



The Green City Index

A summary of the Green City Index research series

A research project conducted by the Economist Intelligence Unit, sponsored by Siemens



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“Cities are the growth engines of the future, offering their populations greater opportunities for education, employment and prosperity. Yet, the negative effects of their growth can also result in traffic congestion, informal settlements, urban sprawl, environmental pollution, exploitation of resources and a significant contribution to climate change.

Efficient and intelligent technology holds the answer to many of these urban challenges. That’s why Siemens has created the Infrastructure & Cities Sector to provide cities and their related institutions with the best possible products, solutions and services.

To make a major contribution to the debate about environmentally sustainable cities, we have commissioned the Green City Index. The research series now covers more than 120 cities worldwide. It has helped city stakeholders to better understand their specific challenges, provides them insights into effective policies and best practices and supports their decision making.

This Green City Index summary report provides you with the key lessons on how to build a greener city and a number of global comparisons between regions and cities.”



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Helping cities learn from each other

Introduction



The unprecedented growth of cities

More than half of the world's people now live in cities and the figure will rise to more than two thirds by 2050, according to United Nations forecasts. North and South America are the most urbanised regions, with slightly over 80% of residents on both continents residing in cities. Europe is not far behind at just over 70%. The share in Asia and Africa is about 40%, however, both continents are undergoing an unprecedented migration to cities from the countryside. In Africa, for example, the number of city residents is expected to more than double from over 412 million today to 870 million by 2035.

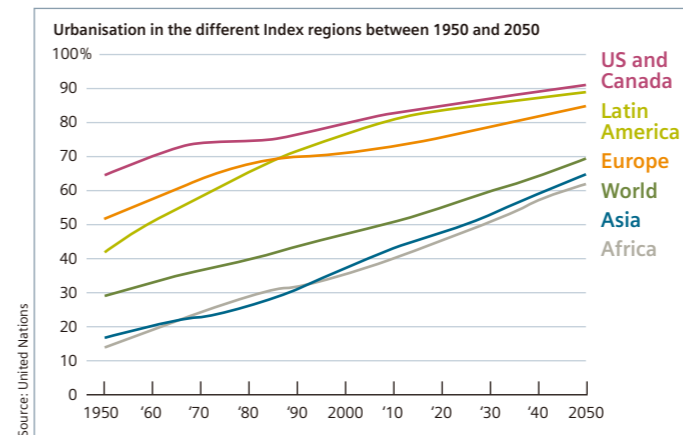
Urbanisation has enormous environmental consequences, both global and local. Already city dwellers are thought to be responsible for up to 70% of the world's greenhouse gas emissions. Sprawling urban development consumes arable land and vital green spaces. Growing numbers of city residents put pressure on energy and water resources, waste

management, sewer systems, and transport networks. Therefore, in order to tackle climate change, avoid lasting damage to vital ecosystems and improve the health and wellbeing of billions of people, solutions to these problems must be sought at the municipal level. At the same time, environmental sustainability must go hand-in-hand with other important goals such as promoting economic development, reducing poverty and improving quality of life. Indeed, the green agenda is a necessary part of holistic, city-led strategies for economic, social and environmental sustainability.

Sharing best practices: The objective of the Green City Index research series

The Green City Index series is a research project conducted by the Economist Intelligence Unit (EIU) and sponsored by Siemens. It seeks to focus attention on the critical issue of urban environmental sustainability by

More and more people are living in cities



creating a unique tool that helps cities benchmark their performance and share best practices.

The series began in 2009 and covers more than 120 cities in Europe, Latin America, Asia, North America and Africa. Seven cities in Australia and New Zealand will be included in late 2012. Each report contains overall lessons for the region as well as detailed city profiles describing individual performances and best practices. The many lessons contained in the series are intended to help cities learn from each other as they debate policies and strategies to minimise their environmental footprint. This is while at the same time accommodating population growth, promoting economic opportunity and safeguarding life for urban dwellers today and the generations to come.

**US and Canada
Green City Index
(27 cities)**

- Atlanta, USA
- Boston, USA
- Calgary, Canada
- Charlotte, USA
- Chicago, USA
- Cleveland, USA
- Dallas, USA
- Denver, USA
- Detroit, USA
- Houston, USA
- Los Angeles, USA
- Miami, USA
- Minneapolis, USA
- Montreal, Canada
- New York City, USA
- Orlando, USA
- Ottawa, Canada
- Philadelphia, USA
- Phoenix, USA
- Pittsburgh, USA
- Sacramento, USA
- San Francisco, USA
- Seattle, USA
- St Louis, USA
- Toronto, Canada
- Vancouver, Canada
- Washington DC, USA

**German
Green City Index
(12 cities)**

- Berlin
- Bremen
- Cologne
- Essen
- Frankfurt
- Hamburg
- Hanover
- Leipzig
- Munich
- Nuremberg
- Stuttgart

**European
Green City Index
(30 cities)**

- Amsterdam, Netherlands
- Athens, Greece
- Belgrade, Serbia
- Berlin, Germany
- Bratislava, Slovakia
- Brussels, Belgium
- Bucharest, Romania
- Budapest, Hungary
- Copenhagen, Denmark
- Dublin, Ireland
- Helsinki, Finland
- Istanbul, Turkey
- Kiev, Ukraine
- Lisbon, Portugal
- Ljubljana, Slovenia
- London, United Kingdom
- Madrid, Spain
- Oslo, Norway
- Paris, France
- Prague, Czech Republic
- Riga, Latvia
- Rome, Italy
- Sofia, Bulgaria
- Stockholm, Sweden
- Tallinn, Estonia
- Vienna, Austria
- Vilnius, Lithuania
- Warsaw, Poland
- Zagreb, Croatia
- Zurich, Switzerland

**Asian
Green City Index
(22 cities)**

- Bangkok, Thailand
- Beijing, China
- Bengaluru, India
- Calcutta, India
- Delhi, India
- Guangzhou, China
- Hanoi, Vietnam
- Hong Kong, China
- Jakarta, Indonesia
- Karachi, Pakistan
- Kuala Lumpur, Malaysia
- Manila, Philippines
- Mumbai, India
- Nanjing, China
- Osaka, Japan
- Seoul, South Korea
- Shanghai, China
- Singapore, Singapore
- Taipei
- Tokyo, Japan
- Wuhan, China
- Yokohama, Japan

More than 120 evaluated around the world

Overview of Index cities

The Green City Index series has measured the environmental performance of more than 120 cities throughout the world, with seven more to be included from Australia and New Zealand in late 2012. The Economist Intelligence Unit chose cities on the basis of size and importance. Most are capital cities, large population hubs and business centres.

**Latin American
Green City Index
(17 cities)**

- Belo Horizonte, Brazil
- Bogotá, Colombia
- Brasília, Brazil
- Buenos Aires, Argentina
- Curitiba, Brazil
- Guadalajara, Mexico
- Lima, Peru
- Medellín, Colombia
- Mexico City, Mexico
- Monterrey, Mexico
- Montevideo, Uruguay
- Porto Alegre, Brazil
- Puebla, Mexico
- Quito, Ecuador
- Rio de Janeiro, Brazil
- Santiago, Chile
- São Paulo, Brazil

**African
Green City Index
(15 cities)**

- Accra, Ghana
- Addis Ababa, Ethiopia
- Alexandria, Egypt
- Cairo, Egypt
- Cape Town, South Africa
- Casablanca, Morocco
- Dar es Salaam, Tanzania
- Durban, South Africa
- Johannesburg, South Africa
- Lagos, Nigeria
- Luanda, Angola
- Maputo, Mozambique
- Nairobi, Kenya
- Pretoria, South Africa
- Tunis, Tunisia

**Australia and
New Zealand
Green City Index (Late 2012)
(7 cities)**

- Adelaide, Australia
- Auckland, New Zealand
- Brisbane, Australia
- Melbourne, Australia
- Perth, Australia
- Sydney, Australia
- Wellington, New Zealand



