Asian Green City Index

Assessing the environmental performance of Asia's major cities

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

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The Cities

The Asian Green City Index measures and rates the environmental performance of 22 Asian cities. They are capital cities as well as certain leading business centres selected for their size and importance. The cities were picked independently rather than relying on requests from city governments to be included, in order to enhance the Index's credibility and comparability.

Expert advisory panel

A panel of global experts in urban environmental sustainability advised the Economist Intelligence Unit (EIU) in developing the methodology for the Green City Index, including the Latin American Green City Index and forthcoming Indexes in other regions. The EIU would like to thank the panel for their time and valuable insight.

Brunella Boselli
Statistician, Regional Development Policy Division, Organisation for Economic Cooperation and Development (OECD)

Brunella Boselli has been with the regional development policy division of the OECD since 2003. She is responsible for regional statistics, and is one of the authors of the flagship publication "OECD Regions at a Glance". She has recently developed the OECD Metropolitan Database, which contains socio-economic data for 82 metropolitan areas, and is currently working on a new OECD territorial definition for metropolitan regions.

Gordon McGranahan
Head of Human Settlements Group, International Institute for Environment and Development

Gordon McGranahan currently directs the Human Settlements Group at the International Institute for Environment and Development. Trained as an economist, he spent the 1990s at the Stockholm Environment Institute, in charge of their Urban Environment Programme. He works on a range of urban environmental issues, with an emphasis on addressing poverty and environmental problems in and around the home, and how the critical scale of urban environmental burdens changes as cities become wealthier. Key publications include: "The Citizens at Risk: From Urban Sanitation to Sustainable Cities" and "The rising tide: Assessing the risks of climate change and human settlements in low-elevation coastal zones". He was the convening lead author of the urban systems chapter of the Millennium Ecosystem Assessment.

Mary Jane C. Ortega
Secretary General CITYNET

Mary Jane C. Ortega is the former mayor of the city of San Fernando, Philippines, and served the city from 1998 to 2007. She is now the secretary general of CITYNET, a network of 119 member cities and NGOs that works to improve living conditions in human settlements in Asia-Pacific. She was the charter president of the Solid Waste Management Association of the Philippines, and was recently elected back to the position of president. She was a member of the executive committee of the United Nations Advisory Council on Local Authorities (UNACLA) from 2000 to 2007. She received the UN-Habitat Scroll of Honour Award in 2000.

Hiroaki Suzuki
Lead Urban Specialist and Eco^2 Team Leader, Corporate Finance Economics and Urban Department, World Bank

Hiroaki Suzuki has more than 20 years of operational experience in the infrastructure sector and public sector at the World Bank. Having worked in the East Asia and Pacific Region, as East Asia urban sector leader and China urban sector coordinator for the last five years, he joined the Bank's Corporate Finance Economics and Urban Department in 2009 as lead urban specialist and Eco^2 team leader. He is the main author of "Eco^2 cities: Ecological Cities as Economic Cities" (www.worldbank.org/eco2).

Pablo Vaggione
Founder, Design Convergence Urbanism

Pablo Vaggione is an urban specialist with over 15 years of experience. His cross-sector and multidisciplinary approach provides cities and actors in urban development with integrated, strategic and practical plans to respond to the challenges of sustainable urbanisation. He has worked in East and South-East Asia, Western Europe, and Latin and North America, in the preparation of city development strategies, plans for the regeneration of historic urban areas, and sustainable development blueprints for new districts. He provides advice on urban issues to a number of multilateral organisations, local governments and companies. His work for Madrid received in 2007 the World Leadership Award. Between 2007 and 2010 he served as the Secretary General of the International Society of City and Regional Planners (ISOCARP), a professional organization of planners from 70 countries.

Sebastian Veit
Senior Climate Economist African Development Bank

Sebastian Veit is senior climate economist at the African Development Bank in Tunis. While at the organisation he has focused on green growth strategies in Africa and renewable energy issues. In 2007 he was a consultant to the United Nations Framework Convention on Climate Change, and from 2004 to 2007 he was a consultant with the World Bank in Washington DC. At the World Bank he specialised in energy and water.

David Wilk
Climate Change Lead Specialist, Sustainable Energy and Climate Change Unit, Inter-American Development Bank

David Wilk joined the Inter-American Development Bank in early 2001 as an urban environmental senior specialist. His professional experience in Latin America and the Caribbean during the 1990s included a range of management and consulting activities with the World Bank, international organisations and consulting firms. His work with these organisations was in the area of land use and environmental planning, watershed management, sustainable urban transport and environmental assessment of development and infrastructure projects.

Nicholas You
Chairman, Steering Committee of the World Urban Campaign, UN-Habitat

Nicholas You is chairman of, amongst others, the Cities and Climate Change Commission of the World Future Council, and the Assurance Group of the Urban Infrastructure Initiative of the World Business Council for Sustainable Development. After running UN-Habitat's Best Practices and Local Leadership Programme for over a decade, he was appointed as the senior policy and strategic planning adviser of the agency. From 2007 to 2009 he led the development and roll out of UN-Habitat's strategic and institutional management plan. As part of that plan, he was asked in January 2009 to spearhead UN-Habitat's World Urban Campaign. Upon his retirement from the UN in July 2010, some 50 partners representing public, private and civil society institutions worldwide elected him as chairman of the Campaign's Steering Committee.

Introduction

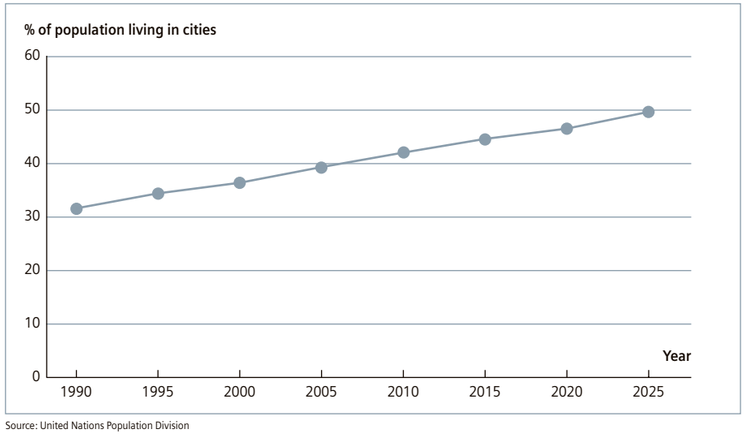
Unprecedented shift from the countryside to cities

The future of Asia is in its cities. Although still one of the less urbanised continents, the share of the Asian population living in urban areas has grown from 32% in 1990 to 42% in 2010, according to the United Nations Population Division. By 2026, the United Nations forecasts that half of Asians will be city dwellers. The sheer size of the continent's population makes the task of managing this urbanisation especially daunting. For the last five years, Asia has added 37 million urban residents each year, more than 100,000 per day, to its growing total. Asia currently has seven of the world's 10 most populous urban areas, and McKinsey and Co, a consultancy, predicts that by 2025, China alone will have 221 cities with more than a million inhabitants. In contrast, Europe currently has just 25.

The Asian Development Bank says the ongoing migration from the countryside to cities in Asia is "unprecedented in human history", and the scale of the change has enormous environmental consequences. In order to cope with this migration, the Asian Development Bank calculates that each day, across the continent, cities currently need to build a total of 20,000 new dwellings, 250 km of new roads, and the infrastructure to deliver an additional 6 million litres of potable water. How Asian governments manage urbanisation will be crucial to the health and wellbeing of billions of people in the region and worldwide.

The Asian Green City Index, a research project conducted by the Economist Intelligence Unit, sponsored by Siemens, seeks to measure and assess the environmental performance of 22 major Asian cities across a range of criteria. This report presents the key findings and highlights from the Index, and is intended to provide stakeholders with a unique tool to help Asian cities learn from each other, in order to better address the common environmental challenges they face.

Urban population in Asia from 1990 - 2025



Source: United Nations Population Division

The report is divided into five parts. **First**, it examines the overall key findings. **Second**, it examines the key findings from the eight individual categories in the Index: energy and CO_2, land use and buildings, transport, waste, water, sanitation, air quality and environmental governance. **Third**, the report presents a variety of leading best-practice ideas from across the region. **Fourth**, it gives a detailed description of the methodology used to create the Index. **Finally**, an in-depth profile for each city outlines its particular strengths, weaknesses, and ongoing environmental initiatives. These profiles rightly constitute the bulk of the report because the aim of the study is to share valuable experience.

A unique Index

The 22 cities selected for the Asian Green City Index include most major Asian urban areas. They are capital cities as well as certain leading business centres selected for their size and importance. The cities were picked independently rather than relying on requests from city governments to be included, in order to enhance the Index's credibility and comparability. Another decisive factor in the selection was the availability of data. One city, Ho Chi Minh City, Vietnam, had to be excluded from the original shortlist due to a significant lack of available information.

The methodology, described in detail in a separate section in this report, has been developed by the EIU in cooperation with Siemens. It relies on the expertise of both organisations, a panel of outside experts, and the experience from producing the European Green City Index in 2009 and the Latin American Green City Index in 2010. One of the great strengths of the Asian Green City Index is the breadth of information it uses. There are 29 individual indicators for each city, and these indicators are often based on multiple data points. Value also comes from how the Index is presented. Each city is assessed in eight categories and placed within a performance band to indicate its relative results. The process is transparent, consistent, replicable, and reveals sources of best practice.

Results

Here are the complete results for the 22 cities in the Asian Green City Index, including the overall results and placements within the eight individual categories. The cities were placed in one of five performance bands, from well below average to well above average.

Overall results

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

Category results

Energy and CO_2

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

Transport

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

Water

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

Air quality

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

Land use and buildings

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

Waste

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

Sanitation

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

Environmental governance

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

Overall key findings

Environmental awareness and income: A tipping point in Asia

Although money is not everything when it comes to environmental performance, wealth helps in some obvious ways. Richer cities are able to make necessary investments in urban infrastructure, and can afford to maintain a professional, experienced civil service to drive environmental initiatives. This holds true in the Asian Green City Index, where wealthier cities consistently perform better. Singapore, for example, is the Index leader with a well above average ranking overall, and is also the fourth richest city, with a GDP per person of US$36,500. It can afford cutting-edge water recycling plants, waste-to-energy facilities and major investments in its transport system. Yokohama, with an above average per-formance overall and a GDP per person of US$30,200, offers generous subsidies for electric vehicles, among other investments, and its innovative Water Bureau provides training and technical assistance to city officials in developing countries. In Asia, the correlation between GDP per capita and environmental performance is as strong as it was in 2009's European Green City Index.

At a certain level, resource consumption does not continue to rise with income

As cities become more prosperous, in addition to investing in infrastructure, one might also expect residents to consume more resources and thereby experience environmental consequences such as higher carbon emissions, or excessive water consumption and waste. Up to a certain level of income, the Asian Green City Index does indeed show a steady rise in resource consumption along with per capita GDP. But when income rises above a certain point, at around US$20,000 per person, average consumption declines.

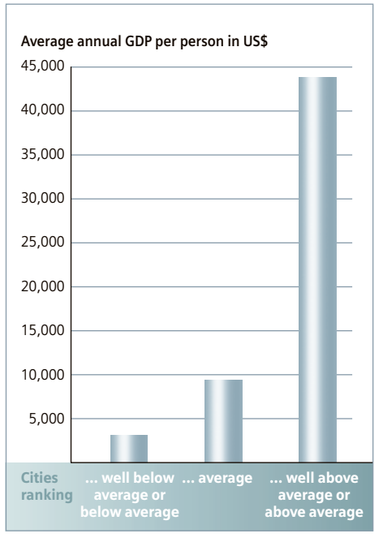
For example, the average waste generation of the six cities in the high income range (each with a GDP per capita above US$29,000) is 382 kg per person per year. This is just 7 kg above the overall Index average of 375 kg and well below the average of 598 kg of the five cities in the mid-income range (between US$10,000 and US$25,000).

There is a similar picture regarding water consumption. The six richest cities consume 343 litres per person per day on average. Although this is higher than the average water consumption of all cities (278 litres), the mid-income cities have higher consumption levels (393 litres). For an illustration of this phenomenon, see chart on the right.

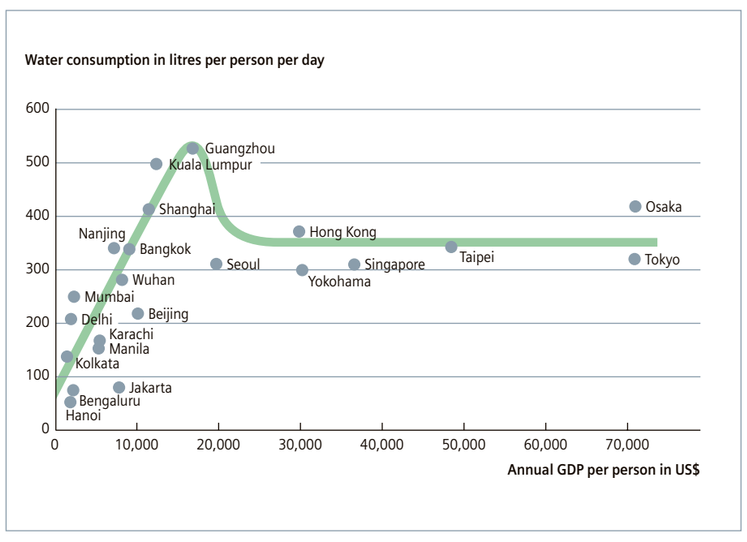
For carbon emissions, this pattern holds true as well. The six richest cities emit an average of 5.8 tonnes per person per year, compared to an overall average of 4.6 tonnes. However, the five cities in the mid-income range produce on average 7.6 tonnes of CO_2 per person per year.

All of this demonstrates that wealthier cities in the Index do not necessarily consume resources at a level that their high incomes might suggest. This shift was not present in the Latin American

Richer cities perform better



Tipping point in water consumption



Index and was less clear in the European Index. There are several potential factors at work. The transition to more service-based industries plays a part in reducing carbon emissions among the richest cities. And the quality of infrastructure contributes to lower water consumption levels. Five of the seven wealthiest cities, for example, have water leakage rates at or below 7%. Policy execution also plays a role in richer cities (see below). In Japan, Taiwan and South Korea, the rise of environmentalism coincided with public outcries over industrial pollution, which led governments to begin addressing environmental issues as a whole. And governments in those countries have remained responsive to citizens' concerns ever since. Dr Hyun Bang Shin of the London School of Economics has noted the link between income and rising environmental awareness in China. As wealth grows, he says, "many of the new middle class are becoming much more aware of environmental issues. They seem to be exerting pressure on local governments." He adds, "Whether or not the interest in environmental protection expands beyond their immediate neighbourhoods and surroundings remains to be seen."

Evidence from the city portraits in this report suggests that the wealthier cities have also made solid efforts to reduce consumption. Taipei City has a longstanding, world-renowned pay-as-you-throw waste charge. In 2003, Yokohama set a goal of reducing waste by 30% in ten years but exceeded the target in five years. By 2030 Seoul aims to cut carbon emissions by 40% compared to 1990. Osaka holds 150 workshops each year to educate primary school children about the water system. There are many more examples of cities pursuing practical steps to encourage sustainable resource use, and the consumption figures in the Index show that they are having a positive effect.

Delhi's approach to waste and recycling: when resources are limited, attitudes make a difference

Such programmes do not necessarily need to wait until cites grow rich, however. Delhi, for example, has one of the lowest levels of GDP per capita in the Index, at an estimated US$2,000. Yet the city still achieves an average overall rating, with a particularly strong result in the waste category, where it ranks above average. This is in part because of residents' attitudes towards consumption and recycling. As the city portrait in this report notes, Delhi's "traditional culture of careful consumption", which economic growth has not yet eroded, helps explain why Delhi leads the Index with an extraordinarily low per capita waste generation figure of 147 kg per year. The city's advanced policies, including one of the more robust strategies in the Index to reduce, re-use and recycle waste, also demonstrate just how much can be achieved with limited resources. Delhi shows that less well off cities do not need to wait to get rich before adopting policies and shaping attitudes towards sustainability.

Policy execution differentiates the best-performing cities

Governments in the 22 cities in the Index, despite varying performances on quantitative indicators, appear to be convinced of the need to improve the urban environment. Most cities have comprehensive policies in place for almost every environmental area evaluated in the Index. Uniformity at the policy level also helps to explain why cities in the Asian Green City Index perform so much more consistently overall. Fourteen of the 22 cities in Asia, for example, appear in the same performance band for at least five of the eight categories. In Latin America, by contrast, the cities showed much more varied results, even though income levels are more homogeneous than in Asia. Results from the Latin American Green City Index showed that cities there are hindered by focusing on immediate, pressing problems rather than taking a long-term holistic approach. With policies so common in Asia, one differentiator in the Asian Green City Index is the ability to execute and enforce those regulations and standards. Professor Yue-Man Yeung, emeritus professor of geography at the Chinese University of Hong Kong, notes that "the most important thing that you must have for a city to clean up is political will."

Singapore, the only city to achieve a well above average overall score, illustrates this point. If Singapore were scored only on quantitative measures, it would have ranked one band below, at above average. But it is comprehensive and effective policies that elevate the city to rank well above average overall. A rich city-state, Singapore has access to resources, but unlike other cities in the Index, the government is not split between competing levels of administration. And it has a highly trained civil service, along with a reputation for transparency, which is underlined by Singapore's fourth place in Transparency International's Corruption Perception Index.

Similarly, Hong Kong, with a large degree of self-government, resources, and a capable civil service, scores well in the Index, not because its policies are inherently more advanced, but because it has the capacity to carry them out. Furthermore, the governments of Singapore and Hong Kong have the capacity to approach their cities as single entities, which enhances their ability to address environmental challenges (see also interview with Nicholas You in a separate section of this report).

City governments need more power to make their own environmental decisions

There is a growing consensus among environmental experts that decentralising authority from national to local governments is a key way to achieve more relevant and responsive envi-

ronmental oversight. The Asian Development Bank states, "although central-local relations are being reconfigured in many different ways, it is quite clear that local, sub-national areas are now overwhelmingly regarded as the site for effective governance." In addition, Dr Xuemei Bai, senior science leader for sustainable ecosystems at CSIRO, Australia's national science agency, points out: "Urban government is the crucial level in addressing the urban environment." There have been fears, according to the World Bank, that decentralisation of authority could lead to deterioration in key public services, but at the same time it notes that in East Asia especially, the effects "appear to have been largely benign so far." However, Dr Bai says that although national governments in Asia have given formal authority to cities in recent years, they have not always handed over adequate funding to meet new responsibilities, and so governments have faltered. Brian Roberts, professor emeritus at the University of Canberra and former chief technical adviser for the United Nations, adds that although in countries such as India, which has a history of a federal structure, cities might have some power, the trend across Asia is that local governments are "incredibly weak". He says that too often, instead of real power being transferred to localities, there is a "decentralisation of corruption." He and others believe that more decentralisation is required to make further environmental progress in cities, but with the accompanying fiscal clout to enforce regulations and invest in initiatives.

China's environmental performance: Looking 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 its latest report on the state of the environment, spoke of "very serious" water pollution, "grave" results from acid rain, and "serious" air pollution problems in some urban areas. Of the country's 113 key cities for environmental protection, 43% are at or below the lowest national air quality rating, Grade III. It should also be noted that China's Grade III standards for nitrogen dioxide are twice the World Health Organisation's recommended healthy levels, and for particulate matter over seven times more. The Grade III sulphur dioxide standard is more than 12 times higher. China's poor environmental record can be attributed to explosive economic development, as a result of being the "factory to the world". The environmental challenges include an energy supply heavily reliant on coal, factory emissions, dust from construction and an increase in automobile traffic. So it is no surprise that the five mainland Chinese cities in the Index, Beijing, Guangzhou, Nanjing, Shanghai, and Wuhan are also the five cities with the highest energy consumption per $US of GDP. And three of the five cities have the highest CO_2 emissions per capita. Similarly, all the cities finish in the bottom half of the Index for their levels of airborne particulate matter, nitrogen dioxide and sulphur dioxide.

These statistics are only part of the story, however. Even with below and well below average results in the quantitative indicators for energy and air quality in the Index, the five mainland Chinese cities fall into the average band in the Index overall.

Two factors help explain this. First, in some environmental areas, Chinese cities are doing reasonably well. Beijing, for example, collects an estimated 95% of its waste, the eighth best figure in the Index. And Shanghai has the sixth lowest water leakage rate in the Index, at 10%, versus the Index average of 22%. Meanwhile, Nanjing generates the third lowest amount of waste per capita, at an estimated 218 kg annually. And Guangzhou, Nanjing and Beijing come first, second and fourth, respectively, for the amount of green spaces per person, although the way the cities draw their official boundaries plays some role in their results for green spaces. Second, the Index rewards policy as well as statistical performance, and here Chinese cities are strong. All are in the average band when only policies are taken into account, and all but Wuhan are above average in transport policy. Even on air quality, Shanghai scores above average in policy terms, with an established air quality code and regular monitoring.

The Chinese performance regarding policies suggests that the authorities take the environment seriously. A major step forward for Beijing, for example, was hosting the 2008 Olympics. In the run-up to the event, with the world's attention on the city, the national and city governments invested heavily in improving air quality, landscaping and transport. Prof Yeung of the Chinese University of Hong Kong also notes a perceptible change across the country. "Not too long ago," he says, "the motto was 'develop first, clean up later.' This is no longer considered acceptable. On green policy, garbage collection, other areas, some cities are doing very well." However, the rapid growth of automobile traffic has held cities back. Prof Yeung notes that about 30 big cities in China are building subway systems, which is a positive development, but construction is not keeping pace with the growth of automobiles. The number of cars in Wuhan, for example, has tripled to 1 million in the last decade. Prof Yeung says, "Things are going both ways in Chinese big cities."

China's economic development is bringing huge environmental challenges, but a closer look at its cities reveals a nuanced picture, with some areas of success and seriousness about policy that should yield improvements in the long run. "With increasing levels of income, infrastructure investment will increase, basic issues like sanitation will improve, but more urban dwellers are joining cities daily," says Dr Bai of Australia's national science agency. "There is a huge need to provide housing and other services. Most cities will continue to struggle with competing interests."

Key findings from the ca tegories

Energy and CO_2

Energy consumption and carbon emissions are rising as emerging economies develop, especially in China. However, most cities in the Index are responding with proactive policies to limit greenhouse gases and use energy more efficiently.

→ Average carbon emissions in the Asian Green City Index are 4.6 tonnes per person, which compares well with the European Green City Index average of 5.2 tonnes per person.

→ Cities using the least energy tend to have the lowest incomes, but when income rises above about US$20,000 in GDP per person, average emissions decline.

→ The share of renewables in electricity production for Index cities is 11%, much lower than the figure for Latin America, at 64%, where hydropower is much more common. In addition, only about 3% of the energy these cities use on average is from renewable sources, which is less than half of Europe's average share of 7%.

→ Governments are trying to improve their renewables performance. All 22 cities in the Index have invested in energy efficiency and clean energy sources. Twenty cities have formal energy strategies, and have also invested in waste-to-energy projects.

→ There is more to be done, however. While 18 cities have a climate change strategy, only 12 have conducted a baseline review of greenhouse gas emissions in the last five years and just ten engage in regular greenhouse gas monitoring.

Land use and buildings

Living conditions in Asian cities vary enormously. Mumbai, the densest city in the Index with 27,000 people per square kilometre, is more than 27 times more tightly packed than Wuhan, which has fewer than 1,000 people per square kilometre. The variation in green spaces is even greater, from 2 square metres per person in Kolkata, to 166 square metres per person in Guangzhou. But the Index shows a consensus is forming on the required elements for successful sustainable land use and building policies.

→ Different regulatory systems and development histories explain most of the divergence in population density and green spaces. China, for example, places more outlying, undeveloped land within official city boundaries.

→ Income is less of an issue with regard to land use. For example, Tokyo, with a GDP per person of US$70,800, and Hanoi, with a GDP per person of US$1,700, have roughly the same amount of green spaces per capita.

→ Despite the variety of conditions, every city has policies to promote energy efficiency, incentives for homes and businesses to save energy, and policies to protect green spaces and contain urban sprawl. All but a few also have full or partial eco-building standards for private and government buildings.

→ Policies do not need to be expensive or technologically difficult. The city portraits show, for example, that tree planting is becoming a common environmental activity, especially for cities with lower incomes.

Transport

Traffic management and congestion reduction policies are widespread and comprehensive in all but the poorest cities. On the other hand, with only a few exceptions, the richest cities have the best superior public transport infrastructure (defined in the Index as transport that moves large numbers of passengers quickly in dedicated lanes, such as metro, bus rapid transit or trams). However, an assessment beyond policy indicators was difficult since many cities lacked reliable data on the overall length of bus networks or the percentage of journeys taken by car, train, cycle or on foot.

→ Every city in the Index has an urban mass transport policy and makes investments to reduce emissions from mass transport. All but two cities promote greener forms of transport. Transport pricing systems are integrated in most cities, with the exception of poorer ones.

→ All but a few cities have traffic management systems, with traffic light sequencing, traffic information systems, and multiple access points for entry. Congestion reduction is common as well: 16 cities have road charges, pedestrian areas and park and ride systems.

→ Although wealthier cities have longer superior public transport networks, such as metros or trams, Jakarta was an exception, employing "bus rapid transit" as its main superior network, a lower cost alternative to rail, and an idea which originated in Latin America and is widespread there.

Waste

Asian cities produce less waste per capita than Europe and Latin America, but waste collection is less effective. Proactive policies in wealthier cities have helped keep waste generation in check.

→ The 22 Asian cities generate an average of 380 kg of waste per person per year, compared with 465 kg in Latin America and 511 kg in Europe.

→ Every city in the Asian Green City Index has a strategy to reduce, recycle or re-use waste. The vast majority have environmental standards governing waste disposal sites and for industrial hazardous waste. Most cities also monitor illegal waste dumping.

→ Every city has recycling programmes covering a comprehensive range of materials including organic waste, electrical items, glass, plastics and paper.

→ Waste collection is weaker. Only seven cities collect and adequately dispose of more than 99% of waste, and on average the figure is 81%, compared with 96% in Latin America.

→ Waste picking is the biggest policy challenge. Only six cities have comprehensive regulations.

Water

Water consumption rates in the Asian Green City Index are similar to Latin America and Europe. In addition, water quality and sustainability policies are widespread in Asian cities. Basic infrastructure is a problem for poorer cities.

→ The 22 Asian cities use an average of 277 litres of water per person per day, which is slightly higher than the figure for Latin America, 264 litres, but lower than the figure for Europe, at 288 litres.

→ The average water leakage rate in Asian cities, at 22%, is slightly lower than Europe's, 23%, but significantly better than Latin America's, at 35%. Wealthier cities have very good leakage rates. For example, Tokyo's figure of 3% is lower than any city in Latin America or Europe. Poorer cities have difficulties. Four of the cities with low incomes (under US$10,000 in GDP per capita) lose over a third of water in the system to leakage.

→ Water meters, grey water recycling, and rainwater collection are nearly universal, although water stress is an issue in only about half of cities.

→ Every city has water quality codes and standards, and policies to publicly promote water efficiency.

Sanitation

Among the eight individual categories, the sanitation category sees the widest performance gap between top-performing and bottom-performing cities. The divide reflects differences in infrastructure, which are closely related to wealth.

→ The overall average rate of access to sanitation is 70%, less than in the Latin American Green City Index, at 93%. However, the percentage of wastewater treated is higher in the 22 Asian cities than in Latin America, at 60% for Asia compared to 52% in Latin America.

→ Six of the seven wealthiest cities in the Asian Green City Index have sanitation access rates of 99% or more, and five of the seven wealthiest cities treat nearly all of their wastewater. Cities with lower income fare much worse. In nine of the 11 cities with the lowest incomes in the Index (below US$10,000 in GDP per capita), an average of 49% of residents have access to sanitation and an average of just 36% of wastewater is treated.

→ Most cities in the Index have environmental codes covering sanitation, as well as minimum standards for wastewater treatment. Most also monitor on-site sanitation systems in homes or communal areas. However, only nine cities fully promote public awareness about the proper use of sanitation systems, and eight of these cities have the highest incomes in the Index.

Air quality

Air pollution is a serious problem across Asia, with average levels of the three pollutants evaluated in the Index exceeding the safe levels set down by the World Health Organisation (WHO). However, most cities are addressing the problem with government policies. Cities with higher incomes perform better for sulphur dioxide emissions and particulate matter, but nitrogen dioxide levels — a primary source of which is automobiles — show no correlation with income.

→ Particulate matter is the biggest air quality challenge identified in the Index. The average annual daily concentration of particulate matter among the 22 cities is 108 micrograms per cubic metre, which is more than five times the WHO's recommended safe level of 20 micrograms. No cities in the Index are below the guideline.

→ The annual average daily concentration of nitrogen dioxide among cities in the Index is 47 micrograms per cubic metre, also well above the WHO's recommended safe level of 40. Only six cities are below that benchmark.

→ The annual average daily level of sulphur dioxide — a primary source of which is fossil fuels burned to generate power — is 23 micrograms per cubic metre. The WHO's safe guideline for sulphur dioxide is in the form of a 24-hour average rather than an annual average, which would be even lower. Even so, the Index annual average still exceeds the WHO's 24-hour average of 20 micrograms.

→ Clean air policies are widespread though. All cities have a code to improve air quality, and all cities conduct air quality monitoring.

→ Policies can make a difference if executed correctly. Yokohama and Tokyo used to have much more polluted air until city authorities tightened regulations.

Environmental governance

Most municipal governments across the region have established institutions for environmental governance. Divided authority between jurisdictions and a lack of administrative expertise to implement policies are ongoing challenges to effective oversight.

→ Index cities generally have environmental departments with broad responsibilities, and the legal capacity to implement regulations.

→ Environmental monitoring and providing public access to environmental information is nearly universal, except among a few lower income cities.

→ The involvement of citizens, non-governmental organisations and other stakeholders in decisions about projects with environmental impacts is widespread and growing, even in China, where there is traditionally less scope for such input.

→ Split jurisdictions can create difficulties: the municipal structure of Metro Manila, for example, causes notable variation in environmental governance among municipalities within the metropolitan area.

Managing the city as a 'living organism'

An interview with Nicholas You, urban environmental expert

The path to greener cities, says Nicholas You, requires rethinking how we manage them. Holistic planning too often suffers from a sector-by-sector approach across competing jurisdictions, and policymakers fail to see the city as a single entity. Mr You is chairman of the Steering Committee of UN-Habitat's World Urban Campaign, a platform for private and public organisations to share sustainable urban policies and tools. He also leads several other global sustainable development initiatives, and served on the expert panel that advised the Economist Intelligence Unit (EIU) on the methodology for the Asian Green City Index. He spoke to the EIU about the results of the Index, the difficulty of measuring the environmental impact of informal settlements and the necessity to administer cities as "living organisms".

The Index results suggest that there is a very strong correlation between income and environmental performance in Asia, with higher income cities performing better. However, the results also show that once cities reach about US$20,000 in GDP per capita, their levels of carbon emissions, water consumption and waste generation do not keep rising with income. Have you seen evidence for this phenomenon more widely in Asia?
I think there is a certain amount of veracity in this correlation. How much is due to environmental awareness and how much is due to technological progress is subject to debate. But generally speaking as cities reach a certain level of wealth, their inhabitants will demand value for money and that includes clean air, clean water and a liveable urban environment.

Although wealth is important for environmental performance, what kinds of initiatives or activities can lower-income cities undertake to improve their environmental performance?
In economic terms, cities in lower-income countries have the most to gain from adopting environmentally sound and sustainable policies and practices. Such initiatives can substantially reduce waste, improve efficiency and create jobs and income generating opportunities. A typical example is waste recycling and reuse. In many cities in developing countries, this is carried out by scavengers working and living in deplorable conditions. The right mix of policies, participation and empowerment could result in win-win situations whereby waste is recycled into usable products; methane is captured to produce green energy; and the scavengers no longer have to work in life-threatening conditions.

Chinese cities perform poorly as expected for carbon emissions and air quality. But they perform perhaps better than expected in other environmental areas, and are particularly strong on environmental policies measured in the Index. How would you evaluate China's current approach to balancing growth with sustainability?
The context of carbon emissions in Chinese cities is different to the situation in Europe or North America. Cities in the west typically account for 70% of energy consumption, of which 70% is used for heating, ventilation, air conditioning and lighting of buildings. Reducing carbon emissions therefore depends to a large extent on reducing energy demand and changing consumption patterns. In Chinese cities, more than two thirds of energy consumption is used for industrial production. The average urban consumer is actually quite frugal, and a sizeable portion of the rural population remains off grid. The focus for carbon emissions, for the foreseeable future, is on reducing energy intensity in industrial production, while at the same time accepting an increase in household energy consumption. While this may appear contradictory, it is perfectly justified, since access to energy is critical to improving quality of life and economic productivity. What is missing, however, is a comprehensive framework for urban sustainability. Such a framework, which is equally valid for all cities worldwide, must look at how we can help foster compact and complete communities that avoid urban sprawl and reduce reliance on individual motorized transport.

Informal settlements clearly affect a city's environmental footprint. Yet by their nature, informal settlements are not well covered by statistics. For that reason the Economist Intelligence Unit could not include data about informal settlements in the Asian Green City Index in a way that was methodologically sound. How might this affect the overall environmental picture of cities in Asia, and how exactly do informal settlements affect the environmental performance of a city?
Informal settlements are, by definition, unsustainable. They represent a high degree of social and economic exclusion. Milton Santos, one of the most advanced thinkers of his time, said that poverty is the worst form of pollution. Informal settlements are living proof that we are not planning our cities well.

Often cities report high levels of access to basic services, such as potable water, waste collection and sanitation, when the situation on the ground may be very different because of the presence of informal settlements. What are the implications for trying to get an accurate picture through data?
If you are looking at indicators, such as water consumption per capita or waste generation per capita, and leave out informal settlements, you're leaving out part of the picture. The water company has a remit, and the sewage company has a remit, and their remits do not typically include informal settlements. They rightly say "100% coverage", while the city as a whole may drop down to 70% access. Since the Green City Index is comparative within a region, that is, comparing Asian cities with each other, the distortion won't be that serious. If we compare across regions, we have to be a little more careful.

What are the objectives of UN-Habitat with respect to improving statistics on informal settlements?
UN-Habitat has been trying to show that the methods being used do not provide an accurate picture of what is happening when it comes to informal settlements. It will take years to change the way statistical offices work and census data is taken. The statistical issue is, how do you gradually refine techniques so these problems are not overlooked. When data is disaggregated, for example, at the household or neighbourhood level, which UN-Habitat has been doing for some time, we begin to see another picture of reality. A common syndrome, for example, is that we often confound proximity with access. People living in informal settlements may literally be living next door to water supply, sewerage and garbage collection services, or for that matter to schools and hospitals, yet not have access to these services.

Can we identify any common approaches in the way cities are addressing the challenge of informal settlements?
I believe that we are beginning to see an emerging pattern which favours upgrading informal settlements, as opposed to removal and demolition. Slums are communities with their own social, cultural and economic networks. A lot of the reason why people don't move from the informal settlement is because, in terms of location, they are ideal, with access to jobs, or services they would otherwise have to pay considerably more for. Most slums started their life located on the margins of the city. Over time, with rapid growth, the slum actually finds itself located in the middle of the city. Removal or relocation is also asking people to move from a neighbourhood where they have lived a good part of their life, if not their whole life.

What kinds of upgrades are cities undertaking?
Upgrading takes place on several fronts — hooking the settlement into the infrastructure grid, and providing waste collection, water and sanitation. There is also an issue of tenure. Most of the time an informal settlement remains informal because it is not clear who owns or has the right to the land. The service provider, the water or sewerage company, for example, is very reluctant to put in infrastructure if tenure is not clear.

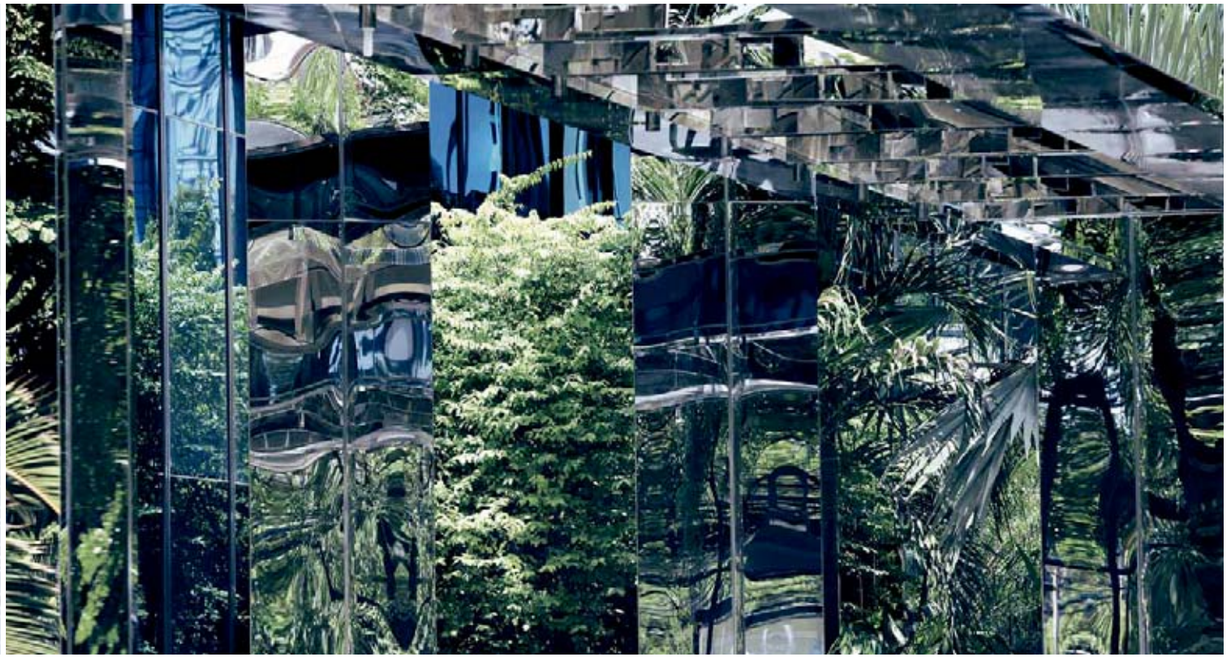
What incentives do cities have to upgrade rather than remove the settlements?
The cities that are trying to play a proactive role realise that globalisation is affecting everyone, everywhere. They can become victims of globalisation, or get some of the benefits. The proactive cities realise you can't have high percentages of your population socially excluded and expect to be a global city.

In general, how can city planning be improved?
For many years I headed a best-practice initiative at UN-Habitat, and we found literally hundreds of examples of innovations, new models, new technologies. The single biggest question I had to ask myself all the time was, 'Why aren't these best practices becoming the norm?' The only answer I came up with is that the lessons from best practices are not being fed into policymaking at the highest level. They remain isolated initiatives that might inspire a few other cities, but they don't necessarily have an impact on public policy, and therefore don't get replicated at scale. We need to realise there is a lot of innovation out there. How can we systematically document these stories and record the lessons learned, and provide a feedback mechanism directly into policy?

The World Urban Campaign is working on an initiative to get cities to tell their stories under a new perspective of "living practices". What are you doing today to tackle tomorrow's challenges? What innovations are being tested, what new tools are being developed?

What are the most important steps that cities in Asia and the rest of the world have to take to become more environmentally sustainable?
We have to take planning seriously. I don't mean 'sectoral' planning, where each sector — water, energy, waste, sanitation — plans independently. We must look at the city or the metro region as a whole. Competing jurisdictions are one of the biggest enemies to sustainable urbanisation. You have metropolitan areas cutting across many jurisdictions, with several planning commissions and independent service providers. You could be busy trying to green your city, but half of the population that depends on your city may live in the suburbs and fall under a different governmental structure; and these governments are busy building the next shopping mall, the next golf course, the next exburb. 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.

Exemplar Projects



Energy and CO_2

Tokyo: The first cap and trade system in Asia

Tokyo performs reasonably well in the Index regarding carbon emissions: it finishes 11th for emissions per capita and first for energy consumed per unit of GDP. The city's ambitious policies, however, are what really sets it apart.

Rather than wait for a national programme, the city created its own mandatory cap and trade system, the first in Asia, as part of its own wider climate change strategy. The system came into effect in April 2010, and aims to cut emissions by 25% from 2000 levels. All organisations that use the energy equivalent of 1,500 litres of oil annually for fuel, heat and electricity are required to participate. In the first five years to 2015, those in the scheme will need to reduce emissions by 6% (from their average level of emissions between 2007 and 2010). In the following five years they must cut an additional 17%. Those who make bigger reductions are allowed to sell credits. The city says that the system is unique because it is the first to cover all major buildings, including offices, hospitals, universities and government buildings.

One reason for the system is the local government's desire to address the city's own emissions, which are estimated to be roughly the same size as Denmark's or Norway's. Just as important, however, is that the city is trying to encourage the adoption of such schemes on the national and international stage. For example, Tokyo publicly contrasts its own mandatory efforts with the voluntary ones of the Japanese government.

Ideas from other cities

Osaka is making concerted efforts to use solar energy to reduce its carbon emissions. In 2009 the municipal government began offering subsidies for the installation of solar power systems, with homes eligible for up to US$3,400 and offices US$17,000. The city is also deploying floating, solar-powered water purifiers on the Dontonbori canal that can each clean 2,400 litres per day. Osaka's biggest solar venture is Japan's first commercial solar electric plant, with a 10-megawatt capacity, to be built on the artificial island of Yumeshima in the city's harbour. **Bangkok** is promoting the use of biofuels. The authorities aim to increase the proportion of gasohol — a mixture of gasoline and ethanol — in the fuel mix (the total of all fuels consumed) from less than 20% in 2007 to 50% by 2012. They are also funding the purchase of used cooking oil for refinement into biodiesel. **Mumbai** has a fragmented energy delivery market which makes overarching conservation projects difficult. In September 2009, the Mumbai Energy Alliance was formed. It is a partnership between the Mumbai government, the International Institute for Energy Conservation, and others, including energy companies, to implement energy efficiency programmes in the region. A pipeline of proposed projects is expected to reduce carbon dioxide emissions by 13 million tonnes.

Shanghai: The largest offshore wind farm in China

Shanghai, which currently produces only about 2% of its electricity from renewable sources — and almost all of that from hydropower — is making massive investments in wind power. The city built its first wind power station in 2003 and by 2007, it had three sites with a total of 24 megawatts of capacity, producing enough electricity to power an estimated 24,000 households. In 2008, one of the three plants, located in a wetland reserve, was expanded from 4.5 megawatts of capacity to 19.5 megawatts, which could provide power for an additional 15,000 households from that single site.

The city's future plans are even more ambitious. By 2020, officials expect to have a total of 13 wind farms producing a total of 2.1 gigawatts of total installed capacity, providing electricity for more than 4 million households. One of the largest of these is the Donghai Bridge Wind Farm, located about 5 miles offshore in the East China Sea, which began feeding electricity into the grid in July 2010. The US$340 million project has 34 turbines, each with 3 megawatts of capacity, and is the first offshore wind farm in China, and the world's first major offshore wind farm located outside of Europe. It is capable of providing about 1% of the city's total power production; and is expected to cut coal use by 100,000 tonnes per year and thereby reduce carbon emissions by 246,000 tonnes annually.

Land use and buildings

New technology: The world's greenest skyscraper in Guangzhou

Skyscrapers spring up almost overnight in China, and the results are not always environmentally unsustainable. When the 71-storey Pearl River Tower in Guangzhou is completed, which is expected in 2011, it will be the largest zero-emission building in the world.

The tower's environmental performance will come from a range of features. The most striking is its curved design, which funnels wind towards turbines that provide 4% of the building's energy. Equally important are features which reduce energy consumption. Solar panels on the roof supply power to automated window blinds that reduce the sun's impact inside the building. Meanwhile, the skin of the building includes an air gap that traps heat; the warm air then rises and is harvested in heat exchangers. The cooling features mean that the air conditioning system is 80% smaller than for a conventional building of its size. That goes a long way towards making the whole structure 58% more efficient than a traditional skyscraper. Looking beyond energy, a rainwater collection system, combined with the solar panels, will provide warm water to the building. Overall, the Pearl River Tower is so rich in ideas that it is well worth studying by other Asian cities.

Old technology: Planting trees in Beijing

Beijing has serious air quality challenges, with levels of nitrogen dioxide, sulphur dioxide and suspended particulate matter that are all above the Index averages. In addition, it has had an increasing number of sandstorms in recent decades, especially in the spring, as the northern desert has crept steadily closer. To address this problem, the local government has encouraged green spaces as one part of the solution.

The most high profile element of these efforts is the "Voluntary Tree Planting Day". The 26th annual event in 2010 saw some 2 million residents, including the president and most senior officials, out planting trees. This event is only the most visible part of a broader policy that involves creating green belts of trees and flowers bordering several of the main ring roads, green separation belts between sections of the city, specific gardens and green spaces where people gather, and the greening of 1 million square metres of rooftop. The goal is that a resident will never be more than 500 metres from a green space.

