

A solutions  
landscape for

# Yixing

China

The Urban Infrastructure Initiative – UII





## Executive summary

This report proposes a set of recommendations and solutions to contribute to the city of Yixing's vision to become China's "scientific and sustainable development demonstration city" (科学和可持续发展示范城市) and an "Oriental water city" (东方水城).

The city of Yixing has the necessary preconditions to make it a demonstration city. The government has achieved much over the past decade, and the citizens are very proud of their city. Yixing has a long-term plan to highlight its nature and unique characteristics and to develop new sustainable urbanization models.

This report was developed under the Urban Infrastructure Initiative (UII) of the World Business Council for Sustainable Development (WBCSD). The UII is a ground-breaking project that provides multi-sector business expertise to help transform a city's sustainability vision into a practical, cross-cutting strategy.

The UII engagement with the city of Yixing had the full support of the Mayor and the Yixing municipal government. This report is the result of consultations and dialogue between leading global companies (as members of the UII), the China Business Council for Sustainable Development

(CBCSD), and city officials from several city departments between April 2012 and February 2013.

The engagement covered three broad areas: **transport and mobility** and **energy efficiency**, integrated under an overarching concept of sustainable **urban planning**. For each of these areas, the report presents a hierarchy of recommendations and solutions, ranging from short-term immediate actions to longer term investments in infrastructure and technology.

### Urban planning

On the urban planning front, two issues were singled out for immediate action to ensure a sustainable development path for Yixing's future:

- **Rational land use and appropriate urban structure.** The key recommendation is to use a scientific approach to

optimizing land use and determining density, structure and borders. This approach is based on the preservation and protection of ecosystems, including forests, wetlands, watersheds and agriculture; the prevention of urban sprawl; and the reduction of the ecological footprint of Yixing.

- **Valorization of ecological and cultural assets through compact mixed-use urban design and green infrastructure.** The key recommendation is to adopt a compact mixed-use urban development pattern for all new development zones. Such a pattern further optimizes land use, favors non-motorized mobility and public transport, and gives expression to realizing an Oriental water city by establishing a continuous band of protected green space, parks and gardens, wetlands and waterways.

## Transport and mobility

A comprehensive approach to addressing transport and mobility challenges is critical for a fast-growing city like Yixing that is confronted with major increases in traffic every year.

The key recommendations for the improvement of the transport and mobility environment include measures to make Yixing a more pedestrian- and bicycle-friendly city; implementing transit-oriented development that dovetails with compact mixed-use urban design; and adopting a concerted, multimodal approach to making better use of existing transport infrastructure, information and traffic management systems.

## Energy efficiency

Yixing typifies the transition phase of Chinese development whereby energy use and demand are dominated by the industrial sector. This will, however, change rapidly as Chinese industry becomes less energy-intensive and the domestic and service sectors increase in importance. The key recommendations address both **industrial and building energy** use and demand.

For the **industry** sector the Ull gives key cross-cutting recommendations, including optimizing heating, ventilation and air conditioning (HVAC), improving power plant efficiency, and optimizing district heating, as well as sector-specific measures for the cement and chemical manufacturing industries. An overriding recommendation, however, is the establishment of an energy management center to monitor consumption patterns to better inform policy-making and performance-enhancing measures.

The Ull team has analyzed energy consumption in the **building sector**. This sector is relatively well balanced between commercial and residential and between public and private use and demand. This pattern, however, is likely to change rapidly in favor of commercial and residential use and demand. In the interim period, energy efficiency in public sector buildings and facilities provides a unique opportunity to kick-start energy efficiency measures and to lead the way for private commercial and residential measures to follow.

A key recommendation is the implementation of a city sustainability tracking and management dashboard. Such a dashboard would measure the carbon footprint of buildings by using readily available data for energy and water consumption and waste generation. Applied to public buildings such as municipal offices, schools, hospitals and post offices, the dashboard has already proven effective in many cities and countries as both a monitoring and behavioral change tool as the data translates into running costs and can be used to assess the effects of retrofits and other improvement measures. Other sector-specific recommendations and solutions include demand management systems, solar powered water heating, and retrofitting the power distribution system.

## Engaging stakeholders and tracking progress

The success of Yixing in realizing its vision depends to a large extent on its ability to engage people and stakeholders to actively participate in helping to realize its vision. This requires a consistent effort to inform the public about actions and results, expand the initiated dialogue, include other key actors, and establish a benchmarking system comprised of key indices to be monitored over time. Such a city index would enable all key stakeholders, including government, civil society and the private sector, to monitor overall and sector-specific performance and to engage in appropriate actions. Regular communication and awareness raising is strongly recommended.

At the same time, the city should engage in continuous learning from experience and in sharing those lessons learned with others. Another recommendation is to undertake a “stress test” of the master plan and its implementation at critical intervals. This could be done in the form of workshops or seminars where local, national and international experts assess progress and make further recommendations to guide the strategic planning and implementation process.



# Introduction

The City of Yixing engaged with a group of leading global companies between April 2012 and February 2013 to identify solutions that will help meet its vision to become China's "scientific and sustainable development demonstration city" (科学和可持续发展示范城市).

The companies are members of the World Business Council for Sustainable Development (WBCSD) Urban Infrastructure Initiative (UII), a unique project that provides multi-sector expertise to help transform a city's sustainability vision into a practical, cross-cutting strategy.

Yixing is one of ten cities to engage with the UII. Through the dialogues with the city's Mayor and Vice Mayor and officials from several city bureaus, the value of private sector involvement in moving from vision to strategy and action on sustainability was recognized. The Mayor welcomed the opportunity to show the potential for cooperation between government and private enterprises to find sustainable municipal development solutions.

The UII and the city identified an issues landscape covering three broad areas: **transport and mobility**, **energy efficiency** and **urban planning**. They agreed that these issues would be the focus of the engagement. Company experts carried out a transformation study to develop solutions, priorities and a high-level implementation plan.

The UII project has demonstrated the value of providing multi-sector input to city thinking early in the strategy development process. It has allowed city officials to consider a variety of ideas and to engage with the private sector collectively rather than only in relation to specific projects.

*Nowadays, sustainable development has become the global trend which is also the consistent pursuit of Yixing. As the national sustainable development pilot district approved by the Ministry of Science and Technology, China, Yixing has been exploring its sustainable development ways as "green economy, urban and rural co-ordination, resource conservation, friendly to environment and public benefiting" through accelerating the transformation process of industrialization and urbanization.*

*It's our honor to closely cooperate with the famous international organization of WBCSD on the Urban Infrastructure Initiative (UII) Project, forming the comprehensive research report covering three broad areas: urban planning, transport and mobility, and energy efficiency, both reflecting the international perspective and adapting to the local circumstance. I am confident that under the in-depth cooperation with WBCSD and scientific guidance of Yixing UII report, the city, as the "Capital of Chinese Pottery and Oriental Water City", will pragmatically take the sustainability pathway in a better way and wider range.*

**Mr. ZHANG Lijun, Mayor of Yixing**





# Urban development in China

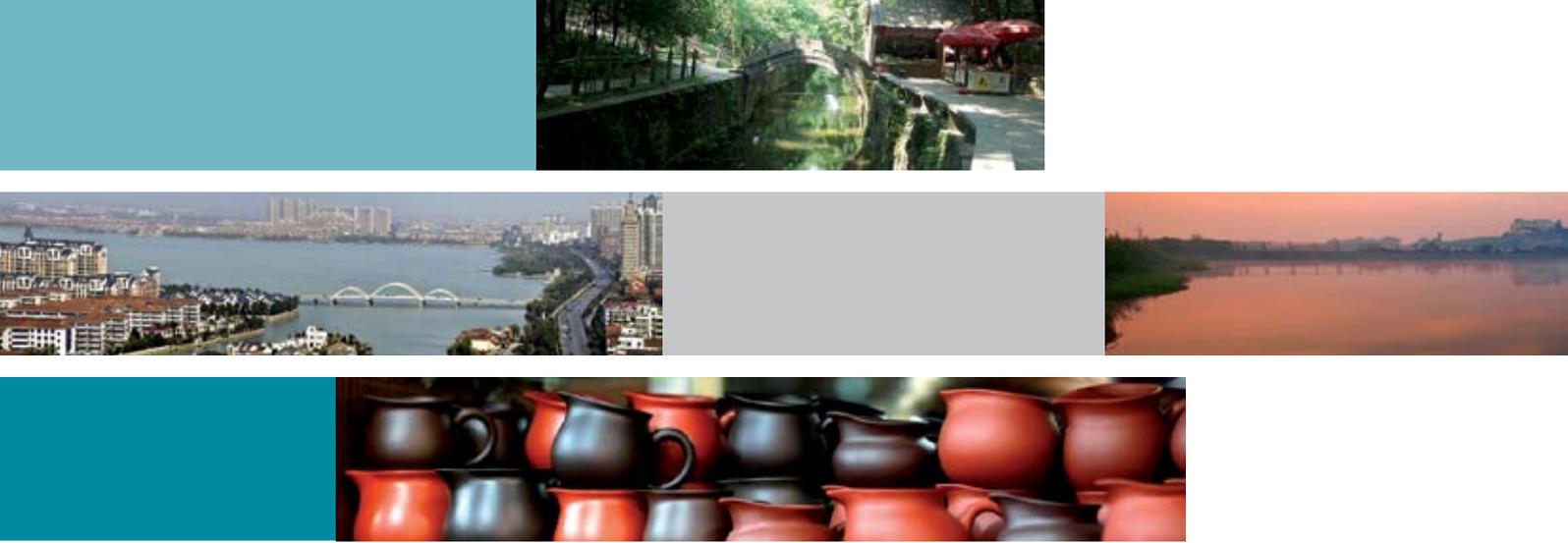
China is in the middle of an urbanization process that is unprecedented in human history.