What the Green City Index measures

Methodology

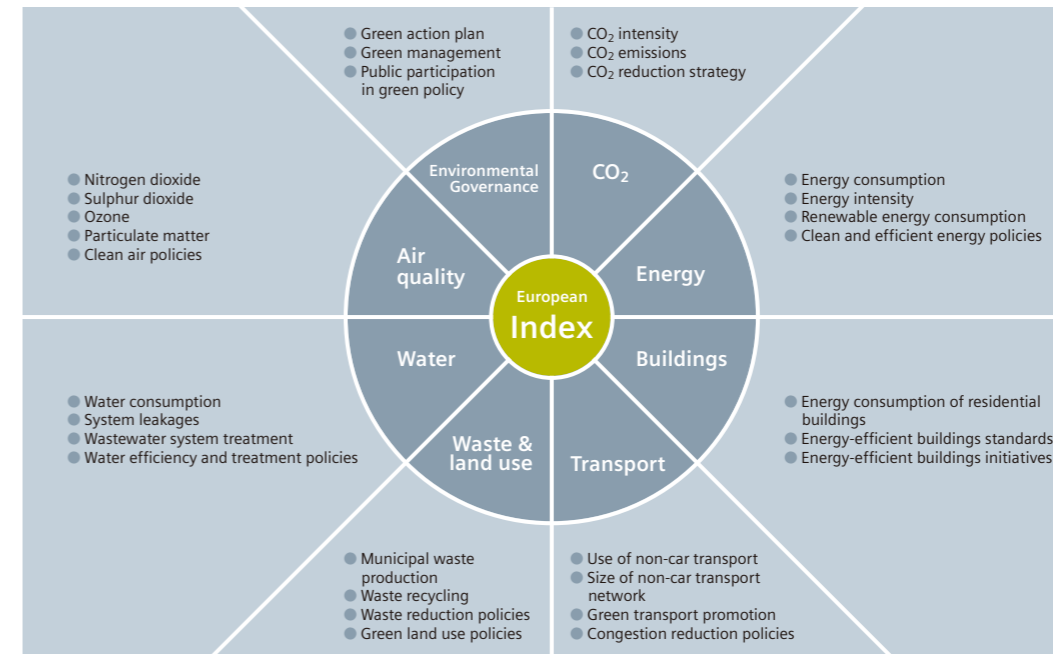
The Green City Index methodology was developed by the Economist Intelligence Unit (EIU) in cooperation with Siemens. Cities were selected for their size and importance (mainly capital cities and large population or business centres). They were picked independently, rather than relying on requests from city governments to be included or excluded, in order to enhance each Index's credibility and comparability.

The Green City Index series measures cities on approximately 30 indicators across eight to nine categories depending on the region. It covers CO₂ emissions, energy, buildings, land use, transport, water and sanitation, waste management, air quality and environmental governance. About half of the indicators in each Index are quantitative – usually data from official public sources, for example, CO₂ emissions per capita, water consumption per capita, recycling rates and air pollutant concentrations. The remainder are qualitative assessments of the city's environmental policies – for example, the city's commitment to sourcing

more renewable energy, traffic-congestion-reduction policies and air quality codes. Measuring quantitative and qualitative indicators together means the Indexes are based on current environmental performance as well as the city's intentions to become greener.

The specific indicators differ slightly from Index to Index, taking into account data availability and the unique challenges in each region. For example, the African Index includes indicators measuring access to electricity and potable water, and the percentage of people living in informal settlements.

Each city receives an overall Index ranking and a separate ranking for each individual category. The results are presented numerically (for the European, and the US and Canada Indexes) or in five performance bands from "well above average" to "well below average" (for the Asian, Latin American and African Indexes). Bandings are used in regions where levels of data quality and comparability do not allow for a detailed numerical ranking.



The European Green City Index evaluates 16 quantitative and 14 qualitative indicators. The methodology for Europe was adapted for the other regional Indexes



More than 20 global experts in urban environmental sustainability from the following organisations advised the EIU in developing the methodology for the Green City Indexes:

- African Development Bank
- Cambridge University
- CITYNET (Regional Network of Local Authorities for the Management of Human Settlements)
- European Commission
- Ford Foundation
- Harvard University
- ICLEI (Local Governments for Sustainability)
- ISOCARP (International Society of City and Regional Planners)

- Inter-American Development Bank
- Karlsruhe University
- Natural Resources Defense Council
- New York University
- OECD (Organisation for Economic Cooperation and Development)
- Regional Plan Association
- Technical University Munich
- UN-Habitat
- University of Pennsylvania
- URBACT
- Vienna Institute for Urban Sustainability
- World Bank

Apples to apples – the challenge of collecting comparable data worldwide

Data collection is a challenge to some extent in all of the regions covered by the Green City Index series. Many cities diligently collect key environmental data and update it regularly and others do not. The challenge comes when comparing information across cities. For example, in Europe, one of the regions with more accessible environmental data, around one third of the 30 cities in the Index do not measure the full amount of energy consumed or the associated CO₂ emissions. In many cases, the EIU makes statistical estimates (extrapolating from partial data or national figures) to fill data gaps. Overlapping jurisdictions within regions are a challenge too. Data for energy, transport or air quality may be collected at the metropolitan level in some jurisdictions, at the municipal level in others or in some cities not at all. A related problem is that urban agglomerations, which need to be integrated into municipal planning for sustainability policies to be effective, often lack a single data

source. The EIU attempts first to collect data at the metropolitan level. When metropolitan data is lacking, data for the central city or state is used according to availability. In all cases the EIU uses statistically robust methods to ensure the data is comparable across indicators and cities.

One additional challenge relates to developing cities, where acquiring data on informal settlements, which have huge environmental impacts, proves especially difficult. Overall, across the Green City Index regions there are very few instances in which one single data point – CO₂ emissions per capita for example – is measured and reported in the same way in each region. This limited comparability is a call to action in itself. Establishing a set of agreed-upon global metrics for urban carbon emissions, energy consumption, air quality and other key environmental performance indicators would be a major step towards providing policymakers with a comprehensive assessment of their cities' current environmental footprint. More importantly, a consistent set of sustainability indicators would help reveal the most appropriate municipal policies and efficient investments to improve green performance.



European Green City Index

Published December 2009 in Copenhagen, Denmark



“Campaigns to motivate lifestyle change are an important tool. We work hard to involve citizens in developing solutions to problems.”

Ritt Bjerregaard, former Lord Mayor of Copenhagen

Best city: Copenhagen

In Europe, Copenhagen leads the Index, with the neighbouring Nordic cities of Stockholm and Oslo close behind. The Danish capital is also joint first (with Brussels, Helsinki and Stockholm) in the individual category of environmental governance, in part for its strong collaborative efforts to set policies. The city appoints environmental coordinators for each administrative unit who meet regularly to exchange experiences. Above all, Copenhagen's standout attribute is consistency. The city finishes among the top five for all categories, except one – waste and land use. Copenhagen is also very ambitious on limiting carbon emis-

sions. In 2009 it set a target to become CO₂ neutral by 2025, which if met would make it the first large carbon-neutral city in the world. The city aims to achieve 10% of its CO₂ reductions through construction and renovation projects, with plans to upgrade all municipal buildings to the highest standards for energy efficiency. Copenhagen also has an extensive public transport system, including a metro system, suburban railway and bus networks, and virtually all residents live within 350 metres of public transport. In addition, the Danish capital aims to become the “world's best cycle city” by raising the share of residents who regularly use a bicycle to commute from 36% in 2009 to 50% by 2015. The city has outstanding green land

Some interesting findings from the European Green City Index:

Oslo uses the highest share of renewable energy at 65%. The Index average is 7%.

Copenhagen's and Berlin's residential buildings consume almost 40% less energy than the Index average.

In **Stockholm**, 68% of people cycle or walk to work, the highest percentage in the European Index.

In contrast, in Helsinki, another Scandinavian city of similar size, only 16% do so.

Riga offers the longest public transport network at 8.6 km per km², almost four times the Index average of 2.3 km per km².

In **Kiev**, 74% of the population uses public transport to get to work.

This is the highest figure in the European Index and the best result for Kiev, which ranks 30th overall.

Tallinn consumes the least amount of water – only 138 litres per person per day, compared with the Index average of 288 litres.

Amsterdam has the lowest water leakage rate of 4%, in Sofia this is 61%.

Helsinki recycles 58% of its waste, compared with the Index average of only 18%.



use policies as well. Between 2000 and 2009, 80% of new developments were built on brownfield sites.

Key finding: The east-west divide

While there has been much progress to bridge the political and economic gaps between eastern and western Europe in the past 20 years, a marked environmental divide remains. Thirteen of the top 15 European Index performers are in western Europe; 11 of the bottom 15 are part of the old eastern bloc. Eastern cities are still dealing with the fallout from decades of environmental neglect during the communist period. For example, even though polluting industries have mostly disappeared in the face of market competition, there is still an abundance of poorly insulated, concrete-slab mass housing.

