Beijing

Two steps to a world city.

Beijing City Ambitions Report

AECOM Global Cities Institute

This is a publication of the

AECOM
GLOBAL
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INSTITUTE

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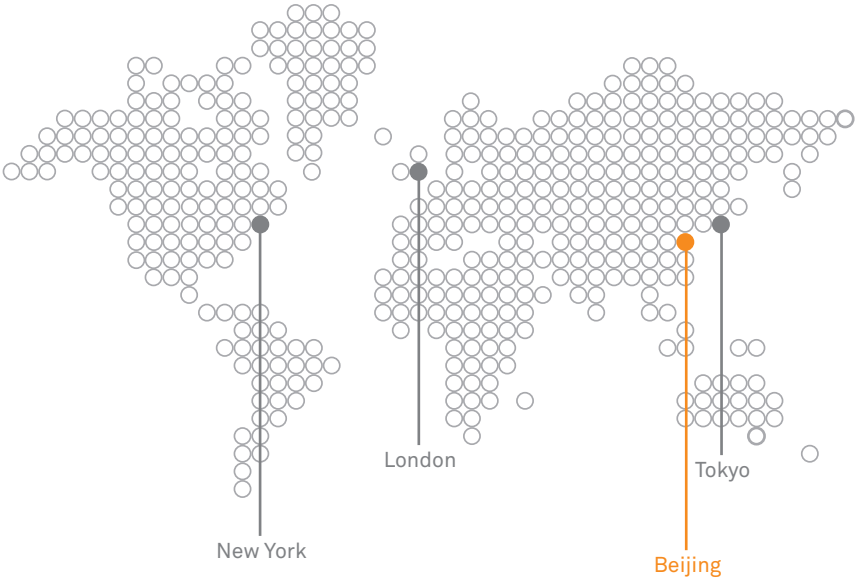
In preparing this city ambitions report, the AECOM Global Cities Institute has partnered closely with the Beijing Municipal Institute of City Planning and Design (BMICPD), which is affiliated with the Beijing Municipal Commission of Urban Planning. BMICPD is one of the key organizations that provide advice to the Beijing municipal government on issues related to urban development and construction.

A kickoff forum in Beijing on July 20-21, 2010, brought together experts from the AECOM Global Cities Institute and BMICPD and formed the basis for the development of four joint committees to focus on key areas of interest to Beijing: transportation, municipal infrastructure, waterfront development, and energy. These four committees met regularly over the following eight months to exchange ideas and identify key issues and opportunities.

The results from this reframing process were presented at a Leaders Forum on February 24-25, 2011 in Beijing, where experts from government, academia, and private industry were invited to provide insights and feedback. This report builds upon the prior work conducted by the joint BMICPD /AECOM committees and the feedback obtained from the Leaders Forum.

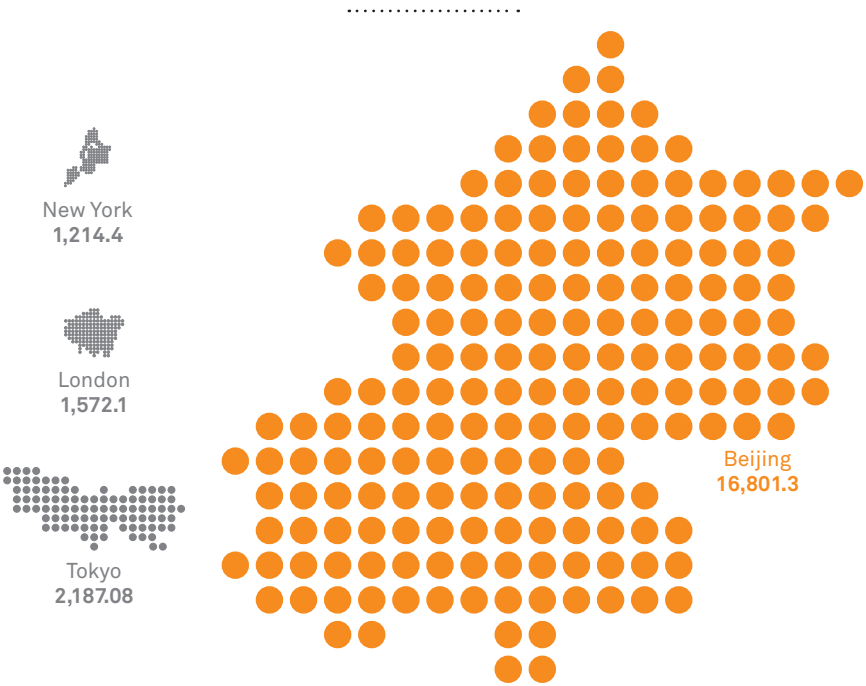
Beijing City Ambitions Report

How does Beijing stack up with other world cities?



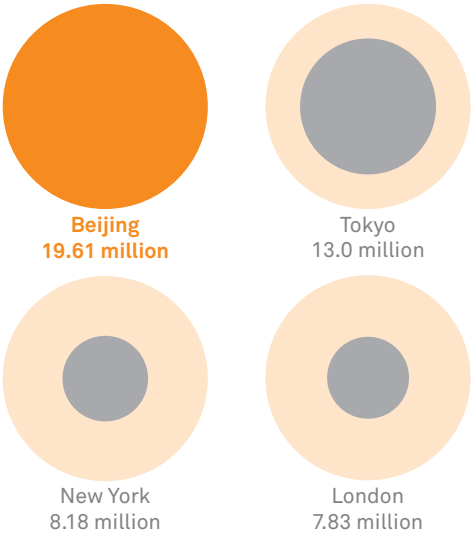
Beijing
in the context of today's 'world cities'

Beijing is a large place.



Surface area of municipality jurisdiction
in km²

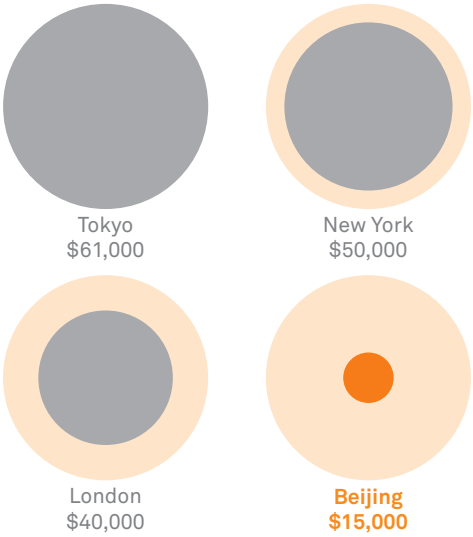
Beijing has more people...



Population
residents living within each municipality.*

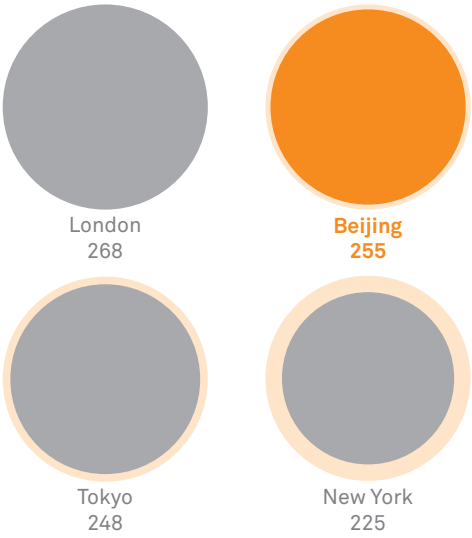
[* This figure is jurisdictional - confined to the city proper.
Metro area figures will differ. Using that figure, Tokyo-Yokohama is by some measures the world's largest urban settlement; New York and London figures would also be larger.]

...but they are still relatively poor.



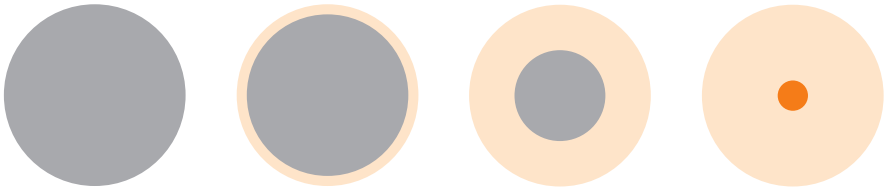
GDP per capita
in U.S. dollars.

Beijing has similar transport needs...

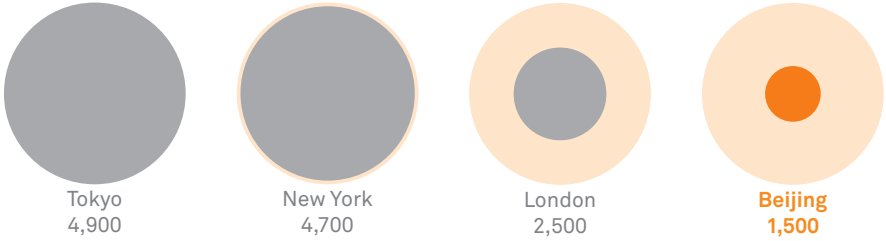


Vehicles
per 1,000 residents.

...but needs additional transport infrastructure.



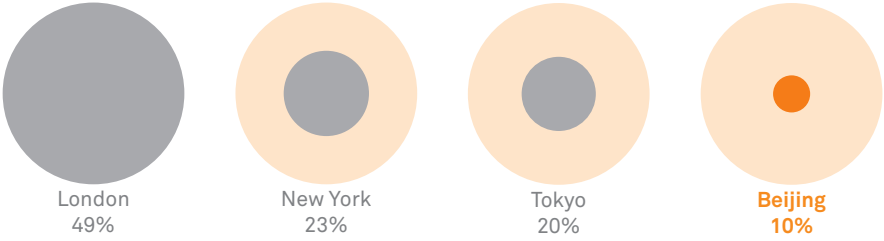
Road density
in km of road surface per km² of land.



Rail density
in m of track surface per km² of land.

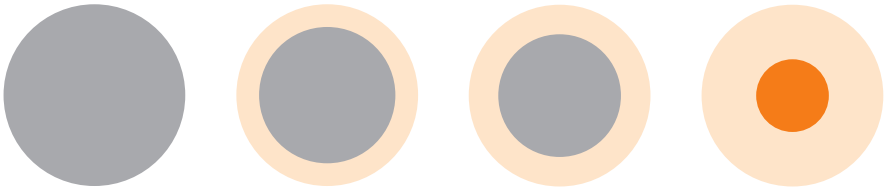
Beijing is polluting...

Reliance on coal
as a percent of total energy supply.

