



50 CLIMATE SOLUTIONS FROM CITIES IN THE PEOPLE'S REPUBLIC OF CHINA

Best Practices from Cities Taking Action
on Climate Change

NOVEMBER 2018

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→ Cities' Role in Low-Carbon and Climate-Resilient Development

Developing Asia's cities must bring forth innovative solutions to protect them against climate change and set the pace for national policies.

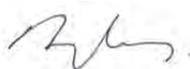
The world is undergoing the largest wave of urban growth in history, with more people living in cities now than in rural areas. This is nowhere more visible than in developing Asia, where new and existing cities and towns are growing with incredible speed. Asian cities are expected to contribute to two-thirds of the world's urban population growth by 2020.

Greenhouse gas (GHG) emissions, especially carbon dioxide, are growing alongside this trend of urbanization. GHG emissions have a significant impact on health, water resources, agriculture, fisheries, and tourism. The region is particularly exposed to climate risk due to its geography; and low incomes, poor infrastructure, and insufficient adaptive capacity further exacerbate its climate vulnerability. Rising risk and vulnerability jeopardize the hard-won socioeconomic gains of recent years and continued economic growth. Climate change could cut developing Asia's gross domestic product by more than 10% by year 2100, if no action is taken.

By taking the lead on low-carbon development, cities have the opportunity to turn the wheel around. In addition to reducing GHG emissions, they can engage in an important dialogue about sustainable development, directly address local issues, implement environmental improvement measures, and create green job opportunities.

The best solutions to climate change often come from cities, which directly experience its consequences. Sharing good practice examples may inspire other cities in their quest to ensure that innovation and climate proofing go hand in hand with further economic development. Putting forth low-carbon development strategies also allows cities to position themselves as major players in climate change mitigation, and set an example for the development of national emissions reduction policies.

The Asian Development Bank is committed to supporting the shift toward a low-carbon and climate-resilient development path.



Amy Leung
Director General, East Asia Department
Asian Development Bank

→ A Drive for Low-Carbon and Climate-Resilient Cities

The People’s Republic of China is aggressively tackling climate change in its ever-growing cities, while improving the lives of its residents.

The People’s Republic of China (PRC) has sustained spectacular economic growth over the past 4 decades since the introduction of market-based reforms and opening up. Gross domestic product growth has averaged about 9.6%, and gross domestic product per capita has increased by 14% per year between from 1978 to 2017. The PRC’s high rate of economic growth has been coupled with rapid urbanization. The PRC’s urban population reached 58.5% in 2017, and is expected to reach 60% by 2020. Growth and urbanization have led to great improvement in living standards of many new urban residents, but placed pressure on the consumption of energy and natural resources, resulting in serious challenges relating to the environment and climate change. The PRC is ranked as the top emitter of greenhouse gases (GHGs) globally. In large urban centers, this has led to poor air and water quality, affecting the health of the urban population. The cost of pollution damage in the PRC is estimated to be close to 10% of gross domestic product.

The PRC recognizes the need for transforming its growth pattern and has established a vision to realize “ecological civilization,” promoting sustainable, inclusive, low-carbon, and resilient growth. Recognizing the need to improve the urban environment, and the critical role that cities play in mitigating the effects of climate change, the PRC has identified and implemented several city-level initiatives for sustainable development. These include measures to conserve energy, reduce emissions, increase mass transit and nonmotorized transport infrastructure, introduce new energy vehicles, increase green infrastructure, rehabilitate wetlands, and improve flood protection. One key initiative is the Low-Carbon City Initiative led by the National Development and Reform Commission. Since its inception in 2005, a total of 87 low-carbon pilot provinces, cities, and districts have been designated. This initiative directly links to the PRC’s national commitment to peak out GHG emissions by 2030 under its Nationally Determined Contributions to Climate Change.

Under the initiative, cities have successfully implemented effective GHG reduction and environmental improvement measures, while continuing to ensure economic prosperity and improvement of people’s lives. This publication showcases several urban case studies from the PRC that demonstrate innovative approaches to reducing carbon emissions and mitigating the effects of climate change. The Asian Development Bank has supported some of these projects, including renewable energy-based district heating and cooling in Qingdao, wind-powered district heating in Hohhot, an emissions trading scheme in Shanghai, and bus rapid transit in Yichang. Sharing these good practice examples will enable other cities, not only in the PRC but also in many other developing Asian countries that face similar challenges, to build on successes and lessons to develop their own road maps for low-carbon urban development.

小西步

Ayumi Konishi

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Asian Development Bank

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Abbreviations

BRT

bus rapid transit

CNY

yuan

CO

carbon monoxide

CO₂

carbon dioxide

CO_{2e}

carbon dioxide equivalent

CYCAN

China Youth Climate
Action Network

ETS

Emissions Trading Scheme

GDP

gross domestic product

HC

hydrocarbon

LED

light-emitting diode

LEED

Leadership in Energy and
Environmental Design

PM

particulate matter

PM_{2.5}

particulate matter
2.5 micrometers and or less

PM10

particulate matter
10 micrometers or less

PRC

People's Republic of China

PV

photovoltaic

Weights and Measures

GW

gigawatt

GWh

gigawatt-hour

ha

hectare

km

kilometer

km²

square kilometer

kW

kilowatt

kWh

kilowatt-hour

m²

square meter

m³

cubic meter

MW

megawatt

MWh

megawatt-hour

MWp

megawatt peak

NO_x

nitrogen oxide

SO₂

sulfur dioxide

Currency Equivalent

\$1.00 = CNY6.36

as of 7 May 2018

Introduction

→ 50 City Projects for Climate Action in the PRC

There is an urgent need for ambitious action to address the challenges posed by climate change. Recognizing this, the People's Republic of China (PRC) is taking measures to foster a true sustainable growth model in which cities are key, since they play a crucial role in mitigation efforts and are exposed to many of the risks posed by climate change.

As this publication shows, urban areas all over the PRC have embraced a wide range of solutions to reduce energy consumption, green and clean their energy supply, transform the concept of waste, promote green and blue spaces, and improve urban mobility. Each of the 50 featured solutions—some are projects sponsored by the Asian Development Bank (ADB)—shows how cities take climate actions and also create valuable co-benefits in terms of positive impacts on citizens' public health and quality of life, as well as providing economic and additional environmental benefits.

This publication is part of ADB's initiative to support the PRC's efforts to address climate change and showcase its innovation in low-carbon city development. ADB hopes that, by sharing these examples, other cities are inspired to drive further innovation and transform their cities to protect against climate change.

CITY PROJECTS IN THIS PUBLICATION ARE DIVIDED INTO FIVE SECTORS.



ENERGY



LAND USE AND RESILIENCE



WASTE



CLIMATE ACTION



MOBILITY



Energy

→ Cities in the People's Republic of China are leading the way in implementing the latest renewable energy technology, and increasingly recognizing the importance and benefits of reducing energy consumption. The energy sector demonstrates some of the most ambitious energy efficiency projects in new and old buildings, renewable energy initiatives powering vast cities, and innovative ways for heating and cooling.



SHIJIAZHUANG

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GUANGZHOU

Public Sector Leading the Charge with Energy Improvements
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CITY: QINHUANGDAO, Hebei



↓ 906

TONS OF CO₂ EMISSIONS WERE REDUCED ANNUALLY IN THE PASSIVE BUILDINGS.



Inhabitants
3,090,000



GDP per capita
CNY43,586



Geographic area
7,813 km²

THE CHALLENGE

As the PRC takes steps to tackle climate change and reduce its greenhouse gas emissions, energy use in buildings, which makes up a significant proportion of energy demand, must be addressed. By introducing and demonstrating green building techniques with its passive building projects, Qinhuangdao is showing the way forward.

CO-BENEFITS

Economic

Residents in the four passive buildings are estimated to save a total of CNY692,300 per year, thanks to reduced heat and electricity costs.



Environment

The development of passive building techniques helps to reduce the consumption of primary energy, improves air quality, protects water resources, and reduces greenhouse gas emissions and waste discharge.



Health

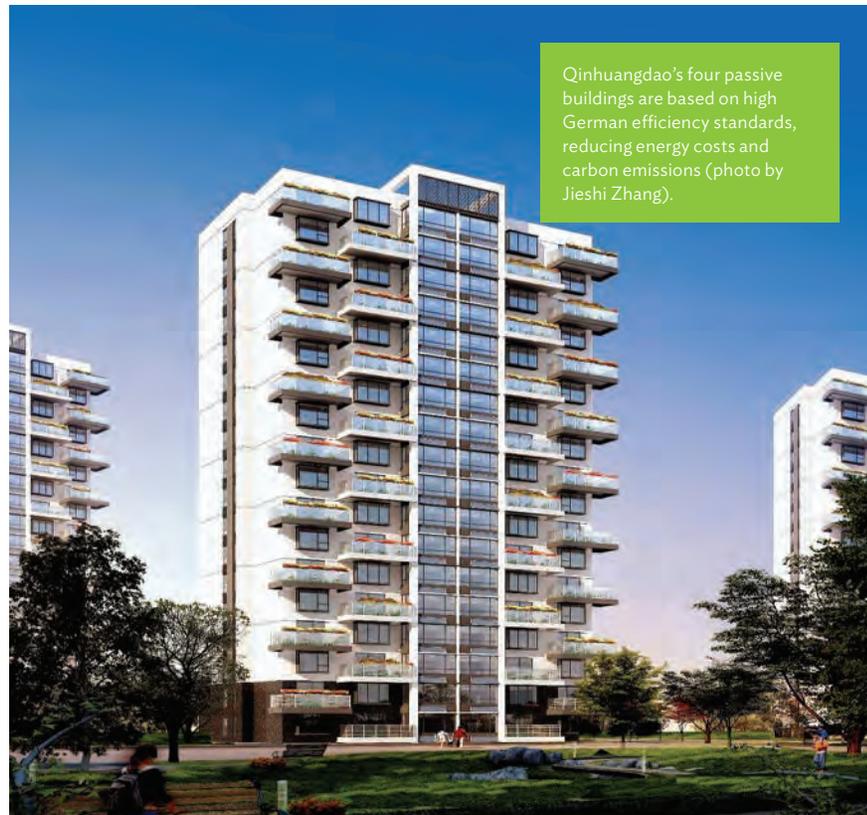
Passive buildings can improve the indoor air quality and reduce PM_{2.5} and dust particles, creating positive co-benefits for human health. Passive buildings also provide better sound insulation, and regulate indoor temperature and moisture levels.

Passive Buildings Deliver Decarbonization and Improve Living Standards

Constructing residential buildings to the highest standards in Qinhuangdao is cutting energy usage to a minimum and, simultaneously, creating better living conditions for residents.

To demonstrate how energy-efficient buildings can be built, Qinhuangdao has constructed four passive buildings totalling 28,050 square meters (m²) in a residential community named “Another Side of the River.” With the help of the German Energy Agency, a range of energy-saving measures have been adopted, including thermal bridge design, heat recovery system, renewable energy, heat insulation, and power-saving devices. By following high German standards, **the ultra-low energy buildings consume 90% less energy than the average building in the People’s Republic of China (PRC).**

The passive buildings have an “A” energy efficiency rating, and the primary energy demand of the building is just 110 kWh per square meter. **The buildings were also constructed to create optimal living conditions for residents**, taking into account the indoor temperature, relative humidity, and noise pollution. Given that buildings in the PRC use an increasingly large proportion of energy, developing passive buildings will be an important tool to reduce energy demand and lower greenhouse gas emissions.



Qinhuangdao’s four passive buildings are based on high German efficiency standards, reducing energy costs and carbon emissions (photo by Jieshi Zhang).

CITY: WUZHONG, Ningxia Hui Autonomous Region

Solar Micro Grids Provide Green Energy and Fight Poverty



↓148K

TONS CO₂ EMISSION WILL BE ANNUALLY REDUCED BY THE INSTALLED 16 VILLAGE-LEVEL PV POWER STATIONS AND 1,700 DISTRIBUTED ROOFTOP SOLAR SYSTEMS FOR HOUSEHOLDS.

 Inhabitants
1,380,000

 GDP per capita
CNY29,853

 Geographic area
20,400 km²

THE CHALLENGE

Wuzhong's economy is dominated by energy-intensive industry and relies on fossil fuels at a great expense to the environment and public health. Several poverty-stricken parts of the city also suffer from regular droughts and resource shortages. This initiative hopes to empower those most vulnerable communities through new sustainable revenue streams.

CO-BENEFITS

Economic

In addition to reducing expenditure on electricity, each household system will bring annual revenues of CNY2,800, while village-level system will generate revenues of CNY200,000 per year.

Environment

To date, approximately 8,565 tons of SO₂ emissions, 4,283 tons of NO₂ emissions, and 77,817 tons of dust emissions have been avoided, thanks to the project.

Social

Hundreds of new jobs have been created in installing and maintaining PV systems across the city.

Villages and households in Wuzhong are benefiting from lower energy bills, and receiving payments for surplus generation, thanks to micro solar energy systems designed to bring people out of poverty.

The City of Wuzhong is taking steps to decarbonize the energy supply and reduce poverty by installing rooftop and micro solar energy systems, **allowing residents to generate electricity for their own use and make money by selling surplus energy back to the grid.** The 'Solar PV+' poverty alleviation project aims to build 74 village-level solar photovoltaic (PV) power stations on land, and 10,000 smaller installations on rooftops. The capacity of power stations on land will be 234 megawatt peak (MWp) and with a further 50 MWp on rooftops.

Operation of the village-level solar PV power stations will bring each village CNY200,000 income annually, improving villagers' living conditions, with **the aim of alleviating poverty for the whole Yanchi County by 2018.** Each household will get a loan to install the rooftop solar system and, after 8 years, will be generating revenues of CNY2,800 annually. The project is part of the city's overall plan to alleviate poverty by 2018, to promote the development of energy diversification, and to speed up the replacement of conventional fossil energy.



284 MWp of solar capacity will be installed as part of the project, with each household earning annual revenues of CNY2,800 (photo by ADB Photo Library).



CITY: HANCHUAN, Hubei

Combining Solar Power and Organic Farming

↓8K

TONS CO₂ EMISSIONS ARE AVOIDED EACH YEAR BECAUSE OF THE INSTALLED 10 MW SOLAR POWER SYSTEM.

Inhabitants
1,100,000

GDP per capita
CNY40,300

Geographic area
1,633 km²

THE CHALLENGE

While solar power generation becomes an increasingly attractive alternative to coal, a great deal of land is needed to scale up generation. In Hanchuan, where farmland is valuable to local livelihoods, the two uses of farming and renewable energy generation have been combined to create a win-win situation for farmers and the environment.

CO-BENEFITS

Economic

By converting arable land to greenhouses with solar roofs, the value of the land is significantly increased, bringing greater economic prosperity to local farmers.

Environment

Besides the 8,000 tons of annual CO₂ emissions avoided, the project also reduces emissions of SO₂ and NO_x, which would have resulted from the combustion of fossil fuels.

Social

The project helped to create employment opportunities for the local people during the construction, operation, and maintenance of PV power generation system and greenhouses. In addition, the greenhouses ensure access to a safe and healthy food source.

Solar panels on greenhouses will not only provide energy to the central grid, but also contribute to growing organic products in Hanchuan in a green symbiosis.

Generating renewable solar energy requires a lot of space, but in Hanchuan there are great pressures on the land for agriculture, housing, and other needs. In a move to combine two land uses, the city has installed PV solar power systems on 42 greenhouse roofs covering 33 hectares (ha) of farmland. **The system delivers 8,841 megawatt-hours (MWh) annually to the national grid and has a lifetime of 25 years.** Organic agricultural products with high value added, such as edible fungus, selenium-enriched tea, and flowers are grown in the greenhouses.

The total installed capacity is 10 megawatts (MW). A local private solar energy firm has provided funds for the construction of the greenhouses and PV power generation system, while subsidies from both the central and Hubei provincial governments bring in CNY0.8 per kilowatt-hour (kWh). Ambitious plans are afoot to increase the capacity by a factor of 10 to a total of 100 MW.



By combining agriculture and energy generation, Hanchuan is making the most out of its valuable land (photo by Hongmin Dong).



↓20M

TONS OF CO₂ EMISSIONS WERE SAVED SINCE 2012 VIA CLEAN ENERGY DEVELOPMENTS.

Inhabitants
9,200,000

GDP per capita
CNY115,959

Geographic area
11,282 km²

THE CHALLENGE

Qingdao's challenge of moving from a coal-based energy strategy to a more sustainable one mirrors the challenge many other PRC cities face. Making use of waste heat from existing sources and investing in energy efficiency will help to reduce reliance on coal and bring down dangerous air pollution levels.

CO-BENEFITS

Economic

Implementing retrofits to old, inefficient buildings alone is estimated to save the city around CNY40 million a year.

Environment

By implementing a clean heating network for the city, Qingdao aims to cut coal consumption by more than three million tons annually, and reduce carbon dioxide emissions by around eight million tons per year.

Social

Hundreds of new jobs have been created in installing and maintaining the renewable energy systems across the city.

CITY: QINGDAO, Shandong

District Heating and Cooling Powered by Air, Ground, and Waste

Qingdao is utilizing waste heat sources to reduce reliance on coal and cut air pollution. Together with ambitious energy efficiency programs and large renewable investments, the city is making strides towards meeting its low-carbon and low-air pollution goals.

Around 9 million people live in the coastal city of Qingdao, which has suffered from high pollution levels, like many other coal-powered cities in the PRC. To combat this and drive investment in green growth, the city is pursuing energy efficiency and clean energy innovations on an enormous scale.

Regulations covering energy efficiency standards in buildings, heating energy consumption limits, and financial incentives have all been put in place to help the city on its low-carbon transition. More than CNY3.65 billion has been invested in renewable energy systems and building retrofits since 2012, more than half of which came from public funds.

Combining energy efficiency with renewable energy investment is not a groundbreaking strategy for reducing emissions, but when it comes to heating, the city is pursuing a truly innovative approach. Qingdao is investing CNY23.2 billion in a clean district heating network covering 180 square kilometers (km²) that will make use of air, ground, and waste-source heat pumps. Waste heat from industry and the sewage system is being mined to reduce the requirement to avoid polluting coal power plants.

The Asian Development Bank (ADB) provided technical assistance and a \$130 million loan for the project.



A sewage heat pump was installed as part of Qingdao's new clean heating network, which will eventually cover 180 km² (photo by Jieshi Zhang).



CITY: QINGDAO, Shandong

Rooftop Solar Energy Cuts Costs and Carbon

↑25

YEARS OF FREE POWER FOR HOUSEHOLDS IN EXCHANGE FOR USE OF THEIR ROOF SPACE.



Inhabitants
9,200,000



GDP per capita
CNY115,959



Geographic area
11,282 km²

THE CHALLENGE

The PRC's reliance on coal for power generation has led to high carbon intensity in the energy system and introduced many health and environmental issues. Through the installation of PV panels on household rooftops, Qingdao is reducing its reliance on coal and improving air quality, while bringing down carbon emissions and energy costs.