An area of concern for the future is how eastern European cities will balance rising prosperity with environmental sustainability. For instance, although

Bratislava has the highest share of people taking public transport to work, there has also been a surge in newly registered cars in the last decade.

Spotlight on Vilnius

Vilnius, the capital of Lithuania, ranks 13th in the European Index, making it the best performing city in eastern Europe and the best among lower-income cities in the Index. It performs very well in the air quality category, ranking first, boosted by its relatively small size, lack of heavy industry and the presence of large tracts of forest in the immediate area. Vilnius has taken the initiative in several areas to improve policies and invest in environmental infrastructure. For example, the city as part of a national plan, offers tax breaks, grants and concessional loans to incentivise energy-efficient retrofitting for housing. A biofuel-fired power generation plant, in operation since 2006, provided 10% of the city's heating in 2009.

Comparison of the European Index cities with other regions:

Among the developed Index cities worldwide, **Amsterdam** consumes the least water, at 146 litres per person per day. The leading city in North America, New York City, consumes 262 litres, and the leading developed city in Asia, Yokohama, consumes 300 litres.

Also among developed cities in the Indexes worldwide, **Oslo** emits the lowest amount of CO₂, at 2.2 tonnes per capita. This is compared to the European average of 5 tonnes and the US and Canada average of 15 tonnes.

63% of the population in the European Index use **green forms of transport** to get to work. In the best cities it's more than 90%, the lowest is 33%. In the US and Canada Index only 13% of the population on average does not use a car to commute.

The average concentration levels of **air pollutants** measured (SO₂, NO₂, PM₁₀) across the European cities are about 25% lower than in Latin American cities and about 50% lower than in Asian cities.

Overall Results

Rank	City	Score
1	Copenhagen	87.31
2	Stockholm	86.65
3	Oslo	83.98
4	Vienna	83.34
5	Amsterdam	83.03
6	Zurich	82.31
7	Helsinki	79.29
8	Berlin	79.01
9	Brussels	78.01
10	Paris	73.21
11	London	71.56
12	Madrid	67.08
13	Vilnius	62.77
14	Rome	62.58
15	Riga	59.57
16	Warsaw	59.04
17	Budapest	57.55
18	Lisbon	57.25
19	Ljubljana	56.39
20	Bratislava	56.09
21	Dublin	53.98
22	Athens	53.09
23	Tallinn	52.98
24	Prague	49.78
25	Istanbul	45.20
26	Zagreb	42.36
27	Belgrade	40.03
28	Bucharest	39.14
29	Sofia	36.85
30	Kiev	32.33



Latin American Green City Index

Published November 2010 in Mexico City, Mexico



“Many cities are reactive, and address environmental issues one at a time where the most visible gains can be made, rather than setting a forward-looking, integrated strategy.”

Pablo Vaggione, former General Secretary, ISOCARP

Best city: Curitiba

Curitiba is the clear leader in the Latin American Index. The Brazilian city is the birthplace of bus rapid transit (BRT) and Brazil's first major pedestrian-only street. Its environmental oversight is consistently strong and it has among the best environmental policies in the Index in each category. Since 2009, for example, the city's environmental authority has been conducting an ongoing study on the CO₂ absorption rate in Curitiba's green spaces, as well as evaluating total CO₂ emissions in the city. The key reason for Curitiba's outstanding

performance is a long history of taking a holistic approach to the environment, which is unusual in the region. Integrated planning allows good performance in one environmental area to create benefits in others. For example, successful public transport has had a strong influence on Curitiba's good results in air quality. Another standout initiative for Curitiba is its now-renowned recycling programme, launched in 1989. Residents separate recyclable materials, including glass, plastics, paper and old electronic devices, which the city collects from households three times a week.

Some interesting findings from the Latin American Green City Index:

Mexico City has the highest level of energy efficiency, only using 0.3 gigajoules of electricity to generate US\$1,000 of GDP (Index average: 0.8 gigajoules).

All cities regularly monitor **air pollution** and have some kind of code to improve air quality.

Rio de Janeiro and Curitiba have the longest public transport networks, with an estimated 8.7 km per km² and 8.5 km, respectively, compared with the Index average of 5 km.

Wastewater is often not treated adequately: 8 of 17 cities treat 50% or less of their wastewater before discharging it.

In **Medellín** only seven in 100 residents own a car or motorcycle. In Buenos Aires this figure is 66 in 100 residents.

Water leakage is a challenge for all cities. The lowest water loss is 21% in Monterrey; the highest amount is lost in Rio de Janeiro, at more than 58%.



Key finding: Brazilian cities lead the way on policy

Five of the six best-performing cities in the Latin American Index are from Brazil – Belo Horizonte, Brasília, Curitiba, Rio de Janeiro and São Paulo. One overriding asset that is common among the Brazilian cities is strong environmental policies. This point comes through clearly when the quantitative indicators are removed from the analysis. Five of the six Brazilian cities perform at least as well, and often significantly better, when only policy indicators are assessed. São Paulo, for example, has one of the most robust climate change action plans in the Latin American Index. Belo Horizonte performs well for its eco-buildings, water and air quality policies, while Rio de Janeiro stands out for its clean energy policies. Environmental issues have received a growing priority, and although there are many longstanding environmental challenges, policy

strength is an indication of likely future improvements in the situation on the ground.

Spotlight on Bogotá

Bogotá has a comparatively low per capita GDP in the Latin American Index, at US\$8,400 (Index average is US\$11,100), but despite that ranks among the better cities in the Index. It performs especially well in six of the Index's eight environmental categories, including energy and CO₂, land use and transport. In the last decade the city has gradually replaced buses that run on carbon-intensive fuel with buses that run on natural gas, which are part of the city's TransMilenio bus rapid transit fleet. The total number of vehicles operating on natural gas in Colombia as a whole rose from about 9,000 in 2002 to 300,000 in 2009. In addition, the city's urban planning framework requires designers to set aside green space for new developments.

Comparison of the Latin American Index cities with other regions:

Latin American Index cities have the **highest water leakage rate** worldwide at 35%. That is more than 50% higher than for the other regions on average.

Latin American Index cities have the **most green space** among the African and Asian Index cities, at 255 m² per person on average, versus 74 m² in Africa and 39 m² in Asia.

64% of the electricity in Latin America is generated from renewable sources. The figure for the Asian Index is only 12%.

Overall Results

well above average	Curitiba
above average	Belo Horizonte
	Bogotá
	Brasília
	Rio de Janeiro
	São Paulo
average	Medellín
	Mexico City
	Monterrey
	Porto Alegre
	Puebla
	Quito
	Santiago
below average	Buenos Aires
	Montevideo
well below average	Guadalajara
	Lima



Asian Green City Index

Published February 2011 in Singapore



Best city: Singapore

Singapore is the top performer in the Asian Green City Index and shows consistently strong results across all individual categories. Singapore's impressive environmental performance is a legacy of its history. Since the city gained independence in 1965 the government has emphasised the importance of sustainability through holistic planning, high-density development and green-space conservation. Furthermore, the self-contained city state has installed cutting-edge water recycling plants and waste-to-energy facilities, and has made major investments in its transport system.

Singapore is the best city in the waste category, generating only 307 kg of waste per person per year, compared with the Asian Index average of 380 kg. The

government has set a target to recycle 65% of waste by 2020, up from 56% in 2008. Authorities distribute recycling bags or bins to households – with successful results: Household participation in recycling rose from 15% in 2001 to 63% in 2008.

Singapore also performs very well in the water category. Suffering from a limited water supply within its territory, Singapore has installed five world-renowned water-reclamation plants, called NEWater factories, which treat wastewater through micro-filtration, reverse osmosis and ultraviolet technology. These deliver one-fifth of the city's water supply.

Likewise, the city has ambitious transport goals, with a target to have 70% of trips taken during the morning commute to be on public transport by 2020, up from 59% in 2008. In order to reach this goal it has

Some interesting findings from the Asian Green City Index:

Tokyo created the **first cap and trade system** in Asia in April 2010. The scheme aims to cut energy related CO₂ emissions by 6% by 2015 and an additional 17% by 2020.

Population density ranges from fewer than 1,000 people per km² in Wuhan to more than 27,000 people per km² in Mumbai.

Seoul stands out with the densest public transport network in the Asian Green City Index. 6.6 km per km² versus the average of 1.7 km per km².