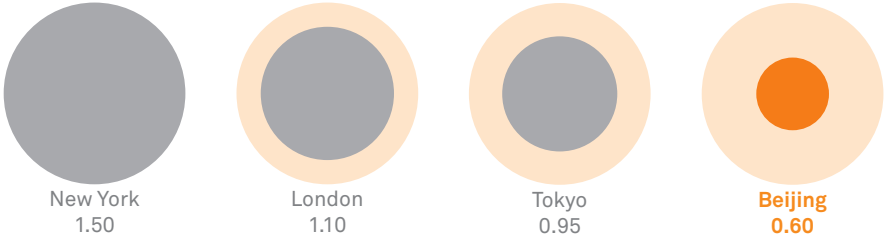


Reliance on natural gas
as a percent of total energy supply.

...but its people use and waste less.

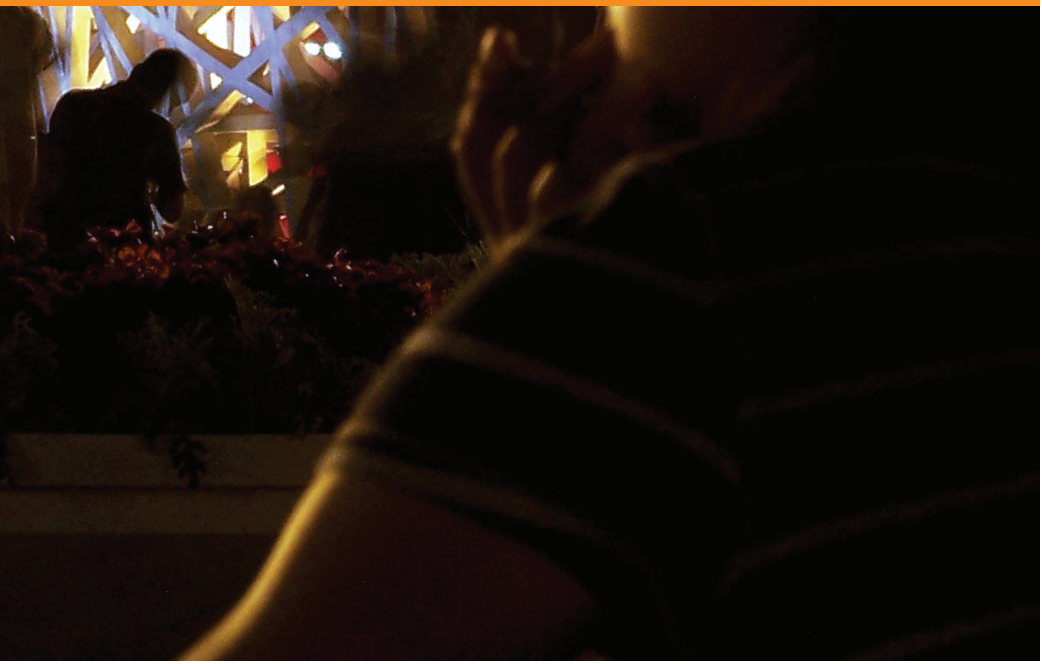


Electricty
as a percent of total energy use.

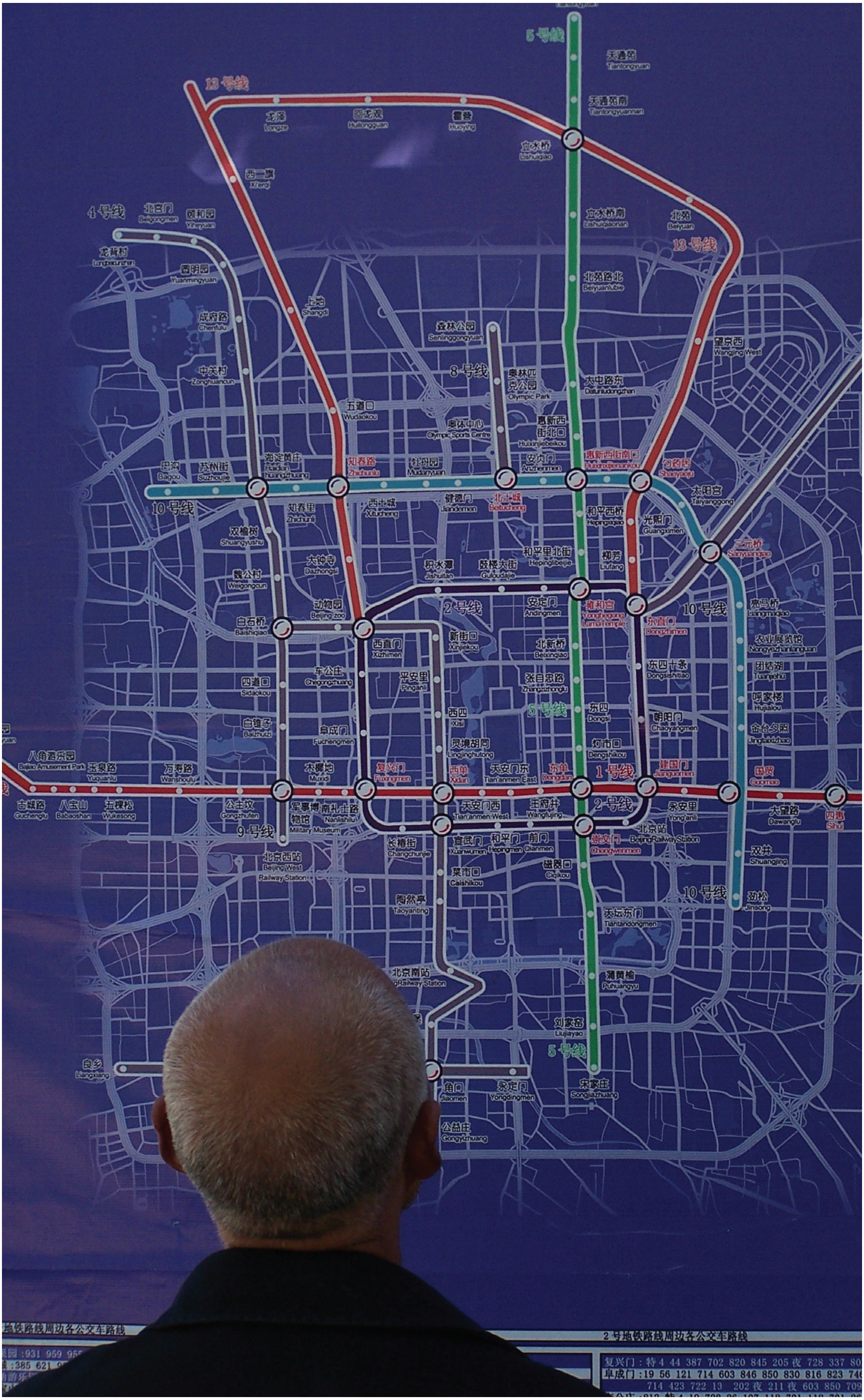


Domestic solid waste per capita
in kg per day.

Beijing, a visual survey




正陽橋

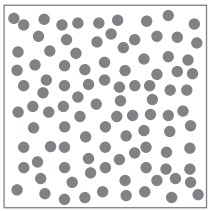


5号线
13号线
4号线
8号线
10号线
2号线
1号线
9号线
天通苑
Tiantongyuan
天通苑南
Tiantongyuannan
龙泽
Longze
回龙观
Huilongguan
霍营
Huoying
立水桥
Lishuiqiao
西二旗
Xi'erqi
立水桥南
Lishuiqiaonan
北苑
Beiyuan
北苑路北
Beiyuanlubei
上地
Shangdi
望京西
Wangjing West
森林公园
Senlingongyuan
奥林匹克公园
Olympic Park
大屯路东
Datunludong
五道口
Wudaokou
惠新西街北口
Huixinxijiebeikou
惠新西街南口
Huixinxijienankou
芍药居
Shaoyaoju
太阳宫
Taiyanggong
安贞门
Anzhenmen
知春路
Zhichunlu
牡丹园
Mudanyuan
健德门
Jiandemen
北土城
Beitucheng
巴沟
Bagou
苏州街
Suzhoujie
海淀黄庄
Haidian huangzhuang
中关村
Zhongguancun
西土城
Xitucheng
和平西桥
Hepingxiqiao
光熙门
Guangximen
三元桥
Sanyuanqiao
和平里北街
Hepinglibeijie
柳芳
Liufang
双榆树
Shuangyushu
知春里
Zhichunli
大钟寺
Dazhongsi
积水潭
Jishuitan
鼓楼大街
Guloudajie
魏公村
Weigongcun
动物园
Beijing zoo
白石桥
Baishiqiao
西直门
Xizhimen
安定门
Andingmen
雍和宫
Yonghegong Lama Temple
东直门
Dongzhimen
亮马桥
新街口
Xinjiekou
北新桥
Beixinqiao
农业展览馆
Nongyezhanlanguan
东四十条
Dongsishitiao
团结湖
Tuanjiehu
四道口
Sidaokou
车公庄
Chegongzhuang
平安里
Pinganli
张自忠路
Zhangzizhonglu
呼家楼
Hujialou
西四
Xisi
东四
Dongsi
朝阳门
Chaoyangmen
白堆子
Baiduizi
阜成门
Fuchengmen
灯市口
Dengshikou
金台夕照
Jingtaixizhao
灵境胡同
Linjinghutong
八角游乐园
Bajiao Amusement Park
玉泉路
Yuquanlu
万寿路
Wanshoulu
木樨地
Muxidi
复兴门
Fuxingmen
西单
Xidan
天安门东
Tian'anmen East
东单
Dongdan
建国门
Jianguomen
国贸
Guomao
古城路
Gucheng lu
八宝山
Babaoshan
五棵松
Wukesong
公主坟
Gongzhufen
军事博物馆
Military Museum
南礼士路
Nanlishilu
天安门西
Tian'anmen West
王府井
Wangfujing
永安里
Yong'anli
大望路
Dawanglu
四惠
Sihui
北京西站
Beijing West Railway Station
长椿街
Changchunjie
宣武门
Xuanwumen
和平门
Hepingmen
前门
Qianmen
崇文门
Chongwenmen
北京站
Beijing Railway Station
磁器口
Ciqikou
菜市口
Caishikou
双井
Shuangjing
陶然亭
Taoranting
劲松
Jinsong
天坛东门
Tiantandongmen
北京南站
Railway Station
蒲黄榆
Puhuangyu
刘家窑
Liujiayao
良乡
Liangxiang
角门
Jiaomen
永定门
Yongdingmen
宋家庄
Songjiazhuang
公益庄
Gongyizhuang
2号地铁路线周边各公交车路线
复兴门：特4 44 387 702 820 845 205 夜 728 337
阜成门：19 56 121 714 603 846 850 830 816 823
714 423 722 13 202 夜 211 夜 603 850 709

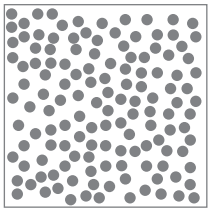
Beijing is a colossus. The population, after accounting for unregistered migrants, is roughly three times that of New York City and London and almost double the size of Tokyo. Further, unlike those cities, whose populations currently rise less than a percentage point a year, Beijing's population is growing rapidly, at an average rate of 3.8% per year.[1]

The city is also expansive geographically, so despite its population, density remains

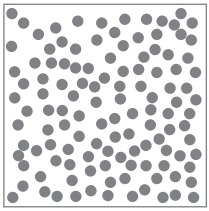
A low-density city.