Progress has been steady, and accelerated in preparation for the 2008 Olympics. The city's green area — that which is covered by lawns, and the shadow of trees and bushes — rose from 36% in 2000 to 43% in 2007, and has since then reached just over 50%. In comparison, the figure for London is 63%. Although this may not prevent sandstorms, it makes for a much more liveable city in such close proximity to a desert.

Ideas from other cities

Hanoi has adopted a long-term strategy to turn itself into a "green, civilised and modern city" by 2050, which will involve setting aside up to 70% of the city's natural territory for "tree and water space." In 2010, **Osaka** planned to more than quadruple the number of its so called green "curtains" for the walls of public buildings and "carpets" for the roofs to 485. It creates these by planting vegetables, such as bitter melons and sweet potatoes, on the roofs and walls of city hall headquarters, primary and middle schools, ward offices, and other public facilities in the city. This eases the city's "heat island phenomenon," which occurs when a metropolis is much warmer than surrounding areas. Residents of **Nanjing** so rarely have central heating that they frequently reverse their air conditioning units in the winter to heat their accommodation — a highly wasteful approach. The city is therefore setting up community heating systems for new residential blocks that use excess heat from electricity generating facilities.

Transport

Shanghai: Doubling the size of the world's longest metro

Shanghai's metro has grown at a stunning rate. The city opened its first line, which covered only 20 km, in 1995. For most of the last decade, it has invested US$4.5 billion per year and now has a system with 12 lines, 268 stations, and 420 km of track, making it the world's longest in absolute terms. By comparison, London has 408 km and New York has 368 km. In August 2010, Shanghai set its one-day record of 6.7 million travellers.The main problem is that the metro is still too small for the city's almost 20 million inhabitants. Shanghai has extensive traffic jams at rush hour, and some metro lines can become so crowded that people have been hired to push passengers into train carriages in order to reduce delays in stations. For the moment, buses are taking some of the overflow. The city has aimed to more than triple the 86 km of exclusive bus lanes set aside between 2002 and 2008. Looking ahead, however, the metro system will see even faster growth than before. The city is building 140 km of new track to be opened in 2012, and expects by 2020 to have 22 lines totalling 877 km. In effect, Shanghai is adding the equivalent of the longest system of any city in the world to its already record-breaking network.

Green transport: A holistic approach in Singapore

Singapore already has a strong foundation in sustainable transport, and achieves an above average ranking for the category in the Index.

Ideas from other cities

Hong Kong's Mass Transit Railway (MTR) became the world's first heavy rail train line to use automated, driverless technology when it introduced it on a 3.8 km route from Sunny Bay Station on the main airport line to the Disneyland Resort. Automation is more energy efficient because trains on the line achieve one of the highest average speeds on the MTR, at 55 km per hour, even though other lines on the system are allowed to reach much higher peak speeds when possible. Other efficiency measures on the line include: automatic adjustment of train service frequency based on the number of passengers actually waiting; and use of natural light and open ventilation in stations to reduce energy consumption. **Wuhan** took a step towards integrating its public transport services by introducing a card that provides discounted fares on ferries, buses and its metro system. **Jakarta** is planning to add seven more lines to the eight which already make up the city's TransJakarta Busway, a tram-like "bus rapid transit" service which first opened in 2004. The service carries passengers in modern air-conditioned buses in dedicated bus lanes which currently cover 124 km. Not only is the service the fastest way to get through the city's traffic-clogged streets, but the buses also use biodiesel, which emits less CO_2 than conventional diesel or compressed natural gas. The **Osaka** city government is installing rapid chargers for electric vehicles at 10 locations, including the main city office's car park.

However, improving the city's performance even further remains a strong priority on an island where roads take up 12% of the island's total land area, and the transport sector accounts for about 13% of total energy consumption, as well as 50% of fine particulate matter in the air.

In response, the city has devised a comprehensive, integrated strategy for the next two decades that aims to both lower the city's environmental footprint and improve the travel experience for residents. The city's plan calls for increasing the share of morning commuting journeys on public transport to 70% by 2020, up from 59% in 2008. Officials will invest US$40 billion to double the rail network, from 142 km to 278 km by 2020, and plan to develop more connections between bus and rail services. Bus operations will be further centralised, with more feeder buses connecting to main routes, more exclusive priority lanes for buses, and real-time public transport information online and through mobile phones. The city has already halved its limit on the annual growth of the vehicle stock, from 3% to 1.5%. A number of other initiatives are also in the pipeline, including piloting diesel-electric hybrid buses, revising fuel duties, improving emissions testing and investing US$43 million to create new cycling paths.

Waste

Hanoi: Making waste pay

Much of the waste central Hanoi produces goes to landfill with little or no sorting. In some districts the trash is simply thrown into lakes. This will soon change. The Advanced International Company, under a 50-year "build-operate-transfer" arrangement with Hanoi, is scheduled to open a US$31 million, 15-hectare waste-processing plant this year that can handle 2,000 tonnes of solid waste per day. After the time period expires, the operation becomes city property.

The plan is to separate waste into three types. First, organic waste, which the company estimates constitutes 40% to 50% of Hanoi's garbage, will undergo anaerobic composting in order to create fertiliser. According to the company, this method is much cheaper than burning waste, and Malaysian plantations have already expressed an interest in the output. Second, recycled waste, such as rubber, plastic and metals, will be packaged and sold to companies in Malaysia, Singapore and Thailand. Finally, some of the other waste can be processed for use as construction material. The company expects that only 15% of the waste going through the plant will need to be sent to landfill, and this will be processed to do the least harm to the environment.

Bangkok: Follow that trash

Bangkok has seen numerous instances of waste dumped in landfill sites without proper treatment or disposed of illegally in some other way. Many industrial waste plants also report false figures and get rid of at least some of the garbage they receive improperly to save money. In order to address this issue, the Industrial Works Department paid two local firms US$151,000 to develop jointly a GPS system to track garbage shipments. It cost just over US$650 to equip each truck, but once they have the system on board, both the department and the companies that created the waste can confirm whether it is transported and disposed of properly.

The system is about more than compliance: it allows insight into the waste itself. Companies equipped with the system, for example, gain a better understanding of the waste they produce, and in particular, what portions they could sell rather than throw away. GPS has also allowed interesting academic investigations of Bangkok's waste collection system, with three Japanese scientists and a Thai colleague tracking garbage trucks in order to understand waste flow in an area on the northern outskirts of the city.

Ideas from other cities

With little room for new landfill sites, **Hong Kong** is concentrating on waste reduction. It imposed a US$0.06 tax on plastic shopping bags in July 2009 to help decrease the estimated 8 billion such bags that end up in landfill annually. **Wuhan** is shifting its waste policy from landfill to incineration. Its Sanitation Master Plan calls for the building of five waste-to-energy incinerators with a total capacity of 6,500 tonnes per day and an output of around 150 megawatts. **Osaka's** municipal government holds a recycling contest for companies in the city, rewarding small and medium-sized enterprises for their efforts to reduce waste. **Taipei City's** government runs a "Repaired Furniture Display Area," where officials accept discarded large items of furniture from residents which the city refurbishes and sells. Since 2009, when the scheme began, the city has sold more than 100,000 items for US$300,000.

Water

Singapore: Water as good as new

Water has long been a concern for Singapore, a city-state with few fresh sources. Moreover, occasional political tension with neighbouring Malaysia, the one possible foreign source, convinced Singapore's leaders to pursue greater self-sufficiency. The most innovative of several strategies which the city has pursued concurrently has been the purification of wastewater, which Singapore has branded "NEWater".

Much of the technology has long existed, although Singapore uses advanced forms. The wastewater first goes through two types of filtration — micro-filtration and reverse osmosis — which between them take out suspended

particles, metals, salts and most pathogens. Then ultraviolet light treatment kills off any remaining microbes that may have unexpectedly remained. The resulting water is more than pure enough to drink.

Most of the NEWater goes to non-domestic users, such as wafer-production plants that need a very pure supply. Nevertheless, the government made a conscious decision to pump a small amount into the reservoir system that feeds the drinking supply. By 2011, it will make up about 3% of what people consume. The strategy has worked: familiarity has led to rapid acceptance. Although the first water recycling facility only came online in 1999, by 2007 there were four, providing all together up to 15% of the city's water needs. This figure has increased to 30% with the full completion of the fifth and largest NEWater plant at Changi in 2010.

Ideas from other cities

Nanjing and **Beijing** both face very low water supplies and are encouraging conservation in various ways. Nanjing is increasing water prices by 12% while Beijing is planning extensive work to reduce leakage in the distribution system, and is encouraging households and businesses to install water meters. **Hong Kong** is spending US$2.5 billion to repair or replace 3,000 km of its 7,700 km water-main network by 2015. The government is considering extending the program to cover the entire network after that year. To help address its high water leakage rate, the **Delhi** city government has set up a leak detection and investigation unit. It began work with sounding rods and pipe locators but is now equipped with more modern sonic and electronic equipment. In 1987, the **Yokohama** Waterworks Bureau, recognising that it had benefited extensively from a British engineer's technical assistance a century earlier, began inviting experts from developing-world cities to attend training programmes. Over more than two decades, nearly 2,000 people have participated from 35 countries. The city, which has one of the lowest water leakage rates in the Index, also sends out experts to other countries, and has entered into technical assistance arrangements with water departments of several developing Asian cities.

Environmental governance

Eco-clubs: Educating future environmentalists in Delhi

Urban environmental sustainability is a result of attitudes as much as anything else, and Delhi's environment department has been using school "eco-clubs" to try to shape students' views. The clubs have broad aims, and engage students in a wide variety of projects, including planting trees, conserving water, creating nature trails and minimising waste. The clubs also provide a convenient way to spread information widely on environmental campaigns, such as the city's efforts to reduce the use of firecrackers during Diwali celebrations.

The environment department provides the framework for the clubs, along with a small subsidy of about US$200 to each, but the enthusiasm of the students and teachers is what really drives the idea. There are clubs in about 1,000 schools, and among these are 100 lead schools, each of which has a teacher who has received instruction to train others. The lead schools also coordinate the activities of up to 30 more schools. The clubs cover every age, from primary schools all the way up to universities. Some are particularly active. At Salwan Public School, for example, a primary school, the club is an institutional member of eight non-governmental organisations, and divides students by interest into those interested in land, air, water, energy, or waste management. Students can engage in a vast range of activities, including air monitoring, water harvesting, recycling paper, awareness-raising campaigns, eco-tours, and even adventure sports. Thus, for a very small investment, Delhi has been able to harness existing interest in the environment in a way that greatly encourages sustainability now and will shape attitudes among residents for years to come.

Ideas from other cities

Singapore's Centre for Liveable Cities is a think tank established by the Singapore government in 2008. It combines expertise from the public and private sectors and produces events, research and reports on sustainable urban development and environmental management. The Orangi Pilot project in **Karachi**, which has been hailed as a success story across Asia, gives residents of poor communities the resources and engineering expertise to help solve their own environmental challenges. The project began in the 1980s in Orangi Town, an area within Karachi, and initially focused on sewer improvements. Within 10 years, the programme had expanded to cover not only environmental challenges, but had also led to the establishment of schools, health clinics, women's work centres, stores and a credit organisation to finance further projects. Today the Orangi project model is being replicated in other cities in Pakistan, as well as Sri Lanka, India, Nepal and South Africa. The **Seoul** city government runs the "Green Seoul Citizen Committee" which encourages citizen participation in environmental policy. Established in 1995, the green committee is chaired by Seoul's mayor and has 100 members from non-governmental organisations and businesses. Meetings take place about 120 times per year to review new policy proposals on conservation and climate change.

Methodology

The Asian Green City Index measures the current environmental performance of 22 major Asian cities, as well as their commitment to reducing their future environmental impact. The selection sought to include the capital cities or leading business capitals of all major Asian countries, selected by size and importance. Where city-specific data were significantly lacking, cities had to be omitted and this was notably the case for Ho Chi Minh City.

The methodology, developed by the EIU in cooperation with Siemens, builds on the work of earlier regional Green City Indices. To be most applicable to Asia, the structure has been adapted to accommodate variations in data quality and availability, and environmental challenges specific to the region. An independent panel of international experts in the field of urban sustainability also provided important insights and feedback in the construction of the Asian Green City Index. Owing to concerns that the data was insufficiently reliable or comparable to justify a detailed ranking of Index results, the Asian Green City Index results are presented in five bands defined relative to the average score.

The Index scores cities across eight categories — energy and CO_2, land use and buildings, transport, waste, water, sanitation, air quality, and environmental governance — and 29 individual indicators. Fourteen are quantitative and measure how a city currently performs — for example, a city's water leakage or waste production. The remaining 15 qualitative indicators assess policies and plans — for example, a city's commitment to reducing the environmental impact of energy consumption, green standards for public building projects, reducing congestion or recycling waste.

Data collection: An EIU team collected data between April and June 2010. Wherever possible, the data were taken from publicly available official sources, such as national or regional statistical offices, local city authorities, local utilities companies, municipal and regional environmental bureaux, and environmental ministries. The data are generally for the year 2008-2009, but when these were not available they were taken from earlier years.

Data quality: The availability and comparability of data across cities is far more limited in Asia than in Europe or North America. The Index has sought to include the most recent data available for each city, even though this may mean that in some cases, because of differences in the capacity of cities to gather and publish information quickly, the comparison points are several years apart. Where gaps in the data existed, the Economist Intelligence Unit has produced estimates from national averages or other available, relevant data.

The EIU made every effort to obtain the most recent data, including checking quantitative data points with the cities' environmental departments. Data providers were also contacted where uncertainties arose regarding individual data points.

With regard to the indicator on CO_2 emissions, the Economist Intelligence Unit used international CO_2 coefficients provided by the UN Intergovernmental Panel on Climate Change to estimate the CO_2 emissions produced by the city's energy mix. Only in very exceptional cases did the Economist Intelligence Unit produce estimates for CO_2 and energy consumption on the basis of regression analysis, referencing data of peer cities if this data was not available for the specific city. This was the case for Kuala Lumpur, Karachi and Hanoi.

Indicators: In order to compare data points across cities, and to calculate aggregate scores for each city, the data gathered from various sources had to be made comparable. For this purpose, the quantitative indicators were "normalised" on a scale of zero to ten, with the best city scoring ten points and the worst zero. Most indicators use a min-max calculation, where the best city receives ten points and the worst city zero. In some cases, reasonable benchmarks were inserted to prevent outliers from skewing the distribution of scores. In such cases, cities were scored against either an upper or a lower benchmark, or both. For example, a lower benchmark of 10% was used in scoring "wastewater treated" and all cities with less than that figure received a score of zero for that indicator.

Cities use varying definitions for certain indicators, notably definitions of green spaces, municipal waste generated, length of superior transport networks, and administrative areas. In such cases, the EIU has sought to standardise the definition used. However, some differences still exist and where significant these are identified in the footnotes.

Qualitative indicators were scored by analysts with expertise in the relevant city, based on objective criteria that consider cities' targets, strategies, and concrete actions. The qualitative indicators were also scored on a scale of zero to ten, with ten points assigned to cities that meet the criteria on the checklist. For the "greenhouse gas (GHG) monitoring" indicator, for example, cities were assessed according to whether they regularly monitor GHG emissions and publish their findings every one to three years. Selected qualitative indicators which seek to measure the existence of policies in certain areas — for example, the containment of urban sprawl — have been multiplied using a rating on the city's efficiency to implement environmental policies (Policy Implementation Effectiveness Rating). These ratings were produced by EIU analysts with thorough knowledge of the relevant city on a scale of one to five, with five being highly effective.

Index construction: The Index is composed of aggregate scores of all of the underlying indicators. These are first aggregated by category, creating a score for each. These are in turn com-

bined into an overall score. To create the category scores, within each category all the underlying indicators received the same weight during aggregation. The scores were then rebased onto a scale of zero to 100. To build the overall Index scores, the EIU assigned even weightings to each category score so that no category was given greater importance than any other. The Index is essentially the sum of all category scores, rebased to 100. The equal weighting of each category reflects feedback from the expert panel.

Finally, the cities were placed in one of five bands, both within categories and overall, reflecting the relevant scores. These bands are built around the average (mean) score and are defined using the standard deviation — a statistical term which is the area around the mean that covers two-thirds of the values. The bands are defined as follows:

→ Well above average: Scores more than 1.5 times the standard deviation above the mean

→ Above average: Scores between 0.5 and 1.5 times the standard deviation above the mean

→ Average: Scores between 0.5 times the standard deviation below and 0.5 times the standard deviation above the mean

→ Below average: Scores between 0.5 and 1.5 times the standard deviation below the mean

→ Well below average: Scores more than 1.5 times the standard deviation below the mean.

Clusters: In order to conduct a deeper analysis of city trends, the 22 cities in the Index were clustered into a series of groups, defined by the size of the population, area, income, density and temperature. These included:

→ Population: "small population", with a population below 5 million; "mid population", with a population between 5 and 10 million; and "high population" with a population exceeding 10 million inhabitants.

→ Area: "small area", with an administrative area smaller than 1,000 square kilometres; "mid area", with an administrative area between 1,000 square kilometres and 5,000 square kilometres; and "large area", with an administrative area larger than 5,000 square kilometres.

→ Income: "low income", with GDP per capita of less than US$10,000; "middle income", with GDP per capita of US$10,000 to US$25,000; and "high income", with GDP per capita of more than US$25,000.

→ Density: "low density", with a population of less than 5,000 people per square kilometre; "mid density", with a population between 5,000 people per square kilometre and 10,000 people per square kilometre; and "high density", with a population of more than 10,000 people per square kilometre.

→ Temperature: "low temperature", with an average temperature of below 16 degrees Celsius; "mid temperature", with an average temperature of between 16 degrees Celsius and 25 degrees Celsius; and "high temperature", with an average temperature above 25 degrees Celsius.

List of categories, indicators and their weightings

Category	Indicator	Type	Weight	Description	Normalisation technique*
Energy and CO_2	CO_2 emissions per capita	Quantitative	25%	Total annual carbon dioxide emissions generated by the city from total energy consumption, in tonnes per capita.	Min-max approximation.
	Energy consumption per unit of GDP	Quantitative	25%	Total annual energy consumed by the city, in megajoules per unit of GDP (in thousands of US$, at current prices).	Min-max.
	Clean energy policy	Qualitative	25%	Measure of a city's efforts to reduce carbon emissions associated with energy consumption.	Scored by EIU analysts on a scale of 0 to 10.
	Climate change action plan	Qualitative	25%	Measure of a city's strategy to combat its contribution to climate change.	Scored by EIU analysts on a scale of 0 to 10.
Land use and buildings	Green spaces per capita	Quantitative	25%	Sum of all public parks, recreation areas, greenways, waterways, and other protected areas accessible to the public, in m^2 per inhabitant.	Zero-max; upper benchmark of $100m^2$ per person inserted to prevent outliers.
	Population density	Quantitative	25%	Population density, in persons per km^2.	Min-max; upper benchmark of 10,000 persons per km^2 inserted to account for differences in territorial definitions.
	Eco buildings policy	Qualitative	25%	Measure of a city's efforts to minimise the environmental impact of buildings.	Scored by EIU analysts on a scale of 0 to 10.
	Land use policy	Qualitative	25%	Measure of a city's efforts to minimise the environmental and ecological impact of urban development.	Scored by EIU analysts on a scale of 0 to 10.
Trans-port	Superior public transport network	Quantitative	33%	Total length of all superior modes of public transport, ie BRT, tram, light rail and subway, measured in terms of the area of the city (in km/km^2).	Zero-max; upper benchmark of $0.3km/km^2$ inserted to prevent outliers.
	Urban mass transport policy	Qualitative	33%	Measure of a city's efforts to create a viable mass transport system as an alternative to private vehicles.	Scored by EIU analysts on a scale of 0 to 10.
	Congestion reduction policy	Qualitative	33%	Measure of a city's efforts to reduce traffic congestion.	Scored by EIU analysts on a scale of 0 to 10.
Waste	Share of waste collected and adequately disposed	Quantitative	25%	Share of waste collected by the city and adequately disposed either in sanitary landfills, incineration sites or in regulated recycling facilities. Expressed in terms of the total volume of waste generated by the city.	Min-max.
	Waste generated per capita	Quantitative	25%	Total annual volume of waste generated by the city, including waste not officially collected and disposed, in kg per capita.	Zero-max.
	Waste collection and disposal policy	Qualitative	25%	Measure of a city's efforts to improve or sustain its waste collection and disposal system to minimise the environmental impact of waste.	Scored by EIU analysts on a scale of 0 to 10.
	Waste recycling and re-use policy	Qualitative	25%	Measure of a city's efforts to reduce, recycle and re-use waste.	Scored by EIU analysts on a scale of 0 to 10.
Water	Water consumption per capita	Quantitative	25%	Total water consumed by the city, on a daily basis, expressed in litres per person.	Scored against a lower benchmark of 500 litres per person per day and an upper benchmark of 100 litres per person per day.
	Water system leakages	Quantitative	25%	Share of water lost in transmission between supplier and end user, excluding illegally sourced water or on-site leakages, expressed in terms of total water supplied.	Zero-max; lower benchmark of 45% inserted to prevent outliers.
	Water quality policy	Qualitative	25%	Measure of a city's policy towards improving the quality of surface and drinking water.	Scored by EIU analysts on a scale of 0 to 10.
	Water sustainability policy	Qualitative	25%	Measure of a city's efforts to manage water sources efficiently.	Scored by EIU analysts on a scale of 0 to 10.
Sani-tation	Population with access to improved sanitation	Quantitative	33%	Share of the total population either with direct connections to sewerage, or access to improved on-site sources such as septic tanks and improved latrines that are not accessible to the public. This figure excludes open public latrines or sewers and other shared facilities.	Zero-max; lower benchmark of 20% inserted to prevent outliers.
	Share of wastewater treated	Quantitative	33%	Share of wastewater produced by the city that is collected and treated to at least a basic/primary level.	Zero-max; lower benchmark of 10% inserted to prevent outliers.
	Sanitation policy	Qualitative	33%	Measure of a city's efforts to reduce pollution associated with inadequate sanitation.	Scored by EIU analysts on a scale of 0 to 10.
Air quality	Nitrogen dioxide concentration levels	Quantitative	25%	Annual daily mean of NO_2 concentrations.	Scored against an upper benchmark of $40ug/m^3$ (EIU calculation based on WHO target) and lower benchmark of $80ug/m^3$ to prevent outliers.
	Sulphur dioxide concentration levels	Quantitative	25%	Annual daily mean of SO_2 concentrations.	Scored against an upper benchmark of $10ug/m^3$ (WHO target) and a lower benchmark of $50ug/m^3$ to prevent outliers.
	Suspended particulate matter concentration levels	Quantitative	25%	Annual daily mean of PM_{10} concentrations.	Scored against an upper benchmark of $20ug/m^3$ (WHO target) and a lower benchmark of $200ug/m^3$ to prevent outliers.
	Clean air policy	Qualitative	25%	Measure of a city's efforts to reduce air pollution.	Scored by EIU analysts on a scale of 0 to 10.
Environ-mental gover-nance	Environmental management	Qualitative	33%	Measure of the extent of the city's environmental oversight.	Scored by EIU analysts on a scale of 0 to 10.
	Environmental monitoring	Qualitative	33%	Measure of the city's efforts to monitor its environmental performance.	Scored by EIU analysts on a scale of 0 to 10.
	Public participation	Qualitative	33%	Measure of the city's efforts to involve the public in environmental decision-making.	Scored by EIU analysts on a scale of 0 to 10.

*Cities score full points if they reach or exceed upper benchmarks, and zero points if they reach or exceed lower benchmarks.

Bangkok_Thailand

Background indicators

Total population (million)	5.7
Administrative area (km^2)	1,568.7
GDP per person (current prices) (US$)	9,095.4[1e]
Population density (persons/km^2)	3,607.4[e]
Temperature (24-hour average, annual) (°C)	28.0

Data applies to Bangkok City, 1) Based on population for Bangkok Metropolitan Region, e) EIU estimate

Bangkok, situated along the banks of the Chao Phraya River, is Thailand's capital and a regional commercial and transportation hub. It is one of the world's most popular tourist destinations, and its services-dominated economy accounts for nearly 30% of Thailand's GDP, with most heavy industry located outside the capital. Bangkok is home to all of the country's major financial institutions and the regional headquarters of numerous international companies. Bangkok faces many environmental challenges such as urban sprawl and insufficient infrastructure to deal with a growing population. Due to data availability, information in the Index for Bangkok comes from a mix of figures from the metropolitan region and the smaller city centre. For example, indicators for green spaces and water consumption take into account the metropolitan region, which has a population of about 12 million, while indicators for waste, transport and air are taken from the city centre, which has a population of about 5.7 million.

Bangkok ranks average overall in the Index. Its best performances are in the air quality and environmental governance categories, where it ranks above average. In the air quality category, Bangkok has below-average daily concentrations of the three pollutants measured in the Index, and the city has also made particular progress on vehicle emissions standards recently. Regarding environmental governance, the city scores well for having a dedicated environmental department with a wide remit, and for involving residents in environmental decisions. The city's performance is below average in the categories of land use and buildings, transport, waste, water and sanitation. Particular weaknesses in these categories include a relative lack of green spaces, higher-than-average levels of waste generation and water consumption, and a low amount of treated wastewater.

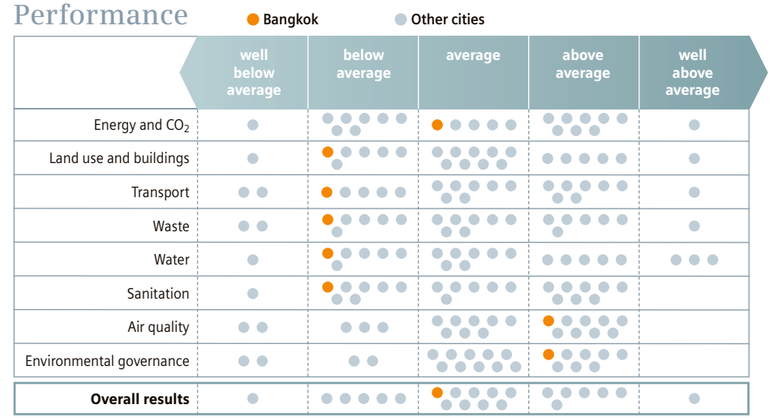
Energy and CO_2: Bangkok ranks average in energy and CO_2. Annual CO_2 emissions are an estimated 6.7 tonnes per person, above the 22-city average of 4.6 tonnes per person. Much of Thailand's industrial activity takes place in zones outside the capital city, and the city's emissions levels are mainly due to high rates of car ownership and electricity generation. According to the national Ministry of Energy, the transportation sector accounts for almost 40% of the city's CO_2 emissions. There are now more than 6 million vehicles registered in the city, up from around 4.2 million in 1999. Electricity generation, used mainly for lighting and air conditioning, accounts for a further third of the city's CO_2 emissions. Only about 5% of electricity is generated through renewable sources, with most electricity coming from natural gas. However, the city is relatively energy efficient, with energy consumption of an estimated 6 megajoules per US$ of GDP, which is equal to the Index average. The city performs relatively well in terms of clean energy policies, in particular for a strong energy strategy and waste-to-energy investments. It has also signed up to international covenants to reduce greenhouse gases, including the C40 group of global cities that have pledged to make CO_2 reductions.

Green initiatives: The city has backed a number of energy conservation measures as part of its global warming action plan, which runs from 2007 to 2012. Few specific details are included in the report, but according to the document, the city is encouraging residents to use air conditioning on an "as-needed basis", which officials believe could reduce electricity consumption by nearly 800 gigawatt hours per year. Other measures mentioned in the plan include promoting the use of energy-efficient light bulbs and appliances, but these initiatives are not mandatory. The city is also considering a waste-to-energy facility that would be capable of processing 3,000 tonnes of waste per day, but the city concedes that further research is needed before the plan can move forward. This would be in addition to ongoing waste-to-energy activities conducted by the Thai Oil Public Company, which buys municipal waste and converts it into gas through decomposition and fermentation. It then produces electricity from the gas. The city also funds the purchase of used cooking oil for refinement into bio-diesel.

Land use and buildings: Bangkok ranks below average in the land use and buildings category, mainly for a relative lack of green spaces. At 3 square metres per person across the metropolitan area, Bangkok is well below the Index average of 39 square metres. Green spaces have suffered at the expense of rapid urbanisation and a general tendency to favour economic development over environmental priorities. Bangkok is attempting to improve this situation (see "green initiatives" below), and has implemented policies to protect its existing green spaces and other environmentally sensitive areas. The city has the opportunity to bolster its eco-buildings policies, since it currently only has a partial code for eco-efficiency standards in new private buildings and has no green standards for its public buildings. However, Bangkok does score well for publicly promoting ways to improve energy efficiency in buildings. The city's climate change action plan also contains a pledge to make its buildings more energy efficient.

Green initiatives: The city is focusing on tree planting to improve and expand green spaces. Its climate change action plan calls for planting 3 million new trees by the end of 2012 along roadsides, canals and estuaries. In April 2010, Bangkok's deputy governor announced plans to redevelop an approximately 740-square-kilometre informal settlement within the city. This will involve building new residential complexes with a focus on increasing park space. Adapting suc-

Performance



The order of the dots within the performance bands has no bearing on the cities' results.

cessful sustainable informal settlement redevelopment projects from China, Japan and Singapore, the plan will be completed in stages until 2022, and will cost a total of US$1.3 billion. Following implementation, total park area will be increased by 320 square kilometres. Final approval for the plan is currently in negotiations with the Port Authority of Thailand and other potential financial backers.

Transport: Bangkok ranks below average in the transport category. In recent years the city has expanded its mass transit network, which now incorporates a 23-km elevated rail network and a 20-km underground train network. Over the next two decades plans are in place to build several new lines and extensions of existing lines, raising the length by some 350 km. In spite of recent expansions, the length of Bangkok's superior public transport network (defined in the Index as transport that moves large numbers of passengers quickly in dedicated lanes, such as metro, bus rapid transit or trams) remains well below the Index average, at 0.04 km per square kilometre compared to the average of 0.17 km per square kilometre. In addition, the city does not have an integrated pricing system for its public transport system. Traffic congestion also remains a serious problem throughout the city, since many residents choose to drive rather than take public transport. However, the city is trying to address the issue through the presence of some congestion reduction policies including "no-car days", road pricing, and park and ride systems. It also has traffic management systems, including traffic light sequencing and traffic information systems.

Green initiatives: In May 2010 the city opened its first bus rapid transit system, with 16 km of new bus routes, and in August it opened a new 28-km rail link to the main international airport to improve its public transport network. The city also has plans to develop more park and ride facilities, although it has given few further details.

Waste: In the waste category Bangkok ranks below average, due mainly to the large of amount of waste the city produces and the relatively low percentage it collects and disposes of adequately. The city generates 535 kg per person, versus the Index average of 375 kg per person, and only collects 63% of it, versus the Index average of 83%. Much of Bangkok's waste is disposed of in landfills after being transported to one of three sorting yards, but officials are concerned that landfill space is running out. There are plans in place to build an incinerator within the next decade. Although the city's approach to waste has suffered in the past because of a lack of initiatives to encourage residents to reduce waste and recycle, the city is marked up in the Index for having a waste strategy in place. It also performs well for enforcing hazardous waste standards, and for its recycling services, which include on-site collection and central collection points throughout the city.

Green initiatives: The city's Industrial Works Department paid two local firms US$150,000 to jointly develop a GPS system to track garbage shipments in its trucks. Once trucks are fitted with the system, which costs about US$660 per vehicle, the department and the companies that own the trucks know whether waste is transported and disposed of properly.

Water: Bangkok ranks below average in the water category. Its performance reflects the city's relatively high level of water consumption, at 340 litres per person per day, compared to the Index average of 278 litres. The high consumption rate is due in part to abundant water resources, with about 90% of the city's supply coming from treated water from the Chao Phraya and the Mae Klong rivers. The quality of river water is deteriorating from pollution, however, and intense groundwater pumping for the rest of the water supply has resulted in land subsidence and salinity contamination. Leakages in the water system are also a problem, with Bangkok losing around 35% of its water supply, compared to the 22-city average of 22%. Bangkok's water quality policies are strong, suggesting the city is addressing the issues. It is marked up for its water quality code, and it monitors surface water quality, although its standards on industry are weaker.

Green initiatives: In September 2010, city officials announced a plan to charge fees on water consumption in 20 districts in the city, which house a total of about 500,000 residents, to begin by early in 2011. The city believes the fees will encourage conservation. The fee will start at about US$0.03 per cubic metre in the first year, and in the third year rise to US$0.06 per cubic metre, the maximum to be charged under the plan. Households that use less than 10 cubic metres of tap water per month will not be charged. A wastewater fee already applies to hospitals, hotels and businesses, at between US$0.13 to US$0.16 per cubic metre.

Sanitation: Bangkok ranks below average in the sanitation category. Only an estimated 51% of Bangkok's residents have access to sanitation, versus the index average of 70%. Bangkok also lacks adequate wastewater treatment facilities, and treats only an estimated 12% of wastewater, compared to the Index average of 60%. Indeed, most wastewater is discharged directly into the city's main river and canals, although there are plans in place to improve its treatment capacity (see "green initiatives" below). Otherwise, the city scores well on sanitation policies, and is marked up for its sanitation code, wastewater treatment standards, and regular monitoring of on-site treatment facilities in homes or communal areas.

Green initiatives: The city has outlined plans to build additional wastewater facilities to almost double treatment capacity from 1 cubic metre to 1.8 cubic metres, although further details, such as timetables, are unclear.

Air quality: Bangkok ranks above average in the air quality category. Average daily levels of the three pollutants measured in the Index — nitrogen dioxide, sulphur dioxide and particulate matter — are below the Index averages. However, air pollution from traffic congestion in the built-up parts of the city remains a challenge, and the city has made some strides to introduce incentives for cleaner vehicles (see "green initiatives" below). It has a robust air quality code and it receives full marks for informing the public about the dangers of air pollution.

Green initiatives: Taxes are 5% lower for cleaner, alternative-fuel vehicles, and the policy is having a positive effect, with sales of cars that run on "E20 fuel" — a mixture of 20% ethanol and 80% petrol — outperforming sales of other vehicles. Bangkok authorities also aim to increase gasohol's proportion of the total fuel mix from less than 20% in 2007 to 50% by 2012 in order to improve air quality.

Environmental governance: Bangkok ranks above average in the environmental governance category. The city performs well for having a dedicated environmental department and the capacity to implement its own environmental legislation. In the Bangkok Metropolitan Area, the Department of the Environment for the Bangkok Metropolitan Administration oversees and implements environmental policies. In addition, the city has jurisdiction to change sections of national law according to local requirements. Officials also involve residents in decisions about projects with environmental impacts, and provide the public with access to online information. The city receives full marks in the Index for regularly monitoring its environmental performance and publishing information on progress.

Green initiatives: The city's cross-departmental climate change action plan features five major initiatives to reduce greenhouse gas emissions: expanding mass transit systems; promoting the use of renewable energy; improving electricity consumption efficiency in buildings; improving solid waste and wastewater treatment efficiency; and expanding park areas. Also, the Bangkok governor has taken a lead role in an initiative by the Association of South-East Asian Nations (ASEAN) to tackle climate change — the "Cool ASEAN, Green Capitals" project — which has been backed by the World Bank.

Quantitative indicators: Bangkok

		Average	Bangkok*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	6.7 [1e]	2008	Metropolitan Electricity Authority; Department of Alternative Energy Development and Efficiency Annual Report 2008; IPCC; EIU estimates
	Energy consumption per US$ GDP (MJ/US$)	6.0	6.1 [2e]	2008	Metropolitan Electricity Authority; Department of Alternative Energy Development and Efficiency Annual Report 2008; EIU estimates
Land use and buildings	Population density (persons/km^2)	8,228.8	3,607.4 [e]	2008	Department of Provincial Administration
	Green spaces per person (m^2/person)	38.6	3.3 [3]	2007	Action Plan on Global Warming Mitigation 2007 - 2012
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.04	2010	Bangkok Metro Public Company Ltd; Bangkok Mass Transit System Public Company Ltd; Bangkok BRT
Waste	Share of waste collected and adequately disposed (%)	82.8	62.9	2002	National Statistical Office of Thailand
	Waste generated per person (kg/person/year)	375.2	534.8	2005	National Statistical Office of Thailand
Water	Water consumption per person (litres per person per day)	277.6	340.2 [3]	2008	Metropolitan Waterworks Authority
	Water system leakages (%)	22.2	35.0 [4]	2003	Asian Development Bank
Sanitation	Population with access to sanitation (%)	70.1	51.0 [5e]	2003	United Nations Environment Programme
	Share of wastewater treated (%)	59.9	12.2 [6e]	2003	United Nations Environment Programme
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	42.7	2007	National Statistical Office of Thailand
	Daily sulphur dioxide levels (ug/m^3)	22.5	12.6	2007	National Statistical Office of Thailand
	Daily suspended particulate matter levels (ug/m^3)	107.8	48.1	2007	National Statistical Office of Thailand

* All data applies to Bangkok City unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Electricity data only available for Bangkok Metropolitan Region, 2) Based on 2005 GDP estimate; electricity data only available for Bangkok Metropolitan Region, 3) Bangkok Metropolitan Region, 4) Non-revenue water, 5) Based on population covered by wastewater control plants, 6) Based on treatment area

Beijing_China

Beijing, China's capital, has long been the country's cultural and political centre. A sprawling commercial hub with a population of some 17.6 million and a per capita GDP of US$10,100, Beijing is trying to balance its growth ambitions with a stated desire to protect the environment. With the world's attention on Beijing for the 2008 Olympic Games, the national and city governments invested heavily in improving air quality, landscaping and transport. Also, in recent years, the city government has made substantial investments in the high-tech and financial sectors, as well as relocating older, highly polluting factories outside city limits. Beijing still faces significant environmental challenges, especially in the areas of greenhouse gases and air quality, but the city performs well for the environmental policies covered by the Asian Green City Index, and has therefore established a foundation to improve its sustainability performance in the longer term.

Background indicators

Total population (million)	17.6
Administrative area (km^2)	16,410.5
GDP per person (current prices) (US$)	10,136.7
Population density (persons/km^2)	1,069.4
Temperature (24-hour average, annual) (°C)	12.0

Data applies to Beijing Municipality

Beijing ranks average in the Index. The city performs best in the water category, with an above average ranking, reflecting the city's vigilance in combating water shortages due to a lack of surrounding rainfall. The city ranks average in the categories of land use and buildings, transport, waste, sanitation and environmental governance. Compared with its mid-income peers (between US$10,000 and US$25,000), Beijing has the lowest level of per capita water consumption, the second most green spaces per person, and collects and disposes of the second highest share of waste. However, like other Chinese cities in the Index, Beijing has substantial energy and air quality challenges, and this is reflected by below average rankings for the energy and CO2, and air quality categories. It is also clear from the Index that China as a whole, not just Beijing, has much more to do in reducing greenhouse gases, becoming more energy efficient and reducing its reliance on private vehicles. Beijing's relative strength in sustainability policies and environmental governance does suggest that officials take green issues seriously, even if policy intentions have not had their full impact yet.

Energy and CO_2: Beijing ranks below average in the energy and CO_2 category. Despite two major waves of industrial relocation since the 1990s, many carbon-intensive businesses remain. And along with the rest of China, Beijing is highly dependent on carbon-intensive coal to meet its energy needs. Coal accounts for 39% of the city's total energy consumption — the third highest share of the 22 Asian cities. And the city uses coal to power almost 100% of its electricity, compared with about 80% for the rest of the country as a whole. As a result the city emits an estimated 8.2 tonnes of CO_2 per capita, compared with the index average of 4.6 tonnes. Beijing and the national government are investing in alternative sources of electricity for the future, including solar, biomass, wind, natural gas, nuclear and "clean coal", which involves capturing and storing greenhouse gases at coal plants. As yet though, renewable energy sources play a negligible role in Beijing's energy consumption. In addition, the relatively large amounts of energy Beijing uses in relation to its economic output means the city scores poorly for energy efficiency. At 12.3 megajoules per US$ of GDP, Beijing uses more than double the Index average of 6 megajoules. Again, Beijing suffers from the large amount of heavy industry remaining in the city, but also because utility prices in the country have been held at artificially low levels, which gives residents little incentive to conserve energy. The government has tried to raise prices slowly but has not made as much progress as it would have liked because the measures have proved so unpopular.

Green initiatives: In response to a central government directive to boost energy efficiency nationally, the city is promoting gas-fueled boilers. Ahead of the 2008 Olympics, the city modified 15,200 coal-burning boilers to burn natural gas. This was to fulfill a pledge by the Olympic committee to reduce greenhouse gas emissions by 1.2 to 1.5 million tonnes ahead of the event.

Land use and buildings: Beijing ranks average in land use and buildings. The city has the second lowest population density in the Index, with just 1,100 inhabitants per square kilometre. At the same time, Bejing has a relatively large amount of green spaces, at 88 square metres per inhabitant, which is well above the Index average of 39 square metres per inhabitant. Beijing's results for green spaces and population density partly reflects the way the government draws it boundaries — the city has the largest administrative area in the Index. And the city's green spaces performance may very well be even stronger than the Index suggests, since, due to data availability, the figure in the Index was calculated from 2005 data, and covers only nature reserves. Since 2005, Beijing has made concerted efforts to boost green spaces, particularly in preparation for the Olympics, although the city is marked down in the Index for only partially protecting its green spaces once they are established. In terms of buildings, Beijing performs well for its eco-buildings policies, driven by the presence of energy efficient codes for new private and public buildings, incentives for households and businesses to lower their energy use, as well as promoting the need for energy efficiency in buildings.

Green initiatives: Ahead of the Olympics, the city conducted an extensive tree planting and landscaping programme to improve green cover, defined by the city as the area covered by lawns, and the shadows of trees and bushes. As a result, green cover was set to increase from 42% in 2000 to 52% by 2007. The government also enforces mandatory standards for new buildings, including insulation for outer walls to conserve heat, and energy-efficient doors and windows.

Transport: Beijing ranks average in the transport category. The city has a relatively short superior transport network (defined in the Index as transport that moves large numbers of passengers quickly in dedicated lanes, such as metro, bus rapid transit or trams), at 0.02 km per square kilometre, compared to the Index average of 0.17 km. But the city is making substantial investments to improve in this area (see "green initiatives" below). The city receives good marks for its policies on reducing mass transport emissions, and encouraging citizens to use mass transit services. Beijing also has several traffic congestion measures in place including "no-car days" and park and ride systems, but the rapid growth in private car ownership in Beijing is undermining the city's efforts to improve traffic flows and encourage the use of public transport. The number of car owners in the city has doubled to 4 million since 2003, and is set to rise even more over the next few years as incomes rise and people aspire to the social status that car ownership brings. The national government has also heavily invested in developing the automobile industry, and while it does its part to promote green policies, it also promotes the automotive sector as a key to overall prosperity.

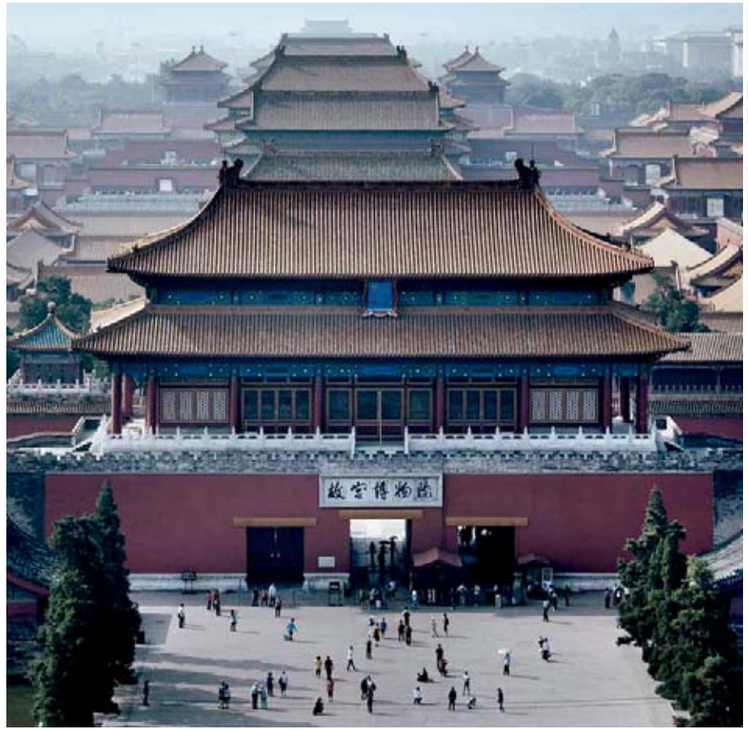
Green initiatives: The city had expanded its underground metro system to a total of nine

Performance

● Beijing ● Other cities

	well below average	below average	average	above average	well above average
Energy and CO_2	●	●●●●●	●●●●●	●●●●●	●
Land use and buildings	●	●●●●●	●●●●●	●●●●●	●
Transport	●●	●●●●●	●●●●●	●●●●●	●
Waste	●●	●●●●●	●●●●●	●●●●●	●
Water	●	●●●●●	●●●●●	●●●●●	●●●
Sanitation	●	●●●●●	●●●●●	●●●●●	
Air quality	●●	●●●	●●●●●	●●●●●	
Environmental governance	●●	●●	●●●●●●	●●●●●	
Overall results	●	●●●●●	●●●●●	●●●●●	●

The order of the dots within the performance bands has no bearing on the cities' results.



lines by 2009, and is expected to open 10 more lines by 2015. Officials have plans to double the length of the city's subway system to 600 km by 2020.