Tokyo has the lowest water leakage rate in the Asian Index, at 3%, compared with the Index average of 22%. Jakarta had the highest water leakage rate, at 50%.

In **Manila**, only 12% of the population has access to sanitation.



made significant investments in its public transport network and has developed more seamless connections between bus and rail services. Singapore's policies also support this target, with a vehicle quota system that controls the number of vehicles in the city. More licenses are available for smaller, fuel-efficient cars. The city also operates a road pricing programme.

Key finding: China's environmental performance – beyond air quality and carbon emissions

In 2009 China overtook the US as the world's largest energy user, and for several years previously it already held the dubious distinction of producing the most

greenhouse gases. The Chinese government, in official reports, has acknowledged serious problems with water pollution, air pollution and acid rain. China's poor environmental record can be attributed to explosive economic development as a result of being the "factory to the world". So it is no surprise that the five mainland Chinese cities in the Asian Index – Beijing, Guangzhou, Nanjing, Shanghai and Wuhan – generate some of the highest CO₂ emissions per capita and suffer from high levels of airborne particulate matter, nitrogen dioxide and sulphur dioxide.

China's economic development is bringing huge environmental challenges, but a closer look at its cities reveals a more nuanced picture. Shanghai, for example, has one of the lowest water leakage rates in the Index as well as the longest metro network world-

wide with a total length of 420 km. Nanjing generates the third lowest amount of waste among the 22 Asian cities and Guangzhou has the largest amount of green spaces.

Chinese cities are also strong on environmental policies that should yield improvements in the long run. Shanghai, for instance, supports investments in wind farms and energy-efficient buildings. The Chinese national government has tightened emissions standards for passenger cars and commercial vehicles. However, Beijing has gone farther, and was the first city in China to introduce emissions standards on passenger cars equivalent to those operating in Europe. The city also has "no-car days" and park and ride systems. Nanjing has a comprehensive mass transport policy, including an integrated public transit pricing

“Not too long ago, the motto (in China) was ‘develop first, clean up later’. This is no longer considered acceptable.”

Professor Yue-Man Yeung, emeritus professor of geography, Chinese University of Hong Kong



system called “one card for all”, which can be used for bus, metro, ferry or taxi travel.

Spotlight on Delhi

Delhi has one of the lowest levels of GDP per capita in the Asian Green City Index, at an estimated US\$2,000. Yet the Indian city still achieves an average overall rating, with very strong results in the waste category, generating 147 kg per capita – the least amount of waste in the Index. This is in part because of what has been called Delhi’s “traditional culture of careful consumption”, a tendency to re-use and recycle as much as possible. Building on this, however, Delhi has introduced advanced policies, including relatively robust strategies to reduce, re-use and recycle waste, demon-

strating just how much can be achieved with limited resources and popular support.

Indeed, public engagement is often a prerequisite for successful policies in any city, developed or developing. Delhi hosted the Commonwealth Games in 2010, which spurred city officials to embrace green policies. They created a separate “eco-code” for the event, setting goals for energy and water efficiency, air pollution and waste management, among other green aims. The city advertised the event as the first-ever “green Commonwealth Games”. The government has also created “eco-clubs” in about 1,000 schools to educate children about environmental protection. Under the programme, schools have set up a number of projects including tree planting, rainwater harvesting and paper recycling.

Comparison of the Asian Index cities with other regions:

Asian Index cities have by far the **highest population density** among the regional Indexes, at 8,200 people per km². The US and Canada Index cities have the lowest, at 3,100 people per km² on average.

Cities in the Asian Index are also the **most populous**, with an average population of 9.4 million. Latin American Index cities have 4.6 million, African cities 3.9 million, European cities 2.5 million and North American cities 1.4 million people on average.

Delhi only produces 147 kg of waste per capita per year. This is the least amount out of all cities, with comparable data, in all the regional Green City Indexes.

19 out of 22 Index cities in Asia have conducted an environmental review in the last 5 years, covering the major environmental categories. In Latin America it was only four out of 17 and in Africa five out of 15 cities.

Overall Results

well above average	Singapore
above average	Hong Kong
	Osaka
	Seoul
	Taipei
	Tokyo
	Yokohama
average	Bangkok
	Beijing
	Delhi
	Guangzhou
	Jakarta
	Kuala Lumpur
	Nanjing
	Shanghai
	Wuhan
below average	Bengaluru
	Hanoi
	Kolkata
	Manila
	Mumbai
well below average	Karachi



US and Canada Green City Index

Published July 2011 in Aspen, USA

“A lot of environmental performance in the US is based on the individual actions of cities rather than a centrally regulated and monitored system.”

Andreas Georgoulas, Harvard University Graduate School of Design

Best city: San Francisco

San Francisco tops the US and Canada Index, driven by strong policies across all categories. Waste management is a particular strength. In 2009 San Francisco became the first US city to require that all residents and businesses separate waste and compost material from normal trash. As a result, the city boasts the best municipal recycling rate, at 77%, in the US and Canada Index. The city has also been a trailblazer in partnering with the private sector on innovative green initiatives. These include energy-efficiency awareness programmes paid for by business and low-cost loans to property owners to fund green improvements. The city also

places the onus on company bosses to promote environmentally-friendly commuting by requiring all businesses with more than 20 employees to offer them a pre-tax benefit for mass transit expenses or to pay for these expenses directly. San Francisco ranks second in the buildings category, in part for its regulations covering commercial buildings in the city. Owners of commercial buildings smaller than 10,000 square feet (equals 930 m²) have been required to track and publish energy-consumption data every year since 2008. Commercial buildings larger than 10,000 square feet are required to complete energy-efficiency audits every five years. The city estimates that through compulsory audits, commercial buildings can reduce energy use by up to half within 20 years.

Some interesting findings from the US and Canada Green City Index:

Electricity consumption by cities ranges widely, from 10 gigajoules per capita in Cleveland to 152 gigajoules in Atlanta.

New York is the most densely populated city in the Index, with almost 10,700 residents per km², compared with the Index average of 3,100.

Atlanta has almost three times as many LEED-certified energy-efficient buildings as the Index average (18.3 buildings per 100,000 people versus the Index average of 6.4 buildings).

Vancouver has the longest public transport network in the US and Canada Index, but it's New Yorkers who use public transport most frequently to get to work (37%).

About **90%** of US residents use their cars to get to work.



Key finding: US and Canadian cities face challenges but excel in many areas

Environmental problems in US and Canadian cities are well-documented: greenhouse gas emissions are high by any standard and urban sprawl remains a challenge. However, water infrastructure, recycling levels and environmental governance mechanisms are comparable to the best cities in other Green City Index regions. For example, the average water leakage rate for the US and Canada, at 13%, is lower than in any other continent, and 26% of waste is recycled, compared with 28% for the richest 15 cities in Europe.

Americans and Canadians are also innovative when it comes to environmental initiatives. For Americans in particular, the private sector and non-governmental organisations (NGOs) are driving forces behind environmental activities and innovation. For example, the Clinton Climate Initiative – an American NGO – recently joined forces with C40 Cities, an international organisation of large cities, to jointly combat climate

change. US and Canadian cities also slightly outperform European cities in their commitments to international environmental covenants and in regularly publishing environmental reports.

Spotlight on Vancouver

Vancouver ranks second overall in the US and Canada Index. It is first for CO₂ and air quality and among the top 10 cities for all other Index categories. This performance comes despite having one of the lower per capita GDPs in the Index, at US\$37,500 (the Index average is US\$46,000). A particular highlight is Vancouver's commitment to reducing greenhouse gas emissions, which has resulted in the lowest CO₂ emissions per capita in the Index. In 2010 Vancouver unveiled plans to reduce greenhouse gas emissions by 33% by 2020 from 2007 levels. The city also set a target for all residents to live within a five-minute walk of a park, greenway or other green space – and for planting 150,000 new trees by 2020.

Comparison of the US and Canadian Index cities with other regions:

CO₂ emissions from US Index cities (nearly 16 tonnes per person), are almost double those for Canada (8.1 tonnes), more than double the emissions for mainland Chinese cities (7.6 tonnes), and triple the level of emissions from Europe (5.2 tonnes).

San Francisco and Los Angeles recycle an astonishing 77% and 62%, respectively, of their waste – more than any city in Europe, except one, Leipzig, at 81%.

Among the regional Indexes, US and Canadian Index cities consume the most water, at **590 litres** per person per day on average. This is more than double the other cities worldwide.