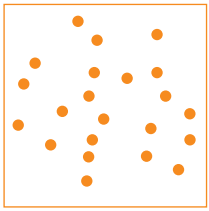
London 4,977



New York 6,732



Tokyo 5,949



Beijing 1,167

Urban population density
in residents per km²

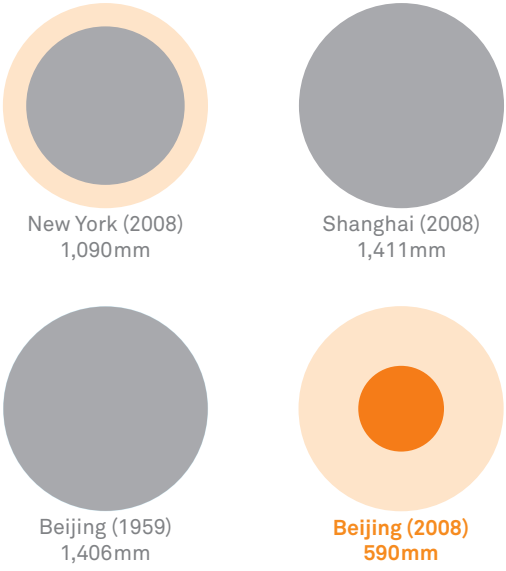
relatively low, about a third of that of Tokyo and New York.[2]

Beijing's demographics and climate pose tremendous challenges to its policy makers and managers whose job it is to provide the population with water and electricity. The city receives roughly half the annual precipitation of New York or Shanghai, which has shrunk reservoirs and led to unsustainable groundwater extraction.[3] Its local power supply remains 30% coal-

derived, compared with only 1% in New York, London and Tokyo, which is one factor in persistently poor air quality. Air pollution in Beijing is a legitimate health concern that has not improved significantly in the past 5 years.[4]

Another important trend in Beijing is the rising standard of living. In just the last year, the average salary in Beijing increased by 14%.[5] Further, wealthier people are demanding more water and electricity. Over the past

An increasingly dry city.



Annual precipitation
in mm of rainfall per year.

decade, domestic water and energy consumption have increased at an average of 3% and 9% year-over-year, respectively.[6] Increased income has also led many people to abandon their bicycles and crowded buses and trains for private cars and mopeds. Bicycle ridership in the city halved between 2004 and 2008.[7] Increased vehicle traffic contributes to air pollution and has strained transport infrastructure. Commuting times in Beijing are the longest in China at

An increasingly wealthy city.

2001
¥285 billion

2007
¥935 billion

2010
¥1,370 billion

Gross City Product
in yuan per year.

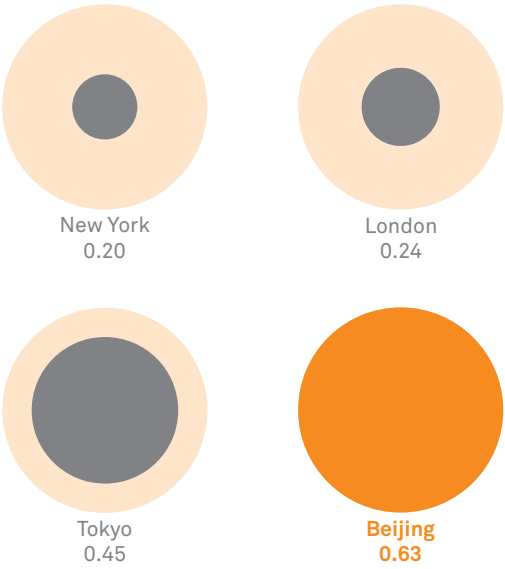
[Source: Starmass International, "Beijing Demographic Analysis and Economy Overview" and Beijing Municipal Bureau of Statistics]

approximately 52 minutes one way.[8]

As we will show in our pilot projects, however, intelligent urban planning coupled with localized technology can reduce demand, while expanding the provision of water, power and transport to an increasingly affluent population. This is critical not only for sustaining Beijing's dwindling water supplies and reducing congestion, but also for improving its air quality.

Air quality is notoriously difficult to measure and compare, but satellite imaging shows that Beijing's air pollution is significantly higher than Tokyo's and roughly double that of New York and London.[9] Clean air is critical to health and can save a city as large as Beijing billions of dollars in health care costs.[10] However, the value of fresh air to Beijingers' outdoor life and the city's reputation far exceeds economic estimates.

A polluted city.



Air pollution indicator
in April 2011, measured by aerosol optical thickness (AOT)

[Source: *http://hedleyindex.blogspot.com/2011/06/world-cities-air-quality-comparison.html*]

As air quality suggests, there is more to a city than its geography, infrastructure and utilities. Concepts like health, quality of life, diversity and vibrancy are impossible to fully quantify but are nonetheless crucial to a city's reputation. There is a city brand, whose importance resounds beyond environmental, economic and demographic statistics, and is meaningful as a symbol of leadership and progress.

This report outlines two pilot projects that would

enhance not only Beijing's physical infrastructure and natural resources, but also its intangible qualities and, in so doing, project a city image that is greater than the sum of its parts. Two steps Beijing can take to become a world city:

Step 1: Smarter density

A smart, dense urban environment in Daxing District can provide a roadmap for balancing the development trajectory of the city.

Step 2: A waterfront

Rejuvenating the Tonghui River can invigorate the city's image and quality of life.

Step 1: Smarter density

A smart, dense urban environment in Daxing District can provide a roadmap for balancing the development trajectory of the city.

Beijing stands out from developed cities in that its population is still on the rise. Beijing's population has grown at an average of 3.8% per year over the last 10 years.[11] The last census put the official population at 19.6 million in 2010,[12] but official numbers are widely understood to vastly understate the actual number of city inhabitants. Official statistics do not include the unofficial 'floating population' of unregistered rural migrants in Beijing, who constitute an estimated 40% of Beijing's actual total population.[13]

Beijing's population, though one of the largest in the world, is not dense. To accommodate population growth, the Beijing Master Plan for 2004 to 2020 designated eleven satellite towns, which would create multiple city centers to spread the population more evenly and relieve pressure on downtown Beijing. In reality, however, the city's expansion pattern has more strongly followed the steady expansion of transport infrastructure—the ring roads (with a seventh planned) and nine subway lines—with people living (and commuting) further and further from the city center.

Dense urban centers reduce pollution and climate change impacts per capita, especially as they discourage private transport. There is a proven inverse relationship, for example, between population density and automobile use per capita.[14] Dense populations are also necessary to make public transport convenient and cost effective. Sprawling cities like Los Angeles, Seattle and Houston have struggled with traffic congestion and air pollution whereas the most dense urban areas—New York, Tokyo, Seoul and Hong Kong—have the world's highest metro ridership per capita.[15]

经济

Guiding principle:
Economy: Increase work opportunities to work home

In order to encourage the sustainability advantages of dense urban areas, Beijing's satellite towns must offer a viable alternative to vehicular commuting into the downtown from the periphery. That means creating an indigenous economy beyond real estate that consists of good jobs and consumer opportunities, as well as an environmental and cultural center that constitutes a viable alternative to downtown.

Beijing has invested significant resources into developing the north of the city into high-tech zones, and the east axes of the city into the central business district, as well as strong transport links to Tianjin, including a high-speed rail that connects the two cities in little more than half an hour. Beijing's southern and western connections, however, remain relatively undeveloped. Daxing provides the connection with the South, including Shijiazhuang, a city of more than 10 million people and an economy similar in size to better known cities such as Changchun and Xi'an.

In addition, Daxing is the planned site of Beijing's next domestic airport, with construction expected to start late in 2011. The first phase is expected to be completed by October 2017 and will generate local opportunities for businesses and talented individuals that will rival the city center and help establish Daxing as a destination in and of itself.

In light of Daxing's positioning as a logistics hub, the district is exceptionally well-positioned to develop a robust economy, which can foster diverse employment opportunities as well as affordable real estate. Creating economic opportunities outside of the city center will be critical for Beijing in relieving pressure on transport infrastructure and the environment.

Beijing's commuting vectors
Rendering of the source, scale and direction of Beijing's commuters

[Source: Meng, B. (2009). The spatial mismatch of jobs and residence in Beijing. *Acta Geographica Sinica*. 64(12):1457-1466.]

Lack of economic diversity and density in Beijing's spatial layout exacerbates the strain on transport infrastructure and air quality. Few Beijingers work near their homes and commuting times are the longest in China, resulting in massive commuter flows (see graphic on page 45). Beijing's trains and buses are extremely crowded, especially in comparison with those in New York or London and even Tokyo and Hong Kong. Unpleasant public transport routes and increasing incomes have contributed to a marked shift towards motorized, lower-capacity modes of travel, which is a major contributor to the city's traffic congestion and air pollution.

Therefore, we propose Daxing as a satellite city that encourages people to work and play nearer their homes. Daxing is well positioned to create local economic activity as a transport hub and, potentially, as an "Airport City" in the model of Amsterdam's Schiphol Airport (see note on adjacent page 47). Commuters would have convenient, efficient public transport options including low-impact private transport options such as electric vehicles and shared bicycles. In this way, Daxing, as an economically independent, public transport-oriented Airport City would increase the city's population density and incentivize low-impact transport, and thereby reduce energy demand, and improve traffic flow and air quality.

The Airport City Formula

Economy: Increase work opportunities to work near home

Amsterdam's Schiphol Airport is the world's sixth largest airport by passenger traffic. Located 9.1 km southwest of Amsterdam, the Netherlands, it is a global hub for travel and trade, as well as a major interchange station at the heart of the Dutch road and rail systems. The government of Amsterdam and the airport management recognized the opportunities that the transport infrastructure can bring to the surrounding towns. They established a joint development company, Schiphol Area Development Co., to develop the airport area into a world-class business centre. The company devised an 'Airport City Formula' to nurture a symbiotic relationship between the airport and its surrounding real estate. Some 150,000 m2 of office and factory space have been constructed around the airport, and another 200,000 m2 is expected to be built, which is almost the size of Amsterdam. With meticulous and creative brand management, the company enlivened the 'Airport City' to the extent that today, office rentals around the airport have outstripped those in the city centre of Amsterdam. In this way, Schiphol grew out of the margin of Amsterdam, and became a transport-based economic zone.

