CHINA ENVIRONMENT SERIES 13

SPECIAL ISSUE ON URBANIZATION

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PHOTOS BELOW: As part of our ***Global Choke Point*** initiative, the Wilson Center's China Environment Forum and Circle of Blue, an independent journalism organization, are closely studying the interlinked water, energy, and pollution challenges in two Pacific port cities—Oakland, California and Shenzhen, China. The initial round of our ***Choke Point: Port Cities*** multimedia reports (see the Wilson Center's New Security Beat blog) by Keith Schneider, Coco Liu, and Susan Chan Shifflett relate stories on the water-energy-pollution constraints facing Oakland and Shenzhen. Although the Oakland municipal government has struggled for decades with growing pollution issues, the city has since become one of the leaders in the United States in energy efficiency, water conservation, and alternative energy production. While significantly larger and wealthier than Oakland, the economic powerhouse of Shenzhen also faced growing pollution problems. Over the past few years, the Shenzhen municipal government has started to tilt towards cleaner, less water-consuming energy development, notably outlawing new coal-fired power plants and ordering existing coal-fired generating stations to convert to cleaner natural gas. Our growing collection of multimedia reports on Shenzhen and Oakland will not only help CEF in creating exchanges and convenings in 2016 between the two port cities,t but also could inform the new U.S.-China Green Ports initiative that was created under the 2014 climate agreement.

Shenzhen (Jennifer Turner)

Port of Oakland (Daniel Parks/Flickr)

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CHINA ENVIRONMENT FORUM

For 18 years, the Woodrow Wilson Center's China Environment Forum (CEF) has created projects, workshops, and exchanges that bring together U.S., Chinese, and other Asian environmental policy experts to explore the most imperative environmental and sustainable development issues in China and to examine opportunities for business, governmental, and nongovernmental communities to collaboratively address these issues.

The networks built and knowledge gathered through meetings, publications, and research activities have established CEF as one of the most reliable sources for China environment information and given CEF the capacity to undertake long-term and specialized projects on topics such as energy development in China, environmental justice, Japan-China-U.S. clean water network, municipal financing for environmental infrastructure, river basin governance, environmental health, water conflict resolution mechanisms, food safety, and environmental activism and green journalism. Our current initiatives are:

- Global Choke Point: a multimedia and convening initiative created in partnership with Circle of Blue examining the water-energy-food confrontations in China, India, the United States and other countries around the world.
- Cooperative Competitors—research and exchanges on U.S.-China climate and clean energy cooperation.
- Storytelling is Serious Business—workshops to help Chinese environmental professionals develop stronger communication skills.
- Complex Connections—meetings and research examining environmental impact of Chinese investment overseas.

The China Environment Forum meetings, publications, and research exchanges as well as Global Choke Point activities in India over the past two years have been supported by generous grants from Henry Luce Foundation, blue moon fund, Energy Foundation China, Ford Foundation, Hewlett Foundation, ClimateWorks Foundation, and the Walt Disney Company.

Dr. Jennifer L. Turner has directed the China Environment Forum since 1999. The China Environment Forum is a project under the Wilson Center's Global Sustainability and Resilience Program.

Contents

FOREWORD

FEATURE ARTICLES

COMMENTARIES

城市

FEATURE BOXES

城市化

SPOTLIGHT ON NGO ACTIVISM IN CHINA

FOREWORD

by Jennifer L. Turner (吴岚), Editor

I am excited to welcome the Year of the Monkey with our 13th *China Environment Series: Special Urbanization Issue*. For the China Environment Forum 2016 is going to be the "Year of the City," not only because Chinese cities are facing sobering pollution challenges, but also because cities are a blossoming area for U.S.-China cooperation. In addition to this urban-focused publication, this year we will monkey around with more meetings, exchanges, and research on the environmental challenges surrounding China's huge urban centers. CEF's urban agenda is closely linked to our ongoing *Choke Point: China* project that we initiated in 2010 with Circle of Blue to investigate China's water-energy-food confrontations. Our initial Choke Point: China reports conclusively demonstrated how water was a limiting factor in the expansion of coal development in China's dry north, exceeding the available supply by the year 2020 or 2025. This year we also plan to look more deeply into the coal-water issue and its link to cities, as well as explore the growing energy and carbon footprint of urban water use.

Moreover, with the support of the Henry Luce Foundation, we have taken our Choke Point: China work to the city level, examining the responses of Oakland, California, and Shenzhen, Guangdong Province to interlinked water, energy, and pollution challenges. Our multimedia reporting will inform exchanges and convenings in 2016 aiming to share best practices among city managers in both Oakland and Shenzhen, which can be adopted by other cities in both countries.

PEEK INSIDE THIS ISSUE

Our lead feature article author, Russell Sticklor, presents an extensive piece on what I have long considered the "black box" of China's energy-water nexus challenge, namely the energy footprint of cleaning, treating, and transporting water to quench the thirst of cities in China's dry north. Iris Cheng and Li Shuo look at the water-energy-urban topic from a different angle, specifically examining how the effort to protect east coast cities from the crushing smog is pushing more coal development to China's ecologically vulnerable west. As a result, coal's expansion is threatening water resource availability in China's north. In his feature box, Al Scott sees promise for lowering coal's environmental impact through expanding U.S.-China cleaner coal cooperation.

Many of our commentaries and boxes focus on China's massive urbanization—from Zhongjie Lin's article on the new "New Town" movement in China to discussions of China's perhaps not sufficiently green eco-cities (Cecilia Han Springer) to the Global Environment Facility's sustainable city projects in China (Xiaomei Tan). Han Cheng ponders whether expansion of natural gas can deliver cleaner air for Chinese cities, while other authors discuss the potential of city-to-city cooperation between Wuxi and Düsseldorf (Olivia Boyd) and U.S.–China mayoral exchanges (Xiaobing Liu) to move Chinese cities onto a greener path. Ella Chou relates fascinating stories on China's emerging green entrepreneurs to address pollution issues in cities and beyond. In a unique twist to our urbanization theme, Fred Gale and Dinghuan Hu talk about how the trend of "urbanizing" China's pigs is opening up innovative ventures that could make the country's pork industry less polluting and safer. Shiming Yang relates an insightful case of how the city of Foshan has wrestled with reducing pollution from its giant ceramics industries. As Chinese urbanites increasingly mistrust the quality of their water supply they turn to bottled water. Abigail Barnes looks at this trend and discusses the contamination scandals and growing environmental footprint of China's bottled water industry.

The *China Environment Series* has long focused on important developments in environmental civil society in China. Thus, for this issue, we invited Yanmei Lin and Shaobo Hu to help us understand whether the provisions for public interest lawsuits in the amended Civil Procedure Law have empowered environmental NGOs in their fight against pollution. Katie Walsh discusses how NGOs and citizens also have more opportunities to improve environmental governance through an improving environmental impact assessment system. Tara Sun Vanacore's feature box looks at the little-explored angle of youth's involvement in China's environmental movement.

This issue's Spotlights on NGO Activism in China include some great work being done by the Global Environmental Institute (GEI) to bring U.S. and Chinese provinces together on climate cooperation. Former CEF research assistant Siqi Han helped the GEI authors (Caroline Jo, Qingchan Yu, & Christopher Dunn) create an infographic—The Power Couple—to summarize the low-carbon partnership they brokered between California and Guangdong. Greenpeace China contributes a story demonstrating its staff's considerable patience and persistence in overcoming bureaucratic hurdles to install rooftop solar panels on top of their office building. Emissions from China's growing car fleet becoming a dominant source of smog in China's cities have underscored the importance of vehicle rating system tools like the one iCET has developed.

MY TEAM

As is usual with our small office, the China Environment Forum team has been quite busy over the past year with our regular meetings and wave of blog posts on the Wilson Center's New Security Beat, as well as two new issues of *InsightOut* and the *China's Water-Energy-Food Roadmap*. As part of our *Choke Point: Port Cities* initiative we conducted multiple reporting trips to Shenzhen and Oakland and with the International Council on Clean Transportation we published a report entitled *Costs and Benefits of Shore Power at the Port of Shenzhen*. All these activities prevented us from getting this issue out in a timely manner and I appreciate the patience of our authors and all the hard work of the research interns and assistants who helped pull this publication together. Early in the editing process, Susan Chan Shifflett and Qinnan Zhou gave me valuable input on the submitted articles. Ilaria Mazzocco then took on the big task of working with my authors to strengthen the articles. My managing editors Joyce Tang and Zhou Yang were heroines doing the lion's share of the final edits to the whole publication. Last but not least, Angelina Fox used her creative eye in the layout of this publication to help the articles shine.

I wish to thank Henry Luce Foundation and blue moon fund for supporting this and related publications over the past two years. Besides the *China Environment Series*, these funders have supported our work in producing online research briefs and infographics on water-energy issues and clean energy and climate challenges facing China. As I have done in the past, I also need to thank you, our readers, who are invaluable members of the CEF team. We work to provide interesting and useful insights into energy and environmental trends in China and many of you in this "mafia" are our authors, speakers, and talented interviewees for in our research. I look forward to seeing and hearing from many of you as CEF embarks on its "Year of the City!"

As a final note on my team, I wish to give a heartfelt shout out to Susan Chan Shifflett who after three years of working tirelessly as my associate (doing the work of at least two people) has moved onto a new and exciting job in DC. Despite the heavy workload, Susan was a prolific researcher who brought a creative dynamism to CEF that helped us shine. 加油, Susan. 乐驰千里猴 ，更上一层楼.

ENERGY DRAIN

The Hidden Costs of Providing Water to China's Urban North

by Russell Sticklor

China's dramatic urbanization over the past four decades has fundamentally reshaped the country, generating considerable wealth, as well as significant environmental damage. Air pollution is the more visible negative impact of the unchecked urbanization, but the intensifying water scarcity in northern China represents perhaps the greatest threat to decelerating economic growth in megacities like Beijing. As water stress intensifies across the urban north, the demand for energy to transport, pump, clean, recycle, and desalinate water for these cities is on the rise. This is especially true because huge growth in northern China's urban population since 1980—a time period in which Beijing's population roughly doubled—have not been offset by corresponding gains in water-use efficiency. Leaving no stone unturned, Chinese cities are desalinating the oceans, withdrawing groundwater supplies for ever-deeper reaches several thousand feet beneath the earth, and transporting water from river basins more than 1,000 kilometers to the south to meet demand. The overall energy requirements needed to support these water-supply practices for China's urban north are almost impossible to estimate due to insufficient data availability, yet the trend appears clear—water's energy footprint in China's urban north is expanding with each passing year, especially as massive infrastructure projects like the eastern arm of the South-North Water Transfer Project come online. While Chinese policymakers and scholars have started to examine the expanding water footprint of China's energy industry, they have paid comparatively little attention to the growing energy footprint of water transfer projects and desalination plants in supplying water to the parched cities and industries in the north. This water currently accounts for a small slice of the overall energy pie, but its share in energy consumption grows steadily. Most problematic is that these energy-intensive water projects offer only short-term solutions to the water shortages, thereby delaying more sustainable urban wastewater treatment and water recycling efforts and reforms in water pricing that could better ensure future water security for northern cities.

A THIRSTY TIGER

With 70 percent of China's population expected to live in cities within 15 years and a growing middle class sporting a more water-intensive lifestyle, water infrastructure in Chinese cities are being burdened like never before. China's ability to meet rising urban water demand while maintaining some degree of environmental sustainability will likely prove to be one of the country's principal challenges in the 21st century.

The intensifying water scarcity in northern China represents the hefty bill now due to pay for the past 40+ years of unchecked seismic economic growth that has reshaped the region from the ground up. Water wastage and overuse by the energy, industrial, and agricultural sectors, have grown exponentially since the late 1970s, driven by the intertwined forces of economic modernization, population growth, and urbanization (Xie et al., 1993). Aging and leaking water distribution infrastructure, unclear water rights, and low water fees are also part of the equation that discourage water conservation. Falling levels of water availability have also periodically threatened the region's food production and pose ever increasing risks to the megacities in the north.

Cities are also part of the problem. While agriculture and coal development use the lion's share of north China's water, the water footprint of cities is growing, as is the energy needed to provide and clean this water for these urban centers. (See Box 1). Two to three percent of worldwide energy use goes to transfer, pump, treat, distribute, and heat water for urban households, industries, and non-agricultural businesses every year. Across northern China the energy footprint of urban water services is significantly higher than global averages and continues to grow. According to one recent study of Changzhou in Jiangsu Province, the city's water infrastructure used roughly 10 percent of the Changzhou's overall energy supply, with industrial use of water accounting for some 70 percent of water-related energy use, while the household sector accounted for less than 25 percent (Zhou, et al., 2013).

There is something of a "Catch 22" at work as China works to combat its perpetual urban water supply problems. With a few notable exceptions, the Chinese government has chosen to prioritize water supply augmentation over demand management and conservation. As a result, water-use inefficiency—particularly in urban areas—has been largely tolerated, and continues generally unabated. The Chinese government recognizes that if urbanization in the arid north is to prove sustainable, a wide net must be cast to bring in as many new water supplies to the region as possible—whatever the cost. These approaches include everything from desalination and aggressive wastewater treatment and recycling to dropping deeper groundwater wells and replumbing parts of the Tibetan plateau to transfer massive volumes of water via the South-North Water Transfer Project.

The energy to power these processes—whether it be desalination, groundwater pumping, or long-distance bulk-water transfers—is primarily provided by fossil fuels. In turn, the burning of fossil fuels contributes to both localized air pollution and contributes to broader global warming, exacerbating ongoing climate change impacts that have made precipitation patterns across northern China more erratic over the years. In this mutually reinforcing cycle, urbanization, water-use inefficiency, fossil fuel consumption, and climate change combine to place the water security of China's urban north in something of a downward spiral.

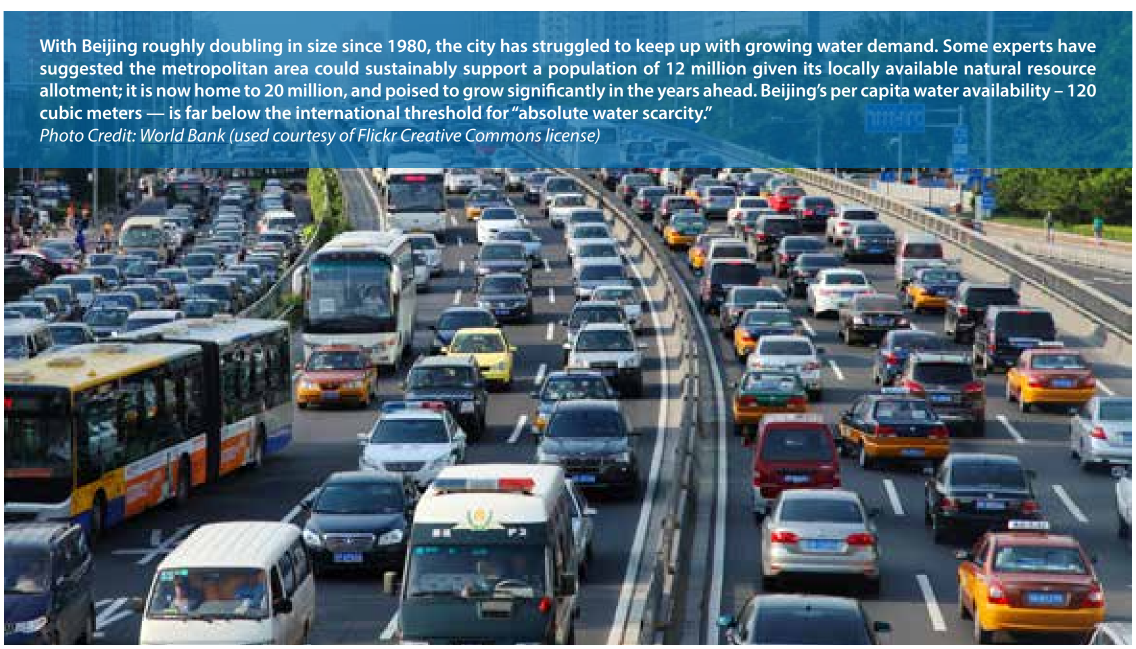
In a country perpetually concerned about meeting soaring domestic demand for energy, it is puzzling that policymakers and researchers are overlooking the growing energy costs of bringing new water supplies online for China's northern cities. In China, data on the energy footprint of urban water services is not often compiled and what data exists is rarely made publicly available. Nevertheless, this paper reviews public documents and examines economic, environmental, and demographic trends to assess the amount of energy China will require to ensure a reliable water supply for its northern cities as the region's water crunch intensifies in the years and decades ahead.

SUPPLY SIDE, DEMAND SIDE, OR BOTH?

China's megacity capital embodies the greatest urban water security challenges facing the country today. Over the past 35 years, Beijing's metropolitan area has become home to some 20 million people—vastly overwhelming the capacity of the city's water infrastructure and natural resource base. Some hydrological experts, such as Xu Xinyi of Beijing Normal University's College of Water Sciences, estimate that available water in the region could provide Beijing 2.1 billion cubic meters of water annually to sustainably support a population of roughly 12 million. With nearly twice the population, it is thus not surprising that Beijing's annual water consumption has reached slightly over four billion cubic meters.

In terms of water, city officials wrestle with frequent droughts, plummeting groundwater tables, and inefficient wastewater treatment that contaminates public water supplies. Yet even in the face of such daunting water challenges, Beijing has managed some elements of its urban water supply impressively—particularly water recycling in its industrial sector. For this reason, Beijing provides a complex case study that is alternatively worrisome and promising, and illustrates the many push-and-pull factors shaping urban water management in an era of increasing scarcity across northern China.

With China's total aggregate water demand expected to reach a whopping 818 billion cubic meters by 2030, the government appears to be prioritizing energy-intensive efforts to bolster supply—such as desalination and long-distance water transfers—over campaigns to incentivize greater water-use efficiency ("Charting our water future," 2009). Indeed, ambitious efforts to make up for the supply shortfall — regardless of the energy required to build and operate this infrastructure—reveal the Chinese government's faith in big-ticket, supply-side interventions over demand-side measures such as improved efficiency standards and intensified water recycling.



With Beijing roughly doubling in size since 1980, the city has struggled to keep up with growing water demand. Some experts have suggested the metropolitan area could sustainably support a population of 12 million given its locally available natural resource allotment; it is now home to 20 million, and poised to grow significantly in the years ahead. Beijing's per capita water availability – 120 cubic meters — is far below the international threshold for "absolute water scarcity."
Photo Credit: World Bank (used courtesy of Flickr Creative Commons license)

BOX 1. Chinese Cities and Water By Numbers

BOOMING URBANIZATION

- More than half of China's 1.3 billion people live in cities.
- By 2020, as China's population approaches 1.4 billion the percentage of urban residents is slated to rise to 60 percent. By 2030 the urbanites will make up 70 percent of the population.
- 15 Chinese cities have a population over ten million.

INCREASING URBAN THIRST

- 70 percent of China's population relies on groundwater for drinking water.
- Out of China's 655 cities, 400 rely solely on groundwater for drinking water.
- 110 trillion m^3 groundwater is pumped out annually for cities and agriculture, accounting for 20 percent of the China's total water supply.
- In China, most cities depend on a single source of water. In 314 prefecture-level cities, only 69 percent of them have a back-up water supply plan.

DROPPING WATER QUALITY

- Only 70 percent of urban water meets the national quality standards. If towns and counties are counted, the number is likely less than 50 percent.
- 50 million people in cities do not have access to clean drinking water due to non-point pollution sources.
- The wastewater treatment rate in Chinese cities increased from 34.3 percent in 2000 to 87.3 percent in 2012 and is expected to reach 95 percent in 2020. However, few cities are treating wastewater sludge.

Sources: Zhang, 2014 and Du, 2016

The Chinese government has not altogether ignored the potential gains that can be made from better demand side management of water:

- **Ramping up Water Conservation Investment:** In 2015, the Ministry of Water Resources announced a 488 billion RMB ($79 billion) investment into water protection—half of which will be spent on major water conservation projects with the rest used to supply drinking water in rural areas ("China plans increased investment," 2015).

- **Advocating Public-Private Partnerships:** In May 2015, China's National Development and Reform Commission also released a list of more than 1,000 proposed projects to be funded via public-private partnerships, some of which include projects focused squarely on improving water conservation ("China invites private investors," 2015).

- **Pushing Water Recycling:** Over the past 40 years, Beijing municipality has made some notable gains in key areas of water-use efficiency— gains that hint at significant potential for continued progress in the years ahead. For example, between 1978 and 1984, the rate of recycled industrial water in Beijing jumped from less than 50 percent to more than 70 percent. Many of today's key economic players in China, including textile manufacturers and the coal industry, were among the parties driving this early improvement in water efficiency. The increased usage of reclaimed industrial water supply was all the more impressive because during that time period, overall water consumption saw a modest drop, while overall industrial production rose by more than 75 percent (Xie et al., 1993).

Water management officials have to walk a tightrope in the years ahead as they look to keep Beijing, Tianjin, and other northern Chinese cities afloat with sufficient water. They will not only have to balance supply-side interventions against demand-side efforts, but also balance the water demands of growing urban populations against the competing water needs of the agricultural, industrial, and power sectors. Complicating matters further, these allocation challenges are surfacing as worsening environmental degradation and evolving climate change impacts are making the quality and quantity of water available in northern China ever more unpredictable. Given the severity and uncertain nature of northern China's water stress, it perhaps comes as little surprise that officials are willing to invest whatever energy resources are needed to mitigate this worsening crisis.

FROM THE SEA TO THE CITY: ENERGY IMPLICATIONS OF CHINA'S DESALINATION PUSH

One of the principal drivers behind the expanding energy footprint of urban water services in China has been the desalination industry. Already, desalination plants dot the coast from Dalian to Tianjin to YuHuan, and between 2015 and 2018, China will be building several more facilities along its coastline as part of a multi-billion dollar desalination construction push. While some of the earliest opened plants have been hemorrhaging money, water planners are confident that in time, the country's investment into desalination will pay off and bolster water security for coastal industries and urban households.

The energy required to desalinate seawater has dropped over the decades as the technology has become more sophisticated—particularly owing to the development of reverse osmosis membranes—but the process remains an energy-intensive undertaking. Physics dictates that at least one kilowatt hour (kWh) per cubic meter must be used to desalinate seawater (Elimelech, 2012). To date, however, the most efficient energy usage for desalination has been two kWh per cubic meter, using reverse osmosis. Currently, energy expenditures of three to four kWh per cubic meter of desalinated seawater are more common, making desalination far more energy-intensive than groundwater extraction or surface water withdrawals (Dashtpour & Al-Zubaidy, 2012). (See Box 2).

As China's desalination industry expands, the country has taken steps to reduce the sector's energy footprint as much as possible. For example, at the YuHuan Desalination Plant in Zheijang Province—one of China's largest plants that opened in 2006—designers have used pressure exchanger technology to make operations more energy-efficient as the plant produces 36,000 cubic meters of desalinated water per day. This technology boasts the potential to cut energy consumption at desalination plants by more than 65 percent, and by 2008, 8 out of every 10 desalination facilities in China were employing similar pressure exchanger technology ("YuHuan desalination," 2008).

NO SILVER BULLET

Desalination operations farther north in Tianjin are also seeking to reduce the amount of energy needed for saltwater conversion. In this water-stressed city, the state-of-the-art Beijing Desalination Plant on the Bohai Sea was built at a cost of more than 12 billion yuan. As a hybrid facility, it both desalinates water and produces 4,000 megawatts (MW)of coal-generated electricity. The plant has sought to set new standards for energy efficiency in the desalination sector, by repurposing the steam generated from its thermal power operations into the desalination process. Despite the high expectations for the facility, it has underperformed. Built to purify 200,000 cubic meters of potable water every day, the plant did not produce even 25 percent of that amount after opening in April 2010, owing to infrastructure issues and problems with utility companies in the area (Watts, 2011). The comparatively high cost of the plant's desalinated water—some 30 percent higher than non-desalinated water in Tianjin—has dissuaded some potential industrial buyers (Hatton, 2013).

The neighboring northern Chinese metropolises of Tianjin and Beijing, as seen from space. As both urban areas continue to grow, water demand in each has soared. China has invested heavily in supply side measures such as desalination and bulk water transfers to mitigate mounting water scarcity in both cities.
Photo credit: NASA (used courtesy of Flickr Creative Commons license)

BOX 2. Rising Energy Costs of Drilling Deeper for Chinese Groundwater

In northern China, California, and many other regions of the world facing droughts, industries, farming communities, and local governments have looked not to the skies but to the ground to supplement water supplies. In many of these places, unsustainable rates of groundwater withdrawals have catalyzed serious land subsidence—with the weight of urban centers such as Las Vegas, Beijing, and countless others, pushing downward on depleted groundwater tables and compacting aquifers. Once aquifers are crushed the ground cannot hold as much water as it once did, greatly lessening long-term water security for cities.

To be fair, in China and most other countries around the world, the agricultural sector consumes the vast majority of groundwater withdrawals and overall water usage. In northern China, groundwater irrigates some 70 percent of all agricultural land (Li et al., 2012). While accounting for a comparatively small percentage of groundwater pumping in the north, cities are contributing to the groundwater depletion trend.

As recent as 30 years ago, those seeking groundwater from the once-vast aquifers beneath the North China Plain only needed to drill about three meters underground. Today the average depth to reach groundwater in northern China is 60 meters. Pollution from agriculture, industry and energy production have been contaminating vast swaths of the remaining groundwater supplies closer to the surface, forcing some cities to drill more than 150 meters into the earth for drinking-quality water. In the suburbs of Beijing, the situation has become worse and some wells must now be dug more than 750 meters deep (Solomon, 2010). With each additional meter that must be drilled downward, the energy needed to pump these dwindling groundwater supplies to the surface increases, although the exact amount of increased energy required depends upon the specific hydrology and geology of a particular aquifer. In 2010, groundwater pumping at the national level made up almost one percent of total China's energy usage ("Water energy nexus," 2015). As Chinese policymakers shift more coal production for power, chemicals and gas to western China so as to reduce air pollution in east coast cities, the water tables are likely to drop even more drastically. (*Editor's Note: See Chang and Shuo feature article in this issue for more on this trend*).

With China's total urban population possibly on pace to reach one billion by 2030, groundwater pumping will remain an important—if unsustainable—means of modestly augmenting urban water supply, particularly in the north (Boyd, 2012). Yet some cities in the region have taken steps toward more sustainable stewardship of their local groundwater resources. In Tianjin, where the urban area's elevation dropped more than two meters between the early 20th and early 21st centuries, groundwater-pumping restrictions have been imposed to stave off further aquifer compaction ("Cities sinking," 2003). Other northern cities will need to follow suit before it is too late to meaningfully recharge groundwater stocks.

Some studies estimate that nonrenewable, accessible groundwater supplies under the North China Plain may dry up by 2035, if not sooner, in some areas like Beijing (Solomon, 2010). The writing is on the wall: groundwater can no longer be relied upon to provide such a large portion northern China's water demand.

Still, expectations remain high for desalination to help Tianjin and Beijing make up their water shortfalls. The energy footprint of desalination is not measured solely by the volume of seawater processed at the plant, but also by the energy needed to transport the desalinated water to the end consumer. With Beijing 90 miles from the sea and Tianjin on the coast, neither city will require distant overland shipments of desalinated water which helps lower the sector's energy footprint. Costs of transport could raise, however, if coastal cities opt to pump and desalinate offshore fresh water reserves. (See Box 3).

Despite desalination's energy-intensive nature and the technology's significant environmental impacts on coastal waters, the sector is projected to grow significantly in China in the decades ahead. Tariffs may help offset some of the financial costs associated with the practice and the Chinese government is funding research and development to lower the energy costs of saltwater conversion and use this technology as one to eventually export.

Even assuming Beijing's water needs remained static and that its entire desalinated water supply used current state-of-the-art practices to convert saltwater using two kWh per cubic meter, the energy costs of desalinating 1.4 billion cubic meters annually would be staggering—roughly the equivalent of powering the state of California for one year (California Energy Commission, 2010).