Waste: Beijing ranks average in the waste category. The city has a good record when it comes to the share of waste collected and adequately disposed of, at an estimated 95% compared with the Index average of 83%. By the end of 2006, Beijing had 23 domestic waste disposal facilities with a capacity for processing 16,200 tons of waste a day. In that same year 270,000 tonnes of waste were composted and 1.4 million tonnes were recycled in Beijing's six recycling plants. Beijing generates more waste than the Index average, at an estimated 395 kg per person per year, compared to the average of 375 kg. The city scores better for its waste and recycling policies, including environmental standards on waste disposal sites, a strategy for reducing, re-using and recycling, and for having on-site and central collection points for recycling.

Green initiatives: The city has a general goal to improve waste disposal and recycling rates. It has set several targets to this end, which include increasing the waste recycling rate in the city through a combination of new regulations and public awareness campaigns. The city also has plans to build several landfills, incineration facilities and composting facilities during the next several years. Unfortunately, the government provides few specific details on many of these initiatives.

Water: Beijing is above average in the water category. The strong performance is a direct result of the government's investment to combat severe water shortages due to a lack of rainfall, and promoting awareness that these shortages will only get more severe as the population grows. The government promotes conservation and also ensures that water system leaks are kept to a minimum, which is reflected in the city's above average performances in these areas. Water consumption in Beijing is 218 litres per person per day, the lowest among cities with a similar income in the Index, and lower than the Index average of 278 litres. Thirteen percent of the water supply is lost through system leaks, against an Index average of 22%. A water-conscious city, Beijing has also implemented comprehensive policies on water quality and promotes efficient consumption.

Green initiatives: The government has plans to improve tap water quality and replace outdated pipes, and continually invests in leakage containment efforts. City authorities are putting plans in place to require houses and businesses to install water meters. The national government has also directed industries to recycle and reduce reliance on surface and groundwater.

Sanitation: Beijing ranks average in the sanitation category. An estimated 70% of people have access to sanitation in the city, which is equal to the Index average. Officials have made substantial investments in recent years, including the construction of four new sewage treatment plants between 2001 and 2007. The city does better than average on the percentage of wastewater treated, with 80%, compared to the average of 60%. However, the city has relatively strong sanitation policies in place, including promoting environmentally sustainable sanitation, setting minimum standards for wastewater treatment, and regular monitoring of on-site treatment facilities in homes or communal areas.

Green initiatives: A major new wastewater reuse plant has been built in North Beijing. With a current capacity of treating 40,000 cubic metres of wastewater per day, the plant will eventually increase to 100,000 cubic metres per day, although a timetable for the capacity increase has yet to be announced. During the 2008 Olympic Games, the plant was responsible for supplying water to the Olympic Park.

Air quality: Beijing ranks below average in the air quality category, with above-average emission concentrations for the three air quality metrics in the Index. Average daily levels of nitrogen dioxide are 53 micrograms per cubic metre, compared to the Index average of 47 micrograms. For sulphur dioxide, the city registers 34 micrograms per cubic metre, much higher than the Index average of 23 micrograms per cubic metre. Particulate matter levels measure 121 micrograms per cubic metre, compared to the Index average of 108 micrograms. Some of the factors highlighted throughout this portrait contribute to Beijing's polluted air — the prevalence of cars, the relative lack of rainfall, the presence of heavy industry and high dependence on coal. The government is aware of the negative public health consequences caused by the city's air pollution, and has stepped up efforts in recent years to monitor pollution levels. Gradually, as the city continues to improve emissions standards, air quality is also likely to get better. Beijing is also among the top-performing cities on air quality policies, including its air quality code, attention to monitoring, and efforts to warn residents about the potential dangers of air pollution.

Green initiatives: The national government has tightened emissions standards for passenger cars and commercial vehicles, but Beijing has gone farther than most other cities in the Index. In January 2008 Beijing became the first city in China to introduce the equivalent of "Euro IV" emissions regulations for passenger cars. Euro IV emissions standards are in force in Europe and set limits on various pollutants emitted by vehicles. The city has also banned trucks and buses that do not meet "Euro I" emissions standards — an earlier, less strict version of the standards — from entering the city centre between 6 am and 9 pm. The government has introduced a "cash for clunkers" programme to buy back older, dirtier cars, and gives tax rebates to consumers who buy cars with smaller, less-polluting engines. In preparation for the 2008 Olympics, the government scrapped older, more polluting buses and taxis. By 2006, more than 47,000 taxis were scrapped or replaced, out of a total fleet of 60,000; and 7,000 older buses were scrapped or replaced, out of a total fleet of 19,000.

Environmental governance: Beijing ranks average in the environmental governance category. The city gets full marks for having a dedicated environmental department, and for monitoring its environmental performance and publishing the results. The Beijing Environmental Protection Bureau has become increasingly powerful as a result of the Olympics, and its overall powers and responsibilities are expected to rise. However, the city is marked down in the Index for relative weakness compared to other cities for involving citizens in decisions about projects with environmental impacts.

Green initiatives: The city government was initially slow to enlist the help of non-governmental organizations to combat Beijing's environmental and pollution problems. But starting in 2006, officials began to allow NGOs to play a greater role in sustainability issues, particularly in combating air pollution and improving traffic management. This participation has been mainly in promoting awareness and providing policy advice to the government. For example, NGOs promoted the "26-degrees Celsius" movement aimed to make hotels and restaurants maintain a temperature higher than 26 degrees Celsius during the summer, which helps reduce energy use from air conditioning, although participation was voluntary and the programme's results were unclear.

Quantitative indicators: Beijing

		Average	Beijing*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	8.2 [e]	2009	Beijing Statistics Yearbook; IPCC; EIU estimates
	Energy consumption per US$ GDP (MJ/US$)	6.0	12.3	2009	China Statistics Yearbook 2010
Land use and buildings	Population density (persons/km^2)	8,228.8	1,069.4	2009	Beijing Statistics Yearbook
	Green spaces per person (m^2/person)	38.6	88.4 [1]	2005	Beijing Statistics Yearbook
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.02	2010	news.cn; Beijing Subway; chinabrt.org
Waste	Share of waste collected and adequately disposed (%)	82.8	95.4 [2e]	2008	China Urban Statistics Yearbook
	Waste generated per person (kg/person/year)	375.2	394.7 [2e]	2009	Beijing Statistics Yearbook
Water	Water consumption per person (litres per person per day)	277.6	218.1	2009	Beijing Statistics Yearbook
	Water system leakages (%)	22.2	12.5	2008	China Urban Statistics Yearbook
Sanitation	Population with access to sanitation (%)	70.1	70.4 [3e]	2009	EIU estimate
	Share of wastewater treated (%)	59.9	80.3	2009	Beijing Statistics Yearbook
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	53.0	2009	Beijing Statistics Yearbook
	Daily sulphur dioxide levels (ug/m^3)	22.5	34.0	2009	Beijing Statistics Yearbook
	Daily suspended particulate matter levels (ug/m^3)	107.8	121.0	2009	Beijing Statistics Yearbook

* All data applies to Beijing Municipality unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Nature reserves coverage, 2) Based on household waste, 3) Based on regression analysis

Bengaluru_India

Background indicators

Total population (million)	7.1[e]
Administrative area (km^2)	709.5
GDP per person (current prices) (US$)	2,066.3
Population density (persons/km^2)	10,034.0[e]
Temperature (24-hour average, annual) (°C)	23.0

Data applies to Bengaluru City, e) EIU estimate

Bengaluru (formerly known as Bangalore) has developed rapidly in the past three decades, shedding its reputation as a pensioners' paradise to emerge as a symbol of India's high-technology prowess. The city's shift from a reliance on publicly owned heavy manufacturing to IT-based industry has had positive effects on the environment — not only because IT is inherently cleaner, but also because the industry has spurred the development of newer, energy-efficient buildings. A favourable climate, plentiful gardens, and access to education and jobs, have all done their part to support the city's energetic growth. However, Bengaluru remains one of the poorer cities in the Asian Green City Index. The estimated 7.1 million residents produce a GDP per capita of just under US$2,100, compared with the Index average of US$18,600, which places limitations on how much the city can do to balance environmental needs with the pressure for economic expansion. Due to data availability, information in the Index for Bengaluru comes from a mix of figures from the central city and wider, officially recognised boundaries.

Bengaluru ranks below average overall in the Index. Its performance is consistent across most categories, ranking average for all but the transport category, where it falls to below average. In transport, it is marked down for lacking superior transport, such as metro, bus rapid transit or trams, although construction is under way on the city's first metro. Bengaluru faces several environmental challenges, including one of the highest levels of particulate matter in the Index. But the city stands out for some other individual indicators: For example, it has the lowest CO_2 emissions per person of all cities in the Index. Bengaluru also has the highest share of energy consumption from renewables, and the highest share of electricity generated from renewables.

Energy and CO_2: Bengaluru ranks average in the energy and CO_2 category. It leads the entire Index for CO_2 emissions per person, at an estimated 0.5 tonnes, compared with the Index average of 4.6 tonnes. Energy consumption per US$ of GDP is also lower than the Index average, at an estimated 4.6 megajoules, versus the Index average of 6 megajoules. The low levels of CO_2 emissions partially reflect Bengaluru's use of renewable energy, which, at nearly 30% of the city's total energy consumption, are the highest in the Index. This is a figure based on an estimate from data covering the use of renewables across Kanartaka State in 2007. In addition, 61% of the electricity is generated from renewable sources, mainly hydropower — again the highest share in the Index. The city's relatively low income, resulting in a less energy-intensive lifestyle, also plays a part in reducing CO_2 emissions, as does the shift from heavy industry to IT-related businesses. Additionally, the national government's policies to promote energy efficiency and renewable energy have been important contributory factors. However, on a city level, Bengaluru's policies are relatively weak when compared with other cities in the Index. The city, for example, is only making partial efforts to consume energy more efficiently. It also fails to regularly monitor greenhouse gas emissions or to publish its findings. The city does not have a comprehensive climate change action plan, and has not signed up to international covenants to lower greenhouse gas emissions.

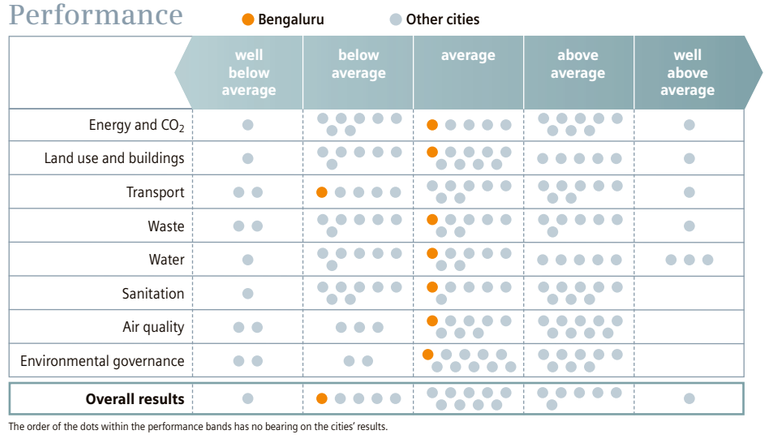
Green initiatives: The state electricity regulator is currently considering a tax on industrial and commercial power consumption in order to fund renewable energy and energy conservation programmes. Several IT companies headquartered in Bengaluru have undertaken their own energy-efficiency measures. The harnessing of wind power, as well as the deployment of various other conservation measures to meet self-imposed carbon- and water-neutral targets, are among some of the environmental steps announced by IT companies located in the city.

Land use and buildings: Bengaluru is average in land use and buildings. Widely known as the "garden city", its particular strength in the Index is plentiful green spaces — at 41 square metres per person, which is higher than the 22-city average of 39 square metres and the average for Indian cities in the Index, at 17 square metres. The city also scores well for having the seventh highest population density in the Index, at an estimated 10,000 people per square kilometre. In spite of Bengaluru's result for green spaces and population density, the city has a mixed performance on land use and building policies. On one hand, it receives full marks for having green standards for public buildings and incentives for households and businesses to lower their energy use. On the other hand, its eco-standards for private buildings are only partial, although the city is addressing this (see "green initiatives" below). Bengaluru has room for improvement for its policies on green spaces protection and urban sprawl containment, and it also lacks policies to protect environmentally sensitive areas.

Green initiatives: Bengaluru's plan for eco-friendly buildings is set down in a 2009 plan sponsored by the Renewable Energy & Energy Efficiency Partnership, a global non-profit organisation that funds energy research. The proposed energy-efficiency regulations include integrating solar energy sources in new buildings, a specific window design to enhance day lighting, energy-efficient artificial lighting and air-conditioning, and mandatory energy audits for existing commercial buildings. Government buildings already undergo mandatory energy audits that include measuring energy conservation and efficiency, as well as the monitoring of greenhouse gas emissions. The state government also requires energy audits and energy efficiency standards for all industrial and commercial buildings that consume 480 kilowatts and above.

Transport: Bengaluru is below average in the transport category. In particular, it lacks any form of superior public transport (defined in the Index as transport that moves large numbers of passengers quickly in dedicated lanes, such as metro, bus rapid transit or trams). The city has only just recently begun work on its first metro system (see "green initiatives" below). Partial policies also play a big part in Bengaluru's transport performance. Investment in green transport is negligible, mainly because the city is allocating its limited resources towards traffic congestion reduction, although currently, the congestion-reduction policies measured in the Index remain relatively weak, as do the city's urban mass transport policies.

Performance



The order of the dots within the performance bands has no bearing on the cities' results.

Green initiatives: The city's new US$1.7 billion metro system will run east-west and north-south, for a total length of 42 km. It is expected to open early in 2011 and to be fully completed by the end of the year. The city police have also devised the so-called B-Trac programme, which aims to cut traffic congestion by 30%. It offers citizens real-time traffic updates that estimate travel time between destinations. In 2007, nearly 60% of the B-Trac system was completed, and the focus now is on pedestrian safety and traffic signal coordination. Total investment in the five-year programme is US$750,000.

Waste: Bengaluru is average in the waste category. Like other Indian cities, it generates comparatively small amounts of waste per person — 267 kg versus the Index average of 375 kg, and the Indian city average of 226 kg. It also collects and disposes of an estimated 80% of its waste, which is just under the Index average of 83%, but above the Indian city average of 72%. Bengaluru and its Indian counterparts in the Index still espouse the less-wasteful lifestyles of poorer economies, even as they grow richer. However, the pressure of a growing population is likely to increase waste, along with the necessity for better waste management and recycling. Bengaluru is marked down for not yet having a comprehensive strategy for reducing, recycling and re-using of waste, and for not fully monitoring industrial and hazardous waste. In many cases, economic growth has outpaced the government's ability to set and enforce standards. And like many other Indian cities, Bengaluru only partly regulates waste picking, and illegal dumping of waste is not uncommon.

Green initiatives: India's first recycling plant for e-waste, E-Parisaraa, became operational in 2005. Located about 50 km from Bengaluru, E-Parisaraa processes one tonne of e-waste per day, although it has a daily capacity of 3 tonnes. The e-waste comprises such things as computers, circuit boards, floppy disks and videos. Similar recycling plants are planned, as Bengaluru alone produces between 8,000 and 10,000 tonnes of e-waste per year, but no firm details have yet been announced.

Water: Bengaluru ranks average in water. While the city consumes an estimated 73 litres per day on a per capita basis, which is much lower than the Index average of 278 litres and the Indian city average of 167 litres, the apparently low demand owes more to poor supply than success at water conservation. Bengaluru loses 39% of its water to system leakages, the fourth highest leakage rate in the Index, and much higher than the Index average of 22%. Water policy development is also uneven in Bengaluru. While the city has set pollution-level standards for surface water that it monitors regularly, water-efficiency policies and promotion could still be improved. For example, it has water metres, greywater recycling and rainwater collection, but lacks other policies, such as hose-pipe bans. In addition, its code to reduce water stress and consume water more efficiently is only partial, as are its efforts to publicly promote conservation.

Green initiatives: In March 2010 the Bengaluru water board installed flow meters at more than 218 strategic spots at a cost of US$1.5 million. The meters continuously measure how much water is used and how much is lost.

Sanitation: Bengaluru ranks average in the sanitation category. Only an estimated half of Bengaluru's residents have access to adequate sanitation, a shortcoming it shares with other Indian cities in the Index where growing populations have put further pressure on already inadequate infrastructure. In addition, only an estimated 42% of Bengaluru's wastewater is treated, against a much higher Index average of 60%, although about equal to the Indian city average of 46%. However, Bengaluru performs well for its sanitation policies. These include a code to promote environmentally sustainable sanitation services, the setting of minimum standards for wastewater treatment, and regular monitoring of on-site treatment facilities in both homes and communal areas. However, the city has room for improvement in promoting awareness of sanitary habits.

Green initiatives: The Japan Bank for International Cooperation is financing more than 80% of a comprehensive, US$720,000 sewage pipe upgrade in Bengaluru. The project is due to be finished in 2013.

Air quality: Bengaluru ranks average in air quality. The city has a mixed performance on levels of emissions. It has below Index average levels for both nitrogen dioxide and sulphur dioxide, registering 41 micrograms and 15 micrograms per cubic metre, respectively. Bengaluru is supported by the national government in air quality efforts, and India has a long history of emission standards. They are set down in a progressive series of laws — the Air Act of 1981 and the Environment Act of 1986. National air quality standards adopted in 1982 underwent another revision in November 2009. Despite this, the city fares badly on daily levels of suspended particulate matter — at 343 micrograms per cubic metre versus the Index average of 108 micrograms. The causes of high levels of particulate matter are domestic fuel usage, construction activities, road dust and, particularly, vehicular emissions. However, the city has an air quality code in place, regularly monitors air quality in various locations around the city, and informs citizens about the dangers of air pollution.

Green initiatives: In April 2010, stricter vehicle-emission standards were introduced in Bengaluru and 12 other Indian cities. Since 2003, low-sulphur-content diesel and petrol have been available in the city's outer ring road, which is favoured by heavy vehicles. Since 2004, the city's auto-rickshaws, heavily polluting vehicles, have been required to run on "bi-fuel", a combination of liquid petroleum gas and petrol, which is considered less harmful than petrol or diesel alone.

Environmental governance: Bengaluru is average in environmental governance. The city receives full marks for offering citizens a central contact point for information about environmental projects. Bengaluru's government is known for its e-friendliness and openness to public enquiries, and scores well for its environmental department's wide remit. Bengaluru is also marked up for having conducted a baseline environmental review in the last five years across all the major environmental areas covered by the Index. By the standards of the Index, however, the city has limited scope to implement its own environmental legislation.

Green initiatives: The city's master plan charting development to 2015 actively sought input from all relevant stakeholders. These included officials from different city departments, members of parliament, representatives from citizen groups, trade and industry associations, and the public.

Quantitative indicators: Bengaluru

		Average	Bengaluru*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	0.5 [e]	2007	Bengaluru Development Authority; Karnataka Government; Indian Oil Corporation; World Institute of Sustainable Energy; IPCC; EIU estimates
	Energy consumption per US$ GDP (MJ/US$)	6.0	4.6 [e]	2007	Bengaluru Development Authority; Karnataka Government; Indian Oil Corporation; World Institute of Sustainable Energy; EIU estimates
Land use and buildings	Population density (persons/km^2)	8,228.8	10,034.0 [e]	2008	EIU estimate
	Green spaces per person (m^2/person)	38.6	41.0 [1]	2007	Indian State Forest Cover - Karnataka Government
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.00		
Waste	Share of waste collected and adequately disposed (%)	82.8	80.0 [2e]	2005	Bengaluru Master Plan - 2015 - Bangalore Development Authority
	Waste generated per person (kg/person/year)	375.2	266.5 [3]	2007	Carbon Emission Report in Asian Cities 2008
Water	Water consumption per person (litres per person per day)	277.6	73.0 [4e]	2005	Bengaluru Master Plan - 2015 - Bangalore Development Authority
	Water system leakages (%)	22.2	39.0 [3]	2005	Bengaluru Master Plan - 2015 - Bangalore Development Authority
Sanitation	Population with access to sanitation (%)	70.1	53.0 [5e]	2003	Evaluation of Bengaluru Water Supply and Sewerage Project - Japan Bank for International Cooperation
	Share of wastewater treated (%)	59.9	42.4 [6e]	2006	Report on City Development Plan for Bengaluru (2006) by JNNURM
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	41.0	2009	Karnataka State Pollution Control Board
	Daily sulphur dioxide levels (ug/m^3)	22.5	15.1	2009	Karnataka State Pollution Control Board
	Daily suspended particulate matter levels (ug/m^3)	107.8	343.0	2009	Karnataka State Pollution Control Board

* All data applies to Bengaluru City unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Based on forest cover in Bengaluru Rural and Urban Areas, 2) Share of municipal waste collected; BMP (Bengaluru Mahanagara Palike), 3) BMP (Bengaluru Mahanagara Palike), 4) Based on per capita water supply; BMP (Bengaluru Mahanagara Palike), 5) Based on access to sewerage; BBMP (Bruhat Bengaluru Mahanagara Palike), 6) Based on daily capacity of wastewater treatment plant; BMP (Bengaluru Mahanagara Palike)

Delhi_India

Background indicators

Total population (million)	17.4[1]
Administrative area (km^2)	1,483.0
GDP per person (current prices) (US$)	2,004.1[e]
Population density (persons/km^2)	11,733.0[e]
Temperature (24-hour average, annual) (°C)	25.0

Data applies to NCT Delhi, 1) Delhi Municipal Corporation, e) EIU estimate

Delhi, the capital of India, is the third most populous city in the Asian Green City Index, with some 17.4 million inhabitants. An additional 2 million commuters from neighbouring areas visit Delhi daily for work or school. The capital produces 5% of India's GDP, second within India only to Mumbai, the bustling financial centre. Delhi's main industries include food production, textiles, leather, energy, media, tourism and real estate. Its average per capita income of an estimated US$2,000 is more than twice the national average, but the city is among the poorest cities in the Index. Only two cities have a lower average GDP per person. All data for Delhi in the Index comes from the National Capital Territory of Delhi.

Despite the environmental challenges that low income can sometimes pose, Delhi ranks average overall in the Index. The city's best performances are in the energy and CO_2, and waste categories. In energy and CO_2, Delhi has one of the lowest levels of CO_2 emissions in the Index. In the waste category, the city benefits from some strong policies on waste collection and recycling, and the fact that Delhi's inhabitants generate the least waste per person of all the cities in the Index. In addition, among cities with a similarly low income in the Index (with a GDP per person of less than US$10,000), the city has the second highest share of waste collected and adequately disposed. Delhi is average in the categories of land use and buildings, transport, sanitation, air quality and environmental governance. In the transport category, among cities with a low income, the city has the second longest superior transport network (a definition which includes a metro, bus rapid transit or trams). The city's weakest performance is in the water category, where it ranks below average, mainly for a high level of water leakages.

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".

Energy and CO_2: Delhi ranks above average in energy and CO_2. Each inhabitant in Delhi generates, on average, an estimated 1.1 tonnes of CO_2 per year, the third best level in the Index, and well below the Index average of 4.6 tonnes. This partially reflects the city's relatively low income, which means residents have less energy-intensive lifestyles, as well as the fact that 12% of Delhi's electricity generation comes from renewables, mainly hydropower. Delhi's result in energy consumption per US$ of GDP is higher than the average, at an estimated 7.7 megajoules, versus the Index average of 6 megajoules. However, the city has proactive policies to limit greenhouse gases. It also scores particularly well for its climate change action plan. While it is strong on policy, Delhi could improve its monitoring. It only partially monitors greenhouse gas emissions, for example.

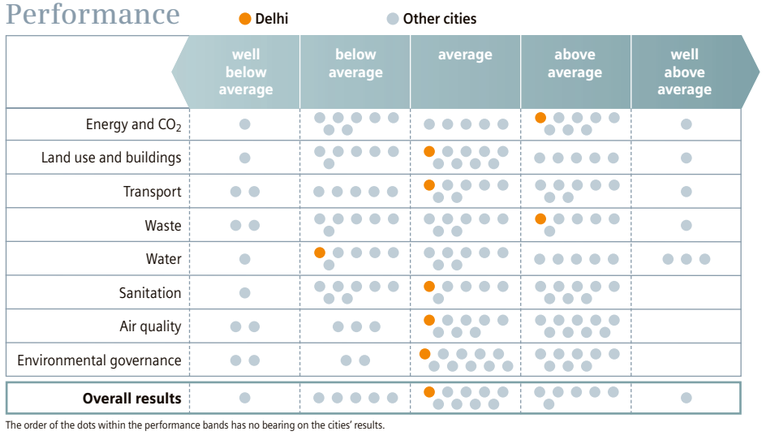
Green initiatives: The Delhi government's report, Climate Change Agenda for Delhi 2009-2012, urges manufacturers to give 30% discounts on sales of compact fluorescent lamps, which use less power and have a longer life than traditional light bulbs. The government has set a target to install compact fluorescent lamps to light 700 km of city roads, which is expected to conserve 100 megawatts of electricity every year.

Land use and buildings: Delhi ranks average in land use and buildings. It has 19 square metres per person of green spaces, less than the Index average of 39 square metres, but above the average for Indian cities in the Index, at 17 square metres. The city's result is bolstered by its relatively progressive policies on developing green spaces. Since 1993 Delhi has increased green cover from trees and forests from 22 square kilometres to 300 square kilometres, which represents around 20% of the city's land space. The city also plans to add more green cover (see "green initiatives" below). Regarding energy efficiency in buildings, Delhi only has partial standards for new private buildings, but receives full marks for its energy efficiency regulations for public buildings.

Green initiatives: Delhi aims to increase green space from 20% to 33% by 2012, through the addition of forests and biodiversity parks, which are dedicated conservation zones that re-introduce threatened and extinct plant and animal species. The city's green spaces policy also aims to prevent urban encroachment of "the Ridge", a dense forest known as the capital's "green lungs". The government is also building a wildlife sanctuary and plans the forestation of 2,100 acres of the southern part of the Ridge. Regarding buildings, the eco-code created for the 2010 Commonwealth Games mandates that new buildings should have solar heating systems, windows that make the best possible use of sunlight, as well as energy-efficient artificial lighting and air conditioning. For example, the city's new Thyagaraj Stadium has large solar panels on the roof, which provide energy to light the venue. The government has also mandated the use of solar water-heaters in buildings larger than 500 square metres, and is subsidising one third of the cost.

Transport: Delhi is average in the transport category. The city's superior public transport network, consisting mainly of a metro system, measures 0.08 km per square kilometre. This is below the Index average of 0.17 km per square kilometre, but is second best among cities with a similarly low income in the Index and is higher than the Indian city average of 0.03 km. Regarding transport policies, the city performs well for its urban mass transport policy. It receives full marks in the Index for taking steps to reduce emissions from mass transport (see "green initiatives" below), and for encouraging residents to take greener forms of transport. However, its pricing system for mass transport is only partially integrated, and it lacks some of the traffic con-

Performance



The order of the dots within the performance bands has no bearing on the cities' results.

gestion measures evaluated in the Index, such as traffic light sequencing or traffic information systems.

Green initiatives: To ease road congestion, Delhi continues to add to its metro system, according to the government's State of Environment Report for Delhi, 2010. New routes totalling 121 km were scheduled to be finished in 2010. This was expected to double the number of 1 million passengers daily. Delhi also has 6,000 buses running on compressed natural gas, a less-harmful fossil fuel than diesel, and aims to double this number by 2012. In April 2010, the city started selling greener diesel that matches European and US fuel standards.

Waste: Delhi ranks above average in the waste category. India's capital scores particularly well by generating the least amount of waste per person of all the 22 cities covered in this report, at 147 kg per inhabitant annually versus an Index average of 375 kg, and below the Indian city average of 226 kg. One contributing factor is Delhi's traditional culture of careful consumption, which emerging prosperity has not yet eroded. In addition, among cities with a similarly low income in the Index, the city has the second largest share of waste collected and adequately disposed of, at 94% versus the Index average of 83%. Delhi performs well for its policies surrounding special waste collection, as well as general waste recycling and re-use. However, officials only partially enforce environmental standards for waste disposal sites. Nor does the city enforce and monitor commercial hazardous waste disposal standards as rigorously as many other cities covered in the Index.

Green initiatives: A recycling plant to handle 500 tonnes of construction waste per day opened in 2009 at Burari, a low-lying area next to one of Delhi's landfills.

Water: Delhi ranks below average in the water category. Although Delhi has a relatively low water-consumption rate, at 209 litres per person per day versus the Index average of 278 litres, this is partly due to low availability. Delhi suffers a supply shortfall of 900 million litres per day, according to the State of Environment report. The strain on Delhi's water resources is made worse by the leakage of 40% of water in the city system, although the city is addressing the problem (see "green initiatives" below). Delhi depends mainly on surface water, which is more prone to contamination than other sources, and this comes largely from the heavily polluted Yamuna river. An action plan to clean the Yamuna is ongoing, but Delhi's water policies address only partly the aim of better quality surface water, and do not fully enforce water pollution standards on local industry.

Green initiatives: A new dam on the Yamuna river, which will reduce the city's reliance on surface water, is scheduled for completion by 2015-16. In addition, the city's water authority has created a leak detection and investigation unit to address water losses, and the authority has replaced 1,200 km of damaged water mains in the last five years.

Sanitation: Delhi ranks average in the sanitation category. This reflects below average results for the share of population with access to sanitation — at an estimated 54% versus an Index average of 70% — and for the share of wastewater treated, at 55% against an average of 60%. Regarding sanitation policies, the city does well in some areas, but could improve in others. Delhi is marked up in the Index for its wastewater treatment standards, for example, but is marked down for only making partial efforts to monitor on-site sanitation facilities in homes and communal areas.

Green initiatives: The city's US$290 million "Interceptor Sewer Project" aims to catch and clean most of the domestic and industrial sewage flowing into the city's three major drains by 2012. To meet the goal, the city will build 50 km of new sewers to intercept effluent from 108 minor drains. Moreover, 693 km of existing old and damaged sewer lines will be replaced, and 91 km will be de-silted and rehabilitated. According to the Delhi city master plan, the city expects to add treatment capacity of 1.3 billion litres per day to its sewage treatment plans by 2021.

Air quality: Delhi ranks average in air quality. Delhi is marked down for having the highest daily level of suspended particulate matter of the 22 cities, at 384 micrograms per cubic metre, well above the Index average of 108 micrograms. Industry, transport and power generation are the main culprits behind the figures. Explosive population growth has increased the number of vehicles, and the need for energy to run homes and businesses. However, Delhi records one of the lowest daily levels of sulphur dioxide emissions in the Index, at 7 micrograms per cubic metre, compared to the Index average of 23 micrograms. The switch from diesel to cleaner fuel for Delhi's buses and the sale of ultra-low-sulphur diesel have helped to bring down Delhi's sulphur dioxide levels. Although Delhi's air quality is still relatively poor, it has improved in recent years. One of the reasons is that pollution-control initiatives have the backing of the government, society and industry. The prospect of hosting the Commonwealth Games in October 2010 also focused the minds of city officials to try and improve air quality, as set down in the eco code for the Games.

Green initiatives: As much of Delhi's undesirable air quality is caused by transport and industry, pollution control in these sectors have helped to clean the air. Emissions standards are set down in India's Air Act of 1981 and the Environment Act of 1986. National air quality standards, adopted in 1982 and revised in 1994, were tightened further in November 2009 to comply with global best practices. The new regulations require industrial areas to conform to the same standards as residential areas, and set stringent standards in ecologically sensitive areas. More than 600 emission-control systems have been installed in air-polluting industrial units, with the aim of full monitoring coverage by 2012. An Air Ambience Fund, set up in 2008, is financed by a US$0.50-per-litre fee on diesel in Delhi. The fund, which collected US$8.2 million in 2008-2009, provides a 30% subsidy on purchases of battery-operated vehicles by refunding the value-added tax and road tax.

Environmental governance: Delhi ranks average in environmental governance. It scores well for having a strong Department of Environment, which is actively engaged in overall environmental assessment, monitoring, and protection. It has a wide legal remit to address the city's environmental challenges, and is also helping to raise environmental awareness among residents. In addition, the city is marked up in the Index for public participation, but is marked down for its efforts in environmental monitoring, which is often inadequate, particularly in the areas of sewage and water-usage efficiency.

Green initiatives: The government has created "eco-clubs" in about 1,000 schools, and these have played an active role in creating environmental awareness among Delhi's young. Under the programme, 80 schools have set up "vermi-composting" projects, using worms to aid decomposition; 28 have rainwater harvesting projects to collect drinking water; and 88 have paper recycling plants.

Quantitative indicators: Delhi

		Average	Delhi*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	1.1 e	2008	Directorate of Economics & Statistics - Delhi Statistical Handbook 2009; NDPL; IPCC; EIU estimates
	Energy consumption per US$ GDP (MJ/US$)	6.0	7.7 e	2008	Directorate of Economics & Statistics - Delhi Statistical Handbook 2009; EIU estimates
Land use and buildings	Population density (persons/km^2)	8,228.8	11,733.0 e	2009	EIU estimate
	Green spaces per person (m^2/person)	38.6	18.8 1	2005	Forest Survey of India
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.08	2010	Delhi Metro Rail; Times of India
Waste	Share of waste collected and adequately disposed (%)	82.8	93.6	2009	Primary research with Municipal Corporation of Delhi
	Waste generated per person (kg/person/year)	375.2	146.8	2009	Primary research with Municipal Corporation of Delhi
Water	Water consumption per person (litres per person per day)	277.6	208.7 2	2008	Directorate of Economics & Statistics - Delhi Statistical Handbook 2009
	Water system leakages (%)	22.2	40.0	2009	The Associated Chambers of Commerce and Industry of India (ASSOCHAM)
Sanitation	Population with access to sanitation (%)	70.1	54.0 3e	2009	Delhi Jal Board
	Share of wastewater treated (%)	59.9	55.0	2009	Delhi Jal Board
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	47.0	2007	Central Pollution Control Board
	Daily sulphur dioxide levels (ug/m^3)	22.5	7.0	2007	Central Pollution Control Board
	Daily suspended particulate matter levels (ug/m^3)	107.8	384.0	2007	Central Pollution Control Board

* All data applies to NCT Delhi unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Total "tree and forest cover", 2) Based on 2009 population data, 3) Based on population with access to sewerage

Guangzhou_China

Background indicators

Total population (million)	7.9
Administrative area (km^2)	3,843.4
GDP per person (current prices) (US$)	16,834.1
Population density (persons/km^2)	2,067.5
Temperature (24-hour average, annual) (°C)	22.0

Data applies to Sub-provincial City of Guangzhou

Guangzhou, with a population of nearly 8 million and a GDP per capita of US$16,800, is the political and cultural capital of the southern Chinese province of Guangdong. The pillar industries in Guangzhou are car manufacturing, petrochemicals and electronic appliances. Since 2008 the city has been at the centre of an ambitious infrastructure investment programme that aims to promote economic integration between the Pearl River Delta, Hong Kong and Macau. As part of this effort, which will run until 2020, the government has completed a number of major public transport projects. Some of these projects were also part of preparations for the Asian Games, which Guangzhou hosted in November 2010. Upgrades to mass transport infrastructure should improve the environment in the long term by encouraging residents to use the public network instead of private cars.

Guangzhou is ranked average overall in the Asian Green City Index. Its best performance is in the sanitation category, where it is ranked above average, driven by relatively robust sanitation standards and strong policies on monitoring. In addition, it is estimated that Guangzhou has the second best rate of access to sanitation among cities in the mid-population range in the Index (between 5 million and 10 million) and among cities in the mid-income range (between US$10,000 and US$25,000 in GDP per capita). The city ranks average for land use and buildings, transport, waste, air quality and environmental governance. Guangzhou registers the most green spaces per person in the Index, and in the waste category, among cities in the mid-population range, it has been estimated that Guangzhou has the third best rate of waste collected and adequately disposed of. The city is below average in the energy and CO_2 and water categories. These results reflect an economy largely built on high-carbon industries, with an especially heavy dependence on coal, and a very high level of per capita water consumption.

Energy and CO_2: Guangzhou ranks below average in the energy and CO_2 category. The city emits an estimated 9.3 tonnes of CO_2 per capita each year, about twice as much as the Index average of 4.6 tonnes. Guangzhou also has a relatively high energy consumption in relation to its economic output, registering an estimated 11.7 megajoules per US$ of GDP, compared to the Index average of 6 megajoules. Like other cities in China, Guangzhou remains very dependent on coal, and it accounts for around 80% of electricity production and half of overall energy consumption. Guangzhou's overall use of renewable sources of energy is still small — accounting for just 1% of total energy consumption — but the city is making some progress in harnessing renewable energy for electricity production, accounting for 12% of the total. Guangzhou does well on clean energy policy, including waste-to-energy investments and investments in renewable energy. The city government is increasingly realising that an energy-intensive growth strategy is not sustainable in the long term and, in recent years, it has boosted energy efficiency. Furthermore, in order to reduce its dependence on coal, Guangzhou has also invested in natural gas, hydropower (see "green initiatives" below) and nuclear energy.

Green initiatives: The national government is building a second West-East natural gas pipeline, which will connect the western province of Xinjiang with Guangzhou and Hong Kong (the first West-East pipeline stretches from Xinjiang to Shanghai), which is scheduled to be in operation at the end of 2011. The US$21 billion project is expected to reduce the country's coal consumption by 77 million tonnes per year, or about 2% of total coal consumption, and also reduce CO_2 emissions by about 2%. In addition, Guangzhou obtains much of its hydro-electric power from plants located 1,400 kilometres away in Yunnan province. The electricity is delivered to Guangzhou over what is claimed to be the world's longest and most powerful high-voltage direct current (HVDC) line in the world. The HVDC line transports power at 800,000 volts, which significantly reduces the loss of power over long distances. Its output of 5,000 MW is delivered to the largest cities on China's south-eastern coast and is capable of supplying up to five million households with electricity. The combination of the hydroelectric plants and the HVDC line reduces China's annual CO_2 emissions by 33 million tonnes compared with the same energy output if using coal.

Land use and buildings: Guangzhou is average in the land use and buildings category. It has one of the largest administrative areas in the Index and only a mid-size population, which makes it one of the least densely-populated cities in the Index. With an average of barely more than 2,100 people per square kilometre, only four other cities in the Index are less densely populated than Guangzhou. The city also has the largest amount of green spaces per person in the Index, at 166 square metres, which is more than four times the Index average of 39 metres. Guangzhou shines when it comes to policy. The city scores well for drawing up strategies to contain urban sprawl and protect green spaces, and local authorities take a proactive approach to promoting energy efficiency in new buildings (see "green initiatives" below).

Green initiatives: The Pearl River Tower, which its designers herald as the "world's most environmentally friendly tower block", is sched-

Performance

● Guangzhou ● Other cities

	well below average	below average	average	above average	well above average
Energy and CO_2	●	●			
Land use and buildings	●		●		
Transport	●●		●		
Waste	●●		●		
Water	●	●			●●●
Sanitation	●			●	
Air quality	●●	●●	●		
Environmental governance	●●	●●	●		
Overall results	●		●		●

The order of the dots within the performance bands has no bearing on the cities' results.

uled to finish in 2011. The 71-storey structure will include a number of energy efficiency features, including wind turbines and solar panels to provide power for the building. It also uses wide-spaced double-glazing, which channels hot air upwards to be harnessed for dehumidification.

Transport: Guangzhou ranks average for transport. At 0.07 km per square kilometre, Guangzhou's superior transport network, consisting of a metro system and a bus rapid transit network, is shorter than the Index average of 0.17 km per square kilometre. However, the city government has emphasised improving public transport and is making investments to extend its metro (see "green initiatives" below). Guangzhou's transport policy results are also strong. The city, for example, has a comprehensive mass transport policy, an integrated system for pricing, and encourages residents to take greener forms of transport.

Green initiatives: Guangzhou has invested heavily in its metro system. The city's first line opened in 1997 and, by the end of 2010, a total of eight lines covering 236 km were carrying more than 4 million riders on a daily basis. According to the Guangzhou Metro Corporation, plans are in place to extend the network to a total of 600 km and 20 lines by 2020.

Waste: Guangzhou ranks average in the waste category. Although the city has an above-average rate of waste generation per capita, at an estimated 415 kg per year, compared to the Index average of 375 kg, it does much better when it comes to adequately collecting and disposing of its waste. At an estimated 88%, Guangzhou's share of waste collected and adequately disposed of is above the Index average of 83%. The city also scores relatively well in policies for collection, disposal and recycling, although it receives only partial marks for enforcing disposal standards for industrial hazardous waste. Local government has been investing heavily to improve waste management in the city ahead of the 2010 Asian Games, which has had a positive impact on the city's performance in this category.

Green initiatives: Panyu, a district of Guangzhou, has a pilot plan to recycle 30% of all rubbish in the district by 2012, according to the New Energy and Environmental Digest, an environmental blog. Statistics on the current level of recycling in Panyu were unavailable.

Water: Guangzhou ranks below average in water. This is due mainly to the city's high daily water consumption of 527 litres per capita, which is nearly double the Index average of 278 litres. The city enjoys a relatively abundant rainfall and, as a result, residents have little incentive to conserve. Guangzhou does slightly better at reducing water system leaks, with a 15% leakage rate, compared to the Index average of 22%. In water policy areas, however, Guangzhou scores well. City authorities set quality standards for key pollutants in surface and drinking water, and are relatively strong at enforcing water pollution standards on local industry. Guangzhou has also put in place water efficiency measures to reduce consumption, including water tariffs, greywater recycling, and rainwater collection.

Green initiatives: In 2008 the city started a US$7 billion, 18-month programme to improve water quality in the city in preparation for the 2010 Asian Games, with a particular focus on cleaning up sewerage and chemical waste in Guangzhou's rivers and canals. However, the project appears to have limited impact, with local residents still complaining of high levels of river and canal pollution. It is unclear if the clean-up operation will be extended.

Sanitation: Guangzhou ranks above average in sanitation, scoring particularly well for its sanitation standards and policies on monitoring. An estimated 79% of Guangzhou's population have access to sanitation, compared to the Index average of 70%. The city also treats a higher percentage of wastewater than the 22-city average, at 74% for Guangzhou versus the Index average of 60%. The city has four major wastewater treatment factories, in addition to several smaller facilities, and more are planned (see "green initiatives" below). Also, sanitation services in the city are open to competition between service providers. Guangzhou's environmental authorities have a public information policy covering village sanitation, which encourages residents to use non-flush toilets when more modern services are not available.

Green initiatives: The city government has invested heavily in sewage treatment facilities. By the middle of 2010, the city authorities had completed work on 38 new sewage treatment plants, and three new major wastewater treatment plans were scheduled be put into service by the end of 2010.

Air quality: Guangzhou ranks average in air quality. The city has higher levels of nitrogen dioxide and sulphur dioxide than the Index averages, which is largely a by-product of its heavy industry and coal-fired economy. Guangzhou has daily nitrogen dioxide levels of 56 micrograms per cubic metre, compared to the Index average of 47 micrograms per cubic metre. Its sulphur dioxide levels are 39 micrograms per cubic metre, compared to the Index average of 23 micrograms per cubic metre. Regarding daily suspended particulate matter, Guangzhou performs better than the Index average — at 70 micrograms per cubic metre versus the average of 108 micrograms. Guangzhou's relatively poor air quality is mainly caused by the large number of polluting vehicles on its roads, since the vast majority of cars are still standard petrol-powered cars, and dust from recent construction activities has contributed to air quality issues. Although air pollution from industry has receded in recent years, rising emissions from the automotive sector has cancelled out much of the progress on improving air quality. To tackle air pollution, the city government is actively encouraging new environmentally friendly technology in the automotive sector and has some firm clean air policies in place, including the regular monitoring of a range of key air pollutants and informing cities about the dangers of air pollution.

Green initiatives: In mid-2009 the government announced plans to spend up to US$88 million to improve air pollution in the city ahead of the Asian Games. The government is moving the most polluting industries out of the city centre, including 32 chemical plants and 91 cement plants. Petrol stations, oil depots and oil tankers have also been overhauled in a move to reduce oil vapour emission by 10,000 tonnes a year. Efforts have also been made to improve environmental standards for cars.