Only **2 out of 27** cities in the US and Canada Index have not developed their own green energy projects like wind farms or thermal heating. This is much better than in Europe, where 13 out of 30 cities have not yet done so.

Overall Results

Rank	City	Score
1	San Francisco	83.8
2	Vancouver	81.3
3	New York City	79.2
4	Seattle	79.1
5	Denver	73.5
6	Boston	72.6
7	Los Angeles	72.5
8	Washington DC	71.4
9	Toronto	68.4
10	Minneapolis	67.7
11	Chicago	66.9
12	Ottawa	66.8
13	Philadelphia	66.7
14	Calgary	64.8
15	Sacramento	63.7
16	Houston	62.6
17	Dallas	62.3
18	Orlando	61.1
19	Montreal	59.8
20	Charlotte	59.0
21	Atlanta	57.8
22	Miami	57.3
23	Pittsburgh	56.6
24	Phoenix	55.4
25	Cleveland	39.7
26	St Louis	35.1
27	Detroit	28.4



African Green City Index

Published December 2011 in Durban, South Africa



“Cities need political institutions that can take the lead in urban planning and design. Once you have that, investment, job creation and improving quality of basic services for citizens will come.”

Dr Joan Clos, executive director, UN-Habitat

South African cities lead on policy

In the African Index, Cape Town, Johannesburg and Durban are among the leading cities in the Index mainly for their commitment to strategies, codes and plans to monitor the urban environment. Cape Town, for example, has established a comprehensive Energy and Climate Change Action Plan to improve green performance in many of the eight Index categories. In land use particularly, it achieves the best result in the Index, especially due to its strong policies to contain urban sprawl and protect green space.

Durban and Johannesburg also generally perform well for environmental policies. Durban is addressing climate change through the Dur-

ban Climate Change Partnership, a collaboration with the private sector and non-governmental organisations to undertake numerous projects. This includes retrofitting the Moses Mabhida Stadium to make it more energy efficient and a reforestation project at the Buffelsdraai landfill site.

Key finding: Access to basic services is a widespread problem

Connecting residents to basic infrastructure is a bigger challenge in Africa than anywhere else in the Green City Index series. A major reason for this is the prevalence of informal settlements, especially in the seven sub-Saharan cities – Addis Ababa, Accra, Nairobi, Lagos, Dar es Salaam,

Some interesting findings from the African Green City Index:

South African Index cities generate on average 3 tonnes of CO₂ emissions from electricity consumption per person. That's more than five times the figure for North African Index cities and 60 times the figure for the other seven Index cities in sub-Saharan Africa.

Cairo is by far the most densely populated city, with 19,000 residents per km², compared with an average of 3,500 in the other African cities.

Cape Town and Johannesburg have the most green space in the African Index, at an estimated 290 m² and 231 m² per person, respectively. The Index average is 74 m².

An estimated 38% of residents live in **informal settlements** across the 15 cities; in Maputo the figure is 70%.

Waste production figures range from 160 kg per capita each year in Addis Ababa to more than 1,000 kg in Pretoria.

Residents' **access to sanitation** also varies widely, from 49% in Maputo to 99% in Casablanca.

Durban has a target to become a zero-waste city within 20 years and carbon neutral by 2050.



Luanda and Maputo. In these cities the average number of people living in informal settlements is 55%, and significant percentages of residents do not have access to water, waste management or sanitation services. In Dar es Salaam, for example, with nearly 70% of residents living in informal settlements, only 7% of the city's households are linked directly to sewers. There is also no regular waste collection and many residents simply burn their rubbish. Only just over half of Luanda's population has access to drinking water, and in Maputo, half of the water supply is lost to leakages. Officials in these economically underdeveloped cities have difficulty making the large investments needed to substantially improve these figures. Most often they rely on international aid agencies or foreign governments to fund upgrades. As an alternative, some proactive politicians, such as Dar es Salaam's minister of lands, housing and human settlements, have called on private developers to invest in sanitation, waste management and traffic management as part of their projects.

In North Africa, the story is different. The four North African cities in the Index – Cairo, Alexandria, Tunis and Casablanca – have fewer people

living in informal settlements and do better regarding access to services. Tunis in particular has been proactive in recent years in connecting households to the electricity grid. In Casablanca, the authorities handed over management of key services such as electricity provision, water, waste management and sanitation services to private contractors in 1997. The move has not been without its critics but the city can point to successes in access and service quality over that time.

Spotlight on Accra

Accra performs well in the African Index, despite its low income. The city's standout category is environmental governance. Accra has strong scores for environmental management, with structures in place for local assemblies to work with the national government in implementing policies. It also performs relatively well for environmental monitoring and policies on public participation. In addition, the city has attracted considerable outside investment in transport, water and sanitation infrastructure from international agencies.

Comparison of the African Index cities with other regions:

Dar es Salaam is among the ten fastest growing cities in the world. Its population of 3 million people is expected to double by 2020.

All cities in the African Index have some form of *slum redevelopment strategy*. In Asia, six out of 22 cities and in Latin America three out of 17 cities don't have such a policy.

In Africa, only *Accra* has maximum ability to implement environmental legislation at city level. In Latin America, 67% of the cities have this ability and in Asia the figure is 77%, leaving those cities with more autonomy to make their own decisions.

Whereas almost all Asian and Latin American cities offer a *central contact point* for environmental information, 10 out of 15 African cities are lacking such a source.

Overall Results

well above average

above average

Accra
Cape Town
Casablanca
Durban
Johannesburg
Tunis

average

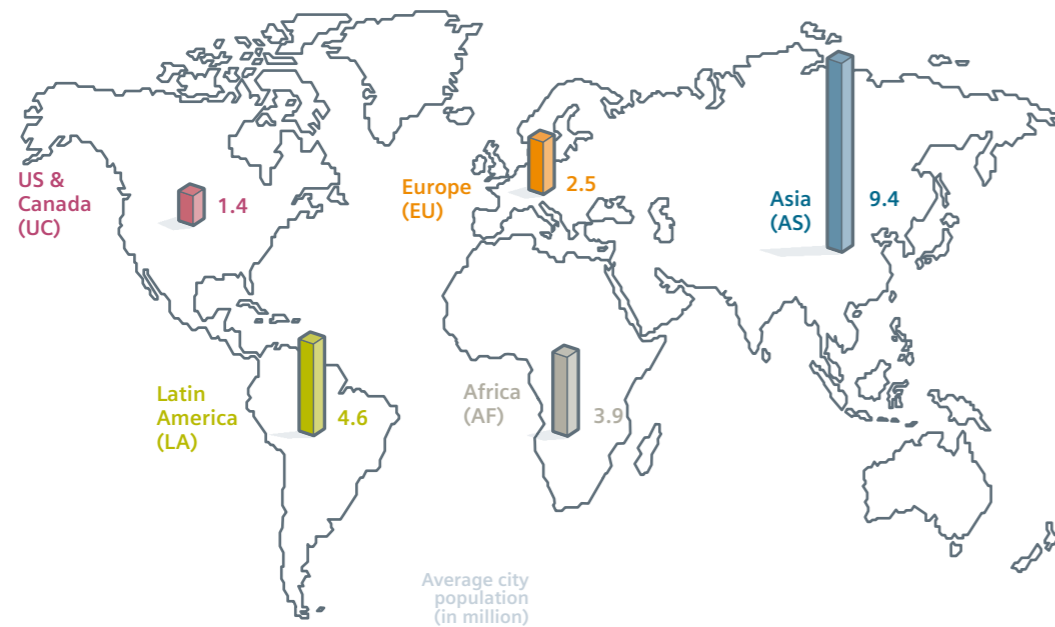
Addis Ababa
Alexandria
Cairo
Lagos
Pretoria