Desalination is no silver bullet and cannot fully meet the growing annual demand for fresh water in China's urban north. Even if the energy costs of desalination drop below two kWh per cubic meter in the future, it is unlikely that desalinated water could eventually meet even 50 percent of Beijing's overall water needs (Watts, 2011).

One promising solution to energy-intensive water supply lies in harnessing the potential for renewable-powered desalination. Using green energy sources such as solar or wind to power the notoriously energy-intensive process of purifying seawater is the focus of research efforts throughout the world, and China is an active participant. In late 2013, it opened the country's first windpower desalination plant in Dafeng. With a 2.5-MW wind turbine powering operations, the plant is expected to generate 10,000 tons of desalinated water every day ("China looks," 2013). If successful this project could be replicated in many other coastal locations, reducing the fossil fuel footprint of China's expanding desalination efforts and decreasing the sector's greenhouse gas emissions.

MOVING EARTH, MOVING WATER: THE SOUTH-NORTH WATER TRANSFER PROJECT

Since construction officially broke ground in 2002, the South-North Water Transfer Project (SNWTP) has proven an enormously ambitious and controversial undertaking. Slated to eventually channel roughly 45 billion cubic meters of water from China's water-abundant south to Beijing and other water-scarce cities in the north via three main branches, this bulk water transfer project—with an estimated price of $62 billion that could go much higher—has been beset by problems from the beginning (Moore, 2013). In December 2013 the SNWTP started supplying Beijing with water, bringing 100 million cubic meters of water in the first year ("China plans," 2015).

Water pollution along the SNWTP's central branch has emerged as a major concern, while criticisms of the project's environmental impacts and its displacement of populations along its route have simmered for years. The project has even triggered rare public opposition from some government officials, such as Qiu Baoxing, vice minister of China's Ministry of Housing and Urban-Rural Development, who argued in February 2014 that northern cities should focus more

Massive earthworks have been required for the South-North Water Transfer Project (SNWTP), which officially broke ground in 2002 and remains under construction. The project, intended to bring much-needed water from the country's water-abundant south to Beijing, Tianjin, and other water-starved northern cities, is a bulk water transfer scheme so ambitious that it has no historical precedent.
Photo Credit: Bert van Dijk (used courtesy of Flickr Creative Commons license)

on water conservation, rather than depend on outside supplies (Wang, 2014).

Lost in the shuffle of the broader SNWTP debate over water pollution, however, has been discussion of the expenditure of energy required to construct and operate the SNWTP infrastructure upon its completion. Long-distance bulk water transfers on the scale of the SNWTP have never before been attempted anywhere else. The three main branches of the project cover large distances and the central and eastern branches are being routed under the Yellow River. In the case of the still-unrealized western branch that is scheduled to be completed in 2050, water would need to be transported at elevations in excess of 4,500 meters above sea level (Moore, 2013).

Portions of the eastern branch, which will help carry fresh water northward to Tianjin among other coastal locations, became operational in December 2013. Operations along this 1,150-kilometer branch will likely leave a substantial energy footprint, due to elevation changes along its route and water contamination concerns in the branch's waterways. To move water over such varied terrain—projected to require more than 0.1 kWh per cubic meter (Jaffe & Schneider, 2011)—23 pumping stations with an installed capacity of more than 450 MW are being built to support seven existing stations ("South-to-North Water," 2014). Some estimates have placed the total annual electricity requirements to move water supplies northward along the eastern arm at roughly 2.8 billion kWh as a result (Jaffe & Schneider, 2011).

In comparison, the SNWTP's 1,260-kilometer central branch may fare comparatively better from an energy use standpoint. Once fully operational—test shipments of water began moving through the central branch's infrastructure in late 2014 to much fanfare—the central branch is projected to bring Beijing one billion cubic meters annually while also slaking the thirst of Tianjin and 18 other northern Chinese cities (Li, 2014). In all, planners project the central branch will pump 6.5 billion cubic meters of new water supplies from the south to be used by industry and municipal water systems in the

BOX 3. Prospects for Pumping China's Offshore Fresh Water Reserves

In late 2013, a report published in *Nature* (Post et al., 2013) broke new ground by confirming that "vast meteoric groundwater reserves" (VMGRs) were actually quite common in coastal waters throughout the world. Collectively, these seabed aquifers may hold an estimated 500,000 cubic kilometers of groundwater. For some sense of scale, "the volume of this water resource is a hundred times greater than the amount we've extracted from the Earth's sub-surface in the past century since 1900," according to Dr. Vincent Post, lead author of the study.

One of these large continental shelf aquifers sits off China's coast under the East China Sea. At least some of these local offshore groundwater stocks had been known previously. In Zhejiang Province's Shengsi Island, for example, the provincial government has already begun operations to pump seabed groundwater. With the increasing sophistication of offshore drilling technology associated with the energy industry, harvesting seabed groundwater in even hard-to-access areas of the continental shelf under the East China Sea appears within the realm of technological possibility in the not-so-distant future. The prospects of pumping offshore groundwater are appealing for eastern Chinese cities because in addition to diversifying supply streams for urban fresh water, it may reduce burden on aquifers sitting under dry land, easing groundwater compaction problems in Shanghai, Beijing, and other major cities.

Lost in the hubbub to date has been discussion of how much energy would be required to successfully extract and desalinate deep-lying seabed groundwater supplies and move them to where they are needed. VMGR water supplies can be harvested using offshore platform drilling into the continental shelf below or by drilling from nearby islands. While not as saline as regular saltwater—and therefore possibly only 20 percent as energy-intensive to desalinate as regular seawater—VMGR water will nevertheless require some degree of energy to purify for human use (Chen, 2014).

While these groundwater stocks could help provide water to some large coastal cities for decades, centuries, or even longer, such projections are far from certain and more research is needed as to the volume of the water and economical ways to extract it. Regardless of where the truth actually lies, these offshore supplies will in time likely emerge as part of a patchwork approach to meet growing water demand in China's thirstiest cities, as well as in other water-stressed coastal areas of the world. As China's issues with urban water scarcity grow more severe, it may be that any water supplies within Chinese territory—onshore or offshore—must be harvested at any cost, making the energy resources needed to obtain these supplies a distant second consideration.

north. Unlike the eastern branch, the central branch is designed to rely primarily upon gravity to transfer huge volumes of water from the south to consumers in the north (Office of the SNWDP Commission, 2014). Energy requirements for pumping supplies with the earth's natural forces along the central branch should be reduced considerably.

The component of the central branch that may likely leave the greatest energy footprint will be wastewater treatment. In November 2013, China's Ministry of Environmental Protection conceded that Hubei Province's Danjiangkou Reservoir—an important component of the central branch's overall waterworks, with a capacity of 1.7 trillion cubic meters—had been receiving raw sewage from industries along five nearby rivers, forcing the government to shut down operations of some of the suspected polluters (Larson, 2013). Consequently, the reservoir's waters may require more energy-intensive wastewater treatment than earlier anticipated to ensure water supplies transported north are of acceptable quality.

It is possible that regardless of the fate of the project's western branch, the SNWTP's central and eastern branches may in time prove critics wrong and help mitigate water supply concerns in Beijing, Tianjin, and other northern cities. However, there exists a third approach to bolstering urban water security in the north that may prove even more effective than any long-distance bulk water transfers or desalination construction boom. It is urban wastewater treatment and water recycling that may give northern Chinese cities a far heftier bang for its *yuan* in terms of enhancing their present and future water security.

The Danjiangkou Dam in Hubei province is a key component of the central arm of the South-North Water Transfer Project (SNWTP). Unlike the project's eastern branch, the central arm is designed to move water supplies to China's arid north primarily via gravity. In late 2013, China's Ministry of Environmental Protection acknowledged untreated sewage entering the Danjiangkou Reservoir had raised concerns about the quality of water supplies being readied for shipment north.
Photo credit: International Rivers (used courtesy of Flickr Creative Commons license)

GREY WATERS RUN DEEP: MAKING THE MOST OF WASTEWATER

Agriculture, industry, and households all draw upon China's water resources for their own purposes. After water supplies have been used within those sectors, whatever water has not been fully consumed is returned to the hydrological system. Insufficient treatment of returned water from these sectors heightens the risk of chemical pollution from agricultural fertilizers, heavy metal contamination from industrial processes or biological contamination from untreated sewage—all of which degrade surface and groundwater supplies and pose significant public health threats.

Insufficient wastewater treatment and the subsequent contamination of water resources are matters of growing public concern nationwide.[1] In terms of total domestic wastewater discharge, six provinces—Guangdong, Jiangsu, Shandong, Zhejiang, Henan and Fujian—generate roughly 45 percent of the country's wastewater ("Wastewater treatment," 2013). To ease worries over water quality in these provinces and elsewhere, wastewater treatment is becoming big business and represents a major growth industry in China. The government has gotten behind the effort in recent years, investing heavily in the wastewater treatment industry during the 11th Five-Year Plan (2006-2010) and pushing to raise the country's urban wastewater treatment rate during that period to 70 percent ("Opportunities," 2009). The country has also announced plans to construct a centralized sewage treatment plant for each individual industrial park by the close of 2017 ("Cabinet officials," 2015).

Wastewater treatment requires significant energy inputs, but still produces a major economic and environmental benefit: a variety of sectors can reuse treated wastewater—in some cases multiple times—for purposes ranging from irrigation to energy production. Recycled water supplies do not necessarily need to achieve drinking level quality either, meaning they can be treated less intensively and therefore require less energy per cubic meter treated. Recycled water for flushing toilets or supplying fire departments, for example, does not need to meet health standards concerning human consumption (Zhou et al., 2013). From an environmental impact perspective, meanwhile, treated wastewater poses less of a hazard to local ecosystems once it is reintroduced back into the hydrologic cycle.

A DISMAL FUTURE?

Despite its many benefits, wastewater treatment has not been widely implemented across China to date. Average water reclamation utilization rates at the national level sit at roughly eight to nine percent, far beneath the average 70 percent water reclamation rate of many developed countries ("Wastewater treatment," 2013). Encouragingly, Chinese cities have been making serious strides in terms of municipal wastewater treatment and water recycling.

As urban areas have grown, there has been an attendant rise in the volume of wastewater they generate. However, wastewater volumes have not increased equally across all sectors:

- Between 2002 and 2012, the amount of municipal wastewater produced throughout the country (excluding agricultural wastewater) increased at a faster rate than industrial wastewater.

- In 2011, municipal wastewater constituted 62 percent of a total 68 billion tons of wastewater produced nationwide, while industrial wastewater—contributed primarily by the steel, chemicals, paper manufacture, leather, and pharmaceutical sectors—constituted 38 percent ("Wastewater treatment," 2013).

- A 1997 law mandating that industrial plant owners curtail water usage is one of the main reasons municipal wastewater generation has outpaced industrial wastewater generation.

- In the Inner Mongolian city of Baotou the massive Baotou Iron and Steel Company plant now repurposes nearly 100 percent of its water supplies (Schneider, 2011).

State-directed water conservation and recycling efforts could play an important role in helping shore up urban water security in the north. Even if the country chooses this course, however, the energy costs of treating and repurposing municipal and industrial wastewater will likely remain high in aggregate for the foreseeable future as China's cities will continue to grow significantly through mid-century. Even if the volume of municipal wastewater generated nationally in 2012 held steady over the coming years at roughly 42 billion cubic meters, the energy needed to treat wastewater from that sector alone would remain substantial. Given that it requires approximately between 0.2 and 0.4 kWh to treat a cubic meter of wastewater (Ivanova, 2011), treating China's municipal wastewater at 2012 levels would require between 8.5 billion and 16.8 billion kWh annually—which is between two and four percent of the power China consumed as a nation in November 2012 (Hua & Chen, 2013).

BEIJING MUNICIPALITY AS RECYCLING LEADER

Beijing hopes to lead the way in terms of water treatment and recycling initiatives. With nine wastewater recycling facilities already, Beijing is pledging it will continue with its ambitious steps to enhance water reuse.

United Nations Secretary General Ban Ki-moon leads a delegation while on a tour of a wastewater treatment facility in Xi'an in Shaanxi province. As China's cities have expanded in recent years, so too has demand for improved wastewater treatment. Under the current Five Year Plan, the Chinese government is seeking to grow investment in the wastewater treatment sector by 15%.
Photo Credit: United Nations Photo (used courtesy of Flickr Creative Commons license)

According to the deputy general manager Hui Li of Beijing's Qinghe Regenerated Water Plant, the central part of the city has made significant progress in reaching its 2015 objective of repurposing nearly all of its wastewater as grey water. City officials now even mandate that new office and residential buildings be constructed with two sets of plumbing infrastructure—one for ordinary fresh water supplies and one for repurposed grey water. The Qinghe facility is also seeking to set an example by making its wastewater processing more energy efficient. The plant has upgraded its processing potential by more than 500 percent in recent years, from 80,000 cubic meters per day to 450,000 cubic meters, and has lowered its energy requirements per cubic meter of recycled wastewater to 0.4 kWh. This feat is significant because the energy needed to treat and recycle local wastewater in this instance is far less than the energy needed to import water supplies from beyond the city's limits (Ivanova, 2011).

These promising developments in Beijing are consistent with trends at the national level in wastewater treatment. Between 2011 and 2012, the number of wastewater plants in China grew by six percent, reaching nearly 4,000, and treatment capacity across China grew more than four percent to 142 million tons. Also by 2012, municipal wastewater treatment rates had risen to 85 percent, while industrial wastewater treatment had reached 95 percent. It merits mention, however, that only 20 percent of the wastewater sludge produced by these plants gets treated. Expanding sludge treatment is hindered in part by the energy it would require (Li & Han, 2015).

As a sector, wastewater treatment can make further gains in energy efficiency as well as coverage, but indicators are pointing in the right direction. Under the 12th Five-Year Plan (2011-2015), China aimed to increase investment in the wastewater treatment sector by more than 15 percent. The current plan also dictates that 57 percent of treatment-related investment be earmarked for wastewater pipeline construction, while 43 percent be earmarked for facilities themselves ("Wastewater treatment," 2013).

LESS IS MORE

As in the past, growing urban water demand will likely continue to outpace energy efficiency gains in the water services sector. What can be done to ease both the country's energy crunch and its water crunch? The only tested and proven means to kill both birds with one stone involves a substantial shift toward demand-side water management in the years ahead. While supply side management strategies dominate, demand-side policy interventions are slowly making progress in addressing China's urban water issues.

Institutionalized water recycling in the municipal and industrial sectors can decelerate growth of urban water demand over time, helping reduce overall energy consumption in the water sector and easing reliance on energy-intensive bulk water transfers and desalination.

One recent study by researchers from Nanjing University analyzed the water-energy nexus under a wide variety of water-use scenarios and suggested that lowering household water demand by 10 percent could reduce energy requirements for the overall water system by between two and three percent. While the study found reusing 20 percent of wastewater could help drop overall water system energy usage by only a very small amount (an estimated 0.06 percent, since wastewater treatment is itself a relatively energy-intensive undertaking), harvest and distribution of rainwater promised the biggest impact in energy savings, potentially reducing the overall water sector's energy usage by some six percent (Zhou et al., 2013).

Conservation—another significantly underutilized demand-side management approach—can also play a major role in easing China's urban water stress. To enhance conservation efforts, public education campaigns targeting urban areas should be considered to raise awareness and induce behavioral change regarding water usage.

Government financial assistance could also be extended to businesses and households willing to invest in retrofitting factories, offices, and homes with conservation-minded items like low-flow toilets. Businesses and households could be offered tax breaks for using recycled water, and current or future water pricing schemes could favor those water consumers who cut down on overall usage. However, it is important to note that water pricing reform remains a thorny and complicated topic in China, as in much of the rest of the world. In order to most effectively incentivize conservation, the Chinese will have to work out a water pricing plan that is acceptable to the public and private sectors alike—a daunting task (Zhou et al., 2013).

Despite the challenges, conservation and recycling measures implemented in concert with one another have the potential to fundamentally reshape public perceptions and behaviors toward water use not just in northern Chinese cities, but in water-stressed cities in other corners of the country as well. In recent years decision-makers in the Chinese water sector are opening up to demand management as a key tool in combatting the country's urban and overall water challenges (Freeman, 2011). If the trend continues, China's cities can only stand to benefit.

AS GOES BEIJING, SO GOES THE COUNTRY?

To achieve a more sustainable energy and water future for Beijing and other urban spaces across the north a more thorough understanding of the energy footprint of urban water services is needed. Beijing will remain a compelling indicator of the evolving successes or failures of water stewardship in the urban north.

The city's about-face regarding the emerging severity of its water problems may have come late, but late is better than never. Beijing has in recent years ushered in a slew of new standards and practices for wastewater recycling. The city's growing embrace of water recycling is undoubtedly a positive development, and represents one of the most promising long-term approaches to bolstering urban water-use sustainability and lowering the water-use energy footprint to other Chinese cities.

Beijing and other water-stressed cities following its lead are recognizing the strategic importance of investing significant funds into shoring up water-treatment and water-delivery infrastructure. Ensuring these investments are sustained—and, just as importantly, coupled with mandatory water conservation and recycling efforts—could go a long way toward bringing urban China back into the realm of environmental and economic sustainability.

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ENDNOTES

1 In 2013, some 40 percent of Chinese surveyed cited water pollution as a "very big problem," up from 33 percent in 2012. In fact, respondents identified water quality concerns as the fourth biggest issue facing the country after air pollution, income inequality, political corruption, and rising costs of living. Poll respondents said water pollution concerns trumped worries over other perennial anxieties, such as traffic, crime, worker conditions and labor protections, and safety of medical supplies ("Environmental concerns," 2013).

Urbanizing China's Pigs

by Fred Gale & Dinghuan Hu

WHY PIGS?

In recent years, the Chinese public's attention has gravitated toward various pork-related problems: rapid price fluctuations, exposés on illegal feed additives, revelations about sale of diseased meat, and reports on carcasses floating in rivers. Chinese farmers, government agencies, and industry owners are responding to these concerns by exploring new ways of producing and consuming pork in an increasingly urbanized society.

In this commentary, we tell the story of the China's changing pork industry by describing some innovative ventures by Chinese farmers, industry leaders and agricultural officials (See Box 1). The efforts we review below are based on on-site visits, company literature and Chinese media news (Gale, Simpson, Snelson, Stuart, & Webb, 2011; Gale and Hu, 2010 & 2011; Gale, 2011; Southern Metropolitan News, 2013).

SEGREGATING PIGS FROM PEOPLE

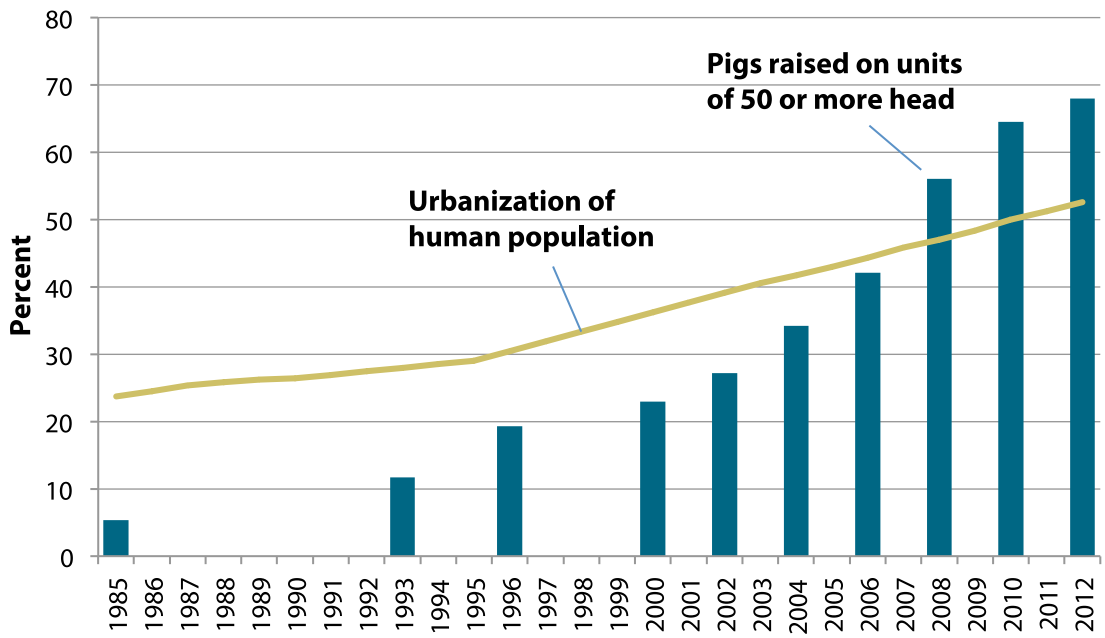
The segregation of pigs from people is one of the broad themes of China's contemporary pork industry. Traditionally, pigs in China lived in close proximity to human populations. This "cheek to jowl" dynamic was still apparent in the 1996 agricultural census, which found that 70 percent of rural households nationwide raised pigs (Li, 2000). However, rural households are now abandoning "backyard" pig-raising, as authorities raise concerns about disease and waste disposal problems arising from the mixing of people and pigs.

As the human population concentrates in cities, it is paralleled by the "urbanization" of pigs sequestered in concentrated units. The urban share of China's human population doubled from just 25 percent in 1985 to over 54 percent in 2014. Over the same period, the proportion of pigs raised in facilities producing more than 50 head annually rose from about five to 68 percent. By 2012, eight percent of Chinese pigs were raised on large farms of 10,000 head or more (Ministry of Agriculture, 2013).

Segregation of pigs and people has been most pronounced in rapidly developing coastal regions. The Brothers Ecological Farm in Zhejiang Province holds dozens of barns for pigs in a walled compound separated from village residences by acres of rice fields. The farm manager said there were no other pigs within a five-kilometer radius of his facility. In contrast, Sichuan's Fuyuan Company works with local officials to develop hog-raising villages where pig sheds are interspersed among human habitations.

Pork suppliers often emphasize their choice of remote, pristine locations to raise pigs. The most extreme example is a network of farms set up to supply pork to Olympic athletes at the 2008 Beijing Olympic Games. Access to the farms was tightly controlled and the location of the farms was kept secret, but they were said to be situated in remote areas free of industrial pollution. The web site of the Number 1 Native Pig Company describes itself as building a premium brand of pork by raising native-breed pigs in "orchards and hillsides with a quality environment, clean air, and free of industrial pollution."

Figure 1. Urbanization and "Above-scale" Hog Production



Source: China Statistical Yearbook and China Livestock Industry Yearbooks (1986-2013).

COMPANY CONTROL

In China, increased company control over the pork supply chain is viewed as a strategy for addressing ecological, disease, and food safety concerns. Regional pork investment projects usually revolve around a meat or feed company that controls the supply of inputs, processing, and distribution of pork. Company control of breeding and propagation of pigs is a common strategy to standardize the genetic stock of the animals and prevent disease spreading among piglets and sows—the most vulnerable segment of the chain. Fattening of hogs remains mostly dispersed among small farmers who have access to land, feeds and labor.

The Fuyuan Company in Sichuan represents a common strategy of linking up companies and pig farms in China. It constructed a large mechanized slaughter house and several large company-owned breeding farms. Scattered rural households fatten the pigs to slaughter weight. The company collaborates with local officials to improve facilities for hog-raising in villages, set up a farmer cooperative to supply piglets and feed, disseminate good agricultural practices, and improve access to financing.

The Number 1 Native Pig Company emphasizes its control over an integrated supply chain from production to table, calling itself the country's largest concentrated production base of native-breed pigs. The company requires farmers that supply pigs to use "traditional" breeds, feed, and husbandry methods.

Some companies are exerting more control over the fattening of hogs. In 2011, the chairman of Shuanghui Group, one of China's largest meat companies pledged to set up company-controlled farms to gain greater control over the safety of products following a scandal involving one of his company's subsidiaries ("Shuanghui decided," 2011). The Fuyuan Company has experimented with production contracts that pay farmers a fixed fee to raise company-owned pigs.

MITIGATING PORK'S ENVIRONMENTAL IMPACT

Environmental pollution from hog waste is an important problem that is only now getting the attention of government officials and farmers in China. China's 2010 census of pollution sources reported that animal waste was a major source of water pollution. Since then, agricultural officials and companies have responded by appending "ecological" and "recycling" measures to the industrialized hog production model. This trend may gain more momentum thanks to the State Council's March 2015 endorsement of a plan for sustainable agricultural development that demands better utilization of animal waste as one of its key points.

The Ministry of Agriculture's main strategy has been a "hog-biogas-fruit" recycling model (Li, 2013). Hog waste is used to produce biogas, and the residual waste is then purposed to fertilize fruit trees or vegetables or feed fish or ducks. The Brothers farm in Zhejiang is designed to demonstrate this recycling model for farming. Biogas is generated from pig waste and the residual is piped to fertilize nearby vegetable farms and rice fields.

The Little Donkey Farm, a community supported agriculture (CSA) farm in Beijing, uses a fermentation bed—a one-meter deep

BOX 1. Innovative Pork Production Ventures in China

- Fuyuan Duo Duo Meat Company in Sichuan Province, is a former county slaughterhouse designated by provincial officials as a flagship pork company.
- Brothers Ecological Farm in an ecologically-planned village in Zhuji City, Zhejiang Province, with designated tracts for houses, rice, vegetables, fish ponds, and a pig farm.
- Olympic Pork Farm was originally set up to supply pork to athletes at the 2008 Beijing Olympic Games.
- Number 1 Native Pig Company sells pork from native pig breeds through a network of specialty shops.
- Netease Company—one of China's major online companies—announced in 2009 a plant to supply pork that could be tracked through the entire production process by consumers over the internet.
- Little Donkey Farm, a community-supported agriculture farm on the outskirts of Beijing, offers vegetables, as well as pork and chicken by subscription.
- Discount pork shops have been opened by commerce bureaus in a number of Chinese cities to build confidence in the quality of pork and cut prices by eliminating middlemen.

mix of sawdust, ground-up crop straw, and microorganisms—in its hog barns as an alternative to the concrete floors used by most Chinese farms. The bedding absorbs and breaks down the waste from the pigs and can be later removed and used as organic fertilizer. The Netease pig farm also devoted substantial time and effort to addressing the problems of smell and waste treatment. The managers say they train pigs to defecate in a designated part of the barn where a drain carries waste directly to a treatment facility.

In 2013, the Fuyuan Company announced a clean-up project for its five breeding and propagation farms that will install fermentation beds in barns holding over 700 pigs; build biogas digesters, storage tanks, and slurry ponds; and pipe wastewater to irrigate fields and orchards near hog farms. The project's environmental impact statement said it intends to relocate 23 neighboring families that could be adversely affected by the project's smell and noise.

BUILDING CONFIDENCE IN PORK

The segregation of pigs from people means that more traders, butchers, processors, and truck drivers are needed to get pork from the farm to the dinner table. With more anonymous intermediaries in the supply chain, there is greater risk of illegal additives, pathogens, and spoiled meat reaching the dinner table without the consumer's knowledge. In this respect, one of the challenges suppliers face is to build consumer confidence in pork.

Supermarket meat counters in China typically display photos or even videos of large farms and mechanized slaughterhouses with a detailed description of the company. Some companies operate small meat stands in wet markets with similar displays. This is meant to show the hygienic conditions in which the meat is processed and consequently, promote confidence. Meat companies are experimenting with sales of pork through their own chain stores, a strategy that also helps companies build consumer confidence.

Commerce bureaus in a number of cities have set up small shops and meat counters to sell pork directly procured from farms or cooperatives. Official news media describe the shops as a government program to improve social welfare. These ventures seem to have dual objectives of reducing costs and increasing consumers' confidence in pork by cutting out expensive and untrustworthy middlemen. News media descriptions emphasize the sanitation and safety of the pork by mentioning stainless steel counters and freezers. The pork is sold at a discount ranging from 5 to 12 percent below the prevailing retail price. Descriptions of the shops underscore the savings from cutting out middlemen, as they also receive subsidies to help offset rent and operating costs. Notably, meat supplied directly by farmers is also exempt from the 13-percent value-added tax.