CO-BENEFITS



Economic

With a PV system installed on their roof, households avoid buying electricity from the national grid, saving roughly CNY4,000 each year.



Environment

Replacing coal-fired power generation, the project is preventing the annual emission of 83 tons of CO₂, 2.8 tons of SO_x, and 1.4 tons of NO_x.



Health

Fewer particulate emissions means cleaner air and less respiratory problems for the people of Jimo district.

One Qingdao district has become a solar town, with residents receiving free and clean electricity for 25 years in exchange for their roof space, reducing carbon dioxide emissions and improving local air quality.

Jimo district in Qingdao has become the first community in Shandong Province to install a solar power generation system on its underutilized rooftops. With the help of government subsidies, a local solar power company has provided CNY1 million to purchase and install PV panels on 74 residential roofs. Each system is capable of producing 4 kWh a day, twice the average consumption of each property, which means that half the energy produced is sold back to the national electricity grid.

While the company that installed the systems receives the income from electricity sold back to the grid, households are guaranteed free electricity for 25 years in return for use of their roof space. The 108 MWh generated annually through this initiative would require 3,360 tons of coal to produce in a coal-fired power plant. By replacing this coal generation with renewables, 83 metric tons of carbon dioxide (CO₂) emissions are avoided annually, and households in Jimo are not only benefiting from reduced energy costs, but also cleaner air.



Local residents work to install PV panels, which will deliver cost-free power for 25 years (photo by Hongmin Dong).



↑9.7

GIGAWATTS IS THE ANNUAL CAPACITY OF THE BIO-METHANE PRODUCTION FACILITY.

Inhabitants
10,780,000

GDP per capita
CNY54,526

Geographic area
15,800 km²

THE CHALLENGE

Although district heating systems supply around 80% of homes in the northern PRC, there is still a heavy reliance on coal. With more circular design thinking like this, the PRC can reduce enormously coal consumption and associated emissions.

CO-BENEFITS

Economic

The circular design initiatives have helped the plant to generate 25%–30% savings on operational costs.

Environment

The circular design used at the wastewater treatment plant is reducing coal demand by 3,500 tons per year, as well as avoiding the emission of 10,500 tons of CO₂, 27 tons of SO₂, and 23 tons of NO_x.

Health

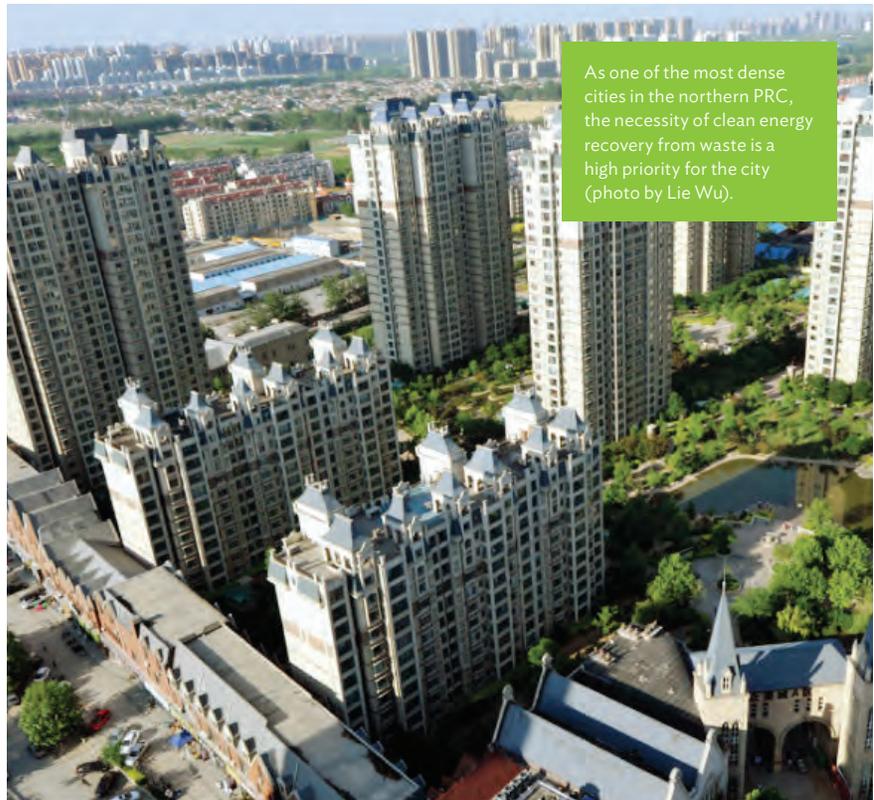
Clean energy initiatives for urban utilities can reduce the risk of water pollution from effluents and solid-residues. Combined with improved air quality as a result of reduced coal use, health threats to local residents are reduced.

CITY: SHIJIAZHUANG, Hebei

Maximizing Energy Recovery at Wastewater Treatment Facility

Shijiazhuang is using circular design principles and energy recovery technology to combine water treatment and district heating, making the most from effluents and excess heat.

The wastewater treatment plant in Shijiazhuang, Hebei's largest city, is starting to close the loop for resource usage, combining the complementary aspects of water treatment and district heating. The facility processes 600,000 cubic meter (m³) of wastewater every day, and collects the naturally occurring methane through an anaerobic digestion process to power the facility's electricity requirements. The plant also uses a novel wastewater heat pump to recover heat from hot industrial wastewater, which is then distributed to over 7,000 homes through a new district heating network. Shijiazhuang's wastewater treatment plant is known for its pioneering approach to sustainable resource use, and was the first in Hebei province to implement a large-scale anaerobic digestion process. Since then, the sustainable capacity has grown and, rather than simply producing methane from the waste, the facility started using its own gas to generate energy for a crucial part of the treatment process.



As one of the most dense cities in the northern PRC, the necessity of clean energy recovery from waste is a high priority for the city (photo by Lie Wu).



↓ 2.5M

TONS OF CO₂ EQUIVALENT EMISSIONS WERE AVERTED OVER THE FIRST 25 YEARS OF OPERATION.

 **Inhabitants**
3,420,000

 **GDP per capita**
CNY30,032

 **Geographic area**
14,176 km²

THE CHALLENGE

The PRC is pushing ahead with a low-carbon future, but engaging the youth and making green attractive are often very difficult. Working with the UN, the panda power plant's design is making it a hub for innovating the renewable energy future of tomorrow.

CO-BENEFITS

Economic

The project is an example of the acceleration of the green economy in Datong, and its novelty features are predicted to bring extra visitors to the area.

Environment

Annually, the panda power plant will reduce CO₂ emissions by 101,376 tons, as well as SO₂ by 1,040 tons and NO_x emissions by 960 tons.

Social

Panda power plant has partnered with the UNDP to become a hub for future climate leaders with summer camps and youth exchanges taking place.

CITY: DATONG, Shanxi

Panda Power: Turning the Sun into Fun

Panda Green Energy in Datong is building a panda-shaped solar power plant covering more than 1 million square meters, fostering innovation and engaging the PRC's youth in clean power generation.

Spotting giant pandas in the PRC just got easier, with the development of a huge 100 MW solar park in the shape of the national animal. Panda Green Energy, the firm behind the project, has used both darker monocrystalline silicon and lighter thin film cells to enhance the panda's visual effect. Both are double-sided panels, 20% more efficient than single-sided alternatives. The plant uses azimuth tracking to capture the most energy possible, technology which can also make the panda appear to wink. The first half of the project went online in June 2017. By completion **the panda power plant will generate enough electricity for over 10,000 homes in Datong City.**

In collaboration with the United Nations Development Programme (UNDP), the panda power plant is becoming a **hub for engaging the youth and innovating low-carbon technologies.** Summer camps, design challenges, and exchange programs are all planned to promote the development of renewable energy. The innovative design has also hailed significant global media attention, and the project has become a beacon for attractive and engaging low-carbon projects.



The solar PV projects make Datong city change from "coal-mining city" to "new energy capital" (photo by Jieshi Zhang).



↓98K

TONS OF CO₂ EMISSIONS WERE EXPECTED TO BE REDUCED IN 2018 UNDER THE PROGRAM.

 Inhabitants
14,040,000

 GDP per capita
CNY145,254

 Geographic area
7,434 km²

THE CHALLENGE

Buildings, particularly those operated by large public institutions, constitute a major part of energy consumption and greenhouse gas emissions in PRC cities. To address these challenges and ensure that future development is energy efficient, Guangzhou mandated that large, energy-guzzling public buildings must undergo energy retrofits to reduce CO₂ emissions.

CO-BENEFITS

Economic

Guangzhou estimates that participating public institutions' electric bills will be cut by about CNY100 million annually with full implementation of the program.

Health

As the goal of this project is significant CO₂ emissions reductions from buildings, the city anticipates corresponding improvements in air quality.

Social

By undertaking these initiatives at major public institutions, visited regularly by thousands of citizens, the project aims to improve public awareness of energy-saving measures.

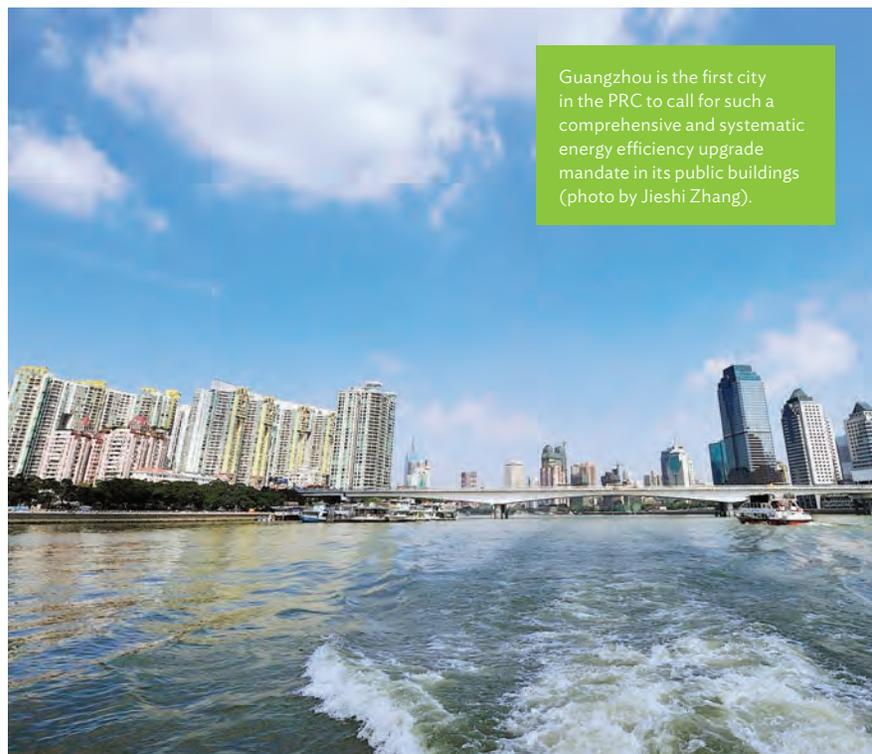
CITY: GUANGZHOU, Guangdong

Public Sector Leading the Charge with Energy Improvements

To cut energy use by one-fifth, large public institutions in Guangzhou were required to conduct energy audits and install efficiency upgrades by the end of 2017.

Guangzhou has instituted a plan requiring large public institutions, such as government agencies, hospitals, schools, and cultural and sports venues, to complete comprehensive energy audits and undertake energy efficiency improvements by the end of 2017. To target the biggest energy consumers, the plan applies to 206 institutions with annual power consumption of at least 1,500 MWh or a gross floor area of 20,000 m², mandating a 20% reduction of energy demand per unit of floor area after improvements are completed.

The plan builds on impressive results from previous years, in which 31 energy efficiency improvement projects implemented at public institutions in Guangzhou cut annual power consumption by 21,000 MWh and reduced CO₂ emissions by 12,000 tons from 2012 to 2015. The intent of requiring energy audits and efficiency improvements for these key energy consumers is to provide examples of green public buildings, and formulate the energy consumption standard for all public institutions in Guangzhou.



Guangzhou is the first city in the PRC to call for such a comprehensive and systematic energy efficiency upgrade mandate in its public buildings (photo by Jieshi Zhang).



↑2.44M

M² HEATED AND COOLED AREA USE HEAT PUMP TECHNOLOGY AFTER PHASE 3 OF THE PROJECT.

Inhabitants
30,480,000

GDP per capita
CNY57,902

Geographic area
82,403 km²

THE CHALLENGE

With some of the longest and hottest summers in the PRC, Chongqing uses a significant amount of energy and water to cool its buildings every year. Air-conditioning units also emit potent greenhouse gases such as hydrofluorocarbons, contributing further to global warming. Smart use of heat pumps in Chongqing is looking to change that.

CO-BENEFITS

Economic

With reduced demand for electricity, heat, and water, approximately CNY2.1 million is saved each year. The 23,070 m² less floor space required are also of value where space is at a premium.

Environment

With less demand for coal-fired power generation, particulate emissions are reduced, as well as noise pollution and water use.

Health

A comfortable temperature for workers helps to improve quality of life, and fewer particulate emissions reduce the risk of respiratory illness.

CITY: CHONGQING

River Water Keeping Chongqing Ice Cool

Workers in Chongqing do not need to break a sweat when it comes to cooling and heating their buildings; a new system uses heat pumps from the Yangtze River and cold temperature storage to deliver a more efficient system.

When designing Chongqing's new Jiangbeizui Central Business District (CBD), developers needed a more energy- and space-efficient way to regulate temperature in its buildings. **Over 1 million m² of buildings are already being cooled in the summer and warmed in the winter using heat pump technology.** With the nearby Yangtze River, the plans are to more than double the capacity in the next phase of construction. Another aspect of the project is the use of ice storage technology. This system works by making ice at night, when electricity demand and price are low, and then dispersing the cold energy during the day, taking strain off the electricity grid and saving costs.

The more efficient system has reduced necessary floor space with 23,070 m² compared with a regular system, freeing up space to create economic value instead. In addition to this, **power requirements have been reduced by 2.62 gigawatt-hours (GWh) annually** in the first two phases of the project, which added to a significant reduction in water demand, resulting in annual savings of CNY2.1 million. The smart system reduces demand for coal-fired power and, therefore, eliminates carbon emissions by 26,000 tons per year, as well as creates a comfortable working environment in Jiangbeizui CBD.



The system uses river water and ice to reduce fossil fuel-based energy demand and ensure good temperature regulation in Jiangbeizui CBD's buildings (photo by Lie Wu).



↓30K

METRIC TONS OF CO₂ EMISSIONS ARE BEING REDUCED ANNUALLY.



Inhabitants
14,040,000



GDP per capita
CNY145,254



Geographic area
7,434 km²

THE CHALLENGE

Guangzhou's fast-growing economy has led to the development of many industrial parks with low environmental standards, with high energy intensity attached to the city's economic growth. By focusing on e-commerce and the mutual development of economy, environmental protection, and social welfare, this industrial park is showing a new way forward.

CO-BENEFITS

Economic

The park's innovative design saves 60,000 metric tons of water and 4,000 MWh of electricity each year, reducing operating costs by approximately CNY6.55 million.

Environment

The park produces very little waste, and reduces energy consumption, bringing down demand for electricity from local coal-fired power stations, and therefore improving air quality and reducing CO₂ emissions.

Social

As well as providing 4,000 local jobs, the industrial park is actively improving employees' awareness of low-carbon development.

CITY: GUANGZHOU, Guangdong

E-Commerce Era Brings Green Growth Opportunities

In Guangzhou, the Zhuangyuangu Low-Carbon Industrial Park is offering companies in the booming e-commerce sector sustainable warehouse and operations facilities that do not cost the earth.

E-commerce in the PRC, worth over CNY5 trillion in 2016, is growing at double the rate of the retail market. As many e-commerce companies look for low-carbon facilities to maximize the sustainability of their operations, the 25 ha premises at Zhuangyuangu Low-Carbon Industrial Park offers a green hub of operations. With big clients including Amazon already on board, the project is employing a holistic approach around the principle of 'smart, low-carbon, and informatization' with a strong focus on better resource use and waste management.

Through the utilization of low-carbon technologies, such as intelligent power generation units, light-emitting diode (LED) lighting, and smart cooling systems, the park is achieving electricity savings of 4,000 MWh annually. To complement this approach, PV panels have been installed on rooftops with the capability of generating 2,250 MWh of renewable solar energy each year, reducing demand from the predominantly coal-based electricity grid. The facility's owners have also taken the chance to educate employees on the park's low-carbon technology, empowering them to take home more sustainable lifestyle choices.



The industrial park has installed 2.3 MWh of solar PV on its spacious roof (photo by Jieshi Zhang).



↓ 270

TONS OF CO₂ EMISSIONS
HAVE BEEN AVOIDED IN JUST
ONE BUILDING.

Inhabitants
21,720,000

GDP per capita
CNY114,590

Geographic area
16,410 km²

THE CHALLENGE

Demands on the coal-powered electricity grid are growing, matching calls for more heating and cooling, leading to high greenhouse gas emissions and particulate matter. Constructing buildings that are cooled and heated in a smarter, more efficient way will help to alleviate this problem.

CO-BENEFITS

Economic

Compared with traditional buildings, this project saved 341 MWh in 2015, corresponding to almost CNY240,000 of avoided expense.

Environmental

The pilot building has achieved 80% energy savings. In addition, the project has also made significant water and material savings, improving environmental standards and comfort.

Health

The pilot building regularly monitors PM_{2.5}, the concentration of volatile organic compounds and CO₂, as well as real-time information on temperature and humidity, ensuring high air quality and safeguarding the health of those who occupy the building.

CITY: BEIJING

Innovative Technology Brings Near Zero Energy Building

Doing away with traditional heating and cooling systems, the latest renewable energy technology has been deployed in a 4,025 m² building in Beijing to achieve an 80% reduction in energy consumption and almost zero emissions.

Many areas in the PRC are hot and humid in summer, but cold and dry in winter, resulting in high energy consumption and CO₂ emissions from heating and cooling buildings. The near-zero-emissions project in Beijing is using the latest technology to explore how to **greatly reduce emissions, while maintaining indoor comfort levels.** The Near-Zero-Energy Consumption Pilot Building by the China Academy of Building Research, a 4,025 m² building with a renewable energy system, has reduced its total energy consumption considerably.

During the cold winters, innovative ground-source heat pumps provide 65% of the heating demand, which can also work to cool the building during summer. PV solar systems power the electrical heat pumps as well as supply much of the power needs throughout the building. **The pilot building shows how to achieve more than 50% emissions savings by implementing innovative technology,** and is a landmark building for the future development of emissions-reducing technology in PRC buildings.



The building roof, with 144 groups of vacuum glass tube middle temperature collectors, provide around a third of the building's annual heating demand (photo by Lie Wu).