According to the World Bank, China is set to add an estimated 350 million people to its cities in the next 20 years.<sup>1</sup> As urban populations grow and become more affluent, the level of environmental impact on “business-as-usual” projections is likely to continue to grow significantly. Chinese cities are expected to more acutely experience the adverse impacts of urbanization, such as traffic congestion, air pollution, loss of local biodiversity, reduced economic productivity and ultimately reduced quality of life for many city dwellers.

However, many Chinese cities are taking a leadership role in tackling these challenges. City leaders are increasingly aware that more environmentally sustainable cities are also more livable, more efficient and more competitive. Furthermore, Chinese cities are politically, financially and administratively organized to act quickly to realize national policy goals,<sup>2</sup> such as energy efficiency targets.

The City of Yixing in Jiangsu province, the subject of this report, is an excellent example of urban sustainability leadership.





## Yixing city overview

Capital of Chinese pottery (中国陶都) and the Oriental water city (东方水城), Yixing is a third-tier city-county in Jiangsu Province covering an area of 2,038 km<sup>2</sup> with a population of 1.248 million. Its administration includes 14 towns, 4 township-level divisions, and 3 development zones.

Yixing is located at the junction of 3 provinces: Jiangsu, Zhejiang and Anhui Province and is at the center of the Shanghai-Nanjing-Hangzhou delta area. This central geographical situation enables Yixing to have excellent transport connections with key centers such as Shanghai, Nanjing, Hangzhou, Suzhou, Wuxi and Changzhou.

Figure 1: Map of coastal China and Jiangsu Province



Yixing has been known as the capital of Chinese pottery for more than 7,000 years. The ceramic culture, especially the Zisha technique, is world-renowned and embraces painting, poetry, carving and sculpture. Yixing is also blessed with a unique natural environment, particularly through its proximity to water. It is surrounded by the Taihu lake (east) and the Gehu lake (north) and is crossed by the Wu-Shen canal and Xi-Li canal. Yixing also has three seasonal lakes in its urban district Xijiu, Tuanjiu and Dongjiu. These assets have given the city the opportunity to position itself as the "Oriental water city", a concept that the city is already developing through a strategic research project.

With its goal of becoming a scientific and sustainable development demonstration city, Yixing has started to develop and implement a rigorous integrated strategy that combines industry, ecology and culture with the city. The city's endeavors have already led to national recognition; in recent years Yixing has been named the National Model City for Environmental Protection, the National Ecological City, the National Sustainable Development Experimental Zone, the National Garden City and Historical and Cultural City. The city also won a gold medal for the Happiest City in China. In 2012, Yixing was ranked 4th for economic competitiveness in a comparison of more than 2,000 counties across the whole of China.



# Issues landscape

The dialogue between Yixing government officials and the UII team that took place in May 2012 focused on the challenges the city faces in moving towards sustainability.

The dialogue included: defining the city structure in the context of a rapidly expanding population; balancing the needs of industry and other urban demands; developing sustainable transport; managing waste; and improving energy efficiency in the city.

The dialogue resulted in an agreement on the overarching issue of urban planning, providing the framework within which other specific issues such as transport and energy efficiency can be integrated. The key issues agreed to include:

- **Urban planning:** lack of clarity on the urban structure and its borders; conflict between development and protection of the old city; and logistical problems as the city expands
- **Transport and mobility:** prioritizing public transport and improving the road network to address increasingly severe congestion
- **Energy efficiency:** improving energy efficiency, especially in the industry sector and in buildings, as required to meet low-carbon goals.

## Box 1: Yixing's vision and mission statement

### An Oriental water city

- Water, as a non-renewable resource, is used in a sustainable manner. It is harvested, conserved and protected. It is recycled and reused, so that there is no water wasted in Yixing.
- Water is fully integrated into the urban landscape. It forms part of a continuous band of interconnected parks and gardens, forest and wetlands that serve two purposes: to help restore and maintain biodiversity and to provide Yixing with a unique urban identity and sense of place.

### A scientific and sustainable development demonstration city

- On the *planning side*, a scientific and sustainable city is a city that pursues a low-carbon and ecological development design. Rational land use is a top planning priority. It prevents urban sprawl, preserves watersheds and biodiversity, and reduces the need for motorized transport by fostering compact mixed-use communities.
- On the *management side*, a scientific and sustainable city is a city that uses information- and knowledge-based tools and systems to optimize energy and water demand, transport and traffic control, and operations and maintenance.
- A *demonstration city* is a city from which other cities can learn. An effective demonstration city is first and foremost a learning city that establishes clear benchmarks in order to assess its own progress and shares lessons learned from experience.



# Urban planning overview

An integrated and interdisciplinary approach to urban planning is critical to driving sustainable urban development.

Planning is a critical driver of sustainability as environmental impact and carbon emissions are closely connected to urban form. Furthermore, spatial development has strong lock-in effects – once cities grow and define their urban form, it is almost impossible (or very expensive) to modify later. This is a very important consideration for Chinese cities experiencing rapid growth, with many Chinese cities having more than doubled their built area in the last decade.<sup>3</sup>

Urban planning will be a critical tool for Yixing if it is to achieve its goal of being a scientific and sustainable development demonstration city by 2020. Fortunately the city already has many strengths and positive assets to build on. It is already a leader among Chinese county-level cities, with an established urban plan, a clear sustainability vision, advanced urban infrastructure, and a high standard of living. It has abundant natural resources, centuries of history, and is a leader in the regional economy. It has positioned itself as the ecotourism city in eastern China, and is identified as the capital of Chinese pottery and the Oriental water city.

## Current challenges for the city

Many cities like Yixing face the same problems in achieving sustainable urban development and a high quality of life: urban sprawl, inefficient transport networks, a mono-functional landscape, ecosystem degradation, stress on cultural heritage, high energy consumption, and the unattractive physical appearance of the city.

Urban planning needs to tackle these problems with an integrated approach to improve the city identity across many different aspects rather than in a piecemeal fashion targeting individual issues separately.

## Planning framework

A comprehensive urban planning framework can enable Yixing to be a pilot project for sustainability and smart growth in China. Such a framework consists of a clear hierarchy of strategies, ranging from overarching to detailed. The main elements of such a framework are:

- Rational land use and appropriate urban structure in support of low-carbon urban development;
- Compact development and mixed land use;
- Valorization and protection of natural and cultural resources;
- Continuous green/open space networks with water as an important cultural element of the urban landscape;
- Integrated mobility systems;
- Green building and neighborhood design;
- Ecological approaches to water resource and storm water management;
- Green energy production and technologies;
- Intelligent urban management measures;
- Public participation and civic education;
- Benchmarking, performance evaluation and feedback.



The UII has identified three key urban planning strategies and solutions that will complement the city's existing planning activities and address the primary concerns of Yixing's urban managers to help establish Yixing as a [city for tomorrow](#) (明日之城):

1. Rational land use and appropriate urban structure
2. Valorization of ecological and cultural assets through compact mixed-used urban design
3. Energy efficiency, including improvement of the transport environment.

#### Box 2: Three mistakes to avoid in urban planning

Three common planning mistakes are part of the reason why many Chinese cities are unable to resolve traffic congestion:

1. The design of road networks;
2. The size and dimension of city blocks;
3. Low average urban density characterized by floor area ratio (FAR) or gross plot ratio (GPR).

Road networks in many Chinese cities are designed contrary to the principle of a hierarchy of avenues, streets and lanes. Contemporary Chinese road networks consist of too many large avenues crisscrossing each other. This results in intersections that are major challenges for traffic management and pedestrian crossing. Yixing can design new road networks and revise existing ones based on a hierarchy of roads that places pedestrian lanes at the top, followed by bicycle- and rickshaw-friendly streets, then roads that favor public transport (including water transport), and avenues designed for inter-zonal vehicular traffic. Cities that have adopted such road use hierarchies, such as Amsterdam, Bogota, Gloucester and New York, have witnessed improvements in road safety and reductions in congestion of more than 30%. In addition, intersections should also be hierarchical, i.e. a six-lane road should not intersect another road of more than 4 lanes, and a four-lane road should not intersect another road of more than two lanes, etc.

Similarly, the urban structure in many Chinese cities consists of "super blocks" measuring 400 meters by 400 meters or more. This size and shape does not favor walking, biking and the use of public transport. It implies that bus stops at, for example, two block intervals would be at least 800 meters apart; that tram or light rail stations at four or more city block intervals would be at least 1,600 meters apart; and metro stations at eight or more block intervals would be at least 3.2 kilometers apart. These distances inhibit access to and the use of public transport, especially by the elderly. A more rational size and shape for city blocks would be no more than 100 meters by 200 meters. This would place bus stations at 200-meter intervals (three minutes walking distance), tram or light rail stations at 400-meter intervals (six minutes walking distance), and metro stations at 800-meter intervals (12 minutes walking distance).

Urban densities in many Chinese cities are low in comparison with typical European cities and better planned cities in North America. The GPR of many Chinese cities is less than 3:1. Beijing has a GPR of 2.7:1. New York has a GPR of more than 8:1 with 14:1 in Manhattan. London and Amsterdam have GPRs of more than 5:1. High GPRs, combined with mixed-use and intelligent urban design, favor walking, biking and the use of public transport.