CSA arrangements are exploring ways of engaging urban consumers with the producers of their food and sharing risks and the financial responsibility of growing food. China's CSA's mainly offer vegetable deliveries by subscription, but Little Donkey Farm members can also get periodic deliveries of pork from pigs raised on the farm. The farm's pigs are kept in a barn open on one side that allows visitors to come into direct contact with the animals. This contrasts with common biosecurity measures on large-scale pig farms that prohibit visitors and keep pigs in enclosed buildings.

CONCLUSION

Many of China's consumption and production patterns are legacies of its agrarian past that need to be "re-booted" for an urban society. Officials, entrepreneurs, and scholars are bringing new ideas and capital to the production and marketing of pork—a very traditional Chinese product.

Over several decades, China has been gradually melding elements of industrial-style farming with Chinese traditions. Experimentation is needed to find models appropriate to China's resource base and consumer preferences. Farmers and officials can encounter serious problems like disease epidemics and pollution problems by haphazardly adopting production and marketing models that developed over decades overseas where resource endowments differ from China's.

Like most of China's agricultural development efforts, the public and private sectors are intertwined. Companies and profit-making play a central role in pork-industry explorations, but the government has an important supporting and coordinating role in many of the described ventures. Discount pork shops, Olympic farms, and mainstream pork-supply programs make use of subsidies and government support. Some company ventures appear to have a mix of profit-making and social responsibility objectives. In contrast, CSAs are grassroots ventures that receive minimal support from local authorities.

Pork is becoming more costly to consumers as producers adopt environmental and food safety controls that have often been neglected in the transition to a "modern" pork industry. High cost seems to be a common feature among the explorations described here. Pork from the Number 1 Native Pig, Little Donkey, and Olympic-supplying farms all cost several times the average retail pork prices and their consumers appear to be drawn largely from high-income groups. The discount pork shops are targeted at middle or low-income urban dwellers, but these businesses appear to rely on subsidies. Thus, it is likely that pork's dominance will recede as consumers pay the "full" cost of eating pork.

Pork is becoming less and less a generic commodity. Chinese consumers have diverse choices of different types of pork at different price points and with different ecological and nutritional attributes. It can be consumed in different forms from different retail outlets. Different types of pork and different production systems will fill the varying market niches. There is no one-size-fits-all solution.

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Muddy Waters: The Public Health Risks and Sustainability of Bottled Water in China

by Abigail Barnes

The men took their positions in front of their lanes, elastic caps tightly gripping their heads and silver diaphanous bulbs shielding their eyes. As the Olympic swimmers geared up for the 400-meter freestyle in London, China's Sun Yang cracked open a bottle of water and doused himself. His Hungarian competition took the more traditional approach, splashing himself with handfuls of pool water. At the 2012 London Olympics, a striking number of Chinese swimmers emptied bottles of water over their bodies before the start of each race. This public spectacle not only reflects China's vibrant consumer culture, but also carries a note of irony given that water shortages affect over half of China's cities. One can't help but wonder whether these acts reflect broader Chinese perceptions of bottled water as a high-status consumer item.

For decades, bottled water has fueled an international industry saturated in secrecy. This is particularly true in China, where data and information concerning business operations can be difficult for citizens to obtain. Although commercial market research on Chinese bottled water exists, these industry reports are generally expensive and thus difficult for the public to access. Moreover, this research generally includes only consumption rates, sales, and key market shareholders. Unsurprisingly, the Chinese public has very little information about the quality of bottled water being consumed in ever-greater quantities. This article relies on the information available surrounding China's bottled water industry to piece together a glimpse of a well-guarded water world.

CHINA'S GROWING BOTTLED WATER MARKET

Urbanization and rising energy demand have strained China's fresh water resources. Approximately 70 percent of China's fresh water supplies are polluted to some degree, and the water pipes in many urban areas are outdated, often leeching impurities into the city's public drinking water. As the country's economic growth outpaces fresh water supplies, national water demand is projected to rise 63 percent by

2030—which is "gallon for gallon, more than anywhere else on earth" (Wines, 2011).

This brings us to bottled water: the ostensibly pure, healthy water source that offers safety and abundance in the face of contamination and scarcity. In 2009, Asia was considered the leading driver of global bottled water growth—with China spearheading consumption ("Some ups," 2010). Between 2004 and 2009, annual bottled water consumption in China doubled (Rodwan, 2010) and nearly doubled again between 2010 and 2015 from 19 billion to 37 billion liters ("Spring tide," 2015).

The remarkable rise in the bottled water industry may be attributable to the consumer belief that bottled water is healthier, cleaner, and safer than tap water. In countries like China, where there is a dearth of bottled water information, the premise that bottled water is safer than tap water is difficult to verify. Despite uncertainties about bottled water quality in China, ongoing contamination scares suggest that the nation's bottled water may present significant public health risks.

An additional area of concern is the broader cost of bottled water, which is not always as clear as its contents. The environmental impacts of water extraction, transportation, packaging, and disposal are generally not reflected in the price of bottled water. This reality leaves society bearing the unaccounted environmental and social costs. However, if they have not already, Chinese bottlers will soon feel the strain of water scarcity, which is expected to worsen in 2050 due to growing demands from cities, industries, energy production. In a country of 1.3 billion people, where bottled water consumption rates are expected to rise, the environmental burden may prove too great for China's water ecosystem to bear.

SURFACING SCANDALS

The 2008 melamine milk scandal, which left six babies dead and more than 300,000 infants with kidney stones, still lingers in the minds of Chinese consumers. After this incident and a wave of other high-profile public health scares in China's food and beverage industry, the government tightened quality control regulations. Encouragingly, in 2015 the long-awaited *Food Safety Law* was passed, but even with this stricter and more expansive new law it will take a number of years for supporting implementing legislation to be passed and governance gaps and transparency problems still plague the sector (Hatton, 2015). Thus, the "cure" for the deficiencies in quality control in China's food and beverage sector is still not in place.

Bottled water in China is particularly susceptible to contamination given the industry's antiquated and lax regulations as well as the high financial costs of proper water filtration. This combination of factors may be converging in a perfect storm exploding into a public health scare on par with China's melamine scandal.

In a country like China—where water pollution is pervasive and tap water notoriously risky—bottled water is presumably a safer alternative because the brand reputation is at stake. But the lack of transparency in this industry challenges this presumption. Additionally, China's infamously poor tap water quality makes purchasing bottled water in China easier to justify than in many developed countries where generally fewer tap water quality concerns exist—tragic exceptions such as the major public health crisis that emerged in late 2015 in Flint, Michigan due to lead pipes leeching into city drinking water.

Skepticism surrounding the quality of bottled water is mounting in the wake of contamination scandals that have compromised perceptions of China's bottled water safety and undermined its perceived superiority.

In July 2011, the government performed random market inspections of bottled water brands and found that over 30 of these brands violated safety standards. One brand purportedly contained bacteria 9,000 times the permissible safety levels ("Beijing halts sales," 2011). A 2009 survey conducted by China's regulatory authorities on single-use 500ml bottled water samples found elevated levels of bromate—a suspected carcinogen. In May 2013, Nongfu Spring, a popular Chinese bottled water brand, was following a provincial standard inferior to national regulatory standards ("Nongfu Spring reels," 2013). This more revelation of regulatory noncompliance underscores China's supervisory shortcomings. Strikingly, China's national standards for bottled water are modeled on old Soviet Union-era standards and are well below international standards for water (Boehler, 2013).

Scandals involving the falsifying of bottled water brands are also emerging from the shadows (Wang, 2013; "Nongfu Spring halts," 2013). An employee of the bottled water business reported "about 60 percent of barreled water on the [Chinese] market is fake brands…and some illegal water factories fill the barrels with tap water but paste the labels of popular brands on them" (Wu, 2013). The art of mislabeling is supported by such anecdotal evidence, as well as statistical data from the China National Health Association on the national quality-grade output for polycarbonate—the material used to make water jugs. These statistics show that sales of polycarbonate fall short of demand (Wu, 2013), inviting another sobering question: what material are bottlers using to make up the difference, and could it pose a risk to human health?

WATER CHALLENGES AHEAD

China's reliance on bottled water as a drinking resource is a symptom of a larger and more serious disease: China's extremely polluted water resources. China is home to some of the most contaminated freshwater resources in the world, and its municipal water systems are in desperate need of repair and modernization. To date, the government has failed to provide its own people with access to safe drinking water—one of the building blocks of life. The government must address water quality problems in its freshwater resources and municipal water systems. If it fails to do this, safe and clean drinking water will only be available to those who can afford it, effectively increasing social unrest and further tarnishing China's already tainted public image. In the years ahead, China's bottled water market will need to respond to increased demand, water scarcity, and public health concerns. Without a firm commitment to quality control, environmental issues, and public water access, more than just the survival and success of China's bottled water industry will be at stake.

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China's Green Entrepreneurs

by Ella Chou

THE STORY OF WANG GANG

Wang Gang, 42, has been a photography enthusiast his whole life. He loves traveling, taking photos, and visiting websites where backpackers post copious pictures of their adventures. However, when he compared his own photos taken at home in China to those snapped by travelers in foreign lands, he always found their photos considerably more vivid. "They must have better camera equipment," he reasoned. It was not until he visited the United States and took a road-trip on U.S. Route 1 that he realized it had nothing to do with camera quality, only the clean air.

Wang's interest in the environment goes beyond capturing clear vistas. He is a green entrepreneur, part of an emerging cohort of ambitious innovators who look to build businesses around the deep need and increasing market demand for solutions to China's environmental challenges. These entrepreneurs face challenges common to entrepreneurs everywhere—building products, attracting investment, and bringing their solutions to the market. But they also see an array of challenges and opportunities unique to China, where public consciousness of environmental problems is increasing quickly.

Wang is the founder and CEO of Iraini, a company whose solar-powered pressure tank irrigation system uses collected rainwater for landscape and greenhouse irrigation. His clients have included the China Pavilion at the 2010 Shanghai World Expo, Kunming World Horticultural Garden, and the 2014 Youth Olympic Games in Nanjing. Wang's solar-powered technology only uses one 100-watt solar panel to irrigate 500 m^2, a fraction of what other solar-powered irrigation systems would use. It requires no additional power or water and the system costs 70,000 to 80,000 RMB ($10,500 to $12,000) to irrigate 500 m2 of land. Larger systems are even less costly at around 100 RMB/m^2 ($1.49/square feet), with low operation and maintenance costs.

Wang started developing ideas for the system in 2004 when he was a contractor in Shanghai installing heating, ventilation, and air conditioning (HVAC) systems in buildings. As a native of Kunming in Yunnan Province, Wang describes himself as "an environmentalist first, and a tech person second." He has always been interested in solar power, but the relatively high cost and the challenges in storing energy drove him to think of ways to make the technology more efficient.

With his background in industrial automation, Wang started drafting designs whenever he was not at work; however, unlike his hero Steve Jobs, he did not have a garage to put his ideas into action. Frustrated, he eventually decided to rent a cheap 20 m^2 workspace in Baoshan, in the outskirts of Shanghai. After half a year of experimenting and blueprinting designs, he finalized a prototype in 2010. It was only in 2012, after two years of development to increase the design's reliability, range of irrigation, and control mechanisms, that he launched Iraini. "The environmental deterioration in China is very saddening," Wang said. "I hope my systems can contribute to a lot of public and private projects."

The entrepreneur wants his systems to replace the current practice of government-run water trucks that roam Chinese city streets watering the roadside landscape, arguing that his solar-powered system would save water, gasoline, and human labor. Iraini's rooftop garden irrigation system has already been incorporated into another Chinese entrepreneur Cai Yugang's building efficiency service company as a low-energy solution to provide landscape irritation.

The entire enterprise is completely self-funded and cost Wang $120,000. At no point did he ever receive any funding from venture capital, banks, or the government. "From an investment perspective, green small and medium enterprises (SMEs) need more capital upfront and have a longer payback period than mobile apps or internet startups," according to Zhang Tao, the co-founder and managing director of China Impact Fund, a multimillion dollar fund that specializes in financing and accelerating SMEs and startups focused on sustainable land use, clean energy and water access. He added that despite gradual improvements in the financing environment for enterprises producing environment-friendly products and services, SMEs and startups have yet to benefit from it.

OVERCOMING THE INVESTMENT GAP

The Ministry of Environmental Protection, the China Banking Regulatory Commission (CBRC), and the People's Bank of China announced a Green Credit Policy in 2007, encouraging banks to take into account a project's environmental impact when lending. In early 2015, CBRC and China National Development and Reform Commission promulgated guidelines on energy efficiency credit, which increased support for industrial, building, transportation efficiency, and other energy service industries.

In practice, the promotion of sustainability projects using green credit still faces three main challenges. First, banks lack expertise in environmental science and low-carbon technologies, preventing them from effectively evaluating the environmental risks and merits of each project. Second, banks do not have the legal authority to demand their clients comply with their rules. Third, banks are less likely to provide upfront loans for green-tech projects due to uncertainty and the low rate of return on certain sustainability-focused projects.

Lack of capital draws many young green entrepreneurs in China to online crowdfunding platforms such as Zhongchou and Demohour, where they can raise money by offering certain perks for different levels of contribution. A number of small green projects obtained their seed funding from a "fan" base, and the entrepreneurs were able to roll out their products by the thousands through these Chinese Kickstarter-like platforms. One example of a project that has successfully used such crowdfunding platforms is Spotmau P1, a desktop air purifier that monitors ambient air pollutants and gives alerts when air quality deteriorates. Another beneficiary of crowdfunding is Lin Haobin, whose Winmart Design mini garden is a Lego-like fully customizable desktop system that uses plants to power a clock, an LED lamp, a USB, wireless charging station, a Bluetooth speaker, or a humidifier.

SEEKING A FACTORY IN A MANUFACTURING EMPIRE

Tinsee is a solar-powered smartwatch that looks like a luxury brand watch but has the functions of a fitness bracelet with workout tracking and sleep monitoring. It was developed by 30-year-old Zhang Pengcheng, along with three friends who have experience in tech, design, and marketing. They raised over 240,000 RMB ($38,650) and were able to use their *guanxi* (personal connections) with a factory to make these watches at a low-profit margin. "This was our biggest challenge," Zhang Pengcheng said. "Factories would ask us what the quantity is and they were not interested in small-batch orders. Entrepreneurs don't appeal to the big, experienced factories."

The difficulty in finding a high-quality factory willing to work with entrepreneurs in small quantities is shared by many green start-ups in China. Denny Dong, CEO of Lifesmart, a cloud-based wireless "smart home" technology company, said they set out to seek Apple's suppliers to make their Lifesmart control boxes. These boxes have sensors and cameras that feed data to their software to learn human behavior, and automatically shut off lights and other electronics to increase energy efficiency. The Apple suppliers were not interested in the Lifesmart products. In the end, Dong picked a smaller factory, whose lack of experience led to an underestimation of the real cost of production. The error in cost projections meant that the first order was produced at a net-loss for the factory. During the process, however, the Lifesmart team collaborated with the plant to develop its production capacity. Despite the initial loss, the factory still sees the partnership positively and now showcases the product to potential clients.

GREEN MARKETING?

Another big challenge for green SMEs is marketing. Clients are often unfamiliar with environmentally friendly products that may feature new technologies or have unusual functions. Given that large-scale publicity campaigns come with big price tags, emerging entrepreneurs must find innovative ways to promote their products.

For Lifesmart and many other green startups, crowdfunding platforms are powerful marketing and PR tools. Zhongchou and Demohour sometimes feature fully funded projects that are seeking to expand their market reach. iKair, for example, is an egg-shaped home environment management device which users can customize to monitor humidity, noise levels, and common in-house pollutants such as formaldehyde and $PM_{2.5}$. Users can track the results and receive warnings on their smartphone app.

Shortly after iKair concluded a $2 million pre-A funding round from Gobi Partners VC in 2013, they launched their project on Demohour to accept pre-orders and sold nearly 232,000 RMB ($37,200) worth of products in two weeks. For well-funded green startups, factories in China are a great advantage. The factories in Shenzhen, for instance, have accumulated vast experience in prototyping and manufacturing, and reached a high level of craftsmanship through working with multinational companies. The factory producing iKair has been making Nokia products for nearly a decade.

The founder and CEO of iKair is 34-year-old Wang Yongtao. His interest in technology comes from his mother, an electrical engineer who gave him an Apple II computer when he was 10. Before iKair, he worked for Tsinghua Tongfang, collecting industrial and environmental data on nuclear and coal-fired power plants. These kinds of data, he thought, were not helpful to the average person. He wanted to collect indoor environment data that would make a substantial difference in people's lives, because the average Chinese urban resident spends 80 percent of her/his time indoors, and China's rapid build-up and low quality interior decoration often come with severe indoor air pollution.

Wang's interest in the environment happened to collide with what he calls a "golden time for hardware innovation" in China. The wave of internet and mobile technology development since 2008 drove down the price of all kinds of electronic components—central processing units (CPUs), semiconductors, Wifi routers, and Bluetooth—which are all widely used in many smart products. Smart products combine dedicated hardware with an app, and use the popularity of the app to open up the market and sell the hardware. Crowdfunding platforms, the rapidly growing product development process and a new willingness of venture capitalists to invest in hardware since 2013, Wang says, are unleashing an unprecedented energy in sustainable hardware innovation in China, even exceeding that of the United States.

REACHING CLIENTS: E-COMMERCE AS A GAME-CHANGER

China's green tech startups also enjoy the advantage of the country's extraordinary e-commerce development: Alibaba facilitated over $240 billion in sales in 2013, more than eBay and Amazon combined. "China has made unbelievable progress and logistic innovations," according to Chris Evdemon, partner at Innovation Works, an incubator and early stage VC founded by Kaifu Lee, former chief of Google China. "These Chinese e-commerce websites offer free same-day shipping, detailed tracking, phone call notification, free returns—a much superior shopping experience." These are the platforms on which green entrepreneurs such as Wang Yongtao are selling their products.

E-commerce is a channel. However, what is really driving China's green entrepreneurship is its huge market and growing environmental consciousness. Over the past few years, China's government has issued new regulations to help achieve its ambitious goals in carbon-intensity reduction and meet stricter environmental standards. The private sector has much to contribute to this end; in 2013, China invested 536.44 billion RMB ($86.36 billion) in low-carbon industries, of which, 37 percent came from policy banks and funds, 37 percent from commercial banks, 14 percent from state and local government investment subsidies, 10 percent from public companies, and two percent from international financial institutions. Adding investment from companies in low-carbon technologies, the total would reach 750 billion RMB ($121 billion).

"The green entrepreneurial environment in China is so much better than that of 10 years ago," says Tian Zhen, official at International Finance Corporation's China Utility-Based Energy Efficiency Finance Program. "Thanks to the huge demand created by the average Chinese, the green industries can reach economies of scale. Even the U.S. doesn't have such high standards in building efficiency for instance."

FUTURE CHALLENGES AND OPPORTUNITIES FOR YOUNG GREEN-TECH ENTREPRENEURS

A growing number of people born in China in the 1980s and 1990s are interested in entrepreneurship. Tian says that this generation is less obedient and more likely to pursue alternative career paths. Richard Brubaker, professor at the China Europe International Business School, says the post-80s generation is far more socially aware and mobile than before; they are interested in project-based work, and a growing number of them are keen on sustainability. He calls them "a generation of want-preneurs."

What prevents the "want-preneurs" from becoming "entrepreneurs" is not the lack of ideas, but rather a reluctance to turn ideas into products. Entrepreneurship only happens when people do not have to worry about their livelihood, Tian says, but the high housing prices in China's major cities exert tremendous pressure on young persons. Brubaker commented that Chinese students tend to be much more risk-averse than their American counterparts. "They are often one-dimensional, limited in cutting-edge innovation and imagination," Evdemon said. Many experts attribute this to the Chinese education system which puts much emphasis on test-taking, thereby inhibiting creativity and out-of-the-box thinking.

Dr. Tian Yajun, a senior manager at National Institute of Clean-and-Low-Carbon Energy who has been involved in the research and development of Shenhua Group Corporation's $1.46 billion carbon capture project at its $3.58 billion coal-to-liquids plant, says the output of China's low-carbon investment has not seen returns. Better enterprise management may help overcome the issue, but it will be hard to change this situation without establishing a truly free scientific research environment and ensuring a free platform for young people to utilize their talents and exercise their full potential.

China's green entrepreneurs face a great challenge. Not only do they have to provide profits and jobs, they have the added responsibility of leading China on a path of sustainability. They operate in a maelstrom of energy that both discourages and provides hope: the dire environmental challenges they are trying to address go beyond what any nation has ever faced, but present a unique opportunity to attempt something no one has tried before and make a lasting impact on future generations. Wang Gang hopes his sustainably irrigated gardens and landscaping can help clean up China's air. This new generation of green entrepreneurs like Wang not only can trailblaze China's transition toward a more sustainable future, but also position the country as a global leader in green innovation.

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Top-down, Bottom-up, and Middle-out: Global Environmental Institute's Comprehensive Approach to U.S.-China Cooperation

by Caroline Jo, Qingchan Yu, & Christopher Dunn

When the Global Environmental Institute (GEI) was founded in 2004, it operated out of a small apartment in Beijing with only a few staff members. While its staff, office, and activities have grown significantly, Madame Jiaman Jin (one of GEI's co-founders) remains as executive director and it was not until late 2015 that GEI moved out of the same neighborhood that had been its home for 11 years.

Back in 2004, on-the-ground efforts to address climate change in China were largely nonexistent and climate change was predominately dealt with only at the highest political levels. In the years since, GEI has strived to involve a range of actors in international climate projects, spearheading collaboration between the governments of California and Guangdong, and undertaking crowdfunding initiatives at the grassroots level to take action. By the time GEI celebrated its 10th anniversary in 2014, the diversity of its partnerships and activities reflected both the internationalization of GEI's work, and more broadly, the internationalization of the Chinese government's environmental efforts.

BROADENING THE PLAYING FIELD: BUILDING DIRECT RELATIONSHIPS BETWEEN GUANGDONG AND CALIFORNIA

When GEI first got involved in 2008 as the only independent Chinese nongovernmental organization (NGO) supporting the *U.S.-China Track II* dialogues on climate change, all eyes were focused on potential bilateral national collaboration. The Track II dialogues consisted of informal meetings between high-level decision-makers and senior advisors in the U.S. State Department and China's National Development and Reform Commission (NDRC), preceding the annual United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP).

Thanks to its involvement, GEI identified the untapped potential of sub-national actors—and the possibilities for sub-national bilateral climate collaboration. Given that state and provincial leaders possess significant leverage, the question arose as to whether or not establishing partnerships between American and Chinese sub-national players would yield much-needed activities to support climate change mitigation.

To scope out interest in sub-national

partnerships, GEI and its U.S. partners began coordinating with the Chinese province of Guangdong and the State of California in early 2009. As regional powerhouses and sub-national leaders in innovation, the two regions seemed to be best positioned to profit from such a partnership. Following GEI's initiative, several other organizations began to champion increased California-Guangdong climate collaboration. The combined efforts culminated in the California-Guangdong Memorandum of Understanding on low-carbon development cooperation in April 2013. (See infographic following this box for a summary of this program). The opportunities for more subnational cooperation are growing due to the U.S.-China climate agreement in November 2014 and the U.S.-China Climate Leadership Forum held in Los Angeles in late 2015 that catalyzed numerous cities, states, and provinces to create partnerships to work together on low-carbon initiatives.

EMPOWERING WITH METRICS: THE TOOLKIT

Through its work, GEI soon realized that sub-national governments often either lacked the necessary science-based analytical tools and metrics to take influential and informed climate action, or otherwise were unable to use such measurements effectively. For example, Chinese officials have traditionally favored qualitative over quantitative analysis in their policymaking and implementation processes. Thus in 2009, GEI launched the *Cooperation on Low-Carbon Development Planning* program to advise sub-national governments about energy and climate metrics so as to empower Chinese officials to make informed decisions for achieving carbon intensity reduction targets. In cooperation with the U.S.-based Center for Climate Strategies and the Institute of Policy and Management at the Chinese Academy of Sciences, GEI developed a toolkit consisting of policy quantification and evaluation models. Adapted from those widely used by American states, the toolkit calculates greenhouse gas emissions reductions and related costs of various energy and climate policies, while also providing macroeconomic impact assessments. The initiative was one of the first in China to provide quantitative analysis to sub-national governments interested in developing low-carbon policies.

GEI first introduced the policy toolkit to tempered enthusiasm; initially, Chinese officials were unconvinced of the practical value of such models. However, GEI and its partners persisted and employed the toolkit in various pilot initiatives. In Guangdong Province, the toolkit has produced detailed economic impact assessments of the provincial emissions trading scheme that is the world's second largest cap-and-trade scheme. Following its application, senior officials in Guangdong Province have recognized the advantages of using the toolkit and have incorporated the results of GEI's analysis into their report on the emissions trading scheme submitted to the NDRC. Guangdong's relative success in the scheme likely influenced Xi Jinping to include carbon trading as one of China's major commitments at the COP21 in Paris.

In Chongqing Municipality, the toolkit has been applied to analyze cross-sector low-carbon development policies and evaluate their economic impact, covering more than 100 carbon emission sources from six key sectors: energy, industry, transportation and land use, buildings, agriculture and forestry, and waste treatment. The analysis showed that total carbon emission reductions from adopting the quantified policy options would prove enough to achieve Chongqing's 2015 carbon intensity target. A report entitled *Analysis of Low-carbon Policies in the Chongqing 12th Five-year Plan and Recommendations* was submitted to the Chongqing Municipal Development and Reform Commission in early 2014. The report was recognized by senior officials, who praised the quality and innovation of the research along with the practicability of the policy recommendations, some of which will be adopted in Chongqing's 13th Five-Year Plan.

ENABLING GRASSROOTS PARTICIPATION

In recent years, GEI also has extended its work on U.S.-China collaboration to the grassroots level. On April 20, 2013, the tragic Ya'an Earthquake hit Baoxing County in Sichuan Province—an ecological hotspot and the site of multiple bio-conservation efforts led by GEI over the past nine years. To assist in the area's recovery, GEI piloted a crowdfunding project to rebuild and expand the Fengtongzhai Honey Cooperative, a local sustainable honey enterprise. Aimee Bailey, a Henry Luce Scholar from the United States who was working with GEI at the time, led the work.

Crowdfunding is a novel financing mechanism that enables many individuals (a.k.a. "backers") to contribute small sums of money to a project through an online platform. While it has yet to gain widespread popularity in China, GEI sees crowdfunding as an important, new mechanism. The Fengtongzhai Honey Cooperative case demonstrates how it can be used to support sustainable development projects among NGOs, and promote grassroots engagement globally to constructively confront China's environmental challenges.

GEI ran two successful crowdfunding

GEI staff and local beekeepers at the Fengtongzhai nature reserve – a GEI Conservation Concession Agreement project site and focus of the 2013 crowdfunding initiative. © Global Environmental Institute

campaigns using the China-based Demo Hour[1] platform and the U.S.-based Indiegogo[2] platform, from 28 April to 6 June 2013. 170 backers from at least nine countries participated in the campaign and contributed 26,927 Yuan on Demo Hour and $10,354 on Indiegogo to support local farmers in Baoxing County. The crowdfunding campaigns together raised nearly $14,700, enough money to purchase 114 beehives, which were critically needed to rebuild and expand a local honey cooperative in order to sustain livelihoods and protect the ecosystem.

In exchange for supporting the project, backers received non-monetary rewards, such as a GEI tote bag, a T-shirt designed by Beijing's iconic Plastered™ T-shirts, and honey produced in Baoxing County. GEI summarized its research work and findings from the pilot project in a report, *Crowdfunding Manual for Nonprofits, Social Enterprises and Grassroots Organizations*,[3] to promote this fundraising alternative. GEI has continued to conduct training sessions on crowdfunding for NGOs in China.

THE IMPORTANCE OF A MULTI-LEVEL APPROACH

In its first decade of work GEI has made a conscious and dedicated effort to engage with a range of actors on climate action and environmental protection more broadly. National governments, sub-national governments and grassroots groups all possess specific skills and opportunities, ranging in their scale of impact, flexibility in execution, and speed of mobilization. Given the diversity and scale of environmental issues, all actors can and should contribute in their own unique ways. Looking forward, GEI is eager to continue working with its existing partners, and forging new partnerships, in order to address environmental issues through a comprehensive approach.