CITY: HOHHOT, Inner Mongolia Autonomous Region

Winds of Change for District Heating



EMISSIONS FROM WIND-POWERED DISTRICT HEATING IN HOHHOT.

Inhabitants
2,870,000

GDP per capita
CNY101,428

Geographic area
17,224 km²

THE CHALLENGE

In the north of the PRC, demand for heat soars in the winter, with cities reliant on polluting coal to provide warmth. Meanwhile, the region's significant wind resources are being underutilized. This project aims to demonstrate the potential of wind power to heat homes through district heating networks in Inner Mongolia.

CO-BENEFITS

Economic

This initiative offers the chance to better utilize the 18 GW of installed wind capacity in the region, which is often curtailed by up to 45%, increasing returns on wind investment.

Health

By replacing coal with renewable wind energy, toxic air pollutants that cause respiratory illnesses, particularly when present in the home, are reduced.

Social

Through the project, district heating has been expanded to poverty-stricken areas of the city that have previously lacked access to the cheaper, more efficient heating system.

Hohhot is taking advantage of the region's underutilized wind resources to spread renewable district heating to its residents, cleaning up the city's air, and reducing demand for coal.

During Inner Mongolia's long winter, winds roar down from Siberia and temperatures drop to -40°C. Therefore, for Hohhot's 2.8 million residents, heating is a must, and until now has been provided by burning coal in households and district heating systems. Under a new pilot scheme, **the city is using the region's massive wind resources, which blow the hardest in winter, to power two new 25 MW electric boilers.** The new boilers are feeding into an expanded district heating network, which covers approximately two-thirds of the city.

The region has 18 GW of installed wind capacity, 25% of the national total, but struggles to make use of the resource, with curtailing rates of more than 45%.

Replacing coal with wind energy to heat homes will reduce the thick, toxic smog that often fills Hohhot's cold air, and bring an end to the associated health problems for the city's residents. With national goals to meet 15% of the country's total energy demand with renewables by 2020, this sort of initiative will need to be supported and scaled to a greater extent.

An outstanding feature of the initiative and driver of its **success is a new kind of three-party business model**, creating more advantageous business circumstances for the wind farm, the grid, and the heating company.

ADB provided technical assistance and a \$150 million loan.



The region's 18 GW of installed wind capacity is now helping to heat homes with this pilot project of two 25 MW electric boilers (photo by Jieshi Zhang).



↓108K

TONS OF CO₂ EQUIVALENT
EMISSION WILL BE REDUCED
OVER THE PROJECT'S LIFETIME.

 **Inhabitants**
4,300,000

 **GDP per capita**
CNY32,869

 **Geographic area**
8,837 km²

THE CHALLENGE

The PRC's love for pork comes at a cost to the environment and public health. Pig slurry not only emits vast amounts of methane into the atmosphere, but pollutes water and air, causing issues from high blood pressure to respiratory problems. This project in Hengshui is turning this challenge into an opportunity.

CO-BENEFITS

Economic

Electricity production from the biogas project creates annual revenues of more than CNY5.9 million.

Environment

Removing open lagoons of manure means a reduction in methane and ammonia emissions, and improved soil and water quality.

Health

Better management of manure reduces odors and wastewater, improving the well-being of all those living near pig farms.

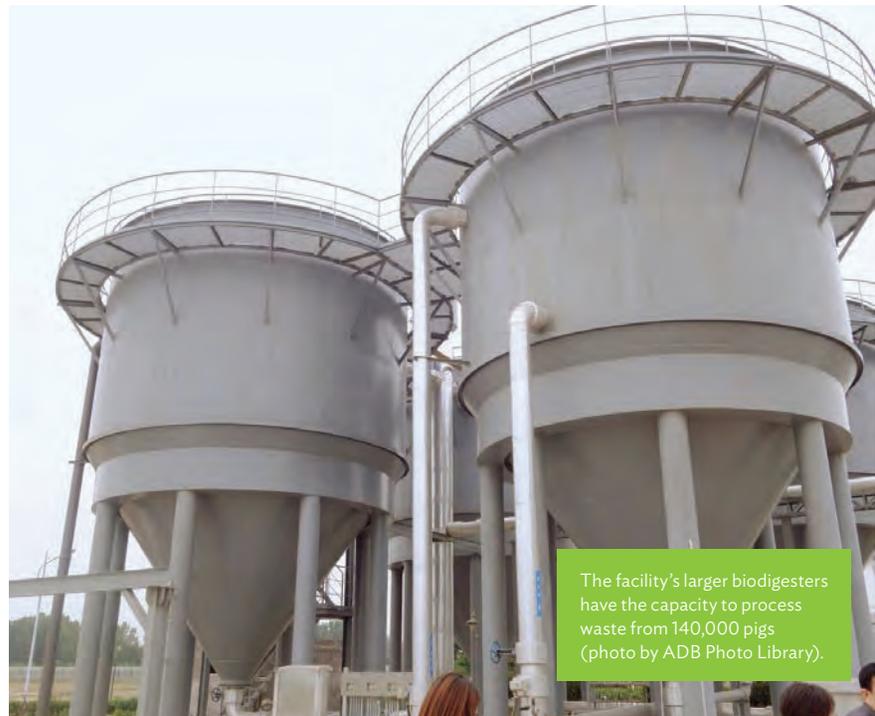
CITY: HENGSHUI, Hebei

Win-Win Scheme Turns Pig Waste into Power

In Hengshui, local farmers are receiving payments for their pig waste and producing electricity using biogas, thereby reducing the need for coal-fired generation.

The PRC has the world's highest per capita pork consumption, but as producers rush to meet demand, waste products from the industry can have detrimental impacts on the environment and public health. In Hengshui, a new facility has the **capacity to treat waste from 140,000 pigs** using four 5,000 m³ anaerobic digesters. The biogas created by this process is then used to generate **8.42 GWh of electricity annually, bringing in revenue of more than CNY 6 million**. Between 2012 and 2015, the project reduced emissions by 108,000 tons of CO₂ equivalent through replacing coal-fired power generation and initiating proper waste processing.

A payment scheme has been developed between the biogas company and local livestock farmers, with those farmers receiving payments for delivering waste of a high solid concentration. **As well as avoiding significant methane emissions, proper processing of manure is improving local air and water quality**, which is of increasing importance as more citizens live in areas close to pig farming. The project is actively helping others to learn from their experience of bringing value to waste products, and three other companies in Hengshui are planning to implement the same measure.



The facility's larger biodigesters have the capacity to process waste from 140,000 pigs (photo by ADB Photo Library).



Pig farms as source of waste for the bio-digesters (photo by ADB Photo Library).



Land Use and Resilience

→ Solutions in the land use and resilience sector are proving that gray cityscapes are a thing of the past. By embracing green and blue spaces, and designing cities in a smarter way, cities can better mitigate against, and adapt to, climate change. The solutions showcased in this sector demonstrate the co-benefits of increased air and water quality, and creation of new recreational spaces for the city's residents and visitors.



DAXING'ANLING

Reforestation Captures Carbon
and Boosts the Economy
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BEIJING

Saplings Sequester Carbon
and Attract Tourists
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JIAOZHOU

Sponge Infrastructure Improves
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XINING

Linking Green Spaces for Cyclists
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SHANGHAI

Innovative Low-Carbon
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CHANGDE

Green Infrastructure to
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SHANGHAI

Redevelopment Incorporates
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NINGBO

Holistic Approach to Water
for Climate Adaptation
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WUHAN

World's Largest Beach Park
Serves as Flood Defense
p. 28



↓1.5M

TONS OF CO₂ WERE SEQUESTERED BETWEEN 2010 AND 2014.

Inhabitants
450,000

GDP per capita
CNY30,800

Geographic area
83,000 km²

THE CHALLENGE

After much of Daxing'anling's vast forest was destroyed by fire, the local forestry bureau did not have the funds to reestablish the forest, resulting in missed carbon uptake and less work in the forestry sector. The new strategy hopes to address this, and bring jobs and environmental benefits to Daxing'anling.

CO-BENEFITS

Economic

The project has created job opportunities for 5,460 people to prepare the land, plant trees, and manage the forest land during project implementation period.

Environment

The reforestation project will increase forest coverage, decrease air pollution, increase biodiversity, enhance the stability of forest ecosystems, and improve soil and water conservation capacity.

Health

The reforestation project will reestablish the forest, which will contribute to improving the air quality for local citizens.

CITY: DAXING'ANLING, Heilongjiang

Reforestation Captures Carbon and Boosts the Economy

Daxing'anling has turned a risk into an opportunity for the environment and citizens, shifting from logging to forest tourism, which improves both carbon sequestration and the local economy.

A major forest fire in Daxing'anling in 1987 destroyed more than 80% of the forest, removed a valuable source of income for local people, and significantly reduced carbon storage. As there was no funding for reforestation activities, the region chose another strategy to reestablish the forest and strengthen the local economy. The strategy involved a shift away from the logging industry to a new focus on tourism. Four forest farms are involved in this project. A total of **39,514 ha of forest were planted between 2010 and 2014.**

Since 2012, reforestation has been eligible for China Certified Emissions Reduction, meaning that **forest carbon sequestration can be sold to offset greenhouse gas emissions** and be traded under the emissions trading schemes in the PRC. With this additional income source for local residents employed in forestry, Daxing'anling's government took the decision to reforest the burned forest land and develop forest tourism, which brings further economic value to the project.



The local forestry bureau has planted trees over a 39,500 ha area and plans to cover a total of 74,500 ha by the end of the project (photo by Hongmin Dong).



CITY: BEIJING

Saplings Sequester Carbon and Attract Tourists

↑307

HA OF LAND HAVE BEEN AFFORESTED UNDER THE PROGRAM.

Inhabitants
21,720,000

GDP per capita
CNY114,590

Geographic area
16,410 km²

THE CHALLENGE

Research suggests that carbon sequestration will have to play a significant role in future climate change strategies. The PRC, as well as being the world's leading carbon emitter, has a history of problems with deforestation and soil erosion, but is now turning that around with afforestation and carbon sequestration projects such as this.

CO-BENEFITS

Economic

For each hectare of land afforested, a government subsidy of CNY22,500 is awarded, with other new revenue streams added for local farmers, such as fruit production.

Environment

Afforestation of the 307 ha has halved soil erosion, reduced ammonia emissions, and, once fully developed, will sequester 2,947 tons of CO₂ each year, in addition to reducing emissions from nitrogen fertilization.

Health

Trees are effective air filters, removing particulate matter that can lead to respiratory diseases as well as having proven benefits for improving mental well-being.

In the outskirts of Beijing, communities are finding new value in old farmland through an afforestation project that sequesters carbon and brings new revenue streams to local residents.

As the country's capital city, Beijing famously struggles with air pollution in its gray landscape. To combat this, the city government is encouraging afforestation as a method to renew the environment in the periphery of the city. One branch of this strategy is taking place in Fangshan district, where old maize and wheat farmland is being converted into forest. The city estimates that the **307 ha of afforested land in this district will sequester 2,947 tons of carbon each year**, with further avoided emissions from reduced nitrogen fertilization. Through participation in the national carbon market, each hectare of afforested land generates government subsidies worth CNY22,500.

The project is also **helping local residents to see the wood from the trees with new revenue streams**. As well as employing over 110 people in the management of the forest, the trees are producing plums, peaches, and other fruits being directly sold to Beijing residents. The project is also bringing in tourists from outside the area who can enjoy the new green surroundings.



The newly planted trees in Fangshan district are improving the quality of life and air in the region (photo by Hongmin Dong).



↓700

TONS OF CO₂ ARE SEQUESTERED ANNUALLY BY GREENING THE CITY.

 **Inhabitants**
5,844,000

 **GDP per capita**
CNY50,572

 **Geographic area**
18,190 km²

THE CHALLENGE

Characterized by many rivers and wetlands, Changde is particularly vulnerable to extreme rainfall. By recreating the natural wetland-ecosystem, the city is now more prepared for extreme events, and has improved the quality of life for its citizens.

CO-BENEFITS

Economic

A more resilient city will reduce emergency expenses and recovery costs associated with landslides and floods, such as infrastructure damage and loss of livelihood.

Environment

The use of wetland and other green infrastructure creates benefits of increased biodiversity, improved air quality, and reduced urban heat effects in the city.

Health

The improvements will all lead to an increasingly active population, through sports and improving the walkability of the city. The green spaces will also help to improve air quality, which will reduce respiratory issues.

CITY: CHANGDE, Hunan

Green Infrastructure to Improve Climate Resiliency

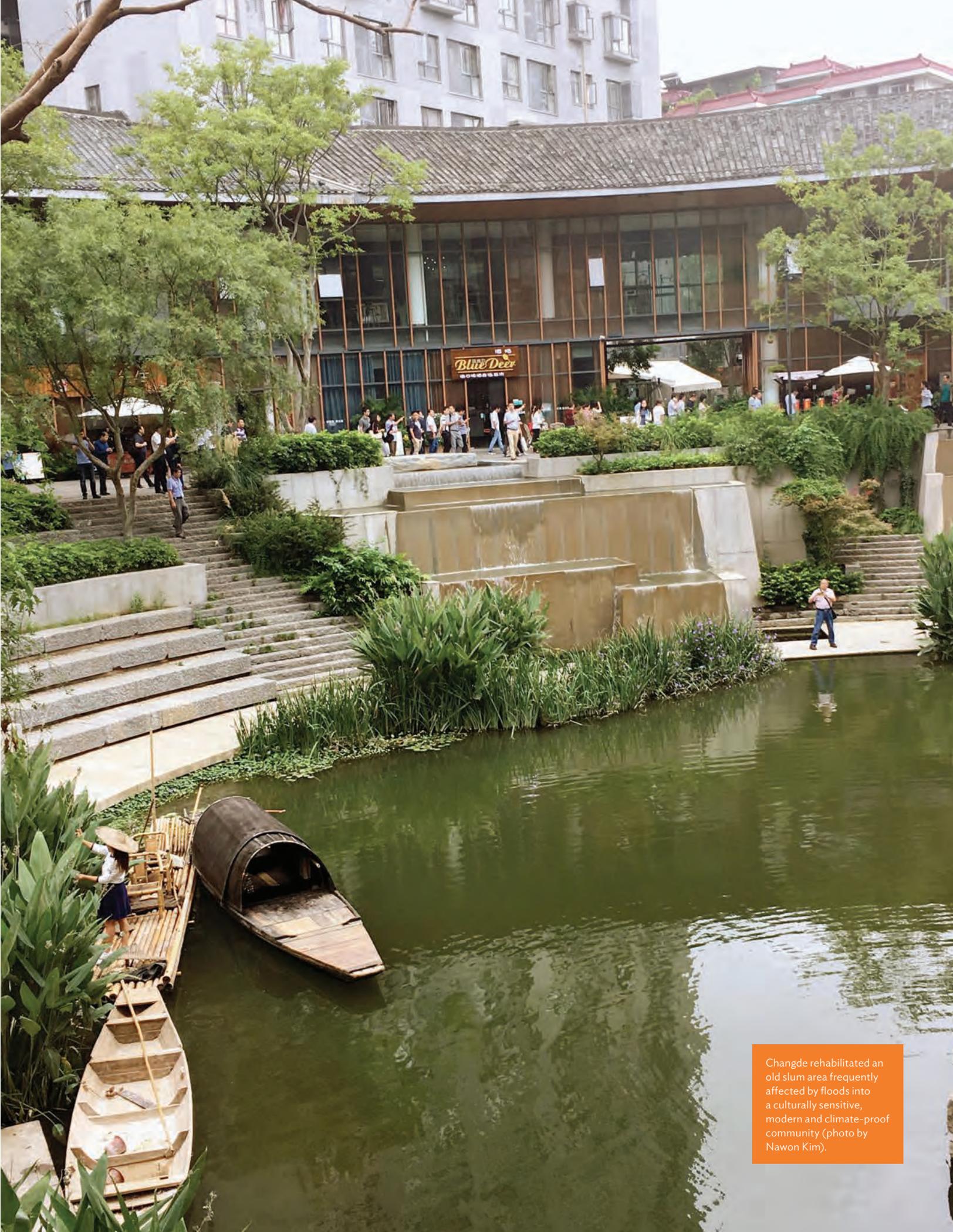
Restoring the extensive river system in Changde increased resilience against future extreme weather events. The ecological adaption project also incorporates new recreational areas and green walkways to the benefit of local residents.

Changde has reclaimed its identity as a river city by restoring the river system that covers more than 17% of the city. Over time, as the city was built up, many of the tributaries were segmented and built over, leaving the city vulnerable to flash flooding. A comprehensive project tackles these direct problems through ecological restoration as well as improving aspects of the riverside life. With a **CNY5.5 billion investment**, **the city has reconnected the tributaries** and, together with other initiatives, including urban dwelling renewal with ecological stream rehabilitation, improved the drainage capacities to make the city more resilient to climate change.

The development also includes **24 recreational sites**, 2 large plazas, 7 sports grounds, and a natural swimming pool, covering a total of 69 ha of green space. The mobility of the citizens was also improved with 22 new pedestrian bridges and green walkways, as well as the reconnected tributaries, which made it possible to use the river as waterway passenger transport. Part of the Sponge City initiative, the project has combined engineering and natural ecosystem service provision to achieve an innovative climate mitigation and adaptation solution.



Changde has climate-proofed the city through integrated ecological engineering (photo by Nawon Kim).



Changde rehabilitated an old slum area frequently affected by floods into a culturally sensitive, modern and climate-proof community (photo by Nawon Kim).



↑ 24%

IMPROVEMENT IN BUILDING ENERGY PERFORMANCE HAS BEEN ACHIEVED ACROSS ALL BUILDINGS IN THE PROJECT.

 **Inhabitants**
24,190,000

 **GDP per capita**
CNY113,719

 **Geographic area**
6,340 km²

THE CHALLENGE

Large international events can leave cities with pockets of underused land and infrastructure. Urban renewal projects can turn these sites into an opportunity for the city, delivering social, economic, and environmental benefits.

CO-BENEFITS

Environment

The redevelopment incorporates sustainable design features, such as water-saving measures, as well as the rehabilitation of native vegetation, and improvement of natural ecosystems.

Health

New access to green spaces, sports grounds, and pedestrian bridges stimulates more physical activities, and the green spaces improve air quality in the neighborhood.

Social

The landscaped gardens, and walking and cycling tracks provide the community with recreational space and sports facilities.