SFO
San Francisco International
39.2m

JFK
New York Kennedy
46.5m

AMS
Amsterdam Schiphol
45.3m

PVG
Shanghai Pudong
40.6m

SHA
Shanghai Hongqiao
25.1m

DXI?
Beijing Daxing (planned)
40.0m

Airport passengers

in millions of passengers per year (2010, measured or estimated)

[Source:
http://www.aci.aero/cda/aci_common/display/main/aci_content07_c.jsp?zn=aci&cp=1-5-212-1376-1380_666_2__.]

Rethinking the need to commute

Smart work centers, when combined with energy saving infrastructure (see note on adjacent page 49) and advanced telecommunications, can help reduce the greenhouse gas emissions of individuals, companies and the city at large.[16] A smart work center provides open work space to the public. It acts like a public library, but instead of bookshelves and books, it houses comfortable office furniture, conference rooms, video-conferencing facilities, and amenities such as cafés and gardens. Most important, it provides full WIFI coverage, high-speed broadband connection, and stable power supply that allow users to connect to multiple locations and people at once with ease and speed.

Smart work centers offer Daxing a platform to attract business, and give residents space to e-commute in Daxing. They are particularly relevant to the emerging IT and new media industries planned for the district.[17] These two industries abound with freelance, self-employed professionals who will require precisely the flexible work style, the telecommunicating capacity, and the social network that smart work centers facilitate.

Smart work centers would reduce the impact on transport networks and air quality as well as stimulate economic activity in Daxing. For every 1000 people who reduce their private car commuting distance by 10 miles per week, there would be a reduction of 0.70, 0.13 and 3.94 fewer tons of smog-forming gases, PM10 and carbon monoxide, respectively, emitted per year.[18]

智能工作中心

Guiding principle:
Smart work centers

Flexibility in work location and time management:
By facilitating telecommunications, smart work centers can serve as people's alternative work space, freeing people from commuting to conventional offices. When established close to residential areas, smart work centers allow people to work closer to home. Overseas experience shows that smart work centers can reduce business travel by as much as 70%.

Operating cost reduction.:
Smart work centers can reduce company overhead costs. For example, small business or self-employed workers no longer need to rent office space larger than needed and larger businesses can reduce employee transport costs and parking spaces. Efficiency is improved by minimizing time spent on business trips and commuting. In summary, smart work centers stimulate economic growth by lowering operating costs, especially for small business and start-ups.

Networking venue:
A smart work center attracts mobile workers from different professions in one place. This creates a social milieu where ideas and information are exchanged more freely than in a traditional office space or e-commuting from home, thus spurring innovation and development.

Rethinking how to commute

For those people who must commute, Daxing should provide rapid and affordable point-to-point mobility in the district. By introducing smart transport, Daxing can improve its air quality, minimize fuel needs, reduce congestion, lower travel costs for its residents, and improve access to services within and outside of the district.

Public transport optimization

Public transport reduces traffic on the road and therefore lessens automobile-born pollution. When well managed, it also shortens commuting time. Bearing in mind that a new airport will be built in Daxing, investment is needed in multi-modal transport to ensure convenient access to the airport for those living and working in the surrounding area and to provide access to the surrounding areas for those entering through the airport. Multi-modal integration that allows travelers to move easily from the airport to high-speed rail, local and commuter rail, or private transportation.

Optimization also occurs through coordination of schedules and single ticket travel enabling a traveler to use a single destination ticket for their flight and train or commuter rail trips. Single ticket travel has been successfully implemented in Frankfurt, Germany's where the AIRail allows travelers to transfer from their Lufthansa inbound flight to an ICE (German high speed rail authority) train for the final leg of their journey on a single ticket and also includes through baggage handling. AIRail's biggest contribution to the airport and airlines has been relieving demand for short-haul flights and

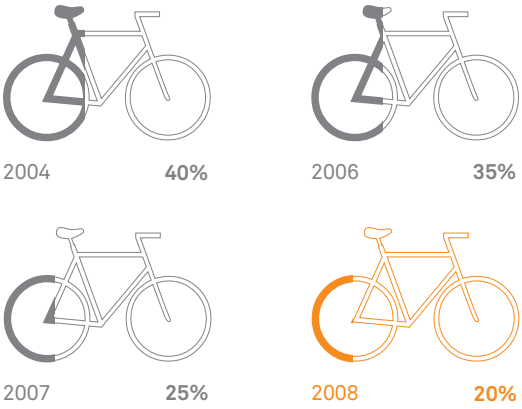
freeing up runway space, aircraft, and flight crews for longer, more profitable routes.[19]

Beijing already has a smart card payment system, but its uses are limited in comparison with other cities'. Beijing's smart card can only be used on the subway, buses, and some taxis. In contrast, in Hong Kong, the 'Octopus Card' can be used not only on all kinds of public transport, but also to pay for a large array of services, including postage, car-parking fees, or purchases from vending machines, convenient stores, supermarkets, and all major fast food franchises. Because the Octopus Card is used in so many aspects of everyday life, monetary incentives for public transport use may be given in wide-ranging ways. Besides conventional incentives such as lower charges for taking the subway or for making connecting trips, users can also redeem rewards that can be used for purposes other than transport. In Shanghai, the public transportation card can be used in taxis, subway, light rail, busses and ferries. It provides its users with slight discounts compared to single-use fares. By expanding the usage of the Beijing card, the city could further incentivize public transport and market the entire network as an integrated system. It would also reduce transaction times at stations, where crowding slows transit times and discourages use by higher income residents.

Car and bicycle sharing schemes

As Beijingers grow wealthier and their commutes lengthen, they are steadily abandoning the bicycle that once symbolized the city. Encouraging the mixed use of motorized and non-motorized transport is another means to reduce the amount of traffic. Beijing rolled out small pilots of bicycle rental schemes in advance of the Olympics

The decline of the Beijing bicycle.



Bicycle travel
among Beijing residents as a percente of total travel

in 2008, but the program was phased out that year due to fragmented services provided by different enterprises.

In February 2011, the scheme was reactivated in Daxing. As of June 2011, forty-three public bicycle rental stations were opened along the subway line that connects the district with downtown Beijing, with 3,600 bicycles available for hire.[20] These services need to be expanded and widely publicized as bicycle commuting from home to the subway not only reduces pollution, but also local traffic congestion. If just one percent of car-owning Daxing residents were persuaded to instead ride their bicycles, the approximate annual reductions in smog-forming gases, PM10 and carbon monoxide would be 0.24, 0.46 and 1.27 tons, respectively.[21]

Electric Vehicles

Electric vehicles (EV) contribute less to pollution and climate change than petrol-fueled vehicles, particularly when their power source shifts from coal to less carbon-intensive sources. When widely deployed, they can significantly contribute to improving air quality and reducing carbon emissions. Conventional vehicles are roughly 15% less efficient in energy production than electric power generation.[22] Daxing should strongly consider an EV pilot, either to support a full-scale roll-out or else an EV rental scheme, based on the Zipcar model in the United States and Europe.[23] [24]

Travel Demand Management

Public transport and EVs alone will not solve Beijing's mobility challenges; they must be supported by a host of travel demand management measures. Beijing

电动汽车

Guiding principle:
Electric vehicles: Ample, equitable and strategic

The deployment of electric vehicle infrastructure on a large scale is still in its formative stage, but two cities stand out as instructive deployment models for Daxing:

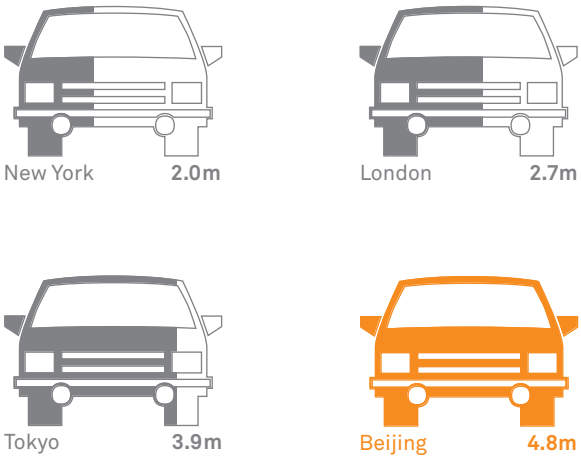
The mission of the **London** deployment effort is that no Londoner will be more than one mile from a public charging point by 2015. By focusing on the location of charging station at transport and mobility hubs, London expects to facilitate the widespread adoption of this technology in the short term. The London EV Delivery Plan sets a target of 25,000 charging points across the city by 2015 to provide comprehensive coverage to people who choose to purchase EVs versus conventional cars as well as to promote uptake of electric vehicles through car sharing schemes.

Vancouver is requiring all new single-family homes and off-street bicycle storage rooms to have dedicated electric plug-in outlets, and requiring electric vehicle charging infrastructure for 20% of all parking stalls in new condominium buildings. The Province of British Columbia has supported this effort with comprehensive deployment guidelines that will provide practical guidance for those cities implementing the new requirements.

has already instituted a number of measures to deal with congestion, including introduction of 'no-drive' restrictions on license plate numbers based on days of the week, traffic management systems and increased construction of metro lines throughout the city. Some other recently-instituted policies include higher parking fees in the city center, a vehicle license lottery that limits the number of new cars to be registered per year to 240,000, and car and bicycle sharing schemes. These tools are especially relevant for reducing air pollution.

One tool that could be better utilized in Daxing to reduce traffic pressure is a comprehensive ITS (intelligent transport system). Although much of the physical infrastructure is in place for information and data collection, better management can provide information about traffic incidents, congestion, traffic patterns and transport fare payment to users and planners. This kind of data helps transport providers design services that actually meet the needs of passengers and reward them for using sustainable forms of transport. For example, data about traffic and people's commuting patterns can inform adjustments to the frequency and coordination of various transport services, and ensure that public transport is optimally deployed during rush hour and on popular routes. It can also provide users with real-time information about traffic problems, especially when integrated with GPS systems. Finally, an advanced system could credit public transport and bicycle users using taxes levied on private vehicles. Taken as a whole, ITS makes more efficient use of roads and reduces congestion, which means saving oil, water and emissions. In London, congestion charges reduced congestion by 30%, increased public transit ridership by 18% and cut fuel consumption and CO_2 emissions by 16%.[25]

Beijing's growing love affair with the automobile.



Total vehicle ownership
ny number of private automobiles owned by residents in 2010.