GEI is a China-based nonprofit, NGO with an international focus. The Energy and Climate Change Program is one of GEI's four core work streams; the others being Biodiversity Conservation, Capacity Building, and Investment, Trade and the Environment. For more information see www.geichina.org.

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ENDNOTES

1 For video in Chinese explaining the beekeeper project see: http://www.demohour.com/projects/318586.

2 English version of the beekeeping project http://www.indiegogo.com/projects/rebuilding-the-fengtongzhai-honey-cooperative.

3 PDF available here: http://www.geichina.org/_upload/file/crowdfunding/crowdfundManual_final%20EN.pdf.

THE POWER COUPLE

In April 2013, Guangdong Province and California State signed an MOU on low carbon development. The economic clout of these two subnational superpowers combined with their drive to promote clean energy and low carbon development sets the stage for a compatible partnership—a true power couple.

DRIVE

Proving themselves subnational pioneers, Guangdong and California have established the largest carbon cap-and-trade schemes in their respective countries.

Early 2012

California launched cap-and-trade program

- more than 300 companies
- covers 35% of regional greenhouse gas emissions
- encompasses about 160 million tons of CO_2 equivalent

Dec 2013

Guangdong launched cap-and-trade pilot

- about 200 companies
- covers 58% of regional greenhouse gas emissions
- encompasses about 350 million tons of CO_2 equivalent

CLOUT

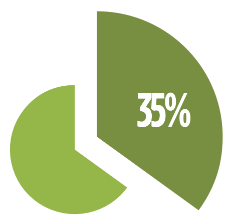
As the largest sub-national governments within their respective countries, their actions have national and global implications.

California	Guangdong
12% of the U.S. population	8% of China's population
13% of the U.S. GDP	11% of China's GDP
2nd largest energy consuming state	7% of China's energy consumption

COMPATIBILITY

Guangdong and California's economies are uniquely positioned for cooperation, with California's extensive low carbon development experience and Guangdong's manufacturing capacity and green aspirations. Electric vehicles (EV) constitute one particularly promising field of cooperation.

ELECTRIC VEHICLES



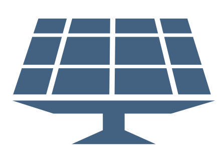
California accounted for 35% of the U.S. electric vehicle market in 2012.

200,000

Guangdong aims to achieve a production capacity of 200,000 new electric and hybrid vehicles per year by 2015.

Other Areas of Collaboration

Green buildings



Clean energy

Sustainable transportation

Source: Global Environmental Institute

THIRSTY COAL

China's Coal-Water Conflict

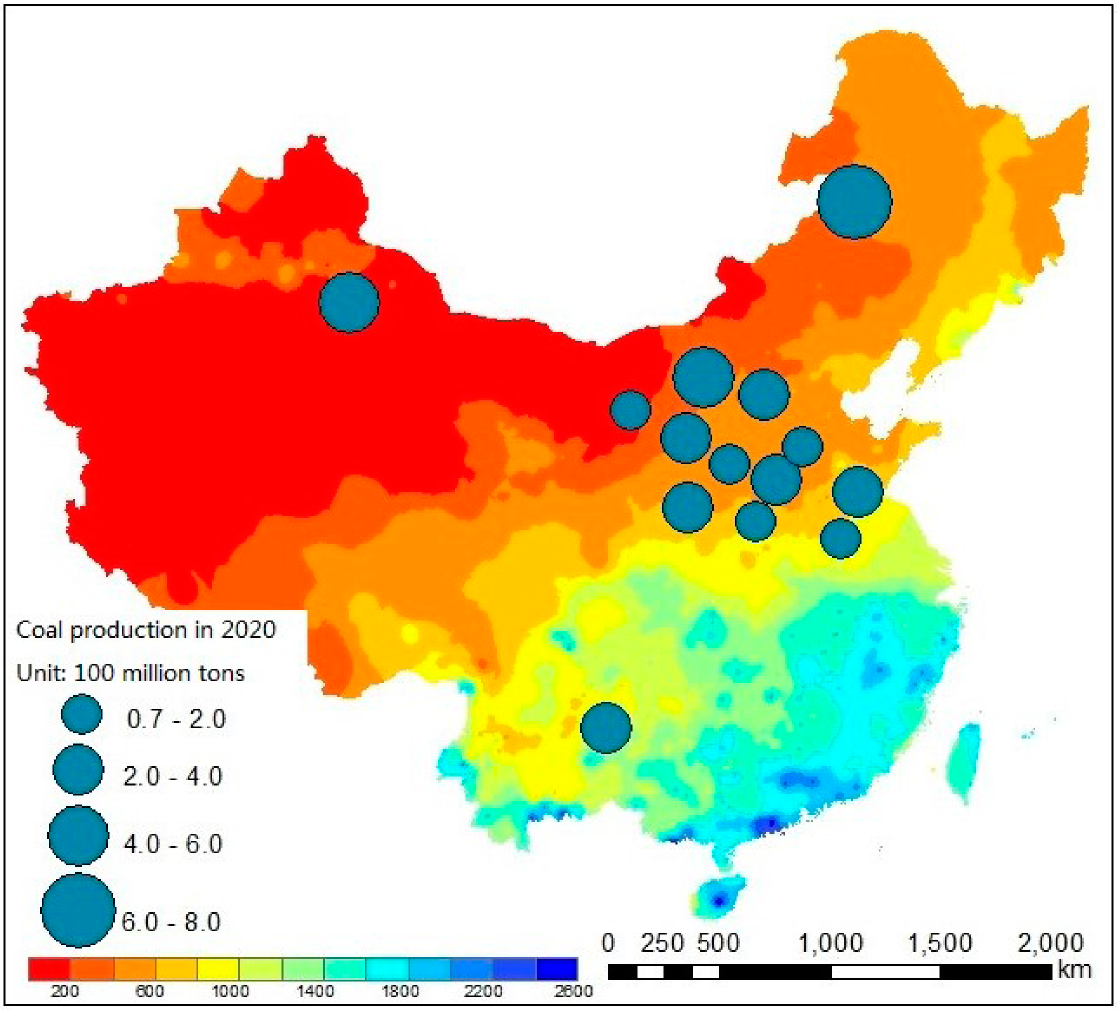
by Iris Cheng & Li Shuo

COAL-WATER MISMATCH OF UNPRECEDENTED SCALE

As China's economy grows, its thirst for energy—nearly 70 percent of which now comes from coal—is intensifying. Over the duration of the 12th Five-Year Plan (2011-15), the world's second largest economy aimed to construct 16 large-scale coal power bases across China's north and west—these huge bases incorporate large-scale coal mines, coal-fired power stations, as well as coal-to-chemical and coal-to-liquid factories together at a scale not seen anywhere else in the world (State Council, 2013; NDRC, 2012). In 2015, seven of these bases—situated in the provinces of Inner Mongolia, Shanxi, Shaanxi, and Ningxia—were expected to produce a total coal output of 2.2 billion tons, or 56 percent of China's projected annual coal output for 2015 (3.9 billion tons) (State Council, 2013). Given that China's coal expansion is primarily taking place in its arid western areas, these water-intensive projects will inevitably trigger a serious water crisis and exacerbate existing water scarcity problems.

To assess the extent to which increased coal production threatens water resource availability in China, Greenpeace and the Institute of Geographical Sciences and Natural Resources (IGSNR, under the Chinese Academy of Sciences) worked together on a groundbreaking study of the estimated water consumption of the 16 planned coal power bases. The findings were published in the report, *Thirsty Coal: A Report on Coal-Power Base Development and Water Resources* in August 2012 (IGNSR & Greenpeace, 2012). The study suggests that water demand created by these plants will have reached at least 9.975 billion m^3 in 2015—equivalent to one-sixth of the annual total water volume of the Yellow River during a normal year. It also estimates that in 2015, the water demand of coal power bases in Inner Mongolia, Shaanxi, Shanxi, and Ningxia would either severely challenge or even exceed the total industrial water supply capacity in each area.

Figure 1: 14 Major Coal Mining Bases Under the 12th Five-Year Plan

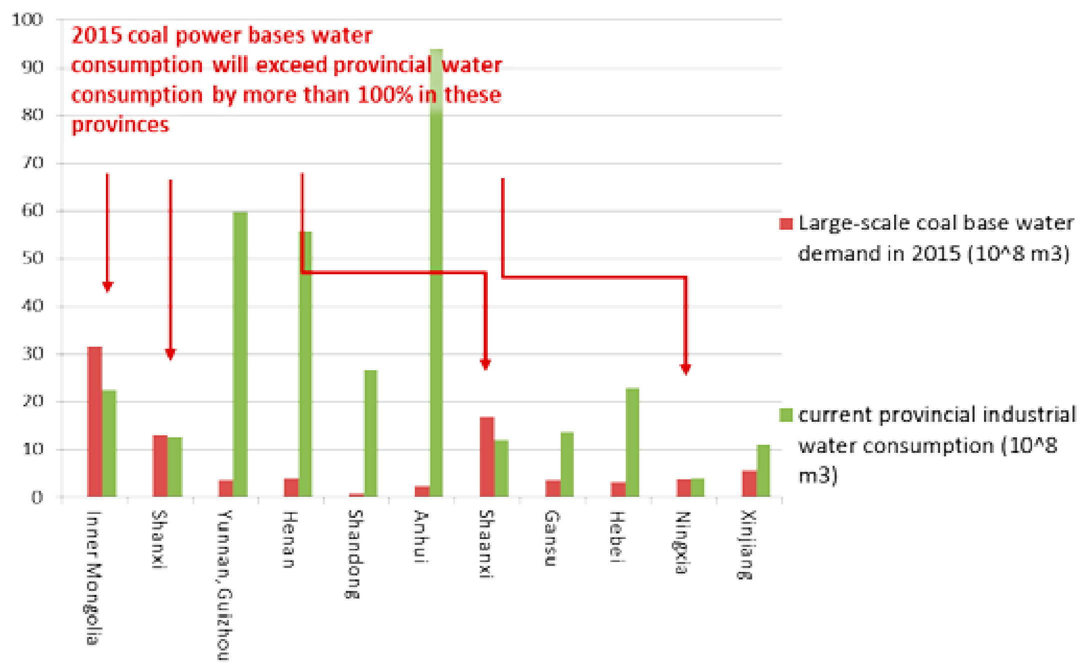


Note: Color indicates annual precipitation milimeters/year

Source: Greenpeace Energy Desk, 2014

By comparing water demand of these coal bases with water supply in their respective locations, this study has put a big question mark over the feasibility of China's ambitious coal expansion strategy. Case studies in the report suggest that the poorly planned development of the massive coal power bases will not only drain groundwater resources, but also contaminate them. This may exacerbate drought, as there will be less usable water available, and cause the widespread destruction of grasslands, forests and other ecosystems. Moreover, it could pollute and over-consume the water resources of the Yellow River and other key rivers in China's dry north. The study also found that the development of coal-related industries in these areas will take up a significant amount of water currently allocated for non-industrial uses, such as farming, drinking water, and ecological conservation.

Figure 2: Comparison of Coal Base Water Demand with Provincial Industrial Water Consumption (2015)



Source: Thirsty Coal: A Report on Coal-Power Base Development and Water Resources

This massive expansion of coal power bases is inconsistent with the country's uneven distribution of water resources. If China insists on going ahead with the goals laid out in the State Council's and National Development and Reform Commission's Five-Year Plans, an already arid western China will likely suffer a series of water crises (State Council, 2013; NDRC, 2012).

THE COAL CHEMICAL BOOM THAT DOES NOT HOLD WATER

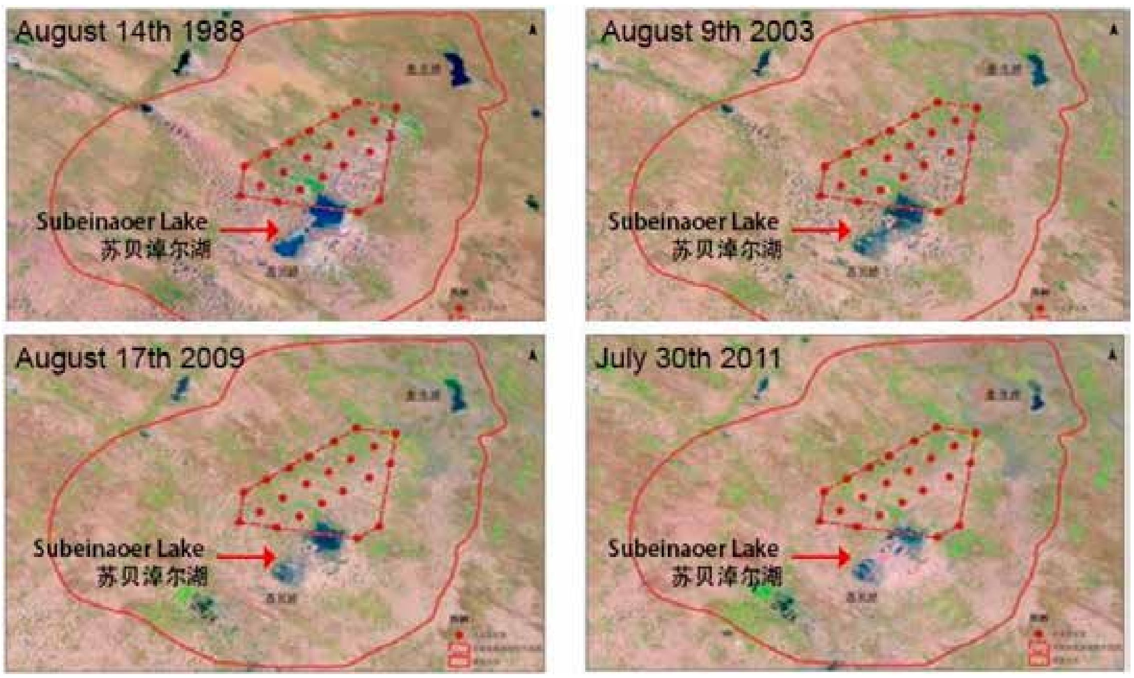
In 2013, Greenpeace continued to investigate the growing conflict between coal and water resources, leading to the publication of the *Thirsty Coal 2* report in July 2013. Greenpeace focused on China's coal-to-chemical sector, which is not only extremely water intensive, but also symbolizes the problem that reckless expansion of coal entails. Greenpeace's investigation focuses on Shenhua's Coal-to-Liquids (CTL) Demonstration Project located in Inner Mongolia's Ulan Moron, near the city Ordos. Given its size and scope, this project is a classic example of the unchecked expansion of coal-reliant industries that is in growing conflict with China's water resources.

Started in 2002, the Shenhua project is the largest CTL plant in China. The complex sources coal from nearby mines, such as the Shendong coal mining zone. The collective, unmitigated excavation of coal resources over the past twenty years had already left a significant impact on the region's water resources. The base itself is even more water intensive than the traditional pulverized coal plants that have plagued China's water resource availability for decades. It is estimated that for every ton of oil produced via direct coal liquefaction, three to four tons of coal and ten tons of water are required (Lei & Zhang, 2009). Based on official analysis, the project's first production line requires at least 6.65 million tons of water annually (Greenpeace

East Asia, 2013). The Shenhua CTL project relies on 22 wells dug over 300 meters deep, each with a maximum capacity to extract 58,000 m^3 per day. In practice, they extract 14.4 million tons of water annually, and 50 million tons of water to date.

This massive groundwater extraction has had an enormous impact on the local Haolebaoji environment. Groundwater in the region has dropped by about 100 meters compared with 10 years ago (Greenpeace East Asia, 2013). Meanwhile, satellite imagery shows a clear decrease in the surface area of Subeinaoer Lake, the largest in the region. When compared with images from 2004, before Shenhua began extracting water for coal production purposes, the lake now covers 62 percent less surface area, equivalent to a loss of 1.27 square kilometers. As a result, surface vegetation has significantly declined, affecting livestock, and therefore threatening the basic living needs of 2,402 households in the region.

Figure 3: Coal Base Water Withdrawals and Subeinaoer Lake, Inner Mongolia



Satellite images show the location and impacts of the coal base water extraction operations on the Subeinaoer Lake and another local lake.

Source: Greenpeace East Asia, 2014

COAL, WATER, AIR: THE TRIPLE THREAT TO WESTERN CHINA

Another family member of the coal chemical sector—coal-to-gas (CTG)—also has received considerably more attention from policymakers in China. Throughout 2013, 15 new CTG projects were approved by the National Development and Reform Commission (NRDC). This was unprecedented given that only four such projects were given the green light from China's top economic planning body before 2013. One important driver behind these project approvals is China's severe air pollution. Heavy coal use in eastern China contributes to frequent smog. In seeking solutions to the crushing smog problem, policymakers have started to support plans for converting coal into synthetic natural gas (SNG) in the country's coal-abundant west, to then deliver it to the eastern regions for consumption. Proponents argue that switching the end fuel from coal to gas will alleviate air pollution. At first glance, this idea may look like a silver bullet for a country desperate for solutions to its environmental woes. Indeed, SNG has gained such strong traction that even the Vice Minister of the Ministry of Environmental Protection Wu Xiaoqing publically expressed support for the development of CTG in the central and western regions of China (Wu, 2014).

A more careful analysis, however, shows that CTG plants are unlikely to alleviate China's air pollution significantly and will instead further burden western China's fragile natural environment. Given the huge amount of coal currently burned in the eastern provinces, CTG will only be able to substitute a tiny portion of the overall coal consumption. The air quality benefits will therefore be very limited, but could create huge costs in terms of long-term environmental impact. The main matter of concern here is the water implications of CTG, which is no less intensive than CTL projects.

According to the latest China National Energy Administration (NEA) target, plants in the northern and western regions of the country will be able to produce 50 billion m^3 of SNG annually by 2020 (NEA, 2014). Assuming one-cubic meter of SNG requires 6-10 liters of water to produce, the NEA target will exacerbate China's water conflict by adding 300-500 million tons of water consumption yearly. The scale of projects waiting for approval is sobering. Up until early 2015, 19 projects have received approvals from the NDRC, levelling the total approved capacity to 89.1 billion m^3. Of these, 17—representing more than 90 percent of the approved capacity—are based in two water-constrained provinces—Inner Mongolia and Xinjiang. If all these projects go ahead, it will lead to unprecedented water overexploitation, as highlighted in the Shenhua CTL project case. This uncoordinated and short-sighted planning will expose these projects to significant water risk and will put the overall environment in the northwest regions in peril.

In the long run, the rapid ramp up of CTG capacity could also fundamentally reshape the geographic layout of China's coal production and lock the country in a heavily coal-dependent path. Based on our calculation, the demand for coal is expected to increase by 290-330 million tons annually if pipeline capacity is expanded to 89.1 billion m^3. Considering that most of the projects are located in Inner Mongolia and Xinjiang, both of which will largely rely on locally supplied coal, such enormous new demand will certainly unleash another round of coal development in the west. As the east gradually phases down coal, CTG is delivering a worrisome signal that might falsely inject new impetus to the coal market that is already losing steam.

WATER HOLDS THE KEY FOR CHINA'S ENERGY FUTURE

The environmental debate around the tension between coal and water is evolving fast and gaining attention in China. The government has clearly identified tackling water scarcity as a national priority, as evidenced by the establishment of a strict water management system and the so-called "three red lines" that include three binding targets on water quantity, water efficiency, and water quality. Government commitment to the issue is also highlighted by the increased emphasis on water resource management in relation to energy planning. The government's coal sector development plan in February 2013 recognized the challenge posed by the constraint of water resources (NEA, 2013). It also required that coal-chemical development remain mindful of the "balance of water resources." In December 2013, the Ministry of Water Resources issued its *Water-for-Coal Plan*, which mandates coordinated water and coal planning for the development of large-scale coal bases. In addition, a water resource evaluation is also required as a pre-condition for the development of new coal bases.

Despite all the recent efforts and the historic fall of China's coal consumption in 2014 and 2015 (Puko & Yap, 2015; Boren, 2015), there is still quite a long way to go to safeguard China's water resources from being overexploited by its rapidly growing appetite for coal. It will be critical for China's relevant water regulatory bodies to officially recognize the significant challenges imposed by the energy sector. Currently it is unclear whether the country's water governance system can get up to speed in time to solve the daunting water crisis in north China. As the environment and water ministries move to better regulate water it remains a question if these existing and upcoming water regulations will be meaningfully enforced on the ground. These questions of water governance improvements and how the upcoming 13th Five-Year Plan addresses coal-water issues will be important to watch over the next year or so.

One trend is becoming increasingly clear: the tightly connected coal-water nexus is unfolding in front of us. Whether China opts for truly optimizing its energy structure or chooses to maintain its reliance on coal is inextricably linked with its choices on water. If air pollution is what pulled the trigger in terms of slowing down China's coal consumption growth, water is poised to be the key determinant of the pace of the country's coal deceleration process.

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The New "New Town" Movement in China

by Zhongjie Lin

After the end of the Second World War, Great Britain launched a nationwide initiative under the 1946 New Town Act to house people returning from the war and to accommodate the rapidly growing urban population. As a result, 27 new towns were built under the "Garden City" model invented by Ebenezer Howard about half a century before. Now, another half a century later, China is undergoing a new "new town" movement on a much larger scale, which could have tremendous impact on China and the global society.

China's national development agenda anticipates 60 percent of the population will live in cities by 2020, meaning that each year about 16 million rural inhabitants—equivalent to nearly half of Canada's population—are moving to urban areas. Indeed, this migration has been taking place for more than two decades in what geographer David Harvey regards as "the largest mass migration the world has ever seen" (Harvey, 2005). In 1985, less than 20 percent of Chinese people were urban residents. Since then, the urban population has grown at an annual rate of about one percent and passed the benchmark of 50 percent of the national population in 2011, despite low birth rates in cities due to China's population control policy.

The outcomes of this massive urbanization can be seen across the country in proliferating large-scale infrastructure projects and real estate developments ranging from dams, bridges, and highways to gated communities, shopping malls, and grand public buildings. 11 million housing units are built each year in China, and 10 to 15 new residential neighborhoods are created every day. They are fundamentally changing the country's urban landscape. More significantly, this dramatic demographic shift and construction boom have led to an ambitious plan to develop entirely new towns. In 2005, China's official media reported a central government project to build 20 new cities each year for the next 20 years. This would translate to at least 400 new cities by 2025.

Changing demography may be a driver for China's "great leap forward" in construction, but local governments' efforts to find new areas of economic growth are no less important. There are currently 218 so-called National Economic Development Zones and 114 National High-tech Industrial Parks—and the number is still growing—as well as numerous similar arrangements at the provincial level. Although originally created to boost industrial development, many of these districts have quietly shifted their emphasis to more profitable residential and commercial development during the two decades of real estate boom since the mid-1990s. They have become new towns located in the outskirts of large cities, alleviating congestion and attracting investment for economic development.

Compared to their British predecessors, the Chinese new towns are much larger in scale and come with more ambitious economic and social agendas. While British projects were normally built to accommodate around 50,000 residents, Chinese new towns often house 500,000 or more people and thus offer better promise as more economically and socially self-sustained entities— following Howard's vision of a "garden city." The municipal governments often view these new towns as opportunities to attract investment as well as branding tools to enhance the image of the cities. The impact of globalization is reflected in the planning and development of these new towns. These projects pursue new ideas and forms of urbanism and architecture to distinguish themselves from the overcrowded old cities, showcasing the latest construction technologies and exploring various themes of planning.

The Suzhou Industrial Park is one of the prototype towns that represents a new model for both city building and economic development in China. It was created from scratch outside the city of Suzhou in 1994 under an inter-governmental partnership between China and Singapore. Nowadays, it is a city of 723,000 residents and an economic juggernaut, housing numerous multinational firms, including plants and branches of more than 80 Fortune 500 companies. Since the first master plan in 1994, urban planning and design have continued to play an important role in guiding the incremental development of the new town, balancing housing and employment and providing high-quality infrastructure and public services. Planning, architecture, and landscape are not only prioritized to add value to property, but promoted as part of the strategy to attract residents, investors, and various institutions.

The eco-city represents another recent development in Chinese leadership's urban planning vision. Pressure for sustainable city planning continues to grow with the country's unprecedented urbanization and industrialization. In 2007 China surpassed

Figure 1. Suzhou Industrial Park, Suzhou. Image courtesy of Suzhou Industrial Park Administrative Committee.
Photo Credit: SIP Administrative Committee

Figure 2. Plan of the First Phase of Dongtan Eco-City, Shanghai. Image courtesy of Arup.

the United States to become the world's largest emitter of greenhouse gases. The central government recognized the urgency of coping with the environmental challenges and incorporated programs for developing sustainable cities in the national agendas starting with the 11th Five-Year Plan, which announced a Renewable Energy Medium-Long Term Plan. Such directives have encouraged local governments to pursue ecological development strategies.

By 2014, more than 230 cities had announced initiatives to create eco-cities or low-carbon cities following the standards set by the Ministry of Environmental Protection and the Ministry of Housing and Urban-Rural Development, including more than a hundred eco-new towns. In the meantime, China has become a laboratory for new technologies and designs where global talents seek to realize their futurist visions, which are sometimes harder to implement in the West. As a result, China has become the site of numerous eco-city experiments—unfortunately, few projects have succeeded so far.

In 2004, an ambitious plan, backed by the central governments of China and the UK, was put forward to build the world's first zero-energy, carbon-neutral eco-city in Shanghai on an alluvial island in the Yangtze River. Arup, a UK-based architecture and design firm, was hired to provide a master plan and sustainable design for this new town known as Dongtan, while a state-owned real estate company was appointed to build it. The Arup team introduced some of the latest environmental technologies and laid out bold strategies needed to meet the ambitious goals, such as achieving a 60 percent smaller carbon footprint than that of conventional Chinese cities, as well as a 66 percent reduction in energy demand for the city. These goals demanded radical action items that include using 100 percent renewable energy and banning all petro-fuelled automobiles in the city.

Although the first phase was scheduled to be completed by 2010 and showcased at the Shanghai International Expo to demonstrate the government's commitment to eco-civilization, no construction began and in 2009, the entire project was cancelled. Among other factors, like political scandals and protests by environmentalists, there was a conspicuous gap between the architects' radical vision and the concrete social and financial capacity that would have been necessary to realize it. Nevertheless, lessons were learned from this experiment, and soon many other eco-new towns followed.

In 2007, the central government of China created another flagship project in partnership with Singapore, called the Binhai Eco-city in Tianjin. Located about forty kilometers from Tianjin, the country's third largest municipality, this eco-city occupies a total area of 30 square kilometers and will be home to 350,000 residents when completed in 2020. The parties involved in this project learned from the lessons of Dongtan, and were able to push forward development with a comprehensive planning framework and a more practical approach.

The project uses a set of Key Performance Indicators (KPI) that includes 22 quantitative indicators and four qualitative indicators as environmental and social guidelines for construction, development, and management. The indexes range from carbon density to percentage of affordable housing. Tianjin Eco-city sets a commendable example of innovation with its clear sustainability goals incorporating the KPI system. Ironically, however, its city planning and design followed a conventional and high-carbon model, leading to segregated communities, freestanding towers, over-scaled streets and urban spaces, and prioritization of roads over pedestrian space. A timeline for the construction of the only light-rail line planned for the eco-city has yet to be released. These issues, along with its remote location from the city center, resulted in the relatively slow progress of the project with just over 10,000 residents currently living in the eco-city.

Suzhou Industrial Park, Dongtan, and Tianjin Eco-city are influential models of sustainable planning that will undoubtedly leave a mark in the future urbanization of China. Like most other new towns, they were established in a top-down manner through government initiatives. The extent of their success, however, is still to be seen given the many challenges in the technological and policy realms. Nevertheless, the rise of hundreds of new towns in the near decade will be a significant phenomenon to observe in China and will surely influence the rest of the world.