CITY: SHANGHAI

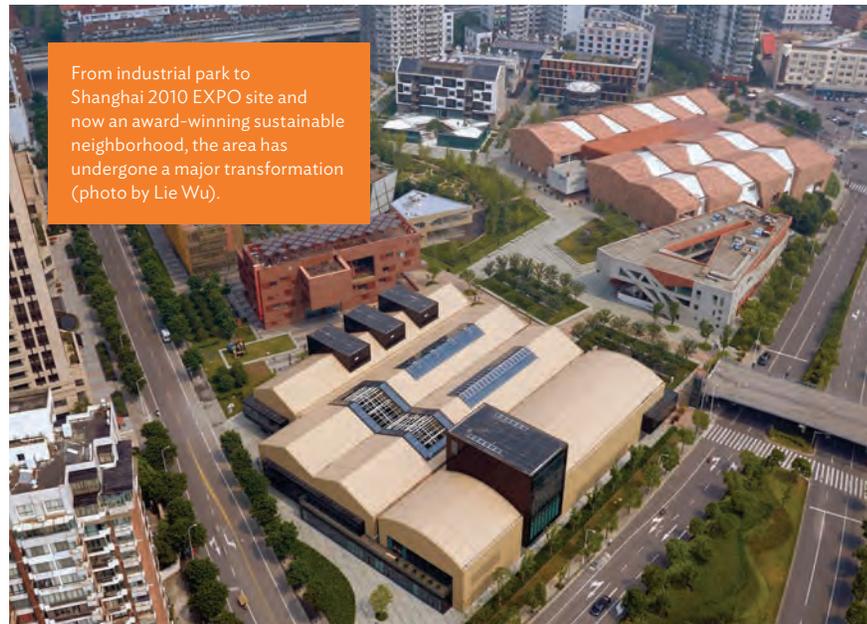
Redevelopment Incorporates Sustainable Design

Shanghai is making the most of existing buildings with the redevelopment of the former Shanghai 2010 EXPO site.

By utilizing urban renewal best practice, green building standards and ecological design will ensure the best sustainability outcomes for the project.

The site from the Shanghai 2010 EXPO is being transformed to provide a sustainable, pedestrian-friendly neighborhood and recreational space for the community. The project has taken a holistic approach to the transformation, with natural ecosystems, green infrastructure, and sustainable building design integrated throughout. Initiatives in the neighborhood include a low-carbon transportation plan to utilize new renewable energy systems, and a water-efficient irrigation system with an interconnected rainwater management system. Two of the three phases of the project are already complete and have received international recognition, with the first Leadership in Energy and Environmental Design (LEED) Platinum level “green” neighborhood design outside North America.

The project involves renewable energy sources and innovative technologies from the Sponge City Technical Guide, making the site able to retain up to 90% of local rainfall events. Water-retention strategies include the provision of green infrastructure and rainwater harvesting systems, resulting in a 59% reduction of the water usage over the site. The integration of old and new buildings and natural ecosystems, combined with convenient access to public transit systems as well as walking and cycling paths, has resulted in the design of a truly sustainable neighborhood.



From industrial park to Shanghai 2010 EXPO site and now an award-winning sustainable neighborhood, the area has undergone a major transformation (photo by Lie Wu).



↑ CNY150M

IN FLOOD PREVENTION BENEFITS PER YEAR.

Inhabitants
893,300

GDP per capita
CNY117,024

Geographic area
1,324 km²

THE CHALLENGE

Flooding and seawater intrusion pose serious threats to Jiaozhou's urban environment. By developing sponge infrastructure, the urban environment is improving and becoming more resilient to climate change.

CO-BENEFITS

Economic

Rainwater harvesting and flood prevention bring economic benefit of CNY150 million per annum after 2021. The sponge infrastructure also creates new markets in carbon sequestration and raw material production.

Health

Prevention of sewer overflow reduces the risk of waterborne disease, while less hard infrastructure reduces air and noise pollution.

Social

Green infrastructure creates new recreational spaces in the city and improves livability for residents.

CITY: JIAOZHOU, QINGDAO, Shandong

Sponge Infrastructure Improves Resilience and Water Security

With careful management of eco-infrastructure, Jiaozhou is transforming into an adaptive and resilient city, with flood protection creating new green spaces and economic benefits.

Jiaozhou City of Qingdao is improving the green infrastructure in the city to better utilize runoff, improve water quality, and create a more livable city. By harvesting rainwater and recycling water in a more intelligent way, it is possible to reduce the problems of water stress. By 2030, the city plans to scale up and **make use of at least 80% of runoff water**, storing it in sponge infrastructure and using it for non-potable demand such as toilets. By incorporating sponge infrastructure, such as retention ponds and permeable surfaces into the city, green infrastructure now makes up almost half of the space in some areas.

Importantly, both flooding and drought resilience have been considered when planning the improved adaptive nature of the city's infrastructure. Dredging and rehabilitating channels, as well as increasing vegetation cover and designating wetland areas, have all improved flood protection in the city, meaning that **a 1 in 10-year flood will now only have an impact every 50 years**. By 2021, these changes are predicted to bring economic benefits of CNY150 million.



Green and blue spaces will be well integrated into new building projects in Jiaozhou (photo by Lie Wu).



↓40%

REDUCTION IN CARBON FOOTPRINT OF WATER TREATMENT FACILITIES UNDER THE RESILIENCY PLAN.

 **Inhabitants**
7,600,000

 **GDP per capita**
CNY108,804

 **Geographic area**
9,816 km²

THE CHALLENGE

Ningbo is a low-lying coastal city on the east coast of the PRC. To adapt to the increased frequency and severity of storms that regional climate models predict, the city is focused on recognizing the interlinked nature of water treatment, and runoff and stormwater management in urban planning.

CO-BENEFITS

Economic

Ningbo's focus on adaptation and flood prevention reduces the financial risks associated with extreme weather events for industry and regional GDP.

Environment

Water-efficient technologies, such as low-pressure membranes and gravity-based water transmission at water treatment plants, are estimated to reduce the operational carbon footprint of the plants by 40%.

Health

Floods affected over 2.5 million people in Ningbo during 2013. The city's Local Resilience Action Plan aims to reduce the negative health effects resulting from such flooding, which will likely increase in frequency and severity.

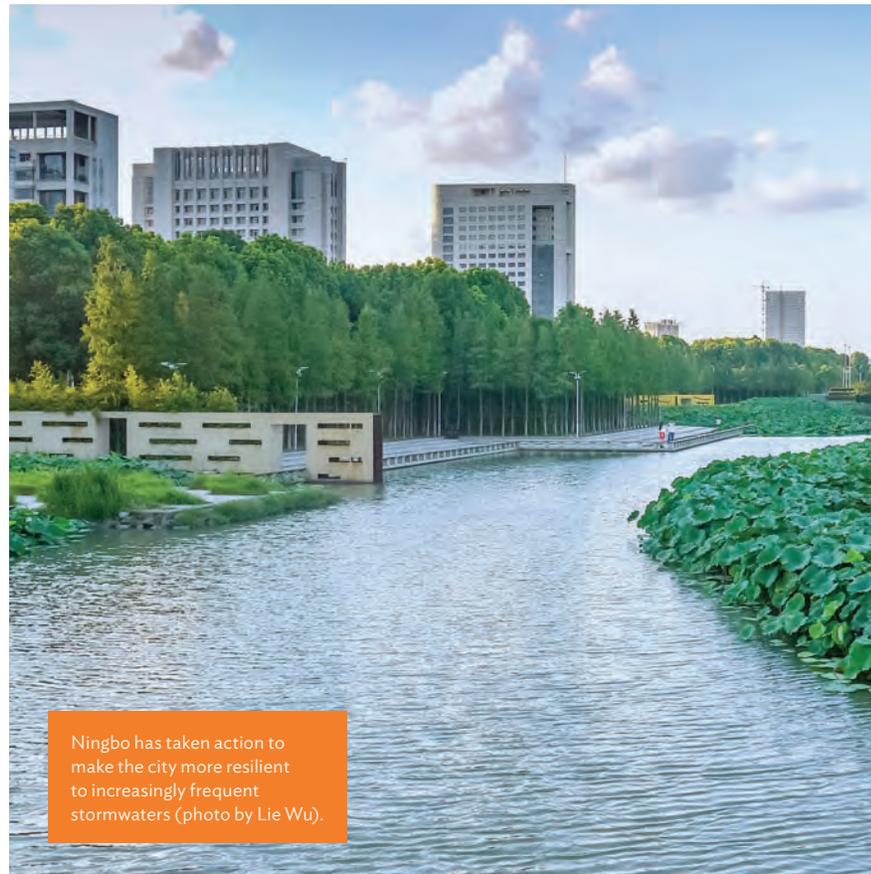
CITY: NINGBO, Zhejiang

Holistic Approach to Water for Climate Adaptation

Ningbo is adapting to climate change risks through a holistic approach to water use, treatment, and drainage.

The city of Ningbo has become an eco-civilization model city for the PRC, through an evidence-based approach to climate change adaptation. Ningbo identified “hot spots” that have the greatest climate change vulnerability, and used climate change scenarios to assess a variety of different adaptation approaches. Finally, **policies with the greatest potential to protect local citizens were selected for implementation.**

At the **heart of the strategy are five water “co-governance” principles** that integrate governance on wastewater treatment, flood prevention, drainage planning, potable water security, and water saving. Low-pressure membrane technologies have been deployed to reduce stormwater runoff, serving to reduce flooding vulnerability as well as filter water before it pollutes the hydrosphere or reaches the treatment facility.



Ningbo has taken action to make the city more resilient to increasingly frequent stormwaters (photo by Lie Wu).



CITY: XINING, Qinghai

Linking Green Spaces for Cyclists

↑350

KM OF CYCLEWAYS
WILL BE BUILT BY 2020.

 **Inhabitants**
2,300,000

 **GDP per capita**
CNY49,400

 **Geographic area**
7,649 km²

THE CHALLENGE

Despite Xining's status as the "cool summer capital" of the PRC, it has some of the worst air quality in the country. A lack of cycle infrastructure and the chaotic roads make cycling an unattractive mode of transport. Xining Greenway aims to change this through designated and pleasant green spaces for cyclists.

CO-BENEFITS

Environment

By encouraging a greater number of cycle journeys, Xining hopes to reduce carbon and particulate emissions in the city, and enhance greener lifestyles for its residents.

Health

Increased mobility has great impacts for public health, and leads to a reduction in lifestyle diseases. The project's green infrastructure will also help to reduce the urban heat island effect.

Social

Xining Greenway is becoming a new leisure and fitness space for citizens of all ages and backgrounds, with many new businesses opening along the cycle paths.

Xining Greenway is linking scenic spots in and around the city with designated cycle paths, with positive benefits for health, air quality, and tourism in the city.

While home to Asia's largest cycling race, the Tour of Qinghai Lake, Xining has struggled to get more of its citizens to use bicycles on a day-to-day basis. With the introduction of a new bike hire scheme and **construction of hundreds of kilometers of cycle greenways**, the city is getting people out of cars and onto two wheels.

Along the banks of the Huangshui River and beyond, Xining city is planting trees and building 350 km of designated cycle lanes that link the city center with scenic spots in the surrounding mountains via green spaces. Xining Greenway has been designed with leisure, tourism, and fitness purposes all in mind, with an underlying "eco-harmonization" approach. The Xining Greenway network is designed to make cycling more accessible to locals and tourists alike, with the help of a cycle hire scheme operated by Changzhou Yongan Hang Cycling Ltd. By replacing car journeys with bike rides, the city hopes to **reduce CO₂ emissions by 12,000 tons annually by 2020**, and improve local air quality.



Xining Greenway makes use of the Huangshui River to create new cycle routes in the city (photo by Shidong Cheng).



↓724

TONS OF CARBON ARE SEQUESTERED ANNUALLY BY VEGETATION IN THE YANGTZE RIVER BEACH PARK.

Inhabitants
10,600,000

GDP per capita
CNY111,469

Geographic area
8,494 km²

THE CHALLENGE

In 2016, Wuhan experienced its worst rain in 18 years, reaching up to 1,087.2 mm in some districts, affecting 1.7 million people and causing almost CNY26.5 billion in damages. The rainfall exceeded 100-year standards of 344 mm, and the flood level reached 1 m higher than the average warning level.

CO-BENEFITS

Economic

Since the completion of the first phase of construction, the value of land in areas surrounding the park has more than doubled.

Environment

In addition to thousands of trees, 325,000 m² of shrubs and 387,000 m² of grass have been planted, improving the regional microclimate and lowering the urban heat island effect, with a drop in temperature of 3°C.

Social

Turning the embankment into a beach with nonpolluted water and a park for recreational activities is enhancing public health and quality of life for city residents.

CITY: WUHAN, Hubei

World's Largest Beach Park Serves as Flood Defense

Wuhan has re-embraced nature to make its city safe from flooding, while also providing the world's largest beach park for the city's nine million citizens to enjoy.

The Chinese megacity, Wuhan, is rehabilitating the embankment of the Yangtze River, as monsoon rains have broken all records in recent years and exposed the city's inadequate flood defenses. Historically, giant dikes lined the river banks, protecting riverside neighborhoods, but during extreme summer rainfall these systems failed. **The city is now dismantling old defenses and instead embracing the natural protection qualities of vegetation.** By modifying the embankment with a gentle slope, the area has now become the Yangtze River Beach Park.

The newly established beach park is more than 7 km long and contains a vegetation buffer strip, 700,000 m² of green park area, including 45,000 trees and rain gardens, which naturally filter polluted runoff water and defend Wuhan from intense storm events. Social perks add further value to the development. So far, 15 km of nonmotorized roads, 7 swimming pools, and 15 football courts cater to the 3.2 million people who have visited the beach park. **A part of the PRC's 13th Five-Year Plan, the beach park is to become the largest urban riverfront park in the world at 10 million m².**



As green areas account for 70% of the Yangtze River Beach Park, the local environment is improved and carbon sequestration increased (photo by Sustainia).



CITY: SHANGHAI

Innovative Low-Carbon Business Development

↑70%

IS THE AVERAGE ENERGY SAVINGS FOR EACH BUILDING IN 'THE HUB.'

 **Inhabitants**
24,190,000

 **GDP per capita**
CNY113,719

 **Geographic area**
6,340 km²

THE CHALLENGE

Buildings in the PRC use 25% of the nation's energy supply and produce 30% of greenhouse gas emissions. To meet the PRC's ambitious emissions reduction goals, buildings will need to be designed in a smarter way to reduce the consumption of energy and water. In Shanghai, The Hub is piloting new sustainable design principles for the future.

CO-BENEFITS

 **Environment**

This office development's innovative design features contain energy-saving measures, water recycling systems, and the integration of recycled materials, contributing to the reduction of carbon emissions and water use in Shanghai's central business district.

 **Health**

The incorporation of natural ventilation, daylight, thermal comfort control systems, and quality lighting improves comfort, and indoor air quality benefits the building occupants.

 **Social**

Green, outdoor spaces are integrated into the design, creating new social spaces for workers and residents alike.

Shanghai is setting the bar for sustainable design with a new 379,000 m² low-carbon business development, showcasing innovative engineering and sustainability features that reduce the facility's carbon footprint.

Hongqiao Tiandi, known as "The Hub," is Shanghai's first low-carbon business development. The whole site is designed to use energy efficiently and from renewable resources; for example, by matching the varied demand for heat and cooling across the development through a smart, integrated network. More than 50% of the whole development has been awarded a three-star China Green Building Label, and the facility has achieved an average energy-saving ratio of over 70%.

In addition to the energy-saving measures, water harvesting and recycling systems provide more than 40% of the water demand, recovering stormwater and condensate from air-conditioning. The design also includes natural ventilation, recycled construction materials, maximized utilization of daylight, and high-efficiency lighting systems. By removing traditional ventilation units, roof space is freed up for social and green space. Since opening in 2015, the facility has attracted sustainable businesses from around Shanghai to get a glimpse into the future of green design.





Waste

→ Cities in the PRC are transforming the concept of waste. This sector showcases how cities are creating new products and clean energy from waste, effectively managing waste collection, limiting food waste, and incentivizing behavioral change among residents. These solutions prove the potential to reduce greenhouse gas emissions from city waste, while providing co-benefits such as reduced air and soil pollution, and fossil fuel consumption.



WUHAI

Smart Route Planning Tool Cuts
Emissions
p. 32



WEIHAI

Turning Waste into Walls
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NINGBO

Changing Attitudes with
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SHANGHAI

Extracting Energy from Sludge Cuts
Coal and Pollution
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CHENGDU

Responsible Recycling of Kitchen
Waste Cuts Emissions
p. 33



WUHAN

Green Haven Rises from
the Ashes of Old Landfill Site
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CITY: WUHAJ, Inner Mongolia Autonomous Region

Smart Route Planning Tool Cuts Emissions

↓27K

LITERS OF FUEL ARE SAVED ANNUALLY, THANKS TO ROUTE OPTIMIZATION.



Inhabitants
558,000



GDP per capita
CNY102,725



Geographic area
2,350 km²

THE CHALLENGE

The urban management department of Wuhai city has been responsible for both the management and operation of the sanitation services in the city, but a lack of investment and personnel was affecting the overall image of the city. Implementing the smart environmental sanitation cloud platform has improved the service level and working conditions for the sanitation workers.

CO-BENEFITS



Economic

Each year, fuel consumption is reduced by 26,907 liters, saving the city CNY139,900 annually.



Environment

More efficient fuel and resource use, enabled through the cloud platform, reduces CO₂ and particulate emissions in the already polluted city of Wuhai.



Social

The project supports more than 1,200 jobs, and substantially improves the working conditions for Wuhai's sanitation workers.

Introducing an intelligence system into the sanitation process allows monitoring, and optimization of the system is reducing the carbon dioxide emissions, while improving the overall performance.

To optimize the work of sanitation vehicles and workers in Wuhai, the city has designed an environment sanitation cloud platform, **linking 194 vehicles to a centralized system**. The smart system gives an overview of vehicle performance and automatically generates optimal route plans for the fleet's waste collection across the city. With optimized vehicle routes, workforce efficiency is improved, and the running time and distances of sanitation vehicles are reduced.

Many stages of the sanitation process are covered by the platform, and data is collected from vehicles and equipment, with industrial, environmental, and consumption data also uploaded to the cloud platform. **Through intelligent data analysis, detailed information is provided on the sanitation process**, waste classification, recycling, and resource distribution to optimize every aspect of the operation. Through implementation of the environment sanitation cloud platform, extensive management of the operation is a thing of the past and, with a standardized workflow in place, the working environment has been improved for the city's sanitation workers.





↑ CNY103M

IS THE REPORTED ECONOMIC BENEFIT FROM THE SCHEME TO DATE.

 **Inhabitants**
15,920,000

 **GDP per capita**
CNY76,960

 **Geographic area**
14,605 km²

THE CHALLENGE

In Chengdu, more than 40,000 catering enterprises produce 1,000 tons of kitchen waste every day, painting just a small piece of the nationwide picture. Most of the waste is directly used for livestock breeding. However, if not properly taken care of, the organic kitchen waste poses a serious health risk as it can pollute the air, soil, and water.

CO-BENEFITS

Economic

The project has disposed 185,000 tons of kitchen waste, and produced 51,400 tons of organic fertilizer, bringing in CNY103 million.

Health

The harmless disposal of kitchen waste ensures safety in the food chain for all residents, while reductions in waste production and vehicle transport are improving air quality.

