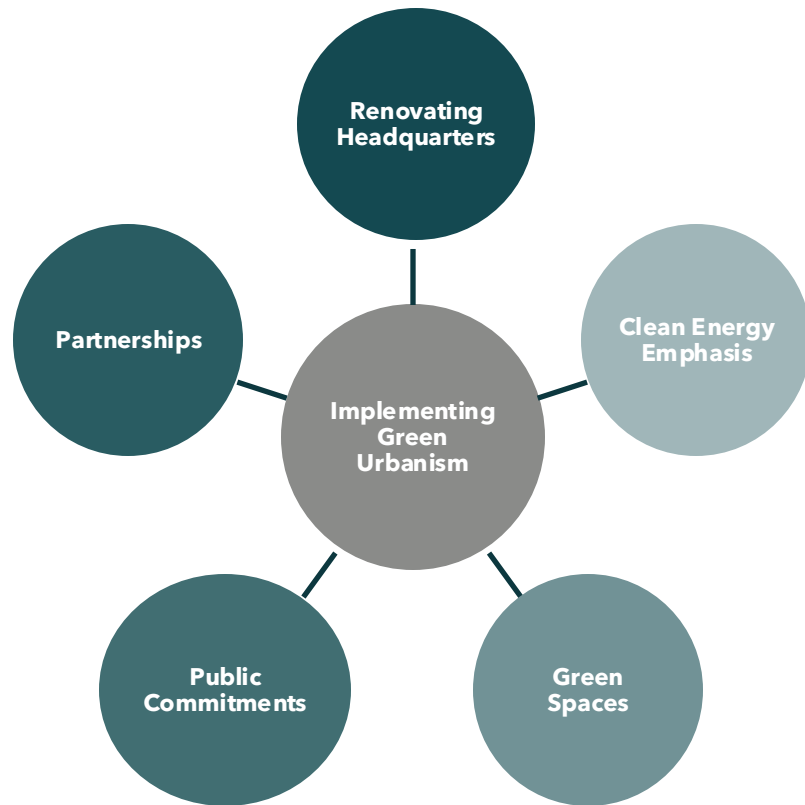
- 1. Optimize AI Algorithms for Efficiency:** Microsoft should collaborate with universities and research institutions to **develop modular AI training processes** that reduce computational intensity and explore federated learning models to **decentralize AI training**, minimizing energy usage.
- 2. Implement Real-Time Emissions Tracking:** Microsoft should integrate a **real-time emissions monitoring feature** into its Cloud for Sustainability platform, allowing AI developers to **track the energy and emissions impact of their models** and encouraging them to optimize accordingly.
- 3. Launch an AI Sustainability Grant Program:** Microsoft should **fund startups and researchers** working on innovative solutions for **green AI technologies**, such as ultra-low-energy chips and renewable energy integration in AI training, while offering **access to its AI infrastructure** for pilot projects.

Common Themes from Private Company Case Studies



The analysis of private company case studies in green urbanism including Google, IKEA, Adobe, Microsoft, and Lendlease reveals common themes in the implementation of sustainable initiatives.

KEY SIMILARITIES



Example Opportunities



RENOVATING HEADQUARTERS

Large public companies are renovating headquarters to be more sustainable. For example, **Adobe Headquarters in San Jose is the first all-electric building of its scale in Silicon Valley** powered entirely by renewable energy.



CLEAN ENERGY EMPHASIS

Switching to cleaner energy sources is a key focus for many private companies. For example, **IKEA is adding solar car parks, additional rooftop solar panels and battery energy storage systems to stores.**



GREEN SPACES

Private companies are choosing to build green spaces. For example, how Google created approximately 67 acres of habitat and **planted roughly 4,500 native trees on Google's campuses** and the surrounding urban landscape.



PUBLIC COMMITMENTS

All the private companies analyzed have **posted sustainability or ESG reports on their website and have news articles** written about sustainable initiatives, as sustainability has been shown to boost consumer satisfaction.



PARTNERSHIPS

Private companies are **choosing to partner with public entities to improve sustainability.** For example, Lendlease partners with local governments while working on development projects that impact the local environment.

Adobe (I), Adobe (II), Adobe (III), Apple Press Release 2024, Environment America, IKEA 2024 Press Release, Lendlease ESG Report 2024, US Green Building Council



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Trending Expansion of Green Spaces in the Private Sector



A rising trend regarding green urbanism in the private sector is the implementation of outdoor green spaces to restore natural local environments, decrease carbon emissions, and improve employee happiness.

DEFINITION



According to the US Green Building Council, **green space** is defined as **land that is partly or completely covered with trees, shrubs, grass or other vegetation**, including urban parks, trails and vertical gardens.