## Rational land-use policy and strategy

Yixing has a population of 1.248 million and an administrative boundary of 2,038 km<sup>2</sup>. Its urban area is 110 km<sup>2</sup>, including 70 km<sup>2</sup> of completed construction.

The urban plan foresees that the current 450,000 residents in the urban area will more than double to 1 million by 2020. Facing such expansion, the city requires a rational land-use plan together with an appropriate regulatory policy to prevent urban sprawl, manage urban growth and plan new townships in a low-carbon and ecological manner.

A multi-faceted approach to defining a land-use plan that can accommodate future growth in a rational and sustainable manner includes:

- Defining the ecological limits of expansion to preserve and enhance non-urban land use (agricultural land, watersheds, biodiversity reserves, etc.) in the metro region. These will form the “do not touch” areas of the city that are off limits for future settlement.
- Developing two or three ecological and spatial footprint scenarios<sup>4</sup> based on current urban district densities, population projections, economic growth trends and corresponding trends in land, energy and water use, and selecting the footprint scenario that most closely supports the vision of a sustainable Oriental water city.
- Translating the selected scenario into planning guidelines and corresponding norms, standards and targets, such as per capita green space and space required for public infrastructure and facilities, and deriving a first set of target indicators, including residential density and floor area ratio (FAR), target commuting times and distances, percentage of non-motorized transport used, proportion of green energy use, so as to achieve an ecologically desirable land-use policy and strategy.
- Integrating the results from above to define the ultimate scale of the city, and generating the boundaries for both central urbanized areas and future strategic growth areas. These boundaries should be used by government agencies to guide land-use and zoning decisions.
- Defining land reserves and making a phasing plan for future development.
- Mandating more effective regulatory policies to manage urban growth boundaries and ensure sustainable development in the city and its surroundings.



# Valorization of ecological and cultural assets through compact urban design

Urban sprawl and emerging new towns (e.g. high-speed railway new towns, lakeside new towns, northern industrial new towns) will lead to confrontation between the old and the new. The result can be low land-use efficiency, overloaded transport systems, deteriorating urban environments, and falling quality of life.

Appropriate urban design can further optimize rational land-use planning and enhance Yixing's cultural and ecological assets while providing for high-quality new towns in an integrated manner. Four key principles are required to enable such a harmonious development:

1. Compact development patterns
2. Mixed land use to favor non-motorized access to local services and jobs
3. Green infrastructure
4. An efficient and integrated public transport system.

Given its importance, public transport is treated as a separate chapter.

The compact mixed-use city approach can make a number of contributions to urban sustainability:<sup>5</sup>

- Optimal use of land resources
- Walkable or bikeable distances to schools, restaurants, entertainment, food shops and other public facilities
- Less dependency on private automobiles
- More possibilities for district-scale energy use and local energy generation
- More efficient delivery of public services
- Better access to a diversity of local services and jobs.

To apply the principles of compact city development, the following specific measures are proposed for Yixing:

- A core and satellite structure for the development of new settlement clusters within the administrative boundary; each of these new settlement clusters should be separated by farmland, forests or wetlands and be well connected by public transport;
- An enhanced "green heart" in the central urban area, with three major clusters connected by green corridors and waterways between them;
- Development with mixed land use within each settlement cluster, and walking-oriented commuting distances, balancing residential, retail and office use, thereby reducing the required investment for infrastructure and energy consumption;
- Regeneration of the old city with functional substitution and an infilling approach, making it more public and full of vitality instead of being overloaded by dense residences and poor infrastructure
- Redevelopment of the old communities and reuse of abandoned brownfield sites within urban areas, maximizing the value of land resources.

## Green infrastructure

Unlike gray infrastructure, such as roads, wires and pipes, green infrastructure consists of a network of forests, farmland, wetlands, watersheds and parks which maintain biodiversity in the city and provide ecosystem services essential for human life. For Yixing, the use of green infrastructure is fundamental to building its brand as an Oriental water city.

A good example of green infrastructure is Boston's Emerald Necklace, which consists of a 1,100-acre chain of nine parks linked by parkways and waterways. It gets its name from the way the planned chain appears to hang from the "neck" of the Boston peninsula. Each unique "jewel" in the Emerald Necklace from lovely waterways to botanical gardens to peaceful meadows to tree museums plays a vital role in linking the citizens of Boston together through nature.

The unique history of Yixing provides many cultural assets within these eco-elements. This offers a great opportunity to have a comprehensive plan to integrate green resources, water systems, urban open spaces and cultural assets. This would follow leading international concepts, such as greenways, green corridors, and linear heritage corridors.

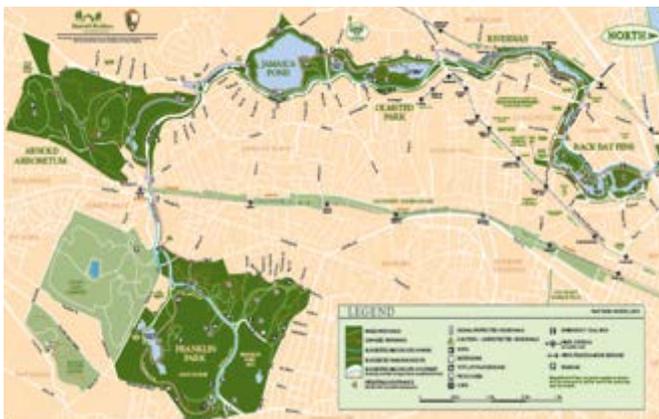
The suggested approach to Yixing's green infrastructure system would consist of:

- Prohibiting any new development in the ecological matrix and restoring the broken points following ecological principles;
- Offering a link between urban and rural and natural environments by connecting individual ecosystems with greenways and waterways along the river and beside transport corridors;

- Creating more ecological stepping stones in the form of a network of forests, wetlands, parks, gardens and artificial lakes to complete the hierarchy and structure of the green system;
- Introducing low-impact green tourism and recreation based on a comprehensive environmental impact assessment and with appropriate cost-recovery mechanisms to finance preservation and restoration activities;
- Making urban parks and pocket green spaces easily accessible and encouraging the sharing of private gardens with the public by removing yard fences;
- Increasing the accessibility and continuity of the green areas by establishing a network of bicycle paths, walking trails and boating routes along the river corridors for tourism, sports and recreation;
- Integrating cultural heritage into the urban fabric by creating a route made up of historic buildings and sites, parks and gardens and retail outlets for local arts and crafts as a way to discover and experience the city.

At the same time, Yixing's gray infrastructure can also be made greener. Options include permeable road and pavement surfaces and redesigning selected streets as eco-corridors. Permeability helps replenish groundwater and can also provide a source of water for green infrastructure. Eco-corridors can filter and treat storm water runoff naturally at the same time that it is used to irrigate parks, gardens and trees lining the street. Eco-corridors can be implemented at any scale, ranging from the width of an avenue to a street. Naturally irrigated trees and shrubs are integrated into neighborhood design to provide shade, reduce the urban heat sink effect, tame traffic and help restore and create habitats for a wide range of bird life and plant species.

Figure 2: Boston's Emerald Necklace



Source: [www.greeningthegray.org/trees-do-it](http://www.greeningthegray.org/trees-do-it)

# High-level strategic plan

## First step

The high-level strategic plan should link the key areas mentioned above to ensure an integrated approach to land use, urban design, green infrastructure and transport. To do so effectively, the following studies and tools should be developed in the course of 2013.

- Projecting urban economic development and growth for 5, 10 and 20 years using different scenarios;
- Assessing the ecological carrying capacity of the area, including ecological and agricultural no-build areas;
- Developing different ecological and spatial footprint scenarios and selecting the scenario that best supports the vision of a sustainable Oriental water city;
- Establishing a set of indicators in the form of a sustainable city index system to ensure progressively more sustainable patterns of growth at 5 year intervals;
- Developing and adopting guidelines, norms, standards and by-laws for compact mixed-use urban design to serve as terms of reference for designers and developers;
- Commissioning a special study and action plan on the sustainable use of water, including an integrated approach to water harvesting, water reuse and recycling, and the protection and creation of waterways and wetlands;
- Commissioning a special study and action plan for the protection and enhancement of cultural heritage and integrating that plan within a larger perspective of creating an Oriental water city and promoting sustainable tourism;
- Surveying residents' lifestyles and travel characteristics.

## Second step

The studies, tools and guidelines noted above should form part of a master plan of provisions and legislation, including controls on development activity. The execution of the master plan, however, needs a degree of flexibility built-in to allow for contingencies and, more importantly, to adjust the plan in accordance with lessons learned along the way. Key areas of focus include:

- Third-party monitoring of the project management cycle from the planning stage to the construction stage;
- Periodic revision of detailed guidelines for execution (e.g. urban design guidelines, construction guidelines, operations and management guidelines) to be adhered to by all functional departments and private developers;
- High-tech approaches, including geographic information system (GIS), global positioning system (GPS), and remote sensing (RS) technologies and digital modeling methods, to be applied for dynamic monitoring and visualization;
- Implementation of a real-time and on-line evaluation methodology so that progress, obstacles, successes and failures can be shared across sectors and jurisdictions to improve learning and avoid repeating mistakes;
- Involvement of citizens in critical phases of project planning, implementation and evaluation.

## Third step

A proposed third step is to stress test the master plan and its implementation at critical intervals. This could be done in the form of workshops or seminars where local, national and international experts assess progress and make further recommendations, thereby guiding the strategic planning and implementation process. This could help fulfill Yixing's ambition to become a demonstration city from which others can learn.