Social

The project created more than 300 jobs, and with 2,024 food kitchen enterprises participating in the food and garbage collection system, the quality of life in Chengdu city has improved, promoting regional economic and social development.

CITY: CHENGDU, Sichuan

Responsible Recycling of Kitchen Waste Cuts Emissions

Through a public–private partnership, converting organic kitchen waste from Chengdu’s numerous restaurants into fertilizer will cut emissions and ensure a clean and safe city.

In a build–operate–transfer project, the city of Chengdu is tackling the challenge of responsible recycling of everyday kitchen waste. With more than 15 million inhabitants and a status as the gourmet capital, Chengdu produces a large amount of kitchen waste daily. To solve the problem, which causes serious pollution in Chengdu city center, the city government is supporting the construction of a cutting-edge waste treatment plant. The CNY8.9 million project will **convert 200 tons of kitchen waste daily into highly active biological humic acid fertilizer**. The project realizes 100% harmless disposal of organic waste and 95% resource utilization, with no secondary pollution.

To ensure the effective operation of kitchen waste treatment plant, a 10-year franchise agreement has been signed with local contractors, who receive CNY80 per ton of waste collected. To ensure that the waste is collected effectively, the project uses 138 kitchen waste vehicles, 1,980 special containers, and 240,000 dedicated collection bins. **The project will be fully operational by 2018, and aims to collect 300 tons of kitchen waste per day.**



The project produces 100% organic fertilizers, utilizing 95% of the resources with no secondary pollution (photo by Jieshi Zhang).



↑12M

VISITORS TO THE 2015 GARDEN EXPO ON THE OLD LANDFILL SITE.

 **Inhabitants**
10,600,000

 **GDP per capita**
CNY111,469

 **Geographic area**
8,494 km²

THE CHALLENGE

Natural degradation of pollutants from the Jinkou landfill would have taken at least 30 years, and restoration through excavation measures is very costly. To solve the issue, Wuhan restored the landfill and the surrounding environment by using aerobic ecological restoration, thereby ensuring that the land is reutilized for enjoyable purposes.

CO-BENEFITS

Economic

The project saved CNY829 million by using aerobic ecological restoration compared with conventional restoration methods.

Health

Restoring the landfill site ensures reduced air pollution for more than 100,000 people living in close proximity to the landfill.

Social

The new ecological park improves the quality of life for the citizens of Wuhan, and promotes economic and social development in the surrounding areas.

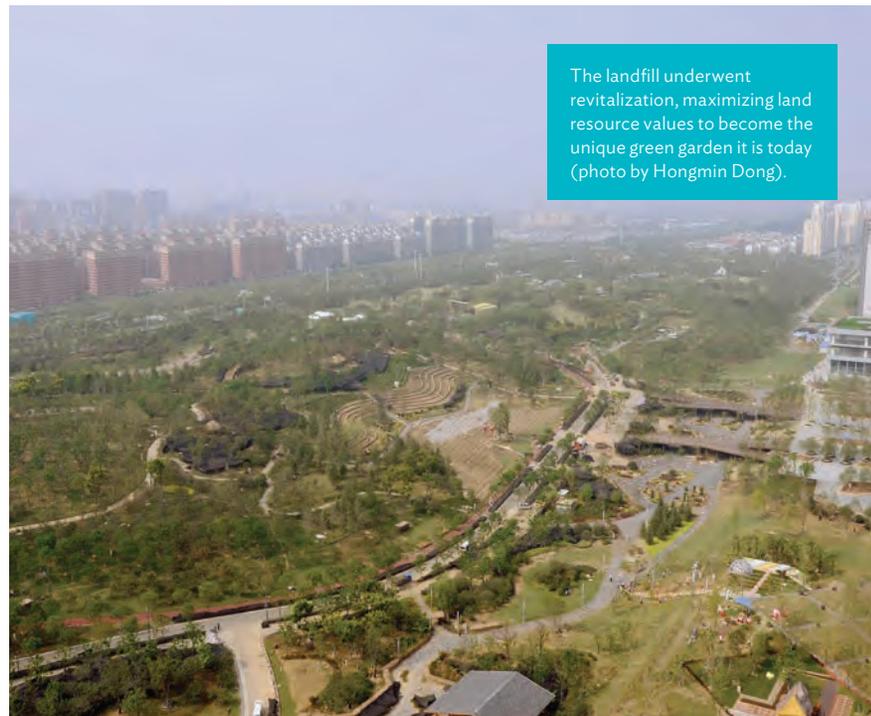
CITY: WUHAN, Hubei

Green Haven Rises from the Ashes of Old Landfill Site

In less than a year, the city of Wuhan has transformed over 50 ha of a closed landfill into a garden for city residents to enjoy, improving life in the city and solving pollution challenges.

The closed Jinkou landfill in Wuhan caused pollution, which natural degradation would have taken decades to remove, affecting not only the environment but also the more than 100,000 residents in nearby areas. To restore this wasteland more efficiently, the city began an aerobic ecological restoration project. Not only does it alleviate risks of long-term safety issues from pollutants and eliminate the threat of methane explosions, this project also restores more than 50 ha of land for city landscaping. Proving that even the **most polluted areas can become ecological havens**, this former landfill site hosted the International Garden Expo in 2015.

The restoration process, which began in 2014, introduced **proper planting techniques, diverse plant species, and measures to improve the soil**, aiming to promote continuity of the fundamental ecological system. The project ties in with Wuhan's general urban planning scheme to improve the quality of the city's ecological environment and enhance sustainable urban development, and eventually become a National Garden City, which is a title the Ministry of Housing and Urban-Rural Development grants to Chinese cities focusing on green, sustainable initiatives.





↓173K

TONS OF CO₂ EQUIVALENT PER YEAR WILL BE SAVED BY THE KITCHEN WASTE TREATMENT FACILITY BY 2019.

 **Inhabitants**
7,600,000

 **GDP per capita**
CNY108,804

 **Geographic area**
9,816 km²

THE CHALLENGE

The PRC produces around 300 million tons of waste per year, the majority of which ends up in landfill or at incineration plants. Ningbo's new strategies aim to reverse this and create an environment that encourages recycling.

CO-BENEFITS

Economic

Increasing recycling rates provides access to cheaper resources, and separating organic waste allows for harvesting of natural gas for energy and heat.

Environment

The project will improve solid waste collection and separation at the household level in six urban districts in Ningbo, reducing the amount of waste sent to the existing landfill and incineration facilities.

Social

Community workshops are designed to educate citizens and improve waste segregation at the source. In 2014–2017, more than 1,750 training sessions have been organized, engaging 108,000 citizens.

CITY: NINGBO, Zhejiang

Changing Attitudes with Improved Waste Management

Embracing circular economy principles, Ningbo is tackling its waste problem head on, with advanced waste separation and recycling, dramatically reducing the amount sent to landfill.

Ningbo is implementing an advanced waste separation, collection, and treatment strategy. The city is incentivizing the separation of municipal waste at the source, before it is collected and either recycled or converted to energy. An anaerobic digestion facility for kitchen waste, through public–private partnership, will be completed in 2018, with **capacity for 30,000 m³ of organic waste per day**. This will harvest natural gas produced from the decomposition process, which can be used for power or heat.

The project links with the national agenda and the 13th Five-Year Plan, which explicitly requires a “sound collection and recycling system” for separated waste, as well as “promoting resource utilization and hazard free treatment of foods and other waste.” Citizens will benefit from **better solid waste management, cleaner environment and living conditions, and improved public health.**



Information campaigns have been held at schools throughout Ningbo to educate pupils about the benefits of waste separation and recycling (photo by Lie Wu).



CITY: WEIHAI, Shandong

Turning Waste into Walls

↑ 65.6M

TONS OF INDUSTRIAL WASTE CAN BE RECYCLED WHEN THE PROJECT IS RUNNING AT FULL CAPACITY.

 **Inhabitants**
2,819,000

 **GDP per capita**
CNY106,922

 **Geographic area**
5,797 km²

THE CHALLENGE

Steel and cement production in the PRC contribute almost 20% of the country's carbon emissions. In Weihai, a new facility is replacing cement in building materials by putting some of the city's 6 million tons of solid industrial waste to use, reducing the amount sent to landfill and improving soil, air, and water pollution.

CO-BENEFITS

Economic

The project used 80,000 tons of waste in 2016, saving approximately 18,000 tons of cement for producing building boards. This resulted in significant savings for purchasing or producing cement.

Environment

This project reduces environmental pollution caused by disposal and storage of solid waste, and could also reduce NO_x, SO₂, and dust emissions caused by cement production.

Social

When the full production capacity of the project is realized, it will provide 2,000 jobs for local residents.

To promote better lifecycle utilization and reduce industrial waste, this project uses industrial solid waste to replace cement in the production of a new type of low-carbon building board for prefabricated buildings.

Since 2014, a local company has been producing building boards for prefabricated buildings from solid waste, with an annual production capacity of 22 million m² in its Weihai factory. In 2016, the factory used about 80,000 tons of solid waste, replacing cement and sandstone to produce building boards totaling 3.76 million m². Up to 70% of waste materials, including paper, styrofoams, and glass, are used to create the new construction materials, which are then processed to form the frameworks and parts for new buildings, leaving only 20% of the construction work to be completed on site. Compared with traditional raw materials for building boards, this initiative saved about 18,000 tons of cement in 2016.

The technology is being developed further, enabling the building boards to be 3D printed at the factory. This will allow 90% of the construction work to take place at the factory. The materials are constructed to be able to withstand earthquakes with a magnitude of 9.0 and are also water- and fireproof.



The factory in Weihai is substituting the greenhouse gas-intensive building materials, cement, and sandstone with waste (photo by Jieshi Zhang).



↓12K

TONS OF CO₂ ABATEMENT IN THE FIRST YEAR OF OPERATION.

 **Inhabitants**
24,190,000

 **GDP per capita**
CNY113,719

 **Geographic area**
6,340 km²

THE CHALLENGE

Sludge, a by-product of wastewater treatment, is a significant and growing problem in the PRC, causing serious water pollution and emitting 11 million tons of carbon each year. Reusing the sludge for energy production and building materials will turn it into an asset.

CO-BENEFITS

Economic

By fully embracing the circular economy, much greater value can be gained from the sludge, estimated to be CNY2.3 million per annum.

Environment

Better sludge management prevents the release of methane to the environment and more coal being burned for energy generation, as well as reducing heavy metal pollution.

Health

Through improved processing of sludge, water quality and odors are controlled, safeguarding the local population's health.

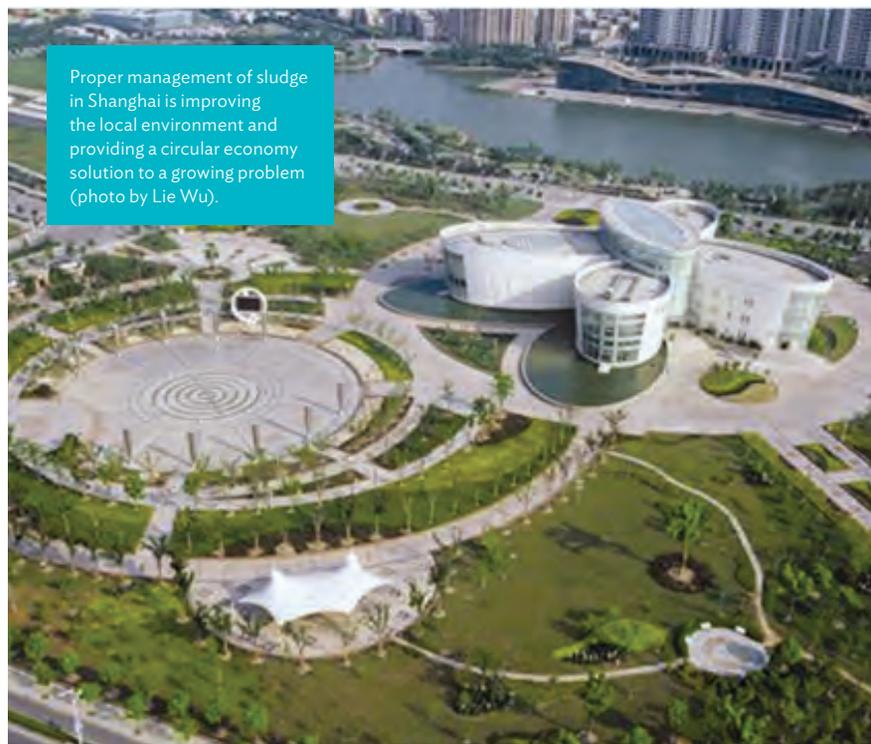
CITY: SHANGHAI

Extracting Energy from Sludge Cuts Coal and Pollution

Shanghai is addressing the problem of sludge with maximizing the circular economy, maximizing financial value, and minimizing environmental damage.

In the western suburbs of Shanghai, Qingpu District is embracing the circular economy to turn sludge into renewable energy and building materials. Under a build-operate-transfer agreement, the Qingpu Sludge Drying Plant has been constructed, with the **capacity to process 200 tons of sludge every day**. While sludge would normally be dumped into landfill, with negative polluting impacts, this project dries the sludge to produce a product that can be burned in a power station to generate electricity.

Creating value from every stage of the process is crucial. Excess heat from the drying process is recycled in the nearby power plant and, after the dried sludge has been burned to generate power, the ash by-product is sold as a building material for use in cement and bricks. **Abating 4,600 tons of coal consumption, the project avoids 11,500 tons of CO₂ emissions each year**, which add to the avoided emissions of not placing the sludge in landfill. The project is part of the national water eco-civilization initiative demonstration program, which aims at sharing knowledge with others.





Climate Action

→ The climate action sector presents a range of cross-sector plans, initiatives, and projects underway in cities to lower carbon footprints and pursue intergenerational social, economic, and environmental results. These solutions underline the value in engaging citizens and taking a holistic approach to climate action.



BEIJING

Residential Communities Creating Change
from the Ground Up
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BEIJING

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QINGDAO

Growing Gross Domestic Product
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SHANGHAI

Ambitious and 100% Compliant
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WUHAN

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Gamifying Green Lifestyles
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WUHAN

Citizens at the Heart of
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Youth Network Engages and Inspires
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with Market-Based Tools
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↓ 8

YEARS AHEAD OF NATIONAL PEAK EMISSIONS TARGETS WITH WUHAN'S ACTION PLAN

Inhabitants
10,600,000

GDP per capita
CNY111,469

Geographic area
8,494 km²

THE CHALLENGE

Wuhan, the largest city in the central PRC, is growing rapidly. Building sustainability into future economic growth plans is a challenge for many cities, and Wuhan is demonstrating how more ambitious strategies can be put in place.

CO-BENEFITS

Economic

Based on the current carbon price, Wuhan will save around CNY2,500 billion by 2022 with carbon emissions reductions.

Health

Reducing emissions associated with polluting transport and coal burning will also improve air quality and save an estimated 50,000 lives by 2022.

Social

Including schools as a main pillar of the low-carbon strategy recognizes the intergenerational nature of climate change, as it is the next generation who need to live radically different lifestyles to achieve carbon emissions reduction goals.

CITY: WUHAN, Hubei

Empowering the Next Generation for Climate Action

Wuhan has set a goal to peak emissions ahead of the PRC targets, and has placed a strong emphasis on education and management of schools to create a generational shift in carbon emissions.

The PRC megacity of Wuhan has committed to reach its carbon emissions peak around 2022. The model-based action plan established yearly carbon emission goals by district and industry across the city, and received inputs from businesses and citizens during the drafting process.

Schools are seen to be a key focus area for Wuhan, which has established a set of low-carbon management and education principles suited for middle and primary schools. This strategy is the first of its kind in the PRC, and will foster awareness of a low-carbon life and society, and help students understand what steps are being taken in response to climate change in their city and why. The city hopes that, with teachers and students as knowledge brokers, awareness among the general public will also increase.



Wuhan is home to more than 10 million people, and faces a huge challenge to decouple growth from carbon emissions (photo by Lie Wu).



↓40M

TONS OF CO₂ EMISSIONS WILL BE REDUCED BY 2020, SLASHING CARBON INTENSITY PER UNIT OF GDP BY 50% FROM 2005 LEVELS.

- Inhabitants**
9,200,000
- GDP per capita**
CNY115,959
- Geographic area**
11,282 km²

THE CHALLENGE

Qingdao is a fast-growing city with a high proportion of manufacturing seeking to pursue further economic growth. The city's new low-carbon plan ensures that Qingdao will not be plagued by air pollution like many neighboring cities.

CO-BENEFITS

Economic

The city has experienced rapid economic growth, yet at the same time cut its carbon intensity, signaling healthy growth and preparing the city to decouple carbon emissions from economic growth in the future.

Environment

The annual average PM2.5 concentration has decreased to around 32%. Likewise, the quality of water and soil has improved.

Health

Morbidity and mortality connected to climate change-related local epidemics have been on the decline. Curbing the growth of carbon emissions can further improve air quality and the well-being of urban residents.

CITY: QINGDAO, Shandong

Growing Gross Domestic Product While Reducing Emissions

Specific reduction targets for each energy-intensive sector will guide the city of Qingdao in achieving its emissions targets, despite experiencing rapid economic growth.

The Qingdao Low-Carbon Development Plan, part of the second batch of the PRC low-carbon pilots, has put forward specific, systematic, and comprehensive actions and policies. The plan, running from 2014 to 2020, includes systems for spatial layout, industry, energy supply, and transportation. **The plan has issued guidance for every department in the city, encouraging the local government to become low-carbon in all operations.** Other PRC cities are expected follow in Qingdao's footsteps to make low-carbon development plans.

Qingdao has established a close connection between its economic development target and mitigation target over the short, medium, and long term. Before 2020, Qingdao will focus on improving energy efficiency and the rationalization of its industrial structure. After 2020, transport and buildings will be the key areas of carbon emissions control. Low-carbon standards in the buildings and transport sectors will be perfected to avoid lock-in effects that could hinder the mitigation efforts. **The city seeks to cut the carbon intensity level per unit of gross domestic product (GDP) by 50% in 2020 from 2005 levels.**



Qingdao's Low-Carbon Development Plan targets the energy and industry sectors in the short term before turning to buildings and transport (photo by Lie Wu).



↑100%

COMPLIANCE OVER
THE PAST 4 YEARS

Inhabitants
24,190,000

GDP per capita
CNY113,719

Geographic area
6,340 km²

THE CHALLENGE

Shanghai's cost of carbon has fluctuated from CNY10.14 to CNY38.38, creating uncertainty in the carbon market, slowing the progress of emissions reductions, but long-running projects like Shanghai's ETS can provide insights into the technical design for the PRC's national policy.

CO-BENEFITS

Economic

Since the initiation of the ETS, a total of 26.7 million emissions allowances have been traded, representing CNY414 million.