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Figure 3. Street view in Tianjin Eco-city. Photograph by Dr. Zhongjie Lin.

A Snapshot of GEF Sustainable Cities Projects in China

by Xiaomei Tan

Investing in sustainable cities with an eye on low carbon offers not only the global benefits in addressing climate change, but also makes cities more livable and economically strong. The Global Environment Facility (GEF) recognized the importance of financing sustainable cities project in 1999 and decided to simultaneously allocate $25 million to improve energy efficiency of Beijing's heating system and $12 million to support hydrogen fuel cell buses in Sao Paulo. Building on the experiences from these two projects, GEF expanded its urban portfolio to become one of the largest sustainable cities programs in the world with 102 projects in over 125 cities across 66 countries. GEF has committed $722 million and an additional $9.71 billion leveraged in co-financing from the private sector, and local and national governments for these city projects.

Traditionally, GEF urban initiatives prioritize projects with significant climate change mitigation potential, targeting three categories:

- Innovative urban technology solutions such as the development of hydrogen fuel cell buses, new building technologies, and smart traffic systems.
- Low-carbon transport systems that include transport planning, traffic demand management, public transport infrastructure, and fleet improvement.
- Comprehensive urban strategies for urban-scale building energy efficiency improvement, installing distributed renewable energy generation capacity, improving municipal solid waste and sewage management, and enhancing urban biodiversity and land use regulation.

These projects are executed in newly-built urban areas as well as existing towns and cities. Recognizing the importance of retrofitting an existing urban environment to reduce its environmental impact, GEF, in 2010, supported a comprehensive green energy scheme in one of the densest urban spaces in the world: Changning District, Shanghai. This scheme has encompassed several key components:

- Piloting a near-zero-emissions building;
- On-site renewable energy and natural gas distributed generation;

Vision of Tianjin's eco-city that aims to be completed in 2020. Credit: Keppel Corporation

- Retrofitting HVAC (heating, ventilation, and air condition) systems in commercial and public buildings;
- Redesigning local public transport systems to connect metro and light rail stations with office buildings to cover the "last mile"; and,
- Providing non-motorized infrastructure and services such as bike lanes and pedestrian paths.

GEF also supports introducing innovative urban technologies in newly-built cities. The Sino-Singapore Tianjin Eco-City project, for which the GEF provided $6.16 million and leveraged $24.54 million through co-financing, demonstrates how to convert a waste land into an environmentally friendly and resource-efficient city. The site, an area of 30 sq. km that originally comprised of mainly saltpans, barren land and polluted bodies of water, is being developed to showcase the newest low-carbon urban technologies and to serve as a model for future Chinese cities.

The design of the city is based upon three planning principles: (1) compact land-use, (2) efficient transit modes, and (3) inclusion of vegetation-and-water networks. Evaluated by the performance indicators listed Table 1, Tianjin Eco-city has met each of the three goals.

To highlight GEF's commitment to sustainable urbanization, The GEF-6 Programming Directions (July 2014 – June 2018) proposed to establish two funding channels for its sustainable cities portfolio that targets many China:

1) Low-carbon Urban System – A Key Component of Climate Change Mitigation Strategy. This program targets urban interventions with significant climate change mitigation potential, to help cities shift towards low-carbon urban development. The indicative funding for this channel is $210 million.

Table 1. Performance Indicators for Eco-Cities

Good Natural Environment	Healthy Balance in the Man-made Environment
• Air quality • Quality of water bodies within the Eco-city • Quality of water from taps • Noise pollution levels • Carbon emission per unit of GDP • Net loss of natural wetlands	• Proportion of green buildings • Native vegetation index • Per capita public green space
Good Lifestyle Habits	**Developing a Dynamic Efficient Economy**
• Per capita daily water consumption • Per capita daily domestic waste generation • Waste treatment • Barrier-free accessibility • Urban services network coverage • Proportion of affordable public housing • Proportion of green trips (e.g., walking, biking, carpooling, taking transit and telecommuting)	• Usage of renewable energy • Usage of water from non-traditional sources • Proportion of R&D scientists and engineers in the Eco-city workforce • Employment-to-housing equilibrium index

Source: Tianjin Eco-City Government.

2) **Sustainable Cities Integrated Approach Pilot.** This flagship program aims to help cities and national governments integrate long-term sustainability principles within their urban design, planning, and implementation. The total GEF grant is $150.3 million and the co-financing is $1,478.6 million. Seven Chinese cities (Beijing, Tianjin, Shijiazhuang, Nanchang, Ningbo, Shenzhen, and Guiyang) are participating in this program that features interlinked global and local actions.

At the global level, the program will cross-fertilize the knowledge and expertise among cities and institutions focused on urban issues and help deepen their ambition to achieve greener cities by providing services such as planning support, developing tools and common metrics for monitoring, and capacity building. At the local level, some priority actions from the sustainability plans will be implemented with investments catalyzed by GEF agencies and national and local sources.

We expect in 5 to 10 years that these seven Chinese cities, together with other 16 GEF Sustainable Cities, will act as global ambassadors for urban green planning, with tangible benefits at both the local and regional levels.

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Growth vs. Air: Can China's Gas Deliver "Eco-Urbanization"?

by Han Cheng

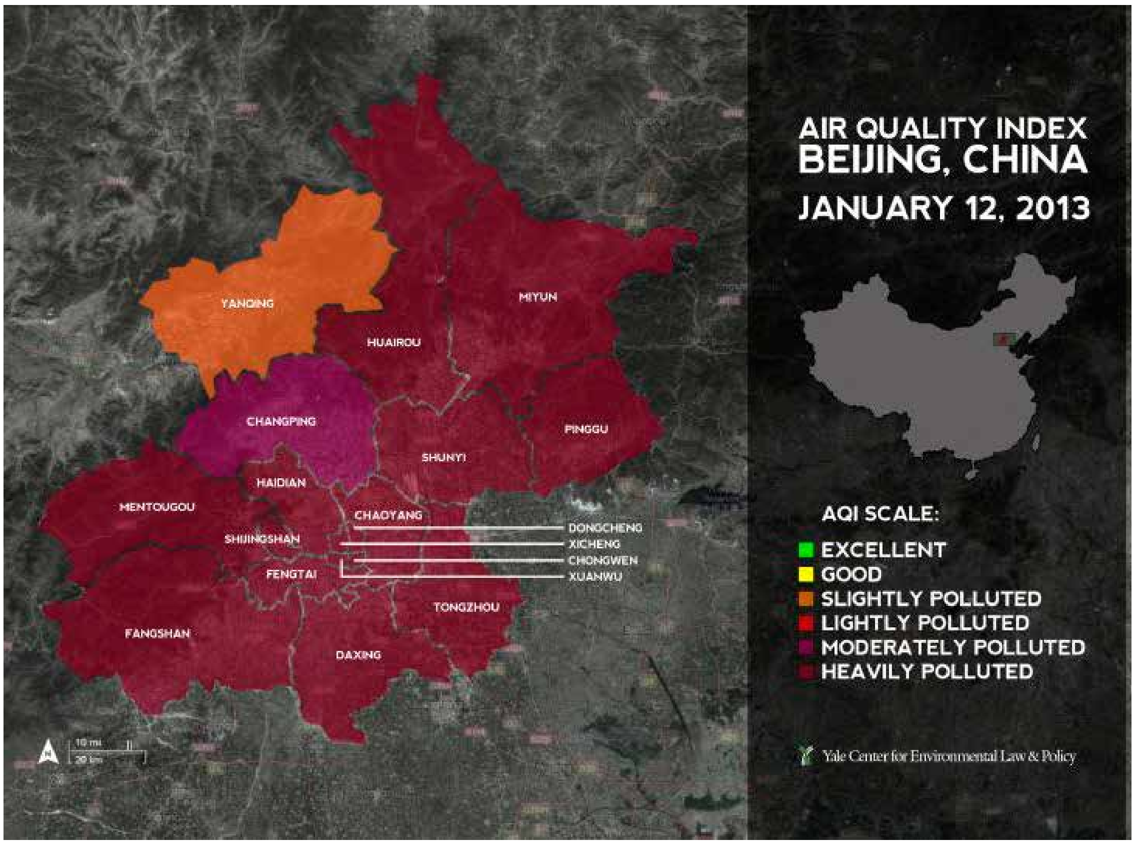
Since 2012, the big story each winter has been smog that engulfs many of China's cities. The country's air pollution in 2013 was the worst in 52 years, with 13 provinces hitting record-high levels and 25 provinces and over 100 big cities were enveloped in heavy smog—most of it small particulates from coal burning and cars. In December 2015, Beijing issued its first-ever "red alert" for smog, which closed all schools, temporarily shuttered 2000+ factories and construction projects, and drastically restricted the number of cars on the road. Less than two weeks later, Beijing issued its second red alert. Besides working to improve enforcement of air pollution control laws and increase renewable energy, the Chinese central government also is promoting the use of gas as a cleaner energy strategy. The plan to transition away from coal to gas is challenging to manage as the China's megacities expand at a breakneck pace.

UNDERSTANDING THE CONTEXT

Under Premier Li Keqiang, China has focused its ambitious economic reform agenda on cities to increase domestic consumption and trigger growth. According to the *National New-Type Urbanization Plan* released in March 2013, the Chinese government aims to expand the proportion of people living in cities to 60 percent by 2020, up from 52.6 percent at the end of 2012, and is gearing up for building the necessary infrastructure accordingly. In 2009, the McKinsey Global Institute estimated that urbanization would more than double China's urban energy demand by 2025.

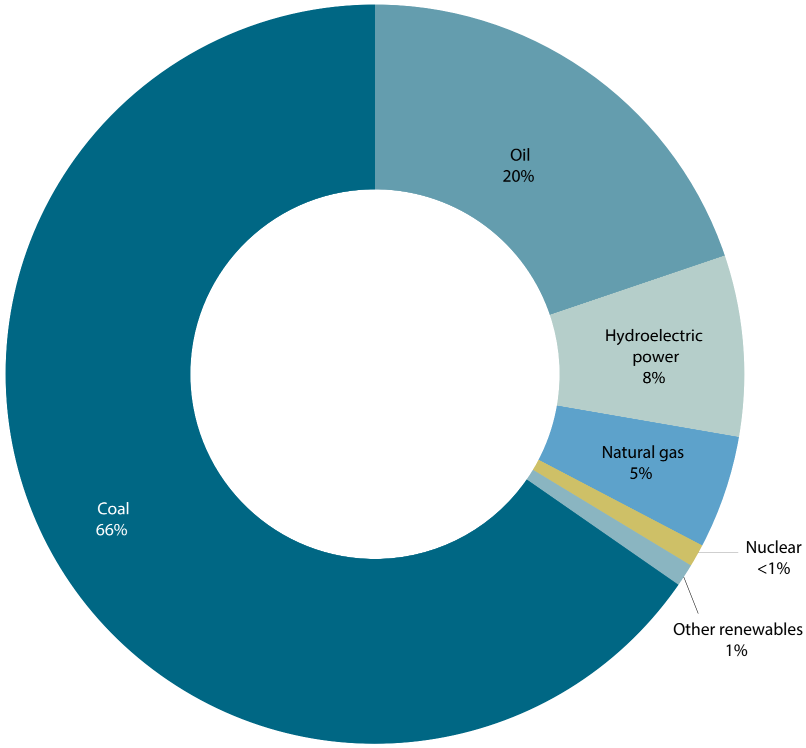
As China remains heavily dependent on fossil fuels, especially coal, fast urbanization and exponential growth in energy consumption is translating into more pollution. In Beijing, concentrations of micro particles in the atmosphere have been found to be more than 10 times the safe level recommended by the World Health Organization. The situation is no better in other parts of the country, and most large cities are experiencing increasingly long periods of heavy smog.

The Chinese leadership has, after some initial hesitation, formally recognized the issue. On the heels of passing the *Action Plan for Air Pollution Prevention and Control* in the fall of 2013, Premier Li officially declared "a war against pollution" in spring 2014 and also launched the Eco-Urbanization initiative. At the heart of this initiative is to find sustainable and clean energy to power China's growing cities. While renewable energy has been identified as an important component of the future energy mix and the *National Urban Plan* indicates that its share will increase from 8.7 percent in 2012 to 13 percent in 2020, a large gap remains unfilled. Central policy planners have now prioritized natural gas as a low-carbon cost-effective option.



Source: Angel Hsu and William Miao. Beyond "Crazy Bad": Explaining Beijing's Extreme Air Pollution. Yale Center for Environmental Law & Policy. January 16, 2013. Info graphic created by Monte Kawahara

Figure 2. China's Overall Energy Mix



Note: Total may not equal 100% due to independent rounding. Includes only commercial fuel sources and does not account for biomass used outside of power generation.

Source: China International Energy Data and Analysis, Energy Information Administration.

GAS –THE GAME CHANGER

While the country is well endowed with coal, China has never been rich in gas. Gas imports have risen dramatically in China over the past 13 years and China is now the third largest gas consumer in the world. Nevertheless, China still suffers gas shortages, especially during the winter when the demand rises to as buildings require more heating. What is worse, by 2020 the country may be facing a supply gap of 70 billion cubic meters. Renewable energy is growing but not enough to keep up with the breakneck urbanization, therefore, to urbanize the country without relying on more coal the Chinese government is pursuing two strategies to enhance its gas supplies.

Connect big networks, link small dots. China is building its nationwide gas infrastructure through domestic and cross-border pipelines, plus coastal liquefied natural gas (LNG) terminals. The government has invested heavily over the current 12th Five-Year-Plan period to reach the goal of adding 44,000 kilometers in pipelines by 2020 and to ensure access to gas for 94 percent of cities as well as 65 percent of counties and towns by 2015. The mega West-East Gas Pipeline, together with supporting regional and international networks, is the core artery, sourcing gas resources from China's northern and western provinces, as well as from Central Asia, Myanmar and Russia to satisfy energy hunger in both eastern industrial hubs and urban centers across the country. However, in addition to big networks, renovating urban gas and central heating pipelines and building transmissions require extensive planning, investment, and capacity.

Unlock unconventional sources. Even with fully developed networks, conventional gas cannot meet the surging demand in urban centers. Hence, the government is now opening the door to using unconventional gases, namely coalbed methane, coal-to-gas or synthetic natural gas (SNG), and shale gas. China's National Energy Administration projects that by 2020 there will be more than 50 billion cubic meters of SNG produced from coal (~12.5 percent of domestic supply). Thus, competition from other fuels and conventional gas no longer stands in the way of developing non-traditional gas reserves due to the increasing energy demand and the push to find less polluting sources of energy. However, significant technical limitations, water scarcity, regulatory constraints, and transportation challenges pose potential roadblocks to gas development.

Figure 3. China's Gas Supply Infrastructure

Source: China's gas supply infrastructure. Forecast: China Coal-to-Gas Project. Platts (January 2014). http://www.platts.com/news-feature/2014/naturalgas/china-coal-to-gas-projects/index

WHAT DOES IT TAKE TO ACTUALLY DELIVER?

China has taken aggressive steps in unlocking potential for both conventional and unconventional gases to fix its energy-environment puzzle in the particular context of rapid and large-scale urbanization. However, policymakers should take care to address several crosscutting issues that could affect implementation.

Energy diplomacy with neighboring suppliers matters. Imports satisfied approximately 32 percent of China's domestic gas consumption in 2015 and central planners are likely to increase such imports. The ongoing sanctions posed by western countries on Russia and long-term fall in global prices—largely attributed to U.S. shale gas boom—likely facilitated the significant gas deal between China and Russia in 2014. The 30-year agreement guarantees annual delivery of 38 billion cubic meters of gas from Gazprom. China also is looking to other markets for gas, but faces competition with other energy importers such as India, Japan and the EU. As a consequence, Beijing has been ramping up assistance programs in countries that export gas to improve regional development alongside and energy trade.

Public-private partnerships to build green urban gas infrastructure. China's major gas pipeline network covers most of the country, and urbanization has brought about another wave of smaller scale, but widespread pipeline and transmission construction in hundreds of large cities. The Chinese government has played a significant role in attracting private sector partners for financing, construction, and coordination of pipeline infrastructure that will provide power that reduces air pollution emissions in cities.

Environmental externalities of unconventional gases. Gas is promoted because it is less polluting than coal, but unconventional gases are no panacea. While gas generally emits fewer greenhouse gases than coal when consumed, its production can be very polluting. In the case of SNG for example, in addition to very high costs and the need for technological investment, well-equipped transport and a robust downstream market, its production requires an abundance of coal and water. In addition to adding stress to China's water resources and causing more carbon emissions, SNG is a continuation of China's reliance on coal.

Gas is the transition, not ultimate cure. The Chinese government has chosen gas for economic, regulatory and technological feasibility to help improve energy security. Gas is meant to fuel cities in a greener way, but the resulting temporary relief from air pollution should not dilute long-term efforts to phase out fossil fuels and strengthen renewable energy.

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If You Build It, They Will Come: Dispatch from the Greenpeace Solar Rooftop in Beijing

by Li Shuo

As Chinese urbanites choke in what has become routine haze and municipal officials desperately seek cleaner energy options, an alternative that could be easily embraced has, astonishingly, been overlooked. The missed opportunity is distributed rooftop solar and its integration into urban planning across the country.

According to the Energy Foundation, China has more than 300 million square meters of suitable rooftop space for solar development in urban areas. As the country continues to urbanize, that space is only poised to grow. However, this energy potential has remained, as of yet, untapped. Despite China's rocketing efforts to ramp up solar installation from virtually zero a year in 2009 to breaking world records by installing more than 10 gigawatts (GW) in 2013 and 28 GW in 2014. While the total new solar was lower in 2015 (23 GW), the lion's share of these installations has been predominately large-scale, land-based solar farms in China's less populous western provinces. If fully utilized, urban rooftop space can help digest more than 30 GW into the solar PV system and power more than 30 million households—five times the number of residences in Beijing.

In part to test the process individuals must undergo to switch to solar, Greenpeace embarked on a journey to install its own pilot project in the summer of 2012. The first and biggest stumbling block was encountered in the application for grid access. Household solar projects need grid connection to both feed surplus power back to the grid and to use grid power when the sun does not shine. Without access to the grid, solar projects can neither ensure safe electricity supply nor profit from its power generation. We therefore approached the local branch of the State Grid Company to clarify the grid connection application process for our project. After a two-month navigation of the giant monopoly's internal bureaucracy, we were eventually told that no such procedure existed and that there was no precedence of distributed solar projects in Beijing.

As we were close to discarding this idea, the State Grid took a 180-degree turn. On October 26, 2012, the State Grid issued a file stating that distributed solar projects with an installed capacity of less than 6 megawatts (MW) would be allowed to connect to the grid at no extra cost. In the same policy file, the company also committed to providing any necessary guidance and assistance.

Greenpeace filed its application immediately after the policy took effect on November 1, 2012. The following days, State Grid engineers reviewed our project proposal and inspected our project site. It was clear that the company was prioritizing this task, though at the time, we did not realize how pioneering our project was. For every single step of the application process we underwent, there were no previous cases to refer to. The State Grid even designed its application form uniquely for our purposes.

After a month and a half, and with numerous "first-time" steps along the way, the State Grid approved our 5-kilowatt (KW) project which was successfully installed on top of Greenpeace's Shunyi warehouse on the outskirts of Beijing. When we signed the power purchase agreement, a senior-level State Grid manager told us there were only two other applicants in the city of Beijing and just a few more across the whole country.

The story did not end there. If grid access is half the game, the application for a feed-in tariff (FiT) proved to be an even more exciting development. In August 2013, the National Development and Reform Commission (NDRC) unveiled its long-awaited FiT rate for distributed solar projects. According to the NDRC, electricity generated by distributed solar installation and consumed on-site by the project owner will enjoy a subsidy of 0.42

Greenpeace China Solar Panels Installation
Workers during the installation of solar panels at Greenpeace's warehouse in the outskirt of Beijing. The 5kWh solar energy project is so far the largest grid connected distributed project in Beijing and among the first batch of such projects in China. 04/17/2013
© Greenpeace / Liu Feiyue

yuan/kWh, on top of not having to pay for the electricity consumed from the grid. The surplus electricity fed back to the grid will be paid based on the local desulfurized coal benchmark price (in Beijing, the price is currently 0.3867 yuan/kWh) in addition to a 0.42 yuan/kWh subsidy. The rate was higher than market expectation and was particularly attractive to power users in the eastern part of China, where tariffs can be as high as 1.5 yuan/kWh.

For our project in Beijing, we expect our initial investment of 50,000 yuan to be paid back in nine years and enjoy a net profit for the next 10 years or so. For commercial or industrial users, as their tariffs higher and PV cost is set to decline further, the payback period could be even shorter.

As is often the case in China, there is a long distance between policy documents and the implementation on the ground. The rubber only hits the road the moment payment arrives in our bank account. In dealing with payment, we again found ourselves running far ahead of policy anticipation and directly into a regulatory vacuum. The pricing department of the NDRC, the Ministry of Finance, the National Energy Administration, the Tax Bureau, and the State Grid, all of which were needed for payment, had not established a streamlined process or coordination.

There was a somewhat trivial matter that hinged upon us for quite some time—providing a *fapiao* (receipt) in exchange for payment. Interestingly, but not surprisingly, the local tax bureau had never processed a request for a *fapiao* for the purpose of electricity generation. We were the first to bring staff from the tax bureau and the grid company under the same roof, and only then could we finally receive a *fapiao* and payment.

Encouragingly, Greenpeace laid the groundwork for itself and to the benefit to us to many of those who followed suit. According to the State Grid, by the end of September 2013, the company had received 1,300 distributed solar applications, totaling 2,090 MW. 351 projects had already been completed and connected to the grid. And more projects continue to spur across the country.

As more applications grow in different provinces, State Grid continues to learn from its experience with the first movers and adopting best practices nationwide. New project developers have informed us the project cycle is now much shorter and the transactional costs much lower.

As China's coal addiction phases out, urban rooftop solar offers a very promising future. We found that our own project estimated that the 5 KW project generated 3,500 kWh of electricity in the first eight months of operation. This translates into a savings of approximately 1.5 tons of coal and 4 tons of CO_2. It is now increasingly possible to for more people to participate in a rooftop revolution that would change China's urban landscape and potentially contribute to optimizing the country's energy portfolio.

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ENVIRONMENTAL CIVIL PUBLIC INTEREST LITIGATION IN CHINA

Empowering Green NGOs to Fight Against Pollution

by Yanmei Lin & Shaobo Hu

We will resolutely declare war against pollution as we declared war against poverty.

Premier Li Keqiang

National People's Congress Meetings, March 5, 2014

A BREAKTHROUGH IN CIVIL PROCEDURE LAW

In 2012, Chinese legislators finally gave the green light to environmental civil public interest litigation. This move represented a turning point and builds on the attempts by Chinese local and central governments and other stakeholders to find ways to address the grave environmental problems facing the country including the creation of environmental courts and right to file environmental public interest litigation (Wang & Jie, 2010). The key step occurred on 31 August 2012, when the Standing Committee of China's National People's Congress adopted the amendments to China's Civil Procedure Law, allowing for the first time "governmental agencies and relevant organizations stipulated by laws" to initiate lawsuits for "acts that harm the public interest," including environmental pollution (NPC, 2012a). This new provision not only created an avenue through which citizens may bring their complaints, but is also a legal tool that has the potential to permit greater access to the courts and empower environmental nongovernmental organizations (NGOs) to act as private enforcers of environmental laws.

Environmental public interest litigation is generally defined as cases filed by "units and individuals who have no direct statutory interests related to the claims…against those who polluted the environment and/or damage natural resources or against administrative agencies that failed to fulfill their legal duties to protect the environment and natural resources" (Wang, 2011). Based on this definition, there are two types of environmental public interest litigation: (1) environmental civil public interest litigation in which the public interest litigants sue the polluters and (2) environmental administrative public interest litigation in which the government agencies are the defendants. Unfortunately, the most recent amendments to *China's Administrative Litigation Law* did not adopt the provision to allow citizen groups or procuratorates who have no property or personal interest involved in the case to sue government agencies on behalf of the public.

Chinese environmental NGOs had brought environmental civil public interest suits in the past. The pilot environmental courts established since late 2007 were the first places that witnessed environmental public interest litigation in China. Before the national legal provision was adopted, local courts accepted ten test cases, for the most part leading to positive environment and social results (Lin, 2010). Unlike "pollution compensation cases," environmental civil public interest litigation once filed can potentially hold polluters accountable at an earlier stage—before the pollution causes actual harm to individuals' property and health and limit damages to natural resources that are either state property or public goods

TABLE 1. Number of Environmental Civil Public Interest Cases Accepted by Local Courts from 2007-2014

Plaintiffs	Number of Environmental Civil Public Interest Cases							
	2007	2008	2009	2010	2011	2012	2013	2014
NGOs	0	0	2	1	4	3	2(9)	13
Procuratorates	0	5	4	4	3	6	1	1
Government Agencies	1	0	2	2	1	5	0	3 (two are co-plaintiffs)
Others*	0	5	8	7	8	1	1	0
Total	1	5	8	7	8	15	4	15

*Source: (Lin, 2014) *Individual Citizens or other Social Organizations.*

PREDAWN DARKNESS

With the breakthrough in the new Civil Procedure Law in 2012, China's environmental NGOs were ready to test the boundary of the new law and the court's interpretation and application of it to specific cases. However, to their surprise, almost all of the filed cases were rejected by local courts in 2013. In the end only two cases were adjudicated in Qingzhen Environmental Court. These failures were disappointing, but provided learning opportunities for the NGOs, particularly the well prepared case brought against a coal-to-chemical company that belongs to Shenhua Corporation.

THE SHENHUA COAL TO LIQUID AND CHEMICAL CASE

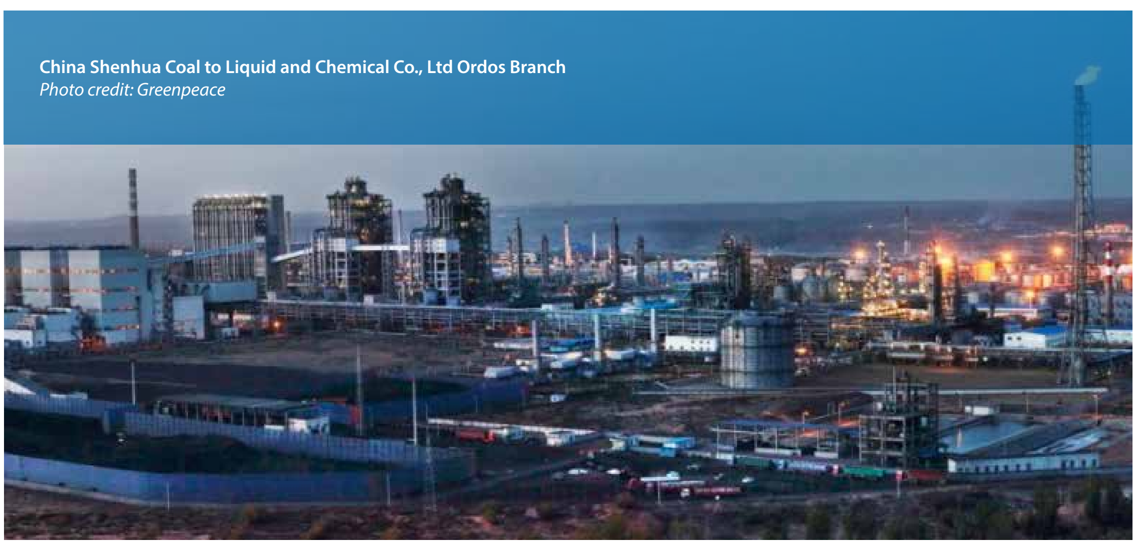
On 26 July 2013, Environmental Research Institute of Beijing Chaoyang District (known as Friends of Nature, FON) and Source Enthusiasts Environment Institute of Beijing Fengtai District (known as Nature University) filed a case in the People's Court of Beijing East District to sue China Shenhua Coal to Liquid and Chemical Co., Ltd and China Shenhua Coal to Liquid and Chemical Co., Ltd Ordos Branch.