# Transport and mobility overview

Yixing's transport vision is "to provide world class transport infrastructure that is safe, reliable, traveler-friendly, highly integrated and accessible to all city citizens and tourists, and has minimal impact on the environment, promotes equality, and supports the long-term growth of the city's economy."<sup>6</sup>

Transport produces about 26% of China's carbon emissions from fuel combustion and is the fastest growing consumer of fossil fuels and source of carbon emissions.<sup>7</sup> The ultimate goal is to provide better ways to connect people, homes, jobs and places with more transport choices in order to realize the city's vision of becoming China's scientific and sustainable development demonstration city by 2020.

Yixing has already made many improvements to its transport infrastructure, which is one of the highest priorities in the planning process for new developments such as the High-Speed Railway New City and Eastern City New District. Transport has been one of the major factors in these developments. Detailed transport studies and long-term planning have also underpinned improvements to key intersections in the road network and extensive connections between local and national roads and expressways. Yixing has highly skilled transport planning, engineering, operation and management teams, and the government is building a new traffic control center.

But like other cities around the world, Yixing is facing tough challenges ahead. These include:

- Lack of an integrated approach between planning authorities and property developers leading to, among other issues, overconcentration of commercial activities in some areas;
- High growth rate of private car ownership (average annual increase rate of 20%);
- Lack of space for parking in the city center;
- Heavy peak-hour congestion, exacerbated by illegal on-street parking;
- Inadequate traffic management systems;
- Underused road network capacities.

The following sections describe the strategies and solutions to tackle some of these challenges and outline an implementation plan by 2020. The proposed solutions would not only raise the city's transport infrastructure to a new level, but also strike a balance between competitiveness, quality of life and the environment.



## Transport strategy

Based on the information collected from site visits and discussions with the city of Yixing, the UII developed strategies to tackle challenges in urban and inter-urban areas.

### Urban and densely populated areas

Yixing city center is a densely populated area with a large number of shopping centers, hotels, offices, schools and hospitals. Some road sections or parts of the road network are oversaturated during peak hours. In most places there is little space to construct pedestrian bridges or other facilities, including parking. This situation is exacerbated by chaotic parking and pedestrian movement.

Yixing developed its inner-city slow transport master plan in November 2012 to improve the situation and cope with further increases in travel demand. The UII recommends combining this plan with the adoption of transit-oriented development (TOD). TOD involves:

- A combination of “slow transport” (e.g. walking and cycling) and public transport services
- An overall approach to urban structure that is oriented towards public transport
- Actions to maximize the use of the existing infrastructure and facilities.

This strategy is applicable to other town centers around Yixing, such as Ding Shu (丁蜀) and Zhang Zhu (张渚), as well as planned new cities: High-Speed Railway New Town and Eastern City New Development District.

### Inter-urban transit corridors

The major centers within Yixing are connected by transit corridors that provide fast transport, including boulevards for cars and buses, light rail or trains and metros. When TOD is properly designed and implemented, the city requires no urban highways or ring roads that constitute urban barriers and destroy the urban fabric.

The corridors that connect urban nodes are crucial parts of the road network. They will become more important because of the city’s rapid expansion and the creation of satellite cities and new development zones and counties around Yixing. Potential facilities such as park & ride (P&R) and variable message signs are usually built along corridors so that travelers can change their travel modes before they enter urban areas.

#### Box 3: Transit-oriented development (TOD)

Transit-oriented development (TOD) links land-use planning with transportation planning. It consists of structuring the city around mixed-use nodes that integrate office, residential, commercial and recreational space. Each node is designed to enable everybody living or working within that node to fulfill their daily needs within walking or biking distance. Typically, this means that the distance between work space, residential space, commercial space, schools and post offices should not exceed 800 meters. Car use is discouraged within the node and is strictly regulated. Public transport within the node can include bicycles, rickshaws, taxis, buses, bus rapid transit (BRT) and trams. As Yixing aspires to be an Oriental water city, water taxis should also be considered.

## Transport and mobility solutions

While TOD will take some time to implement and should be implemented as a matter of priority for all new areas, Yixing can also benefit from more immediate solutions to manage traffic and transport more effectively. The recommended solutions aim to build a sustainable core of the city's transport and mobility system that is expandable beyond current travel demand without redesigning the whole system.

### Solution 1 – Improving the pedestrian experience

Yixing has significant potential to make walking an enjoyable experience. To do this effectively, five key areas of intervention are needed, from the simplest no-cost step to low- and moderate-cost solutions:

- A no-cost solution for all new developments is to design them in such a way that inhabitants of a residential district need not cross a road to go to school, to shop for daily necessities or to access public transport, and that all new shopping malls are directly accessible by mass transit (metro or light rail).
- Another no-cost solution is to ensure that there is no illegal parking or encroachment by cars on pavement and other spaces. As long as cars are allowed to park or occupy spaces for pedestrians and bicycles, driver impunity will prevail and will inhibit most other improvements in behavior change.
- One low-cost solution, especially in the city center, is to improve and upgrade the pedestrian crossings in Yixing. This means narrowing the distance between pedestrian crossings at key junctions to make it easier and quicker to cross roads. This solution also requires installing guard rails at junctions to encourage people crossing the road to use the improved crossing facilities.
- One moderate-cost solution is to transform selected streets into pedestrian-friendly streets. This combines landscaping with traffic calming and preferential treatment for public transport. In the case of Yixing, water should form part of this improved pedestrian experience.<sup>8</sup>
- Another solution is to transform the core shopping and recreational areas into pedestrian- and bicycle-only areas. This will require new and improved parking facilities and “last mile” public transport (see [solution 2](#) below). This also sends an important signal to drivers and all citizens that Yixing is intent on becoming a pedestrian- and bicycle-friendly city, a key indicator of whether it can become a successful demonstration city.



## Solution 2 – Public transport covering the last mile of travel

As a small city, the only solution to avoid gridlock and fundamentally ease congestion is to further expand and develop the city's public transport systems. City management has already focused on improving public transport and defined the following three-year targets:

- Increase the number of bus service routes from 27 to 40 and number of buses from 250 to about 400;
- Increase the public transport modal share from the current 8.9% to 13%;
- Reduce average waiting time from 6.4 minutes to less than 5 minutes and average departure headway from 10.4 minutes to about 8 to 8.5 minutes.

The proposed solutions to help ensure that the above targets are met include:

- Public transport priority systems and dedicated lanes that improve the reliability of public transport services and provide an incentive for modal shift. It is recommended that bus rapid transit (BRT) also be evaluated for eventual inclusion in the mix of solutions.
- Public transport fleet management systems with advanced communication technologies that improve operations management and quickly recover service levels after disruptions. The city has already implemented a 3G closed circuit television monitoring system for smart bus management.
- Passenger information systems that track real-time vehicle location and journey times and display the information for passengers.

Where road space is restricted and there is a concentration of attractions, such as shopping centers and offices, the roads could be designated as pedestrian-only streets. Taxis, electric-powered rickshaws and bicycle sharing would serve the last mile of travel. Tracks above roadways could directly link to trip destinations, such as shops and offices.

Tramways could be used for longer distances. Tramways could serve the distances between the city center and main transport hubs such as park & ride (P&R) sites and the new high-speed railway station. They could also provide local transport within new development zones.

### Suggested next steps

1. Assess current demand for public transport and forecast the future 30 years.
2. Appraise and evaluate options like bus rapid transit, tramways and light rail transit technically and financially, and assess their impact on energy efficiency and reducing congestion.
3. Define detailed investment needs and implementation plans, including integration with other modes of transport and systems.
4. Propose operational plans.



## Solution 3 – More efficient use of existing transport infrastructure and data

Making the best use of existing infrastructure without significant investments can be done in three ways:

1. Optimize junctions and road networks to unleash potential unused capacities, and balance the flows across the whole network through planning and engineering;
2. Optimize signal timings and strategies (i.e. traffic management plans); and
3. Improve the efficiency of the city's transport operations (e.g. through better staffing and training).

These three strategies can be supported by improving the use and analysis of transport data already collected by the city. The value of this additional data analysis is to:

- Have a better understanding of the traffic movement patterns;
- Guide future urban and transport planning and inform transport policies;
- Formulate more effective traffic management strategies;
- Prepare for comprehensive data integration across different transport modes (as discussed in [solution 4](#)).

The existing database package deployed for the traffic control center in Yixing already offers a rich set of algorithms, such as classification, prediction and anomaly detection, for these purposes. This system, if regularly updated and upgraded, will also serve the integrated urban transport management solutions described in [solution 4](#).

### Suggested next steps for network optimization

1. Identify the bottlenecks (e.g. junctions and sections of roads) as well as spare capacity.
2. Carry out detailed assessments (e.g. through simulation).
3. Improve the design of junctions and networks to resolve the bottlenecks and use the extra capacities across the network.

### Suggested next steps for data exploration

1. Assess the data collection capability of the existing systems and evaluate data quality.
2. Define the operational needs for data analysis and levels of detail of the analysis.
3. Use simple analysis to obtain macro-level patterns.
4. Develop detailed analysis (if necessary) using specialized software packages.
5. Validate results if necessary (e.g. through site observations).
6. Create traffic management strategies based on the findings.



## Solution 4 – Urban transport management

Long-term and more sustainable transport management for any city will require an integrated system that monitors mobility needs and demand and allows managers to make better informed decisions regarding how to best match those needs and demands on an hourly, daily, weekly, monthly and annual basis. It optimizes the use of different solutions in real time.