Environmental governance: Guangzhou ranks average for environmental governance. The city has its own environmental protection department, and it also regularly monitors its environmental performance. It is also marked up in the Index for providing a central access point for citizens to receive information about the city's environmental performance. The city authorities also appear to be becoming more responsive to the environmental concerns of city residents and non-governmental organisations. Local government, for example, agreed to postpone a long-planned waste incinerator project in the district of Panyu after concerns were raised by local residents about the potential health risks. The government is now to carry out an environmental impact assessment, and will allow residents to participate in a new feasibility study with a view to announcing plans for a new incinerator by late 2012.

Quantitative indicators: Guangzhou

		Average	Guangzhou*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	9.2 e	2007	Guangzhou Statistical Yearbook; IPCC; EIU estimates
	Energy consumption per US$ GDP (MJ/US$)	6.0	11.7 e	2007	Guangzhou Statistical Yearbook; EIU estimates
Land use and buildings	Population density (persons/km^2)	8,228.8	2,067.5	2009	Guangzhou Statistical Yearbook
	Green spaces per person (m^2/person)	38.6	166.3	2008	Guangzhou Statistical Yearbook
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.07	2010	China Daily; chinabrt.org
Waste	Share of waste collected and adequately disposed (%)	82.8	88.2 1e	2008	Guangzhou Environmental Protection Bureau
	Waste generated per person (kg/person/year)	375.2	415.1 1e	2009	Guangzhou Environmental Protection Bureau; Guangzhou Statistical Yearbook
Water	Water consumption per person (litres per person per day)	277.6	527.2	2009	Guangzhou Statistical Yearbook
	Water system leakages (%)	22.2	14.8	2007	China City Construction Yearbook
Sanitation	Population with access to sanitation (%)	70.1	79.0 2e	2009	EIU estimate
	Share of wastewater treated (%)	59.9	74.1 3	2007	Guangzhou Statistical Yearbook
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	56.0	2009	Guangzhou Statistical Yearbook
	Daily sulphur dioxide levels (ug/m^3)	22.5	39.0	2009	Guangzhou Statistical Yearbook
	Daily suspended particulate matter levels (ug/m^3)	107.8	70.0	2009	Guangzhou Statistical Yearbook

* All data applies to Sub-provincial City of Guangzhou unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Based on household waste, 2) Based on regression analysis, 3) Proportion of sewerage treated

Hanoi_Vietnam

Background indicators

Total population (million)	6.5
Administrative area (km^2)	3,344.6
GDP per person (current prices) (US$)	1,739.6
Population density (persons/km^2)	1,935.1
Temperature (24-hour average, annual) (°C)	24.0

Data applies to Hanoi

Hanoi, Vietnam's 1,000-year-old capital city and one of the country's five centrally controlled municipalities, is located in the north of the country on the banks of the Red River. Hanoi almost tripled in size in terms of land area in August 2008, when it subsumed a neighbouring province in addition to some districts and communes, and is home to around 8% of the country's total population of 86 million. With 6.5 million residents, however, Hanoi still ranks behind the main commercial municipality of Ho Chi Minh City in the south for population size and economic importance.

The city's economy, which has grown rapidly over the past decade, accounts for around 13% of Vietnam's GDP. Compared with the other cities in the Asian Green City Index, Hanoi has a below-average GDP per capita of US$1,700. Hanoi ranks below average overall in the Index.

The city's best results are in the energy and CO_2, air quality, and waste categories, where it ranks average. Particular strengths in these categories include relatively low estimated CO_2 emissions, a high rate of electricity generated from hydropower, and its efforts to set and monitor standards for air pollution. It scores below average in the categories of transport and water, mainly for lacking any form of rapid transit and a high rate of water leakages. The city has significant room for improvement in the categories of land use and buildings, sanitation and environmental governance, where it ranks well below average.

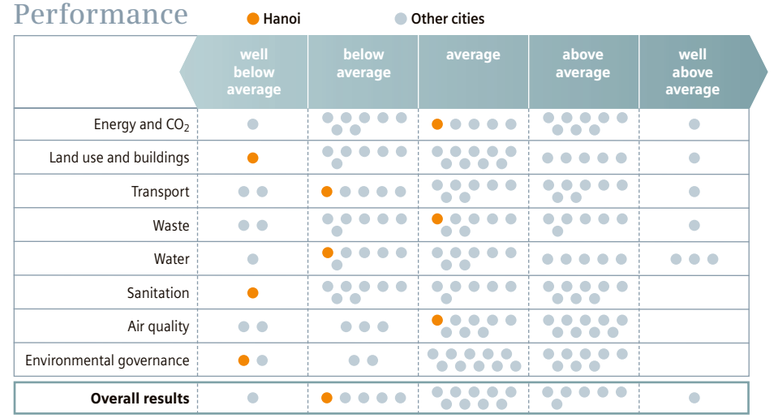
Energy and CO_2: Hanoi ranks average in the energy and CO_2 category, with the city performing particularly well on CO_2 emissions. At 1.9 tonnes per head per year, an estimate based on 2007 figures, Hanoi's CO_2 emissions are much lower than the Index average of 4.6 tonnes. The result for CO_2 emissions may reflect not only an absence of heavy industry within the city limits, but also a growing use of renewable energy, which accounts for 20% of the city's total energy consumption. In particular, Hanoi has embraced hydropower, which is responsible for 43% of its total electricity production — this is the highest proportion of hydropower use for electricity production among all Index cities. The performance is all the more impressive given that electricity accounts for nearly half of Hanoi's total energy consumption. In contrast, Hanoi is marked down for relatively high levels of energy consumption compared to its economic productivity. Consuming 9.5 megajoules per US$ of GDP, another estimate based on 2007 data, Hanoi is above the Index average of 6 megajoules. Hanoi is also marked down in the Index for its relatively weak policies on climate change. It has not, for example, conducted a baseline review of greenhouse gas (GHG) emissions, nor does it monitor them. Hanoi has, however, signed up to international covenants to reduce GHG emissions and is a member of C40, a group of cities committed to tackling climate change. In addition, the national government has been active in promoting energy efficiency (see "green initiatives" below.)

Green initiatives: In an attempt to promote energy conservation, the Hanoi Energy Conservation Centre, which operates under the Hanoi Industrial and Trade Department, began a programme in 2010 to promote energy conservation in about 1,000 households throughout 10 districts. The programme includes training courses, with instruction on how to choose and install energy-efficient household appliances, such as washing machines and refrigerators, and energy conservation equipment. In January, a new law took effect across Vietnam requiring organisations that receive state funds to report on their energy use and develop energy conservation plans. Another initiative, the Vietnam National Energy Efficiency Programme, took effect in 2006, setting out goals to reduce the country's energy consumption from 3% to 5% by the beginning of 2011 and between 5% and 8% by 2015. And in 2004, the national Commercial Energy Efficiency Programme provided grants for energy audits in businesses, as well as marketing efforts to promote energy efficiency in industry.

Land use and buildings: Hanoi ranks well below average in land use and buildings, a performance reflecting in part Hanoi's relatively thin population density — 1,900 people per square kilometre compared with the Index average of 8,200 people — and the city's low amount of green spaces. At 11 square metres per person, it is also below the Index average of 39 square metres. In addition, Hanoi is marked down for some policy deficiencies. In particular, the city authorities have yet to devise and enforce a code for the eco-efficiency of new buildings, and the city does not enforce green standards on public buildings. However, the city does publicly promote the importance of energy efficiency in buildings. Hanoi is marked up in the Index for policies to protect green spaces and other environmentally sensitive areas, as well as for its policies to limit urban sprawl. There are also national planning standards in Vietnam covering the expansion of parks and green spaces, which should help promote the provision of green areas in Hanoi. In order to secure building permits, new residential areas must be designed with the equivalent of between three and four square metres of parks and gardens for every person housed.

Green initiatives: Local authorities aim to turn Hanoi into a "green, civilised and modern city", with a long-term goal, by 2050, of setting aside up to 70% of the city's natural territory for tree and water space. The current trend is the building of urban areas, supported by local authori-

Performance



The order of the dots within the performance bands has no bearing on the cities' results.

ties, with ample green space. Construction of one such area, ParkCity Hanoi, a 77-hectare site some 13 km from the city centre, commenced in March 2010. The new area is aimed at providing mixed-density housing, shops and schools, with a park accounting for around 14% of the total area.

Transport: Hanoi ranks below average in transport, mainly due to Hanoi's lack of a superior transport network (defined in the Index as transport that moves large numbers of passengers quickly in dedicated lanes, such as metro, bus rapid transit or trams). This partly explains why the overwhelming majority of journeys undertaken in the city are via the motorcycle. While the city does relatively poorly in terms of integrating the pricing of urban mass transport, which is maybe not surprising given Hanoi's recent tripling in size through the absorption of neighbouring provinces, progress has been made in other policy areas. City authorities promote the use of greener forms of transport and have taken steps to reduce emissions from mass urban transport. There are also measures in place to reduce traffic congestion, including congestion charges, pedestrian-only areas, and park and ride systems.

Green initiatives: There are major plans to develop Hanoi's mass transit networks, funded primarily by foreign donors. These include a two-line "bus rapid transit" and a metro system, including elevated and underground portions, with up to five routes to be completed by 2020. But given these projects have suffered delays, a lot of catch-up work is required if the 2020 deadline is to be met. More solid progress has been made in enhancing the bus network. A second interchange station, Long Bien, opened in early 2009 and provides a connection point for 21 routes. For a relatively small-scale investment, the new station, which can handle nearly 300 buses an hour, has greatly improved the quality of the city's bus network.

Waste: Hanoi ranks average in the waste category. Hanoi performs relatively well for the amount of waste generated per capita, at 282 kg per year compared with the Index average of 375 kg. City authorities collect and adequately dispose of 95% of waste, compared with the 22-city average of 83%, which is also the highest rate among cities with a similarly low income in the Index (with a GDP per capita of under US$10,000). The city's policies on waste are relatively weak. Hanoi is one of two cities in the Index that does not enforce and monitor standards for industrial hazardous waste. Neither does Hanoi offer an on-site collection service for household waste recycling.

Green initiatives: Local authorities have approved a number of projects relating to waste treatment and recycling. Plans were announced in 2009 for a US$31 million plant in one of the city's rural districts, with a capacity to handle 2,000 tonnes of waste a day and convert it into compost fertiliser for export. A waste-sorting project, financed by Japan International Cooperation Agency, has also been piloted in a number of inner districts. Once implemented across the city, the project is expected to reduce landfill waste by 30% by 2015, and by 70% by 2020.

Water: Hanoi ranks below average in water. Its average daily water consumption is 53 litres per person per day, well below the Index per capita average of 278 litres. However, the Hanoi figure is estimated from data for 2006 household water consumption only, which excludes consumption by industry. Lack of supply may also be a factor in explaining Hanoi's relatively low use of water. However, the city's water supply improved in 2008 when the Da River Waterworks began supplying 50,000 Hanoi households in the southwest of the city, but concerns remain over meeting rising demand. Leakage is a problem in Hanoi, with 45% of the city's water supply lost through system leaks, one of the highest rates in the Index. It is a figure based on 2003 data from the Asian Development Bank covering water delivered but not paid for.

Green initiatives: Hanoi will be one of the main beneficiaries of a planned nationwide project to reduce leakage from water distribution networks. A US$494 million project announced by the Ministry of Construction in early 2010 is centred on the replacement of old water pipes and investment in new technology to identify leaking pipe sections. The target is to cut the water loss rate to 15% by 2025.

Sanitation: Hanoi is well below average for sanitation. Only an estimated 40% of Hanoi's residents have access to sanitation, well below the Index average of 70%, although Hanoi's figure, due to a lack of available data, only represents connections to drainage facilities. Hanoi's sewerage and drainage system is over 50 years old, and insufficient for the city's current population. In addition, the city's policies are relatively weaker than other cities in the Index. For example, it is the only city in the Index that does not have a plan or a code to promote environmentally sustainable sanitation services.

Green initiatives: The authorities are tightening regulations regarding the treatment of wastewater, and the Department for Natural Resources and Environment is increasingly fining offenders. In mid-2010 the Hanoi People's Committee announced that it was compulsory for new industrial parks in the city to have wastewater treatment facilities and that existing parks now have to treat their own waste. Hanoi's authorities have also embarked on a major campaign to clean the city's heavily polluted rivers and lakes. In early 2010 the authorities announced that they would spend US$81 million, backed by domestic private firms, to clean up 45 lakes by 2015, and work has already begun on some of the city's largest lakes.

Air quality: Hanoi ranks average in air quality. While Hanoi has daily levels of sulphur dioxide and particulate matter that are comparable to the Index average, the city achieves relatively low levels of daily nitrogen dioxide emissions — 20 micrograms per cubic metre versus the Index average of 47 micrograms per cubic metre. All the emissions figures for Hanoi are from 2004, but the performance on nitrogen dioxide is no doubt helped by a comparatively small car population. Hanoi also scores reasonably well in policy areas, following an air quality code and measuring air pollutants, although it does less well when it comes to promoting awareness among citizens about air pollution.

Green initiatives: In an effort to reduce vehicle emissions, the Hanoi Transport Services Corporation spent US$11 million in 2009 on replacing 132 of its 800-bus fleet with ones that conformed to European emissions standards. Changes to Vietnam's special consumption tax regime in April 2009 also aim to discourage the purchase of cars that produce high levels of emissions and achieve poor fuel efficiency.

Environmental governance: Hanoi ranks well below average in the environmental governance category, primarily owing to weak policies for environmental monitoring and management. The city has a dedicated environment department, but citizens and other stakeholders are only partly involved in the decision-making process relating to projects of major environmental impact. The city does receive full marks, however, for providing a central point of contact for public information about the city's environmental performance.

Green initiatives: In the first half of 2010, a city-wide research project was conducted with the backing of the Hanoi People's Committee. The results of the project will provide the basis for a strategy to tackle the city's deteriorating environment. The implementation of any future strategy to halt the trend of environmental degradation, though, could be undermined by a national focus on promoting economic growth.

Quantitative indicators: Hanoi

		Average	Hanoi*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	1.9 [1e]	2007	EIU estimate
	Energy consumption per US$ GDP (MJ/US$)	6.0	9.5 [1e]	2007	EIU estimate
Land use and buildings	Population density (persons/km^2)	8,228.8	1,935.1	2009	EIU calculation
	Green spaces per person (m^2/person)	38.6	11.2	2008	Graduate School for International Development and Cooperation, Hiroshima University
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.00		
Waste	Share of waste collected and adequately disposed (%)	82.8	95.0 [2]	2009	Hanoi City Environmental Protection Agency
	Waste generated per person (kg/person/year)	375.2	282.0 [2]	2009	Hanoi City Environmental Protection Agency
Water	Water consumption per person (litres per person per day)	277.6	53.1 [3e]	2006	GMSARN International Conference on Sustainable Development
	Water system leakages (%)	22.2	45.0 [4]	2003	Asian Development Bank
Sanitation	Population with access to sanitation (%)	70.1	40.0 [5e]	2008	Hanoi Water Resources University
	Share of wastewater treated (%)	59.9	10.0 [6e]	2008	Hanoi Water Resources University
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	20.0	2004	Clean Air Initiative
	Daily sulphur dioxide levels (ug/m^3)	22.5	25.0	2004	Clean Air Initiative
	Daily suspended particulate matter levels (ug/m^3)	107.8	110.0	2004	Clean Air Initiative

* All data applies to Hanoi unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Based on regression analysis using city population and GDP, 2) Based on domestic waste 3) Based on household consumption, 4) "Non-revenue water", 5) Based on access to drainage facilities, 6) Based on industrial waste water treated due to lack of data

Hong Kong_China

Background indicators

Total population (million)	7.0
Administrative area (km^2)	1,104,4
GDP per person (current prices) (US$)	29,990.5
Population density (persons/km^2)	6,362.2
Temperature (24-hour average, annual) (°C)	23.0

Data applies to Hong Kong

Hong Kong is a major financial, trading and transport hub in East Asia. Many of the shipments to and from southern China pass through Hong Kong's port, making it one of the world's busiest. Although the port brings economic benefit to Hong Kong, it has also added environmental pressure through water pollution and emissions from cargo-carrying road traffic. The city has a GDP per capita of nearly US$30,000, which places it in the high-income group in the Asian Green City Index. As one of two special administrative regions of China, along with Macau, Hong Kong retains a high degree of autonomy from the Chinese central government.

Hong Kong ranks above average overall in the Index. The city's best performance is in the land use and buildings category, where it ranks well above average, boosted by one of the largest amounts of green spaces in the Index. In most other categories, Hong Kong ranks above average. As well as having well-developed transport and sanitation infrastructures in place, Hong Kong benefits from having a wide range of proactive policies to improve and protect its environment. The city ranks average in the water category, mainly due to a high rate of consumption and a relatively high level of water leakages.

Energy and CO_2: Hong Kong ranks above average in the energy and CO_2 category, performing particularly well for its clean energy policies and climate change action plan. Hong Kong is one of only six cities covered in the Index that regularly monitors greenhouse gas emissions and publishes the results. The city also consumes a relatively small amount of energy per US$ of GDP, at an estimated 1.5 megajoules, well below the Index average of 6 megajoules. There is still room for improvement, however. Hong Kong's CO_2 emissions, at an annual 5.4 tonnes per capita, are above the Index average of 4.6 tonnes. While electricity accounts for half of Hong Kong's total energy consumption, carbon-intensive coal is responsible for generating 54% of Hong Kong's electricity supply. Heavy road traffic also helps to push up Hong Kong's CO_2 emissions. In addition, Hong Kong is one of only a few cities in the Index that does not use renewables for either energy consumption or electricity production. However, the city has focused on relatively cleaner natural gas as an energy source, with 15% of its energy consumption coming from natural gas, and 24% of its electricity production.

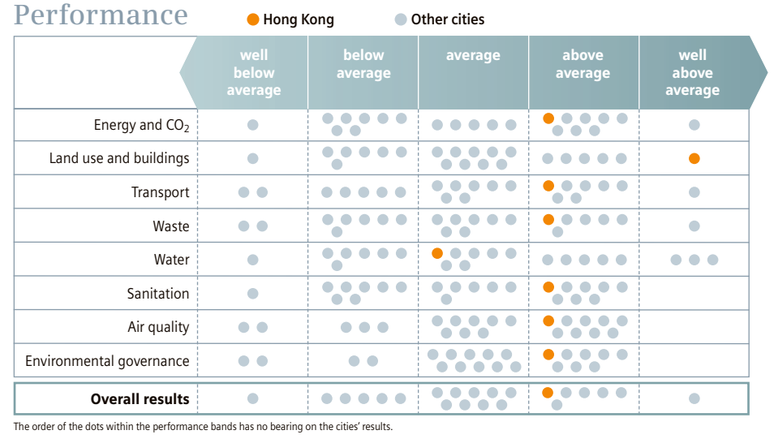
Green initiatives: An inter-governmental working group that coordinates Hong Kong's policy response to climate change is currently carrying out a comprehensive study on how the city can cut greenhouse gas emissions. The group has not set specific targets for reductions because under the Kyoto protocol Hong Kong is considered part of China, which, as a developing country, does not have to meet specific targets. Hong Kong does have policies, however, to reduce its carbon footprint by enhancing energy efficiency. One of several measures introduced in the last decade is an energy efficiency labelling scheme for appliances and vehicles, which has been mandatory since 2008.

Land use and buildings: Hong Kong ranks well above average in land use and buildings. The city's score is boosted by having the third largest amount of green space in the Index, at 105 square metres per person, well above the Index average of 39 square metres. The city's success in green spaces is partly due to its natural geography — some mountainous areas are not easily developed — but also because of proactive policies towards conservation. About 48,000 hectares of land are also under statutory protection in Hong Kong, with most of it designated as country parks and marine parks. Besides the parks, 6,600 hectares designated for conservation must follow strict planning and development controls. Hong Kong also has strong policies on eco-buildings and land-use. Standards are well established for the eco-efficiency of new buildings, as are incentives and regulations to motivate businesses and households to lower their energy use. The city also actively promotes citizen awareness about ways to improve buildings' energy efficiency, and leads by example through adopting its own green standards for public building projects.

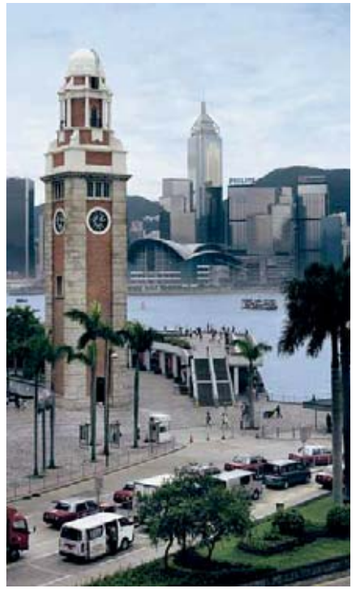
Green initiatives: In a city famous for its skyscrapers, buildings account for about 90% of total electricity consumption. Since 1998 the government has maintained building energy codes, which stipulate minimum requirements for the energy efficiency of lighting, air-conditioning, lifts and escalators. Compliance with the codes was initially voluntary but the government has a proposal in the legislature to make it mandatory.

Transport: Hong Kong ranks above average in transport. The city scores well for having a comparatively well-developed superior public transport network (defined in the Index as transport that moves large numbers of passengers quickly in dedicated lanes, such as metro, bus rapid transit, or trams). Measuring 0.24 km per square kilometre, it stretches farther than the Index average of 0.17 kilometres. Hong Kong also does well on transport policy. The city has an integrated pricing system for its mass transit system, and has taken steps to reduce emissions from mass transport. The city's transport performance further benefits from policies to reduce traffic congestion, with measures such as pedestrian areas, congestion charges, "no-car days", and park and ride systems. Hong Kong's traffic management system is also among the most sophisticated in the Index.

Performance



The order of the dots within the performance bands has no bearing on the cities' results.



Green initiatives: Hong Kong has plans to substantially expand its metro system. For example, the city's subway authority began building a three-station extension of the main Hong Kong Island line through its densely populated western district in July 2009. The project is scheduled for completion in 2014. The city has also embraced innovation. In 2005, in a separate project, Hong Kong's Mass Transit Railway opened a 3.8 km line to take tourists to the Disneyland resort. It was the first heavy rail train line to use automated, driverless technology. Regarding road congestion, the city has installed Area Traffic Control systems to ensure smooth traffic flow and optimum use of the road network in the Tuen Mun and Yuen Long districts. The project involves the real-time coordination and adjustment of traffic control signals at 249 junctions.

Waste: Hong Kong ranks above average in waste. Although Hong Kong produces 434 kg of waste per capita per year, which is more than the Index average of 375 kg, the city collects and adequately disposes of all of the waste it generates, primarily through the city's three existing landfills. However, as Hong Kong's economy continues to grow and more waste is generated, particularly from construction, the city's landfills are running out of space earlier than expected. There is strong public resistance to new landfills, so the government is focusing more of its efforts on waste reduction, primarily through the "polluter pays" principle (see "green initiatives" section below) where the city charges those responsible for distributing the polluting items rather than raising funds through other means. Hong Kong scores well for already having strong polices in place for waste, which include the encouragement of better waste management by citizens through such measures as litter bans and making it illegal to dump waste. Waste re-use and recycling services are also very well developed in Hong Kong.

Green initiatives: The government relies on the "polluter pays" principle for its waste reduction strategy. The most conspicuous policy so far has been a US$0.06 levy on plastic shopping bags started in July 2009. Authorities estimate that some eight billion plastic bags end up in landfills annually. On the first anniversary of the levy, the government reported that retailers are distributing 90% fewer bags than before the policy was adopted.

Water: Hong Kong is average in the water category, mainly due to comparatively high water consumption. It consumes 371 litres of water per capita per day, compared to the 22-city average of 278 litres. The city has an ageing water network, and an estimated 21% of the water supply is lost to leakages, close to the Index average of 22%. In terms of policy, however, Hong Kong scores well. The city regularly monitors the quality of surface water, maintains targets for key pollutants in drinking water, and is strong at enforcing water pollution standards on local industry. Regarding water efficiency initiatives, Hong Kong is one of the most robust in the Index, with measures in place such as water tariffs, rainwater collection and public campaigns to promote conservation. These conservation efforts partly reflect the fact that Hong Kong has to import more than 70% of its water supply from mainland China, according to the city government.

Green initiatives: Since 2000 Hong Kong has undertaken major investment to upgrade the city's decades-old water mains to minimise water leakages. It will spend a total of US$2.5 billion by 2015 to replace or repair some 3,000 km of the 7,700 km-long water-main network. In another initiative, the Hong Kong government and the government of the mainland Chinese province, Guangdong, have been collaborating on a water quality initiative in the Pearl River Delta. The two governments joined forces in 2000 to produce an innovative computer model that accurately simulates the flow of pollution in the river network and coastal waters, which allows for regional cooperation in monitoring water quality in the delta.

Sanitation: Hong Kong ranks above average in sanitation. The city scores well on policy, regularly monitoring wastewater treatment facilities and running public awareness programmes. Hong Kong treats 98% of its wastewater, compared to the Index average of 60%. However, due to data availability, Hong Kong's figure in the Index comes from 2001. In addition, an estimated 93% of the population has access to sanitation, well above the Index average of 70%. Hong Kong has also made firm progress in preventing toxic effluents from flowing into its famous Victoria Harbour. Today, about 75% of sewage discharged into Victoria Harbour is chemically treated and disinfected, according to the Hong Kong government.

Green initiatives: The Harbour Area Treatment Scheme to clean up Victoria Harbour is ongoing. By 2014 more sewage from further districts within the city will be diverted to a sewage treatment plant located on a promontory at the north-western corner of the harbour that opened in 2001. When it is finished, the project is expected to prevent another 190 to 500 tonnes of sewage sludge from flowing into the harbour every day, and eliminate disease-causing pathogens in the water by 90% and toxic ammonia by 10%, according to the Hong Kong government. The government hopes to recoup operating costs through "polluter pays" sewage charges.

Air quality: Hong Kong ranks above average in air quality. Although the city's daily nitrogen dioxide levels are higher than the Index average — at 50 micrograms per cubic metre compared to the 22-city average of 47 micrograms — Hong Kong performs well for relatively low levels of sulphur dioxide and suspended particulate matter. At 14 micrograms per cubic metre, Hong Kong's average daily sulphur dioxide concentrations are lower than the Index average of 23 micrograms, while the level of average daily suspended particulate matter, at 47 micrograms per cubic metre, is less than half the Index average of 108 micrograms. Although Hong Kong's air quality is strongly impacted by emissions from mainland China, which might help explain the relatively high levels of nitrogen dioxide, the city benefits from strong air quality policies. The city regularly monitors air quality in various locations around the city, not just in industrial areas, and promotes awareness among citizens about the dangers of air pollution. Hong Kong also scores well for measuring a wide range of air pollutants, including suspended fine particulate matter and carbon monoxide.

Green initiatives: The government has taken steps to reduce vehicle emissions, which are the city's second biggest source of air pollution behind power generation. Since 2007 the government has provided financial and tax incentives for owners of older cars and trucks to replace them with newer, less-polluting models, or cars with hybrid engines. Environmental authorities are also promoting biodiesel by exempting duty on the fuel for motor vehicles. In addition, cross-border emissions from mainland China are a major contributor to Hong Kong's air quality, so close cooperation with the mainland government is very important. A number of meetings, studies and agreements have taken place in the past few years to improve such cooperation.

Environmental governance: Hong Kong is above average for environmental governance. The city regularly monitors its environmental performance and publishes information on progress, and enjoys strong powers to implement its own environmental legislation. The city's environmental department, which has a wide remit, has also conducted a baseline environmental review in all of the main areas covered by the index within the last five years. Hong Kong also does well at involving citizens, non-governmental organisations and other stakeholders in decisions on projects of major environmental impact.

Quantitative indicators: Hong Kong

		Average	Hong Kong*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	5.4	2008	Government of the Hong Kong Special Administrative Region
	Energy consumption per US$ GDP (MJ/US$)	6.0	1.5 e	2009	Hong Kong Census and Statistics Department
Land use and buildings	Population density (persons/km^2)	8,228.8	6,362.2	2009	Hong Kong Census and Statistics Department
	Green spaces per person (m^2/person)	38.6	105.3	2009	Government of the Hong Kong Special Administrative Region
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.24	2010	Hong Kong Tramways Ltd; Hong Kong MTR
Waste	Share of waste collected and adequately disposed (%)	82.8	100.0	2009	Hong Kong Waste Statistics
	Waste generated per person (kg/person/year)	375.2	434.3	2009	Hong Kong Waste Statistics
Water	Water consumption per person (litres per person per day)	277.6	371.2	2009	Water Supplies Department, Hong Kong
	Water system leakages (%)	22.2	21.0 e	2009	Hong Kong Water Bureau
Sanitation	Population with access to sanitation (%)	70.1	93.0 1e	2008	Drainage Services Department, Hong Kong
	Share of wastewater treated (%)	59.9	98.0	2001	Drainage Services Department, Hong Kong
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	50.0	2009	Environment Protection Department, Hong Kong
	Daily sulphur dioxide levels (ug/m^3)	22.5	14.0	2009	Environment Protection Department, Hong Kong
	Daily suspended particulate matter levels (ug/m^3)	107.8	47.0	2009	Environment Protection Department, Hong Kong

* All data applies to Hong Kong unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Based on access to sewerage

Jakarta_Indonesia

Background indicators

Total population (million)	9.2
Administrative area (km^2)	664.0
GDP per person (current prices) (US$)	7,636.4
Population density (persons/km^2)	13,889.9
Temperature (24-hour average, annual) (°C)	27.0

Data applies to Jakarta

Indonesia's capital, Jakarta, is the country's largest city, with a population of 9.2 million, extending across 660 square kilometres on the northwestern coast of the island of Java. The capital generates around 16% of Indonesia's economic output, and has a GDP per person of US$7,600. This makes it Indonesia's richest city, but it is still among the lower income cities in the Asian Green City Index. Services account for 71% of Jakarta's economy, followed by industry, at 28%. The city's tropical climate can lead to flooding in the rainy season, aggravating sanitation and health problems. The city faces several environmental challenges, but it has shown leadership in pledging to reduce carbon emissions beyond national targets.

Jakarta is ranked average overall in the Index. The city's best performance is in the energy and CO_2 category, where it ranks above average, mainly for its low levels of CO_2 emissions and energy consumption. In addition, Jakarta has the lowest energy consumption in relation to its GDP among cities with a similarly low income in the Index (with a GDP per person of less than US$10,000). Jakarta is average in the categories of land use and buildings, transport, air quality and environmental governance. In the air quality category, Jakarta has the lowest average daily levels of nitrogen dioxide of all 22 cities in the Index, and in the transport category, among low-income cities, it has the longest superior public transport network (which can include a metro, bus rapid transit or trams). The city ranks below average for water and sanitation. Regarding water, although Jakarta has the third lowest water consumption rate in the Index, it also has the highest level of water leakages. The city has the most room for improvement in the waste category, where it ranks well below average.

Energy and CO_2: Jakarta ranks above average in the energy and CO_2 category, bolstered by relatively low levels of CO_2 emissions and energy consumption. The city, with its service-dominated and relatively low-carbon economy, emits an estimated 1.2 tonnes of CO_2 per person per year, compared to the 22-city average of 4.6 tonnes. Jakarta consumes an estimated 2.4 megajoules per US$ of GDP, compared with the Index average of 6 megajoules, which also is the lowest rate of energy consumption among cities with low incomes in the Index. The city performs well in the Index for its policies on carbon emissions. For example, it receives full marks for having conducted a baseline review of greenhouse gas emissions within the last five years, and it also regularly monitors green-house gas levels and publishes the results. The city performs less well for clean energy policies, largely because it lacks a strategy to reduce the environmental impact of energy consumption, and makes only partial investments in waste-to-energy initiatives and other forms of renewable energy. About 4% of Jakarta's energy consumption comes from renewable sources, and it generates about 10% of its electricity from cleaner production, mainly hydropower.

Green initiatives: Indonesia won plaudits at the 2009 UN Conference on Climate Change when it committed itself to voluntary reductions in CO_2 emissions, pledging to reduce emissions by at least 26% from 2009 levels by 2020. Going farther than the nationwide target, the Jakarta governor has said he will reduce the city's emissions by 30% from 2009 levels by 2020. However, detailed policies aimed at meeting this commitment have yet to be announced.

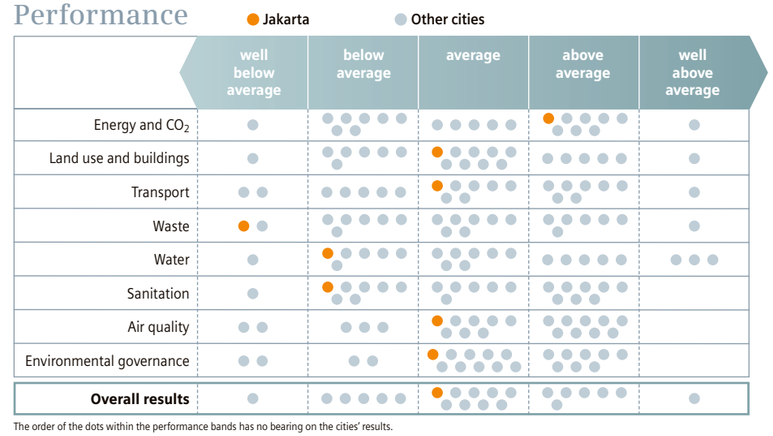
Land use and buildings: Jakarta is average in the land use and buildings category. With nearly 13,900 people per square kilometre, only three other cities in the Index have higher population densities than Jakarta. The city has a relatively small amount of green spaces, at 2 square metres per person, compared to the Index average of 39 square metres. Regarding land use policies, Jakarta makes only partial efforts to contain urban sprawl or protect environmentally sensitive areas. In addition, the city could improve its eco-buildings policies. It does have energy efficiency standards for private buildings, but its regulations are weaker for public buildings. In practice, Jakarta officials presently do not take account of environmental factors when issuing building permits, although independent groups have called for greater third-party scrutiny of developers who claim to be green. However, officials are working to improve the situation with plans for new standards (see "green initiatives" below).

Green initiatives: In January 2010, the national government issued a decree on green buildings, setting some standards for energy efficiency and other environmental standards. But so far its provisions remain voluntary. The decree includes standards for labelling energy efficient building materials, low-carbon fuel, water and waste management, and air quality. It also directs developers to build facilities to conserve water and harvest rainwater. Meanwhile, the Jakarta administration, with the support of the International Finance Corporation, the private sector arm of the World Bank, is preparing regulations of its own covering green buildings, which will also be voluntary.

Transport: Jakarta ranks average in the transport category. It performs well for the length of its superior public transport network (defined in the Index as transport that moves large numbers of passengers quickly in dedicated lanes, such as metro, bus rapid transit or trams), at 0.19 km per square kilometre, above the Index average of 0.17 km per square kilometre. This is also the longest superior network among the lower income cities in the Index. Some 7 million passengers per month are estimated to travel by the TransJakarta Busway, a "bus rapid transit" service which first opened in 2004. The service carries passengers in modern air-conditioned buses in dedicated bus lanes which cover about 120 km. Although the system appears too small to meet current demand, the city has plans to extend it (see "green initiatives" below). Regarding its transport policies, Jakarta is marked down in the Index for only partly integrating the pricing system for the transport network, for example, and for limited attempts to reduce emissions from mass transport.

Green initiatives: The city has plans to improve the TransJakarta Busway by adding seven new lines, bringing the total number of lines to 15.

Performance



The order of the dots within the performance bands has no bearing on the cities' results.

A metro has been on the drawing board for several years too, and the first phase of a 22-km north-south line is scheduled to begin operation in late 2016. Regarding measures to ease traffic congestion, in September 2010 the city administration announced that it would build six elevated roads in order to handle cross-city traffic. The city also has a longstanding regulation banning private vehicles with fewer than three passengers from central Jakarta's main roads during peak hours.

Waste: Jakarta is well below average in the waste category. Jakarta generates less waste than the Index average, at an estimated 292 kg, compared to the average of 375 kg. However, the city collects and adequately disposes of only an estimated 35% of its refuse, well below the average of 83%. Most of Jakarta's collected waste ends up at open rubbish dumps, such as the 110-hectare Bantar Gebang landfill, situated around 30 km east of the city. Jakarta is marked down in the Index for lacking standards for waste disposal sites and for only making partial efforts to enforce standards for industrial hazardous waste. The city performs better for recycling policies, with an integrated policy to reduce, re-use or recycle waste. The city also has special waste collection services in operation for the types of waste evaluated in the Index — including household hazardous waste, medical and infectious waste, and chemical waste. Jakarta also has on-site recycling collection services.

Green initiatives: Modern waste-treatment facilities are limited. There is an environmentally friendly facility at Ciangir, around 20 km west of Jakarta in Banten province, that has yet to begin operations amid disagreements between two authorities over the choice of a technology supplier. The Jakarta administration has also been promoting a so-called "3R" campaign to reduce waste, and promote re-use and recycling through outreach work with businesses and households.

Water: Jakarta ranks below average in the water category, despite having the third lowest per capita water consumption rates in the Index, at 78 litres per day, compared with the Index average of 278 litres. However, Jakarta loses an estimated 50% of its water supply to leakage, the highest rate in the Index, and more than twice the Index average of 22%. Jakarta sometimes experiences water shortages during the dry season, when supplies run low at the reservoir that provides 60% of the capital's water. Regarding policies, Jakarta has a code in place covering surface water quality, but it is marked down for partial standards on drinking water and regulations covering industrial water pollution. It lacks a code to reduce water stress or to consume water more efficiently, but does publicly promote the importance of water conservation.

Green initiatives: The government is spending around US$225 million upgrading Jakarta's water transmission network in a project that is expected to provide additional water supplies to the city through closed pipes. However, the project is not expected to be completed until 2012.

Sanitation: Jakarta is below average in sanitation. An estimated 67% of Jakarta's residents have access to sanitation, which is the highest rate among cities with a similarly low income in the Index, and close to the Index average of 70%. Because of data limitations, Jakarta's figure in the Index was estimated from 2006 World Bank data on the whole of Indonesia. In contrast, the city has one of the lowest rates of wastewater treatment in the Index, at an estimated 1%, compared to the Index average of 60%, reflecting the fact that the city has only one sewage treatment plant in South Jakarta. Wealthier households typically use septic tanks for sewage treatment, but the less fortunate living in the city's informal settlements invariably discharge waste directly into the city's rivers and waterways. Regarding sanitation policies, Jakarta has a partial code to promote environmentally sustainable sanitation services and only partially promotes the clean use of sanitation systems. Although the city has wastewater treatment standards, they are relatively weak when compared with other cities in the Index.

Green initiatives: Flooding in the rainy season can overwhelm the sanitation system in Jakarta, and officials have introduced measures in recent years to address the problem. These include flood canals to handle overflow, and the acquisition of 300 water pumps that can remove more than 300 cubic metres of water per second.

Air quality: Jakarta ranks average in air quality. The city benefits from the lowest rate of average daily concentrations of nitrogen dioxide among the 22 cities, at 19 micrograms per cubic metre, compared with the Index average of 47 micrograms. It also has below average levels of average daily suspended particulate matter, at 43 micrograms per cubic metre, compared to the average of 108 micrograms. The city's service-based economy may partly explain the low emissions levels for these two pollutants. However, the city's sulphur dioxide emissions, at 53 micrograms per cubic metre, are above the Index average of 23 micrograms. Sulphur dioxide is produced mainly through burning sulphur-containing fuels, usually coal and oil, and Jakarta indeed consumes and produces relatively high percentages of its energy from these sources. For example, it has the highest share of oil used in electricity production in the Index, at 26%, and coal accounts for a further 29%.

Green initiatives: In 2005 the government started requiring all vehicles in the capital to undergo regular emissions tests, but there have been problems with enforcement. In addition, TransJakarta Busway vehicles use biodiesel, which emits less CO_2 than conventional diesel or compressed natural gas.

Environmental governance: Jakarta ranks average for environmental governance. It has a dedicated environmental department with legal capacity to implement its own legislation and a wide remit over many aspects of sustainability management. It receives full marks for regularly monitoring the city's environmental performance and publishing the results, and citizens and non-governmental organisations are involved in decisions on projects with an environmental impact. However, environmental governance is weakened in Jakarta by problems associated with conflicting responsibilities between the various government agencies, and confused rules and regulations.

Quantitative indicators: Jakarta

		Average	Jakarta*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	1.2 [e]	2007	Jakarta Central Statistics Bureau; IPCC; EIU estimates
	Energy consumption per US$ GDP (MJ/US$)	6.0	2.4 [e]	2007	Jakarta Central Statistics Bureau; EIU estimates
Land use and buildings	Population density (persons/km^2)	8,228.8	13,889.9	2009	Statistics Indonesia
	Green spaces per person (m^2/person)	38.6	2.3	2008	Statistics Indonesia
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.19	2010	TransJakarta
Waste	Share of waste collected and adequately disposed (%)	82.8	35.0 [e]	2009	Jakarta Sanitation Agency; Jakarta Globe
	Waste generated per person (kg/person/year)	375.2	291.5 [1e]	2008	Jakarta Central Statistics Bureau
Water	Water consumption per person (litres per person per day)	277.6	77.6 [2]	2008	Statistics Indonesia
	Water system leakages (%)	22.2	50.2 [3e]	2008	Water Environment Partnership in Asia
Sanitation	Population with access to sanitation (%)	70.1	67.0 [4e]	2006	World Bank
	Share of wastewater treated (%)	59.9	1.0 [5e]	2006	USAID
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	18.5	2008	Clean Air Initiative
	Daily sulphur dioxide levels (ug/m^3)	22.5	52.7	2008	Clean Air Initiative
	Daily suspended particulate matter levels (ug/m^3)	107.8	42.6	2008	Clean Air Initiative

* All data applies to Jakarta unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Based on typical solid waste density, 2) Based on total volume of water sold, 3) Based on source water lost through network, 4) All urban areas in Indonesia, 5) Based on coverage of Jakarta treatment plant from USAID

Karachi_Pakistan

Background indicators

Total population (million)	14.5
Administrative area (km²)	3,527.0
GDP per person (current prices) (US$)	5,379.3[1]
Population density (persons/km²)	4,111.1
Temperature (24-hour average, annual) (°C)	26.0

Data applies to Karachi, 1) Based on 2007 population and US$ PPP prices

Karachi is Pakistan's largest city and the country's commercial capital, with a GDP per capita of US$5,400. Figures in the Index are for the urban population of Karachi, at about 14.5 million, according to the latest official estimates. The city's appearance reflects the fact that it is one of the world's fastest growing metropolises. Karachi is a combination of old seafront districts, residential and commercial developments, golf clubs, skyscrapers, crowded roads and informal settlements. Its industries include shipping, trade, finance, banking, information technology, manufacturing, real estate, media and education. Karachi is situated on a natural harbour facing the Arabian Sea, Pakistan's primary seaport. Because of its central location between India and the Middle East, Karachi has been an important trading port for centuries. Rapid growth has exacerbated environmental challenges, and the city has struggled to improve basic infrastructure, such as roads, water pipes and sanitation, to match rising demand.

Karachi ranks well below average overall in the Asian Green City Index. The city's best performance is in the water category, where it ranks average, mainly for a low rate of per capita water consumption. Karachi is below average in most other categories. The city has the biggest challenges in the transport and air quality categories, where it ranks well below average. In these categories, it is marked down particularly for lacking a superior public transport network, such as metro lines, bus rapid transit systems or trams, and for high average daily concentrations of the three air pollutants evaluated in the Index. For the future, there are several projects underway to improve transport, sanitation, water and waste infrastructure, financed by international organisations such as the Asian Development Bank, the Japan Bank for International Cooperation and the US Trade Development Agency.

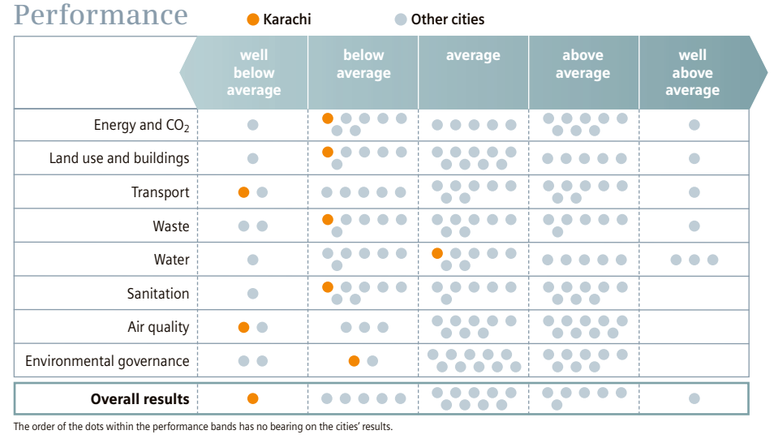
Energy and CO_2: Karachi ranks below average in the energy and CO_2 category. The city produces less-than-average levels of CO_2 per person, at an estimated 3.1 tonnes compared to the Index average of 4.6 tonnes. But emission levels could be higher since lack of current data meant that the figure was estimated based on 2006 data. Regarding energy efficiency, Karachi consumes an estimated 7.8 megajoules per US$ of GDP, compared to the average of 6 megajoules. The city does receive full marks for policies to consume energy more efficiently, but is marked down for not monitoring greenhouse gas emissions. Its climate change action plan covers only three of the six areas evaluated in the Index: waste, transport and energy, but not water, sanitation or buildings. The city has signed up as a participating member of the C40 group of cities, which have pledged to reduce greenhouse gas emissions.