The plaintiffs alleged the defendants had illegally extracted groundwater from the Haolebaoji agricultural and grazing region, an important source of water within Inner Mongolia's Mu Us desert region. The defendants constructed 22 wells that are more than 300-meters deep in the region and began extracting water on a large-scale in 2006. According to the local Haolebaoji residents, Shenhua's water extraction resulted in significant drops in groundwater levels and deterioration of the quality of groundwater. As a result, extremely low water levels in the region led to the die-off of surface vegetation and some areas to experience total desertification. In addition, drinking water for people and livestock was also severely threatened, as water quality testing revealed toxic and hazardous substances. The plaintiffs also alleged that defendants had unlawfully discharged untreated waste water to the nearby river ways and sandy lands, consequently forming a large wastewater pit located 500 meters away from defendants' plant.

The plaintiffs, on behalf of the public, sought for the alleged to: (1) stop discharging waste water to sandy land, (2) take measures to remediate the waste water pit and restore the ecological function of that area, (3) stop extracting water from Haolebaoji region, and (4) to pay the plaintiffs' litigation fee and attorney fee.

If the court accepted and adjudicated this case it would represent the first legal step in holding Shenhua accountable for its illegal polluting activities and negative impact on the local environment and communities. Environmental public interest litigation could have become a powerful tool for FON and NU in this fight.

Unfortunately, on 30 August 2013, the court informed the representing attorney by phone that the case had not been accepted. The court concluded that the *Civil Procedure Law* does not provide clear provision on who can bring environmental public interest litigation: article 55 of the Civil Procedure Law explicitly



China Shenhua Coal to Liquid and Chemical Co., Ltd Ordos Branch
Photo credit: Greenpeace

Surrounding Vegetation died due to the illegal waste water discharges and the waste water pit.
Photo credit: Greenpeace

allows "relevant organizations" stipulated by law to sue on behalf of the public on matters such as environmental pollution and consumer rights but there was no national law defining what qualifies as a "relevant organization."

Seven other lawsuits filed by All-China Environment Federation (ACEF), an organization affiliated with the Ministry of Environmental Protection, faced the same fate and were rejected, even though these cases were arguably less politically sensitive compared to the Shenhua case. Various local courts have since stated that they would not accept any NGO-initiated civil public interest cases without a clear mandate from national legislators.

LEGISLATIVE BATTLE ON THE AMENDMENTS TO ENVIRONMENTAL PROTECTION LAW

In 2012 and 2014, the Standing Committee of the National People's Congress (NPC) considered several amendments to China's 1979 *Environmental Protection Law* (EPL). This was a historic opportunity to include the legal provisions favoring the expansion of environmental public interest litigation in the new law. The 11th NPC released its first draft of the amendments to the EPL on 31 August 2012 but not a single word in this draft touched upon public interest litigation (NPC, 2012b).

On the heels of this disappointing first draft, environmental NGOs such as Friends of Nature led efforts to fight for a favorable provision on environmental public interest litigation. The new 12th NPC Standing Committee promulgated the second draft version on 19 July 2013 adding one article to stipulate that the All-China Environment Federation (ACEF) and its member associations at the provincial, autonomous region and self-governing municipality levels could present in people's courts environmental cases where the social public interest was damaged (NPC, 2013). This proposed provision excluded all other environmental organizations from using public interest tool in courts and triggered an intense public debate.

On 21 October 2013, the Standing Committee reviewed the third draft, which was not released for public comments. It was reported that this version "expanded" the litigation. After this closed-door deliberation, environmental groups and environmental legal professionals further increased their advocacy efforts, leading to another round of debates that delayed the quick approval of the draft. Although legislative procedures usually stipulate three rounds of reviews, the Standing Committee was forced to call a fourth review in April 2014. The protests from civil society proved to be so effective that the fourth draft finally opened environmental public interest litigation to a significantly larger number of NGOs.

THE NEW ENVIRONMENTAL PROTECTION LAW MADE THE CLARIFICATION

Finally, on 24 April 2014, the Standing Committee of the NPC approved the amendments to the EPL, including the provision on environmental public interest

Judicial Interpretation on Environmental Civil Public Interest Litigation is a powerful sword that can cut through the dirty stream and clean the grey smog air. It will be like a sword of Damocles that hangs above the polluters.

Justice Zheng Xuelin

Director of Environment and Resources Law Tribunal, Supreme People's Court, January 7, 2015

peripheries of who could file environmental public interest cases from only one organization—the ACEF and its member associations—to include all environmental social organizations registered with the Ministry of Civil Affairs (MOCA). However, MOCA has only registered only 12 such organizations, most of which are academic societies and industry associations that are unlikely to file environmental public interest litigation standing. Article 58 of the new EPL permits Chinese social organizations to file suits on behalf of the public interest involving pollution or ecological damage if they: (1) are registered with the civil affairs departments at or above the municipal/district levels, (2) have specialized in environmental protection public interest activities for five or more consecutive years and (3) have no record of violating the law. This new environmental public interest litigation provision is much more expansive than expected.

Although falling short of calls by activists to give public interest standing to all environmental NGOs, the new provision is a positive step forward, permitting grassroots and more independent NGOs to bring suit. It has the potential to have an enormous impact, changing the current government regulator and regulated industry paradigm by strengthening the influence of civil society on environmental protection in China.

SUPREME PEOPLE'S COURT AND ITS JUDICIAL INTERPRETATION

Following the adoption of the new *Environmental Protection Law*, the Supreme People's Court (SPC), China's highest court and critical stakeholder in this new system, took action to lead the development of environmental public interest law.

- **Creation of a New Environmental Law Division:** On 23 June 2014 the SPC announced the establishment of a new Division on Environmental and Resources Law within the SPC, which is responsible for developing judicial interpretations related to environmental and natural resources law. There are 32 judges and clerks in this new division.

- **Guidance to Lower Courts:** The SPC also issued an opinion on improving effective environmental adjudication. Though there is no binding effect on the lower court, SPC's opinion showed the higher court's position and efforts to promote environmental civil public interest litigation. The opinion specifically directs the lower courts to accept cases filed by NGOs meeting the criteria stipulated in Article 58 of the EPL.

- **Opinion to Limit Local Government Interference:** The opinion also states that the intermediate people's courts located where the offending activities take place or where the offending parties are based have jurisdiction over environmental public interest cases. This is meant to address possible interference of local governments with the decisions of local courts in this type of cases (SPC, 2014).

Given the clear support from the SPC, a few local courts, especially in Jiangsu Province, began to take on more environmental public interest law cases. In total, 13 such cases were accepted in 2014, even before the new EPL took effect. Among these, one resulted in a landmark decision as the court ordered six companies to pay 160 million RMB (~$26 million) in restoration costs for illegally dumping about 25,349 tons of chemical waste into two rivers in 2012 and early 2013 in the Taizhou area. On 29 December 2014, the high court upheld the lower court's decision, but ordered the companies to pay 60 percent of the restoration costs within 30 days to a special fund that would be used to restore the environment in Taizhou area. The court also ordered that the companies use the remaining 40 percent of the settlement to upgrade their pollution prevention and control system within a year, stating that if the companies failed to do so, they would be required to pay that amount to the restoration fund. This is the biggest award ever issued in an environmental public interest lawsuit in China (Zhang, 2015).

In addition to issuing the opinion providing guidance to lower courts, the SPC promulgated a judicial interpretation entitled *Interpretation Regarding Certain Issues Related to Application of the Law in Environmental Civil Public Interest Litigation* (MOCA, 2015) to clarify and elaborate on stipulations related to the environmental public interest lawsuits in the revised *Civil Procedure Law*, the new *Environmental Protection Law* and the *Tort Law.*

The judicial interpretation includes the following provisions to help eliminate certain barriers and create incentives that shape the future development of environmental public interest law:

- Article 1 in the interpretation adds a stipulation that courts shall hear environmental public interest law suits not only after harm has occurred, but also if the conduct of a polluting party poses serious risks to the public interest, which expands on the provision in the Environmental Protection Law and the Civil Procedure Law. It should be noted that showing imminent environmental or ecological harm is comparatively easier than proving that actual harm has occurred.

- Articles 2 and 3 in the interpretation clarify and expand on which environmental organizations may present a lawsuit. According to the SPC "social organizations" (shehui zuzhi) include social groups, private non-enterprise units, and foundations. Groups registered with civil affairs bureaus in sub-districted municipalities, autonomous prefectures, regions or prefecture-level cities without sub-districts or districts of direct-controlled municipalities or higher level can bring environmental public interest case to courts. This expansion is important as it allows NGOs like FON and Nature University that registered at the district civil affair bureaus in Beijing to have standing. An official from MOCA estimates around 700 NGOs in China are now eligible for filling environmental public interest lawsuits.

  The interpretation's Article 18 sanctions remediation efforts that a court may impose based on the types and scope of environmental damages. These remedies include to "stop harm," "cessation of inference," "elimination of danger," "return of property," "restoration to original status," and "damages." SPC further clarifies that in cases where the plaintiff requests so, courts may require the polluters to restore the environment to the original condition and function. In cases where complete restoration is not feasible, the courts may allow other measures. For example, a natural wetland was filled by an illegal construction project and it was economically impossible to removing the illegal construction project and to restore the natural wetland. Thus, the court will allow restoration of another natural wetland in another location. If the polluters fail to implement its restoration obligations, the court can order the defendant to cover ecological restoration costs, such as the cost of designing and implementing restoration projects and the cost of monitoring supervision (Article 20). The remedy tool box of environmental public interest law incorporates market-based principles such as capturing the economic benefits of non-compliance from polluters. This stipulation has the potential to strengthen incentives for companies to comply with environmental laws.

- Article 22 of the interpretation provides that courts should support public interest plaintiffs' claims for attorney fees, investigation costs, assessment fees, and other reasonable litigation costs if they prevail. This attorney fee and litigation cost recovery provision will provide incentives for private attorneys and NGOs to engage in environmental public interest law.

Justice Zheng Xuelin, Director of Environment and Resources Law Tribunal proclaimed that the "Judicial Interpretation on Environmental Civil Public Interest Litigation is a powerful sword that can cut through the dirty stream and clean the grey smog air. It will be like a sword of Damocles that hangs above the polluters."

HAS CHINA'S ENVIRONMENTAL PUBLIC INTEREST LITIGATION ERA ARRIVED?

There has not been explosive growth in the number of environmental public interest litigation cases since 1 January 2015 when the *Environmental Protection Law* came into force. As of the end of March 2015, there were only five cases filed and accepted by the courts. While it may be an exaggeration to consider this "the era of the environmental public interest litigation," with the new law and the new judicial interpretation, it merits pondering whether such cases could boom in the near future. Will civil public interest litigation become a powerful weapon for citizens to address environmental problems and challenge big state-owned companies in China's judicial system?

Though these questions remain to be answered in the years to come, Chinese environmental NGOs continue to take action. A number of environmental NGOs led by FON and the Center for Legal Aid to Pollution Victims formed an advocacy and legal support network to develop collective action and public interest litigation strategies for civil society. The Friend of Nature Foundation, with support from the Alibaba Foundation, established a special fund to provide financial support to NGOs interested in filing environmental public interest lawsuits (FON, 2015). Some 2015 cases that were accepted include the following:

- In 2015, FON and Fujian Green Home, a local environmental NGO, filed a complaint with the Nanping Intermediate People's Court in Fujian Province to seek the cleanup and restoration of an illegal mining site. This case was accepted as the first environmental civil public interest case under to the new *Environmental Protection Law* ("Civil group," 2015).
- In March 2015, Dezhou Intermediate Court accepted a case filed by ACEF against the Dezhou Jinghua Group, which makes chemicals for the glass industry, requesting environmental damage compensation of 30 million RMB ($4.8 million) for air pollution. The proposed amount of damage is based on the economic benefits of the company's non-compliance (EBN) and the monetary gains from shutting down its air pollution treatment facilities. If the court upholds this claim, this case will set a strong precedent; damage compensation based on EBN can be imposed on environmental violators through environmental civil public interest litigation.

It is true that Chinese environmental NGOs still lack tremendously funding, knowledge, and legal support to file cases, but the new *Environmental Protection Law* and Judicial Interpretation represents a significant change from before. One can be hopeful that the era of citizen enforcement with Chinese characteristic is on its way.

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China's Eco-Cities: A Gray Area for Green Progress?

by Cecilia Han Springer

As one of the fastest urbanizing countries in the world, it is perhaps not surprising that China's current administration is prioritizing urbanization as a key development strategy. Li Keqiang, who succeeded Wen Jiabao as China's Premier in 2012, has long espoused the economic benefits of urban development—in the 1990s he wrote his doctoral dissertation on the economics of urbanization. In March of 2014, the central government released a new urbanization plan for 2014-2020. The document revealed a consumption-oriented development strategy; by increasing the number of urban residents and improving their standard of living, China plans to stimulate domestic consumption and maintain the high GDP growth previously driven by investment in domestic manufacturing and heavy industry.

The crushing air and water pollution in many of China's existing cities raises the question of what China's new urbanization vision means for the environment. Over the past few decades, China's approach to urbanization policy focused on economic growth and poverty reduction through land-intensive development and placing economic goals over environmental ones (World Bank & DRC, 2014). Chinese policymakers have recognized that the country's new urbanization plan must take into account increasing social and environmental pressures that have arisen from the country's rapid development. One experiment that is receiving significant funding and political backing is the creation of eco-cities. Eco-cities are new, centrally planned urban areas in China that aim to incorporate sustainable design and equally prioritize economic, environmental, and social targets. As part of a Fulbright Fellowship I conducted many interviews in China's most fully developed eco-city being built on the outskirts of Tianjin, using it as a case to explore how building, planning, and populating eco-cities is redefining green lifestyles in a way that raises questions about social and environmental sustainability.

WHAT IS AN ECO-CITY?

The term "eco-city" was first coined in 1987 by Richard Register, a California-based architect whose views grew out of a community of planners who espoused environmentally minded development in the 1970s and 1980s (Rapoport, 2014). This development was typically small-scale, guided by residents or environmental architects like Register. Western definitions of "green" or "eco" urban development typically conceptualize these cities as beneficial to the global environment, by reducing waste or decreasing carbon emissions that cause global climate change. International media outlets have, in some cases, scathingly criticized Chinese eco-cities as greenwashing schemes. However, such criticism often neglects to account for differences in eco-city definition, theory, and design between Western and Asian institutional planners.

Although the term still stands as an umbrella concept for urban sustainability, the meaning behind the term eco-city has changed over time, especially in non-Western contexts. The majority of today's eco-cities are large, new, and centrally planned. They are primarily built in developing countries by governments in collaboration with the private sector.

Eco-cities were endorsed in China's 12th Five-Year Plan (2011-15), and enjoy the support of formalized governmental processes. China's Ministry of Environmental Protection and the Ministry of Housing and Urban Development have developed two indicator systems for eco-cities that specify environmental targets and will be used to monitor and evaluate eco-city performance. Locally designed indicator systems can also be submitted for ministry-level approval in order to win eco-city designation for a project (Wong & Yuen, 2011).

THE SINO-SINGAPORE TIANJIN ECO-CITY

The Sino-Singapore Tianjin Eco-city (SSTEC) is currently under construction east of Tianjin, China's fourth largest city. The SSTEC began in 2008 and is due for completion in 2020, making it the most developed eco-city in China. From 2008 to 2015, more than 6,720 households with 20,000 residents and more than 3,000 companies have moved into the eco-city (Liu, 2015; Liu, 2016). Ultimately, the eco-city aims to house 350,000 residents.

The SSTEC is a flagship government project and reflects a number of national goals. The SSTEC slogan – practical, replicable, and scalable—underscores the intent of the government and developers to use the city as a model for future eco-cities across China. The eco-city is the latest in a series of collaborative developments between China and Singapore. These joint ventures can provide benefits to both governments by attracting foreign direct investment (FDI), promoting knowledge transfers, and strengthening diplomatic ties. In September 2008, then-Premier Wen Jiabao and then-Senior Minister Goh Chok Tong of Singapore broke ground at the eco-city site in a public show of political support for both green urban development and Sino-Singapore bilateral relations.

In addition to its political goals, the SSTEC also has clearly stated environmental objectives. SSTEC planning is governed by a locally developed the Key Performance Indicators system of 26 indicators for environmental and social performance. This indicator system features environmental targets unique to the SSTEC, but approved by the central government. For example, one indicator requires that 20 percent of the SSTEC's energy come from renewable sources by 2020. GM will also test a fleet of new electric vehicles in the eco-city, which will help meet the 90 percent intra-city green transportation target. In addition, the SSTEC also aims to improve the efficiency of the urban metabolism, with a per capita daily domestic waste generation target of 0.8 kg (about 1.76 lbs) per person and a goal to render all eco-city waste non-toxic through treatment. Other indicators address recycling rates, water consumption, and more.

To succeed in meeting many of the SSTEC's key performance indicators, the city's initial planning process (for example, the number of recreational parks within a certain area) is crucial. But some of the indicators, such as the recycling rate, depend on resident compliance. To what extent, then, are the behavior, needs, and opinions of residents accounted for in the planning process?

PLANNING THE ECO-CITY

Unlike Western eco-cities in the 1970s and 1980s, China's eco-cities are planned in a rigorously top-down manner. The plans for the SSTEC were developed in a series of closed-door meetings between Chinese and Singaporean teams beginning in 2007. Each year, the premiers of China and Singapore discuss the project in annual high-level meetings, with mid-level meetings taking place more frequently to produce reports and detailed plans for specific buildings within the SSTEC. Planners execute their vision starting from the eco-cell: 16-hectare parcels of land that are allocated to construction and service firms for development. Through this process, a number of real estate and design companies, including foreign ones, have been granted a strong hand in developing parts of the eco-city.

Like most Chinese eco-cities, the Sino-Singaporean Tianjin Eco-city featured a number of partnerships with foreign architecture and technology firms. Foreign firms are brought in to work on eco-city projects for two reasons. First, eco-city development is a politically palatable method of facilitating FDI and capturing the benefits of knowledge and technology transfers. Second, Chinese planners perceive foreign firms as prestigious partners that can appeal to China's aspirational middle class and also elevate the esteem of an eco-city project among planning and government peers, as well as investors and businesses.

International partnerships, while sought after by Chinese planners, have led to a number of problems for China's eco-cities. The Huangbaiyu Eco-village in northeastern China, for instance, was largely the brainchild of William McDonough, the American sustainable design pioneer. Yet few villagers ended up moving into the village, because the houses were unfamiliar in design and inconvenient—specifically unable to accommodate livestock and far from fields (Sacks, 2008).

The strong hands of the central government, local planning bureaus, and foreign design firms have largely placed the planning of eco-cities like SSTEC outside the realm of influence of the citizens who will ultimately inhabit these cities. In reality, many residents are unaware of the eco-city's indicator system. The ability of the city to achieve its indicators without resident buy-in is unclear.

BUILDING THE ECO-CITY

The construction process for the SSTEC reveals how its planners are altering the natural environment to create a new definition of a green living environment that is highly artificial. SSTEC marketing material typically describes the eco-city development as a remediation and reclamation project on polluted, non-arable, unpopulated land. The eco-city planners claim they selected the location because it would not displace agricultural production, given food security priorities in China. In addition, the central lake in the SSTEC was formerly a wastewater reservoir for the chemical

Artist rendition of Tianjin Eco-city. Credit Sino-Singapore Tianjin Eco-City Development and Investment.

industry in the nearby Hangu District, and its remediation by SSTEC developers represents a major environmental success.

Despite this reclamation and remediation narrative, the area on which the SSTEC was built has a rich natural history. The wetlands and saltmarshes east of Tianjin were the center of a thriving salt trade in the early 1900s (Rogaski, 2004). In addition, previous inhabitants found a natural beauty in this land that inspired art and poetry. Fan Bin, a Tianjin native who wrote over a hundred poems about the area in the nineteenth century, praised the "gently swaying reeds," "misty landscapes," and "bucolic beauty in Tianjin's watery world" (Rogaski, 2004). This effusive description strongly contrasts with SSTEC's advertising material that implied the land has never had significant economic or environmental value, characterizing the site as an unattractive, low-value area waiting for development.

Rather than preserve or rehabilitate the original wetland and saltmarsh environment, SSTEC planners have incorporated a number of constructed 'eco-parks', 'eco-valleys', and 'eco-corridors' that aim to increase greenery within the eco-city. One of the eco-city's key performance indicators is the "green space ratio," which mandates that at least 40 percent of the eco-city's land area consist of greenery. However, this greenery has largely been imported rather than preserved using existing land. SSTEC gardeners (many of them migrant workers from southern China) asserted that many of the city's plants are native to Hunan and warmer southern provinces. The intensive gardening and landscaping activity, land reclamation and remediation, and construction of new eco-corridors indicate a willingness from the SSTEC planners to reform the natural environment in order to construct a new environment that aligns with a new vision of being "green" and "eco-friendly."

Vision of the Tianjin Eco-City. Credit Sino-Singapore Tianjin Eco-City Development and Investment.

POPULATING THE ECO-CITY

Who will live in China's eco-cities? The advertising techniques of real estate developments within the SSTEC reveal a clear targeting of young, upper middle-class residents—a new class of suburbanites for China's satellite eco-cities, which tend to be located on the fringes of major cities. In contrast to Western conceptions of green living, advertising in the SSTEC pitches green living and an 'eco-lifestyle' based on luxury, comfort, and cleanliness.

In addition to contracting foreign firms, Chinese eco-city planners seek to infuse eco-cities with a sense of luxury by directly imitating other East Asian models. This aspirational design caters to upper-middle class Chinese by claiming to offer lifestyles similar to those of Singaporean or Taiwanese elites. For example, the Farglory real estate development in SSTEC has constructed a small recreational island in the shape of Taiwan, with Taiwanese décor and goods sold nearby. The website for residents living in Farglory housing is called "Rich Family." In the case of Vantone, a large Beijing-based property developer, their

SSTEC apartments are described as "Western style garden houses." As an advertising poster for these "legacy homes" highlights, "comfort is the ultimate aim of living." While seeking to emulate cities in more developed regions is not necessarily at odds with environmental performance, the SSTEC's interpretation of aspirational lifestyles is highly consumption-based, highlighting access to imported goods and services that are typically associated with a large environmental footprint.

Some of the white-collar residents that the eco-city aims to attract have already moved in. During the early stages of the SSTEC's development, the first operational businesses in the eco-city were the local SSTEC government bureau and a number of animation companies within the "animation park," a clean technology hub in the center of the eco-city. The white-collar workers at these businesses indicated that they had moved to the SSTEC because of their jobs, not because of an inherent desire to live a green lifestyle. Interestingly, the SSTEC master plan mandates that 20 percent of all residential units are designated as public housing (also a key performance indicator). But, prices for these units are currently only 15 percent less expensive than standard, private eco-city housing. Typically across China, public housing has a 40 percent or greater discount relative to the average housing price, and is a quarter of the price of luxury housing (as most of SSTEC's housing is branded) (Huang, 2012).

Despite socioeconomic homogeneity among the planned demographic of the SSTEC, a fair amount of diversity exists due to the city's unofficial residents—laborers and construction workers. The construction workers building unfinished parts of the eco-city are migrant laborers living in temporary dorms around the city. Sanitation workers, gardeners, and other blue-collar laborers live in permanent dormitory-style housing in the western part of the eco-city; however, this encampment is not included in the official population of the eco-city. These blue-collar workers, too, in discussions with the author expressed the sentiment that they moved to the SSTEC for their jobs, and not for a greener lifestyle. Across socioeconomic classes, there is scant evidence of people moving to the eco-city out of environmental motivations.

Copyright: Sino-Singapore Tianjin Eco-city Development and Investment.

A GRAY AREA FOR GREEN PROGRESS

Both blue-collar and white-collar residents have expressed appreciation for the SSTEC's relatively uncrowded streets, greenery, and low noise levels. These characteristics are described as "eco" and "environmental" improvements in the Chinese context, though they refer to improvement of the built environment rather than the natural environment. China's top leaders, local planners, and residents describe the goals of eco-cities in terms of improving living conditions rather than for the sake of the natural environment.

The planning, building, and moving-in processes in the SSTEC give cause for concern due to the environmental impact on the natural landscape, both at the local and global level. Social sustainability is also a concern, since socioeconomic diversity is necessary for healthy cities. The SSTEC's eco-city housing caters largely to upper-middle class residents. For now, eco-cities are not planned for the diverse, heterogeneous Chinese society that naturally exists in typical urban areas.

Chinese eco-cities are a core part of the country's new vision of consumption-oriented urbanization. In many ways, planning patterns in Chinese eco-cities mirror urban sprawl and suburbanization that have occurred over the past century in Western countries. Within China's rural-to-urban transition, eco-cities may represent a new kind of green suburb that favors consumption-oriented lifestyles while at the same time trying to mitigate environmental impact and promote social stability. These goals may at times be at odds—placing Chinese eco-cities in a gray area for green progress. Planning that incorporates economic, social, and environmental sustainability is a step in the right direction, but whether China's eco-cities will be able to achieve these goals in a balanced manner remains to be seen.

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Coal's Slow Exit Strategy: Cleaner Coal Trends in China and The United States

by Al Scott

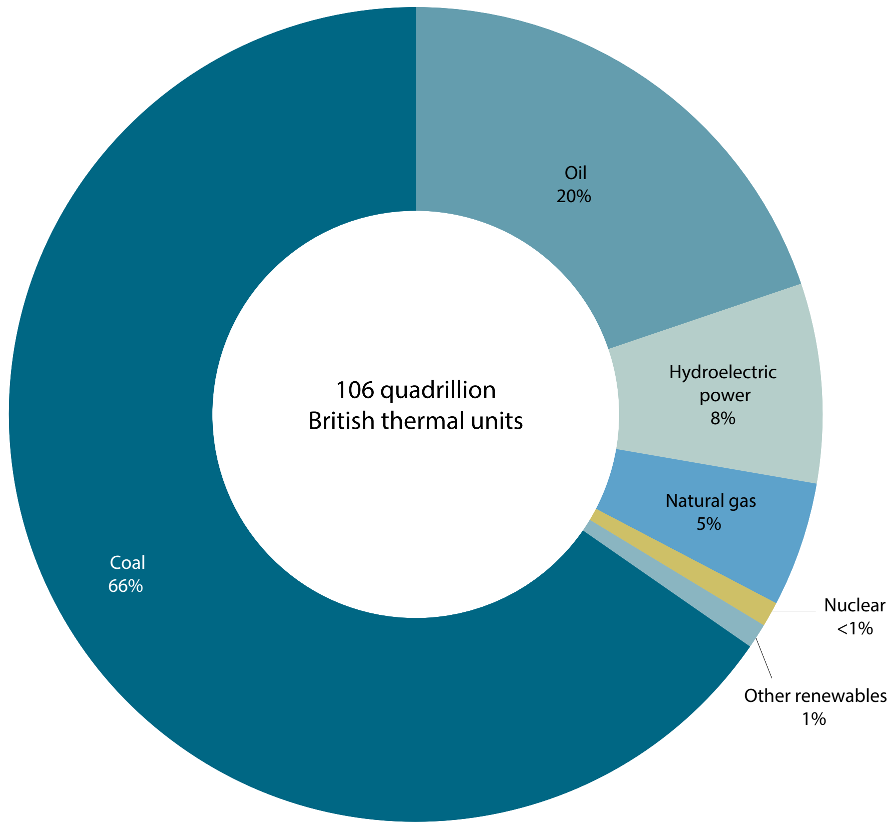
COAL ISN'T GOING AWAY SOON

At the COP21 Climate talks in Paris, the Chinese and U.S. governments reaffirmed the ambitious commitments they jointly made to reduce coal consumption in their November 2014 climate and clean energy agreement. These intentions are serious, but it will remain challenging for these two largest coal and energy consumers in the world to ratchet down dependence on coal as quickly as hoped. Coal provides around 30 percent of the world's primary energy needs, generates 41 percent of the planet's electricity, and is used in the production of 70 percent of the world's steel. In 2014, coal was utilized to generate around 70 percent of electricity in China, and 39 percent of electricity in the U.S. (Bernton, 2014; U.S. Energy Information Administration, 2015). In the United States, despite the continued boom in the supply of natural gas, coal will remain a stable fuel source in the foreseeable future.