Environment

The scheme is estimated to have saved around 300 million tons of CO₂ equivalent since its inception in 2013.

Health

Reducing emissions is also associated with improving air quality—one of Shanghai's greatest health-related problems.

CITY: SHANGHAI

Ambitious and 100% Compliant Emissions Trading Scheme

One of the PRC's earliest market-based Emissions Trading Schemes boasts of impressive success metrics, and is also providing lessons for the other PRC mitigation projects.

Shanghai is the PRC's most populous city and an important financial center for the country. It was in Shanghai where one of the first Emissions Trading Scheme (ETS) pilots was launched in 2013. ETS creates a carbon market where emitters can buy and sell credits that permit them to emit greenhouse gases. It creates an efficient market mechanism and means that companies who can make low-cost reductions in emissions receive a financial incentive to do so. Despite continued population, urbanization, and industrial growth predictions, the PRC has committed to peaking emissions by 2030 and reducing carbon intensity of GDP 60%–65% by 2030.

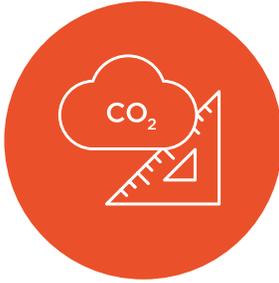
Market-based policy tools like ETS can help the PRC realize its ambition of decoupling growth from emissions.

Around 60% of the city's total emissions are covered by the ETS, which involves over 300 enterprises across a diverse range of sectors. Uniquely, the Shanghai ETS also includes the aviation sector, unlike many other similar schemes around the world. Since its creation, a total of **26.7 million emissions allowances have been traded**, representing CNY414 million.

ADB provided technical assistance for this project.



Shanghai's Emissions Trading Scheme encourages the lowest-cost reductions in greenhouse gas emissions from industry and transport (photo by Lie Wu).



↑1.7K

STUDENTS WERE ATTRACTED TO INTERNATIONAL SUMMITS HELD BY CYCAN.

Inhabitants
14,040,000

GDP per capita
CNY145,254

Geographic area
7,434 km²

THE CHALLENGE

The PRC is the world's leading contributor of greenhouse gas emissions and has suffered from associated side effects of burning fossil fuels, particularly in air quality. But, with an estimated army of 45 million college students, organizations like CYCAN can reshape tomorrow's future with tomorrow's generation.

CO-BENEFITS

Economic

Inspiring future entrepreneurs to focus their innovative efforts on green and clean technology could have untold economic benefits for the world's second largest economy.

Environment

Empowering a generation who have faced some of the worst environmental conditions ever is a potent accelerator of future change for the environment.

Social

Providing a platform for environmentally conscious youth to engage in climate action can open their eyes to future careers influencing the PRC's green transition.

CITY: GUANGZHOU, Guangdong

Youth Network Engages and Inspires Tomorrow's Climate Leaders

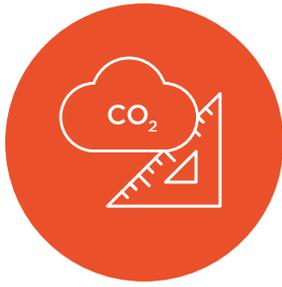
Guangzhou has created an ambitious network of climate action youth leaders to reshape the approach to climate action in the next generation.

The China Youth Climate Action Network (CYCAN) is an active nongovernment organization born out of a desire to inspire and call to action the increasingly concerned and educated Chinese youth, who have been brought up with the worst air quality any generation has seen. The network, associated with the Climate Action Network, works to **raise public awareness on climate change and transition to sustainable energy**, while also engaging and inspiring youth communities in the PRC.

The network has a number of running projects, and is holding its ninth International Youth Summit on Energy and Climate Change, where thousands of students and young people gather to discuss how younger generations can **better react to opportunities and challenges brought about by the green transition**. Other projects include a low-carbon campus project, which aims to empower university students to take control of energy management on their campuses and cut emissions from universities.



The youth networks seeks to inspire and guide green leaders of young generation to take the action on climate change (photo by Lie Wu).



↓5.58M

TONS OF CO₂ EMISSIONS HAVE BEEN AVOIDED AS A RESULT OF THE 483 COMPANIES' EFFORTS IN THE ENERGY STAR SYSTEM.



Inhabitants
10,600,000



GDP per capita
CNY145,000



Geographic area
8,488 km²

THE CHALLENGE

Energy-intensive manufacturing and continued growth of energy consumption make it difficult for Suzhou to control greenhouse gas emissions. The total energy consumption of Suzhou in 2015 was equivalent to almost 50 million tons of coal, with a high proportion of fossil fuel energy sources. Therefore, energy efficiency schemes are important to develop the city in a more sustainable way.

CO-BENEFITS



Economic

In 2011, the first year of implementation of the Energy Star Index scheme, an economic benefit of CNY1.55 billion was achieved, and, in the three following years, a further CNY400 million annually.



Environment

The implementation of the scheme reduces the pollution caused by fly ash, slags, and other industrial solid waste. It also reduces the emission of air pollutants, including sulfur dioxide and nitrogen dioxide, significantly improving air quality.



Social

The project aims to engage citizens at every stage, increasing awareness of the importance and ease of energy savings among the public.

CITY: SUZHOU, Jiangsu

Economic Incentives to Reduce Consumption and Go Green

To reduce energy consumption and carbon dioxide emissions in the heavy industry heart of Suzhou, the city is incentivizing companies to conserve energy through its Energy Star Index scheme.

To reduce energy consumption and carbon dioxide emissions in the heavy industry heart of Suzhou, the city is incentivizing companies to conserve energy through its Energy Star Index scheme. The Energy Star Index system comes with a range of service manuals and industrial energy efficiency standards, all contributing to lowering the energy consumption in the heavy industry-dominated city. **The index system evaluates the overall efficiency of each company annually**, using four categories with nine subitems, including aspects of policy, regulation, energy management systems, technological progress, and energy performance. The purpose is to stimulate the internal transformation to more energy-efficient firms through market mechanisms, promoting the development of energy savings in the PRC.

The Energy Star Index rates companies' energy efficiency performance from one star to five stars, and offers economic rewards of up to CNY200,000 for the highest-achieving firms. Since 2011, **a total of 483 enterprises in Suzhou have been rated as "Energy Star" firms**, with sectors ranging from energy and pharmaceuticals, to textiles and high-tech industries. A total of CNY5.8 billion has been invested to date in energy-saving technologies from these enterprises.



The reduction of air pollutants is beneficial for citizens' health, especially for children and seniors who are particularly vulnerable to respiratory diseases (photo by Jieshi Zhang).



Urban greening design to improve flood control and to provide green space (photo by ADB Photo Library).



↓40%

REDUCTION TARGET IN CARBON INTENSITY BY 2020

 **Inhabitants**
12,000,000

 **GDP per capita**
CNY171,305

 **Geographic area**
2,723 km²

THE CHALLENGE

The PRC has long faced the challenge of decoupling rapid economic growth from greenhouse gas emissions. Market-based schemes such as this provide a financial incentive for companies to reduce their emissions at the lowest possible cost.

CO-BENEFITS

Economic

12 million tons of CO₂ equivalent were traded in the first half of 2017 between all companies on the scheme, representing a total of CNY296 million.

Health

Reducing CO₂ emissions in Shenzhen-based companies not only reduces the climate impact of the PRC city, but also improves air quality for the 12 million citizens.

Social

To involve the local community, the city holds exhibitions, site visits, and promotional campaigns to promote the uptake of a low-carbon lifestyle.

CITY: SHENZHEN, Guangdong

Decoupling Emissions and Growth with Market-Based Tools

One of the PRC's largest cities has implemented an Emissions Trading Scheme (ETS) to bring down carbon intensity in an economically efficient way.

Shenzhen created the first PRC carbon market with functioning trading mechanisms for trading carbon emission allowances between the city's largest companies. This market-based policy is driving down carbon intensity without harming growth prospects for the city. The ETS was first launched as a pilot in 2013, and will become an integrated component of the national emissions reductions program.

The system first sets an overall cap on carbon emissions, after which permits are allocated to companies that emit carbon dioxide. Firms can then trade the permits with other companies through the ETS, giving them the ability to make money from excess permits, or incur costs for emitting too much. This creates financial incentives for companies to reduce their emissions through the most-efficient means possible.

The city plans to have over 1,000 companies participating in the ETS by 2018, and aims to peak emissions by 2022, all the while reducing the carbon intensity of GDP. By 2020, the ETS hopes to have reduced carbon intensity by 40% compared with 2005 levels.



Shenzhen's dramatic growth levels over the past decade have created an immense megacity. Decoupling future growth from emissions is a must for the municipality (photo by Lie Wu).



CITY: ZHONGSHAN, Guangdong

Low-Carbon Collective Inspires and Educates

↑25

PIONEERING FAMILIES HAVE INSTALLED SOLAR SYSTEMS TO INSPIRE COMMUNITY ACTION.

Inhabitants
3,100,000

GDP per capita
CNY102,653

Geographic area
1,784 km²

THE CHALLENGE

While many individuals are aware of the problems caused by climate change, they are unsure of how their actions can be part of the solution. By demonstrating how various low-carbon technologies can be implemented, the Beiqu community is setting the way for green urbanization.

CO-BENEFITS

Environmental

Improved waste management, more green space, and increased renewable energy have led to a cleaner, greener urban environment.

Health

Eating locally grown organic vegetables and breathing cleaner air bring great health benefits to the residents of Beiqu.

Social

Community members are at the heart of this project, with volunteering opportunities and low-carbon lifestyles creating a more harmonious neighborhood.

A community in Zhongshan is implementing a mix of low-carbon technologies to reduce their carbon footprint and inspire other citizens to follow suit.

Beiqu is a community of around 150,000 people within the city of Zhongshan and has been established as a low-carbon community, demonstrating how various technologies can improve the town's livability and reduce residents' carbon footprints. Over 2 MW of PV solar has been installed on rooftops and wasteland, and integrated with charging points for electric vehicles, with low-interest loans provided to residents to install the systems. Other rooftops have been converted into green roofs, sequestering carbon and harvesting rainwater.

Waste management and improved recycling are also being implemented, with food waste converted into compost to fertilize garden plots run by local residents. Beiqu's diverse range of low-carbon measures are showcased in a "low-carbon station" in which technologies are displayed to the public, raising awareness about the newly available technologies. This demonstration area was created by a team of citizens, with the aim of integrating the technologies further into the community. With such a strong educational aspect to this project, Beiqu is keen to share the opportunities that decarbonizing can offer with other communities in the county.



More than 2 MW of PV has been installed in the low-carbon demonstration town (photo by Lie Wu).



CITY: BEIJING

Growing Up: Efficient, Vertical Farming

↓1,680

TONS OF CO₂ EQUIVALENT EMISSIONS ARE SAVED EACH YEAR.

 **Inhabitants**
21,720,000

 **GDP per capita**
CNY114,590

 **Geographic area**
16,410 km²

THE CHALLENGE

Rising demand for food in PRC cities has brought with it a great deal of environmental degradation and a growing reliance on imports. In addition, climate change is revealing the vulnerability of supplies to extreme weather events. Growing food at an efficient and predictable rate, vertical farming hopes to provide a solution to these issues.

CO-BENEFITS

Economic

To grow plants in artificial conditions requires a lot of light, but through the use of LED lighting in the premises, operating costs are reduced by CNY142 million annually.

Environment

Vertical farming reduces fertilizer and pesticide use, as well as soil erosion, high water use, and biodiversity loss.

Social

As well as providing employment opportunities in the local area, the factory has been visited by students and policy makers from across the PRC, serving as a learning platform for future projects.

Beijing is home to the first vertical farm in the PRC, growing mushrooms and vegetables year-round in a space- and energy-efficient way, protected from the impacts of climate change.

As the PRC's population grows and arable land is diminished and polluted, there is growing pressure to meet the food demand of the future generation that increasingly lives in cities. Beijing Nongzhong is offering a vision of the future with its new vertical farm, the first of its kind on the PRC. The three-story factory can produce mushrooms, vegetables, and medicinal plants year-round in a fully controlled, optimal-growth environment. The result is food produced more rapidly and efficiently, protected from droughts and floods.

The facility uses a smart air circulation system to cycle CO₂ produced by fungi on the lower levels to the upper levels, where it increases the photosynthesis rates of vegetables. This reduces the need for chemical fertilizers. Growing food in artificial environments can be expensive, with lighting accounting for up to 80% of operating costs. At the Beijing Nongzhong factory however, the use of LED technology has resulted in an energy saving of 62.5%, saving CNY142 million and 1,680 tons of CO₂ equivalent emissions annually.



Growing food in a highly efficient manner use only a fraction of water and energy compared with conventional agriculture (photo by Hongmin Dong).



↓9.1%

DECREASE IN CO₂ EMISSION PER UNIT OF GDP FROM 2011 TO 2015

Inhabitants
7,870,000

GDP per capita
CNY80,136

Geographic area
11,434 km²

CITY: HEFEI, Anhui

Planning for the Future with Smart Data and Financing

Holistic planning approach to green growth in Hefei is paying dividends, with economic growth and emissions decoupling.

Since receiving the status of a low-carbon pilot city in early 2017, Hefei is putting into action **170 programs to stimulate green growth** beginning in 2018. Worth CNY371 billion, the programs cover seven emerging industries and three traditional sectors, from manufacturing to artificial intelligence. The city will use improved carbon data management and improved financing options to target green building, smart transport, pollution control, among others.

THE CHALLENGE

With a fast-growing population and economic growth, Hefei, like many other PRC cities, faces risks from environmental damage and high energy and resource use. By including carbon as a restraint to economic development, and championing data management, the city is on a track towards more sustainable growth.

The Hefei High Tech Zone is at the heart of the city’s low-carbon ambitions. One example of a smart initiative here is the integrated pipe gallery project, that improves water management in the area. This is one of the many projects that have contributed to Hefei’s recently awarded status as an “adaptive city with resilience.” In this coal-rich region of the PRC, Hefei has been shifting towards renewable energy production, with a 6.4% increase from 2010 to 2015. In addition to this, Hefei’s economic blueprint has placed emphasis on reducing carbon emissions, and **14.4% of the city’s energy consumption is now clean energy, 6.4% higher than in 2010.**

CO-BENEFITS

Economic

Hefei has jumped on the opportunities presented by the low-carbon industry, significantly reducing carbon emissions and energy intensity while increasing GDP.

Environment

Pollution control is central to the retrofitting of traditional industry in Hefei’s strategy, and reduced energy intensity is decreasing the demand for coal-fired power in the region.

Social

The Chao Lake area of the city, which has many struggling communities, is one focus area of the strategy, bringing more sustainable jobs to workers.



Hefei is a pioneer city in promoting seven strategic emerging industries and in retrofitting three pillared traditional sectors: electric appliances, automotive, and machinery (photo by Ant Financial).



CITY: NANPING, Fujian

Low-Carbon Passport Improves Ecotourism

↑10K

LOW-CARBON PASSPORTS TAKEN UP IN THE FIRST 4 MONTHS OF THE SCHEME.

 **Inhabitants**
3,200,000

 **GDP per capita**
CNY55,000

 **Geographic area**
26,300 km²

THE CHALLENGE

In the Wuyi Mountain region, 40% of the GDP can be attributed to the tourism industry, with tourists growing by 12% and associated revenue by 27%. However, most of the tourists come to enjoy the natural environment, which, without careful management, is at risk of being ruined. By encouraging ecotourism, the local scenery can be preserved for future visitors.

CO-BENEFITS

Economic

The tourism industry accounts for 40% of Wuyi Mountain's GDP, and revenues are growing 27% year-on-year. To ensure this growth is sustainable and long-term, it is important to safeguard the local environment.

Environment

The scheme encourages environmentally sustainable behavior, leading to reduced pollution, waste generation, and carbon emissions from the tourism industry.

Social

The tourism industry supports a growing number of jobs in Nanping, which will be safeguarded through sustainable growth in the sector.

Nanping is protecting the beautiful natural environment and encouraging more sustainable tourism through the distribution of a low-carbon passport, with uptake of over 10,000 in the first 4 months.

With millions of tourists visiting the Wuyi Mountains every year to enjoy the beautiful scenery offered by the local ecosystem, it made sense for the local government to encourage environmentally responsible tourism in the area. In December 2015, the low-carbon passport initiative was launched to encourage ecotourism. The scheme offers tourists the opportunity to earn carbon credits on their travels in the region, and receive discounts on entry to various tourist attractions in return. **In the first 4 months of the program, over 10,000 passports were distributed.**

Further measures have also been taken in the region to encourage low-carbon tourism. One such measure is the **introduction of improved green infrastructure and services**, helping to provide more sustainable transport, shopping, hotel, and restaurant options. The local government has also put in place a financing mechanism to implement green measures in the area.



To encourage environmentally responsible tourism in the area, Nanping has issued low-carbon passports to tourists (photo by Lie Wu).



↓205K

TONS OF GREENHOUSE GAS EMISSIONS REDUCED BY THREE INITIATIVES.

Inhabitants
21,720,000

GDP per capita
CNY114,590

Geographic area
16,410 km²

THE CHALLENGE

Residential and industrial buildings contribute to approximately 40% of greenhouse gas emissions in the PRC, and, in recent years, Beijing has made significant strides to address the carbon intensity of industry. The PRC's capital is now focusing on initiatives to reduce emissions from residential buildings.

CO-BENEFITS

Economic

Improving the efficiency of resource use has significant economic benefits, totaling CNY7.7 million annually for three of the low-carbon communities.

Environment

Initiatives that save water and energy, increase recycling, and reduce waste contribute directly and indirectly to a reduction in pollution from low-carbon communities.

Health

Local residents experience a range of health co-benefits. Active transport prevents lifestyle diseases, and expanded green areas improve mental well-being, while cleaner air reduces the risk of respiratory illness.

CITY: BEIJING

Residential Communities Creating Change from the Ground Up

Beijing's low-carbon pilot communities are showcasing the best decarbonization initiatives, engaging citizens in lowering emissions and leading more sustainable lives.

Beijing is complementing its clean industrial growth with new initiatives to decarbonize communities and residential areas. Launched in 2014, the low-carbon communities pilot scheme has been met with enthusiasm by Beijing communities. Projects under the scheme are varied in scale and sector, tackling issues from energy and water consumption to waste management and recycling rates. Implementation of each project is the responsibility of village-level committees, emphasizing the importance of local engagement. Researchers from the Beijing Normal University have been involved in monitoring progress in three of the pilot communities, and have estimated **annual carbon emissions reduction of over 200,000 tons** in these three communities alone.

One example in Minan community is the "Green Kitchen House" project, processing 36 tons of kitchen waste daily. The project treats the organic matter, diverting it from landfill and creating a valuable compost product offered for free to residents. **The scheme has been so successful that several other communities in Beijing are emulating Minan's efforts.** By initiating change from the ground up, city officials are hoping to start a chain reaction of sustainability changes in Beijing's communities.