Yixing is constructing a smart transport management center to be operational in 2013. This will provide a good basis for further system and data integration. The ultimate goal is to attain a high-level information platform that manages all transport modes centrally in order to move people and goods smoothly and efficiently.

The Ull recommendations for transport management in urban areas can be divided into three categories: adaptive traffic control, integrated traffic management, and a multimodal transport management platform.

### Adaptive traffic control

Adaptive traffic control goes several steps beyond the efficient use of traffic information and data as it operates in real time and is designed to automatically respond to traffic fluctuations. Adaptive traffic control systems can increase the efficiency of traffic management and reduce the daily workload and also provide facilities for traffic managers to modify or override the adaptive system at any time. These systems lay down a solid foundation and essential groundwork for integrated traffic management systems.

### Integrated traffic and transport management platform

An integrated traffic and mobility platform uses different data sources to provide a real time one-stop shop to better inform traffic and transport managers and the traveler. Travelers can decide to change their time or mode of travel depending on circumstances, traffic control can decide to go into manual override to adjust traffic flow, and operators of public transport can also decide on resource allocation.

### Multimodal transport management platform

A multimodal information platform aims to offer a seamless travel experience to the public and optimizes the use of the city's transport networks. The information platform selectively extracts data in real time from each individual transport system – bus, railway, water transport, road traffic management and airport information systems. The data is processed, combined with optimized operational strategies (such as routing advice to drivers and modal shift advice to travelers), and disseminated to the public through a variety of media and channels.

The integrated transport information platform in Shanghai includes road network real time status data, video-based information, incident detection data, automatic number plate recognition data, road work information, urban traffic control (UTC) data, and public transport data, which are processed by advanced data mining techniques. The results provide deep insights into historical and real time performance, projections into the future, regional network performance indicators, quantification of congestion level, public transport passenger volume and strategic decision support, etc. Such results have provided the city management and transport operators with a better understanding of the overall performance of the transportation systems of the city.

### Suggested next steps for urban transport management

1. Review the existing signal control systems against the functionality and standards of adaptive control systems.
2. Assess the existing traffic management/control platform and subsystems and data quality.
3. Specify the system integration plan (including prioritization and optimization).
4. Identify technical and political issues regarding system integration on a multimodal level, and define action plans (long-term plan and strategies).
5. Select the first system to integrate (usually public transport, bus and train information).

## Solution 5 – City center parking and Park & Ride (P&R) infrastructure

Parking is the final destination of any car user and its availability or non-availability determines not only user behavior but also, to varying degrees, traffic congestion and conflict with pedestrians. As mentioned in [solution 1](#), illegal parking also has to be stopped as a matter of priority. Based on the current situation in Yixing, three solutions are proposed:

1. Install parking guidance signs not only in the vicinity of car parks but also at key junctions and arterials to give real-time information on car park occupancy in the town center;
2. Provide real-time information on parking status on the Internet and mobile devices, such as mobile phones and tablet PCs;
3. Update existing infrastructure to make it more user-friendly, including the payment/charging systems for car parks and on-street parking.

### Box 4: Effective P&R systems

Effective P&R systems such as the ones in Beijing and Washington are based on seamless travel between rail-based public transport (e.g. metro) and private cars. For this reason P&R sites are built near metro stations in the suburbs. In the case of Beijing, travelers using the metro the same day can park for 2 RMB a day and pay for it using the same smart card as for the metro. The distance between the parking and the metro entrance is 3-5 minutes by foot.

P&R will help to reduce parking problems. Travelers can park and take public transport or, depending on the volume, take dedicated P&R services. The road network linking Yixing city's several towns and rural areas is ideal for P&R infrastructure. The sites can be built on the outskirts of the city close to major arterial roads and expressways. The potential site locations are Changshen Expressway (Yixing Exit) and Huyi Expressway (Yixing Exit West).

Such a scheme requires alignment between the public transport network and the P&R sites. P&R will also be more attractive with:

- Parking guidance and occupancy detection, which instruct drivers to the closest car parks based on car park occupancy and traffic management strategies;
- Public transport priority control and enforcement to guarantee the reliability of public transport services that link P&R sites and the city center;
- Fleet management system (e.g. GPS tracking) to optimize the operational performance of public transport services ;
- Ticketing and payment systems to facilitate the use of the parking infrastructure by the public;
- Enforcement systems that are required for the operation of P&R sites to prevent violation of parking rules;
- Incentives to motivate the public to take up the solutions, such as using parking tickets as public transport tickets in the city center.

Bike sharing schemes can also be introduced to complement the public transport link between parking sites and the city center. This requires bicycle lanes to protect cyclists from other traffic.

### Suggested next steps

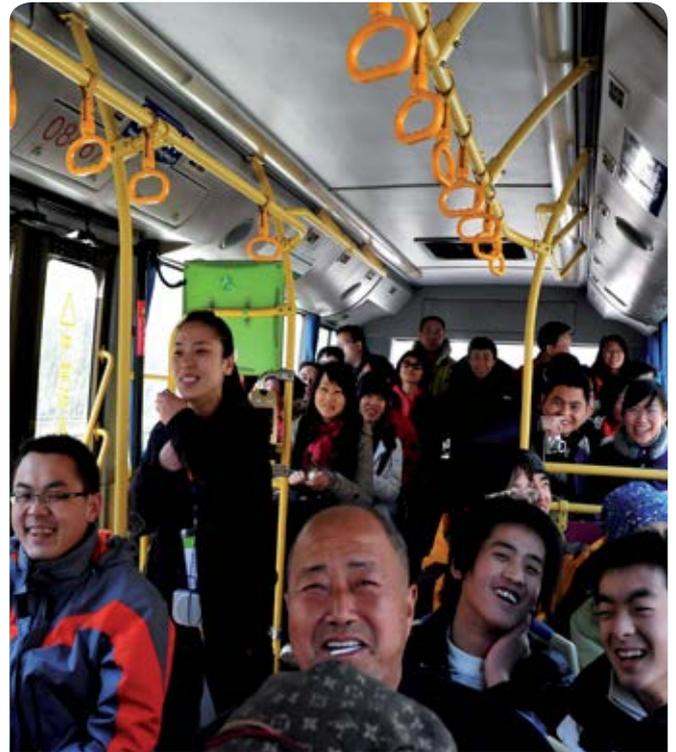
1. Survey the public to understand their requirements and opinions (including opinions towards P&R).
2. Assess the current status of car parks and associated systems and review government policies.
3. Plan and design improvements in parking infrastructure and policies.
4. Plan P&R and associated public transport links and analyze the impact. Also devise some "soft" measures to incentivize take-up by the public, for example smart cards for parking and shopping with a discount.



## Solution 6 – Transport policies

At this stage, Yixing's transport policy should focus on promoting sustainable and safe travel, transport accessibility and social inclusion. Emphasis should be on full integration of the travel value chain, increasing travel convenience by aggressively extending the city's public transport system and implementing advanced traffic management systems.

The experiences of developed cities have demonstrated that the most effective way to reduce the use of private transport is through financial means, e.g. greater taxation and road tolls. However, for Yixing such a system should only be envisaged when a well-established and efficient public transport network is well on its way to being implemented and when the city can prove to car users that they can save time and money using alternative means of transport.



## Other imperatives

City transport is complex and some other solutions could help Yixing:

- **Cooperation with other cities surrounding Taihu Lake.** This could be a first important step towards becoming a demonstration city devoted to sharing, exchange and learning for mutual benefit to the Taihu lake region.
- **Public-private financing models.** To ease the financial burden, more and more projects are arranged through public-private partnership (PPP) models. The flexibility of the business model makes collaboration between the private sector and the public sector increasingly popular worldwide, especially for the construction and operation of public transport infrastructure.
- **Collaborative approach to transport planning.** To achieve transparency of technologies, exchange of expertise, and transfer of knowledge, it is crucial to set up regular panel discussions and workshops with transport experts from reputable companies, public sector organizations and citizens' organizations to keep up to date with the latest developments in transport management worldwide. This will help avoid the mistakes made in other parts of the world.



# Transport and mobility high-level execution plan

The solutions and measures recommended can be implemented in four phases.

Figure 3: Four-phases of implementation

<b>2020</b> <b>Long term</b>	<ul style="list-style-type: none"> <li>• Light railway and metro at city centre and linking major transport hubs and town</li> <li>• Automated real time traffic management and passenger guidance systems</li> <li>• Intelligent transport as part of city's Smart City Initiative</li> <li>• Urban and inter-urban, and national road networks and public transport interaction</li> </ul>	Implementation of most advanced transport technologies and role of transport in Yixing's smart city initiative
<b>2017</b> <b>Medium term</b>	<ul style="list-style-type: none"> <li>• Integrated multimodal transport management platform with real time data mining and predictive transport management capabilities</li> <li>• Park &amp; Ride infrastructure (including bike sharing) at suburban areas</li> <li>• Last mile public transport coverage (e.g. APM and bikes)</li> <li>• Reliable and comfortable public transport (e.g. tram) linking major transport hubs and towns</li> </ul>	Focusing on advanced information systems and multimodal transport infrastructure
<b>2014</b> <b>Short term</b>	<ul style="list-style-type: none"> <li>• Integrated traffic management system with priority being public transport priority</li> <li>• Real time fleet management systems and advances passenger information systems</li> <li>• Walking streets and bike and car sharing schemes</li> <li>• Improved pedestrian crossings in the city centre</li> </ul>	Focusing on city centre and major corridors, and major transport hubs and system integration
<b>6 months</b> <b>Quick wins</b>	<ul style="list-style-type: none"> <li>• Adaptive signal control to balance the traffic load across urban network</li> <li>• Traffic data assessment and drill-down analysis to optimise traffic management strategies</li> <li>• Re-organised traffic flows and road network (e.g. one way roads)</li> <li>• Upgrade of existing parking facilities and public transport facilities, and implement stronger enforcement</li> </ul>	Focusing on assessment and planning, and laying foundation for the next steps

Quick wins concentrate on proven measures that can be rapidly deployed to tackle the urgent needs of the city – building a clear understanding of traffic hotspots and easing congestion at these places. Improvements to existing parking facilities will make a big difference and can be done fairly quickly. In general, these solutions require relatively small investments over a short timescale.