Coal is the most prevalent and least expensive fossil fuel available. It dominates China's energy supply. In 2015, China led the world with an estimated 3,370 billion tons of coal produced, compared to the United States—the second largest coal producer with an estimated production of 688 metric tons (Rose, 2015). It took up almost half of global coal production in 2012. Currently, coal comprises about two-thirds of China's total primary energy consumption. Although China is currently both the largest consumer and producer in the world, the coal's reign as king may be challenged.

The U.S.-China Clean Energy and Climate Agreement catalyzed a new momentum for reducing coal use and adopting cleaner coal technologies. Strikingly, in 2015 China's coal imports dropped by 23 percent and overall consumption also sank around three percent.

Figure 1. Total primary energy consumption in China by fuel type, 2012



Note: Total may not equal 100% due to independent rounding. Includes only commercial fuel sources and does not account for biomass used outside of power generation.

Source: U.S. Energy Information Administration.

CURRENT CLEAN COAL EFFORTS IN THE UNITED STATES

The U.S. Department of Energy (DOE) Office of Fossil Energy has been a driving force behind R&D and commercialization efforts in clean coal technologies in recent years. DOE's clean coal R&D focuses on two primary areas of interest: further development of carbon capture, utilization and storage technologies (CCUS) and advanced power generation for existing facilities and new fossil-fueled power plants.

1. Carbon Capture, Utilization and Storage Research

CCUS includes technologies that capture CO_2 either before or after combustion:

- **Post-Combustion Capture** applies to conventional pulverized coal fired power plants, where the fuel is burned with air in a boiler to produce steam, driving a turbine/generator to produce electricity. CO_2 is captured from flue gas after fuel combustion.

- **Pre-Combustion Capture** can be used in Integrated Gasification Combined Cycle (IGCC) power plants where solid fuel is converted into gaseous elements ("syngas") by applying heat under pressure in the presence of steam and oxygen. Carbon is captured from the syngas before completing the combustion process.

2. Advanced Energy Systems

The Office of Fossil Energy's Advanced Energy Systems program focuses on improving the efficiency of coal-based power systems, enabling affordable CO_2 capture, increasing plant availability, and maintaining the highest environmental safety standards. The program supports gasification R&D to convert coal into synthesis gas that can be converted into electricity, chemicals, hydrogen, and liquid fuels. The program also advances hydrogen turbine designs to improve the performance of pre-combustion CO_2 capture systems, as well as supports advanced combustion systems through R&D focused on new high-temperature materials and the continued development of oxy-combustion technologies.

One ongoing effort from these R&D efforts—hydrogen from coal—is based on the production of hydrogen from coal by gasification, a process that avoids burning coal (e.g., partial oxidation). Another novel approach for clean coal technology is coal-to-liquids technology.

CURRENT EFFORTS IN CHINA

It is no big surprise that energy conservation and environmental protection is one of China's seven Strategic Emerging Industries (SEIs) in its 12th (and likely 13th) Five-Year Plan. Designated as the backbone of China's economy in the decades ahead, the Chinese government is likely to prioritize more investments into SEIs, such as cleaner coal technologies. Successful adoption of more clean coal technologies will have a positive impact on other industrial policies in China as well as help continue the downward trend of importing coal. Clean coal technology is an increasingly pertinent topic in China's energy policy agenda and aligns with the Chinese government's continual plans of consolidation in the coal industry to improve energy efficiency.

Besides the Carbon Capture and Sequestration (CCS) program, clean coal technologies currently being developed in China include high efficiency combustion and advanced power generation technologies, coal transformation technologies, and Integrated Gasification Combined Cycle. Coal post-treatments are the main focus for government clean coal investments, with a particular emphasis on Carbon Capture, Utilization and Storage (CCUS).

Although China only recently began developing clean coal technologies, there have been many successes. China Huaneng Group GreenGen Corporation Limited's Tianjin IGCC demonstration project, utilizing pre-combustion technology, began operations under oil-fired operating conditions on October 2, 2011, and is slated to be completed in three phases. In its second phase began in early 2014—a 101-250 megawatt plant was designed to produce "clean" electricity and sequester carbon dioxide for industrial use. Scheduled to begin in 2020, the final phase plans to expand to an 800-megawatt plant.

U.S.-CHINA JOINT EFFORTS

- The 2014 U.S.-China Climate Agreement announced goals to advance major carbon capture, use, and storage demonstrations. By expanding work under the Climate Change Working Group and the Clean Energy Research Center mechanism, the U.S. and Chinese government and private sector companies are undertaking a CCUS project to capture and store CO_2, while producing fresh water to be stored in a suitable, secure underground geologic reservoir in China. Both sides will make equal funding commitments to the project and will seek additional funding commitments from other countries and the private sector.

- Within the U.S.-China Energy Cooperation Program, which was created by ~20 U.S. energy companies under the 2009 Obama-Hu Clean Energy Agreements, a Clean Coal Working Group was created. This working group is active in four primary areas:

  - Mining & Pre-conversion Processing
  - Power Generation
  - Coal to Chemicals
  - Land Reclamation, Waste Disposal, and CCUS

- The U.S.-China Clean Energy Research Center (CERC) is another joint effort whose primary purpose is to facilitate joint R&D and commercialization of clean energy technologies between the U.S. and China. One of CERC program—the Clean Coal, including the CCS program—addresses technology and practices for clean coal utilization and CCUS. In 2014, this CERC was renewed for another five years, so the research and pilot projects will be able to expand. Research areas in development include:

  - **IGCC partnership with CCS,** combining advanced gasification with CCS in the power sector remains a critical pathway towards low-carbon power generation
  - **Post-combustion CO_2 capture, utilization, and storage technology**
  - **CO_2 –Algae biofixation and use,** based on capacity of microalgae to absorb carbon dioxide directly from the flue of a coal burning power plant
  - **Coal co-generation with CO_2 capture** including new coal-to-demand co-generation, new CO_2 capture process, and co-generation system with combined pyrolysis gasification and combustion

INDUSTRY BENEFICIARIES AND POTENTIAL LOSERS

Besides cleaner coal investments and developments, technologies that increase the efficiency of power generation from coal while removing the byproducts that cause health issues (SO_2, NOx, particulate matter, CO_2 emissions and mercury, among others) are likely to become of greater importance. As these cleaner coal technologies advance, coal companies should stand to benefit from the improved image association, as well as receive an increase of environmental and political support. Likewise, companies that produce equipment associated with coal, from mining machinery to railway transportation, along with other coal-intensive industry input producers, will benefit. Conversely, alternative energy companies and their affiliates may face slower growth in the face of viable progress in clean coal technologies. This may not be true in China where hunger for energy is so great that all forms of energy are needed to "keep the lights on."

One potential wild card in CCS and CCUS efforts that has yet to be researched thoroughly is sequestration technology. The front-end has been the focal point thus far, but storage technologies have yet to be tested on a large scale under real-time conditions. Non-trivial concerns still persist on the complexity, viability, safety, and efficiencies of this aspect from these processes.

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Improving Environmental Governance in China: Public Participation in Environmental Impact Assessments

by Katie Walsh

In the past, maybe people would want a subway next to them, but now they don't because what they want is quality of life and green space. People's needs have changed and we have learned that through public participation in an Environmental Impact Assessment.

Shanghai Environmental Protection Bureau

Chinese citizens gained an unprecedented change in their legal right to participate in decisions affecting the environment when China enacted the Environmental Impact Assessment (EIA) Law in 2003 (Moorman & Zhang, 2007). Public participation provides an opportunity for the Chinese public to learn about a proposed project and voice concerns or express support, through a legal channel. The participation process provides a framework for the proposed plan or project to incorporate public values and preferences into decision-making.

Although there is a legal obligation for public participation in EIAs, it does not always happen in a meaningful way (Mol, 2006). There are procedural, technical, attitudinal, and structural challenges that constrain sound practice and performance. Public awareness of environmental conditions and of the impacts of environmental degradation has probably been one of the most important forces for environmental improvement worldwide. With worsening environmental degradation, rapid urbanization, and an increase in citizen protests on environmental issues, public participation in EIA has the potential to integrate citizen concern into the decision-making process and support local environmental governance in China. In this respect, the public participation process in China's EIA system deserves further adjustment and monitoring by Chinese EIA scholars, policymakers, and authorities.

POOR DEFINITION OF THE "PUBLIC" AND METHODS OF PUBLIC PARTICIPATION

Current procedures in China's EIA do not clearly spell out who the "public" is. It is common practice for consultants and the local environmental protection bureau (EPB) officials overseeing the EIA process to seek the opinions of a few experts from universities and research institutes rather than the views of the general public (Zhao, 2005). The problem with relying on experts' opinions is that the issues raised by specialists may not reflect the views of the public, at-large (Li, Liu, & Li, 2012).

Public participation methods in China's EIA guidelines are also criticized for serving more as a data-gathering exercise than for educating and engaging the public. Sanctioned procedural practices reveal that China's public participation process is more oriented toward consultation than participation. Project developers and EIA consultancies are given the flexibility to choose the form of public participation. More often than not, questionnaires are employed as more of a means to gather information about the public in the affected area than to understand the public's views.

VARIABILITY OF THE CHINESE PUBLIC'S ENVIRONMENTAL AND LEGAL AWARENESS

The solicitation of comments during the EIA process provides a framework to understand public opinions on the proposal. In practice, however, public comments are too brief or inconspicuous in Chinese EIA reports. This phenomenon severely diminishes the effect of the process (Du, Yang, Xu, Harashina, & Li, 2010). The Chinese public is generally unaware of environmental protection legislation and does not recognize that EIA can serve as a tool to review and comment on development decisions before they occur (Du et al., 2010).

There is also an implicit assumption that the public, given the opportunity to participate, will readily and willingly make constructive comments. This varies according to geography and the background of the public engaged in the process. However, city dwellers are generally more aware of their "right" of public participation in EIA than their rural counterparts.

LACK OF TECHNICAL TRAINING IN ENGAGING PUBLIC PARTICIPATION

Public participation faces another challenge as EIA consultancies lack education and experience in engaging the public. Neither the 2003 EIA law nor the 2006 Provisional Regulation establishes a system to promote public participation in the Chinese EIA system, such as a fund or database to collect examples of solid public participation in EIA, as well as offer technical support, training, and monitoring responsible entities (Yang, 2008).

ATTITUDES TOWARDS PUBLIC PARTICIPATION AND LOW TRUST

Low trust in the process and value of public participation severely diminishes the quality of public participation in China's EIA. In interviews with government departments and private sector organizations, a recent study found that the public's comments were of "questionable value" in EIA reports (Li, Ng, & Skitmore, 2012).

The rise of environmental protests in China has been attributed to Chinese citizens' distrust of decisions and lack of transparency by local governments (Zhu, 2012). Citizen distrust is driven by repeated interactions in the past under these types of situations (Li, Liu, & Li, 2012). Chinese citizens may infer from past experience with other approved projects that there will be foreseeable damages to nature, the environment, and their health.

PERVERSE INCENTIVES FOR LOCAL GOVERNMENT AUTHORITIES

A major barrier to the successful implementation of public participation in China's EIA process has been the perverse incentives that exist for the local government and the EIA consultancies. GDP figures factor largely into the evaluation system for local officials that can affect their promotion. Especially in the case of major projects that are linked to local economic priorities or political interest, an EPB may be subject to pressure from local political leaders (Cheng & Huo, 2001; Wang, 2003). Projects go ahead despite significant adverse impacts identified in the EIA process and an omitted or limited public participation process (Wang, Morgan, & Cashmore, 2003).

Another issue is the conflict of interest that exists between the EIA consultancies and the local EPBs. One method that local EPBs adopt for creating additional revenue is to establish subsidiary institutes and companies that can produce EIA reports (Mao & Hills, 2002). A manager at a firm who develops large-scale urban development projects in China discussed his company's awareness of this conflict of interest. When asked if the firm has considered using other consultancies that are not recommended by the local EPB, and if there was a possibility the EIA would be more rigorous, he responded: "Of course not, we want to see the project get passed too; why would anyone go with a consultant that isn't going to pass the project?"

RECOMMENDATIONS ON IMPROVING PUBLIC PARTICIPATION IN EIA

Improve monitoring and enforcement. EPBs have some of the highest responsibility to implement environmental policies at the local level, but are often restricted by insufficient resources and are administratively weak. The EPBs are often considered "powerless" when conflicts arise with other agencies in the local governments (Ran, 2013). Providing additional administrative, legal, and resource support to local EPBs can help to improve monitoring and environment, and in turn, strengthen the public participation process in EIA.

Higher penalties and compliance costs. Firms with strong relations with local authorities will choose to invest heavily in projects before it reaches the approval stage (Stanway, 2013). The developers then argue that it is difficult to change project after funds have already been disbursed. Under current EIA law, environmental authorities must order project developers to stop and submit a "make-up" EIA document if they start construction without conducting an EIA. The fine for not submitting this form carries a maximum fine of 200,000 RMB ($33,000). This amount is nominal for a project involving a multi-billion RMB investment (Zhao, 2009). "Make-up" reports also defeat the fundamental purpose of an EIA as a preventive tool to assess, avoid, and mitigate potential environmental hard and engage the public. Higher penalties and compliance costs should be placed on project developers, and thus such loopholes would be eliminated.

Appropriate recourse for the public. There is limited legal recourse when EIA consultancies violate the EIA procedures and technical guidelines. There have been numerous cases of substandard practices and fraud. In early 2013, the MEP released findings from a three-year survey on the country's EIA consultancies. Of the 1,163 organizations registered as of 2012 to conduct EIAs, most did not meet required standards. Unprofessional practices included weak quality control, lack of follow-up surveillance reports, and poorly compiled evaluated documents. MEP claimed to ensure that EIA agencies improve, but did not offer how enforcement would be carried out. There have been cited public participation cases that have claimed the falsification of data in EIA reports.

Timing and incorporation of public comments. Public participation in China's EIA should also be conducted throughout the project cycle, including project preparation, planning and feasibility studies, the design and tendering process, and finally in the construction stages. The public should be able to provide feedback on a project or plan early enough in the drafting of the EIA document, in order to contribute to the formation of the ultimate conclusions that inform the substance of the draft EIA document (Moorman & Zhang, 2007). Attention to the diversity of participation methods should also be strengthened in the technical guidelines for EIA.

In order to have a successful EIA, the public should have multiple opportunities for engagement, including hearings and meetings. Moreover, there should be a requirement that clearly defines how public input is considered in the final EIA report.

Improve attitudes on the utility of public participation. A "carrot and stick" method might address some of the negative attitude toward public participation. A "carrot" serves to highlight the perspectives from municipalities and environmental protection authorities that value public participation. This illustrates why these groups comply with the process and seek to improve it, including initiatives to solicit opinion and coordination with other agencies.

The "stick" method demonstrates to local government officials the need for participation to ensure social stability, as well as share the economic benefits for developers. EIA consultancies should be made to understand the risk of delaying or losing their government-approved certifications.

Increase environmental and legal awareness among the Chinese public. To mitigate the diversity in the Chinese public's awareness, environmental training should be made easy to understand, use, and accessible (Li, Ban, & Cai, 2005). Ways to reach the public may be to carry this work out through residential committees, schools, residential area management companies, or the growing homeowner's associations (Yang, 2008). Such efforts will enable the public to participate more effectively and improve local environmental governance (Wang, 2003).

FINAL THOUGHTS

Public participation in EIA unlocks a door to manage China's development process and improve environmental governance. Public participation brings diverse knowledge and expertise to the table, and provides both government and project developers an understanding of the public's input. This mutual interaction can likewise enhance the public's understanding of development projects and strengthen civil enforcement of environmental legislation. Public participation will undoubtedly prove critically valuable as China faces severe environmental degradation, energy challenges, rapid urbanization, and an unprecedented pace of development.

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Keeping Up with the World's Fastest Growing Fleet: iCET's Vehicle Rating System

by Maya Ben Dror

Greenhouse gas emissions were on China's to-do list for over a decade, but geopolitical concerns, economic pressure to keep depending on cheap coal, and inadequate methods to quantify emissions delayed an aggressive hands-on approach to curbing carbon. The one-two punch of serious air pollution and intensified air-quality reporting led the Xi administration to declare a war on pollution, launch many top-down measures to mitigate urban pollution and sign a historic climate agreement with the United States. Many stakeholders in China, from the government, industry to civil society organizations, seek to develop strategies and policy tools that will capitalize on the new opportunity promoted by the leadership to meet a coal cap and lower carbon emissions. There has been some success in dropping coal emissions, but carbon and other pollution from cars continues to rise.

Since 2009, iCET's Clean Transportation Program has provided interested public and private stakeholders with a free online tool that measures on-road transport CO_2 emissions and fuel consumption. We update the tool annually and share it on our website and social media sites. This Environmental Friendly Vehicle (EFV) tool provides information on a vehicle's emission components and emissions impacts, but the tool's effectiveness will depend on whether it leads policymakers to improve regulations and incentives for the industry and public to follow.

Figure 1. iCET Environmentally Friendly Vehicle Online System

iCET's free online system covers (for 2007-2013 model years) the vehicle's lifecycle emissions and air quality impacts, as well as provides state-of-the-art vehicle and auto-manufacturers rating. The website is promoted through iCET's over 62,000 Weibo blog members.

Source: www.greencarchina.org

VEHICLES AS MAJOR CO_2 AND AIR POLLUTION CULPRIT

Social unrest, needless to say, is a major driver for change in China's air pollution policymaking. Chinese officials responded quickly to discontent from the news media and citizens on social media during the major 2013 smog "airpocolypse" in Beijing. In response, China's national government introduced new binding city pollution control requirements and guidelines (*Atmospheric Pollution Prevention Action Plan*, 2013) and in 2014 committed to capping coal emissions by 2030 as part of the historic U.S.-China Climate Agreement. Moreover, in 2015 the Chinese government amended both the *Environmental Protection Law* and the *Air Pollution Control Law*, which strengthened pollution control regulations and standards and increased punishments. In the face of this tsunami of new legislation and regulations, local governments are searching for implementation guidance and useful tools to meet these stricter policy regulations, particularly in the challenging transport sector where emissions continue to climb.

Beijing officials declared two code red alerts in December 2015, which required drastic reductions of cars on the road and limitation in factory operations and construction. While coal emissions have been dropping gradually, auto emissions continue to climb.

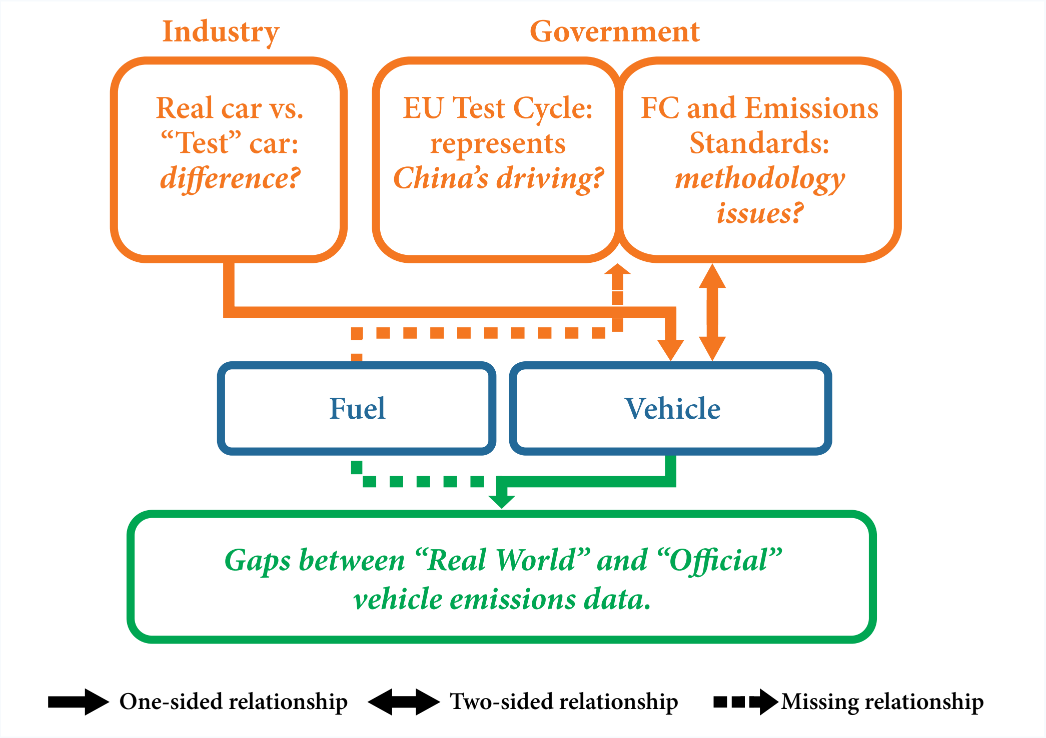
China's oil imports account for about 60 percent of national consumption and the country became the world's largest oil importer in 2013. China's transport sector is responsible for about 70 percent of oil consumption growth, and 40 and 22 percent of city-center air pollution and $PM_{2.5}$ emissions, respectively. The on-road transport sector is projected to increase national CO_2 emissions by over 50 percent between 2010 and 2020. These projections are based not only on the rapid increase of vehicle use and the low fuel-efficiency rates of Chinese vehicles, but also on the low-quality of transport oil fuels, as evidenced by reported car engines exploding after short usage periods on China's roads. On the national level, transportation sector emissions have been tackled through fuel economy and vehicle emissions standards' design. Automakers have been introducing these new standards in their designs since 2004.

FALSE DATA MAY UNDERMINE EMISSIONS CURBING EFFORTS

The quality and reliability of the data for CO_2 emissions and air quality are still under debate, and until recently government departments as well as national research institutions have rarely provided official estimates online. In some cases, local governments would remove emission data posted online if it attracted negative public comments. New air pollution rules are requiring public disclosure of many air pollutants plaguing Chinese cities, but CO_2 emissions are generally not. The blurred distinction between institutions that have "the right" and "the obligation" to provide information has hampered attempts to establish credible baselines and make effective plans to transition towards cleaner modes of transportation. As result, local governments and automakers can easily use false figures to meet the recent national emissions curbing guidelines. The recent VW scandal underscored how car manufacturers can create false readings for emission tests.

Transportation emissions quantification is problematic on several fronts. First, automakers select (and arguably even tailor) a representative vehicle for each new model to be tested for production approval. Even if the vehicle meets emissions and fuel consumption requirements, it may not accurately represent the vehicles that would hit the roads. Second, the test through which vehicles' standards compliance is assessed has been borrowed "as is" from the EU. As a consequence, the test does not reproduce China's typical driving cycle of a vehicle, which tends to include less rural driving

Figure 2. Key Issues in Mapping Vehicle Emissions Data



The value of official vehicle emissions data is often questionable because of questions on the credibility of data sources (at both government and industry levels) and discrepancies in methodologies (e.g., missing processes for incorporating data on fuel quality).

and more congestion, for example. Finally, official standards which are not well supervised and regulated do not account for the wide variation in fuel quality. Vehicles with similar characteristics may produce significantly more emissions and pollutants when using a low quality fuel. Overall, the official emissions and air quality values attached to every vehicle are not credible, and cannot provide a good baseline for informed decision-making, either by consumers or policymakers.

THE NEXT STEP FOR ICET'S EFV FREE ONLINE TOOL: TO HELP FILL DATA GAPS.

iCET's Environmental Friendly Vehicle (EFV) rating system is based on the contention that a fair, unbiased environmental passenger vehicles rating system is essential for all three market decision-makers:

1. Government entities can assess market uptake and responses in relation to the regulatory framework for better informed decision-making responses;

2. Consumers can easily compare vehicles' environmental impacts and fuel consumption rates; and,

3. Automakers can gain insights into the market demand for fuel-efficient vehicles.

iCET's EFV free online tool provides a green rating score for all vehicles on the Chinese market. The EFV methodology is based on a comprehensive meta-analysis that draws lessons from leading international Green Vehicle rating systems. Through the incorporation of China's unique vehicle production and usage characteristics, the EFV provides a tailored lifecycle analysis. It is based on several key factors:

- Vehicles fuel consumption and fuel type;
- Vehicle tailpipe emissions; and,
- Vehicle curb-weight.

The system, however, does not challenge the accuracy of fuel consumption per vehicle model or the official test-cycle which determines the fuel-consumption values per vehicle.

In order to overcome the gap between the real world and officially provided fuel consumption and emissions data, iCET is collaborating with official research institutes and governmental entities to provide state-of-the-art quantifications of primarily private vehicles in China. iCET's media partners, such as the largest portal, Sina, and various experts at Chinese think tanks and universities disseminate our work's results to policy decision-makers at all levels. The EFV system can be further extended to include economic implications in order to attract consumers and identify greater transportation solutions. Nevertheless, iCET's Clean Transportation Program is consistently searching for further distribution channels of its research outcomes, funding sources for enabling even better execution and the broadening of its scope of work, and collaborators that can reflect on and amplify the EFV's impact.

Maya Ben Dror serves as iCET's Clean Transportation Program Manager. Maya is responsible for the strategic development, international alliances of the program, and new-energy vehicle research work. Maya gained China-focused global work experience in the area of clean technologies and policies through both the government, private and third sectors and holds MSc in Environmental Change and Management from Oxford University. She can be reached at maya.bd@icet.org.cn.

Foshan City Tackling Pollution from Ceramic Production and the Industry Migration

by Shiming Yang

Chinese cities are increasingly struggling to balance competing demands for economic development and environmental quality. As pollution problems have intensified, municipal governments face growing pressure from the central government, the general public, and industry. The drivers and solutions to the pollution are complex, but there are some insightful experiments going on in many Chinese cities. A case study of well-designed and executed pollution regulation in the ceramics industry in Foshan city in Guangdong Province offers a snapshot of how pollution-control policies can help Chinese cities both mitigate pollution while minimizing the damage to local industry.

SNAPSHOT OF A TYPICAL INDUSTRIALIZING CITY

Foshan is a typical prefecture-level city in China that industrialized rapidly since the 1980s. The city has benefited from specialized market clusters and supply chain support networks that fueled urbanization and increased overall living standards for the existing and growing population of Foshan. The explosion of energy-intensive and polluting industries, however, has increasingly threatened the city's economic and social prospects. Recognizing the challenges, Foshan was among the first prefecture-level cities to take effective measures to control industrial pollution, taking a systematic approach beginning with the ceramic industry.

THE CERAMIC INDUSTRY POLICY: DRIVE AWAY THE POLLUTION

The municipal government had good reason to choose the ceramic industry since it has been a pillar in Foshan's economy. The largest ceramic production bases and market clusters in China are in Foshan, which by 2007 had 366 above-scale enterprises (those with annual revenue of five million RMB or above) with 124,000 workers. The ceramic industry accounts for 18.5 billion RMB (~eight percent) of the city's annual GDP (Foshan Government, 2008).

Despite providing jobs and wealth, the ceramics are a heavily polluting and energy intensive industry. Shockingly, while it makes up less than 10 percent of industrial GDP, ceramic production accounts for almost 60 percent of industry dust, 42 percent of SO_2, and about 32 percent of NO_x emissions in Foshan. Not surprising this industry is a major contributor to the serious smog and acid rain impacting the city and surrounding region. Another significant footprint of this industry is that it represents 37.5 percent of total industrial energy consumption, using 75 metric tons of coal for every million RMB in GDP produced, second only to the electricity industry in Foshan. Moreover, most ceramic facilities were located in Chancheng District, the political center of the city, making industrial pollution highly visible (therefore sensitive) to local governments (Li, 2007). Thus, mitigating pollution by cleaning up the ceramic industry was a clear and smart choice.

The municipality set strict energy efficiency targets and sulfur standards for fuels in 2008 (Foshan Government, 2008). The city government then divided the ceramic enterprises into three classes by size and technology. Among the 366 above-scaled enterprises, 42 enterprises were encouraged to expand production with a series of preferential policies that facilitated access financing, markets, innovation, and human resources. Another 146 enterprises were encouraged to upgrade, and the rest (approximately 175) that did not reach the emission goals had to close down or relocate outside the city.