BENEFITS



- Harvard Business School studies show that **employee exposure to nature at work boosted productivity, helpfulness, and creativity**, with no evidence of negative effects, while a genuine **commitment to sustainability helps distinguish business brands in an eco-conscious market**.
- Operating from a green office is a visible sign that a business is dedicated to sustainability, which **attracts a growing number of eco-conscious clients**. Studies suggest that green-certified buildings with **green spaces contributed towards a 4% increase in occupancy**.



Google

Building for Biodiversity Initiative

- As of the end of 2023, **Google created approximately 67 acres of habitat and planted roughly 4,500 native trees on Google's campuses** and the surrounding urban landscape, primarily in San Francisco, according to their annual environmental report.
- Google's St. John's Terminal building in New York City, which opened in February 2024, **incorporates extensive exterior green spaces with 1.5 acres of native vegetation** at street level, in railbed gardens, and on terraces.
- Google shares that its goal is to **restore the site's native ecology within a modern urban context**. Over 95% of the exterior plants installed at St. John's Terminal are native to New York State, and **over 85% are native to New York City**.



Lendlease

Sustainability Framework Initiative

- Lendlease is an Australian **real estate and construction company** with locations and projects worldwide that **has pledged commitment to creating green spaces as part of their sustainability framework**.
- At office locations and commissioned building projects, Lendlease has **implemented living seawalls in Sydney, Australia, urban tree parks in London, England, terrace garden spaces in Milan, Italy, and biodiverse shorelines in Boston**.
- The company **publishes an annual ESG report on their website** to illustrate a commitment to sustainability and aims to create \$250 million of social value by 2025 through green space and decarbonization initiatives.

[Google Environmental Report 2024](#), [Harvard Business Review](#), [International Workplace Group](#), [Lendlease ESG Report 2024](#), [US Green Building Council](#)

Trending Expansion of Clean Energy in the Private Sector



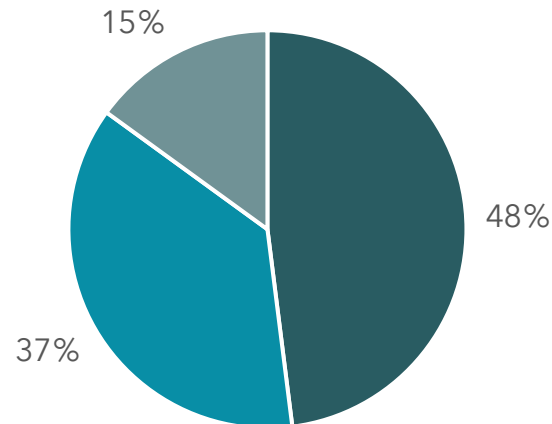
Another trend regarding green urbanism in the private sector is the implementation of clean energy in corporate buildings and throughout supply chains, as large companies work towards lowering carbon emissions.

DEFINITION

According to the US Green Building Council, private business **clean energy use is employing on-site renewable energy systems or procuring renewable energy from offsite sources** for all or a portion of the building's annual building energy use.

Clean Energy Investments

Distribution of investment in the energy sector worldwide between 2018 and 2023, by investor



■ Private sector ■ Government ■ Households



IKEA International Clean Energy Initiative

- IKEA is adding **solar car parks, additional rooftop solar panels and battery energy storage systems to seven stores** across the US and implementing renewable heating and cooling systems to **replace HVAC air conditioning in five stores**, beginning in 2023.
- In the U.S., the company **currently owns over 250,000 solar panels across 90% of its locations**, two geothermal properties, seven fuel cell arrays and two wind farms to **produce renewable energy to power their locations**.
- IKEA already uses **100% renewable energy in all of its facilities in 25 markets, including the United Kingdom, Canada, and Denmark**, and it has pledged to cut fossil fuels from their US operations by 80% by 2030.



Apple Supplier Clean Energy Initiative

- As of March 2024, **more than 320 of Apple's suppliers committed to sourcing renewable electricity for Apple production**, representing 95 percent of its direct suppliers.
- In the US, Apple is investing in solar projects across Michigan, with construction underway to **bring 132 megawatts of clean energy online later this year**. Internationally, Apple has launched renewable energy initiatives at **locations in India, China, and more**.
- **Apple's headquarters in Cupertino are powered by 100 percent renewable energy**, in part from a 17-megawatt onsite rooftop solar installation, and the company reports **avoiding more than 18 million tons of carbon emissions in 2023**.

[Apple Press Release 2024](#), [Environment America](#), [IKEA 2024 Press Release](#), [US Green Building Council](#)

Potential Private Partnership Projects




Private companies explored in the case studies can form partnerships among themselves to launch sustainable products and programs, capitalizing on collaboration to reach shared ESG and green urbanism goals.