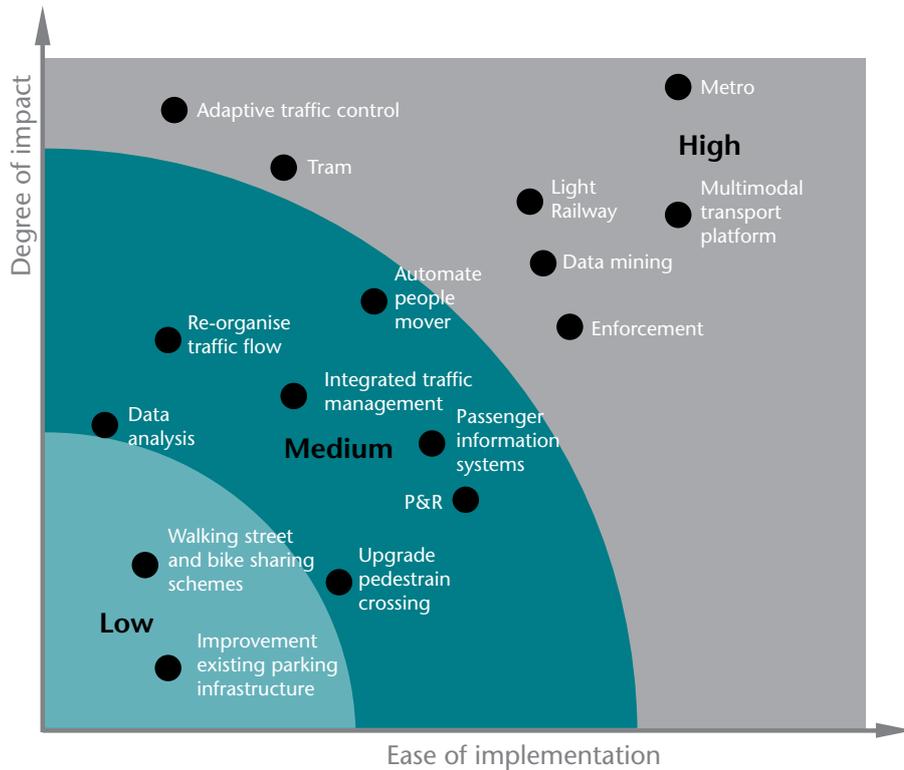
Short-term solutions will create the backbone of transport infrastructure with an emphasis on transport hubs and public transport linkage between them. The UII estimates that at least 20% of private car drivers (in current terms) will shift to public transport or other more environmentally friendly modes (e.g. biking and walking) once these measures are in place.

Over the longer term, gridlock would be inevitable without further measures because of the growing population and

rapid economic growth of the city. By 2017 the city should have tram lines to provide reliable and comfortable public transport services between major transport hubs and towns. By 2020, the city would need metro and/or light rail infrastructure to enable point-to-point travel in less than 30 minutes within a given zone.<sup>9</sup>

Figure 4 shows the impact on easing traffic congestion and the complexity of the solutions (technically and politically), assuming Yixing has sufficient funds to invest (i.e. the chart does not consider the potential complexity of raising funds for infrastructure investment). The quick win solutions are those that would have a big impact while being relatively easy to implement. The principle is to establish a sustainable core quickly, with refinement and improvement measures running in parallel, and finally to attain a truly integrated transport system.

Figure 4: Prioritization of transport and mobility solutions for Yixing



## Test beds and pilot projects

Test beds and pilot projects will showcase the benefits and share best practices. The solutions recommended in this report largely focus on two areas: better control and management of vehicle traffic, and promotion of public transport. Therefore, two test beds could be set up as part of the implementation of the quick win solutions.

### Integrated traffic and transport management test bed

The integrated traffic and transport management test bed will be based on and use the existing infrastructure within the traffic control center. All the solutions related to traffic and transport management pilot projects will be built up and evaluated. These could include:

- Adaptive traffic control and integration with the subsystems of the existing traffic control system;
- Improved and upgraded parking facilities and integration with the traffic management system, and traffic information dissemination via mobile devices;
- Public transport priority within the traffic management system.

### Public transport test bed

Pilot projects in the public transport test bed could include:

- A bus fleet management system and advanced passenger information systems;
- A tramway linking the Yixing High-Speed Railway New City and Yixing city center.

These pilot projects not only provide opportunities for knowledge sharing and transfer, they also become the breeding ground for futuristic transport systems in Jiangsu Province and even in China. They would keep Yixing at the forefront of transport solutions. Pilot projects will also trigger innovative thinking and help to overcome restrictive rules and discover counterintuitive solutions that adapt to Yixing’s needs.



## Energy efficiency overview

China is a global leader in driving improvements in energy efficiency. During the 11<sup>th</sup> Five-Year Plan period, the country achieved an impressive 19.1% reduction in the energy intensity of GDP. Major action is set to continue at the national level, driven by the following key targets:<sup>10</sup>

- The Chinese government's commitment to a 40-45% reduction in the carbon intensity of GDP by 2020, relative to 2005;
- The 12<sup>th</sup> Five-Year Plan (2011-2015) includes, for the first time ever, an explicit target to further reduce carbon intensity by 17% by the end of 2015.

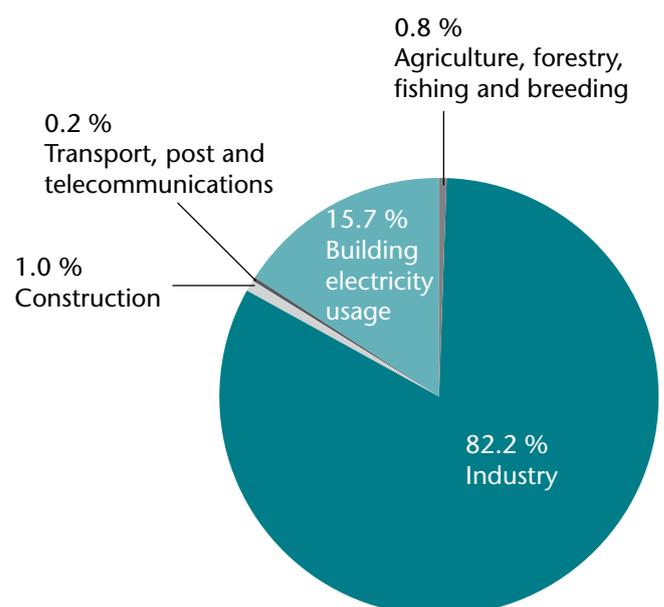
Ambitious targets are also being set at sub-national government levels, such as the following building energy efficiency goals for Jiangsu province for the 12<sup>th</sup> Five-Year Plan:

- 30% of new buildings must rate above 2 stars in the Chinese Green Building Label. Within the next three years at least 600,000 m<sup>2</sup> of new building must be at least 2-star rated;
- Existing and new office buildings and large-scale public buildings will have to upload their energy data to local and provincial inspection centers;
- Buildings will have to be retrofitted for energy efficiency;
- Within 2 years, the total green building construction area should exceed 2 million m<sup>2</sup>.

To confirm its place as a leading city for sustainable development in China, Yixing needs to meet and exceed these targets. It has already taken significant steps in the construction of more sustainable buildings: Yixing Dongjiu New City has been declared a key demonstration area for green buildings.

The UII identified the main sectors for sustainability action in energy efficiency. There are two main sources of electricity consumption in Yixing: **industry and buildings**. The detailed solutions, benefits and implementation guidelines therefore focus on these two sources.