below average

Luanda
Nairobi
well below average
Dar es Salaam
Maputo

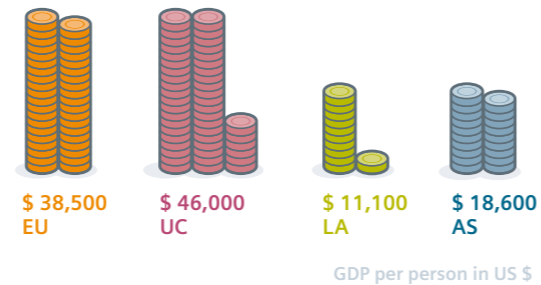
Worldwide comparisons

Where the data allows



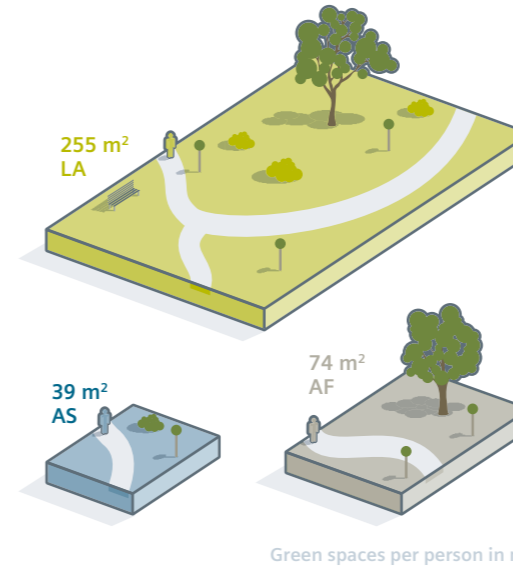
Introduction

In general, data used for each regional Green City Index are difficult to compare to other regions due to differences in the way statistics are collected. Furthermore, many specific indicators are different for each Index, reflecting data availability and the specific environmental challenges of each continent. Just two of the quantitative indicators – water consumption and water leakages – are measured across all regional Green City Indexes. However, a number of indicators have been collected at least in two to three regions. A summary of indicators that were comparable across at least two regions is presented on the following pages.



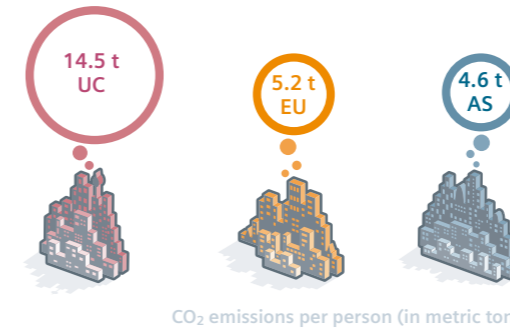
Average GDP

As expected, cities in the US & Canada and Europe are the wealthiest among the regions.



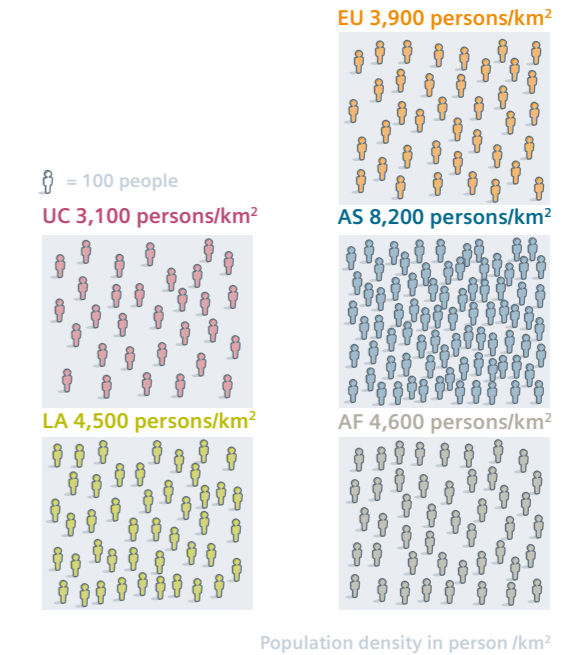
Green Spaces

Latin American Index cities lead Asian and African cities for the amount of parks, open spaces and other green areas.



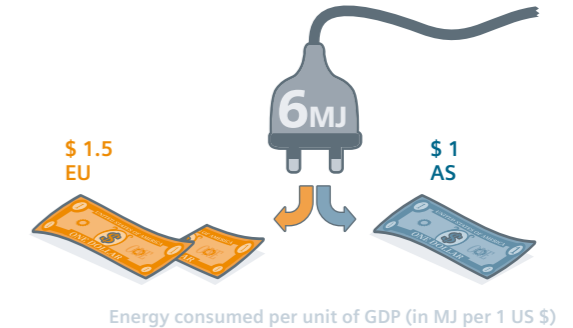
CO₂ Emissions

The US & Canada Index cities have higher per capita CO₂ emissions than Europe and Asia combined.



Population Density

Asian Index cities are by far the most dense among the regions; US & Canada cities trail the rest.

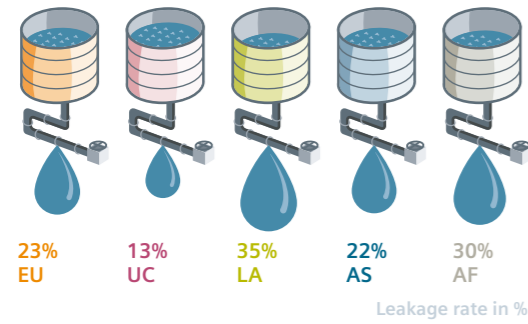


Energy Intensity

Europe compares favourably with Asia for energy consumption per unit of GDP.

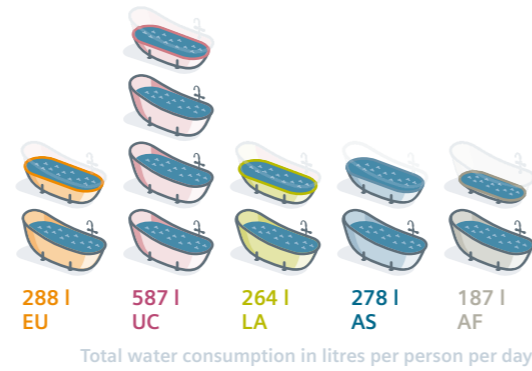
Worldwide comparisons

Where the data allows



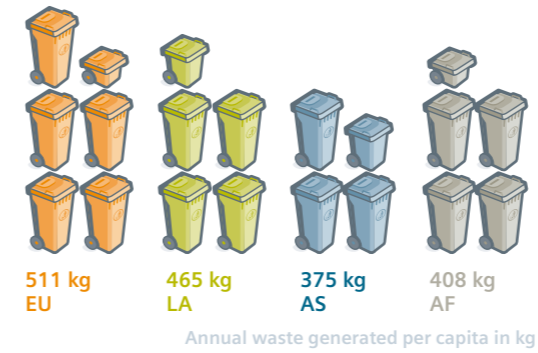
Water System Leakage

Latin American Index cities lose the most water across the five regions. US & Canada cities lead the rest on this metric.



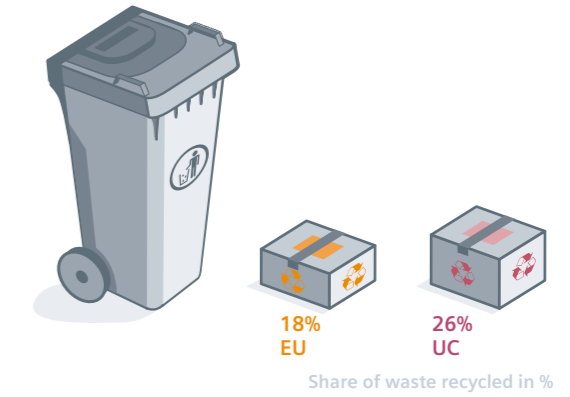
Water Consumption

The US & Canada Index cities consume by far the most water among the five regions.



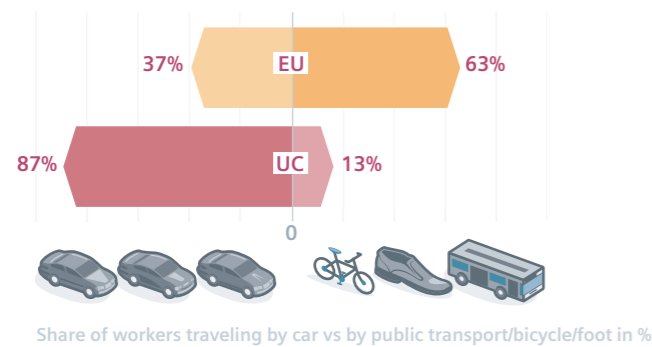
Waste Production

European Index cities produce the most waste per capita, followed closely by Latin American and African cities.