Green initiatives: The Landhi Cattle Colony in Karachi has undertaken a US$5 million pilot project to convert cow dung into electricity and biogas. The pilot plant is currently producing 25 kilowatts of electricity per day, but plans are in place to build a larger plant with a 30-megawatt daily capacity. The larger plant will cost an estimated US$120 million, and its potential financial backers include the Asian Development bank, which will invest in return for carbon credits from the project. On energy efficiency, the Karachi Electricity Supply Corporation has brought down the rate of losses in transmission from 4.2% in 2008 to 2.4% in 2009 through a number of measures to track more accurately where electricity is being delivered. The US Trade Development Agency has also provided a grant for a feasibility study on improving efficiency in the electricity grid.

Land use and buildings: Karachi ranks below average in land use and buildings. This is due to a relatively low population density, a lower-than-average result on green spaces per person, and weaknesses on government policies. The amount of green spaces, at 17 square metres per person, is below the Index average of 39 square metres, and the city only partially protects green spaces through regulations. Karachi's land use policies aimed at maintaining green spaces and other environmentally sensitive areas are relatively weak, largely because local government authority over policy is divided between agencies. Thus there is poor enforcement of existing planning regulations. Karachi performs well for its eco-buildings policy, including full marks for energy efficiency standards on public buildings, and incentives for households and businesses to lower their energy use.

Green initiatives: The government is making attempts to urge developers to include parks in urban planning. In 2008 and 2009 the mayor energetically promoted the concept of green space, resulting in new parks and green areas within new developments. For example, in 2007 the city opened a new 130-acre park, one of the largest in Asia. In 2009, the national government adopted eco-buildings policies that outline mandatory minimum energy efficiency standards for homes, offices and public buildings such as hospitals.

Performance



The order of the dots within the performance bands has no bearing on the cities' results.

Transport: Karachi is well below average in transport, mainly because it lacks a superior public transport network (defined in the Index as transport that moves large numbers of passengers quickly in dedicated lanes, such as metro, bus rapid transit or trams), although the city is in the early stages of creating a bus rapid transit network and circular railway (see "green initiatives" below). Currently public transport consists of minibuses and coaches. Many of these do not operate on fixed routes, and most are filled to capacity. The result is an over-reliance on cars, and as a result the roads are badly congested. Karachi also has room for improvement in its performance on mass transport policy and congestion reduction policies, including any form of road pricing, carpooling lanes or "no-car days".

Green initiatives: The government is planning to implement a "bus rapid transit" system. The 45 km, three-line system is estimated to cost around US$600 million, about three quarters of which is being financed by the Asian Development Bank. A total of 4,000 buses are expected to be introduced within the first five years of the plan. Officials have announced plans to move forward with a plan to construct a 49 km circular railway in the city, although financing the US$872 million initiative is still proving to be a challenge. If financing can be arranged, then a portion of the new system could be expected to open within four years. Financing problems have also impeded plans to build another 87 km light rail system in the city.

Waste: Karachi is below average in the waste category. The city does produce a less-than-average amount of waste per person, at 229 kg per person compared to the Index average of 375 kg. The city collects and adequately disposes of an estimated 83% of its waste, which is equal to the Index average, although this figure is based only on household waste. This is also the fourth highest rate among low-income cities (below US$10,000 in GDP per person). However, Karachi is marked down for the absence of environmental standards for waste disposal sites and for not enforcing standards for industrial hazardous waste disposal or encouraging proper waste management by residents. Waste is not separated before collection and is dumped at two sites near the city's western border, one of which will be at capacity within only a few years. Collection is poorly organised and is mostly dependent on community dustbins located around the city.

Green initiatives: The city is in the early planning stages of a project to add two more landfills that are closer to the city, and which will therefore reduce transport costs. But no firm construction plans have been announced.

Water: Karachi is average in the water category. It has a relatively low water consumption per person, at 165 litres per person per day, compared to the Index average of 278 litres. However, this performance is more likely a result of water shortages and inefficiency than conservation efforts. The water distribution system in Karachi is about 40 years old on average, with many corroded pipes that disrupt effective transmission to homes and businesses. The city has seen improvements in the past decade however, with one nationally recognised project, the Greater Karachi Water Supply project, supplying 100 million gallons per day to city residents through two pumping stations. Still, the city suffers from a relatively high rate of leakages: 25% of the water is lost, compared to the Index average of 22%. Policies on water are also largely partial. Karachi has a water quality code in place, but only partially monitors surface water. The city is marked down for its efforts to encourage water conservation and to enforce industrial water standards. The city does, however, receive full marks for setting targets on the level of pollutants in drinking water.

Green initiatives: The Karachi water board is in the first phase of a long-term plan for additional reservoirs and pumping stations that is expected to double the city's water supply. Financing for the US$273 million project is currently being arranged through the city government and a grant from the Asian Development Bank. Once under way, the first phase of the project — land acquisition and surveying potential sites — will take an expected four years.

Sanitation: Karachi ranks below average in the sanitation category. Access to sanitation is below the Index average, at an estimated 57% compared to 70%. Karachi is also below the average for the share of wastewater treated, at 22%, compared to 60%. Overall, the sewage system is ageing, and the three existing treatment plants serving the city operate at about 50% efficiency, experiencing blocked pipes and frequent mechanical failure. In terms of sanitation policies, Karachi lacks regular monitoring of on-site treatment facilities in homes or communal areas, nor does it promote public awareness around clean and efficient use of the sanitation system. Karachi is marked down for lacking a comprehensive sanitation strategy, but the city does have minimum standards for the monitoring and treatment of wastewater.

Green initiatives: The provincial government has approved the Greater Karachi Sewage Treatment Project, a four-year, US$112 million initiative to build three new wastewater treatment plants, renovate the existing plants and install new sewer pipes. Land has been acquired for the new treatment plants, and the government will be seeking additional financing within the next few months.

Air quality: Karachi is well below average for air quality, with high average daily concentrations for nitrogen dioxide, sulphur dioxide and suspended particulate matter. Karachi's main challenges — vehicle emissions, industrial pollution, dust and open burning — afflict many cities in Asia. But Karachi is especially vulnerable because its policies are not comprehensive. Its air quality code, set at national level, is only in draft stages. Also, the city does not fully monitor air quality around the city, nor does the government fully inform citizens about the dangers of air pollution.

Green initiatives: From July 2012 the government will require all diesel vehicles in the city, including buses, to comply with "Euro II" emissions standards. Euro II is an earlier version of current European standards, which put restrictions on the amount of particulate matter which vehicles are allowed to emit. Furthermore, the Japan Bank for International Cooperation is funding an environmental monitoring system across Pakistan, which includes two air-quality monitoring stations in Karachi.

Environmental governance: Karachi ranks below average in environmental governance. The city has an environmental department, but it lacks the full legal remit to enact environmental regulations. The city gets full marks for having conducted a baseline environmental review within the last five years, but is marked down for not fully monitoring its environmental performance and publishing the results. Karachi also has some of the weaker policies in the Index regarding public access to environmental information and involving citizens in decisions about projects with environmental impacts, but this is improving within the city.

Green initiatives: The Orangi Pilot project, hailed as a success story across Asia, gives residents of poor communities the resources and engineering expertise to help solve their own environmental challenges. The project, which began in the 1980s in Orangi Town, an area within Karachi, initially focused on sewer improvements, with residents laying hundreds of kilometres of pipes. By 1993, 72,000 additional houses had been connected. Within ten years, the programme had expanded to cover not only environmental challenges, but had also led to the establishment of schools, health clinics, women's work centres, stores and a credit organisation to finance further projects. Today the Orangi project model is being replicated in other cities in Pakistan, as well as Sri Lanka, India, Nepal and South Africa.

Quantitative indicators: Karachi

		Average	Karachi*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	3.1 [1e]	2006	EIU estimate
	Energy consumption per US$ GDP (MJ/US$)	6.0	7.8 [2e]	2006	Karachi Master Plan 2020
Land use and buildings	Population density (persons/km^2)	8,228.8	4,111.1	2007	EIU calculation
	Green spaces per person (m^2/person)	38.6	17.0 [3]	2007	City District Government of Karachi
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.00		
Waste	Share of waste collected and adequately disposed (%)	82.8	82.7 [4e]	2006	Urban Resource Centre of Karachi
	Waste generated per person (kg/person/year)	375.2	229.0	2006	Urban Resource Centre of Karachi
Water	Water consumption per person (litres per person per day)	277.6	164.5 [5]	2007	Karachi Master Plan 2020
	Water system leakages (%)	22.2	25.0 [6]	2007	Karachi Master Plan 2020
Sanitation	Population with access to sanitation (%)	70.1	57.0 [7e]	2006	Karachi Master Plan 2020
	Share of wastewater treated (%)	59.9	22.0	2006	Karachi 2020 Master Plan
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	59.5	2008	Karachi Urban Resource Centre
	Daily sulphur dioxide levels (ug/m^3)	22.5	57.3	2008	Karachi Urban Resource Centre
	Daily suspended particulate matter levels (ug/m^3)	107.8	180.4	2008	Karachi Urban Resource Centre

* All data applies to Karachi unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Based on regression analysis, 2) Based on 2007 GDP data, 3) "Tree and vegetation cover" 4) Based on household waste, 5) Based on final water supply, 6) "Water loss", 7) Based on access to sewerage

Kolkata_India

Background indicators

Total population (million)	15.6
Administrative area (km^2)	1,851.0
GDP per person (current prices) (US$)	1,414.1[e]
Population density (persons/km^2)	8,451.6
Temperature (24-hour average, annual) (°C)	26.0

Data applies to Kolkata Metropolitan Area, e) EIU estimate

Kolkata, the capital of the Indian state of West Bengal, is located in the eastern part of the country, alongside the Hooghly River. With a population of 15.6 million in the metropolitan area, it is the fourth most populous city in the Asian Green City Index, and a regional hub for financial services and IT. The city is also home to domestic manufacturing, producing a range of products including electronics and jute, a plant-based fibre used in rugs and ropes. Despite its growing economy, Kolkata's GDP per capita is the lowest among the 22 cities the Index, at an estimated US$1,400. Due to data limitations, all environmental figures for Kolkata in the Index only cover the urban centre, called Kolkata City, which has a population of about 5.1 million.

Kolkata is ranked below average overall in the Index. Its best performance is in the water category, where it is average, with one of the lowest per capita water consumption rates in the Index. The city ranks below average in most other categories. Kolkata does relatively well for low levels of CO_2 emissions per person and low concentrations of sulphur dioxide. In addition, among cities with a similarly low income in the Index (below US$10,000 in US$ GDP per person), it has the third longest superior public transport network (a definition that includes metro, bus rapid transit or tram lines). However, Kolkata's policies are generally weaker than in other cities in the Index. The city's major challenges are in the transport and environmental governance categories, where it ranks well below average.

Energy and CO_2: Kolkata ranks below average in the energy and CO_2 category, despite performing relatively well for CO_2 emissions and energy consumption. CO_2 emissions, at an estimated 1.5 tonnes per person, are better than the Index average of 4.6 tonnes. Energy consumption per US$ of GDP is also better than average, at an estimated 4 megajoules, compared to the 22-city average of 6 megajoules. In addition, the city generates 10% of its electricity from hydropower. However, Kolkata is marked down in policy areas. Kolkata has not conducted a baseline review of greenhouse gas emissions in the last five years, nor are greenhouse gas emissions monitored on a regular basis. The city has also not signed up to any international covenants to limit greenhouse gases. Its clean energy policies are also weaker than in other cities in the Index. For example, it receives partial marks for its energy strategy and only makes partial efforts to consume energy more efficiently.

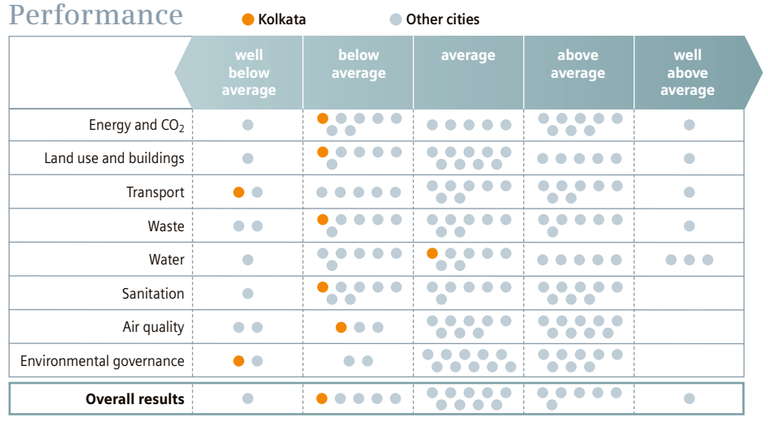
Green initiatives: As an initial attempt to promote the use of solar power and reduce greenhouse gas emissions, the West Bengal state environmental department has required all backlit billboards in the state to go solar. Billboards using grid electricity were required to make the switch by December 2010 and those powered by diesel generators were required to make the switch from June 2010. The department has also directed local governments not to issue permits to any new billboards powered by fossil fuel. West Bengal's environmental department says the measure can reduce CO_2 emissions by several tonnes per hour across the Kolkata metropolitan area, assuming that all billboards make the switch.

Land use and buildings: Kolkata is below average in the land use and buildings category. It has the ninth highest population density, at 8,500 people per square kilometre, and the least amount of green spaces in the Index, at 2 square metres per person, compared to the Index average of 39 square metres. This is also lower than the average of Indian cities in the Index, at 17 square metres per person. Urban development has cut into existing green spaces, and many construction projects have taken place without building parks or other green spaces to compensate. Kolkata is not as strong as other cities in policy areas covered by the Index, including eco-buildings standards, energy efficiency incentives and urban sprawl containment, although it does receive full marks for having green standards for public building projects and for publicly promoting energy efficiency in buildings.

Green initiatives: Nine residential projects in Kolkata have received recognition from the Leadership in Energy and Environmental Design, an internationally recognized green building certification system developed by the US Green Building Council.

Transport: Kolkata is well below average in the transport category. Its superior public transport network consists mainly of trams and a metro, and measures 0.05 km per square kilometre. This is below the Index average of 0.17 km per square kilometre, but is the third longest system among cities with similarly low incomes in the Index, and similar to the Indian city average of 0.03 km per square kilometre. The city is also investing in upgrades to the network (see "green initiatives" below). On the policy side,

Performance



The order of the dots within the performance bands has no bearing on the cities' results.

Kolkata still has room for improvement. The city does not have an integrated pricing scheme for public transport, nor does it encourage residents to take greener forms of transport. It only gets partial marks in the Index for its urban mass transport policy and its efforts to reduce emissions from public transport. It lacks most of the congestion reduction and traffic management systems evaluated in the Index, such as road pricing, or carpooling lanes, although it has established dedicated times for freight deliveries and access points around the city. The city also has plans to implement traffic information systems to ease traffic congestion. The city has also been making investments to extend its road network in recent years (see "green initiatives" below).

Green initiatives: Kolkata looks set to benefit from central government investment to improve urban infrastructure. Under the Jawaharlal Nehru National Urban Renewal Mission, eight projects primarily aimed at reducing traffic congestion in Kolkata — at an estimated cost of US$194 million — are expected to be finished by 2011. These include new flyovers, bypasses and interchanges throughout the city. Furthermore, the Kolkata Metro, the first underground railway in India, is to be extended to Howrah, a municipal town in the metropolitan area. Funded by the Kolkata Metro Rail Corporation, construction began in March 2009 and is due to be completed in October 2014 at an estimated cost of US$106 million. Another initiative designed to ease traffic congestion is the Kolkata Monorail mass transit system, which has been under construction since March 2009. The first phase of 20 km is scheduled for completion by mid-2011; the second phase will add another 52 km, although the project deadline is not clear.

Waste: Kolkata ranks below average in the waste category. The city performs relatively well on waste generation and collection. Kolkata generates 282 kg of waste per person per year, compared to the Index average of 375 kg. It collects and adequately disposes of 80% of its waste, only slightly less than the 22-city average of 83%, although because of data availability, Kolkata's figure in the Index comes from 2002. However, Kolkata is one of three cities in the Index that does not enforce environmental standards for waste disposal sites. There are no official dumping grounds in many of the metropolitan area's municipalities, and waste is often dumped inappropriately in low-lying areas. Kolkata is also marked down for its insufficient efforts to enforce and monitor standards for disposing hazardous industrial waste, and for its overall strategy for re-using and recycling waste. However, although it lacks a comprehensive strategy, the city does separately collect and dispose of most of the special materials evaluated in the Index, including household hazardous waste, medical waste and chemical waste. In addition, Kolkata has on-site recycling collection, as well as central collection points around the city.

Green initiatives: A range of projects are underway in Kolkata to improve waste management. A nationally-funded project has already been completed at a cost of around US$12 million to provide a solid waste management system for ten municipal towns in the metropolitan area, with plans to extend it further. The Kolkata Solid Waste Management Improvement Project, with financial and technical support from the Japan Bank for International Cooperation, also aims to improve waste management in a number of towns within the metropolitan area. This project targets a population of 1 million at an estimated cost of around US$40 million. In addition, the Kolkata Environment Improvement Program has a solid waste management component aimed at effective management of municipal, hazardous, and biomedical waste in the urban centre. A new "sanitary landfill" site spread across 114 hectares at Dhapa is also being built as part of this programme.

Water: Kolkata is average in the water category. The city benefits from a relatively low level of water consumption, at 138 litres per person per day. This is one of the best rates among the 22 cities, and better than the average of 278 litres, although due to data availability, the figure in the Index comes from 2006. The low rates of water consumption might partly be explained, however, by a lack of supply. Kolkata also has a high leakage rate, losing 35% of its total water supply through leaks, versus an Index average of 22%, although, again, Kolkata's figure comes from 2006. Regarding policies, the city has a water quality code in place covering pollutants in surface water, and it is marked up for having standards for key pollutants in drinking water, as well as enforcing water quality standards on industry. For example, the state government authorities regularly monitor water quality in the Hooghly river, with river water samples collected every month from eight stations.

Green initiatives: One aim of the Kolkata Environment Improvement Project is to install water meters in every household in the urban centre that has a water connection. But some elected officials have sided with consumers who would have to pay more if meters replaced flat-rate tariffs, which has stalled progress.

Sanitation: Kolkata ranks below average in the sanitation category. An estimated 52% of Kolkata's population has access to adequate sanitation facilities, compared to the Index average of 70%. But this figure comes from 2006. Yet according to more up-to-date figures from 2009, the city treats only 20% of its wastewater, compared to the Index average of 60% and the Indian city average of 46%. Kolkata is also marked down for its sanitation policy. There is only partial monitoring of on-site treatment facilities in residential and communal areas, and Kolkata's policy towards promoting environmentally sustainable sanitation services could be improved.

Green initiatives: As part of the Jawaharlal Nehru National Urban Renewal Mission, backed by the central government, US$120 million is being invested in building and improving sewerage systems in the urban centre and the municipal town of Bhidannagar.

Air quality: Kolkata is below average in air quality. The result is largely due to relatively high average daily levels of nitrogen dioxide, at 61 micrograms per cubic metre, versus the average of 47 micrograms, and average daily suspended particulate matter levels, at 190 micrograms per cubic metre against the average of 108 micrograms. Both can be explained by traffic congestion and various air-polluting industries, including foundries. However, Kolkata manages to register one of the lowest daily levels of sulphur dioxide in the Index, at 7 micrograms per cubic metre, well below the average of 23 micrograms. The relatively low sulphur dioxide levels in Kolkata can be attributed to an increased use of low-sulphur coal, as well as low-sulphur petrol and diesel.

Green initiatives: A project between the Pollution Control Board and the India Canada Environment Facility, an environmental joint venture by the two governments, has provided businesses with 50% of the total cost to adopt cleaner fuel technology. The Board has also enforced tighter European-style emissions standards for all new four-wheeled passenger cars in the metropolitan area. Cleaner fuels, including unleaded petrol, low-sulphur petrol and diesel, containing 0.05% sulphur, and liquefied petroleum gas, are also available in the urban centre. The measures to reduce vehicle emission have been reinforced by the introduction of an extensive network of upgraded emissions testing centres.

Environmental governance: Kolkata ranks well below average in the environmental governance category. The city's environmental department lacks full authority to oversee the city's environment, and Kolkata is also marked down for a lack of environmental monitoring. The city does make efforts to involve citizens, non-governmental organisations and other stakeholders in projects with environmental impacts, but there is no central point of public access for information about the city's environmental performance. In addition, Kolkata is one of the few cities in the Index that has not conducted a baseline environmental review in the last five years.

Quantitative indicators: Kolkata

		Average	Kolkata*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	1.5 [e]	2007	ICLEI; CESC; CPCB; IPCC; EIU estimates
	Energy consumption per US$ GDP (MJ/US$)	6.0	4.0 [1e]	2007	ICLEI; CESC; CPCB; EIU estimates
Land use and buildings	Population density (persons/km^2)	8,228.8	8,451.6 [2]	2008	EIU calculation
	Green spaces per person (m^2/person)	38.6	1.8 [3]	2009	National Commission on Urbanisation
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.05	2010	Calcutta Tramways; Metro Railway India
Waste	Share of waste collected and adequately disposed (%)	82.8	80.0	2002	Abfallwirtschaft und informeller Sektor in der City of Calcutta, Dr Lutz Trettin, Ruhr-Universität Bochum
	Waste generated per person (kg/person/year)	375.2	282.0	2007	Carbon Emission Report in Asian Cities 2008, ICLEI
Water	Water consumption per person (litres per person per day)	277.6	137.8	2006	Kolkata Municipal Corporation
	Water system leakages (%)	22.2	35.0	2006	Kolkata Municipal Corporation
Sanitation	Population with access to sanitation (%)	70.1	52.0 [4e]	2006	World Bank
	Share of wastewater treated (%)	59.9	20.0 [5]	2009	Kolkata Municipal Corporation
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	61.4	2009	West Bengal Pollution Control Board
	Daily sulphur dioxide levels (ug/m^3)	22.5	7.1	2009	West Bengal Pollution Control Board
	Daily suspended particulate matter levels (ug/m^3)	107.8	189.6	2009	West Bengal Pollution Control Board

* All data applies to Kokata City unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Energy for Kolkata City; GDP only available for Metropolitan Area, 2) Based on Kolkata Metropolitan Area, 3) "Green cover", 4) Estimate based on average of urban areas in India due to lack of data, 5) Excluding "natural treatment" into wetlands

Kuala Lumpur_Malaysia

Background indicators

Total population (million)	1.7
Administrative area (km^2)	243.0
GDP per person (current prices) (US$)	12,365[e]
Population density (persons/km^2)	6,811.1
Temperature (24-hour average, annual) (°C)	27.0

Data applies to W.P. Kuala Lumpur, e) EIU estimate

Kuala Lumpur is the capital of Malaysia and the country's business and financial centre. Although the metropolitan area has a population of some 7 million people, due to limited data availability all information in the Asian Green City for Kuala Lumpur comes from the inner city, which has a population of 1.7 million. This makes it the least populous city in the Index with the second smallest administrative area. Kuala Lumpur is relatively prosperous, however, with a GDP per capita of an estimated US$12,400. The city's economic performance partly reflects the national government's success in attracting foreign investment in the country's burgeoning technology sector. This has been mainly achieved through its Multimedia Super Corridor project, a government-designated zone offering tax breaks to technology companies that locate there. Kuala Lumpur is also home to several other major industries, including banking, insurance, media, manufacturing and education.

Kuala Lumpur ranks average overall in the Index, with category performances ranging from well below average to above average. Transport and air quality are Kuala Lumpur's strongest categories, with above average rankings. Proactive transport policies, along with a relatively extensive and advanced rapid transit network are strengths for Kuala Lumpur. So too are the city's longstanding air quality measures, stretching over two decades, to promote low-sulphur fuel and reduce emissions. Although vehicle traffic is still heavy in the city, Kuala Lumpur has the second lowest level of sulphur dioxide emissions in the Index. Kuala Lumpur's main environmental weaknesses are in the energy and CO_2, sanitation, waste and water categories, where it ranks well below average, due in part to high water consumption and waste generation. In addition, the city ranks average in land use and buildings, and environmental governance.

Energy and CO_2: Kuala Lumpur ranks below average in the energy and CO_2 category. The city's fondness for automobiles has driven annual CO_2 emissions per capita past the Index average of 4.6 tonnes to an estimated 7.2 tonnes. Nevertheless, Kuala Lumpur's growing technology sector has helped to contain energy consumption in relation to its economic output to an estimated 5 megajoules per US$ of GDP, which is below the Index average of 6 megajoules. And the city also generates 8% of its electricity through renewable sources, primarily hydro power. In policy areas, Kuala Lumpur is less ambitious than the majority of other cities in the Index at converting local waste by-products to energy, and has made only partial efforts to produce and consume energy more efficiently. The city also does not regularly monitor its greenhouse gas emissions, and it has not conducted a baseline review of greenhouse gas emissions in the last five years.

Green initiatives: The Malaysian national government, rather than the city, has taken the lead on setting targets to reduce greenhouse gases. For example, the national government has announced targets to reduce greenhouse gases by up to 40% by 2020, compared with 2005 levels, but few specific initiatives have been announced in order to reach this target. The Malaysian government has, however, recently announced its National Renewable Energy Policy and Action Plan to increase renewable energy from 1% to 5.5% of electricity supply by 2015. The government plans to introduce a "feed-in tariff", a government subsidy for utilities that buy wind, water or solar energy to feed into the national grid. If the legislature approves the plan, it will come into effect in 2011.

Land use and buildings: Kuala Lumpur is average in the land use and buildings category. With 44 square metres of green spaces per person, the city is above the Index average of 39 square metres. Its population density is just below the Index average, at 6,800 people per square kilometre, compared to the average of 8,200 people. Kuala Lumpur performs relatively poorly in policy areas, particularly in relation to eco-buildings. In comparison with most other cities in the Index, Kuala Lumpur's eco-efficiency standards for new buildings are not as comprehensive. There is a national "green buildings index" that measures water and energy efficiency, but the plan provides a rating as a guideline and is not mandatory. Regarding land use policy, Kuala Lumpur does relatively well at protecting and promoting the development of green spaces and conservation areas. By contrast, its policies to contain urban sprawl are relatively weak.

Green initiatives: The Kuala Lumpur government is adding to its three existing forest reserves with plans to build more parks in the city centre. The new parks will increase coverage area of public parks and open spaces from the current 5% of Kuala Lumpur's total area to 8% in 2020. The government is also developing guidelines on protecting environmentally sensitive areas. In addition, the national government expects to plant 100,000 new trees in the city by 2020, as well as connect parks through green corridors, under a comprehensive "Economic Transformation Programme" launched in October 2010.

Transport: Kuala Lumpur ranks above average in the transport category. Its superior public transport network (defined in the Index as transport that moves large numbers of passengers quickly in dedicated lanes, such as metro, bus rapid transit, or trams) is a light rail system measuring 0.27 km per square kilometre. This makes it the fourth longest superior network in the Index, and second longest among cities in the mid-income range (with a GDP per person of

Performance

● Kuala Lumpur ● Other cities

	well below average	below average	average	above average	well above average
Energy and CO_2	●	●			
Land use and buildings	●		●		
Transport	● ●			●	
Waste	● ●				
Water	●				
Sanitation	●	●			
Air quality	● ●	●		●	
Environmental governance	● ●	●	●		
Overall results	●		●		

The order of the dots within the performance bands has no bearing on the cities' results.

between US$10,000 and US$25,000). In addition, the national government has plans to fund a new metro system, which is scheduled to begin construction in July 2011. The city's transport policies also show that the government has ambition to improve (see "green initiatives" below). The city has an integrated pricing system for public transport, encourages citizens to take greener forms of transport, and has a relatively advanced traffic management system. Kuala Lumpur could do better, however, at developing policies to reduce emissions from mass urban transport. Although some measures are in place to reduce traffic congestion, such as road charging, the city has not undertaken other key initiatives, such as carpooling lanes, pedestrian areas and "no-car days".

Green initiatives: The city government aims to more than quadruple the number of daily commuters using public transport, from the estimated 480,000 in 2010 to two million by 2015. It is expanding the metro with additional coaches, adding bus lanes, and will institute park and ride facilities at rail stations. The government also plans to improve existing bus lanes in 2011 by installing barriers to separate them from the part of the road used by automobiles. In addition, the national government is planning a high-speed rail link between Kuala Lumpur and Singapore.

Waste: Kuala Lumpur ranks well below average in the waste category. The city generates a relatively large amount of waste, at 816 kg per capita per year, more than double the Index average of 375 kg. Rapid population growth, an increase in packaging from convenience goods and a lack of recycling facilities have all played their part in driving up waste levels. Furthermore, the city performs relatively poorly at collecting the waste it generates and disposing of it adequately. Only an estimated 58% of Kuala Lumpur's waste is collected and adequately disposed of, according to 2005 data based on the waste collected at landfills only, versus the Index average of 83%. Kuala Lumpur performs better for its waste collection and disposal policies. The city does relatively well at enforcing environmental standards for waste disposal sites, as well as being vigilant at enforcing and monitoring standards for industrial hazardous waste. Compared with many other cities in the Index, Kuala Lumpur has a weaker strategy for reducing, recycling and re-using waste. Even so, Kuala Lumpur does have infrastructure in place for waste recycling, both in terms of collection services available and the wide range of materials it recycles.

Green initiatives: Under the Kuala Lumpur 2020 City Plan, the city's comprehensive long-term development plan, the government plans to raise the proportion of waste recycled from the current 20% level to 30% by 2015. (The national government has announced a further target of 40% by 2020.) To help achieve this target, a solid waste treatment plant on the outskirts of the city is planned by 2015. It will convert waste into energy or reusable products, such as ethanol and other fuels. The national government is also funding a programme to raise recycling awareness as part of the national curriculum, and is considering other measures to improve waste management, including billing based on the amount of waste generated.

Water: Kuala Lumpur is well below average in the water category, due to a combination of relatively high water consumption and one of the highest leakage rates in Index. Kuala Lumpur's water consumption per capita, on a daily basis, measures an estimated 497 litres, well above the Index average of 278 litres. Relatively low water tariffs have played their part in stimulating demand. But there are also difficulties on the supply side, with water leakages running at an estimated 37%, compared with the Index average of 22%. In policy areas, Kuala Lumpur scores better. Water quality standards are in force, backed up by regular monitoring, and city authorities are relatively strong at enforcing water pollution standards on local industry. The city also promotes public awareness around efficient water consumption, although it could implement a wider range of water efficiency measures. There are no separate pipes for non-drinking water in Kuala Lumpur, for example, and the city does not enforce hose-pipe bans.

Green initiatives: The Kuala Lumpur city government is currently drafting a series of initiatives aimed at encouraging rainwater harvesting, which is the direct collection of rainwater from roofs and other specially built facilities. In addition, there are ongoing initiatives regarding recycling and water conservation. The government has several pilot projects under way in houses and schools and hopes to make rainwater harvesting mandatory by 2020, but these proposals are at very early stages.

Sanitation: Kuala Lumpur ranks below average in the sanitation category. An estimated 70% of the city's population has access to sanitation, which, although in line with the Index average, is the lowest proportion among other mid-income cities in the Index. A significant number of households are still served by primary sewage treatment plants, such as septic tanks. Data is also lacking. No information was available, for example, on the share of wastewater treated. Regarding sanitation policies, minimum standards exist for the treatment of wastewater, coupled with regular monitoring, while on-site treatment facilities are also regularly checked. But Kuala Lumpur is marked down for only partly promoting public awareness around the efficient and hygienic use of sanitation systems.

Green initiatives: The national government has announced a major initiative to clean up the Klang river, which will be ongoing in 2011, including upgrades to the sewage system to prevent wastewater from polluting the river. The plan also calls for relocating informal settlements and enforcing wastewater regulations on homes and businesses.

Air quality: Kuala Lumpur ranks above average in air quality. The city scores well for better-than-average levels of sulphur dioxide, nitrogen dioxide and suspended particulate matter. Average daily sulphur dioxide emissions are particularly low in Kuala Lumpur, at 6 micrograms per cubic metre. This is the second lowest level in the Index, and well below the Index average of 23 micrograms. The relative absence of large-scale industry in the city, combined with stricter standards for emissions and the increased availability of low-sulphur fuel, have all played their part in improving Kuala Lumpur's air quality. For two decades the government has operated incentives to use unleaded gasoline and has required new vehicles to have catalytic converters, which reduce emissions from combustion engines. Fuel in Malaysia is also blended with palm oil — Malaysia is the world's largest palm oil producer — which further lowers emissions. In addition, a ban on open burning has been in place since 2005. The protection of the three forest reserves in the city has also benefitted air quality.

Green initiatives: The government plans to require all vehicles to use biofuel from June 2011. This programme will start in Kuala Lumpur before being rolled out across peninsular Malaysia. In addition, there are plans to adopt tougher European standards on vehicle emissions, which would further reduce sulphur content in fuel.

Environmental governance: Kuala Lumpur is average for environmental governance. Officials regularly monitor the city's environmental performance and publish information on progress. Kuala Lumpur's government also has relatively strong powers to implement its own environmental legislation. The city's environmental department, however, has a narrower remit than most other cities in the Index, with climate change, human settlements and sanitation each falling outside its purview. Kuala Lumpur is also marked down for omitting to do a baseline environmental review of those areas, as well as energy, in the last five years, although the city has conducted a baseline environmental review within that timeframe in all of the other main areas covered by the Index, including water, waste, air quality, transport and land use. Kuala Lumpur also does well for involving citizens, non-governmental organisations and other stakeholders in decisions on projects with major environmental impact.

Quantitative indicators: Kuala Lumpur

		Average	Kuala Lumpur *	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	7.2 [1e]	2007	EIU estimate
	Energy consumption per US$ GDP (MJ/US$)	6.0	5.0 [1e]	2007	EIU estimate
Land use and buildings	Population density (persons/km^2)	8,228.8	6,811.1	2009	EIU calculation
	Green spaces per person (m^2/person)	38.6	43.9	2004	Kuala Lumpur Master Plan
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.27	2010	Kuala Lumpur City Hall Urban Transport Department
Waste	Share of waste collected and adequately disposed (%)	82.8	57.5 [2e]	2005	Kuala Lumpur Structure Plan 2020
	Waste generated per person (kg/person/year)	375.2	815.7	2005	Universiti Sains Malaysia, WHO
Water	Water consumption per person (litres per person per day)	277.6	497.2 [3e]	2008	National Water Services Commission
	Water system leakages (%)	22.2	37.0 [4e]	2004	Public Services International Research Unit (PSIRU)
Sanitation	Population with access to sanitation (%)	70.1	70.0 [5e]	2003	Kuala Lumpur Structure Plan 2020
	Share of wastewater treated (%)	59.9	0.0		
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	40.1	2008	Compendium of Environmental Statistics 2009
	Daily sulphur dioxide levels (ug/m^3)	22.5	6.2	2008	Compendium of Environmental Statistics 2009
	Daily suspended particulate matter levels (ug/m^3)	107.8	44.0	2008	Compendium of Environmental Statistics 2009

* All data applies to W.P. Kuala Lumpur unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Based on regression analysis, 2) Landfill figures available only; waste generation figures from Universiti Sains Malaysia, WHO, 3) Based on water supply; Based on Selangor region, 4) Based on non-revenue water in Malaysia, 5) Access to "reticulated sewerage service"

Manila_Philippines

Background indicators

Total population (million)	11.6
Administrative area (km^2)	636.0
GDP per person (current prices) (US$)	5,365.3
Population density (persons/km^2)	18,165.1
Temperature (24-hour average, annual) (°C)	27.0

Data applies to Metro Manila

The Philippines' capital, Manila, is the country's largest city and political centre, housing the presidential palace, government ministries and the central bank. The metropolitan area, Metro Manila, comprises 16 different cities, each with its own elected mayor and officials. However, there is a department of the environment and natural resources that has responsibility for environmental management across the metropolitan region. All data for Manila in the Asian Green City Index refer to Metro Manila. Some 11.6 million were living in the metropolitan area in 2007 — which is the latest available official population figure for Metro Manila. Services account for about 69% of the city's economy, with industry accounting for the remaining 31%. Overall, Manila produces 37% of the country's GDP. The city's per capita GDP of around US$5,400 is the highest in the Philippines, but in comparison to the other cities in the Index, it is the sixth lowest. Manila is also characterised by wide disparities of income between individuals.

Manila ranks below average overall in the Index. Its best performance is in the air quality category, where it ranks above average, mainly for registering relatively low levels of the three pollutants measured in the Index. It ranks average in the categories of energy and CO_2, and environmental governance, and below average in the remaining categories — land use and buildings, transport, waste, water and sanitation. The weaker performances in these categories can be attributed mainly to poor results for some quantitative indicators, such as amount of green spaces per person, access to sanitation and the share of wastewater treated. In addition, the city could improve in some policy areas such as eco-buildings standards and water quality codes. When compared against other cities in the low range for income in the Index (with a GDP per person below US$10,000), Manila registers the second lowest rate of energy consumption per unit of GDP, and the second lowest level of particulate matter emissions.

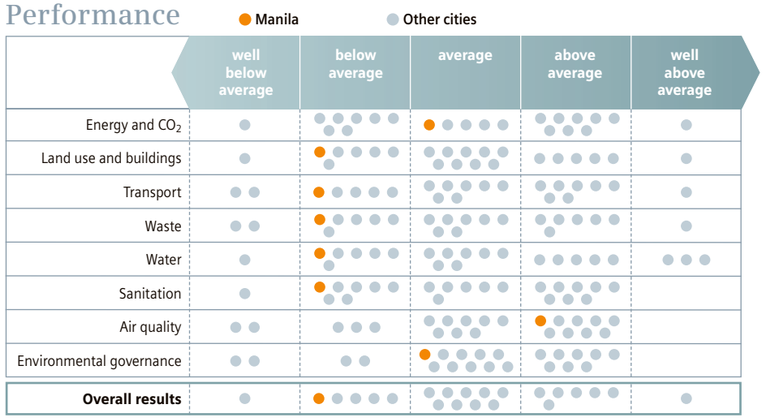
Energy and CO_2: Manila ranks average for energy and CO_2. The city generates an estimated 1.6 tonnes of CO_2 per person, well below the Index average of 4.6 tonnes. Manila's performance in this category partly reflects the fact that many residents cannot afford energy-intensive lifestyles. Although coal accounts for about 63% of electricity generation, the remainder comes from relatively cleaner natural gas. Manila performs less well in terms of energy efficiency, although its consumption of an estimated 4 megajoules per US$ of GDP is still better than the average of 6 megajoules, and is the second lowest level among cities with a similar income in the Index. Manila's ranking in this category is adversely affected by the lack of a strategy to reduce the environmental impact of energy consumption, for not having conducted a baseline review of greenhouse gas emissions within the last five years, and for not monitoring greenhouse gases regularly and publishing the results.

Green initiatives: The national government's 2008 Renewable Energy Act provides financial incentives to developers of renewable energy projects, including income-tax holidays for seven years and duty-free imports of machinery, equipment and materials for 10 years. However, the act does not set emission-reduction targets.

Land use and buildings: Manila ranks below average in the land use and buildings category. The city performs well in terms of population density, with 18,200 people per square kilometre, more than double the Index average of 8,200 people per square kilometre. However, it scores poorly for green spaces, and for its relatively weak policies governing eco-buildings and land use. The amount of green spaces in Manila, at 5 square metres per person, is well below the Index average of 39 square metres. Although the city has some attractive parks, including the famous Spanish colonialera Luneta in central Manila City, uncontrolled building in other parts of the capital means that green spaces are limited overall. The city also has scope to improve its policies to contain urban sprawl and protect environmentally sensitive areas from development. Regarding eco-buildings policies, Manila lacks energy efficiency standards for public and private buildings, and it has few incentives in place to motivate businesses and households to lower their energy use. A national building code was approved by the national government in 1972 and is now outdated. Some lawmakers are calling for new legislation to promote environmentally friendly buildings, but no legislation has yet been introduced. Still, some developers, eager to market their developments as "green", have signed onto their own voluntary standards (see "green initiatives" below).

Green initiatives: In 2009 the Philippine Green Building Council, an independent group, launched a rating scheme known as Building for Ecologically Responsive Design Excellence (BERDE) to provide voluntary assessments of buildings based on their energy and water consumption, and waste management. BERDE is modelled on Singapore's successful Green Mark Scheme. In another initiative, city authorities

Performance



The order of the dots within the performance bands has no bearing on the cities' results.

have partnered with leading private developers and Greenpeace, an environmental NGO, to encourage local authorities and private citizens to introduce energy efficiency measures in schools, hospitals and businesses. It builds on a prior initiative in Makati City in 2007, in which the government partnered with local businesses to promote changing to energy-efficient lamps in public buildings throughout the city.

Transport: Manila ranks below average in the transport category. The city has only 0.05 km per square kilometre of superior mass transport routes, consisting of a light rail network, well below the Index average of 0.17 km per square kilometre. The capital's three mass transit rail lines, operated by the Light Rail Transit Authority and the Metro Rail Transit Corporation, only extend approximately 50 km across the capital. Jeepneys, which were originally refurbished US army jeeps, but are currently produced by private workshops and factories, remain the most popular mode of public transport. Many of Manila's transport policies could be improved. It is marked down, for example, for having only a partially integrated pricing system for mass transport. It also lacks congestion reduction initiatives such as congestion charges or carpooling lanes.

Green initiatives: The city government has introduced dedicated bus lanes, although there are still problems with enforcement, with other vehicles sometimes intruding into lanes.

Waste: Manila ranks below average in the waste category. The city scores well in terms of waste generated per person per year, at 248 kg, compared with the Index average of 375 kg. Manila's relatively low income also constrains consumption, and results in less waste. Only an estimated 77% of Manila's waste is collected and adequately disposed of, compared with the 22-city average of 83%. Regarding policies, Manila has relatively weak environmental standards for waste disposal sites and for disposing industrial hazardous waste. For example, the enforcement of the 2000 Ecological Solid Waste Management Act varies widely. The act established a national commission to promote environmentally friendly waste management practices, prohibited the use of open dump sites, introduced segregation of solid waste at the source, and set ten-year targets for waste disposal. The Metropolitan Manila Development Agency estimates that only 48% of local authorities in Metro Manila are segregating waste at the source. Waste that is not collected by the authorities is either dumped or burnt. Smokey Mountain, a notorious open dump situated in Manila City's Tondo district, was closed 20 years ago and its tens of thousands of residents were resettled in public housing. But waste picking remains widespread in Manila, and the city lacks regulations on this activity. Although on-site recycling collection and central collection points exist in the city, a recent report by the national waste management commission revealed that most recycling is performed by the informal sector.

Water: Manila is below average in the water category. The city scores well in terms of water consumption per person, with an average daily consumption of an estimated 155 litres per person, significantly less than the average of 278 litres per person. Frequent droughts often result in low water levels at the Angat reservoir, which supplies most of Manila, leading the city to ration water. There are also disparities in water delivery in different parts of the city, with one of the two main water companies supplying 24-hour water to almost all of its customers in 2009, while the other company only provided 24-hour water to two-thirds of its customers in that same year. Manila loses an estimated 36% of its water to system leakages, well above the Index average of 22%. The city's policies regarding water quality and water sustainability remain relatively weak. For example, the national 2004 Clean Water Act was meant to improve water quality, but pollution remains a serious concern, mainly owing to untreated wastewater. Lack of financing remains a serious problem and the national government has yet to establish a dedicated fund to improve water quality, which is mandated by the Clean Water Act.

Sanitation: Manila ranks below average in the sanitation category. Although the city has an environmental code governing sanitation services, only 12% of the city's households have access to sanitation, well below the Index average of 70%. Likewise, officials have established wastewater treatment standards, but the city treats only 21% of its wastewater, compared to the 22-city average of 60%. Wealthier housing developments maintain private septic tanks, but sludge treatment and disposal facilities are limited, resulting in the discharge of untreated waste into the city's rivers.

Green initiatives: As directed by the national 2004 Clean Water Act, the Department of Public Works and Highways and other government agencies prepared a national programme on sewerage and septage management, which has raised awareness of the importance of sanitation. Also, the Department of Health published a manual on the rules and regulations of domestic sludge and septage, which improved disposal practices among septic tank owners. A national sustainable sanitation programme also promotes environmentally sound sanitation practices such as not disposing untreated waste in waterways. Manila's two water companies are only slowly connecting new customers to sewer systems and investing in new sewage-treatment facilities.