Figure 5: Electricity usage in Yixing



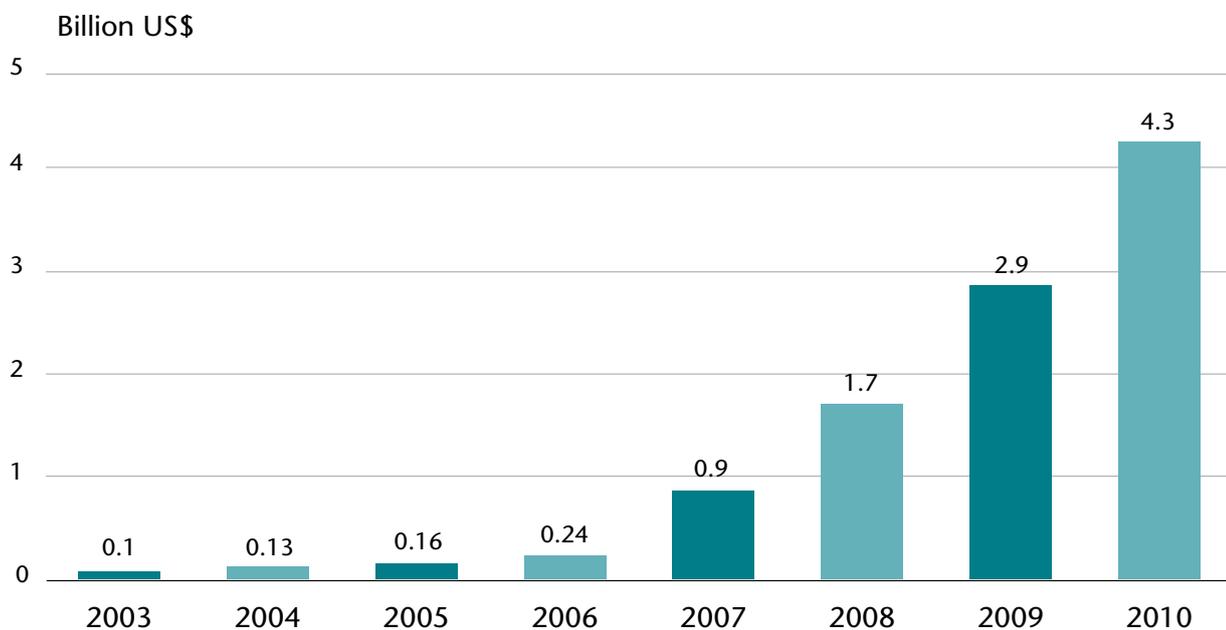
Source: Yixing statistical annual report 2012



**Box 5: Energy service company (ESCO) activities in China**

Energy service companies (ESCOs) have witnessed very rapid development in China in recent years. Their role is very likely to increase in the coming years. China currently counts about 50 active multinational-linked ESCOs, and about 800 domestic ESCOs of various sizes currently operating in the Chinese market. At the local level, eco-district and science parks have been the most common entry point for ESCO involvement. ESCOs and other technology companies would certainly have a very important role and contribution in applying the latest science and technology to Yixing's energy sector.

**Figure 6: Total ESCO project investments in China, 2003-2010**



Source: Sun, Xiaoliang, et al. (2011). "China's ESCO Industry: Saving More Energy Everyday Through the Market". Unpublished manuscript. Available at [ryanschuchard.files.wordpress.com/2011/06/chinas-esco-industry-2010.pdf](http://ryanschuchard.files.wordpress.com/2011/06/chinas-esco-industry-2010.pdf).

## First focus: Industry sector

To make the biggest impact and get the best return on investment, Yixing needs to focus on industries with high energy consumption relative to their output.

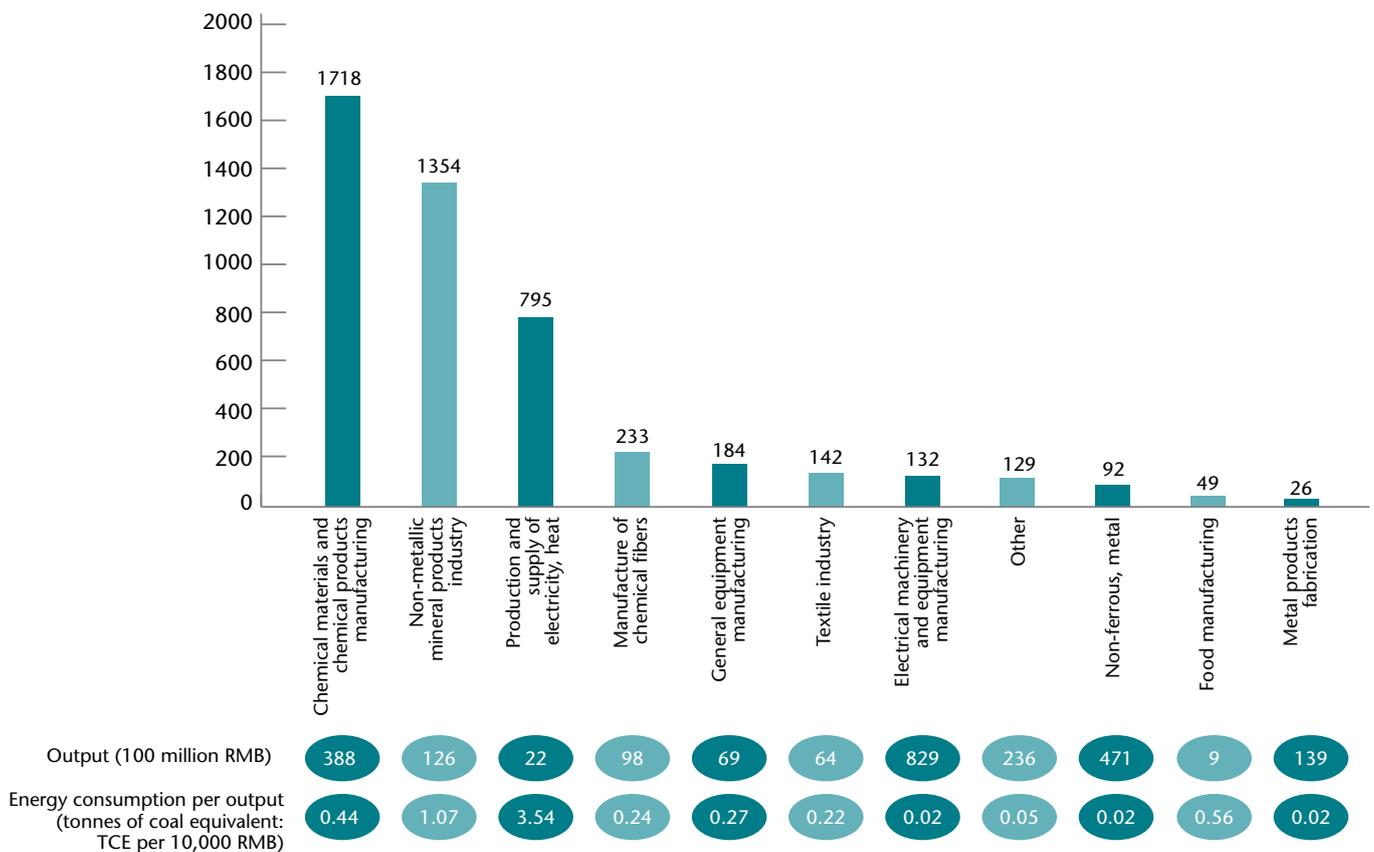
Three sectors in Yixing are responsible for 80% of the energy consumption while they account for only 22% of total industrial output:

1. Production and supply of electricity and heat
2. Non-metallic mineral products industry
3. Chemical materials and chemical products manufacturing.

The UII focused on these three sectors in order to provide energy efficiency solutions.

It should be noted that whether industrial companies are state-owned enterprises or independent firms, the sector should be a key area for policy-making. Appropriate policies and incentives can help steer companies in the direction of both competitive and sustainable growth (see the detailed action plan on page 33).

Figure 7: Yixing industry energy consumption for major industrial sectors (thousand tonnes of carbon equivalent)



Source: Yixing statistical annual report 2012

## Industry sector cross-cutting solutions

### Solution 1 – Energy management center

The first step to real and durable energy savings is to get a clear view of the consumption of current assets. Energy management centers enable building and industrial facility users to understand where their consumption arises as a first step to taking action. Integrated in several industrial facilities, such centers enable one city or company to have a global vision of its efficiency performance.

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Typical return on investment time: 3-5 years

Novelty of the technology: High

### Solution 2 – Optimization of heating ventilation and air conditioning (HVAC) systems

A retrofit of air-conditioning systems enables users to maximize comfort and minimize cost, reduce energy consumption and improve indoor air quality. The retrofit involves more efficient drives, flow rate adjustments, equipment monitoring for better asset management, reduced fan operation noise and remote monitoring.

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Typical return on investment time: About 3-5 years

Novelty of the technology: Medium

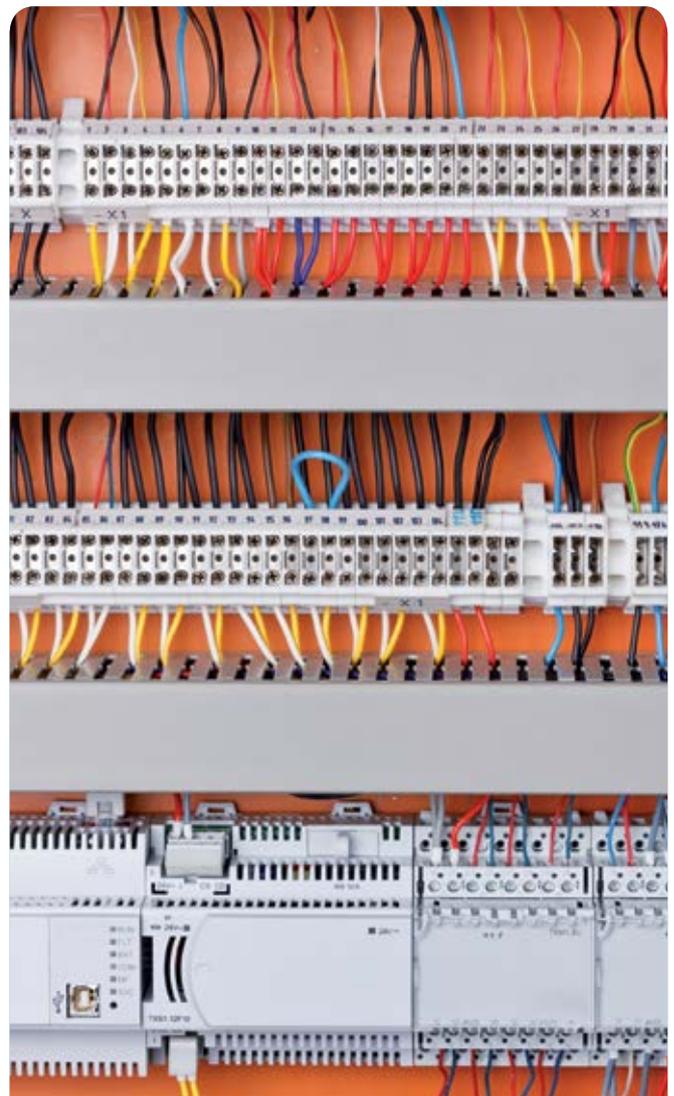
### Solution 3 – High-performance speed drives and fans

Electric motors – used for equipment such as fans, pumps and conveyors throughout the plant – are a critical target. Variable speed drives are an excellent way to optimize their energy efficiency. Benefits include significant energy savings, optimized process control, longer motor life and reduced maintenance costs.