Rooftop garden in one of the low-carbon communities Beijing is encouraging its citizens to live more sustainably (photo by Hongmin Dong).



CITY: HANGZHOU, Zhejiang

Gamifying Green Lifestyles for 3% of the World

↑ 220M

REGISTERED USERS IN THE 9 MONTHS SINCE THE APP'S CREATION.

Inhabitants
9,180,000

GDP per capita
CNY121,394

Geographic area
16,596 km²

THE CHALLENGE

The PRC is suffering from extreme desertification, and increased temperatures and rainfall as a result of climate change. Ant Forest is providing a bottom-up solution for the masses to take action on mitigation against climate change.

CO-BENEFITS

Environment

The combination of behavior change and tree planting is estimated to be having a combined effect of 5,000 tons of CO₂ emissions reduction per day.

Health

Ant Forest encourages increased active mobility among its users, reducing the likelihood of lifestyle diseases, while afforestation activity improves air quality, reducing respiratory illness.

Social

The gamification of the platform brings fun and competitive aspects leading to a more sustainable lifestyle, mobilizing the masses to make tangible change, pushing the low-carbon revolution.

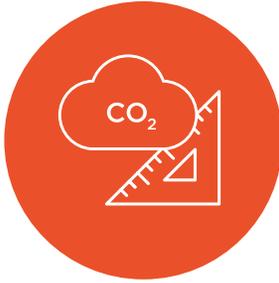
Ant Forest, with more than 220 million registered users, is a digital platform bringing about significant sustainable behavior change, planting millions of trees and bringing low-carbon lifestyles into the 21st century.

The world's most valuable fintech company, Ant Financial, launched its new carbon footprint platform, Ant Forest, **gamifying low-carbon lifestyles and planting millions of trees** in Inner Mongolia. In the platform's first 9 months of operation, it has attracted over 220 million users—almost 3% of the world's population. While the change required to protect our planet is often dictated top-down, Ant Forest harnesses the power of technology to foster behavior change from the bottom up, bringing carbon footprint to people's online profiles for the first time.

Tracking multiple aspects of users' daily lives through integration with Alipay and Alibaba, the app rewards users for sustainable behavior, helping them to grow their "virtual tree" and compete against their friends. Once the "virtual trees" have matured enough, the company will plant a real tree in Inner Mongolia to protect against desertification. By April 2017, **over 8.45 million "virtual trees" had been planted** and real trees are following, thanks to the program, providing significant carbon storage. Ant Forest is an entirely new way of thinking about carbon markets and engaging people, with huge scalable potential.



Over 220 million registered users are using the app to track their carbon footprint (photo by Jieshi Zhang).



CITY: WUHAN, Hubei

Citizens at the Heart of a Low-Carbon Future

↓500K

TONS OF GREENHOUSE GAS EMISSIONS WILL BE REDUCED ANNUALLY IN 2020 IN BAIBUTING DUE TO ITS GEOTHERMAL HEAT PUMP AND SOLAR ENERGY SYSTEM.

 **Inhabitants**
10,600,000

 **GDP per capita**
CNY 111,469

 **Geographic area**
8,494 km²

THE CHALLENGE

Residents of Baibuting live in a very dense area in one of the nation's most populous cities. While the area's space constraints promote mobility, the district needed to improve its energy efficiency as well. Therefore, Wuhan initiated a holistic low-carbon approach to the neighborhood's development that engages residents and incentivizes the uptake of green technologies.

CO-BENEFITS

Economic

By reducing energy consumption and promoting energy conservation in buildings, Baibuting's low-carbon focus is also saving residents money on energy bills.

Environment

The geothermal heat pump and solar energy system have already reduced CO₂ emissions by 300,000 tons annually.

Health

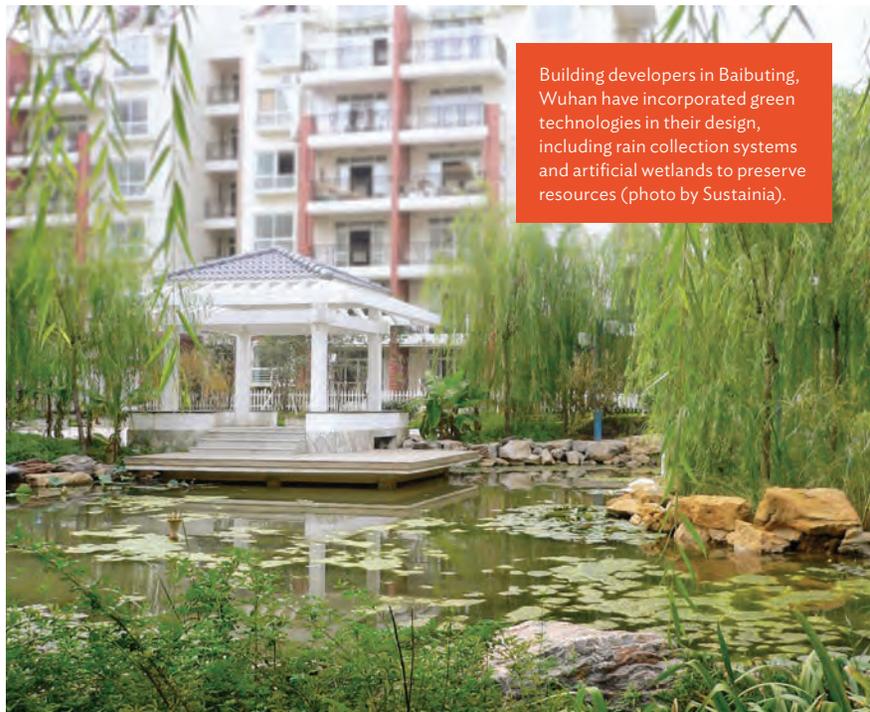
Baibuting's low-carbon transportation projects encourage walking, cycling, and the use of public transit, which will improve residents' health outcomes.

Case provided courtesy of C40 Cities Climate Leadership Group (C40).

By focusing on infrastructure development and community engagement, Baibuting, a densely built community in Wuhan, is successfully integrating a low-carbon philosophy into its strategic development.

As part of Wuhan's Low-Carbon City Pilot Program, Baibuting, a community of 150,000 people living on 5.5 km² area, is infusing a low-carbon philosophy into its strategic development goals. Launched in 2011, some of the main directives guiding Baibuting's development are affordable low-carbon housing, convenient transport, access to green space and essential services, and energy efficiency. According to the area's development strategy, housing construction is encouraged to incorporate **low-carbon and climate-resilient technologies**. So far, developers' investment in renewable energy has yielded a geothermal heat pump heating system and a solar energy water heater system for the community's benefit.

Baibuting's strategy focuses not only on physical improvements, but also on the importance of instilling a low-carbon culture and environmentally responsible habits among residents. With the help of **40,000 volunteers**, almost a third of the population, the Baibuting council helps residents adopt a green lifestyle by, among other initiatives, bringing awareness to power and water savings and clarifying waste separation guidelines.



Building developers in Baibuting, Wuhan have incorporated green technologies in their design, including rain collection systems and artificial wetlands to preserve resources (photo by Sustainia).



Mobility

→ The transport sector highlights how the PRC cities are improving public transport systems, promoting the use of clean-fuel vehicles, and encouraging more active means of transport for citizens. Improving the urban mobility of residents is helping to create healthy, low-carbon, and more livable cities.



BEIJING

Carpooling Tackles
Congestion and Emissions
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BEIJING

Speedy and Comfortable Commute
with Shared Bus Service
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TAIYUAN

Electric Taxis Replace
Traditional Fleet
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HUAI'AN

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YICHANG

Bus Rapid Transit
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CHONGQING

Cleaner Mobility
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SHANGHAI

Buses Go Truly Zero Emission
with Solar Power
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FOSHAN

Zero-Emission
Hydrogen Bus Fleet
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WUHAN

Cycling Scheme Incentivizes
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p. 60



↓698K

TONS OF GREENHOUSE GAS EMISSIONS ARE AVOIDED ANNUALLY BY INCREASED USE OF CARPOOLING.

Inhabitants
21,720,000

GDP per capita
CNY114,590

Geographic area
16,410 km²

THE CHALLENGE

The total number of private cars in Beijing has passed 4.2 million, with an average trip distance of 45 km². Many cars are often only occupied by a single person, making the transport very inefficient in terms of space utilization and greenhouse gas emissions per person.

CO-BENEFITS

Economic
Car pools are contributing to more efficient use of vehicles, while reducing the number of cars on the streets. Benefits include reduced congestion, improved commute times, and savings in operating costs.

Environment
Through more efficient use of car resources, hydrocarbon emissions are reduced by 973 tons and NO_x emissions by 2,432 tons annually.

Social
Carpooling is fostering a wider sharing economy in Beijing, with applications from washing machines to bicycles.

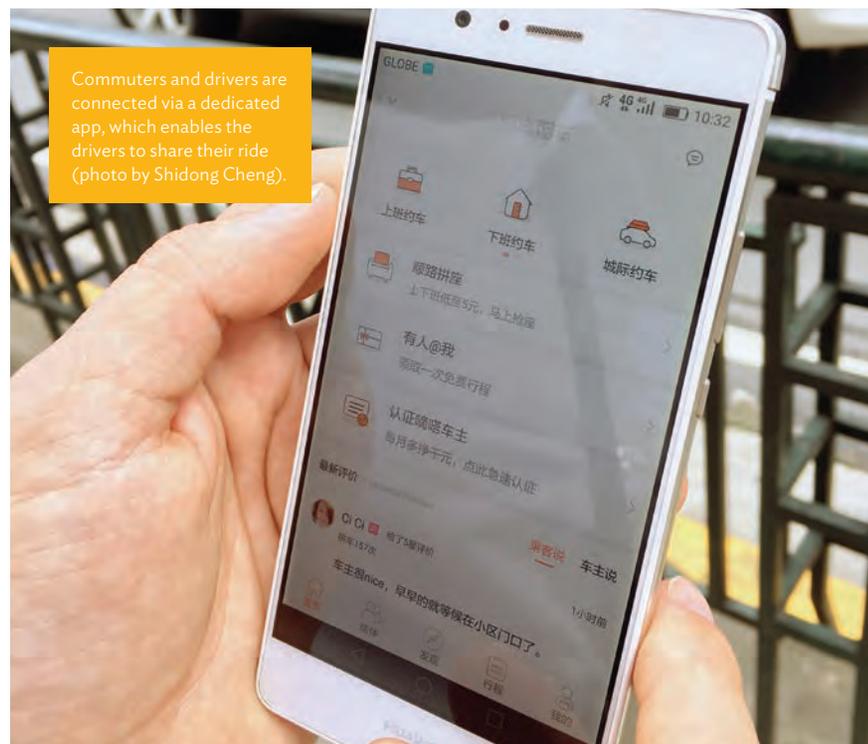
CITY: BEIJING

Carpooling Tackles Congestion and Emissions

Traffic congestion in an urban area with more than 21 million people requires extraordinary solutions. Beijing is embracing app-based carpooling, reducing private car journeys and air pollution.

Beijing is stepping up its efforts to bring mobility to its citizens by promoting more ride-sharing in the city. “Dida Carpool” platform is **the largest people-to-people carpooling platform in the PRC**. Differentiating from other well-known car-sharing platforms, Dida uses commuters as drivers instead of professionals, meaning that the platform is not putting more cars on the road. By connecting drivers with other commuters travelling a similar route, both parties can save time and money, and congestion and air pollution woes are reduced.

Dida’s app uses smart technology to match drivers and passengers, and share the costs of fuel and parking. According to the platform’s creators, **2016 witnessed almost 100 million trips within the city and 10 million intercity trips**, lowering greenhouse gas emissions by reducing private car trips in and around Beijing. The city is encouraging the use of carpooling and has adjusted legislation to support this mode of transport. The platform is rapidly expanding nationwide, with over 60 million users, of which 10 million are car owners.





CITY: TAIYUAN, Shanxi

Electric Taxis Replace Traditional Fleet

↓222K

TONS OF CO₂ WILL BE REDUCED PER YEAR AFTER THE FULL FLEET IS REPLACED.

Inhabitants
4,340,000

GDP per capita
CNY68,234

Geographic area
6,959 km²

THE CHALLENGE

Taiyuan is an industrial city where poor air quality adversely affects the daily lives of its citizens. Vehicle emissions are a big contributor to the poor air quality, accounting for about 16% of PM_{2.5} and 14% of PM₁₀ in the city. Taiyuan's new electric vehicle fleet has reduced tailpipe and CO₂ emission levels, and helped increase investments in the electric vehicle industry.

CO-BENEFITS

Economic

Since the start of the project, taxi operators, in total, have been able to save about CNY11.8 million in operating costs.

Environment

In the eight service years of the vehicles' lifetime, 1.78 million tons of CO₂ emissions will be saved.

Health

Reductions in CO, HC, and NO_x, thanks to the full fleet overhaul, will improve air quality and help reduce the incidence of respiratory diseases.

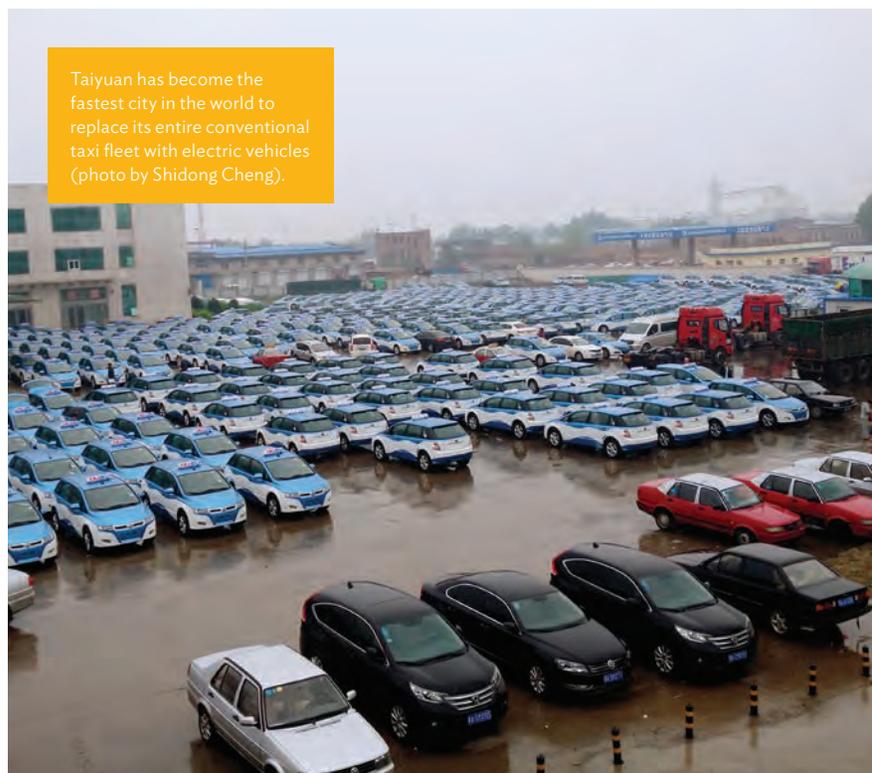
Social

The new electric vehicle fleet has received a significant amount of public support, and citizens have helped to promote the program.

Taiyuan, the largest city in Shanxi province, has moved to cut street-level air pollution by replacing the extensive taxi fleet with iconic new electric vehicles.

Since January 2016, Taiyuan has undertaken one of the world's most extensive electric vehicle overhaul projects. In just 8 months, the city replaced all of its 8,292 taxis with electric vehicles, making it the fastest city to have replaced its entire taxi fleet with electric vehicles. The taxis currently rely on more than 2,000 units of 40-kilowatt (kW) high-power charging outlets for taxi use, and the city will also install 18 towers capable of providing power to 7,200 taxis simultaneously. By June 2016, 8,000 tons of CO₂ emissions were saved thanks to the fleet.

According to national regulations, the city's conventional taxis have to be replaced with new vehicles in 2015 and 2016. Taiyuan took advantage of the deadline to usher in the new electric vehicle fleet. By swapping the internal combustion taxis for their electric counterparts, the city will significantly improve air quality; the municipality estimates reductions of 21,176 tons of CO₂, 2,451 tons of hydrocarbon (HC), and 3,478 tons of nitrogen oxides (NO_x) per year.



Case provided courtesy of C40.



↓4.9K

TONS OF CARBON EMISSIONS WERE REDUCED ANNUALLY BY SHIFTING JOURNEYS TO LOW-CARBON TRAMS.

Inhabitants
5,680,000

GDP per capita
CNY62,400

Geographic area
10,072 km²

THE CHALLENGE

Rapid population growth and increased car ownership have created serious congestion and air pollution problems in Huai'an. By expanding energy-efficient, affordable, and convenient public transport options, the city is minimizing the number of cars on the road and reducing energy demand on the city's coal-fired power stations.

CO-BENEFITS

Economic

The CNY3.7 billion investment in Huai'an's tram infrastructure is expected to boost local GDP by CNY9.7 billion.

Environment

The supercapacitor tram will reduce annual hydrocarbon emissions by 196 tons and NO_x emissions by 490 tons, improving air quality for the city's 5.7 million citizens.

Health

Shifting journeys from private cars to low-carbon trams not only reduces the chance of respiratory illness, but also encourages more active lifestyles in the city.

CITY: HUI'AN, Jiangsu

Supercapacitor Technology Leading the Charge for Public Transport

State-of-the-art battery technology enables electric trams to fully recharge in just 30 seconds. With a 20 km long route, Huai'an has introduced the world's longest-running electric tram powered by supercapacitors.

Huai'an has implemented one of the first electric trams powered by supercapacitors to run on a 20 km route, servicing 23 stops in the busiest area of the city.

Supercapacitor technology has a number of advantages over regular batteries, with a 30-second recharging time and long lifetimes. **Huai'an's trams can run all day every day for up to 10 years, recharging at each stop on the line.** The trams also use energy recovery technology to salvage 85% of the energy generated from braking.

With no need for overhead cables to power the trams, infrastructure and maintenance costs are significantly reduced, and the system is less vulnerable to adverse weather conditions. **The CNY3.7 billion project carried 7 million passengers in 2016,** with about 30% of journeys replacing private car trips, reducing roughly 4,900 tons of CO₂ emissions annually. While many cities are using electric trams and buses, this is one of the first in the world to use supercapacitors for energy storage, and plans are afoot to expand the service even further.



One of the world's first electric trams uses supercapacitors for energy storage, which has been implemented in Huai'an (photo by Shidong Cheng).



↓658

TONS OF GREENHOUSE GAS EMISSIONS REDUCED ANNUALLY DUE TO THE SHIFT TO SHARED BUS USE.



Inhabitants
21,720,000



GDP per capita
CNY114,590



Geographic area
16,410 km²

THE CHALLENGE

Beijing suffers from a lack of public transport capacity, resulting in a low service level for passengers, with long travel times and inadequate space at stations and on buses. As such, many of Beijing's workers rely on the slow subway system or polluting single-occupancy vehicles for their commute; this shared bus system is out to change that.