Air quality: Manila ranks above average in the air quality category. The city's performance mainly reflects relatively low average annual levels of the three pollutants — nitrogen dioxide, sulphur dioxide and suspended particulate matter. For particulate matter, Manila registers the second lowest rate of emissions among cities with a similarly low income in the Index. Nonetheless, Manila's air quality is not uniform, and the city's most congested areas, such as the Epifanio de los Santos Avenue, have significantly higher levels of pollutants. Authorities say traffic congestion accounts for 80% of air pollution in the city, and there is evidence that air quality has worsened after improving from 2004 to 2007, which is the latest year for which data was taken in the Index. Manila also has one of the weaker air quality codes among the 22 cities, although it is marked up for regularly monitoring several pollutants. City authorities have pursued policies aimed at improving air quality, mainly to comply with the national 1999 Clean Air Act, but enforcement varies.

Green initiatives: The Clean Air Act mandates annual surveys of air quality and calls on local authorities to develop action plans to improve air quality by lowering pollutants. Transport policies, including the conversion of public and private vehicles to run on cleaner fuels, such as liquefied petroleum gas, have played an important role in reducing pollution. The Metropolitan Manila Development Agency has also worked with international donors to reduce pollution from vehicles by conducting checks on exhaust emissions.

Environmental governance: Manila ranks average in the environmental governance category. The city receives full marks for having a single citywide authority with responsibility for overall environmental policy, for regularly monitoring its environmental performance and for having a single point of public access for environmental information. Still, because there are different municipalities within the metropolitan area, standards of environmental governance vary enormously, with some municipalities more committed to environmental issues than others. Richer parts of Metro Manila, such as Makati City, have performed relatively well in championing environmental causes, but poorer neighbourhoods have often found it more difficult to do so.

Quantitative indicators: Manila

		Average	Manila*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	1.6 [1e]	2009	Department of Energy; Meralco; IPCC; EIU estimates
	Energy consumption per US$ GDP (MJ/US$)	6.0	4.0 [e]	2009	Department of Energy; Meralco; EIU estimates
Land use and buildings	Population density (persons/km^2)	8,228.8	18,165.1	2007	EIU calculation
	Green spaces per person (m^2/person)	38.6	4.5	2007	Metro Manila Development Authority
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.05	2010	Light Rail Transit Authority
Waste	Share of waste collected and adequately disposed (%)	82.8	76.9 [2e]	2009	Metro Manila Development Authority
	Waste generated per person (kg/person/year)	375.2	247.6	2007	Environment Management Bureau
Water	Water consumption per person (litres per person per day)	277.6	154.8 [3e]	2009	Manila Water; Maynilad
	Water system leakages (%)	22.2	35.9 [4e]	2009	Metro Manila Water Agency
Sanitation	Population with access to sanitation (%)	70.1	12.0 [5]	2009	Manila Water; Maynilad
	Share of wastewater treated (%)	59.9	21.0	2009	Metro Manila Water Agency
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	33.7	2003	Air Quality Management; National Air Quality Status Report
	Daily sulphur dioxide levels (ug/m^3)	22.5	7.3	2007	Air Quality Management; National Air Quality Status Report
	Daily suspended particulate matter levels (ug/m^3)	107.8	48.0	2007	Air Quality Management; National Air Quality Status Report

* All data applies to Metro Manila unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Using population figures for 2007, 2) Data for controlled landfills only. Recycling not undertaken by Metro Manila Development Authority, 3) Based on household consumption, 4) Average of "East zone" and "West Zone" of Metro Manila Water Agency, 5) Based on primary research with Manila Water and Maynilad. Includes septic tanks.

Mumbai_India

Background indicators

Total population (million)	12.7
Administrative area (km²)	468.0
GDP per person (current prices) (US$)	2,184.3[1]
Population density (persons/km²)	27,136.8[e]
Temperature (24-hour average, annual) (°C)	27.0

All data applies to Greater Mumbai, 1) Based on estimated 2007 population figures, e) EIU estimate

Mumbai is a burgeoning metropolis and India's financial capital. For the purposes of the Asian Green City Index, Mumbai data is based on Greater Mumbai, which has a population of about 12.7 million and comprises both the urban and suburban areas. Mumbai's economy is dominated by the services sector, particularly IT, although manufacturing still accounts for around one in five jobs according to city authorities. Despite generating a slightly higher GDP per capita than its other three Indian counterparts, at about US$2,200, the city is one of the least prosperous in the Index. Spread across a comparatively small area of 470 square kilometres, Mumbai also has the highest population density in the Index, at an estimated 27,100 people per square kilometre.

Mumbai ranks below average overall in the Index. Its best performances are in the categories of energy and CO_2, land use and buildings, and water, where it ranks average. Regarding energy, the city has relatively low levels of CO_2 emissions, and has embraced sources of renewable energy for electricity production, particularly hydro power. In the water category, Mumbai benefits from a relatively low level of water leakages, and it is second best for this indicator among cities with a similarly low income in the Index (under US$10,000 in per capita GDP). The city, however, ranks below average in several other categories: transport, waste, sanitation and environmental governance. Air quality is a particular challenge, with Mumbai registering a well below average result in this category. This is due mainly to very high levels of the three air pollutants measured in the Index.

Energy and CO_2: Mumbai ranks average in energy and CO_2. Its inhabitants emit an estimated 1 tonne of CO_2 per capita per year, which is much lower than the Index average of 4.6 tonnes. Due to a lack of comprehensive data, however, Mumbai's CO_2 emissions performance is based on calculations which include data from 2004. Mumbai does well on the share of renewables it uses for electricity production. At 21% it has the fourth highest percentage in the Index, with hydro power accounting for most of it. On the other side, Mumbai registers an above average rate of energy consumption compared to its economic output. It consumes an estimated 6.5 megajoules of energy per US$ of GDP, compared to the Index average of 6 megajoules. However, the same caveats apply to the calculation of energy consumption figure as for the CO_2 emissions figures above. Elsewhere in the energy and CO_2 category, Mumbai scores poorly in policy areas. For example, it has a relatively weak strategy to reduce the environmental impact of energy consumption. And Mumbai's climate change action plan covers only energy, buildings and waste, while missing, for example, transport. However, the city has signed up to the C40 group of cities that have made a pledge to reduce greenhouse gases, and it does score highly in the Index for its efforts to source renewable energy.

Green initiatives: The Mumbai Energy Alliance (MEA), a partnership between local government and non-governmental organisations, promotes energy efficiency programmes in the Greater Mumbai region. Since 2008 the MEA has developed a pipeline of 25 projects that apply innovative and energy-saving technology in lighting, heating and cooling applications for residential, commercial, municipal buildings and small-scale industries. The combined projects, over a ten-year period, are targeted to make energy savings of 1,900 million kilowatt-hours and reduce CO_2 emissions by 13 million tonnes.

Land use and buildings: Mumbai ranks average in land use and buildings. While Mumbai scores well for having the highest population density in the Index, it scores poorly for green spaces per person. The city only has 7 square metres of green space per person versus the Index average of 39 square metres, and the Indian city average of 17 square metres. It is also marked down for only having partial policies to contain sprawl and to protect its green spaces and other environmentally sensitive areas. Mumbai is also among the weakest in the Index at providing incentives and regulations to motivate business and households to lower their energy use. However, it does have eco-building standards in place for both private and public buildings, and receives full marks for publicly promoting ways to save energy in buildings.

Green initiatives: An eco-housing program makes it mandatory for construction companies to obtain "Eco-Housing certification" from the city. The programme, launched in partnership between the city government, the United States Agency for International Development, and the International Institute for Energy Conservation, provides incentives to property developers to make their buildings more energy efficient. The incentives include rebates on development charges and some tax allowances. The MEA (Mumbai Energy Alliance) has also successfully piloted an initiative to install new energy-efficient water pumps in buildings around the city. The new pumps have been operational since March 2010 and have resulted in improved efficiency, as well as electricity savings. The pilot initiative is now to be extended and, if implemented in 100,000 buildings, will make annual electricity energy savings of 200 million kilowatt-hours and reduce CO_2 emission by 1.8 million tonnes over a ten-year period.

Transport: Mumbai ranks below average in transport. Although Mumbai's suburban rail, bus and road network has seen real improvements in recent years, boosted by nearly US$1 billion in investment since 2002 (see "green initiatives" below), the network is overstrained. Although the city is well served by suburban rail services, the city lacks a superior public transport network as defined in the Index (metro, bus rapid transit, or trams). In transport policy areas, Mumbai also has room for improvement. The city government has yet to implement measures to reduce traffic congestion, such as the creation of car pooling lanes, pedestrian areas, or park and ride facilities in congested areas. Among traffic management measures evaluated in the Index, Mumbai has traffic

Performance

● Mumbai ● Other cities

	well below average	below average	average	above average	well above average
Energy and CO_2	●	●●●●	●●●●●	●●●●●	●
Land use and buildings	●	●●●●●	●●●●●●	●●●●●	●
Transport	●●	●●●●●	●●●●●	●●●●●	●
Waste	●●	●●●●●	●●●●●	●●●●●	●
Water	●	●●●●●	●●●●●	●●●●●	●●●
Sanitation	●	●●●●●	●●●●●	●●●●●	
Air quality	●●	●●●	●●●●●●	●●●●●●	
Environmental governance	●●	●●	●●●●●●	●●●●●	
Overall results	●	●●●●●	●●●●●	●●●●●	●

The order of the dots within the performance bands has no bearing on the cities' results.

light sequencing but currently lacks traffic information systems or central access points around the cities, although they are in the planning stage.

Green initiatives: The Mumbai Urban Transport Project has led to improvements in both rail and road transportation infrastructure. The project, initiated in 2002 and completed at a cost of US$945 million, built new railway tracks, introduced more comfortable railway coaches, converted two major east-west roads into six-lane highways, and modernised the bus fleet by introducing more user-friendly buses that run on compressed natural gas. The second phase of the project, to be implemented over the next five years until 2015, will focus on improving passenger-carrying capacity, operational efficiency and strengthening the management of the suburban rail system.

Waste: Mumbai ranks below average in waste, despite scoring well for the relatively low amount of waste it produces. On average, Mumbai generates 209 kg of waste per year on a per capita basis versus an Index average of 375 kg, and under the Indian city average of 226 kg. However, with a population of nearly 13 million, the seventh highest in the Index, that still leaves a lot of waste to handle, and Mumbai struggles to cope. It is estimated that just under a third of the city's waste is collected and adequately disposed of, the lowest proportion of the cities covered in this report, and much lower than the Index average of 83%, as well as the Indian city average of 72%. The city could improve regulations covering its waste disposal sites, although it receives higher marks in the Index for its standards on industrial hazardous waste. Mumbai's recycling strategy is comparatively weak, although it does operate on-site collection and central recycling collection points within the city.

Green initiatives: The local government is promoting a programme called "Advance Locality Management", a voluntary association of citizens who maintain cleanliness and reduce waste in their respective "colonies", groups of 100 to 200 houses. Initiated in 1998, the programme currently covers over 700 colonies. The main activities undertaken by the group include segregation of waste at the source, handing over dry waste to waste-pickers, composting wet waste and associated public awareness activities. Another local government initiative is the "slum-adoption scheme", which has extended door-to-door waste collection to 550 informal settlements.

Water: Mumbai ranks average in water. The city's score is helped by a fairly efficient water system, losing just 14% of its water flow through leaks versus the Index average of 22%. This is the second best rate among cities with similarly low incomes in the Index (under US$10,000 in per capita GDP). The city has benefited from recent official efforts to reduce water leakages, which once ran as high as 50%. Mumbai is also comparatively sparing in its water use, consuming on average 250 litres per capita per day versus the Index average of 278 litres. In addition, Mumbai's sources its water supply from lakes and rivers rather than less sustainable sources, such as deep aquifers and desalination plants. To combat periodic water shortages, however, Mumbai has undertaken feasibility studies to build a number of desalination plants.

Green initiatives: The city has introduced universal metering and water rates to control demand. With greater vigilance on water use, the city also hopes to deter water theft and tampering with the water mains.

Sanitation: Mumbai ranks below average in sanitation. Only an estimated 42% of the city's population have access to sanitation versus the Index average of 70% (the Indian city average is 54%), although the Index figure for Mumbai dates back to 2005. Despite these difficulties, Mumbai still manages to treat 68% of the collected wastewater, which is higher than the Index average of 60%, and the Indian city average of 46%. And the city scores relatively well for its wastewater treatment standards. That said, Mumbai is one of only a handful of cities in the Index that does not regularly monitor sanitation facilities, either in communal areas or in the home.

Green initiatives: Mumbai is implementing the second phase of the "Mumbai Sewerage Disposal Project", which aims to comply with national and international standards by improving sanitation access, sewerage-conveyance infrastructure and treatment facilities. An important component of the first phase of the project, from 1996 to 2005, was the construction of 330 community toilet blocks — totalling about 6,000 seats — that served 400,000 people within informal settlements. The second phase aims to build another 35,000 toilet seats by 2012.

Air quality: Mumbai ranks well below average in air quality, due mainly to the city's legacy manufacturing base, especially foundry production, combined with high volumes of car traffic. Mumbai has the highest level of average daily nitrogen dioxide emissions in the Index, at 86 micrograms per cubic metre. Similarly average daily levels of suspended particulate matter, at 202 micrograms per cubic metre, are almost twice the Index average. Sulphur dioxide levels are also high, at 34 micrograms per cubic metre, compared to the average of 23 micrograms. Mumbai has recognised the challenge and has implemented an air quality code, and monitors air quality at different locations around the city, with the results published on a web site. However it is marked down for not monitoring carbon monoxide emissions. Mumbai is also one of two cities in the Index that do not inform citizens about air pollution and its associated health dangers.

Environmental governance: Mumbai ranks below average in environmental governance. Its environmental authority only has partial jurisdiction to formulate and implement policies on environmental protection. The city performs well for environmental monitoring, reflecting the fact that one of the Municipal Corporation of Greater Mumbai's duties since 1994 has been "environmental protection and promotion of ecology and urban forestry". The agency monitors environmental quality and reports the status of the environment annually through an official status report. In 2008-2009 about 8% of the agency's budget went to "cleanliness and improvement of the city's environment", including activities pertaining to solid waste, eco housing, trees and air pollution. Yet while the city government is responsible for most services with a direct impact on the environment, including water, sanitation, waste, air quality, land use and human settlements, a number of other agencies with unclear jurisdictions and overlapping roles are also involved. These include the Mumbai Metropolitan Region Development Authority, Maharashtra Housing and Area Development Authority, Maharashtra State Road Development Corporation and the Slum Rehabilitation Authority. The city also receives partial marks for its efforts to involve citizens in decisions about environmental projects, and provide a central contact point for Mumbai's citizens to access information on environmental performance.

Quantitative indicators: Mumbai

		Average	Mumbai*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	1.0 [1e]	2007	Maharashtra Economic Survey; Mahanagar Gas Limited; Central Pollution Control Board; Bharat Petroleum Corporation; IPCC; EIU estimates
	Energy consumption per US$ GDP (MJ/US$)	6.0	6.5 [1e]	2007	Maharashtra Economic Survey; Mahanagar Gas Limited; Central Pollution Control Board; Bharat Petroleum Corporation; EIU estimates
Land use and buildings	Population density (persons/km^2)	8,228.8	27,136.8 [e]	2005	Greater Mumbai City Development Plan 2005-2025
	Green spaces per person (m^2/person)	38.6	6.6	2009	Mumbai Metropolitan Region Development Authority Statistics
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.00		
Waste	Share of waste collected and adequately disposed (%)	82.8	32.4 [2e]	2009	Municipal Corporation of Greater Mumbai
	Waste generated per person (kg/person/year)	375.2	209.0 [3]	2007	NSWAI - State Reports - Maharashtra - Mumbai
Water	Water consumption per person (litres per person per day)	277.6	250.0	2005	Greater Mumbai City Development Plan (2005 to 2025)
	Water system leakages (%)	22.2	13.6	2005	Benchmarking and Data Book of Water Utilities in India - 2007
Sanitation	Population with access to sanitation (%)	70.1	42.0 [4e]	2005	Greater Mumbai City Development Plan (2005 to 2025)
	Share of wastewater treated (%)	59.9	67.6	2005	Maharashtra Pollution Control Board
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	86.0	2008	Maharashtra Pollution Control Board
	Daily sulphur dioxide levels (ug/m^3)	22.5	34.0	2008	Maharashtra Pollution Control Board
	Daily suspended particulate matter levels (ug/m^3)	107.8	202.0	2008	Maharashtra Pollution Control Board

* All data applies to Greater Mumbai unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Diesel and gasoline based on 2004 data; estimates for coal based on country consumption and city GDP, 2) Includes disposal by incineration only, 3) Based on estimated 2007 population figures, 4) Based on access to sewerage

Nanjing_China

Background indicators

Total population (million)	7.7
Administrative area (km^2)	6,582.3
GDP per person (current prices) (US$)	7,284.9
Population density (persons/km^2)	1,171.8
Temperature (24-hour average, annual) (°C)	15.0

Data applies to Sub-provincial City of Nanjing

Situated in the Yangtze River Delta and with a population of 7.7 million, Nanjing is a major manufacturing base in China's eastern Jiangsu province. The city has a special focus on chemical and car production, but also a growing service economy, which now accounts for over half of total GDP. The city boasts the largest inland port in China. Even so, Nanjing generates a GDP per capita of only US$7,300 and therefore falls into the low-income range of the Asian Green City Index (with a GDP per capita of below US$10,000). The state sector dominates the economy, with more than 100 enterprises affiliated with state-owned businesses, primarily related to manufacturing. Nanjing's government is also in the midst of a drive to attract more foreign investment into the city. However, like other fast-growing Chinese cities, Nanjing struggles with the adverse environmental effects of rapid development. In particular, the city's air quality has suffered from a coal-driven economy, the presence of large-scale manufacturing, and chronic traffic congestion.

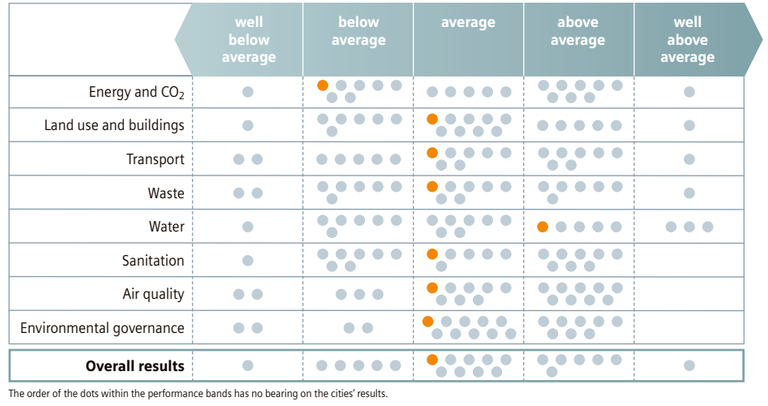
Nanjing ranks average overall in the Index. Its best performance is in the water category, where it ranks above average, benefitting from a relatively low level of water leakages and robust policies on water quality and sustainability. Its rate of water leakages is also the lowest in the Index for cities with similarly low incomes. For most of the other individual categories, the city ranks average. However in some aspects Nanjing stands out. In the land use and buildings category, for example, the city has the second highest amount of green spaces per person in the Index. For the share of waste collected and adequately disposed of, Nanjing is third among low-income cities, and second in this group for the share of wastewater treated. Its weakest overall performance is in energy and CO_2, where it ranks below average, reflecting high levels of carbon emissions and energy consumption, similar to other Chinese cities in the Index.

Energy and CO_2: Nanjing ranks below average in energy and CO_2, scoring particularly poorly for its carbon emissions and energy consumption. Nanjing emits an estimated 5.7 tonnes of CO_2 per person, above the Index average of 4.6 tonnes, and consumes an estimated 10.5 megajoules of energy per US$ GDP, compared to the 22-city average of 6 megajoules. While these results are under par, they are similar to the results of the four other mainland Chinese cities in the Index, all of which rank below average or well below average for carbon emissions and energy consumption. That said, Nanjing is not as heavily dependent for its energy as its Chinese counterparts on coal, which accounts for only a quarter of the city's total energy consumption. Although high by Index standards, the other four Chinese cities consume more coal than Nanjing, particularly Guangzhou, which relies on coal for 51% of its total energy consumption. Nanjing also scores relatively well in policy areas, including particularly high marks for having a strategy to reduce the environmental impact of energy consumption. It is marked down, however, for not having conducted a baseline environmental review of greenhouse gas emissions within the last five years, or regularly monitoring greenhouse gas emissions.

Green initiatives: The national government wants 20% of China's total energy consumption to come from renewable sources by 2020, and the Nanjing government is focusing on solar power to help meet this ambitious target. For example, in July 2009 the Nanjing government announced plans to offer a subsidy until 2011 to integrate solar power into buildings.

Land use and buildings: Nanjing ranks average in land use and buildings. While Nanjing is marked down for having one of the lowest population densities in the Index, at 1,200 people per square kilometre, compared with an Index average of 8,200 people, the city performs much better for green spaces. Each of Nanjing's residents have on average 108 square metres of green spaces, the second highest figure in the Index and more than twice the Index average of 39 square metres. Like other Chinese cities, Nanjing is helped by the expansive way it draws its administrative city boundaries, but the city also actively promotes and protects its green spaces. Regarding policies for the promotion of environmentally friendly buildings, Nanjing shows mixed results. On the downside, it is one of only two cities in the Index that makes only partial efforts to promote public awareness about ways to

Performance



The order of the dots within the performance bands has no bearing on the cities' results.

improve energy efficiency in buildings. On the positive side, it has in place energy efficiency standards for new buildings and also provides incentives for businesses and households to lower their energy use.

Green initiatives: Very few buildings in Jiangsu province have central heating, so officials in Nanjing have unveiled plans for a new central heating project, scheduled to come into operation in 2011. According to new regulations, surplus heat which is generated by the city's thermoelectric power stations, such as coal-fired power stations, will be pumped into newly-built residential blocks in the surrounding areas.

Transport: Nanjing is average in the transport category. Perhaps not surprisingly, given Nanjing's large administrative area, the city does not fare so well in the length of its superior public transport network (defined in the Index as transport that moves large numbers of passengers quickly in dedicated lanes, such as metro, bus rapid transit or trams) when compared with all the other Index cities. Its network registers just 0.01 km per square kilometre, compared to the Index average of 0.17 km per square kilometre. The city has a comprehensive bus network, however, serving the central area and suburbs. It is also making other improvements to the transport system, such as opening an extension to the city's existing single metro line in 2010. Furthermore, the city government has a comprehensive mass transport strategy, which includes goals to increase the average car speed by 10% and the average bus speed by 15%. The city has taken steps to reduce emissions from mass transport and has an integrated pricing system called "one card for all", which can be used for bus, metro, ferry or taxi travel.

Green initiatives: Nanjing has been at the centre of the national government's efforts to introduce high-speed rail links across China, which have the potential to ease inner-city traffic congestion if commuters opt for the train over the car. In July 2010 one of the key pillars of the government's nationwide strategy was unveiled, with the opening of the Nanjing-Shanghai high-speed rail route. The new route is expected to cut journey time between the two cities from two hours to just 72 minutes. The line will also go through the major industrial towns of Changzhou, Suzhou and Wuxi.

Waste: Nanjing is average in the waste category, scoring particularly well for the relatively little waste it generates. At an estimated 218 kg of waste per capita each year, versus the Index average of 375 kg, only two other cities in the Index produce less waste than Nanjing. It also collects and adequately disposes of an estimated 86% of its waste, above the Index average of 83%, and the third highest rate among low-income cities in the Index. Nanjing enforces environmental standards for waste disposal sites, although it is marked down in the Index for only partially enforcing standards on industrial hazardous waste. Regarding waste recycling policy, Nanjing has a strategy in place aimed at recycling and re-use, on-site collection for recyclable materials, and facilities to recycle the five types of waste materials evaluated in the Index — organic, electrical, glass, plastics and paper.

Water: Nanjing ranks above average in the water category, performing well for its water quality and sustainability policies, and its low rate of water leakages. Nanjing's score on water sustainability policy is boosted by fortunate geographical circumstances, since it is able to source much of its water supply from nearby lakes and rivers rather than from less sustainable sources, such as deep aquifers and desalination plants. The city's water system is comparatively sound. It loses just 12% of its water supply through leaks, against an Index average of 22%. This makes Nanjing's system the most efficient of all the low-income cities covered in the Index. The city, though, fares less well for water consumption. On a per capita basis, Nanjing consumes 341 litres per day, which is well above the Index average of 278 litres. The city also scores well for water quality policies. These include developing a code for improving and sustaining the quality of surface water, water quality monitoring that takes place on a weekly basis, and enforcing water pollution standards on local industry.

Green initiatives: In April 2009 the Nanjing city government raised residential water prices by 12%. The measure, which has been copied in cities across China, is designed to increase the incentives for residents to use water more sparingly. The city offers subsidies to limit the impact of rising water prices on low-income households.

Sanitation: Nanjing ranks average in the sanitation category. An estimated 65% of the city's population has access to sanitation, compared to the average of 70%, although up-to-date and accurate figures are hard to come by for Nanjing. However, the city does particularly well for treating 86% of its wastewater, the second best rate among low-income cities in the Index, and well above the 22-city average of 60%. Sanitation policies are relatively weak for Nanjing. In particular, minimum standards for wastewater treatment are not as ambitious as in other Index cities, although the city has a sanitation code in place and regularly monitors on-site sanitation facilities in homes and communal areas.

Green initiatives: As part of the city's five-year plan that ended in 2010, the Nanjing government's Integrated Water Management Initiative called for spending US$560 million to improve its wastewater treatment capacity, although no specific targets were disclosed.

Air quality: Nanjing ranks average in air quality. Like other Chinese cities, it depends heavily on a coal-fired economy, and its resulting emissions levels reflect that fact. In terms of daily sulphur dioxide levels in the air, Nanjing has one of the highest levels in the Index at 35 micrograms per cubic metre, above the average of 22 micrograms per cubic metre. For nitrogen dioxide the city registers 48 micrograms per cubic metre, about equal to the Index average of 47 micrograms. Particulate matter concentrations are just below the average, at 100 micrograms per cubic metre, versus the 22-city average of 108 micrograms. The city does well on air quality policies, with an air quality code in place, and receives full marks for making the public aware of the dangers of air pollution, particularly the dangers of household pollution from, for example, inhaling the by-products of smoky fuels. Nanjing also scores well for its monitoring efforts, which take place in different locations around the city on a daily basis. It regularly monitors three of the five pollutants evaluated in the Index, sulphur dioxide, nitrogen dioxide and one form of particulate matter; but does not regularly monitor carbon monoxide or fine particulate matter.

Green initiatives: In July 2009 the Nanjing government introduced a pilot scheme to help reduce dust pollution in the city, which involves charging firms according to the amount of dust they generate.

Environmental governance: Nanjing ranks average in the environmental governance category. The city performs reasonably well for its environmental monitoring, environmental management and for giving the public access to environmental information. The city has also carried out a baseline environmental review that covered all of the areas evaluated in the Index — water, sanitation, waste, air quality, transport, land use, human settlements, energy and climate change. Nanjing is marked down in the Index for only making partial efforts to involve citizens, non-governmental organisations or other stakeholders in decisions about projects with major environmental impacts. The city's environment department, the Nanjing Municipal Environmental Protection Bureau, has a full remit to enact environmental legislation, and has been gaining an increasingly important profile in recent years, reflected by its growing budget. In 2009, the city government's environmental protection budget was increased to US$1.9 billion, up 12% on the previous year, and equivalent to around 3% of the city's economic output.

Quantitative indicators: Nanjing

		Average	Nanjing*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	5.7 [e]	2008	Nanjing Statistical Yearbook; IPCC; EIU estimates
	Energy consumption per US$ GDP (MJ/US$)	6.0	10.5 [e]	2008	Nanjing Statistical Yearbook; EIU estimates
Land use and buildings	Population density (persons/km^2)	8,228.8	1,171.8	2009	Nanjing Statistical Yearbook
	Green spaces per person (m^2/person)	38.6	108.4	2008	Nanjing Statistical Yearbook
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.01	2010	Nanjing Metro
Waste	Share of waste collected and adequately disposed (%)	82.8	85.8 [1e]	2007	Nanjing Statistical Yearbook
	Waste generated per person (kg/person/year)	375.2	218.3 [1e]	2007	Nanjing Statistical Yearbook
Water	Water consumption per person (litres per person per day)	277.6	341.4	2007	China Urban Statistics Yearbook
	Water system leakages (%)	22.2	11.6	2007	China Urban Statistics Yearbook
Sanitation	Population with access to sanitation (%)	70.1	64.7 [2e]	2008	EIU estimate
	Share of wastewater treated (%)	59.9	86.0	2008	Nanjing Statistical Yearbook
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	48.0	2009	Nanjing Statistical Yearbook
	Daily sulphur dioxide levels (ug/m^3)	22.5	35.0	2009	Nanjing Statistical Yearbook
	Daily suspended particulate matter levels (ug/m^3)	107.8	100.0	2009	Nanjing Statistical Yearbook

* All data applies to Sub-provincial City of Nanjing unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Based on household waste, 2) Based on regression analysis

Osaka_Japan

Background indicators

Total population (million)	2.7
Administrative area (km^2)	222.3
GDP per person (current prices) (US$)	70,927.4
Population density (persons/km^2)	11,981.2
Temperature (24-hour average, annual) (°C)	16.0

Data applies to Osaka City

Osaka is Japan's third largest city and an economic powerhouse. The metropolitan area has a population of 8.8 million, but Osaka City itself has a population of only 2.7 million. Due to data availability, all data for Osaka in the Asian Green City Index refers only to the smaller central city. Osaka City occupies just 200 square kilometres, making it one of the most densely populated cities in the Index. It is also the most prosperous city in the Index, with a GDP per capita of approximately US$71,000, although due to data availability, this figure was taken from 2006. Small- and medium-sized businesses form the backbone of the city's economy, accounting for nearly all of its enterprises. The services industry is Osaka's largest sector, accounting for almost a quarter of the city's economy, followed by wholesale and retail, at 20%, and manufacturing, at 19%. Real estate and government services make up the remainder. The city's main environmental priorities include promoting waste reduction and recycling, and closer collaboration between residents, businesses and the city government.

Osaka is ranked above average overall in the Index. It performs best in the transport category, where it is the only city to rank well above average. The city benefits especially in transport from having the second longest superior transport network in the Index (defined as transport that moves large numbers of passengers quickly in dedicated lanes, such as metro, bus rapid transit or trams) in relation to its administrative area. Osaka performs well in other areas, too, ranking above average in the remaining seven environmental categories of the Index. Its particular strengths include a robust waste collection and sanitation infrastructure; and one of lowest levels of particulate matter in the Index. In addition, Osaka performs well for environmental policies, including some of the strongest water sustainability policies among the 22 cities. The city is not without environmental challenges, including relatively high CO_2 emissions per person, although officials are addressing the issue through investments in renewable energy.

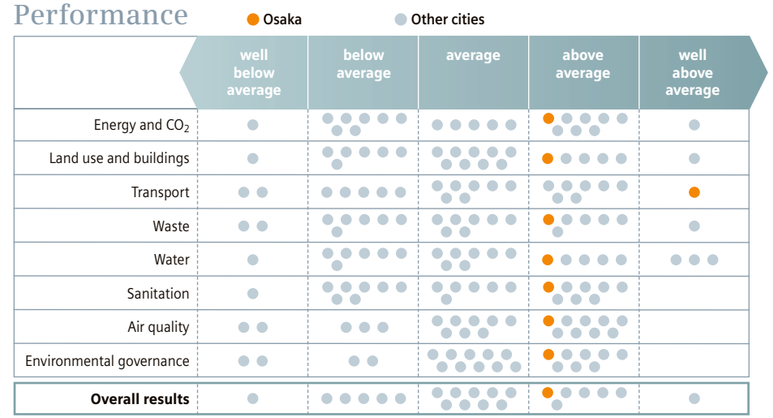
Energy and CO_2: Osaka ranks above average in the energy and CO_2 category, largely because of strong performances in energy consumption and policy areas. The city consumes an estimated 1.6 megajoules of energy per US$ of GDP, which is well below the Index average of 6 megajoules. Osaka's high standing in this area is partly a reflection of a relatively high GDP and stringent national emission regulations. Osaka currently generates about 10% of its electricity from renewable sources, just under the 22-city average of 12%. By early 2010 it had 13 solar power facilities that produce an annual 400 kilowatt hours of electricity. By the end of 2010, the city had plans to have a total of 98 facilities producing an estimated 2,000 kilowatt hours. The city also scores well in clean energy policy areas, with a comprehensive energy policy, investments in renewable energy and other investments in energy efficiency. These are driven in part by the Japanese government's policy of reducing CO_2 emissions by 25% in 2050 from 1990 levels. Osaka also performs well for its approach to climate change, receiving full marks for conducting a baseline review of greenhouse gas emissions and regularly monitoring them. The city, however, emits a relatively high level of CO_2, at an annual 7.6 tonnes per person, compared to the Index average of 4.6 tonnes. Osaka's manufacturing sector is its top CO_2 emitter, releasing around 7 million tonnes per year. But municipal government-backed initiatives have helped to reduce total greenhouse gas emissions by 5% in fiscal 2008 from 2004 levels, and the city was aiming to cut emissions by 7% from 2004 levels in 2010.

Green initiatives: The city put out a tender in May 2010 for a private enterprise to work with the city to build a "Megasolar" large-scale solar power project on the artificial Yumeshima Island in the city's marine area. Osaka hopes the project will turn the area into a green technology island and help to combat global warming, while stimulating the local economy through the development of industries that produce green materials such as solar panels and batteries. In another initiative, the municipal government launched a programme in 2009 offering subsidies to homes and businesses to install solar power systems. The city government expects the installation of standard 4 kilowatt solar generators in homes to reduce household CO_2 emissions by about 40%.

Land use and buildings: Osaka ranks above average in the land use and buildings category. The city benefits from having a high population density, at 12,000 people per square kilometre, compared to the Index average of 8,200 people per square kilometre. Osaka is marked down for having one of the lower amounts of green spaces in the Index, at 5 square metres per person, compared to the Index average of 39 square metres. This is the result of historical legacy, when planners paid little attention to green spaces during Osaka's development. Currently the city has strong policies in place to protect the green spaces that it does have, as well as good controls on urban sprawl and developing environmentally sensitive areas. Osaka also has strong policies on the eco-efficiency for new buildings, and it receives full marks for having incentives to motivate businesses and households to lower their energy use.

Green initiatives: In 2004 Osaka adopted the Comprehensive Assessment System for Building Environment Efficiency (CASBEE). The voluntary scheme provides advice on energy efficiency measures to developers at all stages of the process, from pre-design through to construction. Developers who sign on for the assessment

Performance



The order of the dots within the performance bands has no bearing on the cities' results.

can then market their "green" buildings to environmentally aware buyers or tenants. Furthermore, in Osaka's Morinomiya district, officials use heat and energy generated from incineration and sewage plants to provide power for nearby homes, as part of a larger plan to boost recycling in the district.

Transport: Osaka ranks as the only city in the Index well above average in the transport category. The city scores particularly well for having the second longest superior transport network in the Index (defined as transport that moves large numbers of passengers quickly in dedicated lanes, such as metro, bus rapid transit or trams), at 0.62 km per square kilometre versus an index average of 0.17 km per square kilometre. Although Osaka's superior network, consisting of a metro and trams, is well developed, its strong result in this indicator is partly due to having one of the smallest administrative areas in the Index. The city also scores well for its mass transport and congestion reduction policies. These include an integrated pricing system, investments in reducing emissions from mass transport and "no-car days". Rail is the most popular mode of transport in Osaka, at 32% of all journeys, followed by walking, at 27%, and cycling, at 23%. Cars make up just over 15% of journeys, with buses accounting for about 2%.

Green initiatives: The Osaka city government is in the process of installing rapid chargers for electric vehicles at ten locations in the city, including the car park of the main city office. As part of city policy to encourage the use of low-emission vehicles, such as electric cars, natural gas-powered vehicles and hybrids, the city began introducing these vehicles for use by civil servants in April 2007.

Waste: Osaka ranks above average in the waste category. The city collects and adequately disposes of an estimated 100% of its waste, compared to the Index average of 83%. However, like other high-income cities, it also generates a relatively large amount of waste, at 573 kg per person, compared to the Index average of 375 kg. But the city has made significant improvements over the past two decades. According to city officials, the volume of waste processed in Osaka peaked in 1991 at 2.2 million tonnes, a figure the city had managed to reduce to 1.2 million tonnes by 2009. Reducing business waste is an important challenge for city officials, since business waste represents about 60% of the total amount of waste processed in the city, well above the national average of 40%, and Osaka has initiated several projects in this area (see "green initiatives" below). Osaka performs well in the Index for its recycling policies. It has an integrated strategy for reducing, re-using and recycling waste, and it has on-site recycling services as well as central collection points. The city also recycles all five of the materials measured in the Index – organic waste, electrical waste, glass, plastics and paper. Osaka has recently increased the number of locations where items such as paper cartons, fluorescent lights and batteries can be recycled. Collection boxes for these items have been placed at 300 public buildings in the city and at 61 private facilities such as supermarkets. In 2008, 360 tonnes of paper cartons, 29 tonnes of batteries and 16 tonnes of fluorescent lights were collected for recycling.

Green initiatives: Companies that generate a large amount of waste are obliged to employ a waste management supervisor at their buildings and to develop a waste reduction plan. City officials also conduct on-site inspections, and offer guidance on waste reduction. As early as 1999, buildings that had significantly reduced their waste were granted the Certification of Achievement for Excellence in Waste Reduction. Since then, two additional awards have been established to reward continued efforts to reduce waste. In addition, 12 organisations participated in a city recycling competition in 2009. Past winners have reduced waste generation by about 60% and have comprehensive recycling programmes in place, including information campaigns for employees. In parallel to this, an ongoing campaign is currently promoting the use of special bags certified by the city to contribute to more efficient recycling by individuals and businesses.

Water: Osaka is above average in the water category, boosted by the fact that relatively little water leaks from the system, at an estimated 7% compared to the Index average of 22%. Osaka also has a wide range of water efficiency initiatives, including meters and tariffs, separate pipes for non-drinking water, greywater recycling and rainwater collection. In addition, it has strong water quality policies, with strong codes and standards in place, including regularly publishing the results of monitoring. The city is marked down for a relatively high level of consumption, at 418 litres per person per day, compared to the Index average of 278 litres.

Green initiatives: In December 2008, Osaka's waterworks bureau became the first public water supply body in the world to be certified with the international food safety administration standard ISO22000. Advanced purification technologies enable the bureau to supply safe tap water at a comparable standard to bottled water. Additionally, every year the city holds about 150 workshops to educate primary school children about the water system and the purification process, as well as measures to maintain the quality of the city's water sources.

Sanitation: Osaka ranks above average in the sanitation category, bolstered by providing access to sanitation to an estimated 100% of its residents, compared to the Index average of 70%. It also treats all of its wastewater at 12 sewage plants, in line with strict national sanitation laws. In comparison, the average wastewater treatment rate in the Index is only 60%. The city employs a sophisticated computer mapping system to manage its 4,900-kilometre sewer network. The city's sanitation and wastewater treatment standards, including regular monitoring, are also some of the strongest in the Index.

Green initiatives: The city government has launched a special water purification programme for two of the city's principal rivers, the Dotonbori and the Higashiyokobori. The project, due for completion in 2012, includes constructing a stormwater pipeline that will relieve pressure on the system during heavy rains, when clogged pipes can push wastewater into the rivers.

Air quality: Osaka ranks above average in the air quality category. The city has one of the lowest daily average levels of particulate matter in the Index, at an estimated 35 micrograms per cubic metre, much lower than the Index average of 108 micrograms. Its average daily nitrogen dioxide and sulphur dioxide levels are also below the Index averages. Osaka scores well for its air quality code, and it uses automated measuring instruments to monitor air quality in industrial, commercial and residential areas on a daily basis.

Green initiatives: In 2010 the Osaka municipal government will increase the number of green "curtains" and "carpets" from roughly 100 to almost 500. It will plant vegetables such as bitter melons and sweet potatoes on roofs and walls of primary and middle schools, the city hall headquarters, ward offices and other public facilities in the city to help ease the city's heat island phenomenon. This is a situation in which a city is warmer than its surroundings, and can also increase the levels of pollutants in the air.

Environmental governance: Osaka ranks above average in the environmental governance category. The city has a dedicated environmental department with a wide remit, and it ranks among the top cities in the Index for environmental management and environmental monitoring. The city government has established a clear, colourful web page dedicated to providing up-to-date information on the city's environmental initiatives and information on waste, recycling and other green issues. Through public campaigns, city officials consistently reinforce the need for residents and businesses to help conserve the environment.

Green initiatives: The Eco Museum of Osaka was established in 1997 to encourage schools, companies and individuals to get involved in environmental conservation. Its advisers work to distribute information and train residents to lead environmental projects. The facility was refurbished in April 2006 to create more hands-on exhibits, and a screening room was installed to show films about environmental issues. As of May 2009, about 3 million people had visited the museum.

Quantitative indicators: Osaka

		Average	Osaka*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	7.6	2006	Osaka Environment Bureau
	Energy consumption per US$ GDP (MJ/US$)	6.0	1.6 [1e]	2007	Yokohama Municipal Government; Agency for Natural Resources and Energy, Japan; Kansei Electric Power Company; IPCC; EIU estimates
Land use and buildings	Population density (persons/km^2)	8,228.8	11,981.2	2009	EIU calculation
	Green spaces per person (m^2/person)	38.6	4.5	2005	Osaka City Hall
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.62	2010	Osaka City Hall; Yokohama City comparative statistics
Waste	Share of waste collected and adequately disposed (%)	82.8	100.0 [2e]	2008	Bureau of Environment, Osaka City Hall
	Waste generated per person (kg/person/year)	375.2	573.4	2008	Bureau of Environment, Osaka City Hall
Water	Water consumption per person (litres per person per day)	277.6	417.9	2008	Statistics Bureau of Osaka City Hall
	Water system leakages (%)	22.2	6.9 [3e]	2007	Osaka City Hall
Sanitation	Population with access to sanitation (%)	70.1	100.0 [4e]	2004	Ministry of Land, Infrastructure, Transport and Tourism
	Share of wastewater treated (%)	59.9	100.0	2009	Osaka Bureau of Construction
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	45.1	2007	Osaka City Hall
	Daily sulphur dioxide levels (ug/m^3)	22.5	14.3	2007	Osaka City Hall
	Daily suspended particulate matter levels (ug/m^3)	107.8	35.3 [e]	2007	World Bank; Osaka City Hall

* All data applies to Osaka City unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Estimate of "other fuels" using total CO_2 actual data, 2) Waste disposed in fiscal year. Waste collected in calendar year, 3) Based on estimates of non-effective water ratio, 4) Population coverage rate of sewerage system

Seoul_South Korea

Background indicators

Total population (million)	10.5
Administrative area (km^2)	605.3
GDP per person (current prices) (US$)	19,597.1
Population density (persons/km^2)	17,288.8
Temperature (24-hour average, annual) (°C)	12.0

Data applies to Seoul

Seoul, the capital of South Korea, is the country's political, economic, intellectual and cultural centre. The city is home to most of the country's big corporations, major financial institutions, top universities and national media. Service industries account for about 90% of Seoul's economic output. However, Gyeonggi-do, the province surrounding Seoul, has a concentration of manufacturing industries, including electronics and textiles, which affect the capital's air quality. The city generates almost a quarter of South Korea's gross domestic product and has a per capita GDP of US$19,600, the seventh highest in the Asian Green City Index. With 10.5 million residents living in the sixth smallest area in the Index, Seoul also is the third most densely populated city in the Index.

Seoul ranks above average overall in the Index, and the city is above average in six of the eight individual categories. Seoul sees particularly strong results in the transport category for having the longest superior public transport network (defined in the Index as metro, bus rapid transit or trams). The city also has one of the lowest levels of water leakages, and one of the highest rates of access to sanitation. In addition, Seoul leads the Index for many individual indicators when population and income are taken into account. For example, the South Korean capital has the lowest CO_2 emissions per capita and lowest energy consumption per unit of GDP among cities in the middle range for income (between US$10,000 and US$25,000 in GDP per person). Seoul faces its biggest challenges in air quality, where it ranks average, and in the waste category, where it ranks below average. For air quality, Seoul has a relatively high level of nitrogen dioxide concentrations, and in the waste category, the city generates the most waste per capita in the Index. However, Seoul is consistently strong across most categories on policies to maintain and improve the urban environment.