[Sources: Streets Blog, Greater London Authority, Statistics Japan and *Beijing Review*]

智能交通解决方案

Guiding principle:
Integrated Transport System (ITS): Rulebook for deployment

Although Beijing does have an existing ITS infrastructure, it is under-utilized. Below is a rule-book for ITS deployment for the city:

- Develop and commit to a long term integrated ITS strategy
- Ensure that all traffic/travel information is freely shared and centralised from whatever source
- Ensure all responsible government departments work together with one objective: to optimize transport
- Ensure all ITS implementations are designed and planned *before* being procured and implemented
- Ensure there is a management and operations plan in existence before approving any ITS implementation
- Take true account of Quality in assessing competing systems
- Make traffic law enforcement a priority
- Build ITS into future road designs and improvements
- Upgrade all existing major highways with ITS management
- Improve access to travel information
- Fully take into account pedestrian needs during design and implementation
- Always have a target to meet when implementing ITS, and review the success or otherwise when finished
- Create a single transport department which can coordinate all transport modes
- Never simply purchase “out of the box” solutions; it is the planning, design, implementation and management of the box that is the solution.

Rethinking resource conservation

The reduction of domestic and service sector energy and water use is critical to Beijing. We have considered many ways Daxing could reduce its impact on air quality and congestion through smart transport measures. In this section, we address the other main contributor to growing energy and water demands in Beijing—buildings.

Buildings (and the people who inhabit them) comprise the bulk of energy consumption in the growing domestic and service sectors. Although there are innumerable technologies, pricing schemes, propaganda campaigns and "command and control" measures that would reduce Daxing's electricity and water consumption, we propose smart-metering as the most realistic and effective solutions for residential and commercial buildings.

Real-time metering measures electricity and water consumption in intervals of several minutes. With real-time metering, utility companies can charge consumers the market value of electricity or water at the moment it is used, and consumers can see what price they are paying for electricity and water at what time. This differs from traditional metering and pricing which collects data about consumption every month, and charges consumers the average cost of electricity and water. Real-time metering and pricing allows consumers to better manage electricity and water consumption peak hours – when electricity and water is most expensive – and off-peak hours.

Real-time metering and pricing helps conserve energy and water through technical as well as psychological means. The technical aspect is mostly concerned with

Water use in Beijing
in 100 million m^3

[Source: Beijing statistical yearbook, 2009, water resources]

Guiding principle:
Water: Reduce domestic and commercial demand

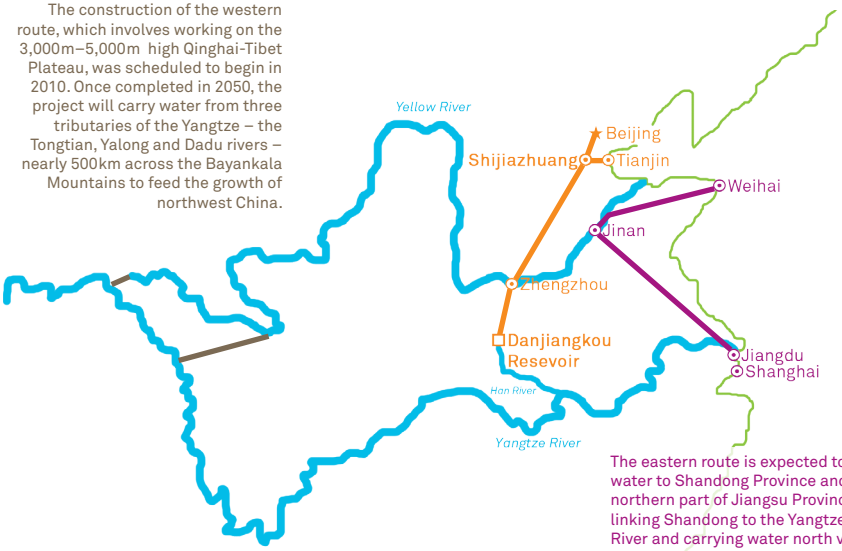
Due to population growth and persistent drought, Beijing's per capita water availability declined from 1,000 cubic meters in 1949 to less than 230 cubic meters in 2007. Total demand for water in Beijing has not increased markedly in recent years, but there has been a clear shift in the makeup of demand. Agricultural and industrial water use have declined as domestic and urban environment (landscaping, street cleaning, etc.) water use have expanded to approximately 40% of water consumption in Beijing today.

Beijing's current water management strategy is to meet demand through increased ground water exploitation and engineered imports. The economic cost and environmental risks of Beijing's water policy are staggering. Together with the central government, Beijing is investing $62 billion in securing its water supply, by diverting water from areas of relative surplus to Beijing and other drought-ridden regions of the northeast. However, the price tag of the so-called "South-to-North Water Diversion Project" is only the most visible part of the cost. What may come to be the greatest risk is the ecological disruption as a result of such a large-scale intervention in international river eco-systems.

Our Daxing pilot proposes to restructure demand to meet a sustainable level of supply. By focusing on efficiency and local responsibility, less water can be used to sustain a growing population's rising standard of living.

China's south-to-north water diversion
at a glance

The construction of the western route, which involves working on the 3,000m–5,000m high Qinghai-Tibet Plateau, was scheduled to begin in 2010. Once completed in 2050, the project will carry water from three tributaries of the Yangtze – the Tongtian, Yalong and Dadu rivers – nearly 500km across the Bayankala Mountains to feed the growth of northwest China.



The eastern route is expected to bring water to Shandong Province and the northern part of Jiangsu Province, linking Shandong to the Yangtze River and carrying water north via the Beijing-Hangzhou Grand Canal. The project has met with delays, but is projected to be completed by 2013.

The central route diverts water from the Danjiangkou reservoir on the Han River through a network of new canals, tracing a route through Henan and Hebei Provinces to its ultimate destination, Beijing. The diverted water will cover 1,267 km in its journey from the Han River to Beijing. This route was scheduled to be completed in 2010 but has met with delays and is now expected to be put into operation in 2014.

17.0 bn m^3 / yr
water diverted per year in the eastern route

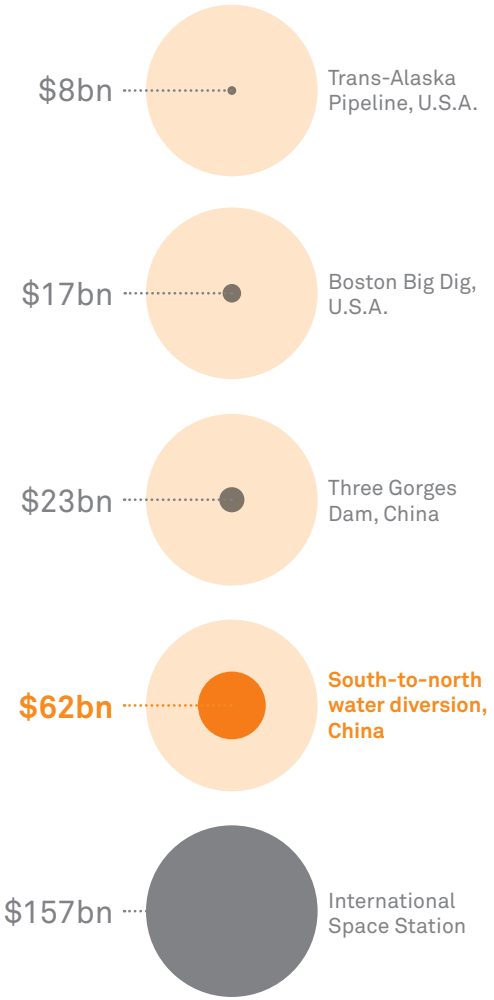
14.8 bn m^3 / yr
water diverted per year in the central route

13.0 bn m^3 / yr
water diverted per year in the eastern route

44.8 bn m^3 / yr
water diverted per year in total

[Source: *http://www.water-technology.net/projects/south_north/*, Chinese Ministry of Water Resources]

China's south-to-north water diversion
in the context of the world's most expensive grand projects



[Source: *http://www.water-technology.net/projects/south_north/*, Chinese Ministry of Water Resources]

the generation of electricity. Power plants are most efficient when they run at a peak volume of output, while troughs in output (especially coming on and off line) lead to inefficiencies and waste. When consumers are made immediately aware of pricing schedules and their current balance, they will have the incentive to reduce consumption overall as well as to shift high consumption to off-peak hours. This way, total demand is reduced and power plants can generate electricity with less input energy. Though it is very difficult to calculate how much efficiency this will create, improvements in smart metering of buildings overall have the potential for a five-to-ten percent improvement in electric efficiency.[26] Real-time metering also produces a psychological effect on consumers. It brings consumers in to a greater awareness of their consumption and increases their sense of responsibility more effectively than a once-per-month bill. Initial residential studies have shown that frequent feedback raises energy awareness and lowers energy consumption by 11% on average.[27]

Rethinking supply

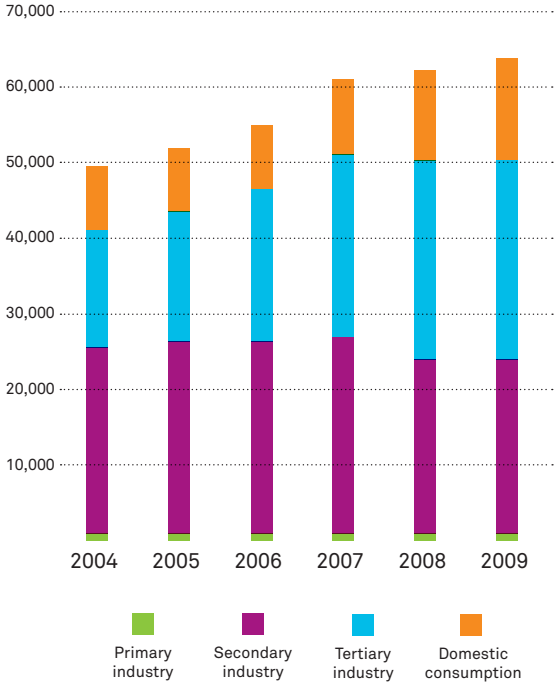
Although Daxing should focus its efforts on reducing demand for water and energy, there are also important ways that it can pilot for cleaner, more efficient energy generation and transmission. By utilizing existing energy facilities and pipelines as well as constructing new ones, Daxing can become a model for efficient energy production and distribution for Beijing.

A large scale district implementation effort would involve the installation of a new natural gas-fired turbine that produces electricity and heat. The project would install a series of steam-fired turbine centrifugal chillers and absorption chillers and associated cooling pumps and pipework that result in district cooling from steam and hot water input from the natural gas fired turbine. The heating produced from the turbine would also be used for district heating. Buildings served from this plant, which would produce electricity, heating and cooling, would all be equipped with smart metering that can monitor demand.