IKEA and Lendlease

IKEA can launch a sustainable furnishings line in collaboration with Lendlease. For example, **Lendlease’s designs for living seawalls or rooftop gardens can be used to create products for individual homeowners.**



Google and Apple

Google’s Nest technology and Apple’s HomeKit ecosystem are leaders in smart home automation, and a collaboration between the two could create a powerful platform to enable energy-efficient buildings with energy dashboards.



Microsoft and Adobe

Combine Microsoft’s cloud computing (Azure), AI, and IoT solutions with Adobe’s design and visualization tools (e.g., Adobe Creative Cloud, Substance 3D) to create platforms for sustainable urban planning.

PRIVATE PARTNERS

POTENTIAL COLLABORATION

Adobe (I), Adobe (II), Adobe (III), Apple Press Release 2024, Environment America, IKEA 2024 Press Release, Lendlease ESG Report 2024, US Green Building Council



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Key Takeaways: Sustainable Public-Private Partnerships



Partnerships in the public and private sector, commonly between cities and corporations, contribute to green urbanism in a few major categories, with positive impacts exemplified through case studies.

Cities and Corporations



Cities are partnering with private companies to enact green urbanism. **Singapore and Copenhagen have implemented public-private partnerships** to drive innovation in sustainable urban development, enhance data-driven monitoring systems, and advance renewable energy projects aimed at reducing emissions.

Major Categories



Public-private partnerships worldwide have made substantial investments to reduce emissions specifically in the **categories of green infrastructure, transportation, smart city technologies, and renewable energy in the form of solar and wind power.** For example, the **implementation of smart sensors, bioswales, and electric bikes.**

Case Study Analysis



The city of Vancouver has capitalized **on public-private partnerships through its Arbutus Greenway Program, Laneway Housing Initiative, and Canada Line Program,** all designed to address traffic and urban density concerns in a highly-populated area. These programs have received positive feedback from residents and have reduced costs.

[Arbus \(I\)](#), [Arbus \(II\)](#), [Arbus \(III\)](#), [Lanefab](#), [Laneway \(I\)](#), [Laneway \(II\)](#), [Laneway \(III\)](#), [Laneway \(IV\)](#), [Smallworks](#), [The Canada Line \(I\)](#), [The Canada Line \(II\)](#), [The Canada Line \(III\)](#)

Key Takeaways: Private Green Urbanism Initiatives



In the private sector alone, green urbanism has economic pros and cons, while case studies on companies have shown the positive impacts of green energy and nature conservation initiatives on employees and brand image.



Trends in the Private Sector

A rising trend regarding green urbanism in the private sector is **the implementation of outdoor green spaces** to restore natural local environments, decrease carbon emissions, and improve employee happiness. Also, the **expansion of green energy** is a major component of green urbanism in the private sector, while companies work to meet ESG goals.



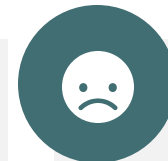
Case Studies

Adobe is a leader in private sustainability by minimizing environmental impacts through innovation, achieving renewable energy targets, promoting transparency, and engaging in community-focused initiatives. **Lendlease works on sustainable developments** incorporating geothermal heat exchange systems, rooftop gardens, recycled water, solar panels, and living shorelines.



Benefits

Green urbanism offers **economic advantages to private businesses, including increased property values, lower energy costs, and growing market opportunities** for sustainable products. Employee exposure to nature at work **boosts productivity** and a genuine commitment to sustainability helps **distinguish business brands in an eco-conscious market.**



Challenges

Adopting green urbanism poses challenges for businesses, **including high initial investment costs, substantial compliance expenses, and financial risks** tied to noncompliance with strict environmental standards. Corporations also face challenges **navigating diverse environmental policies globally, while balancing societal differences.**

[Adobe \(I\)](#), [Adobe \(II\)](#), [Adobe \(III\)](#), [Lendlease](#), [Rockwood](#), [Runstad Center](#), [Ugreen](#).



Section 1: Green Urbanism Overview

Section 2: Case Studies

Section 3: Green Transportation

Section 4: Private Sector

Section 5: Technology

Data Center Locations



Major U.S. data center hubs, including Northern Virginia, Silicon Valley, Dallas-Fort Worth, Chicago, Phoenix, and Atlanta, present significant opportunities to repurpose waste heat for residential and commercial heating.

275 Centers

In Northern Virginia, there are over 275 data centers in an area known as Data Center Alley, which is ideal for waste heat transfer due to its high density of data centers, growing urban areas like Ashburn, and cold winters.

1.8%

Silicon Valley's data centers, consuming 1.8% of U.S. energy, offer significant potential for waste heat recovery. A San Jose project will heat six buildings with waste heat, showcasing the region's leadership in sustainable initiatives

247%

Dallas-Fort Worth (DFW) has seen a 247% growth in data center capacity since 2015, now totaling 390 megawatts. With over 170,000 new residents in 2021-2022, heating demand has risen, primarily relying on natural gas.