In Chancheng District, the Nanzhuang township government set aside 50 million RMB to pay for potential land or salary defaults, and another 50 million RMB for land purchase to relocate enterprises outside of Foshan. Tax incentives were also made available for enterprises relocating to designated industry parks (Chancheng Government, 2007). These measures aimed to reduce inner city pollution and develop a "Headquarter Economy" in Foshan ("Coordinate with ceramic companies," 2007).

Foshan municipal and district governments also built industrial parks to attract high-value segments of the ceramic supply chain, such as R&D, design, exhibition and tendering, and financial services. Moreover, local governments designated financial resources to facilitate the clean-up transition; for example the Chancheng District government offered each enterprise that was to close down or relocate a compensation of about 50,000 RMB.

EXAMINING FOSHAN'S DUAL GOALS

How Foshan's clean-up policy promoted the duel environmental and economic goals offers some important lessons for other cities.

THE ENVIRONMENTAL GOAL

Overall, the clean-up policy targeting the ceramic industry was focused, feasible, and effective. Each district drafted a plan, while the Chancheng District government, decided to close down 90 out of 115 ceramic enterprises (Li et al., 2010). Notably, the decision was implemented within a few months, leaving enterprises little buffer time. By early 2013, fewer than 70 ceramic enterprises with production lines remained in Foshan. The environmental quality in these areas made quick and visible improvement and by the end of 2008 in Nanzhuang town the concentration of SO2 , NOx, and PM10 decreased from 2003 levels by 66, 56, and 47 percent, respectively.

The environmental benefits of the policy, did not lead to an export of pollution emissions, for the large and medium ceramic enterprises that moved their new production lines outside Foshan (mostly in neighboring areas) rebuilt with significantly more efficient and cleaner facilities.

However, several small highly polluting factors that were exempt from the clean-up policy continued to operate in Foshan in 2010 ("Behind Foshan's," 2013). Some other medium-sized ceramic industries that had installed cleaner production equipment still were not very efficient and according to local news reports factories were secretly polluting air and water in the city ("Ceramic waste," 2013).

THE ECONOMIC GOAL

Improved environmental quality comes with a cost. The mayor of Foshan at the time estimated that cleaning up the ceramic industry may have led to a GDP loss of nearly 50 billion RMB. After the ceramic industry's "de-industrialization," its contributions to Foshan industrial GDP halved to less than four percent in 2012. Effectively, the ceramic industry was no longer a pillar industry in Foshan.

The "Headquarter Economy" goal that aims to retail high-value businesses of the ceramic

Figure 1. Expansion of Foshan's Ceramic Enterprises

industry is under test, too. Many ceramic enterprises continue to have headquarters in Foshan, which is also the major marketplace for sales, design, R&D, and financial services. However, it is uncertain how long these businesses will remain in the city as their manufacturing bases are moving away. Whereas enterprises migrating to neighboring counties within Guangdong Province may maintain their headquarters in Foshan, those enterprises moving to Szechuan, Hunan, and Jiangxi provinces may move their business to those emerging market clusters.

According to a survey in 2005 examining factors that were accelerating the migration of Foshan ceramic enterprises, the five most important factors in sequence were: fuel cost, proximity to raw materials, enterprise coordination network, industrial structure, and electricity and water costs. Local government policies and efficiency ranked only seventh and eighth. Emerging ceramic bases attract ceramic enterprises previously located in Foshan with cheap raw materials and energy, infrastructure, supply-chain coordination, and other preferential policies. It is uncertain for how long Foshan will be able to keep the 'high value-added' segments of the ceramic industry in its district.

IMPLICATIONS

A review of the environmental and economic goals shows that the ceramic industry clean-up policy has largely served the purposes of pollution reduction and industrial upgrading. Foshan government was aware of the potential GDP loss, but readily traded it for a cleaner environment and more space for higher value-added sectors. Given the diminishing raw materials for ceramic production and the soaring land prices of ceramic facilities, cutting the ceramic industry is a win-win strategy for the local government and economy as a whole, but at the cost to the ceramic industry.

Two important implications come from Foshan's case. First, industry relocation does not necessarily result in pollution migration. Many enterprises take the opportunity to upgrade their production facilities to cleaner and more efficient ones. This is an economic decision with a positive environmental spillover. Smaller-scale enterprises, while meeting the current standards, lack long-term capability to comply with stricter standards and can easily escape compliance monitoring. Second, we find that local governments are increasingly aware of the economic costs of environmental clean-up than they were in the past.

Foshan's case also sheds light on industrial policies in China more broadly. Manufacturing industries are energy-intensive; improving access and affordability of cleaner energy sources will be a vital strategy to reduce industrial air pollution. Energy accounts for 30 percent of production costs for ceramic factories and is the biggest driver for companies to relocate (Li, 2007). According to interviews with local entrepreneurs and scholars, more enterprises would improve their environmental standards if given the option to use natural gas. However, natural gas—emerging as the cleaner energy source in China—is not yet readily accessible and affordable to most industrial users in Foshan.

Imposing emission standards without ensuring access to cleaner fuels deprived the industry of the opportunity to adjust, hence encouraging plants to migrate to regions that provide clean (or not-so-clean) fuels. Policymakers should also pay attention to market dynamics. Foshan's past success is largely attributed to its industrial clusters that supported individual enterprises with supply chain networks and logistical services. Driving away the critical production segment can jeopardize the supply chain integrity. Moreover, it is hard to discern if the business environment, Foshan branding, and various sunk costs are enough to retain the high-value segments of the supply chain. A city like Foshan, which is trying to upgrade its economic base, must be aware of a range of potential risks and tradeoffs.

Last but not least, radical and initiative-based industrial policies have their limitations as compared to long-term, well-enforced regulations. Attacking the pollution problem by focusing on one industry makes implementation easier for the local government in the short term, but may create an unpredictable policy and market environment that discourages competition and innovation.

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Mapping A Greener Future For China's Industrial City Of Wuxi: City-to-City Cooperation with Düsseldorf

by **Olivia Boyd**

Germany's fashion and advertising capital Düsseldorf and China's industrial center Wuxi do not, at first glance, have a great deal in common. However, the two cities have been paired up in a research project that aims to give Chinese policymakers an opportunity to learn from Germany's experience and help plot a route to a cleaner future.

Despite the gulf between these two cities, the Wuppertal Institute for Climate, Environment and Energy (Wuppertal hereafter) chose Düsseldorf as the ideal partner for Wuxi. Located in Germany's manufacturing heartland, Düsseldorf has shaken off its old guise as a base for heavy industry and has transformed itself into a service-oriented economy. Düsseldorf 's transition offers a potential model for a similar shift in Wuxi, says Daniel Vallentin, coordinator of the project led by Wuppertal, as some Chinese cities such as Wuxi strive to transition away from the predominance of heavy industry.

Both cities, moreover, have proved themselves proactive on environmental policy. Wuxi is already the center of the Chinese solar-panel industry, and its local carbon intensity target (emissions produced per unit of GDP) is higher than the nationwide goal.

The environmental crisis at Wuxi's tourist hotspot, Lake Tai, may have played a role in the drive to clean up the city. Regular algal blooms have plagued the lake in recent years. In 2007, waste and untreated sewage triggered a massive outbreak, which swamped a water-treatment plant, cutting off supplies to two million people and driving tourists away. This threat to an important economic sector has likely been the main motivator for Wuxi government's environmental ambitions.

In reality, Wuxi faces a mammoth decarbonization challenge. Energy-intensive sectors such as iron and steel are crucial to the economy, and account for 13.5 percent of Wuxi's total emissions, according to Wuppertal's research. Coal dominates the power sector, producing 95 percent of local energy-related CO_2 emissions. The city's energy demand is expected to rise sharply—leaping from about 40 terawatt-hours (TWh) in 2010 to about 120 TWh in 2050. In this light, developing a low-carbon, a diverse energy portfolio in Wuxi's power sector is essential.

By highlighting lessons from Germany's own mitigation efforts and writing a low-carbon roadmap for Düsseldorf, the Wuppertal project hopes to help this process. Its work has included building an emissions inventory for Wuxi to identify key sources of CO_2 emissions.

VERY DIFFERENT PLACES

Vallentin admits that readily transferable solutions are hard to achieve when conditions on the ground are as different as those in Wuxi and Düsseldorf. Standards and understanding of concepts like "sustainable" and "low-carbon" can vary dramatically. For example, in the German context the Wuppertal Institute defines "low-carbon" as an emission level of two tons of CO_2 per capita. For Wuxi—currently at 13 tons per capita and rising—such a target is simply out of range.

The most optimistic scenario mapped out for Wuxi would see CO_2 emissions peaking at 100 million tons between 2020 and 2030, leading to a gradual decline in emissions to 36 million tons by 2050. Though this is hugely ambitious, it would result in per capita emissions dropping to 6.4 tons.

Prospects of success also differ between sectors. Most emissions in Wuxi come from the power sector and industry. The former is comparatively easier to make inroads into simply as that is where most progress has been made elsewhere. Specific recommendations include using sludge from a wastewater treatment plant for natural gas and hydrogen production—creating in essence a wastewater power plant to replace a coal-fired one.

Perhaps unsurprisingly, therefore, the Wuxi city government has shown specific interest in Germany's policies and projects to promote renewable energy. Officials have been particularly taken with its model of local and regional energy agencies, which offer information and advice to investors in renewables. As a result, one of Wuppertal's key recommendations for Wuxi is to establish an agency for itself.

The industrial challenge is trickier as it requires a transformation of the city's entire economic structure. In Wuxi, steel production illuminates some of these challenges relating to carbon emissions reduction—namely optimizing production processes and identifying alternative products that use less material.

In order to achieve any of this, better data is needed. While compiling the emissions inventory, Wuppertal's researchers were held back by a paucity of information in key areas like steel, cement, electronics and chemicals. There was also a lack of data on waste emissions, despite strong speculation they were a significant emitting source.

CITY PARTNERSHIPS

The Wuxi-Düsseldorf tie-up is part of a growing trend of city-to-city climate partnerships. Advocates point out that urban areas produce 80 percent of global greenhouse gas emissions and argue that these focused relationships are more effective than international climate negotiations. Other examples include the C40 network of megacities seeking solutions to climate change threats and a partnership between Vietnam's Ho Chi Minh and Rotterdam in the Netherlands, two cities that are geographically located in low-lying deltas. As well as offering advice to Wuxi, Wuppertal hopes to bring some lessons back to Germany on how to rapidly upscale electric vehicle programs, for instance.

"Cities have to learn from each other so that not every single city has to go through its own process of trial and error," says Vallentin.

In the case of Wuxi, this learning process needs to simultaneously focus on finding ways to share experiences as well as developing concrete policies. Despite many implemented regulations, such as a command and control policies and standards, there is still a lack of mechanisms for knowledge sharing among different industries. This presents an opportunity to build a partnership with cities like Düsseldorf. The same could be said of China's multitudinous green-city projects, from eco-cities to low-carbon pilot zones to carbon-trading pilot cities.

A highly crowded, fragmented landscape presents a challenge for China. A workshop by Vallentin's team held in Beijing in 2012 called for the creation of an umbrella organization to promote dialogue between China's various sustainable urban programs.

This prompts another question, however: how likely are the project's recommendations to be implemented? Despite lofty statements, Chinese green-city ambitions often fail to materialize. The most infamous example is Dongtan, a mooted energy self-sufficient, zero-emissions city for mudflats near Shanghai, which was flattened by a local corruption scandal.

In the case of the Wuxi-Düsseldorf collaboration, the project ends before on-the-ground implementation starts, due to a lack of funding. It will be up to the Wuxi city government to take and run with the lessons gained from this unique collaboration.

This text is drawn from the article "Wuxi-Düsseldorf and the challenge of green city partnerships" published on chinadialogue.net in June 2013.

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Challenging the Mandate of Heaven: The Role of Youth in China's Environmental Movement

by Tara Sun Vanacore

WITH BATED BREATH

As smog shrouds the horizon, virtual sunrise will have to suffice for residents of China's capital. On 16 January 2014, the giant screen in Beijing's Tiananmen Square broadcasts not advertisements for tourist destinations, but an image of the sunrise, blazing red against the gray sky. For that day it was the only place Beijingers could go to observe the passing of night to day. Commuters wear industrial strength facemasks; the elderly and children are warned to stay indoors. The density of $PM_{2.5}$ is 671 micrograms at 4:00 a.m., according to the monitoring post at the U.S. Embassy, which is 26 times higher than what the World Health Organization deems safe. In northern cities such as Harbin, where the coal-fueled heating season begins in October, PM2.5 levels reach a suffocating 1,000 micrograms (Nye, 2014).

A motivational slogan broadcast on the Tiananmen screen later that day flashes: "protecting the atmospheric environment is everyone's responsibility." However, economic policies that prioritize GDP growth are at the heart of the increasing demand for coal-powered energy, which ultimately drives much of the pollution. Chinese youth are actively challenging these policies, creatively providing alternatives to the paradigm that suppresses public participation and ignores the public health risks of a toxic environment. Youth commitment to environmental issues has the potential to challenge existing neoliberal economic policies and lead to societal transformation.

This commentary focuses on one characteristic of youth contribution to China's environmental movement: channels of knowledge production. The expression "the mountain is high and the emperor is far away" (*shan gao, huangdi yuan*), usually used to describe weak political enforcement at the local level, is apt to describe the way knowledge production, specifically around environmental issues, is shifting in China. Instead of relying on a distant, inaccessible central government for information about environmental quality, young citizens are creating and dispersing information that contests the official narrative. In the environmental movement, the ability to collect and broadcast pollution data is revolutionary—no longer must citizens rely on dubious data produced by the government; knowledge production and transmission are emancipatory.

While there is a growing body of literature on civil society organizing in response to environmental policies in China, the role of youth is under examined. While definitions vary by country and organization, in this article, I refer to youth as being people between the ages of 15 and 29. This article focuses on the activism of college students and young leaders of environmental NGOs and grassroots organizations. What distinguishes young activists in China is their use of networks and social media to transform attitudes toward the environment and to affect policy at the local, provincial, and national levels.

Environmental pollution in the name of economic development has led to a loss of legitimacy for the Chinese Communist Party. Xiaowei Wang, a Harvard graduate student and founder of FLOAT Beijing, a project that attaches air quality monitors to kites in order to collect and upload PM2.5 levels, argues that "the government is probably realizing that it can only control these channels of expression to a certain extent, and the backlash from controlling these channels is far more detrimental than what it would mean to allow the expression of dissent."

Between 1997 and 2009, the number of conflicts spurred by environmental issues increased 25 percent annually, and the Central Committee of the CCP has acknowledged that pollution and environmental deterioration are a leading cause of unrest in the country (Xie, 2009). The inability to address environmental concerns has led to lack of confidence in the government on the part of the people.

The social media connected Chinese youth have become increasingly vocal in challenging growth policies that sacrifice resources and public health. Environmental protests no longer feature "middle-age and older Chinese who had little to lose if the police put disparaging remarks about them into the files that the government maintains on every citizen." Instead, in recent years there has been more involvement from "angry youths [who] have gathered from several towns and have used social media to coordinate their activities during clashes with security forces" (Bradsher, 2012).

In addition to broadcasting information about pollution and environmental hazards, young people are greatly affected by environmental policies in China. Industrial pollution and environmental degradation from China's rapid modernization since 1979 "stand to affect nearly 300 million Chinese youth" (Johnson, Johnson-Pynn, & Pynn, 2007). As is often the case, disenfranchised populations are disproportionately impacted by practices such as waste incineration and industrial chemical usage. "Cancer villages," such as Xinglong in southern China where the Chinese NGO Friends of Nature and lawyers from the American Bar Association had accused a factory of dumping 5,000 tons of 'chromium 6' into a reservoir, are widespread (Levitt, 2012). Young activists in these areas are critical to the grassroots effort to reveal these trends. As the cases discussed below demonstrate, they are heeding the call of leading environmental activists such as Ma Jun, who says that "China's environmental conundrums will not be solved by changes in the government alone. New mechanisms are needed to allow the communities which may be affected and the citizens concerned about the environment to join in" (Ma, 2012).

GREENPOINT GUANGZHOU: TRACKING THE MOVEMENT

A critical contribution to environmental advocacy by youth-led environmental groups, such as GreenPoint Guangzhou, is to collect and deploy meaningful data. GreenPoint conducted a detailed 10-year-long study investigating the motivations, trajectories, and membership statistics of activists working on campuses in southern China. This group organized on university-based student environmental associations providing a natural support network and measure of autonomy, as student groups do not need to register with the government and thus, can pursue activities with a fair amount of independence.

To strengthen their capacity to generate reliable and sound information on student environmental activism, GreenPoint staff consulted with outside experts such as Baohua Yan of Global Greengrants Fund, a veteran in data analysis, on the study design and pilot interviews. Organizers of the study were considering such questions as what it means to be a member of a club, whether groups are independent or receive university funding, the parameters for being a group leader, and the range of activities that the groups sponsor.

The study, which was completed in May 2014, includes an online survey distributed to all members of university environmental clubs with which GreenPoint interacts, interviews with former leaders of student environmental groups and focus groups with active members. The goal of the study has been to identify the challenges that these individuals face and to address the critical question of how to keep these leaders involved once they move on from their roles in the university groups. Thus, the survey aimed to mobilize new activists, as well as ensure that veteran leaders continue to influence environmental policies.

Based on preliminary data from GreenPoint, the number of activists is substantial. GreenPoint is an organizing platform for approximately 61 student-led environmental groups, 19 of which are outside of Guangzhou and the rest exist within the city limits. There are approximately 122 association leaders—each group has one leader and one deputy leader.

According to the most recent membership statistics, in 2010, 70 percent of the total survey participant groups maintained or increased their membership levels; only one showed a significant decline in the number of members. The organizations had an average of 131 member chapters, translating to approximately 7,964 students registered in environmental associations. By recording, analyzing, and disseminating data on membership and successes and setbacks these groups have faced, GreenPoint provides information that is vital for funders, researchers, and organizers. Former Greenpeace Toxics Campaigner Ma Tianjie described university-based groups as "training camps" for the Chinese environmental community. Members of student environmental associations have often gone on to form prominent environmental NGOs after they graduate.

WEAVING THE WEB, ON AND OFFLINE

In China, mass communication is heavily monitored by the state, which often uses new technologies to promote its message. Young activists in China's movement are appropriating forms of communication once monopolized by the state, both on and offline. Xiaowei Wang of FLOAT Beijing describes the phenomenon as "an expression of dissatisfaction that is being enabled by the spread of a well-informed civil society with access to many channels of expression." As interviews reveal, young activists are mobilizing citizens around a grassroots message that often runs counter to the state policies that privilege GDP growth over environmental concerns.

ONLINE NETWORKING IMPORTANT AND...

Social media can be a catalyst for the types of dialogue that can alter the status quo. According to veteran environmentalist Wu Haoliang, online social media programs akin to Facebook are important modes for connecting activists and concerned citizens. Though their use of mobilization and advocacy may not be as widespread or sophisticated as elsewhere, the simple fact of being able to "broadcast what I'm doing" raises the level of independence and validation experienced by young activists.

Youth are uniquely positioned to recognize and vocalize the issues that dampen democratic participation. New media is instrumental in this process: communications on Facebook, Twitter, microblogs, and via text message are "situated outside the parameters of hierarchical structures of learning and knowledge production" (Skalli, 2010). Youth-led environmental NGOs are empowering citizens to monitor pollution levels, upload that data to open source platforms visible to polluting companies and neighbors alike, participate in environmental impact assessments, and organize for demonstrations.

According to Christie Keith of the Global Alliance on Incineration Alternatives (GAIA), her position within an international NGO that supports anti-incineration efforts offers her a bird's-eye view of activism across the globe. She finds that media work, citizen monitoring of development projects, and the environmental impact assessment process are important because often proposals presented to the public are deceptive. Keith notes that the use of Weibo (the Chinese version of Twitter), connectivity, blogs, microblogs, and Facebook are "intense and inspiring." Though young leaders in China all have their own different niche, they are fostering positive relationships among themselves—more so than in any other country where GAIA works.

Kristen McDonald of U.S.-based Pacific Environment observes that culturally, new media has transformed the way some youth view their role in society, as seen in who is engaged with the environmental movement. The environmental groups that work with Pacific Environment are usually staffed exclusively by young people. An example is Green Anhui, whose staff members are mostly 25 years old or younger. McDonald notes that according to Weibo culture, it is becoming more acceptable to fashion yourself as an "iconic individual with an opinion"—you can become an "overnight star." There is an increasing desire to be innovative and entrepreneurial online. In the environmental sphere this means that activists are mobilizing across sectors to include traditional and new media. For example, learning from internationally based groups such as 350.org is a core strategy of groups such as the China Youth Climate Action Network.

According to Chen Liwen, lead organizer for the environmental NGO Nature University and formerly of Green Beagle, knowledge production does not always mean a direct challenge to the official narrative. She explains that her group works very closely with the Chinese news media. Nature University's email list includes many journalists who are interested in covering the same pollution incidents and other environmental challenges that Nature University is exposing. Connections to journalists are crucial to NGOs, as media reports can "make the event known by the public and [pressure] governments," says Chen.

…OFFLINE ENGAGEMENT IMPORTANT TOO

While connectivity through social media is important, the networks established by young environmental activists online exist outside the blogosphere as well, and are equally vital. An example is the Wuhu Ecology Center's work to combat waste incineration. Significantly, the Wuhu Ecology Center is not located in Beijing or Shanghai, but rather in a second-tier city in Anhui Province; this raises the salience of this issue outside the capital. Like other NGOs, the Center works as a platform from which to act, providing opportunities for leaders who might otherwise not be able to make their voices heard. Led by young women, the Center trains activists who often go on to work at prominent Beijing NGOs.

The Center runs a waste information network (waste.cwin.org) that provides international and domestic updates on waste policies and incineration projects, as well as community resources. Several hundred visitors frequent the site each day, suggesting that the work being done in Wuhu serves communities across the country.

LOOKING FORWARD

In sum, young people's questioning of the government's monopoly on knowledge production is vital to giving voice to citizens' concerns. Social media and interpersonal networks facilitate this transformation. Xiaowei Wang expresses enthusiasm over the fact that the Beijing municipal government is releasing software for smartphones with updates on the level of PM2.5 in the air, which taken on its own may seem insignificant. However, once people are able to monitor the quality of the air they breathe and have access to a channel for disseminating that information, public dissatisfaction with practices that conceal the truth about pollution levels will be more and more difficult to ignore.

From disappearing rivers to lethal air pollution levels, contemporary leaders have much to do in order to assuage angry citizens. Young activists are critical in revealing the danger of maintaining the status quo and the explosion of micro-blogging and other online tools have helped instill a sense in Chinese citizens that they have a right to better and more timely information on pollution that is impacting their health (Brown, 2013). Youth have the flexibility, connections to domestic networks, and claim to knowledge production channels that will prove invaluable in transforming the current system.

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U.S.–China Eco-City Mayoral Exchange

by Xiaobing Liu

RAMPING UP NEW CLIMATE COLLABORATION

In 2008, the U.S. and Chinese governments established a Ten-Year Framework for Cooperation on Energy and Environment to drive solutions to common energy and environmental dilemmas. A year later, presidents Obama and Hu announced seven new bilateral clean energy agreements, including the *U.S.-China Energy Efficiency Action Plan*. As a part of this Action Plan, the U.S.-China Eco-City Mayoral Exchange Program was inaugurated and ran through 2014.The Mayoral Exchange succeeded in promoting new subnational collaboration between the U.S. and China around shared energy and pollution challenges. This program and other subnational U.S.-China engagements helped to lay the foundation for the highly successful U.S.-China Climate Leaders Summit held in Los Angeles in September 2015, three months before the COP21 talks. This summit brought together a diverse set of U.S. and Chinese city and state leaders to discuss and sign a declaration committing to concrete actions on low-carbon development. China will host the next Climate Leaders Summit in 2016, which could help solidify these new subnational climate partnerships. This strengthening of subnational climate cooperation is bringing more U.S. and Chinese local governments, businesses, and nongovernmental organizations into new bilateral mechanisms.

MAYORS COME TO TOWN

Under the Eco-city Mayoral Exchange Program, mayors and other senior sustainability officials from Chinese and U.S. cities visited with each other and with clean energy investors and technology and solution providers. They discussed the energy and environmental challenges faced by urban regions and their experience with policy and technology in solving them. The program recognized that local governments are on the frontlines of evaluating environmental issues, developing and implementing energy efficiency and clean energy projects, and assessing their actual impacts.

The aim of the program was to build partnerships between Chinese and U.S. officials to encourage collaboration and information sharing, boost investment in clean energy and energy efficiency, and promote opportunities for economic development in both countries. Clean energy industry representatives were included in the program to enable more widespread awareness of clean energy technologies and products, and promote bilateral trade and investment.

There were seven Mayoral Exchanges between 2010 and 2014, five hosted by the United States and two by China. 80 Chinese mayors and senior officials visited U.S. cities, and 23 U.S. mayors and officials visited Chinese cities. Each exchange delegation included officials from participating cities and states or provinces, federal officials, private energy groups, and other stakeholders, including 53 U.S. companies over the course of the program. They met with their counterparts and public and private sector leaders in the host country. The U.S. Department of Energy coordinated the program on the U.S. side, and the Chinese Ministry of Housing and Urban–Rural Development and the National Academy for Mayors of China managed it on the Chinese side.

During these events, government officials and experts in a wide range of energy and environmental fields presented and discussed many challenges that cities in both countries face. A recurring theme among the Chinese participants was the environmental harm created by the extremely fast growth in industrial production and the consequent surge in migration to cities from rural areas. In addition, as incomes increase in China, the citizens are buying huge numbers of electric appliances and automobiles. The energy footprint of China's growing megacities are demanding that city officials take quick actions to develop and deploy policies and technologies that improve energy efficiency and reduce the emissions from coal-fired power plants that are creating already crippling air pollution. City officials are increasingly interested in clean energy technologies.

The U.S. mayors and other city participants are well equipped to provide insights on energy and water use practices and policies that help abate environmental damage. At the same time, American delegates can learn from China's unprecedented experience in rapid, large-scale deployment of sustainability technologies.

The Chinese government is undertaking "eco-city" projects to move tens of millions of people from the countryside into urban centers in a sustainable manner. During the two Mayoral Exchanges hosted in China, U.S. delegates visited a few eco-cities (Photo 1) to observe how these developments were being planned and carried out and see what kinds of research and development were needed (e.g., in building energy efficiency, efficient appliances and lighting, water conservation, wastewater management, and technical standards) to enable the local governments to achieve a sustainable future. The benefits of the Mayoral Exchange included:

Sharing of best practices: Chinese and U.S. city officials were able to discuss strategies for incorporating clean energy and sustainability measures in efforts to improve land use, transportation planning, and water conservation.

Economic development assistance: The exchange offered great prospects for networking and commercial partnerships, and provided city officials with the opportunity to engage with senior government and company representatives.

Foreign investment opportunities: China's economic growth and clean energy manufacturing industries present excellent opportunities for foreign direct investment. Similarly, Chinese companies are investing in clean-tech projects both locally and in U.S. cities.

Eight U.S. and Chinese municipalities have entered into partnerships through the Mayoral Exchange: Birmingham, Alabama, with the Chayang District of Beijing; Charlotte, North Carolina, with Langfang in Hebei Province and the Chinese ENN group; Denver, Colorado with Kunming, Yunnan Province; Columbus/ Franklin County, Ohio, with Heifei, Anhui Province; Fort Worth, Texas, with Guiyang, Guizhou Province; Honolulu with Fengxian District of Shanghai; Richmond, Virginia, with Zhengzhou, Henan; and San Francisco with Shanghai.

U.S. and China collaboration continues on topics like city planning and evaluation tools, which help city officials make policy and development decisions, and to estimate emissions reductions and other benefits and impacts. City-level leadership and cooperation remains essential for both China and the U.S. to meet their clean energy and climate goals.

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