A small scale implementation would involve the installation of series of gas-fired reciprocating engines that produce electricity and heat. The project would install a series of absorption chillers and cooling pumps and pipework that produce cooling for district cooling from hot water input from the natural gas reciprocating engine. Heating produced from the reciprocating engine would also be used for district heating. Buildings served from this plant would all be equipped with smart metering that can monitor demand.

Utilizing natural gas rather than coal in Daxing would

Energy demand in Beijing
in metric tons carbon equivalent (mtce)



[Source: Beijing Municipal Statistics Bureau]

能源

Guiding principle:
Energy: Localize generation and reduce building and transport demand

Beijing's energy use trend in the past decade has shown a gradual reduction of industrial energy use to supplement service sector growth and domestic consumption. In today's Beijing, agriculture and mining are no longer a factor in energy demand and heavy industry is no longer the largest energy consumer. The 2004-2009 trend is a 9% per year increase in domestic consumption, due to a richer, growing population, and the expansion of service sector consumption, at 11% year-over-year, which combined still well outstrips the reductions in industrial consumption. Therefore, although Beijing has made great strides in reducing its consumption in secondary industries, its total energy demands are still growing at an average of 4.4% per year due to the growing needs of commercial and private consumption.

To meet demand, Beijing is increasingly reliant on fossil fuel and electricity imports. In 2009, more than two thirds of Beijing's electricity was imported from Inner Mongolia, Shanxi and surrounding provinces. Inner Mongolia and Shanxi are, in turn, increasingly dependent on fossil fuel imports from abroad. Less than one percent of Beijing's energy supply is derived from renewable sources.

Importing electricity from increasingly distant sources contributes to waste and long-term risks. The length of transmission lines is inversely proportional to their efficiency. A general industry rule of thumb is that 10% of energy is lost in transmission. Further, by outsourcing power generation, Beijing can ignore its complicity in the pollution and emissions impacts of a large portion of its energy supply, and exposes itself to long-term risks. It loses control of the means of electricity production and with it the cost, resulting pollution and climate change impacts.

A sustainable energy policy for Beijing would support the localization of energy production to reduce waste and take responsibility for emissions. It would address the two rising factors of demand, domestic and commercial consumption through improved building management and transport demand. Strategies to localize energy generation and reduce the impact of transport and buildings are articulated in our Daxing pilot framework.

immediately reduce the carbon intensity of electricity generation by 75%. Transmitting electricity over long distances from centralised energy supply networks, sometimes over hundreds of kilometres, results in a great deal of wasted energy. By generating electricity locally, Daxing can effectively save 10% of the electricity normally lost in transmission for consumption. By setting up its electricity generation stations using natural gas and according to the principles of distributed energy generation (DEG), Daxing can drastically reduce carbon emissions and effectively eliminate transmission and distribution losses. This would result in a reduction in generation requirements, particularly fossil fuels and water. Similarly, in traditional power generation, more than 60% of the energy is lost through heat in the transfer of fuel to energy. By integrating heating and cooling with the electricity generation process, Daxing can reduce its overall energy needs and, as an extension, further reduce its carbon footprint as well as demand for fossil fuel and, notably, water.

Rethinking growth

After some twenty years of expansion, the time has come for Beijing to reverse its urbanization trends. Outlined in the previous pages are the most accessible solutions to alleviate the pressure of rapid population growth on infrastructure, the urban environment, air quality and climate change. Starting in Daxing, Beijing can invest in growing indigenous economies based on local advantages of its satellite towns. It should find creative ways, such as smart work centers, to incentivize people to work nearer their homes. When commuting and travel are necessary, the city should provide convenient and accessible low-carbon transport options, starting with walking and bicycling. The urban fabric should be designed around public transport and electric vehicles should be the foundation of private transport. Localized energy production and real-time metering would not only reduce the city's resource needs, but also foster a sense of responsibility and culture of conservation.

Step 2: A waterfront

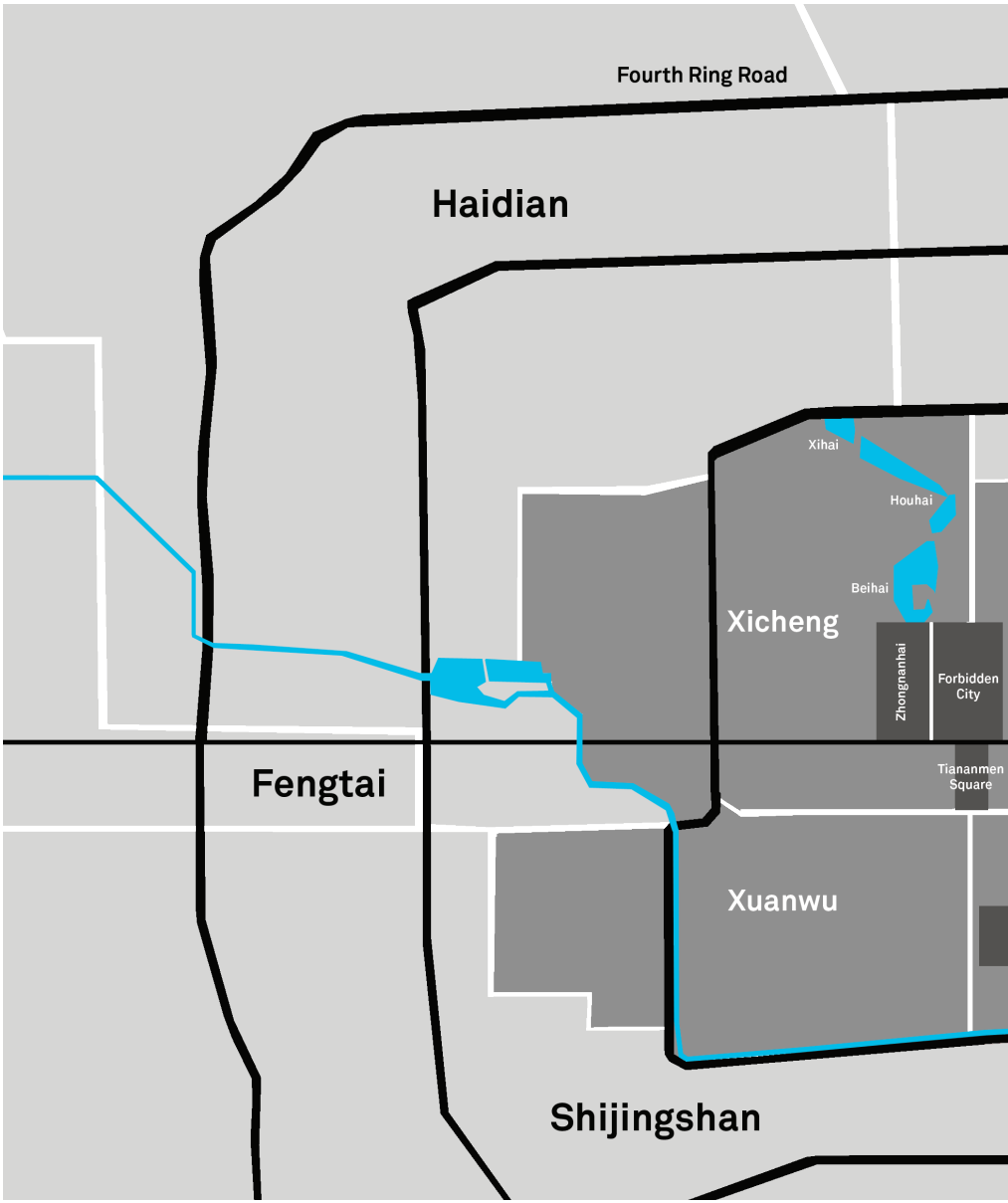
Making the most of every drop: Rejuvenating the Tonghui River to invigorate the city's image and quality of life.

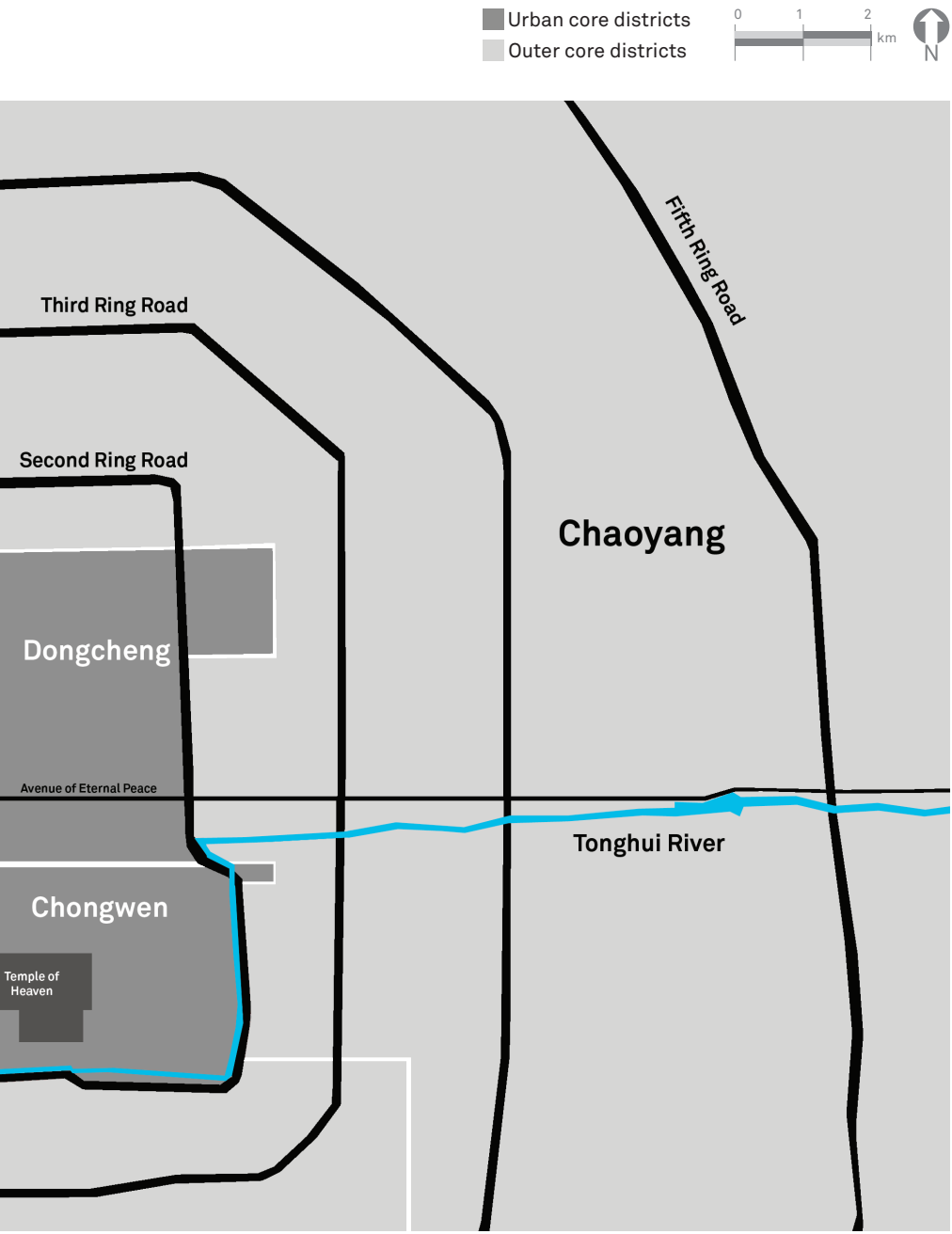
The global cities referenced in this report have developed as strategic ports whose geographies are dominated by water. Other large cities in China, such as Shanghai, Guangzhou, Chongqing, and Wuhan, were also built around a dominant water feature. Beijing, by contrast, is somewhat unique in its lack of a major water transport route. Yet, Beijing does not necessarily lack in waterfront space. Its urban shoreline is comparable to Tokyo and London in length. Rather it stands out because its waterways are under-nourished, lack public access, and are under-developed, creating the impression that they do not exist.