Energy and CO_2: Seoul ranks above average in the energy and CO_2 category. The city's CO_2 emissions, at an estimated 3.7 tonnes per person, are below the Index average of 4.6 tonnes. The city does well on energy efficiency too, consuming 3.2 megajoules per US$ of GDP compared to the average of 6 megajoules. Among cities with incomes in the middle range in the Index, Seoul leads the Index for both CO_2 emissions and energy efficiency. The fact that service industries dominate Seoul's economy partly explains the city's good performance. The city's policies on energy and CO_2 are generally strong too. Seoul has a strategy in place to reduce the environmental impact of energy consumption, and the city has conducted a baseline review of its greenhouse gas emissions. It has also signed international covenants to reduce emissions, such as membership to the C40 group of cities that have pledged reductions.

Green initiatives: In 2009 Seoul unveiled a master plan to reduce greenhouse gas emissions by 25% by 2020 and 40% by 2030 from 1990 levels. Since the percentage of greenhouse gas emissions from industry is already relatively low, the city plans to achieve these targets partly by increasing the amount of energy generated from renewable sources. By 2030 Seoul hopes to meet 20% of its energy demand with hydrogen fuel cells, solar power and geothermal heat. In 2009, the city opened a 2.4-megawatt power station that runs on fuel cells as a pilot project. Subsidies from the national government will fund 60% to 70% of these projects.

Land use and buildings: Seoul ranks above average in the land use and buildings category. The city has one of the highest population densities in the Index, at 17,300 people per square kilometre, which is more than twice the Index average of 8,200 people per square kilometre. Green spaces are limited in Seoul, however, at 23 square metres per person, below the Index average of 39 square metres. This is mainly a result of a long-ingrained habit of placing development over conservation. The city scores well for protecting its green spaces, but it only has a partial strategy for protecting environmentally sensitive areas from development, and containing urban sprawl. Buildings in Seoul account for 60% of the city's energy consumption — they require both heating and cooling systems to deal with extreme summers and winters — and the city has addressed the challenge with comprehensive eco-buildings policies. Seoul has eco-efficiency standards in place for new buildings, green standards for public buildings, and incentives to motivate businesses and households to lower their energy use. Furthermore it promotes public awareness among residents to improve energy efficiency in buildings.

Green initiatives: In 2007 the city implemented "low-carbon, green-energy" building-design guidelines. The guidelines aim to reduce buildings' energy consumption by 20% by 2030 from 2000 levels. They include using double-layered windows, limiting the size of balconies and replacing incandescent light bulbs with LED lights.

Transport: Seoul is above average in the transport category. The city has the longest superior transport network in the Index — consisting of a metro and a bus rapid transit system — at 0.94 km per square kilometre, compared to the Index average of 0.17 km per square kilometre. The city is still expanding its subway system, but the existing 13 lines already handle some 6.3 million commuters per day, making it one of the world's busiest. A further 5.6 million people

Performance

● Seoul ● Other cities

	well below average	below average	average	above average	well above average
Energy and CO_2	●	●●●●●	●●●●●	●●●●●	●
Land use and buildings	●	●●●●●	●●●●●	●●●●●	●
Transport	●●	●●●●●	●●●●●	●●●●●	●
Waste	●●	●●●●●	●●●●●	●●●●●	●
Water	●	●●●●●	●●●●●	●●●●●	●●●
Sanitation	●	●●●●●	●●●●●	●●●●●	
Air quality	●●	●●●	●●●●●	●●●●●	
Environmental governance	●●	●●	●●●●●●	●●●●●	
Overall results	●	●●●●●	●●●●●	●●●●●	●

The order of the dots within the performance bands has no bearing on the cities' results.

use the city's extensive bus network every day, and according to the city, it is one of the largest networks in the world. It consists of some 8,000 buses operating on a two-way distance of 7,000 km, and 206 km of these routes are dedicated exclusively to buses. Seoul has comprehensive mass transport policies in place, with an integrated pricing system for public transport, and promotional campaigns to encourage citizens to use greener transport. The roads are often gridlocked, and the city has made a concerted effort to ease traffic flows in recent years. As a result, the city is strong on congestion reduction policies, and has introduced road-congestion tolls, pedestrian areas, "no-car days", and park and ride systems. It also scores highly for having established traffic light sequencing, traffic information systems, dedicated delivery times for freight, and access points around the city.

Green initiatives: Since 2007 the city has added more than 100 km of bicycle lanes to promote the use of bikes for non-leisure purposes. In 2006 Seoul began participating in the annual "World Carfree Day" to raise public awareness about the need to reduce dependence on cars. In the same spirit, in 2003 the city launched a voluntary "leave your car at home" programme that asks residents to do so once a week. As of March 2010 about 40% of Seoul's car owners were participating in the programme, contributing to around a 6% drop in daily traffic volume.

Waste: Seoul ranks below average in the waste category. The city collects and disposes of almost 100% of its waste, well above the Index average of 83%, and the best rate among cities with incomes in the middle range. It also has robust policies on waste. Seoul has environmental standards in place for waste disposal sites, for example, and enforces standards for hazardous industrial waste, in line with national regulations. In addition, organic and electrical waste, glass, plastics and paper are all recycled. However, the city produces the most waste among all 22 cities in the Index, at an estimated 996 kg per person per year, well above the Index average of 375 kg.

Green initiatives: Since 2003 Seoul has levied fines on businesses that exceed limits on distributing disposable goods, such as shopping bags, plates, cups, chopsticks, razors, toothbrushes and paper fliers. In 2005 the city adopted the "producer responsibility" principle for recycling such items as TVs, refrigerators, washing machines, computers and mobile phones. For example, for these products, buyers can ask retailers to take back free of charge the ones being replaced, and the retailer is responsible for properly disposing of the item.

Water: Seoul is above average in the water category. The city is better than average when it comes to leakages. Only 7% of the water is lost in leaky pipes. This is the best rate among cities with mid-range incomes in the Index, and below the 22-city average of 22%. It has a slightly higher-than-average water consumption rate, at 311 litres per person per day, compared with the average of 278 litres. Policies in place in the city include water efficiency codes and promoting conservation awareness among the public. Seoul also has an array of strategies to improve and monitor the quality of surface water, and enforce industrial water pollution standards. Authorities have identified water shortages as one of Seoul's key environmental vulnerabilities and as a result have promoted the expansion of water saving devices and adopted water charges, among other measures.

Green initiatives: Since 2001 Seoul has made a major push to improve the quality of household water by replacing old pipes and water tanks. The water department aimed to have its inspectors do a free inspection of pipes and water tanks for every household in the city by the end of 2010. It also offers subsidies to finance upgrades when deficiencies are found.

Sanitation: Seoul ranks above average in sanitation. An estimated 100% of residents have access to sanitation, compared to the 22-city average of 70%. And Seoul treats an estimated 82% of its wastewater, well above the Index average of 60%. For both sanitation access and wastewater treatment, Seoul leads among cities with similar mid-range income in the Index. Seoul is marked up in the Index for having established policies evaluated in the Index, including regular monitoring of on-site treatment facilities, as well as promoting public awareness on the clean use of sanitation systems.

Green initiatives: In April 2010 the city government began installing closed-circuit television cameras throughout Seoul's sewer network, at a cost of about US$440,000, to facilitate maintenance of ageing sewer pipelines. Images from the cameras will feed into a computerised sewer-monitoring system, which will enable sanitation authorities to respond more promptly to cracks and floods.

Air quality: Seoul is average for air quality, a performance due mainly to the city's record on nitrogen dioxide emissions. It has the second highest concentration of this pollutant in the Index, at 71 micrograms per cubic metre, compared to the average of 47 micrograms. This is due to Seoul's over-reliance on cars — automobiles are a main source of nitrogen dioxide — and they are responsible for almost three quarters of Seoul's air pollution. The city performs well on sulphur dioxide and suspended particulate matter, with levels well below the Index averages, driven in part by the spread of natural gas consumption in homes, rather than dirtier fuels. Seoul officials are well aware of the potential for improvement, and Seoul achieves good results for its clean air policies, including regularly monitoring air quality, and informing citizens about the dangers of air pollution. For example, the city operates 43 air quality measuring stations throughout the city and publishes information on a regular basis from 37 of them.

Green initiatives: By 2010 Seoul had planned to replace all city buses running on diesel with new ones powered by natural gas. The city also has plans to introduce 7,000 electric and hybrid buses, and is currently conducting pilot programmes. In addition to initiatives aimed at reducing the number of cars on the road (see "transport" above), the city is addressing industrial emissions. Environmental officials inspect industrial facilities up to four times a year, and those that meet the highest standards are rewarded by being allowed to self-inspect and self-report in subsequent years. Underperformers continue to be subject to further official inspections.

Environmental governance: Seoul ranks above average in environmental governance. The city has a dedicated environmental department with a wide remit to cover the areas evaluated in the Index, including water, sanitation, waste, air quality and climate change. The city also has strong policies on public participation (see "green initiatives" below). For example, it regularly publishes the results of its environmental reviews, provides a central point of access for the public to receive environmental information, and involves the public and other stakeholders in decisions about projects with environmental impacts.

Green initiatives: The city runs the "Green Seoul Citizen Committee" which encourages citizen participation in environmental policy. Established in 1995, the green committee is chaired by Seoul's mayor and has 100 members from non-governmental organisations and businesses. Meetings take place about 120 times per year to review new policy proposals on conservation and climate change.

Quantitative indicators: Seoul

		Average	Seoul*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	3.7 [e]	2008	Korea Energy Economics Institute, Yearbook of Regional Energy Statistics; Korea Electric Power Corporation Annual report 2009; IPCC; EIU estimates
	Energy consumption per US$ GDP (MJ/US$)	6.0	3.2	2008	Korea Energy Economics Institute, Yearbook of Regional Energy Statistics; Korea Electric Power Corporation Annual report 2009
Land use and buildings	Population density (persons/km^2)	8,228.8	17,288.8	2009	EIU calculation
	Green spaces per person (m^2/person)	38.6	23.4	2008	Seoul Statistics Online Database
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.94	2010	Seoul Metro; Seoul City Transportation Department
Waste	Share of waste collected and adequately disposed (%)	82.8	100.0	2008	Seoul Statistics Online Database
	Waste generated per person (kg/person/year)	375.2	995.6 [1e]	2008	Seoul Statistics Online Database; Environment of SEOUL
Water	Water consumption per person (litres per person per day)	277.6	311.0	2008	The Office of Waterworks, Seoul Metropolitan Government
	Water system leakages (%)	22.2	7.0 [2]	2009	The Office of Waterworks, Seoul Metropolitan Government
Sanitation	Population with access to sanitation (%)	70.1	100.0 [3e]	2008	Seoul Statistics Online Database
	Share of wastewater treated (%)	59.9	82.0 [4e]	2008	Environment of SEOUL
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	71.4	2008	Seoul Statistics Online Database
	Daily sulphur dioxide levels (ug/m^3)	22.5	17.2	2008	Seoul Statistics Online Database
	Daily suspended particulate matter levels (ug/m^3)	107.8	55.0	2008	Seoul Statistics Online Database

* All data applies to Seoul unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Based on estimate of household waste, 2) Water loss, 3) Based on access to sewerage
4) Based on construction of treatment plants almost finished in 2008. 58% in 2005 otherwise.

Shanghai_China

Background indicators

Total population (million)	19.2
Administrative area (km^2)	6,340.5
GDP per person (current prices) (US$)	11,463.7
Population density (persons/km^2)	3,030.2
Temperature (24-hour average, annual) (°C)	16.0

Data applies to Shanghai Municipality

Shanghai, often referred to as China's commercial and financial centre, has enjoyed strong economic growth over the past two decades. It is now among the country's richest cities, with a GDP per capita of US$11,500. The State Council, China's cabinet, approved a blueprint in March 2009 for Shanghai to become a global international financial and shipping centre by 2020. A sign of Shanghai's growing international status was the city's selection as venue for World Expo 2010, a world trade fair, held between May and October 2010. Heavy industry, however, still accounts for a large proportion of Shanghai's economy. With 19.2 million inhabitants, Shanghai has the most highly populated administrative area within the Asian Green City Index.

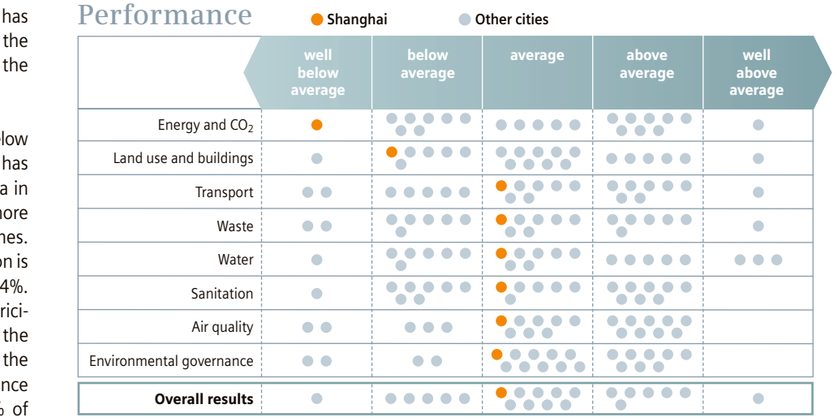
Shanghai ranks average overall in the Index. The city ranks average in six of the eight categories: transport, waste, water, sanitation, air quality and environmental governance. The results reflect the fact that Shanghai is generally average for indicators such as green spaces per person or the share of wastewater treated. Government policies in these areas also have room for improvement, although Shanghai's clean air policies are among the strongest in the Index. When compared to other cities with incomes in the middle range (with a US$GDP of between US$10,000 and US$25,000), Shanghai generates the least waste per capita and has the second lowest level of water leakages. In the land use and buildings category, Shanghai ranks below average, and for energy and CO_2 the city ranks well below average, mainly because it has the highest CO_2 emissions per capita and the highest level of energy consumption in the Index.

Energy and CO_2: Shanghai ranks well below average in the energy and CO_2 category. It has the highest level of CO_2 emissions per capita in the Index, at an estimated 9.7 tonnes, more than twice the 22-city average of 4.6 tonnes. Nearly half of Shanghai's energy consumption is based on coal, versus an Index average of 14%. Coal also accounts for 95% of the city's electricity production, compared with about 80% for the rest of the country as a whole. Nevertheless, the city is making progress in reducing its reliance on coal. In 2000, coal accounted for 65% of Shanghai's total energy consumption, whereas in 2007 the figure was down to 47%. But the prevalence of energy-intensive heavy industry in the city — particularly steel, construction and automotive manufacturing — has driven up Shanghai's energy consumption per US$ of GDP, which is the highest in the Index at 14.8 megajoules. Falling steel prices, which reduce the amount of revenue collected from steel, have also played a part in increasing the city's ratio of energy consumption to economic output. And recent construction work to prepare for the World Expo in 2010 may also have increased the figure. Shanghai scores better in clean energy policies, however, by investing in waste-to-energy projects, sourcing or producing clean and renewable energy, and making efforts to consume energy more efficiently. In addition, Shanghai and the national government are investing in alternative sources of electricity for the future, including solar, biomass, wind, natural gas, nuclear and "clean coal", which involves capturing and storing greenhouse gases at coal plants. But there is still room for improvement in policies with regard to climate change. Shanghai, for example, has not conducted a baseline environmental review of greenhouse gas emissions within the last five years.

Green initiatives: Shanghai has been investing in wind farms, and in 2006 the city set a target to have 13 major wind farms in operation by 2020. They will have a total capacity of 2 gigawatts and will provide enough electricity to meet the annual needs of four million households.

Land use and buildings: Shanghai ranks below average in land use and buildings. The city has a relatively low population density, at 3,000 people per square kilometre, compared to the Index average of 8,200 people per square

Performance



The order of the dots within the performance bands has no bearing on the cities' results.

kilometre. In addition, Shanghai's amount of green spaces, at 18 square metres per person, is below the Index average of 39 square metres. However, it does have measures in place to protect existing green spaces and other environmentally sensitive areas (see "green initiatives" below). Shanghai also has a policy aimed at containing urban sprawl, and has taken steps to protect environmentally sensitive areas from development. Policies on eco-buildings are also relatively strong. The city actively increases public awareness of ways to improve the energy efficiency of buildings, as well as providing incentives and regulations to motivate businesses and households to lower their energy use. In addition, the city leads by example through adopting its own green standards for public building projects.

Green initiatives: Shanghai's city government has undertaken a range of projects aimed at reducing energy consumption in buildings, with a goal to save the equivalent of 9 million tonnes of coal between 2006 and 2010. The projects include energy-efficient lighting, reusing waste heat, and improving efficiency of coal burners. Shanghai's authorities have also made a concerted effort to increase green spaces in the city. The United Nations estimates that the city doubled the amount of green spaces between 2000 and 2008. As part of its green spaces expansion, a number of parks have been established in Shanghai's urban areas, including the Yanzhong Green Area, Minhang Sports Park and the North Bund Green Area.

Transport: Shanghai is average in the transport category. The city's superior public transport network (defined in the Index as transport that moves large numbers of passengers quickly in dedicated lanes, such as metro, bus rapid transit, or trams) measures 0.07 km per square kilometre, shorter than the Index average of 0.17 km per square kilometre, but it is the longest in the world in absolute length (see "green initiatives" below). In 2008 the city announced plans to invest US$16 billion for a range of improvements in its transport infrastructure, including significantly extending its metro lines (see "green initiatives" below). As in other Chinese cities, traffic congestion is a challenge, and according to some estimates, Shanghai's road traffic could outstrip road capacity by three times by 2025. In policy areas, Shanghai scores relatively well. The city has taken steps to reduce emissions from public transport, encourages citizens to travel more sustainably, and has an integrated pricing system for the network. Shanghai also scores well for its proactive policies to reduce traffic congestion, implementing measures such as pedestrian areas, congestion charges, "no-car days", and park and ride systems. In addition, Shanghai has a very well-developed traffic management system.

Green initiatives: By the end of 2012, the city government plans to extend Shanghai's metro, already the world's longest in absolute terms, from 420 km currently to 560 km, and then to more than 800 km by the end of 2020. Exclusive bus lanes have also been introduced into Shanghai: 86 km were created between 2002 and 2008, and more have been planned. In July 2010 the central government announced plans for a Shanghai-Nanjing high-speed rail route. The new route is expected to cut journey time between the two cities from two hours to just 72 minutes, and has the potential to ease traffic congestion if commuters opt for the new train rather than their cars.

Waste: Shanghai ranks average in the waste category. An estimated 82% of the city's waste is collected and adequately disposed of, just below the Index average of 83%. The amount of waste that the city generates annually on a per capita basis, at an estimated 370 kg, is just below the Index average of 375 kg. Shanghai generates the least waste per capita in the Index when compared with cities in the middle-income range. In policy areas, Shanghai scores moderately well. While the city does a good job at enforcing environmental standards for waste disposal sites, it is relatively poor at enforcing and monitoring industrial hazardous waste standards. Shanghai does have, however, a well-developed infrastructure for waste recycling, both in terms of collection services available and the wide range of materials it recycles.

Green initiatives: According to the United Nations, two waste incinerators have been established in Shanghai over the last decade with a total capacity of 2,500 tonnes per day. Through investment in more facilities, and the closing down of sub-standard waste plants, Shanghai's authorities aim to increase the proportion of waste the city safely disposes of to 85% by 2020.

Water: Shanghai is average in the water category. The city is marked down for its relatively high daily consumption of water, at 411 litres per capita, compared to the Index average of 278 litres. If Shanghai's large population of 19.2 million is factored in, the huge scale of Shanghai's total water consumption becomes even more apparent. The high water demands of Shanghai's manufacturing sector largely explain the above average per capita consumption level. But water is also plentiful in Shanghai, located at the mouth of the Yangtze River, and the city scores well for its comparatively efficient water system. Losing just over 10% of its water flow through leaks, compared with the Index average of 22%, Shanghai has the second most efficient water system among cities with mid-range incomes. In water policy areas, Shanghai scores reasonably well for having regulations in place to improve and sustain the quality of surface water. The city also sets standards for levels of key pollutants in surface or drinking water, and enforces water pollution standards on local industry. In addition, Shanghai is among the most proactive cities in Index at implementing a wide range of measures, including water tariffs, to improve water efficiency and reduce overconsumption.

Sanitation: Shanghai ranks average in the sanitation category. The city does relatively well on the proportion of wastewater treated, at an estimated 78%, compared to the Index average of 60%. And this figure has risen sharply in recent years (see "green initiatives" below). The level of access to sanitation in Shanghai, at an estimated 73%, is also above the Index average of 70%. Shanghai has the third best rate of sanitation access when compared among cities with the highest populations in the Index (above 10 million people). While Shanghai performs reasonably well for sanitation policy overall, including a code to promote environmentally sustainable sanitation services and minimum standards for wastewater treatment, the city does not promote public awareness around the efficient and hygienic use of sanitation systems.

Green initiatives: Shanghai has built 50 new sewerage treatment plants in recent years, allowing the city to treat more than three quarters of its total sewage, up from only 55% in 2000. The goal is to treat 90% of sewage by 2020.

Air quality: Shanghai ranks average in air quality. High traffic volumes and a heavy reliance on coal have helped push up average daily sulphur dioxide emissions to 35 micrograms per cubic metre, higher than the Index average of 23 micrograms. Daily nitrogen dioxide levels, at 53 micrograms per cubic metre, are also higher than the Index average of 47 micrograms. In terms of daily suspended particulate matter, Shanghai does relatively better, measuring 81 micrograms per cubic metre versus an Index average of 108 micrograms. For its clean air policies, Shanghai scores well. The city regularly monitors air quality in different locations in the city, not just in business areas, and informs citizens about the dangers of household pollution. Shanghai is also marked up for measuring a wide range of air pollutants, including suspended fine particulate matter and carbon monoxide.

Green initiatives: Shanghai forced more than 1,500 heavily polluting enterprises to close between 2005 and 2007. To help meet the Shanghai government's target to reduce sulphur dioxide emissions 26% by 2010, compared with 2005 levels, the city also introduced tougher European standards on vehicle emissions.

Environmental governance: Shanghai ranks average in environmental governance. The city performs particularly well for environmental monitoring and environmental management, but does not fare as well in terms of public participation. The city regularly monitors its environmental performance and publishes information on its progress. It has also conducted a baseline environmental review in all of the main areas covered by the Index, apart from air quality, within the last five years. The Shanghai Environmental Protection Bureau also has a wide remit, monitoring all the main areas covered by the Index, while the city enjoys relatively strong powers to implement its own environmental legislation. Shanghai is marked down, however, for being relatively weak at involving citizens, NGOs and other stakeholders in decisions on projects of major environmental impact.

Green initiatives: The World Expo 2010, with the motto "Better city, better life", took place in Shanghai from May to October. More than 200 countries participated and 73 million visitors attended displays relating to economic prosperity, the role of science and technology in city life, and urban sustainability. Some of the buildings used in the displays demonstrated the potential for innovation, with, for example, technologies to improve energy efficiency, such as LED lights rather than traditional incandescent bulbs.

Quantitative indicators: Shanghai

		Average	Shanghai*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	9.7 [e]	2008	Shanghai Statistics Yearbook; IPCC; EIU estimates
	Energy consumption per US$ GDP (MJ/US$)	6.0	14.8	2009	China Statistical Yearbook 2010
Land use and buildings	Population density (persons/km^2)	8,228.8	3,030.2	2009	EIU calculation
	Green spaces per person (m^2/person)	38.6	18.1	2008	Shanghai Statistical Yearbook
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.07	2010	news.163.com; Shanghai Metro
Waste	Share of waste collected and adequately disposed (%)	82.8	82.3 [1e]	2009	Shanghai Statistics Yearbook
	Waste generated per person (kg/person/year)	375.2	369.5 [1e]	2009	Shanghai Statistics Yearbook
Water	Water consumption per person (litres per person per day)	277.6	411.1	2008	China Urban Statistics Yearbook (2008)
	Water system leakages (%)	22.2	10.2	2008	China Urban Statistics Yearbook (2008)
Sanitation	Population with access to sanitation (%)	70.1	72.5 [2e]	2009	EIU estimate
	Share of wastewater treated (%)	59.9	78.4 [3e]	2008	Shanghai Statistical Yearbook
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	53.0	2009	Shanghai Statistical Yearbook
	Daily sulphur dioxide levels (ug/m^3)	22.5	35.0	2009	Shanghai Statistical Yearbook
	Daily suspended particulate matter levels (ug/m^3)	107.8	81.0	2009	Shanghai Statistical Yearbook

* All data applies to Shanghai Municipality unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Based on household waste, 2) Based on regression analysis, 3) Based on share of sewerage treated

Singapore_singapore

Background indicators

Data applies to Singapore

Total population (million)	5.0
Administrative area (km^2)	710.3
GDP per person (current prices) (US$)	36,519.6
Population density (persons/km^2)	7,025.2
Temperature (24-hour average, annual) (°C)	27.0

Singapore is a prosperous city-state on the southern tip of Malaysia, with a population of about 5 million people. Its residents are on average the fourth wealthiest among the 22 cities in the Asian Green City Index, generating a GDP per person of US$36,500, nearly double the Index average. Services account for about two-thirds of the city's economic output, with industry making up just over a quarter. Singapore's government faces challenges in maintaining the city's economic success, however, including a lack of fossil-fuel resources and a limited water supply. And like many cities in Asia, economic growth must be balanced with environmental demands. The city's relatively large industrial presence, for example, contributes greatly to Singapore's wealth, but compared to the services sector, industry produces more waste, uses more energy and consumes more water.

Still, Singapore appears to have found a successful formula. It is the only city in the Index to rank well above average overall, and it shows consistently strong results across all individual categories, performing especially well for its policies to maintain and improve the urban environment. Singapore's best performances are in the waste and water categories, where it ranks well above average. It has one of the highest rates of waste collection in the Index and the second lowest rate of water system leakages. Singapore ranks above average in all other categories, with particularly strong results for its large amount of green spaces per person, the length of its rapid transit network and its sanitation system. Overall, 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.

Energy and CO_2: Singapore ranks above average in the energy and CO_2 category. Cities with high incomes in the Index tend to produce more CO_2, and Singapore is no exception: The city generates 7.4 tonnes of CO_2 emissions per person, compared to the Index average of 4.6 tonnes. Industry is partly the reason. Although the industrial sector contributes just over a quarter of the city's GDP, it accounts for more than half of Singapore's CO_2 emissions. Singapore is also one of five cities in the Index that does not consume any energy produced from renewables. It does, however, generate 80% of its electricity from natural gas, a cleaner source than coal, for example. The city's policies on energy and CO_2 are generally strong, however. For example, it gets full marks in the Index for having an energy reduction strategy, for making efforts to consume energy more efficiently, for having a climate change action plan and for signing up to international environmental covenants. The city is also relatively energy efficient, consuming only 3 megajoules per US$ of GDP, compared to the Index average of 6 megajoules.

Green initiatives: In the last decade significant investments in natural gas pipelines have moved the city away from its dependency on high-emission, oil-fuelled power stations. In 2008 natural gas plants accounted for 80% of electricity generation, up from 19% in 1999. The construction of a liquefied natural gas import terminal is expected to allow Singapore to generate 90% to 95% of its electricity from natural gas by 2013. Regarding waste-to-energy projects, Singapore also has Asia's largest "anaerobic digestion" facility, which uses microorganisms to break down biodegradable material. It processes around 800 tonnes of organic waste per day, reducing the amount of food that Singapore incinerates by 50%, and the resulting methane is used in power generation.

Land use and buildings: Singapore ranks above average in land use and buildings, driven by full marks for almost all of the land use and eco-buildings policies evaluated in the Index. Land constraints in Singapore require careful urban planning, and the city has robust policies in place to contain urban sprawl and to protect green spaces from the negative side effects of development. The tone was set early, with Singapore's first prime minister, Lee Kuan Yew, vowing that Singapore would not become a "grey city". Presently Singapore has 66 square metres of green space per person, well above the Index average of 39 square metres, and the highest amount among cities with a small population in the Index (under 5 million people). Singapore's environmental building standards are also among the best in the Index, with policies in place for eco-efficiency in new buildings, green standards for public buildings, and incentives to motivate households and businesses to conserve energy.

Green initiatives: The government wants 80% of all buildings to meet its minimum "Green Mark Certified" energy efficiency standards by 2030. The standards are mandatory for new buildings, and the city has a cash incentive scheme to encourage the owners of existing buildings to adopt them. The government also aims to increase park space in the city from 3,300 hectares currently to 4,200 hectares by 2020. It is also adding "eco-links" between parks so wildlife can move freely from park to park. In 2007 Singapore had 100 km of such connections, and it aims to raise this figure to 360 km by 2020.

Transport: Singapore is above average in the transport category, boosted by one of the longest superior public transport networks in the Index (defined as transport that moves large numbers of passengers quickly in dedicated lanes, such as metro, bus rapid transit or trams), and robust urban mass transport policies. The city's superior network, at 0.21 km per square kilometre, is above the 22-city average of 0.17 km per square kilometre. The government has been investing in mass transport improvements ever since the metro opened in 1987, realising that limited land area — 12% of which is taken up by roads — could not sustain big increases in traffic. The government supports its network with a comprehensive mass transport policy, a fully integrated pricing system and emissions-reduction plans. The city's congestion reduction policies are also a strong complement to its management of mass transport. For example, road-pricing has been in place since 1975, and traffic is monitored so prices can be altered depending on volumes. An "intelligent transport system" monitors the roads in real time so authorities can divert traffic away from accidents and breakdowns.

Green initiatives: By 2020 the government wants 70% of trips taken during morning peak hours to be on public transport, up from 59% in 2008. To achieve this goal it plans to double the rail network and develop more seamless connections between bus and rail services. This will include running more frequent and direct feeder bus services so that commuters can reach transfer hubs and metro stations from their homes more quickly. Real-time travel information will also be supplied online and to mobile phones to help commuters plan their journeys. Singapore also has a vehicle quota system that controls the number of vehicles in the city. Between 1990 and 2008 the vehicle stock was allowed to grow by 3% a year, but growth has since been capped at 1.5% a year. Within the quota system, more licences are available for smaller, fuel-efficient cars. The government offers a 40% rebate on purchases of green vehicles, such as hybrid, electric and compressed natural gas cars.

Waste: Singapore ranks as the only city well above average in the waste category. The city generates 307 kg of waste per person per year, lower than the Index average of 380 kg, and the authorities collect and dispose of all of it. Singapore's waste disposal policies are also among the best in the Index. The city burns some organic waste at temperatures of more than 1,000°C, which removes acidic gases and dioxins, and these plants in turn account for around 1% of Singapore's power generation. In addition,

Performance

● Singapore ● Other cities

	well below average	below average	average	above average	well above average
Energy and CO_2	●	● ● ● ●	● ● ● ●	● ● ● ● ●	●
Land use and buildings	●	● ● ● ●	● ● ● ● ●	● ● ● ● ●	●
Transport	● ●	● ● ● ●	● ● ● ●	● ● ● ●	●
Waste	● ●	● ● ● ●	● ● ● ●	● ● ● ● ●	●
Water	●	● ● ● ●	● ● ● ●	● ● ● ● ●	● ● ●
Sanitation	●	● ● ● ●	● ● ● ●	● ● ● ● ●	
Air quality	● ●	● ●	● ● ● ● ●	● ● ● ● ●	
Environmental governance	● ●	● ●	● ● ● ● ●	● ● ● ● ●	
Overall results	●	● ● ● ●	● ● ● ●	● ● ● ●	●

The order of the dots within the performance bands has no bearing on the cities' results.

some of the ash created is then used in construction materials.

Green initiatives: 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, and recycling bins have been placed in public areas. Singapore residents have responded well to the initiative, with household participation in recycling rising from 15% in 2001 to 63% in 2008.

Water: Singapore ranks well above average in the water category. The city's consumption per person is 309 litres per person per day – a figure that includes domestic and industrial usage – above the Index average of 278 litres. However, Singapore's performance in the water category is bolstered by the second lowest leakage rate, at 5%, compared to the Index average of 22%. The city imports 40% of its water from Malaysia, with the rest gathered through its wide catchment network, or through reclamation and desalination. The city hopes to become completely self-sufficient in water by 2061, when its long-term agreement with Malaysia runs out. As a result, it has some of the best policies in the Index for water conservation, and it also leads the Index for its policies on water quality.

Green initiatives: Singapore has five world-renowned water-reclamation plants, called "NEWater" factories, which treat wastewater through micro-filtration, reverse osmosis and ultraviolet technology. These currently deliver one-fifth of Singapore's water supply. Singapore has a desalination plant that provides 10% of its water, with a second plant due to open in 2013. The government wants desalination to meet at least 30% of its water needs by 2060. But mindful that desalination is currently the most energy-intensive water source, it is also funding research into more efficient processes that use only half the energy. Regarding water efficiency, the government also aims to reduce residential water consumption by promoting water-efficient appliances and through public awareness campaigns in the media and in schools. As part of the city's "Water Efficient Homes" programme, authorities have given households "do-it-yourself" water efficiency kits, which include thimbles to fit on taps and showers to limit leakage, and water-saving bags for cisterns.

Sanitation: Singapore is above average in the sanitation category. All of its residents have access to sanitation and all of the wastewater collected is treated. The government laid the groundwork for this first-class system in the 1960s, when it began an intensive sewerage development programme to meet the demands of industrialization and an expansion in modern housing. The current system has separate networks for used water and rainwater, which helps to ensure high standards for water collected in reservoirs. Singapore also has strong sanitation policies, achieving full marks for environmentally sustainable sanitation standards and for wastewater treatment and monitoring, among others.

Green initiatives: Over the last decade Singapore has also built a so-called "deep tunnel" sewage system, which is set to meet the city's wastewater needs far into the future. The tunnels, which are sloped to conserve energy, channel wastewater to the Changi Water Reclamation Plant. The plant is capable of treating 800,000 cubic metres of wastewater per day to international standards. After it is treated, the water is discharged into the sea or sent to a NEWater factory to be purified further.

Air quality: Singapore ranks above average in the air quality category, with some of the lowest levels of nitrogen dioxide and sulphur dioxide emissions among the 22 cities. Its daily levels of suspended particulate matter are also much lower than average. Singapore achieves its clean air primarily through stringent controls on industry and by carefully managing the number of vehicles in the city. The city also performs well in the Index for its comprehensive air quality policies. For example, air quality is monitored at 11 stations scattered around Singapore in residential, commercial, industrial and roadside areas.

Green initiatives: Singapore will apply stricter Euro IV emissions standards for all taxis by 2014 and all buses by 2020. The city is also running trials on emission-reducing "diesel particulate filters" for diesel-powered vehicles, as an initial step before planning to introduce them more widely. Regarding industrial emissions, the city mandates that industries conduct self-monitoring on air pollutants. This is supported by regular checks from the government and backed by the ability to fine offenders.

Environmental governance: Singapore ranks above average for environmental governance. The city regularly monitors all aspects of its environmental performance, publishes the results and involves citizens in environmental decisions. Singapore has had a Ministry for Environment and Water Resources since 1972, and together with two statutory boards — the National Environment Agency and the PUB, the national water agency — the ministry is charged with ensuring a clean and hygienic living environment. It sets targets in a broad range of areas and the government has a good record of meeting them. Policies are usually implemented in a highly competent manner. The government informs the public about environmental issues through schools and media campaigns.

Green initiatives: The city established the Inter-Ministerial Committee on Sustainable Development in January 2008, a cross-functional initiative to create Singapore's national strategy on sustainable development. Its members include ministers of finance, environment and water resources, transport, and trade and industry. The committee held hundreds of meetings with the business community and members of the public. It also recommended numerous initiatives in four strategic areas: improving resource efficiency; enhancing the physical environment through controlling pollution, increasing green spaces and cleaning major water sources; encouraging residents to adopt a more environmentally responsible lifestyle; and developing technologies to help balance growth with sustainability. The plan includes proposals to improve environmental education in schools, fund partnerships with environmental NGOs, and a pledge to implement ideas from the public and business community to improve environmental sustainability.

Quantitative indicators: Singapore

		Average	Singapore*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	7.4	2008	National Environment Agency
	Energy consumption per US$ GDP (MJ/US$)	6.0	2.9	2008	National Environment Agency; Singapore Government Statistics
Land use and buildings	Population density (persons/km^2)	8,228.8	7,025.2	2009	Singapore Government Statistics
	Green spaces per person (m^2/person)	38.6	66.2	2009	Singapore National Parks data; Singapore Government Statistics
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.21	2010	Land Transport Authority
Waste	Share of waste collected and adequately disposed (%)	82.8	100.0 [1]	2009	Ministry of Environment and Water Resources
	Waste generated per person (kg/person/year)	375.2	306.6 [1]	2009	Ministry of Environment and Water Resources
Water	Water consumption per person (litres per person per day)	277.6	308.5	2009	Key Environmental Statistics 2010
	Water system leakages (%)	22.2	4.6	2009	Key Environmental Statistics 2010
Sanitation	Population with access to sanitation (%)	70.1	100.0	2009	Ministry of Environment and Water Resources
	Share of wastewater treated (%)	59.9	100.0	2009	PUB Singapore
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	22.0	2009	Key Environmental Statistics 2010
	Daily sulphur dioxide levels (ug/m^3)	22.5	9.0	2009	Key Environmental Statistics 2010
	Daily suspended particulate matter levels (ug/m^3)	107.8	56.0	2008	Yearbook of Statistics Singapore

* All data applies to Singapore unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Based on domestic waste disposed

Taipei_Taiwan

Background indicators

Total population (million)	2.7
Administrative area (km^2)	271.8
GDP per person (current prices) (US$)	48,400.0
Population density (persons/km^2)	9,789.9
Temperature (24-hour average, annual) (°C)	22.0

Data applies to Taipei City

Taipei City, the capital of Taiwan, is the second smallest city in the Asian Green City Index, with a population of 2.7 million. The city lies on the Danshui river, and is divided into 12 districts, although responsibility for environmental policies across the whole city lies with a single Environmental Protection Department. Taipei City is the third richest city in the Index, with a GDP per capita of US$48,400, well above the Index average of US$18,600. The economy within the city is dominated by services and business headquarters. There is a significant industrial presence in the wider surrounding area of New Taipei City (formerly Taipei County) but data from these outlying areas was not considered in the Index.

Taipei City ranks above average overall in the Index. The city turns in a consistently strong performance, with above average rankings in seven of the eight individual categories. In the energy and CO_2 category, Taipei City has the second lowest energy consumption level in the Index, and among cities with a similarly high income (above US$25,000 in GDP per capita), it has the lowest CO_2 emissions per person. The city also has the third longest rapid transit network in the Index, a relatively large amount of green spaces, and one of the highest rates of waste collection among the 22 cities. In one category, water, Taipei City is ranked average, mainly for a relatively high rate of per capita water consumption.

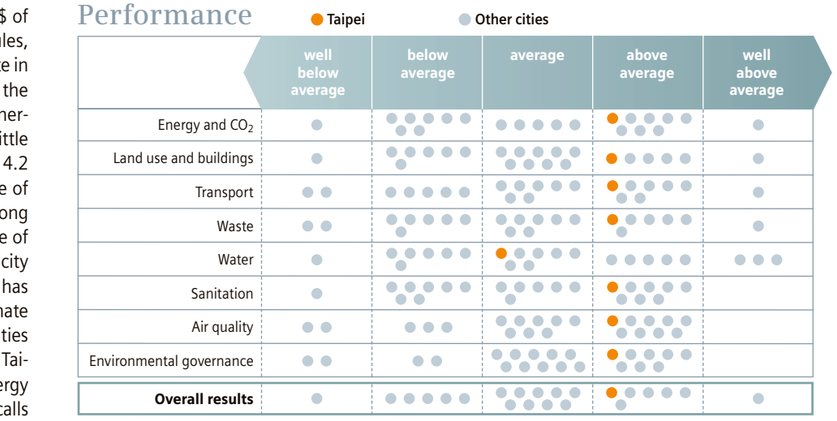
Energy and CO_2: Taipei City is above average in the energy and CO_2 category, driven by its performance in energy efficiency. The city consumes an estimated 1.5 megajoules per US$ of GDP, well below the average of 6 megajoules, and the second best energy consumption rate in the Index. This can be explained in part by the city's productive business sector, which generates a high GDP while only consuming little energy. CO_2 emissions are an estimated 4.2 tonnes per person, below the Index average of 4.6 tonnes – a figure that leads the Index among other high-income cities. Although very little of Taipei City's energy consumption or electricity generation comes from renewables, the city has strong policies on clean energy and climate change. The city is following national priorities to reduce greenhouse gas emissions. The Taiwan government, as part of its 2008 "Energy Saving and Carbon Reduction Action Plan", calls for lowering greenhouse gas emissions to 2008 levels between 2016 and 2020.

Green initiatives: The Taiwan government has outlined 167 specific actions as part of its 2008 "Energy Saving and Carbon Reduction Action Plan", including initiatives to promote hydroelectric, solar and wind power; introduce "clean coal" technology to contain the carbon emissions from burning coal; and improve the energy grid to reduce losses in transmission.

Land use and buildings: Taipei City ranks above average in the land use and buildings category. The city's population density of 9,800 people per square kilometre is above the Index average of 8,200 people per square kilometre. Given the limited availability of land, the conflict between land conservation and development is ongoing in Taipei City. But still the city manages to maintain more green spaces than the Index average, at 50 square metres per person. This is one of the highest rates in the Index, compared to the average of 39 square metres. City officials are conscious of the need for green spaces, and receive good marks in the Index for protecting them. Regarding eco-building standards, Taipei City has improved from the lax regulations during its early development in the 1960s and 1970s. The city now has strong policies on green standards for public buildings, incentives for households and businesses to lower energy use, and is promoting awareness of the value of energy efficiency in buildings.

Green initiatives: The Green Building Regulation code was revised in the early 2000s to improve the quality of new buildings in Taipei City. The regulations, which include specifying a minimum percentage of eco-friendly materials, are mandatory. In addition, the authorities are encouraging neighborhoods to improve their local environment by providing engineers free of charge to create roof gardens and improve landscaping. In another initiative, in mid-2011 the owners of TAIPEI 101, the island's tallest building, are due to finish a flagship project to reduce energy and water consumption by 10%

Performance



The order of the dots within the performance bands has no bearing on the cities' results.

by upgrading the cooling, heating and ventilation systems. Another initiative applies to heavy energy users, such as hotels and office buildings. From July 2010, the Taipei City municipal government started an energy-saving campaign, mandating that these buildings must maintain an indoor temperature at above 26° Celsius. The first phase of the regulations applied to businesses using more than 100,000 kilowatt hours per month, a total of about 540 locations. From January 2011, formal energy-saving inspections will be carried out at these sites.

Transport: Taipei City ranks above average in the transport category. Investments in the metro system and the bus network in the last decade have paid off, and the city has the third longest superior transport network in the Index (defined as transport that moves large numbers of passengers quickly in dedicated lanes, such as metro, bus rapid transit or trams). It measures 0.55 km per square kilometre, above the 22-city average of 0.17 km per square kilometre. Pricing systems for all forms of public transport have been integrated since the early 2000s. The city's rapid rise in car and motorcycle ownership, a sign of growing prosperity, has led to more traffic congestion. But city officials have responded with comprehensive congestion reduction policies. These include traffic light sequencing, traffic information systems and several access points around the city. More generally, Taipei City has a high-quality road network and its traffic laws are effective at managing parking and traffic flow. Traffic is an ongoing challenge, however, and one of residents' main complaints is congestion at peak times of the day.

Green initiatives: The main initiative to improve the transport system centers on continually expanding the metro system. Since it opened in 1996 the metro has added 9 lines totalling just over 100 km.

Waste: Taipei City is above average in the waste category, managing to collect and dispose of an estimated 100% of its waste. The city has an advanced incineration system, with 95% of household waste incinerated, and the rest ending up in landfills. Moreover, the ash left over is used to make paving blocks or bricks. Taipei City has effective recycling policies, including an integrated strategy to reduce, recycle and re-use waste, on-site collection and central collection points. Taipei City produces an estimated 304 kg of waste per person per year, below the average of 375 kg, and also the second best rate among cities with high incomes in the Index. This demonstrates the success of initiatives such as "pay as you throw" (see "green initiatives" below) to encourage recycling and limit waste.

Green initiatives: In the "pay as you throw" scheme, households and companies have to purchase specially printed bin bags for their waste, and authorities will only collect rubbish in these bags. This scheme has encouraged the use of recyclable packaging, which does not require the special bags and is disposed of for free. The scheme has been adjusted in recent years so that, for example, kitchen waste is collected separately, to be used as compost. "Pay as you throw" has reduced average daily waste by a third over the past decade, and the waste recycling rate has more than doubled to its current rate of 45%. In another initiative to encourage recycling, the Taipei City government runs a "Repaired Furniture Display Area". City officials accept discarded large items of furniture such as cabinets, tables, sofas and bicycles; then refurbish and re-sell them. Since 2009, when the display area was set up, the city has sold more than 100,000 items for US$300,000.

Water: Taipei City is average in the water category. This result is mainly due to relatively high levels of water consumption, at 342 litres per person per day, compared to the average of 278 litres. A metering system is in place, but it has failed to reduce consumption, suggesting that perhaps charges remain too low. The leakage rate is 22%, equal to the Index average, although the city is addressing the issue with substantial investments during the next 15 years (see "green initiatives" below). Authorities have put less effort into water issues, in part owing to limited concerns over water shortages in the past, because Taipei City experiences sufficient rainfall and has well-established water sources and supply systems. However, this official stance has changed in recent years amid fears of water shortages, most recently in 2009 and 2010.