1,070 MW

Chicago's data center market is projected to grow from 1,070 MW in 2024 to 1,650 MW by 2029, reflecting a 9% compound annual growth rate. This expansion aligns with the metro area's population increase to 8.98 million in 2024, up 0.53% from the previous year.

6.9 m

Phoenix, Arizona, has become the nation's second-largest data center market, with over 6.9 million square feet of data center space and an additional 2.8 million square feet under construction. The city's population is approximately 4.78 million residents.

530 MW

Atlanta's data center market is projected to grow from 530 MW in 2024 to 1,420 MW by 2029, reflecting a compound annual growth rate of 21.83%. Concurrently, the metro area's population increased by 1.42% from 2023 to 2024, reaching approximately 6.19 million residents.

Key Takeaway

With rapid data center growth, rising populations, and high energy demands, these regions can improve energy efficiency and sustainability through heat recovery systems.

[APL Data Center](#), [Data Center Dynamics](#), [Data Center Knowledge](#), [MDPI](#), [Smith Group](#)

Implementing Data Center Heating Innovation



Through energy management and heat capture systems, as well as policy support and public-private partnerships, data centers' heat can be utilized for the economic and environmental benefit of surrounding communities.

Leveraging Data Center Heat for Building Heating: Technology, Policy, and Partnerships

Technology and Policy

Technology and Logistical Capacity

- **Heat Capture and Distribution:** Use **liquid cooling systems** and **heat exchangers** to capture and transfer waste heat. Also, expand **district heating networks** and retrofit buildings to integrate with these systems.
- **Energy Management:** Deploy **thermal energy storage** to store excess heat for later use and integrate **IoT-based monitoring** to optimize heat transfer and demand response.
- **Infrastructure Planning:** Address location gaps between data centers and urban heating demand through coordinated infrastructure development.

Policymaking: Federal, State, and Municipal Roles

- **Federal Level:** Offer **grants, tax incentives, and R&D funding** for heat recovery systems. Establish **national standards** for heat recovery and district heating.
- **State Level:** Mandate **energy efficiency** and waste heat utilization in facilities. Additional Integrate waste heat recovery into state **energy policies**.
- **Municipal Level:** Plan and develop **local heating infrastructure**, encourage data centers near high-demand areas and promote **community awareness** about waste heat benefits.

Environment and Partnerships

Environmental and Economic Benefits

- **Environmental Benefits:**
 - Reduce carbon emissions by replacing fossil-fuel heating.
 - Improve energy efficiency by minimizing heat waste.
- **Economic Benefits:**
 - Lower heating costs for connected buildings.
 - Create jobs in engineering, construction, and energy management.
 - Enhance the competitiveness of sustainable data centers.

Public-Private Partnerships (PPPs)





- **Government and Utility Companies:** Collaborate to fund and distribute captured heat through new or existing infrastructure.
- **Data Center Operators:** Integrate heat recovery systems, led by companies like Google, Microsoft, and AWS.
- **Construction and Technology Firms:** Design and build heat recovery systems and provide IoT and energy storage solutions.
- **Community Engagement:** Work with local organizations to ensure buy-in and address concerns.

[Aalto University](#), [arXiv](#), [Data Centers](#), [IEEE Xplore](#)

The Stockholm Data Park



Through the innovative initiative, Stockholm utilizes the excess heat generated by data centers, which will become increasingly prevalent with the rise of AI, the city has been able to significantly reduce carbon emissions.

	<h2>Information Type</h2>	<h2>Information</h2>
	<h3>Explanation of Data Parks</h3>	<ul style="list-style-type: none">The Stockholm Data Parks initiative integrates data centers into Stockholm's district heating system, using the excess heat generated by data centers to heat residential and commercial buildings. Data center operators are paid for their involvement in the program.Stockholm's district heating system supplies over 90% of the city's heating.
	<h3>Private Partnerships</h3>	<ul style="list-style-type: none">Stockholm Exegri operates the district heating network and collaborates with data center operators to recover excess heat and integrate it into the heating system, providing technical expertise in heat recovery and distribution and sharing revenue with Data Center Operators.Data Center operators, like AWS, install and operate energy-intensive data centers in the parks.
	<h3>Metrics</h3>	<ul style="list-style-type: none">Recovered heat from data centers provides heating for up to 10,000 apartments.The project has led to a reduction of about 50 grams of CO2 per kilowatt-hour of heat produced.For 10 MW data center can save up to 8,000 tons of CO2 annually, which is equivalent to removing thousands of cars from the road annually.
	<h3>Challenges</h3>	<ul style="list-style-type: none">Data center operators were initially hesitant due to high setup costs and strict sustainability requirements. Stockholm addressed this by offering financial incentives for contributions to the district heating system.To meet energy demands, partnerships with renewable energy providers and long-term power purchase agreements ensured green electricity availability.

Apolitical, Covenant of Majors