Today's cities develop their waterfronts less for industry and transportation and more as public amenities and venues for social interaction. Without a sustainable water supply or a dominant water presence, Beijing must make the most of what it has. It must unlock the potential of its hidden waterways, improve the quality of the remaining water and find creative ways to transform dry river beds and stormwater canals into vital public spaces. Beijing's dormant waterfronts potentially offer a setting in which to make an immediate improvement in quality of life for its citizens and from which it can better project an image of health and vitality.

Tonghui River is one of Beijing's four main urban rivers. It conveys stormwater from the southeastern area of the city to the Beiyun River. It is large, seventeen kilometers long by forty meters wide, and holds 1,430,000 m^3 of water. [28] We propose a step-by-step program that begins with restoration of water quality, and ultimately reinvigorates a sense of community. In parallel, the project must link the two sides of the river through paths and parks along the banks and commercial nodes,

The Tonghui River in context




Urban core districts
Outer core districts
0
1
2
km
N
Fifth Ring Road
Third Ring Road
Second Ring Road
Chaoyang
Dongcheng
Avenue of Eternal Peace
Tonghui River
Chongwen
Temple of Heaven

Urban shoreline length
in km

New York
930

London
630

Tokyo
590

Beijing
530

and introduce signage and entrances that beckon the surrounding community. With these improvements, Tonghui River would immediately enrich the southeast region of the city and set a strong precedent for similar waterfront programs elsewhere, potentially offering a makeover for the city as a whole.

Water quality first

The extremely successful Suzhou Creek project in Shanghai demonstrates the primary importance of water quality as a driver. Here, a heavily polluted urban waterway has been transformed into a city landmark. Healthy water is inextricably linked to healthy communities and cities. And in Beijing, where water is a particularly precious resource, water has special significance.

The water of the Tonghui River is currently classified as grade four, which precludes swimming, fishing and boating activities. The first important step in improving water quality is to reduce the amount of combined sewer overflow and prevent it from entering the river. All wastewater and stormwater must be filtered and disinfected before it is let into the outfall pipes. In Beijing, the capacity of the drainage and sewage piping system must be expanded so that all untreated water first can be directed to treatment plants. Additional piping and retention basins are also needed close to the river to capture and treat overflowing wastewater and urban runoff. At the moment, Beijing's stormwater and wastewater are treated in the same system. In the long run, the city should aim to separate stormwater treatment from wastewater treatment, which reduces the pressure on wastewater treatment, and therefore, the risk of overflows.

Thermal pollution is another issue. Measures must be taken to prevent hot water from heating stations and power plants from entering the river without undergoing cooling first. Cooling ponds or towers are needed for this purpose. If considered as part of a holistic approach,

湿地

Guiding principle:
Wetlands: a typology for improving Beijing's environment

How wetlands can improve Tonghui River:

- Add greenery to the waterfront.
- Absorb the nutrients and toxins in untreated water
- Promote biodiversity along the river.
- Provide and improve habitat for wetland animals.
- Improve the quality of water.
- Absorb excessive nutrients that would lead to eutrophication
- Release nutrients in the form that freshwater animals and plants require
- Accommodate water from flash floods and prevent overflow onto the land during periods of heavy rainfall

the warm water generated from cooling could be used for heating in public facilities around Tonghui River or to prevent the river from freezing during the winter.

Where the water is less contaminated, ecological solutions may be applied, specifically, the establishment of wetland parks along the banks to cleanse urban runoff and gray water. We have identified eight sites along the river suitable for establishing wetland parks of varying size. Some sites will only serve to filter and polish untreated water; others can double as rainwater retention basins or public education centers as well.

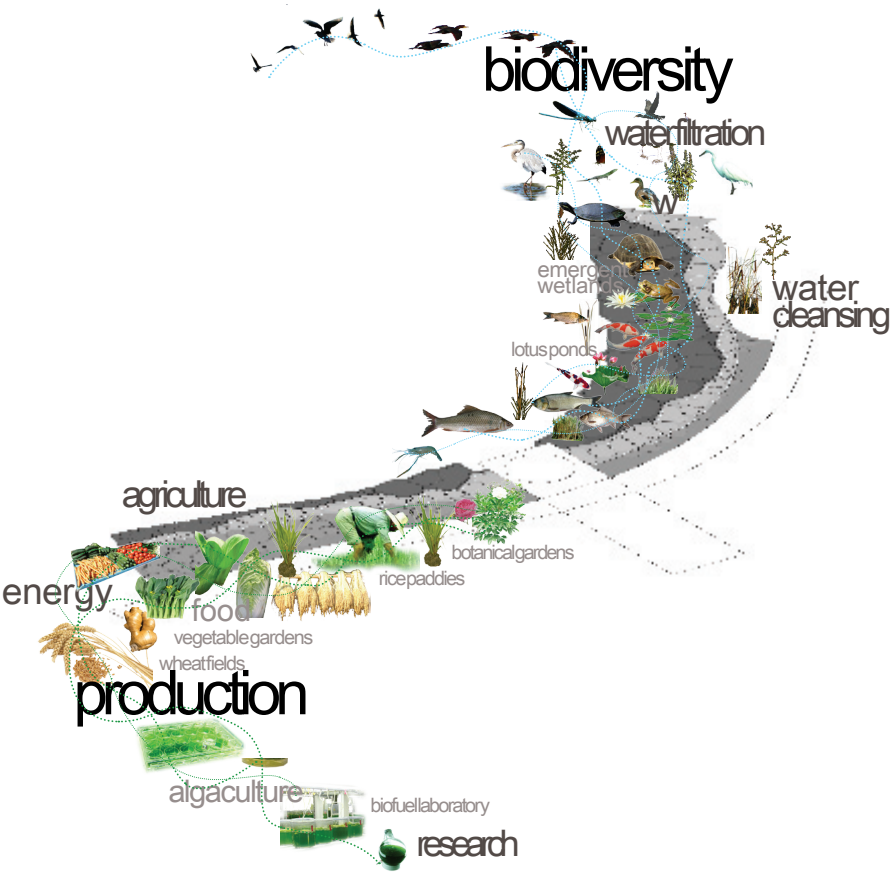
Wet *and* dry riverbeds

The landscape of the Tonghui waterfront should be a mosaic of memorable spaces that connect it to the surrounding city, while providing a contrast to the glass, cement and steel of the CBD. These spaces should be designed to attract people, enliven ecology and encourage a diverse range of visitors to spend time in the area.

While the Qingfeng Park sets a good example for the type of green, open space that should characterize the Tonghui riverside, it lacks ecological significance and engagement with the water. We envision the riverside as including natural, educational and park environments. Set within an aesthetically unique recreational landscape, these 'living machines' will express the ways in which human and natural systems are interrelated and have a dual focus on biodiversity and production.

As the river's level rises and falls seasonally and in response to severe storms, the parks along the river would ideally be divided into 'wet' and 'dry' zones. The parks would be designed to respond to the Tonghui River's fluctuating water levels. Leveling should allow pools and islands to emerge as the water levels change. The "wet" zone of the park would be completely inundated at peak flood levels. Rather than being a constraint, ever-changing stormwater discharge and diverse water levels should be embraced to create a unique and dynamic landscape.

The "dry" zone would be delineated by a flood defense levee, which creates an elevated recreational promenade in the area between the wetland and productive areas


biodiversity
water filtration
water cleansing
emergent wetland
lotus ponds
agriculture
botanical gardens
rice paddies
energy
food
vegetable gardens
wheatfields
production
algaculture
biofuel laboratory
research

of the park. The promenade forms the main connective spine of the park and consists of a combination of recreational and leisure areas as well as plaza spaces. Productive fields and gardens could flank the promenade, demonstrating both ancient and modern organic agricultural traditions. Algae serve as biofuel for gardens tied to research and educational facilities that explore cutting-edge technologies for sustainable energy production and the reduction of carbon emissions.

The “wet” zone, located below the flood defense level would be made up of a series of wetlands, marshes, pools, and recreational areas which are flooded at times of high water level. Filtration ponds and marshes will cleanse surface water runoff from the development prior to its being released into the river. The “wet” zone focuses primarily on habitat creation, increasing biodiversity, water cleansing and filtration, and aquaculture.

A promenade provides a continuous link along the length of the park. At one end of the park, the promenade brings visitors close to the river’s edge via a dramatic level change. At the other, the promenade offers sweeping views over the wetland zone.

Coming attractions

Global cities are often defined by their memorable community amenities and atmosphere. Beijing has the opportunity to create these conditions with the Tonghui riverside. Bustling local markets, historic interests and frequent events would attract young and old, low-income and high-income, locals and tourists to the riverside for a myriad of reasons.

Attractive spaces and paths alone are not enough to truly engage people in the waterfront experience. Particularly when water levels are low, space has to be designed in a way that accommodates a variety of activities: conversing, fishing, dancing, kite-flying, badminton and tai-chi. Rubberized jogging tracks, canopied tai-chi or dance spaces would cater to health-conscious urbanites, who use time before or after work for exercise. During the weekend, kiosks, farmer's markets or bazaars would attract locals and tourists alike to linger around the waterfront. Outdoor facilities such as exercise bars, pebbled ground-patches, and chess tables would attract seniors. And playgrounds and jungle-gyms would attract children.