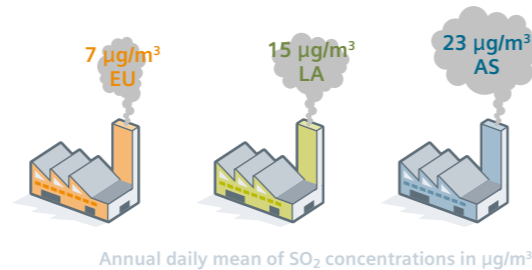
Recycling Rates

On average, US & Canada Index cities outperform European Index cities when it comes to recycling.



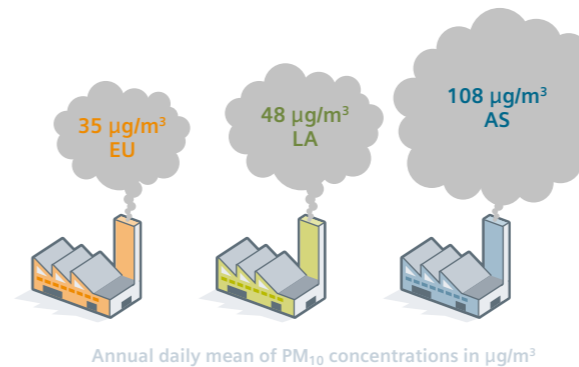
Modal Split

Far more US & Canada Index city residents travel to work by car than in European Index cities.



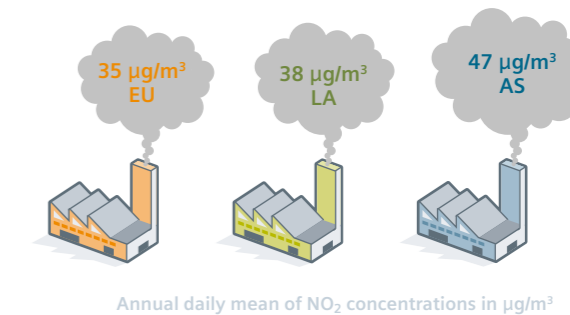
Sulphur Dioxide

Asian Index cities have higher sulphur dioxide concentration levels than European and Latin American Index cities combined.



Particulate Matter

Particulate matter pollution in Asian Index cities far outstrips levels in Latin American and European Index cities.



Nitrogen Dioxide

Asian Index cities have high levels of nitrogen dioxide, but there is a smaller gap between Europe and Latin American Index cities.



Seven steps to a greener city

Action points



“Urban government is the crucial level in addressing the urban environment.”

Xuemi Bai, senior science leader for sustainable ecosystems, CSIRO (Australia’s national science agency)

1. Good governance and leadership at the metropolitan level

National environmental regulations can have far-reaching impacts, and are able to provide overall strategic direction. Yet city-level leadership is just as crucial. Indeed, at their best, national directives incentivise local governments to establish their own initiatives. For example, the Mexican government has a plan to replace more than 45 million incandescent light bulbs with energy-saving bulbs by the end of 2012. In the US state of Colorado, legislation requires that 30% of all electricity produced should come from renewable sources by 2020. Germany has strong national legislation too, covering many environmental issues including building codes and water management. In addition, there are numerous examples in all parts of the world where national, regional and local ju-

risdictions follow common goals and set mutually re-enforcing standards. However, the Green City Index series also demonstrates that the national legislation needs to leave enough autonomy to cities to address their most pressing issues and make their own investment decisions. Experts across Asia, Latin America and Africa call for better leadership and governance at the urban level. Although national governments are important for setting direction, they can also have competing priorities or do not always understand the nuances of local needs. There is a correlation between good governance and top performance in the Indexes. The leaders in the regions, such as Copenhagen, San Francisco or Curitiba all set policies that meet or exceed national or state standards. Crucially though, when cities receive more autonomy to set policies they also need the funding to implement them. More must be done to address this problem, especially in the developing world.

2. A holistic approach

Top-performing cities take a holistic approach to environmental problems, recognising that performance in one category, such as transport, is linked to success in others such as air quality. These cities often have strong mayors who set an overall strategy. They also have dedicated environmental departments, structured communication and joint target setting between departments with different responsibilities (for example, water, waste management and transport). One of the best examples from the series is Curitiba. As early as the 1960s, city officials implemented several integrated initiatives with the single goal of tackling the effects of rapid population growth. These included policies across a number of departments, including strategies to limit urban sprawl, create pedestrian areas and provide low-cost rapid transit. By the 1980s, one

“The city is a living organism that needs to be managed as a single entity, and just like any living organism, it needs to develop holistically.”

Nicholas You, Chairman, World Urban Campaign, UN-Habitat

single integrated urban plan addressed issues such as the creation of green areas, waste recycling and management, and sanitation.

Singapore and Copenhagen, both leaders in their regions, also plan holistically. Singapore has the Inter-Ministerial Committee on Sustainable Development, which brings together many different departments to set an integrated strategy on sustainable development. Copenhagen has co-ordinators in each environmental department who meet regularly to exchange information. In the US and Canada Index, cities like San Francisco, New York, Seattle and Boston integrate their environmental programmes into wider development strategies that simultaneously revitalise their economies and make urban areas more liveable. These cities stand out as examples pointing the way forward for urban governments where different departments manage different aspects of sustainable urban development, without following a consistent strategy.



3. Wealth is important, but at the early stages of development the right policies matter more

In most regions the Green City Index series shows a clear link between greater wealth and better environmental performance. The reason is obvious: More affluent cities can invest more money in infrastructure and set aside more generous budgets for environmental oversight.

However, money is not everything. In each Index some cities with a below-average income clearly outperform their peer cities with higher incomes. This was the case, for example, with Berlin and Vilnius in Europe, Bogotá in Latin America, Delhi in Asia, Vancouver in the US and Canada, and Accra in Africa. Delhi in particular, with the third lowest average income in Asia (US\$2,000 per capita versus the average of US\$18,600), achieves a relatively good placing. This shows that less-well-off cities can adopt policies or low-cost projects to improve environmental sustainability. For example, tree planting is becoming a common environmental activity in Asia, especially for cities with lower incomes. Beijing holds an annual "Voluntary Tree Planting Day" where some two million residents participate, including the president and most senior officials. Belo Horizonte in Brazil has legalised waste picking, which has a

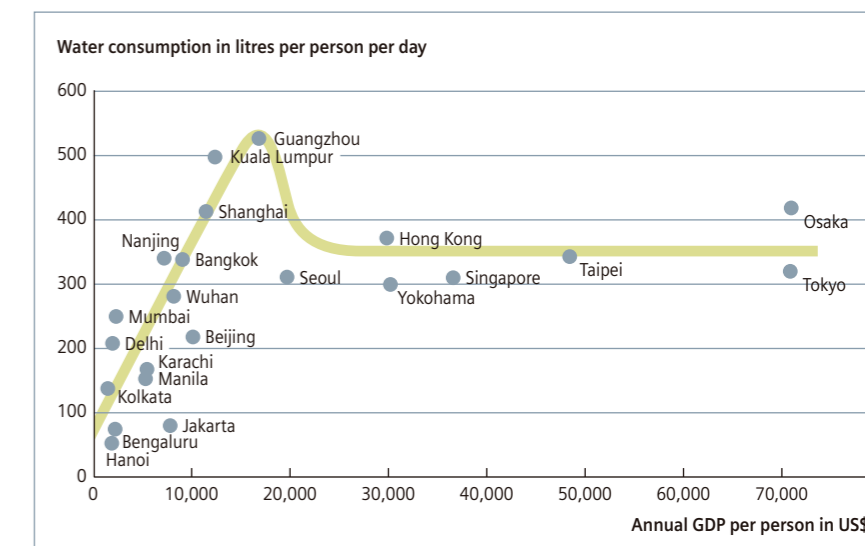
major environmental impact but also provides economic and social benefits for waste pickers. Low-income cities can also look to international agencies to finance environmental goals. One example is Vilnius, in Lithuania. The city took advantage of funding from the World Health Organisation's Healthy Cities Project to promote the use of cycling and public transport. It also drew on European Union funds to improve its water supply and treatment network.

Wealth can even be counter-productive in the early stages of economic development, when more affluence often correlates with more emissions, more urban sprawl, lower density and more cars. The Asian Index shows that only when GDP per capita rises above approximately US\$20,000 per person, a "tipping point" occurs and the trend reverses. Cities with a higher income start to consume relatively less water, and generate less waste and carbon emissions. A central issue for cities in the developing world is to work towards limiting the environmental impact of rising consumption today, rather than waiting for attitudes to change as incomes grow. This can be done by investing in efficient infrastructure, initiating public education campaigns and setting targets – for example, for more renewable energy, green spaces and air quality as well as addressing the growth of informal settlements.