Green initiatives: Reservoirs are being improved and new ones are being built outside the city, although these fall outside the city's jurisdiction. The main focus of city policy is water conservation awareness campaigns, urging consumers to save water by using efficient appliances such as low flush or low-flow toilets. The city's environmental department has been improving enforcement measures, including increasing fines for businesses caught illegally polluting the water system, but it is too early to evaluate any results. Regarding leakages, the city is investing US$800 million between 2003 and 2025 to improve the water pipeline network, with a goal to reduce the leakage rate by 1% per year.

Sanitation: Taipei City ranks above average for sanitation. An estimated 99% of the population has access to sanitation, compared to the 22-city average of 70%. Taipei City is weaker on the share of wastewater treated, but still above the Index average, at 77% compared to 60%. Taipei City has sanitation policies in place, such as promoting environmentally sustainable sanitation services, minimum standards for wastewater treatment, and regular monitoring of on-site treatment facilities in homes and communal areas.

Green initiatives: The national government, as part of a larger infrastructure improvement programme, is spending US$5.1 billion to upgrade the wastewater treatment system in Taipei City and the rest of Taiwan.

Air quality: Taipei City is above average for air quality. Average daily particulate matter and sulphur dioxide concentrations are below the Index averages, and levels of nitrogen dioxide are about equal to the 22-city average. Despite a rapid rise in vehicle ownership since the 1980s, there has been a corresponding improvement in car emissions standards. There are other concerns besides cars. Sandstorms in mainland China can contribute to a deterioration in air quality, and the city's proximity to mountains means that pockets of pollution can be high in certain areas even as the average air quality meets international health guidelines. Officials began monitoring air quality in the 1990s, as a first step towards formulating policies, and Taipei City performs well in the Index for its robust clean air policies.

Green initiatives: The official focus has been to control emissions from vehicles, mainly by progressively improving emissions standards in new cars. The authorities have supplemented emissions standards by giving tax breaks and other financial incentives for people who buy cars that run on liquefied petroleum gas or electricity. The central government and the Taipei City municipal government offer subsidies to buy electric motorcycles, and the city government exempts electric motorcycle owners from the cost of charging their batteries. In addition, there are 60 hybrid buses operating in Taipei City. The city government also requires its officials to drive business vehicles with low emissions.

Environmental governance: Taipei City ranks above average for environmental governance. It receives high marks for having a dedicated department to deal with environmental issues, regularly monitoring its environmental performance and publishing progress reports, and giving citizens access to information. A key challenge, in practice, relates to the enforcement of initiatives, in part a reflection of the opposing demands between economic development and the environment. At the same time, there are various levels of administration in Taipei City, and this means there are sometimes problems when officials from different departments have to coordinate with each other. However, officials in Taipei City have shown that they are able to act effectively – waste management is an example – where there are no conflicting interdepartmental agendas.

Green initiatives: Developers in Taipei City must publish environmental impact assessments on the government web site. They are also required to hold a public hearing to answer questions about how they will mitigate the environmental impacts of their projects. All questions are documented in the meeting minutes and developers are required to respond.

Quantitative indicators: Taipei

		Average	Taipei*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	4.2 [e]	2008	Department of Environmental Protection; IPCC; EIU estimates
	Energy consumption per US$ GDP (MJ/US$)	6.0	1.4 [e]	2008	Department of Environmental Protection; EIU estimates
Land use and buildings	Population density (persons/km^2)	8,228.8	9,789.9	2009	EIU calculation
	Green spaces per person (m^2/person)	38.6	49.6	2009	Department of Environmental Protection
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.55	2010	railway-technology.com; cleanair.net
Waste	Share of waste collected and adequately disposed (%)	82.8	100.0 [1e]	2009	Department of Environment Protection
	Waste generated per person (kg/person/year)	375.2	304.0 [2e]	2009	Department of Environment Protection
Water	Water consumption per person (litres per person per day)	277.6	342.0	2009	Department of Environmental Protection
	Water system leakages (%)	22.2	22.0	2009	Department of Environmental Protection
Sanitation	Population with access to sanitation (%)	70.1	99.0 [3 e]	2009	Department of Environmental Protection
	Share of wastewater treated (%)	59.9	77.4	2009	Department of Environmental Protection
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	45.7 [4]	2008	Department of Environmental Protection
	Daily sulphur dioxide levels (ug/m^3)	22.5	8.6 [4]	2008	Department of Environmental Protection
	Daily suspended particulate matter levels (ug/m^3)	107.8	50.2	2008	Department of Environmental Protection

* All data applies to Taipei City unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Based on household collection rate, 2) Based on sum of waste recycled, land filled, incinerated and composted, 3) Based on connection to sewerage system, 4) Converted from ppm

Tokyo_Japan

Background indicators

Total population (million)	13.0
Administrative area (km^2)	2,187.7
GDP per person (current prices) (US$)	70,759.6
Population density (persons/km^2)	5,946.9
Temperature (24-hour average, annual) (°C)	15.0

Data applies to Tokyo Metropolis

Tokyo is Japan's political, commercial and cultural capital. The majority of Japan's largest corporations are headquartered in the city, which is also a global financial centre. As a consequence, Tokyo's annual GDP accounts for almost a third of the country's economic output. All data for Tokyo in the Asian Green City Index is for the Tokyo Metropolis, which has a population of 13 million and an administrative area of 2,200 square kilometres. In contrast, the greater Tokyo area has a population of about 36 million. High land prices mean that little heavy industry is located in the city, sparing the metropolitan area air from factory emissions. However, the city port handles around 90 million tonnes of cargo annually, which has an effect on air quality. The Tokyo Metropolitan Government has attempted to establish the city as a pioneer on environmental issues. It has started initiatives such as controls on diesel vehicles, offers subsidies for solar panels and has even instituted policies which were later adopted by the national government.

Tokyo ranks above average overall in the Asian Green City Index. Its best performances are in the categories of water, and energy and CO_2, ranking well above average in both. It is the only city in the Index to rank at this level for energy and CO_2, mainly due to highly efficient energy consumption and strong policies on energy and climate change. In the water category, Tokyo has the lowest level of water leakages among the 22 cities, and comprehensive policies on water quality and water sustainability. Tokyo ranks above average in transport, waste, sanitation, air quality and environmental governance. Particular strengths in these categories include consistently strong policies, as well as the lowest average daily sulphur dioxide emissions in the Index. It ranks average in land use and buildings, reflecting a lower amount of green spaces compared to the Index average.

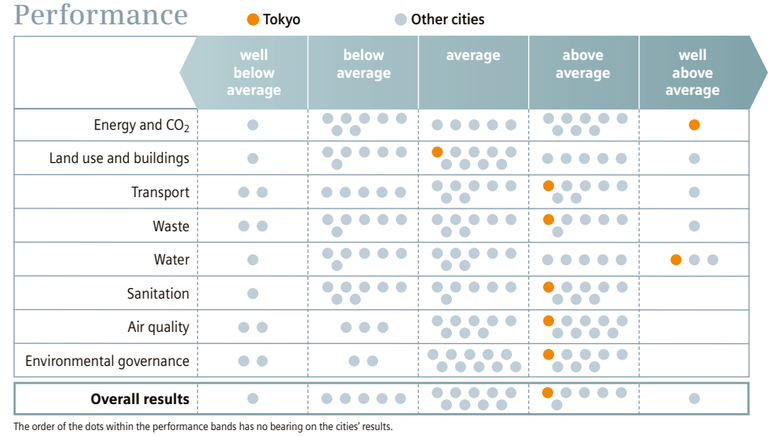
Energy and CO_2: Tokyo ranks well above average in energy and CO_2, bolstered by the lowest energy consumption per economic output in the Index. The city consumes an estimated 1.2 megajoules per US$ of GDP, well below the Index average of 6 megajoules. The low rate of consumption is driven by the lack of heavy industry, and the very high GDP generated by the concentration of Japanese corporate headquarters and major international financial institutions. Tokyo's CO_2 emissions per capita, at an estimated 4.8 tonnes per person, are about equal to the average of 4.6 tonnes. Tokyo generates about 5% of its electricity from renewable sources, but a significant portion of its electricity generation comes from natural gas, at 45%, and nuclear power, at 28%. Reducing carbon emissions even further is a key civic priority, with a goal to cut emissions by 25% from 2000 levels by 2020. The city has several initiatives in place to meet these goals (see "green initiatives" below). In addition, its policies on clean energy and climate change are among the strongest in the Index. These include policies to reduce the environmental impact of energy consumption, to source clean and renewable energy, and regular monitoring of greenhouse gases.

Green initiatives: In 2007 the Tokyo metropolitan government's "Ten-Year Project for a Carbon-Minus Tokyo" outlined five initiatives for climate change mitigation in a number of environmental areas, including energy and transport (for more details, see "green initiatives" in "Land use and buildings" and "Transport" below). In 2005 Tokyo inaugurated the nation's first business-oriented CO_2 Emission Reduction Program, in which large greenhouse-gas-emitting companies are required to submit a five-year carbon reduction plan that is subsequently evaluated, rated and announced publicly. Additionally, as part of the Green Power Purchasing Programme, the city government plans to introduce tax benefits for companies investing in renewable energy. The project includes provisions to replace incandescent light bulbs in the city with fluorescent lighting to reduce energy consumption by 80% per lamp.

Land use and buildings: Tokyo ranks average in land use and buildings. The city has 11 square metres of green spaces per person, less than the Index average of 39 metres, although Tokyo's figure in the Index was taken from 2005 due to data availability. The relatively low amount of green spaces can be partly explained by a historical legacy of favouring economic growth over the environment. However, the city is making efforts to improve, with strong policies on protecting existing green spaces, containing urban sprawl, and protecting environmentally sensitive areas from development. Eco-buildings policies are also comprehensive, and Tokyo receives high marks for setting environmental standards for private and public buildings, and incentivising home and business owners to improve energy efficiency in buildings. It also has many ongoing initiatives in this area (see "green initiatives" below).

Green initiatives: Tokyo's flagship cap and trade system, the first such system in Asia, according to city officials, aims to cut carbon emissions by 25% from 2000 levels. It mandates cuts in energy consumption for 1,300 private offices, commercial buildings and factories. Under the programme, launched in April 2010 and due to be in full operation in 2011, any build-

Performance



The order of the dots within the performance bands has no bearing on the cities' results.

ings that consume more than the crude oil equivalent of 1,500 kilolitres of energy annually, will have to cut CO_2 emissions by 6% to 8%. The system allows businesses to fulfill reduction obligations by buying credits from other businesses that have met reduction targets. In another initiative, the city is subsidising solar panel purchases by homeowners, a scheme that began in Tokyo and which the national government has now adopted. Additionally, from October 2010, a Tokyo Green Labelling System of Condominiums requires all new residential buildings with a floor space of more than 5,000 square metres to display a record of environmental performance when renting or selling apartments. Regarding green spaces, the Tokyo Greenship Action Program is helping to preserve greenery in the metropolitan area through a partnership between local companies and non-profit organisations to maintain green private land. If owners are unable to preserve the land, the city government has a system for buying the most important nature areas. The initiative was launched in 2003 and so far the city has bought about 50 pieces of land.

Transport: Tokyo ranks above average in the transport category. The city has 0.14 km per square kilometre of superior mass transit routes (defined in the Index as transport that moves large numbers of passengers quickly in dedicated lanes, such as metro, bus rapid transit or trams), compared to the Index average of 0.17 km per square kilometre. Tokyo's figure for superior transport is second among cities of a similarly high population (above 10 million people). The city's superior network includes more than 1,000 km of train, subway and monorail lines, and the system overall is well developed, safe, clean, punctual and reasonably priced. Tokyo's mass transport policies are also strong – it has an integrated pricing system, for example, and the city makes investments in reducing emissions from mass transport. Although the public transport system is very good, Tokyo still suffers from traffic congestion. But the city has many congestion reduction and traffic management initiatives in place, including traffic light sequencing and traffic information systems.

Green initiatives: In 2009 Tokyo introduced a system of tax breaks and subsidies for electric vehicles and hybrids. Environmentally friendly cars receive 50% to 75% tax reductions depending on their fuel economies and exhaust emissions. Tokyo's "Ten-Year Project for a Carbon-Minus Tokyo" provides for an eco-driving campaign and a car-sharing programme, with further plans to introduce a park and ride system. The city has set a target to increase the average vehicular speed in the city to 25 kilometres per hour by 2016, and to increase the use of biomass fuel by metropolitan buses. Both measures will help to achieve the city's overarching plan to reduce greenhouse gas emissions related to traffic by 40% from 2000 levels by 2020.

Waste: Tokyo ranks above average in the waste category. Tokyo performs consistently among the best cities in the Index for its waste disposal and recycling policies. It also does well, for a high-income city, for the amount of waste it generates, at 375 kg per person per year, lower than the Index average of 380 kg. According to city officials, the city has managed to reduce the average amount of waste produced from 401 kg in 2007. Tokyo collects and adequately disposes of 100% of its waste, compared to the Index average of 83%, but recycling is at the heart of the city's waste strategy. From 2011, waste from businesses is no longer be allowed to be sent to landfill and has to be recycled. Household waste that cannot be recycled currently is incinerated at temperatures of more than 800 degrees Celsius, and at that temperature does not produce smoke or hazardous emissions.

Green initiatives: In 2006 the Super Eco Town Project was established on reclaimed land in Tokyo Bay, where several companies now process industrial and commercial waste, including construction waste, food waste and discarded electronic devices. All food waste processed at the site is used for energy generation or making animal feed. The process saves landfill space and air pollution is minimal.

Water: Tokyo is well above average in the water category. As with most of the more affluent cities in the Index, it has a high rate of consumption, at 320 litres per person per day, compared to the Index average of 278 litres. However, the city has the best water leakage rate in the Index, at 3%, compared to the Index average of 22%. Tokyo officials say the low leakage rates are due to the high number of checkpoints in the system, far more than are mandated by national standards. In addition, 98% of old pipes had been replaced by 2008, with the city aiming to replace 100% by 2013. Water policies are strong in Tokyo, and officials are continually looking for ways to improve on a strong foundation (see "green initiatives" below).

Green initiatives: The city has made improvements in recent years in order to use gravity more effectively to deliver water, and thereby reduce the need for pumps. It also employs advanced methods to enhance water quality, including ozone and membrane filtration systems. The city says its own standards are higher than national standards and indeed, Tokyo tap water is currently sold as bottled water.

Sanitation: Tokyo ranks above average in the sanitation category, and has few challenges in this area. An estimated 99% of its population has access to sanitation, compared to the Index average of 70%. The city treats all of its wastewater, which is the best rate among cities with a similarly high population in the Index. Tokyo's sanitation policies are also strong, with a robust sanitation code in place, as well as policies promoting the clean and efficient use of sanitation facilities, and monitoring the use of on-site facilities in homes and communal areas.

Air quality: Tokyo is above average in the air quality category. It registers the lowest average daily concentrations of sulphur dioxide in the Index, at 6 micrograms per cubic metre, and well below the Index average of 23 micrograms. It is second in the Index for particulate matter levels, at an estimated 33 micrograms per cubic metre, compared to the Index average of 108 micrograms. It is nearly as strong on nitrogen dioxide, with average daily concentrations that register below the Index average. In addition to the lack of heavy industry in the city, the air has been improved through reductions and changes to the waste incinerator system, and restrictions on diesel vehicles in Tokyo, which began in 2003. City officials point out that Mount Fuji, which is approximately 100 km away, can now be seen from Tokyo on more than 100 days a year – a very different picture from the smog-like conditions that prevailed in Tokyo from the 1950s to the 1970s.

Environmental governance: Tokyo is above average in the environmental governance category, with some of the strongest policies on management and monitoring in the Index. It has a dedicated environmental department with a wide remit to implement its own legislation. The city regularly monitors its environmental performance and publishes information on the results. Citizen and stakeholder involvement in projects with environmental impacts is also strong, and there are central access points for public information. In addition, city departments tend to cooperate well on policy. An example is the fact that multiple departments have cooperated on the previously mentioned ten-year plan to reduce carbon emissions. The city's governor has also aimed to position the city as a leader in environmental policies.

Green initiatives: The city has initiated environmental lessons at all public elementary schools, targeting students beginning at age nine. Teachers also attend classes on the environment, in collaboration with non-profit organisations. As part of this curriculum, schoolchildren visit a study facility on reclaimed land in Tokyo Bay to learn about issues such as waste management and global warming.

Quantitative indicators: Tokyo

		Average	Tokyo*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	4.8 [e]	2008	Agency for Natural Resources and Energy, Japan; Tokyo Electric Power Company; IPCC; EIU estimates
	Energy consumption per US$ GDP (MJ/US$)	6.0	1.2 [e]	2008	Agency for Natural Resources and Energy, Japan; Tokyo Electric Power Company; EIU estimates
Land use and buildings	Population density (persons/km^2)	8,228.8	5,946.9	2009	EIU calculation
	Green spaces per person (m^2/person)	38.6	10.6	2005	Statistics Division of Bureau of General Affairs, Tokyo
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.14	2010	Tokyo Metropolitan Government Bureau Of General Affairs; Yokohama City comparative statistics
Waste	Share of waste collected and adequately disposed (%)	82.8	100.0	2005	Statistics Division of Bureau of General Affairs, Tokyo
	Waste generated per person (kg/person/year)	375.2	375.1	2008	Environment of Tokyo, Volume Change of Refuse Generation and Collection in Tokyo
Water	Water consumption per person (litres per person per day)	277.6	320.2	2008	Statistics Division of Bureau of General Affairs, Tokyo
	Water system leakages (%)	22.2	3.1	2008	Statistics Division of Bureau of General Affairs, Tokyo
Sanitation	Population with access to sanitation (%)	70.1	99.4 [1e]	2008	Statistics Division of Bureau of General Affairs, Tokyo
	Share of wastewater treated (%)	59.9	100.0	2009	Bureau of Waterworks, Tokyo
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	39.5	2007	Statistics Division of Bureau of General Affairs, Tokyo
	Daily sulphur dioxide levels (ug/m^3)	22.5	5.7	2007	Statistics Division of Bureau of General Affairs, Tokyo
	Daily suspended particulate matter levels (ug/m^3)	107.8	33.1 [2e]	2007	Statistics Division of Bureau of General Affairs, Tokyo; World Bank Development Indicators

* All data applies to Tokyo Metropolis unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Based on access to sewerage, 2) Estimate using SPM

Wuhan_China

Background indicators

Total population (million)	8.4
Administrative area (km^2)	8,494.4
GDP per person (current prices) (US$)	8,093.9
Population density (persons/km^2)	983.6
Temperature (24-hour average, annual) (°C)	17.0

Data applies to Wuhan

With a population of 8.4 million and a GDP per capita of US$8,100, Wuhan is the provincial capital of Hubei, and one of central China's most productive economic centres. The city is a major transport and logistics hub, and boasts the country's largest inland river port. As with many Chinese cities, Wuhan's rapid growth has led to significant environmental challenges. Its industrial base is dominated by carbon-intensive sectors, including the emissions-intensive steel industry and car manufacturing. More recently, however, the city government has sought more of a balance between economic growth and the environment. In 2007 the central Chinese government designated Wuhan an experimental zone for sustainability policies, and the city has responded by putting a greater emphasis on lower-carbon industries and services, as well as promoting several environmental initiatives.

Wuhan ranks average overall in the Asian Green City Index. Its best performance is in the water category, where it ranks above average, helped by strong policies on water efficiency and quality monitoring. Wuhan is average in the categories of transport, waste and environmental governance. And although Wuhan ranks average in sanitation, it still has the highest share of wastewater treated among all the other low-income cities in the Index (with a GDP per person of less than US$10,000). The biggest environmental challenges for Wuhan are found in the categories of energy and CO_2, land use and buildings, and air quality, where the city ranks below average. However, Wuhan scores reasonably well for policies in each of these three categories, which suggests the city can improve its overall environmental performance going forward.

Energy and CO_2: Wuhan ranks below average in energy and CO_2. High dependence on carbon-intensive energy sources drives up Wuhan's CO_2 emissions, which measure an estimated 5.1 tonnes per person per year against an Index average of 4.6 tonnes. Coal accounts for a third of all energy consumed in Wuhan, the fifth highest share among the cities in the Index, while 42% of energy consumed in the city comes from carbon-intensive crude oil and "coke", a fuel produced by distilling coal. Renewable energy does not yet play a big part in energy consumption or electricity production, but the city is making some investments towards sourcing and producing energy from renewables. With much heavy industry driving its economy, the city is also among the most intensive energy consumers in the Index. It uses an estimated 10 megajoules per US$ of GDP, compared with the 22-city average of 6 megajoules. But the city has made efforts to consume energy more efficiently, leading to good score for its energy policies. Lack of a climate change action plan, however, hampers Wuhan's overall policy performance. The city has not carried out a baseline review of greenhouse gas emissions in the last five years, and neither does it regularly monitor greenhouse gas emissions and publish the results.

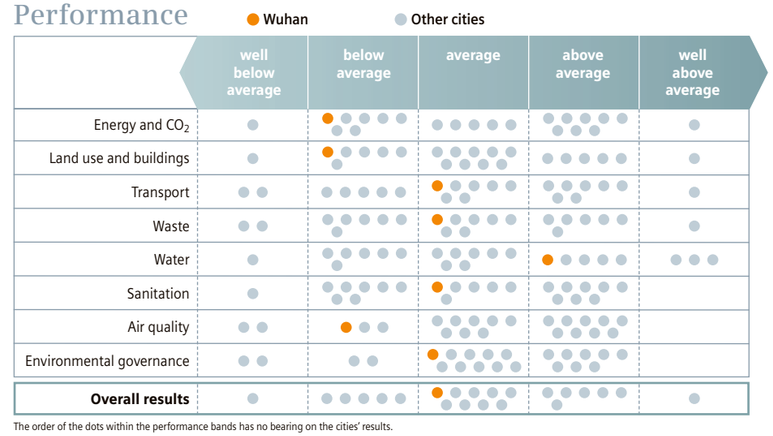
Green initiatives: Other city efforts to reduce CO_2 emissions include converting a small coal plant to biomass-generation in 2009, and a project to capture gas from the Chenjiachong landfill site for power generation, which will reduce the city's CO_2 footprint. No information was readily available from the city government on either targets set or the progress made from its initiatives to reduce CO_2 emissions.

Land use and buildings: Wuhan ranks below average in the land use and buildings category, which partly reflects the city's geography and population size. As the second biggest administrative area in the Index next to Beijing, along with a mid-sized population, Wuhan has the lowest population density in the Index. The city registers 21 square metres of green spaces per person, which is despite its large administrative area, well below the Index average of 39 square metres. In policy areas, Wuhan performs much better, particularly in terms of eco-buildings. Standards have been set for the eco-efficiency of new buildings, incentives and regulations are in place to motivate businesses and households to lower their energy use, and the city actively promotes citizen awareness about ways to improve energy efficiency in buildings. The city also has measures in place to contain urban sprawl, as well as to protect green spaces and environmentally sensitive areas. The city's policies are relatively weak, however, on adopting green standards for public buildings.

Green initiatives: Wuhan authorities have audited and published figures for energy consumption in public buildings, and have run advertisements in the local media to increase public awareness of the need to raise energy efficiency in buildings. The city government is one of the few in China to implement national energy efficiency standards for China's "hot summer/cold winter" climate zones, which Wuhan falls into. The city has also facilitated "energy management contracts" between companies. For example, a construction firm installed energy-saving devices worth US$700,000 for the local China Construction Bank, in return for a share of the expected annual US$200,000 cost savings.

Transport: Wuhan ranks average in transport. The city's public mass transit network is limited in scope compared to its geographic area, with a light rail system that measures about 30 km. Consequently it registers at a length of 0.0 km per square kilometre in the Index, versus the Index average of 0.17 km. Meanwhile, Wuhan's roads are becoming more and more congested. The number of vehicles

Performance



The order of the dots within the performance bands has no bearing on the cities' results.

has tripled to nearly 1 million over the last decade. In addition, Wuhan straddles the Yangtze river, and its many large lakes complicate efforts to build efficient transport systems. Wuhan scores relatively well, however, in many of the policy areas covered by the Index. The city, for example, has an integrated pricing system for public or mass transport, has taken steps to reduce emissions from urban mass transport, and has encouraged citizens to take greener forms of transport. Policy for reducing traffic congestion is also well developed, incorporating congestion charges, pedestrian areas, "no-car days", and park and ride systems. The city is marked down in the Index for only making partial efforts to establish a comprehensive urban mass transport policy.

Green initiatives: When it comes to mass transit, Wuhan is adding two metro lines to its current single line, and is expected to finish by 2012. By 2020, the government plans to have seven lines in place, covering 227 km. Furthermore, Wuhan took a step towards integrating its transport system in 2010 by introducing an e-card that provides discounted fares for ferries, buses and the metro. Regarding electric vehicles, in September 2010 the Chinese national government announced an agreement between the district government of Hannan in Wuhan and Wuhan-based Grand China Electric Vehicles to invest US$443 million over the next two years to build production facilities that will be capable of producing 3,000 electric vehicles annually. A smaller-scale electric car initiative was agreed in early 2010 between the Wuhan government and private automakers, to introduce 25 electric cars into the city in 2011. The Wuhan government committed to build 250 chargers throughout the city as part of the project. The city is also trying to boost cycling through a free bicycle borrowing scheme that began in 2009. It was expanded in 2010, although the scheme has not been without problems, such as users failing to return the bicycles promptly.

Waste: Wuhan ranks average in the waste category. The city performs well for the relatively low amount of waste its inhabitants generate per head, at an estimated 263 kg versus an Index average of 380 kg. Nevertheless, with 8 million residents, the total amount of waste generated by the city presents a huge challenge, and one that Wuhan appears to struggle with. Only an estimated 74% of the city's waste is collected and adequately disposed of — a figure based on household waste only — which is below the Index average of 83%. In policy areas, the city enforces environmental standards at waste disposal sites, and it has on-site collection and central collection points for recycling. Wuhan is, however, relatively weak at enforcing and monitoring standards for industrial hazardous waste.

Green initiatives: The Wuhan Sanitation Master Plan foresees the construction of five waste-to-energy incinerators by 2014, adding a total capacity of 6,500 tonnes per day. At present, virtually all of Wuhan's waste is disposed of through landfills, which has encouraged the government to increase the proportion that is incinerated due to growing capacity restraints.

Water: Wuhan ranks above average in the water category. The city benefits from abundant water supplies, drawing most of its water from the Yangtze river. But it also scores well for maintaining an efficient water system, being fairly conservative in its water consumption, and for having strong policies. Wuhan's water system leakage levels are relatively modest, at 14%, which is below the Index average of 22%. And water consumption per capita per day, at 281 litres, is only just above the Index average of 278 litres. Surface water pollution affects 56% of the city's rivers and 89% of its lakes, with water quality having declined sharply as a result of rising household and industrial waste emissions, both solid and liquid, from Wuhan's urban region. However, the city is trying to address the issue by setting maximum levels for key pollutants in surface and drinking water, and regularly monitoring water quality. The city also enforces water pollution standards on local industry. In spite of these efforts, water pollution remains a major problem.

Green initiatives: Water pollution has been aggravated by urban development, which has impeded natural flows of water between the city's various major water bodies. Of the some 100 lakes that were within Wuhan city limits by the middle of the last century, just 38 now remain. The city government is currently working with the Asian Development Bank to de-silt and de-contaminate the remaining lakes. A comprehensive programme has been put in place to improve water quality, restore animal life, provide an outlet for floodwaters, and, ultimately, prevent the lakes from disappearing altogether.

Sanitation: Wuhan ranks average in sanitation. Ninety percent of the city's wastewater is treated, which is above the Index average of 60%, and is also the highest share of wastewater treated of all the low-income cities in the Index (with a GDP per person of less than US$10,000). However, only an estimated 67% of Wuhan's population has access to sanitation. Although below the Index average of 70%, this is still one of the highest levels of sanitation access among the cities in the low-income group. In policy areas, Wuhan sets minimum standards for wastewater treatment, and regularly monitors on-site treatment facilities in homes and communal areas. The city is marked down, however, for not promoting public awareness around the clean and efficient use of sanitation systems.

Green initiatives: Wuhan has ten wastewater treatment plants in operation, but these are currently overloaded. To address wastewater issues, Wuhan has been cooperating with the Asian Development Bank since 2000, and in 2006 the Bank approved a US$100 million loan to develop wastewater treatment capacity. A further three plants are set to open in the near future within the urban core.

Air quality: Wuhan ranks below average in air quality. The city's relatively poor performance partly reflects continued high dependence on coal-fired power, as well as burgeoning levels of car ownership and industrial emissions. These factors have contributed to push up daily nitrogen dioxide levels to 54 micrograms per cubic metre, compared with the Index average of 47 micrograms. Daily sulphur dioxide levels, at 44 micrograms per cubic metre, are almost double the Index average. In policy areas, Wuhan does better. The municipal government has advanced systems for monitoring air pollution, which are used in various locations around the city, not just in industrial areas. Moreover, the city is marked up in the Index for informing citizens about air pollution and the dangers of household pollution, which complements its overall policy to improve local ambient air quality. Wuhan is marked down, however, for not regularly monitoring levels of suspended fine particulate matter or carbon monoxide.

Green initiatives: To date, air quality initiatives in Wuhan have been modest. Under China's 11th five-year plan period (2006-2010), however, Wuhan Steel's flue gas systems were fitted with desulphurisation equipment to reduce sulphur dioxide emissions.

Environmental governance: Wuhan ranks average for environmental governance. The city regularly monitors its environmental performance and publishes information on progress. The environmental department has a wide remit, with the ability to implement its own environmental legislation, however, jurisdiction is split across several government departments. Wuhan has also conducted a baseline environmental review in all of the main areas covered by the index within the last five years. The city could do better, however, at involving citizens, non-governmental organisations and other stakeholders in decisions on projects of major environmental impact.

Quantitative indicators: Wuhan

		Average	Wuhan*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	5.1 [e]	2009	Wuhan Statistical Yearbook; IPCC; EIU estimates
	Energy consumption per US$ GDP (MJ/US$)	6.0	10.0 [e]	2009	Wuhan Statistical Yearbook; EIU estimates
Land use and buildings	Population density (persons/km^2)	8,228.8	983.6	2009	EIU calculation
	Green spaces per person (m^2/person)	38.6	20.9	2009	Wuhan Statistical Yearbook
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.00	2010	ccnews.people.com.cn
Waste	Share of waste collected and adequately disposed (%)	82.8	74.0 [1e]	2008	China City Construction Yearbook (2008)
	Waste generated per person (kg/person/year)	375.2	262.9 [1e]	2008	Wuhan Environmental Protection Bureau
Water	Water consumption per person (litres per person per day)	277.6	281.0	2009	Wuhan Statistical Yearbook
	Water system leakages (%)	22.2	14.2	2008	China Urban Statistics Yearbook (2008)
Sanitation	Population with access to sanitation (%)	70.1	66.5 [2e]	2009	EIU estimate
	Share of wastewater treated (%)	59.9	90.4	2009	Wuhan Statistical Yearbook
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	54.0	2009	Wuhan Environmental Protection Bureau
	Daily sulphur dioxide levels (ug/m^3)	22.5	44.0	2009	Wuhan Environmental Protection Bureau
	Daily suspended particulate matter levels (ug/m^3)	107.8	105.0	2009	Wuhan Environmental Protection Bureau

* All data applies to Wuhan unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Based on household waste, 2) Based on regression analysis

Yokohama_Japan

Background indicators

Total population (million)	3.7
Administrative area (km^2)	435.0
GDP per person (current prices) (US$)	30,211.7
Population density (persons/km^2)	8.441.3
Temperature (24-hour average, annual) (°C)	15.0

All data applies to Yokohama

Yokohama is Japan's second largest city, with a population of 3.7 million. It lies south of Tokyo, but is still part of the greater Tokyo area. The city is a major port, manufacturing centre and tourist attraction. The city is also one of the richest in the Index, with a GDP per person of US$30,200. It has been a model of Japanese innovation since the mid-19th century, a major point of contact with foreigners, and saw the introduction of the country's first newspaper, brewery, railway and power station. In 2008 the city was named as one of six "environmental model cities" in Japan. Officials have set targets to reduce the city's greenhouse gas emissions by 30% by 2025 and 60% by 2050, and have also targeted waste reduction as a key environmental priority. Yokohama regularly exports its environmental expertise, including consulting on water and sewerage projects in developing countries.

Yokohama turns in a strong performance in the Asian Green City Index, ranking above average overall. The city does consistently well across all categories, with a well above average ranking in the water category, and above average rankings in the remaining ones: energy and CO_2, land use and buildings, transport, waste, sanitation, air quality and environmental governance. In the water category, the city has one of the lowest rates of water leakages in the Index and strong policies for water quality and water sustainability. Yokohama is also one of the most energy-efficient cities in the Index, with a relatively low consumption rate compared to economic output. Other strengths include the lowest level of particulate matter in the Index, and consistently robust policies across all categories. In addition, Yokohama has the lowest rates of waste generation and water consumption when compared to other cities with high incomes in the Index (with a GDP per person of above US$25,000).

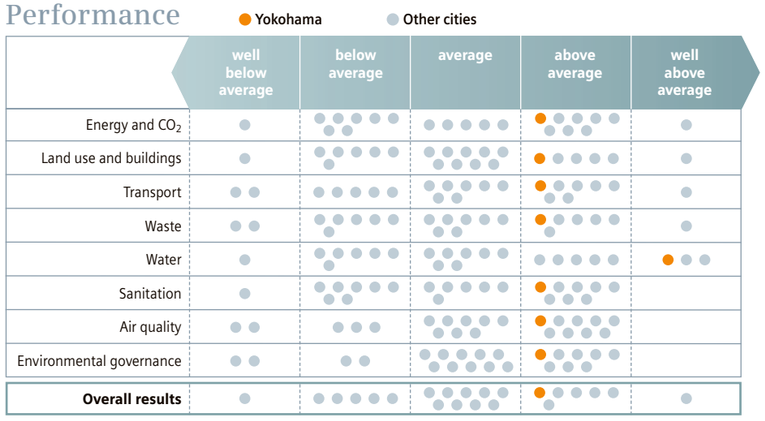
Energy and CO_2: Yokohama is above average in the energy and CO_2 category. The city is efficient in energy consumption compared to economic output, using an estimated 2.4 megajoules of energy per US$ of GDP, compared to the Index average of 6 megajoules. It also has ambitious clean energy policies and a climate change action plan: the city receives high marks for its clean energy code, for investing in waste-to-energy projects, and other investments in energy efficiency. Regarding climate change, the city receives full marks for having conducted a baseline review of greenhouse gas emissions within the last five years. It also regularly monitors greenhouse gas emissions and publishes the findings, and has signed up to international agreements, such as the C40 group of cities, to reduce greenhouse gases. However, the city's per capita CO_2 emissions are above the 22-city average, at 5.2 tonnes compared to the average of 4.6 tonnes, although Yokohama's figure in the Index is from 2006, the latest official data available. The share of renewables the city uses is low, both as a percentage of overall energy consumption, at 1%, and as a percentage of electricity production, at 5%. Gasoline is the most prevalent energy source in the city, at 48% of the overall energy consumption. Electricity is generated in Yokohama primarily through nuclear energy and natural gas. According to city officials, because Yokohama is a commuter city, a higher proportion of emissions in Yokohama come from private homes than in other neighbouring cities, so this is where officials are focusing reduction efforts.

Green initiatives: The city's CO-DO30 (Carbon Off Do) plan, adopted in 2008, calls for reducing per-person greenhouse gas emissions by 30% from 2004 levels by 2025. The plan contains numerous initiatives across almost every part of civic life designed to lower greenhouse gas emissions, including a ten-fold increase in renewable energy, and promoting energy-saving measures in all of Yokohama's businesses. A major initiative contained in the plan is the Yokohama Smart City Project, which is being developed in cooperation with the central government and several large international companies. Yokohama is one of four cities selected for the project, which launched in April 2010. Under the US$85 million plan, the city will introduce an energy efficient smart grid covering 170,000 households, with a goal to reduce CO2 emissions by 64,000 tonnes by 2014. In another initiative, a biomass waste-to-energy trial project involving about 1,000 households is currently running in one of the city wards, and city officials aim to expand it in the future.

Land use and buildings: Yokohama ranks above average in the land use and buildings category, with particular strengths in eco-buildings and land use policies. It receives top marks for having standards for energy efficiency in private buildings, and full marks for leading by example with green standards for public buildings. It also has incentives in place to motivate households and businesses to lower their energy use, and publicly promotes energy efficiency in buildings. The city's policies on land use are strong too; it is marked up for policies to contain urban sprawl, and protect existing green spaces and environmentally sensitive areas. The actual amount of green spaces in the city is close to the Index average, at 37 square metres per person, compared to the average of 39 square metres, although the city is taking action to boost this amount (see "green initiatives" below).

Green initiatives: Yokohama is taxing residents and businesses to pay for more green spaces. The programme, called "Green Up", will charge each private citizen approximately US$10.50 between 2009 and 2013. Businesses will have to pay the equivalent of 9% of the existing business tax, with a maximum charge of US$3,176. The money will be used to create

Performance



The order of the dots within the performance bands has no bearing on the cities' results.

more green spaces in the city. Furthermore, in 2005, the city introduced the Comprehensive Assessment System for Built Environment Efficiency (CASBEE). Buildings larger than 2,000 square metres are required to be assessed for their environmental performance at the planning stage. This has so far been carried out through self-assessment by owners.

Transport: Yokohama ranks above average for transport. Yokohama has a well-developed mass transit system, with 197 km of trains, 53 km of subway routes and more than 1,000 km of bus routes, and is currently connecting Japan Railways to existing private lines to improve transport efficiency. The city's superior transport network (defined in the Index as transport that moves large numbers of passengers quickly in dedicated lanes, such as metro, bus rapid transit or trams) is 0.12 km per square kilometre, compared to the Index average of 0.17 km per square kilometre. Under the Yokohama City Traffic Plan, officials are building new roads to ease congestion. The city receives generally high marks for its transport policies, including a comprehensive urban mass transport policy, a fully integrated pricing system and efforts to reduce emissions from mass transport.

Green initiatives: As part of the Smart City project, the city has a goal to introduce 2,000 electric vehicles and 500 charging stations, in cooperation with large automakers in the city. Officials also provide subsidies of US$1,800 for electric vehicles and up to US$4,800 for chargers, in addition to subsidies available from the national government.

Waste: Yokohama ranks above average in the waste category. The city generates an estimated 301 kg of waste per person, lower than the Index average of 380 kg per person. This is the lowest rate among the high-income cities in the Index. It also collects and adequately disposes close to an estimated 100% of its waste, a rate well above the Index average of 83%. The city's policies on waste disposal and recycling are also some of the strongest in the Index. It has, for example, an integrated policy for reducing, recycling and re-using waste. It enforces standards on waste disposal sites and standards for hazardous industrial waste. Authorities operate special waste collection for household hazardous waste, medical, chemical and construction debris, as well as both on-site and central collection for recycling. In 2003, the city set a goal to reduce waste by 30% within 10 years. It exceeded the goal five years early, with a 34% reduction by 2005, mainly due to a programme to have residents separate their household waste for recycling (see "green initiatives" below). The city currently operates four incinerators, and because of reductions in waste, a fifth incinerator was closed and plans for two more have been shelved, saving the city about US$1.3 billion.

Green initiatives: In order to promote its separation and recycling policies, the city held around 11,000 meetings over two years to explain directly to citizens the programme aims and why it was important to reduce waste. The city has continued to organise these meetings at large public events such as summer festivals, or when new apartment blocks open.

Water: Yokohama is well above average in the water category. Like many of the affluent cities in the Index, it has a relatively high amount of per person water consumption, at 300 litres per person per day, compared to the 22-city average of 278 litres, although it is the lowest rate among high-income cities in the Index. The city scores well for water leakages, at 6%, well below the Index average of 22%. Although some parts of the water system are 40 to 50 years old, the city has an ongoing pipe replacement programme, with the new pipes designed to last 80 years. The city also scores very well for its water quality policies. It has a water quality code, monitors surface water and has standards for levels of pollutants in drinking water, and enforces pollution standards on local industry. It also receives high marks for water efficiency policies and public information campaigns to promote water conservation.

Green initiatives: The Yokohama Water Company, with the backing of the national Ministry for Economy, Trade and Industry, runs several international projects, including constructing and maintaining water and sewage systems in India. The city has had a policy of exporting technical expertise, in recognition of the efforts that a British engineer made to improving the city in the 19th century. It also invites developing-world engineers to training programmes in Yokohama, and exports consulting expertise to developing countries in cooperation with the Japan International Cooperation Agency. Furthermore, Yokohama is building what will be the country's largest water purification plant to use innovative ceramic nano-filtration membrane technology. It is expected to be start operations in about two years. The city has also introduced small-scale hydroelectric power generators at its water purification plants, producing 1.8 million kilowatt hours, as well as solar power generation producing 949,000 kilowatt hours. Another initiative is the Doshi Water Conservation Forest, to store, purify, and protect natural water sources, which is an integral goal of Yokohama's previously mentioned 2008 CO-DO30 Plan.

Sanitation: Yokohama is above average in the sanitation category. An estimated nearly 100% of its population has access to sanitation, and the city treats all of its wastewater. The city performs well for sanitations policies too, receiving high marks for its code to promote environmentally sustainable sanitation services, minimum standards for wastewater treatment and promoting the clean and efficient use of sanitary systems.

Air quality: Yokohama ranks above average in the air quality category. Levels of the three pollutants measured in the Index – nitrogen dioxide, sulphur dioxide and particulate matter – are all below the Index averages. The city registers the lowest average daily levels of particulate matter in the Index, at 27 micrograms per cubic metre, and well below the 22-city average of 108 micrograms. The city has seen levels of particulate matter drop by two-thirds since 1960 in some areas. Nitrogen dioxide has also been decreasing continuously due to tighter regulations on automobile exhaust, as well as stricter enforcement of regulations on industrial and business sites in Yokohama. The city is strong on policies as well. It has a strong air quality code and monitors air quality at several locations around the city.

Green initiatives: Since 2008 the city has provided electricity to ships unloading coal at Yokohama docks, allowing them to turn off their engines and reduce air pollution.

Environmental governance: Yokohama is above average for environmental governance. It has a dedicated environmental department with the capacity to implement its own environmental legislation. It also receives full marks for regularly monitoring its environmental performance, including publishing annual reports, and giving citizens access to environmental information. The city government collaborates with several non-governmental organisations on projects relating to water, green spaces, animal protection, recycling resources and environmental education.

Green initiatives: Yokohama's "eco schools" bring together government, industry, academics, and citizens to provide seminars and events to teach about climate change. Under the Yokohama Smart City Project, private citizens and companies will be encouraged to propose ideas to improve the urban environment.

Quantitative indicators: Yokohama

		Average	Yokohama*	Year**	Source
Energy and CO_2	CO_2 emissions per person (tonnes/person)	4.6	5.2 [1]	2006	Yokohama CO-DO30 Road Map
	Energy consumption per US$ GDP (MJ/US$)	6.0	2.4 [e]	2007	Environment Bureau of Yokohama
Land use and buildings	Population density (persons/km^2)	8,228.8	8,441.3	2009	EIU calculation
	Green spaces per person (m^2/person)	38.6	37.4 [2]	2006	Yokohama City Hall
Transport	Superior public transport network , covering trams, light rail, subway and BRT (km/km^2)	0.17	0.12	2010	City of Yokohama
Waste	Share of waste collected and adequately disposed (%)	82.8	100.0 [3e]	2008	Yokohama Municipal Government
	Waste generated per person (kg/person/year)	375.2	300.8 [3e]	2008	Yokohama Municipal Government
Water	Water consumption per person (litres per person per day)	277.6	300.3	2008	Yokohama Municipal Government
	Water system leakages (%)	22.2	5.5	2008	Yokohama Waterworks Bureau
Sanitation	Population with access to sanitation (%)	70.1	99.8 [4e]	2008	Environment Development Bureau, Yokohama
	Share of wastewater treated (%)	59.9	100.0	2009	Environment Bureau of Yokohama
Air quality	Daily nitrogen dioxide levels (ug/m^3)	46.7	39.5	2008	Yokohama Municipal Government
	Daily sulphur dioxide levels (ug/m^3)	22.5	14.3	2008	Yokohama Municipal Government
	Daily suspended particulate matter levels (ug/m^3)	107.8	27.0	2008	Yokohama Municipal Government

* All data applies to Yokohama unless stated otherwise below, ** Where data from different years were used only the year of the main indicator is listed, e) EIU estimate, 1) Greenhouse gas equivalent, 2) "Share of green space coverage", 3) Based on total waste collected, 4) Based on share of population under the sewerage treatment areas

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