Emphasizing existing sites of interest would enhance the attractiveness of the riverfront. The river has over seven centuries of history, and a series of heritage sites are located along the river, most notably, the Ming Wall ruins, the Ancient Observatory, the Qingfeng Gate, and the stone dam at the eastern end. By connecting historic sites along the river, a historic trail could be established to give the river a story to tell to its visitors. Dong Jiao Market – located on the south bank, at the fringe of the CBD – could be regenerated into a farmer's market that

向圣安东尼奥学习

Learning from...

Community engagement and events in San Antonio

One successful case of small-scale riverfront reactivation is the Riverwalk in San Antonio, Texas, a 2.5 mile stretch of waterfront that is one of the biggest tourist attractions in the United States.

Following a severe flood in the 1921, the local government planned to take a hard engineering approach to deal with flooding. However, a motivated community group, the San Antonio Conservation Society, pushed for a more innovative approach that took form over the following decades with citizen and government support and eventually became the San Antonio Riverwalk.

Today, the San Antonio Riverwalk is a public amenity and major state-wide tourist attraction that draws over nine million visitors a year and contributes over $800 million a year into the local economy. The riverwalk is a focal point for city activities from victory parades for the local basketball team or connecting the city's major tourist attractions.

combines fresh food retail with alternative restaurants and cultural shops. These shops and markets would provide a welcome contrast to the high-fashion shopping malls and office towers in the CBD and perhaps augment the avant-garde galleries and performing arts companies that are beginning to sprout on the river's south bank.

Creating spaces for public events is another way to invigorate and populate a waterway and its surroundings. The Riverwalk in San Antonio has excelled at this, positioning itself as a site for city-wide celebrations, concerts and parades, which have increased its exposure and given it a special place in the city's life. With some water quality improvements, Tonghui River would present an excellent venue for water-borne celebrations or holiday events such as dragon boat racing or New Year's fireworks.

Global cities are memorable places

Waterfronts are often what distinguish a city. People need to know the Tonghui riverside exists and they need access to it, across it and along it. The Tonghui riverside is a ripe opportunity to integrate the public space along and across its banks as well as connect to surrounding neighborhoods and public transport routes. Weaving the riverside into the fabric of the surrounding city could add an important and missing dimension to Beijing as it emerges as a global city.

Continuity of public access along the water is an important quality of successful waterfront design. There are a number of parks, paths and green spaces that dot the riverside, including Qingfeng Park, which is clean, new and manicured. And yet, they are not connected. Simply removing barricades and ensuring that temporary housing is set back from the riverside paths would be a simple, meaningful improvement. Where the promenades intersect with bridges and roads, pedestrian crossings should be designed to ensure safe and engaging continuity of access.

The riverside would benefit greatly from pedestrian and bicycle-only pathways and bridges along and connecting the two banks. By improving existing and adding new foot bridges, the river could better attract people to commute or exercise. Bicycle lanes along the river would provide a practical connection between the waterfront and the surrounding urban landscape as well, making it a low-carbon commuting corridor.

The most formidable challenge of opening up the Tonghui river to the surrounding community is the North Tonghui

Learning from...
Integrating recreation as infrastructure in New York

The 2002 Vision for Lower Manhattan recognized the lower East River waterfront as an untapped asset. Much like Tonghui, it was disconnected and underutilized. It faced many of the same challenges: broken links to the city, lack of amenities, blockages and vacancy. The location of the FDR Drive—along the riverside—turned out to be more of an inspiration than a constraint. Instead of re-routing the highway, the city devised a plan to use it as a canopy that would activate the space beneath it with social, historical and recreational activity. The plan further emphasized connecting this space to its urban surroundings. The waterfront would be accessible to the city at every slip, approximately every one to two blocks. Further, it would connect to other parks and regeneration projects.

The outcome has been a huge public and commercial success for the city. Its location and connections have attracted people and activity. Memorable public spaces like this that, contribute to the impression of New York as a Global City.

River Road that runs along the river's north bank. Where the highway runs closest to the river, we envision raising it either completely or partially to create a covered activity space beneath, similar to what has been done in New York City, along the East River, under the FDR expressway. In sections where there is sufficient space, large trees should be planted along the highway to dampen noise, filter exhaust and dominate the landscape.

The final connectivity challenge is to make the riverside more accessible and visible to the surrounding community. The number of connections must be increased between the river and the parallel roads and also with public transport. Existing links can be improved by introducing special pavements and cycling lanes that connect the carparks and public transport stations on either bank to the shore.

Currently most public transport links are located north of the river and, critically, the Tonghui Highway. The river is not visible and must be better advertised by cultural signage in the subway and public bus stations. As the southern bank offers more space for promenades and parks, more bus routes could be designed to pass through and stop there so people have more ways to approach the river. The addition of cross-river elements could also stimulate the area by promoting a new economic and cultural interaction between the business-driven north and the traditional, more recreational, south sides of the river.

Man cannot live on air, water and energy alone

The Daxing pilot focuses on balancing Beijing's resource demands to meet sustainable supply. However, improving the quality of life of city residents involves more than supplying them with basic needs. Just as air quality is a primary concern for the city, so too should be the provision of clean waterways and public space astride them. In the context of Beijing's water shortage, waterways like Tonghui take on added significance, each a rare opportunity to make the most of the city's urban environment for its residents. In implementing riverway revitalizations, water quality is paramount and riverside paths and parks need to be contiguous, accessible, activated and publicized so they are utilized to their full potential. Even dry riverbeds and flood catchments can be developed as dynamic public spaces.

Enhancing the health and community of waterfronts like that of the Tonghui River is no less important to quality of life than the physical essentials of survival.

Two steps to a world city.
Welcome to Beijing's bright present and future.

This report has presented two, straight-forward ‘steps’ to optimizing Beijing’s resource utilization and public space, but our intention is that the momentum that results will lead to compounded benefits for the city.

In Daxing, we conceptualize a new town built around the principles of efficiency and conservation that will lower water and energy needs, reduce traffic congestion and improve air quality. Along the Tonghui River, we

envision a vibrant public waterfront that connects communities, commuters and cultures, thereby improving quality of life as well as promotes the natural environment, public health and Beijing's overall city image.

Four principles for minimizing resource demand and maximizing quality of life guide the project frameworks.
The first is stimulating indigenous economies in satellite districts to reduce

pressure on transport infrastructure, air quality and energy demand. The second is optimizing energy generation and transmission through a focus on localized, natural gas-fired, combined heating and cooling plants. The third is reducing water demand in the growing domestic and commercial sectors through real-time metering and pricing incentives. The fourth is improving air quality by eliminating or reducing the length of the commute, improving the operations of

public transport networks and imposing heavier taxes and restrictions on private vehicle use.

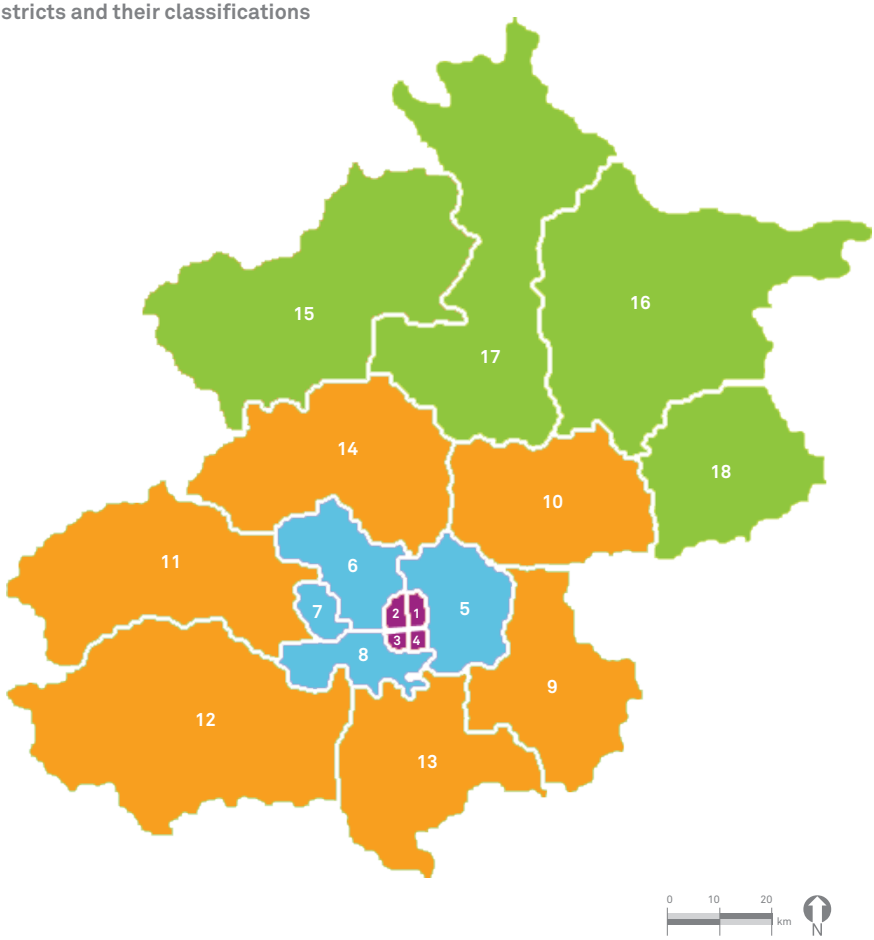
We foresee a ‘virtuous cycle’ as these guiding principles are applied throughout the city. For example, at the same time as smart work centers and communications technology make physical presence in an office or distant meeting less relevant, private vehicle restrictions and taxes will further discourage travel. These trends will

both promote indigenous economies, which, in turn, will further reduce the need to travel.

A proliferation of waterfronts and other public spaces, based on the Tonghui model, also has a great potential for synergistic benefits. Not only will the area of green, public space grow, but as these spaces are better connected to one another, the total impact on the city will be greater than the sum of each development.

In this way, two steps can set in motion a sea change in Beijing's ability to reconcile growth with constrained resources, while continuing to improve its citizens' quality of life.

Beijing municipality
Districts and their classifications



Urban core districts
1 Dongcheng
2 Xicheng
3 Chongwen
4 Xuanwu

Outer core districts
5 Chaoyang
6 Haidian
7 Fengtai
8 Shijingshan

Suburban districts
9 Tongzhou
10 Shunyi
11 Mentougou
12 Fangshan
13 Daxing
14 Changping

Rural districts
15 Yanqing
16 Miyun
17 Huairou
18 Pinggu

Beijing in a national context
The 15 largest urban areas in China, including the Hong Kong Special Administrative Region

Endnotes

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