"It's about policies and programmes. Power consumption can be limited by having good controls on development. Currently planning seems to overtly support unsustainable consumption."

Alfred Omenya, professor of architecture, University of Nairobi

Tipping point in the Asian Green City Index





4. Civic engagement

Environmental performance is also a matter of civic engagement. This is seen in the European Green City Index, when comparing the results with an independent report from the European Foundation for the Improvement of Living and Working Conditions (EFILWC)¹. The study measured the level of voluntary participation in organisations. The comparison found that the more volunteerism in the city, the better the score in the Index.

In general, involving citizens in environmental decisions is an important element, and there are several good examples throughout the world. One of these is the Seoul city government's "Green Seoul Citizen Committee" which is chaired by the mayor and has 100 members from non-governmental organisations and businesses. Another one is Porto

Alegre's "participatory budgeting" programme, in which city residents and delegates meet annually to vote on a wide range of municipal spending priorities, including for environmental areas such as transport and sanitation. Yet out of more than 120 cities evaluated, just over half receive full marks for involving their citizens in important environmental decisions. It is clear that more needs to be done across the world to engage the public in sustainability issues.

5. The right technology

Technology plays an important role in reducing environmental impacts. For example, the "Sustainable Urban Infrastructure: London Edition"², a separate study by Siemens in conjunction with McKinsey and the Econ-

omist Intelligence Unit, found that technological levers alone could cut almost 44% of London's total CO₂ emissions. This would go a long way in meeting its overall reduction target of 60% by 2025, without requiring a change in lifestyle or consumption.

At the same time technologies can reduce costs for energy, water or waste disposal. The London study referenced above found that about two thirds of the technological solutions it assessed would pay for themselves through energy savings. Collaboration between the private and public sector is also a useful way to pay for the up-front costs. In Berlin, for example, the "Energy Saving Partnership" involves private companies retrofitting public buildings and then benefitting from the cost savings. The scheme has received more than €60 million in private investment and has brought carbon emissions down by more than 600,000 tonnes.

Other examples of cutting-edge technologies in the Index series include a state of the art waste-to-energy plant in Amsterdam that provides power to more than three-quarters of the city's households, while sending just 1% of the original waste to landfill. A new landfill in Rio de Janeiro will cut CO₂ emissions by 1.4 million tonnes by capturing methane gas. In Tokyo, technology has allowed the city to use gravity more effectively to deliver water, thereby reduce the need for pumps. It also employs advanced methods to enhance water quality, including ozone and membrane filtration systems. In addition, technology can help cities in the developing world "leap-frog" less sustainable infrastructure in the developed world. One example is Guangzhou's 71-storey Pearl River Tower, called the "world's greenest skyscraper", which includes state-of-the-art technology to utilise solar power and energy-efficient cooling systems.



“By definition, sustainability is a long-term issue, requiring investment now for a longer-term benefit. If you have a queue of people outside your office with people struggling to meet basic needs, immediate priorities trump longer-term ones.”

Professor David Simon, head of the Geography Department, University of London

“Planning and governance in African cities no longer sees the dichotomy (between formal and informal settlements) as relevant.”

Anton Cartwright, economist, African Centre for Cities

6. The green and brown agenda need to go hand in hand

Developing cities often emphasise the so-called “brown agenda”, which focuses on human health and poverty reduction, as distinguished from the “green agenda”, which looks to improve the sustainability of eco-systems. The two agendas should go hand in hand, as many experts have pointed out throughout the Green City Index series. Among the benefits, adopting environmentally sound policies reduces municipal waste and sewage (and the spread of disease), improves the efficiency of energy and water provision, and creates jobs and wealth through investment in infrastructure.

The Johannesburg Development Agency, for example, has transformed decayed inner city areas by integrating urban environmental improvements with social and economic development. Environmentally, Johannesburg’s efforts are helping to curb urban sprawl by drawing residents back to the rehabilitated city centre. In these central neighbourhoods, the city has built new mixed-income houses, increased access to municipal services and has extended the public transport network. In addition, the city has boosted security and culture to make these neighbourhoods attractive for businesses as well as for individuals.

Unfortunately, in many parts of the developing world, the immediate demands of survival in some cities tend to prevent officials from integrating sustainability into their plans.

7. Tackle informal settlements

Experts agree that addressing informal settlements is key to the environmental agenda because they exist outside of formal planning policies and often lead to pollution through inadequate sewerage and waste management. With up to 70% of the African urban population living in slums, the African Green City Index in particular shows a strong correlation between a city’s environmental performance and the percentage of residents living in informal settlements. In brief, the fewer city residents living informally, the better the city performs.

The Green City Index series also shows that cities have different approaches, but many experts favour upgrading and integration over re-

moval. As an example, the state water company operating in Curitiba has extended water services and sewerage connections to all of the 1,790 households in the informal settlement of Vila Zumbi dos Palmares, which is located along the banks of one of the city’s main water sources. The upgrading has helped to reduce sewage pollution in the river and cut back informal connections to the water system. Likewise, Medellín has connected its cable car system, Metrocable, to informal sections of the city to provide the people living there with better access to central city areas and job opportunities. Mumbai has what it calls a “slum adoption scheme”, which has extended door-to-door waste collection to 550 informal settlements. There are many other examples of attempts to integrate informal settlements that can serve as models for action.



Cities need to take the lead

Conclusion

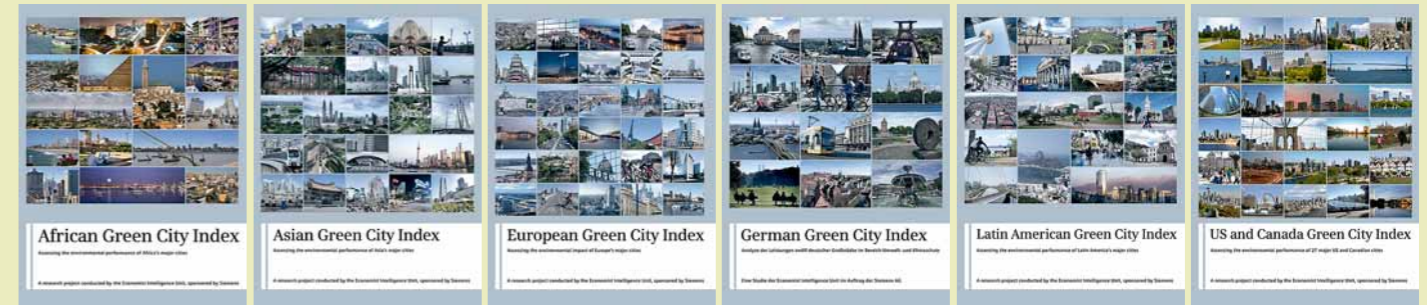
The world's growing cities are the engines that will drive future economic growth, create national wealth and offer millions of people hope for a better quality of life. Yet the ongoing, unprecedented migration from rural areas to cities is already putting tremendous pressure on urban environments. Environmentally sensitive land is under threat, and infrastructure to deliver crucial public services is creaking under the strain. In addition, extreme weather events caused by climate change threaten untold damage through flooding, droughts and storms.

The challenges are clear. The Green City Index series, covering almost every continent over the past three years, has directed much-deserved attention to forward-thinking, progressive environmental strategies, policies and initiatives. The good news is that there are hundreds of examples of smart governance, efficient technologies and environmental monitoring that will be required if we are to successfully limit the impacts of human consumption and ensure continual prosperity for future generations.

Unfortunately, however, the many positive examples highlighted throughout the series remain by and large best practices rather than standard practices. Here the Index series has also been instructive. National, state and local governments must work together to share authority in service to a common goal. Cities themselves need to take a more holistic approach to environmental problems and avoid addressing each issue in single, lone departments.

Finally, measurement often is the prerequisite for good management. Governments everywhere need to collaborate on a uniform standard for environmental data, so that a given city in one part of the world can easily compare its results to any other, in order to learn from its peers and improve its performance. Guaranteeing sustainable growth in the face of overwhelming urbanisation is one of the world's biggest tests in the coming decades. To meet the challenge we must ensure that proven strategies and initiatives become the reality in the majority of the world's growing cities.

The Green City Index research series



Further information on the regional Indexes as well as detailed city profiles for each city can be found in the individual reports or at www.siemens.com/greencityindex.

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