CO-BENEFITS

Economic

Assuming each shared bus trip could save half an hour, the total time saved per year is 107,500 hours. Based on the 2016 average Beijing income, this time saved is worth approximately CNY3.2 million.

Environment

By reducing the number of single-occupancy car journeys, the shared bus scheme is annually reducing HC emissions by 26 tons and NO_x emissions by 66 tons, according to the company's estimates.

Health

In a city where almost 100,000 people visit hospitals each year for respiratory illnesses, this initiative aims to improve air quality and respiratory health for Beijing's residents.

CITY: BEIJING

Speedy and Comfortable Commute with Shared Bus Service

Public transport in Beijing can be a slow and unpleasant experience, with many people choosing the car instead. To overcome this, private bus operators are now offering a convenient commuter service right to the office door.

In response to the crowded public buses in Beijing, the "Pick Me Technology" offers a higher level of service for daily commuters who are willing to pay a little extra. Founded in 2014, it is now **the biggest internet commuter bus-sharing platform in the PRC, serving 20,000 passengers daily**. The system is operated using privately owned buses that must comply with strict standards before being allowed to operate in the system. Users can either use their public "WeChat" account or the app "Pick Me Technology" to select a route and pay for the ride. The comfortable shared buses provide a nonstop service from residential areas to workplaces, making the commute faster for users.

Although the bus system is privately operated, the city government is encouraging use of the system by providing access to public bus stations and bus lanes. **Thanks to Pick Me Technology's success in Beijing, the bus service now covers several other PRC cities**, including Shanghai, Hangzhou, and Nanjing, operating thousands of routes daily, providing millions of white-collar passengers with a fast, efficient mobility service.



The shared bus service offers a fast, convenient, and comfortable alternative to other modes of transport in Beijing (photo by Shidong Cheng).



CITY: WUHAN, Hubei

Cycling Scheme Incentivizes Carbon Reductions

↓170

TONS OF CARBON WILL BE
REDUCED ANNUALLY BY 2018 WITH
THE BIKE-SHARING PROGRAM.



Inhabitants
10,600,000



GDP per capita
CNY111,469



Geographic area
8,494 km²

THE CHALLENGE

Faced with problems of air pollution and traffic congestion, Wuhan, one of the most populous cities in the central PRC, launched an ambitious bike-sharing project that helps curb growing motor vehicle dependence and related emissions, while also solving last-mile transportation and boosting citizen engagement through the carbon credit system.

CO-BENEFITS

Economic

As the first hour of bike use is free, and most bike trips last less than one hour, users are able to save money on transport.

Environment

Annual CO₂ emissions reduced by the bike-sharing system have reached 25,000 tons.

Health

The bike-sharing program addresses health problems related to vehicle emissions, and encourages the population to participate in a daily fitness activity.

Wuhan unveiled one of the world's largest bike-sharing programs in an effort to solve last-mile transportation, while engaging citizens through a fun and interactive carbon credit system.

Wuhan rolled out one of the world's largest bike-sharing projects, installing 20,000 bikes at 856 stations since 2015. Plans call for **80,000 bicycles and 3,160 stations to be installed citywide by 2018**. The new system is integrated with other modes of public transport in the city to increase connectivity. As a bonus feature, the stations offer charging facilities for electric vehicles, to further promote green transportation. Daily rides have risen from more than 1,000 during the trial period to about 80,000 in May 2016, amounting to 15 million total rides since launching.

A unique component of the system is the **integration of a carbon credit scheme**, through which bike-sharing users' individual CO₂ reduction is calculated based on average riding speed and other factors, and converted into a carbon credit registered to individual users. The credit can be used to purchase small personal commodities and services, such as movie tickets, or used to offset other carbon emissions.



The carbon credit concept enables citizens to know about their individual contribution to carbon emission reduction with every ride (photo by Sustainia).

Case provided courtesy of C40.



Use of smart card system for bicycle sharing (photo by Sustainia).



↓150K

KM OF BUS JOURNEYS PER YEAR ARE POWERED BY THE SOLAR SYSTEM.

Inhabitants
24,190,000

GDP per capita
CNY113,719

Geographic area
6,340 km²

THE CHALLENGE

Shanghai's 18,000 diesel-powered buses consume a huge amount of energy, and emit many harmful toxins, bringing high social, environmental, and economic costs. Harnessing the power of the sun through PVs can provide cheap and clean electricity to charge electric buses, promoting renewable energy and reducing air pollution.

CO-BENEFITS

Economic

Distributed PV generates 20 MWh of green power per year, which according to the current electricity tariff in Shanghai, will save the bus company CNY170,000 annually.

Environment

Using solar power to generate energy substituting fossil fuels, will reduce 6 tons of oxynitride and 160 CO₂ emissions.

Health

Using solar energy to power electric buses reduces vehicle emissions, urban haze, and air pollution, bringing many benefits to human health.

CITY: SHANGHAI

Buses Go Truly Zero Emission with Solar Power

Shanghai is the first city in the PRC to generate power for the city's electric buses using a rooftop PV system on the bus depot, exploring a new model of direct recharging zero emission vehicles.

To run electric buses on renewable energy and achieve 100% emission-free transport, Shanghai has set up the very first solar power project for bus depot in the PRC. The 195 kW rooftop PV system is providing enough energy to recharge six buses at the same time, and the expected annual power generation is up to 20 MWh. The system also provides energy for other purposes at the facility and even feeds electricity back to the grid. Covering nearly 2,000 m², the solar panels have also improved the heat insulation of the roof.

Since 2013, the local bus company has introduced 70 pure electric buses into operation, providing citizens with clean, green mobility. Each electric bus typically travels between 100 km and 120 km a day, consuming 220–230 kWh. The solar power installation will not only benefit the environment, but will also bring economic benefits for the bus company through reduced electricity costs.



The installed rooftop PV system can recharge 6 of the 70 electric buses at the same time, and provide electricity for other purposes at the bus depot (photo by Jieshi Zhang).



CITY: YICHANG, Hubei

Bus Rapid Transit Unlocks Urban Mobility

↑90%

INCREASE IN BUS MODE SHARE
DURING PEAK MORNING TRIPS.

 **Inhabitants**
4,130,000

 **GDP per capita**
CNY89,978

 **Geographic area**
21,227 km²

THE CHALLENGE

Air pollution is estimated to be responsible for around 1.1 million deaths every year in the PRC. Solutions like this in the transport sector can help to decrease this figure.

CO-BENEFITS

Economic

The economic benefits of the BRT project include reduced congestion, improved commute times, fewer road accidents, and savings to vehicle operating costs.

Health

Taking cars off the road contributes to reduced particulate and NO_x emissions—the primary contributors to respiratory illnesses.

Social

Following consumer surveys, female passengers felt the BRT offered them additional security at the stations compared with previous bus stops, and commuters rated the conditions inside the buses highly.

Yichang's new bus rapid transit (BRT) system is offering an efficient and accessible means of transport for citizens, improving urban mobility and air quality.

Rapid urbanization, economic growth, and rising private vehicle ownership have led to extreme congestion on the roads of Yichang, Hubei's second largest conurbation. To remedy this, the city has introduced a new BRT system and a bypass route for freight. Providing citizens with a **24 km green public transport corridor offers a cheaper and more efficient means of urban mobility** for those previously stuck in private cars. It also connects the main residential areas with other modes of transport, including the high-speed railway.

Prior to the implementation of the BRT, more than three quarters of all trips were taken by means of private transport. Over the 3 months following the BRT's opening in Yichang city, **car mode share dropped from 40% to 30% and bus mode share nearly doubled**, increasing from 18% to 34% of morning peak trips. Bus waiting times have been reduced from 13 minutes before BRT to an average of 6 minutes in BRT locations.

ADB provided a \$150 million loan to the municipal government for this project.



Yichang's dedicated bus lanes reduce air pollution from private fossil-fuel consuming vehicles (photo by ADB Photo Library).



CITY: FOSHAN, Guangdong

Zero-Emission Hydrogen Bus Fleet

↑160

TONS OF CARBON EMISSIONS ARE REDUCED ANNUALLY THROUGH THE INITIATIVE.



Inhabitants
7,460,000



GDP per capita
CNY116,141



Geographic area
3,875 km²

THE CHALLENGE

Like many other cities in Guangdong province, Foshan suffers from suffocating air pollution and, in 2016, there were an average of 29 hazy days across the region. Schemes like this are helping to improve the situation, and are already having a positive effect, as air quality in 2016 was the cleanest since 1989.

CO-BENEFITS



Economic

Converting buses in the fleet to fuel-cell vehicles involved localized commercial production of fuel cells, including a local fuel-cell bus manufacturing facility, stimulating the local economy.



Health

Zero tailpipe emissions from hydrogen buses greatly helps with air pollution in the city, the majority of which is caused by polluting diesel vehicles.



Social

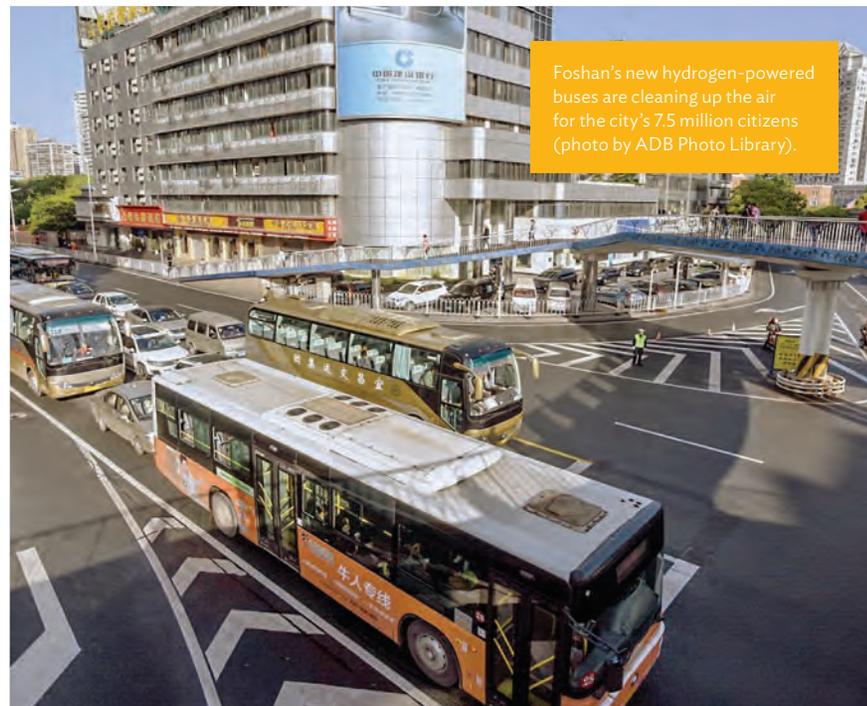
The new bus fleet has been praised as providing outstanding passenger comfort.

The new hydrogen-powered bus fleet in Foshan is a product of years of collaboration and innovation between government departments, and offers a breath of fresh air for citizens on the move.

Foshan is a large, manufacturing city in Guangdong province, with a bus fleet that has been converted to zero emissions—the product of hydrogen fuel cells. It follows a 10-year collaborative initiative between the National Reform and Development Commission, the Ministry of Finance, the Ministry of Science and Technology, and international agencies to develop and commercialize fuel-cell vehicles in the PRC. Entering the third phase and supported by a national hydrogen fuel cell subsidy scheme, Foshan received 12 fuel-cell buses to pilot the innovative technology.

The fleet will eventually contain 330 buses that are 11 m long, each with a capacity of around 80 people.

The buses convert tanks of hydrogen to gas and electricity, used to power the vehicles, producing only water vapor and oxygen as waste products. With a short recharging time and 300 km range, the buses provide an effective alternative to electric vehicles and traditional fossil-fuel vehicles. The city is now planning to replicate the technology in a light rail project, expected to be deployed later this year, bringing economic benefits for the bus company through reduced electricity costs.





CITY: CHONGQING

Cleaner Mobility through Car Sharing

↓3.8K

TONS OF CO₂ EMISSIONS ARE REDUCED ANNUALLY BY REPLACING PRIVATE CAR TRIPS.

 **Inhabitants**
30,480,000

 **GDP per capita**
CNY57,902

 **Geographic area**
82,403 km²

THE CHALLENGE

Chongqing is challenged by heavy congestion, caused by the fact that the population density is particularly high in the core area as a result of the hilly topographical conditions. The fast-growing city is experiencing an increase in mobility demand and rapid private motorization, which the city is now seeking to reduce with a car-sharing system.

CO-BENEFITS

Economic

Sharing cars will reduce the difficulties in finding a parking space and, according to the operators, will save the citizens 273,750 hours per year, freeing up time to be used for either work or leisure.

Environment

Efficient car-sharing schemes can reduce car ownership. This will reduce the environmental impacts caused by car production and free up space previously used for car parking.

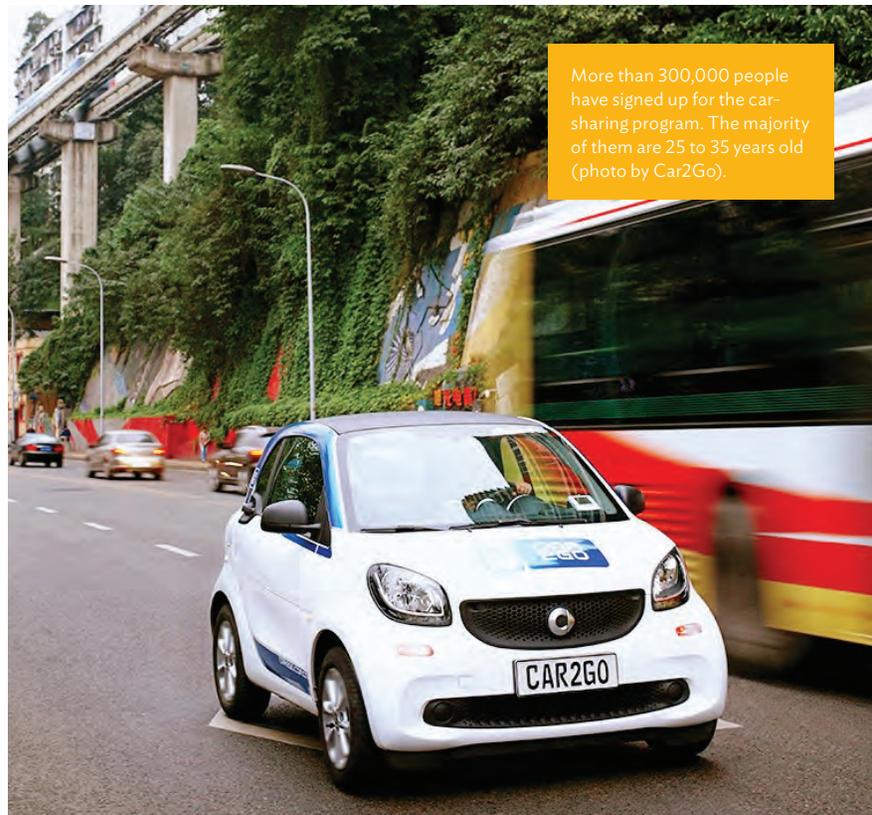
Health

Car sharing in Chongqing could reduce the annual HC emissions by 154 tons and NO_x emissions by 383 tons, thereby improving air quality in the city.

A new car-sharing system allows citizens to move around more easily, cuts greenhouse gas emissions, and alleviates heavy congestion that plagues Chongqing's streets.

Together with an international car manufacturer, Chongqing has rolled out the eco-friendly car-sharing system Car2Go. The system is free floating, with no fixed rental location, and is the first of its kind in Asia. Currently, **there are more than 300,000 registered users of the system**, mainly young people, and the 600 Car2Go shared vehicles help to reduce the car ownership in the city. The system allows the user to unlock the cars using an app and, upon arrival at their destination, they can park the car either in a public parking place or in one of the designated Car2Go parking spots.

For a fixed price per minute and kilometers driven, citizens can enjoy improved mobility in the mountainous city. The vast majority of the cars in the system are small, fuel-efficient cars, which use **approximately 50% less fuel than ordinary private vehicles**, reducing the fuel consumption and greenhouse gas emissions.



→ Sourcing Climate Solutions in Chinese Cities

This publication has come to life as a result of a multi-step process involving the Asian Development Bank (ADB), Sustainia, and on-the-ground sustainability experts from the People's Republic of China (PRC).

Finding the solutions:

Local consultants with expertise in sustainable urban development completed initial research on city projects and solutions. With guidance from ADB and Sustainia, the local experts then gathered information and data on the solutions from across the PRC to aid the assessment and selection process.

Assessing and selecting the solutions:

Once solutions had been submitted, ADB's urban experts assessed each case based on the four selection criteria. With guidance from Sustainia, the solutions that best met the criteria were put forward to be featured in the final 50. In addition, some solutions were sourced from the Cities100 publications¹ that Sustainia has created in partnership with C40 and Realdania.

Writing notes:

The administrative city boundary was considered in this publication, which contains both urban and semi-urban areas.

All city data (GDP, area, and inhabitants) are based on 2016 statistics and sourced from:

Beijing Municipal Bureau of Statistics, Changde Municipal Bureau of Statistics, Chengdu Bureau of Statistics, Chongqing Statistics, Datong Municipal Bureau of Statistics, Daxing'anling Statistics Bureau, Foshan Municipal Statistics Bureau, and own research.

HOW DID WE ASSESS THEM?

Each case has been assessed on the following four criteria:

1

CLIMATE ACTION

The expected or achieved CO₂ reduction and/or climate risk mitigation of the project.

2

CO-BENEFITS

The extent to which the project has positive co-benefits (economic, environmental, health, and social) in addition to its climate change mitigation and CO₂ reductions.

3

INNOVATION

The extent to which the project takes an entirely new or groundbreaking approach to address major environmental issues.

4

GOVERNANCE

How well the project collaborates with other entities in the city, engages citizens, and plans to scale the case.

¹ Sustainia, C40, and Realdania. 2016 and 2017. *Cities100*.

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50 Climate Solutions from Cities in the People’s Republic of China *Best Practices from Cities Taking Action on Climate Change*

This publication showcases 50 innovative case studies from cities in the People’s Republic of China that are mitigating against and adapting to climate change. Solutions being implemented in these cities are proving that reducing carbon dioxide emissions and protecting the environment need not sacrifice economic prosperity. This publication is an initiative of the Asian Development Bank to support efforts of the People’s Republic of China to address climate change and showcase innovations in low-carbon city development. The sharing of these examples could inspire other cities and drive further innovation.

About the Asian Development Bank

ADB is committed to achieving a prosperous, inclusive, resilient, and sustainable Asia and the Pacific, while sustaining its efforts to eradicate extreme poverty. Established in 1966, it is owned by 67 members—48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