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Typical return on investment time: 3-5 years

Novelty of the technology: Medium



## Sector-specific solutions: Production of electricity and heat

### Solution 4 – Improvement of power plant process

Many power plant processes can be improved in order to generate significant energy efficiency savings. Some possible examples are upgrading heat pumps, heat exchange systems and pipe networks, retrofitting steam turbine seals, and automatic boiler control and heat recovery.

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Typical return on investment time: 2-3 years

Novelty of the technology: High

### Solution 5 – Optimization of district heating system

District heating uses complex distribution grids. Like the electricity grid, these can also get “smarter”, leading to better energy efficiency and operational savings through better asset management. This can be achieved in three steps:

1. Collect hardware and software data to get the most accurate figures
2. Modeling to optimize distribution at all stages of the distribution network
3. Retrofit of turbines and boilers to get the best efficiency at station level.

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Typical return on investment time: About 2 years

Novelty of the technology: High

#### Box 6: Case study - District heating system in Jinzhong, Shanxi

##### **Solution implemented**

The city of Jinzhong implemented a system that enables more efficient management of its district heating system. The solution includes real-time energy monitoring of heating and heating equipment backed by simulation tools for more efficient decision-making and planning. The performance and availability of the network can easily be controlled through a GIS-based asset management system. On the customer side, a new information and charging system enables more transparent heating data.

##### **Customer benefit**

The retrofit led to impressive savings: 30% reduction in power consumption, 20% reduction in water consumption. In total, the energy savings amount to 20%, equivalent to a reduction of 50,000 tonnes of carbon dioxide emissions every year.



## Sector-specific solutions: Cement industry

### Solution 6 – Waste heat to green energy conversion

The cement industry is very energy-intensive and the manufacturing process releases a lot of heat. Instead of expelling this heat from the plant, it can be used to generate green power. This mature technology has already been installed in about 1,000 plants worldwide.

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Typical return on investment time: Within 3 years  
Novelty of the technology: Medium

### Solution 7 – Quality management system and advanced process control

Advanced process control enables improved energy efficiency and ensures the best possible cement quality. Advanced process control optimizes the blend of raw materials and improves the measurement and control of airflow, temperature levels, weight, pressure, emissions, material balance and energy use.

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Typical return on investment time: 3 to 5 years  
Novelty of the technology: High

#### Box 7: Case study - International cement plant in Dujiangyan, Sichuan

##### **Solution implemented**

A major cement plant in Dujiangyan implemented an energy optimization system for the cement industry. The retrofit includes power quality management systems and the replacement of assets for high-performance devices such as drives and air compressors. The project also enables a better understanding of and control over plant performance through the deployment of power meters.

##### **Customer benefit**

The project led to major energy savings (600k-3.6 million kWh/year of energy-saving potential) translating into better financial performance (600k~1.7 million RMB/year savings) and greener operations (carbon dioxide emissions reduced by 2,200 tonnes). These performance improvements enable a return on investment period of one and a half years.



## Sector-specific solutions: Chemical manufacturing industry

### Solution 8 – Chemical process improvement

Various improvements can enhance the processes of the chemical industry. They include energy efficiency improvements for the synthesis of ammoniac and heat recovery for calcium carbide production. A careful audit of processes is needed to identify the most relevant opportunities for improvement.

Typical return on investment time: About three

years on average

Novelty of the technology: High

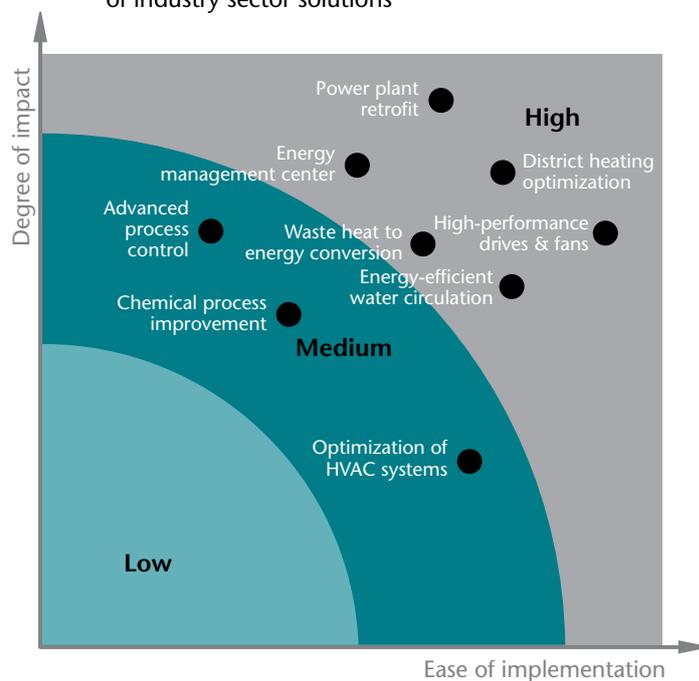
### Solution 9 – Energy-saving process for water circulation

The chemical industry uses large quantities of water. A comprehensive water circulation process enables better control over water use. This reduces operational costs while improving sustainability through a better water recycling process.

Typical return on investment time: 1-2 years

Novelty of the technology: High

Figure 8: Impact vs. ease of implementation of industry sector solutions



## Second focus: Building sector

The building sector represents 15.7% of Yixing’s total electricity consumption. This consumption is balanced between government, commercial and residential buildings (see figure 9).

For this reason it is important that efforts to ensure a high level of energy efficiency in buildings in Yixing be made immediately. To do this effectively, two aspects of achieving energy efficiency need to be considered: (i) the technical and technological aspect; and (ii) the human behavior aspect.

The first aspect will help Yixing achieve its goal of becoming a city for scientific development and the second to becoming a sustainable development demonstration city.

### Solution 1 – City sustainability tracking and management dashboard

A city sustainability tracking and management dashboard could be designed to help Yixing accomplish both of the above-mentioned goals. The data collected would enable Yixing’s leaders to determine policies and priorities regarding key building code aspects and standards for new buildings, retrofitting of existing buildings, water conservation and reuse, and waste management.

By making the dashboard publicly accessible and visible, the tracking system can also help change human behavior. Therefore, the dashboard provides a strong incentive to identify the causes of higher costs and to take remedial action.<sup>11</sup>

Roll out could start with public institutions such as schools, municipal offices, post offices and banks, and then proceed to commercial and residential buildings.

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Typical return on investment time: Software as a service, low investment, very high and rapid return.

Novelty of the technology: Very high

### Solution 2 – Integrated building management system

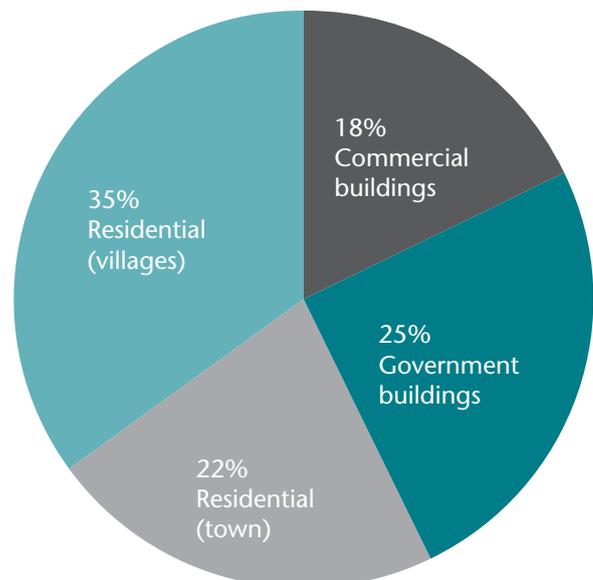
Building management system solutions enable monitoring and control of HVAC, lighting, access control and other security features across one or more sites. Centralized control optimizes the use of natural light (through light tunnels, electro-chromic glazing, etc.), centralized sensors and LEDs. It also improves the efficiency of HVAC systems. The system can also include integrated fault detection and weather intelligence for improved performance by pre-heating or pre-cooling buildings.

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Typical return on investment time: 2-4 years

Novelty of the technology: High

Figure 9: Energy usage in Yixing buildings



### Solution 3 – Demand management

Demand management programs are implemented through the use of dedicated control systems to shed loads in response to peak electricity consumption. This solution will enable Yixing to smooth its electricity demand, thereby reducing the need to import energy from other cities and regions, stabilizing the distribution network and increasing the share of renewable energy consumption.

Typical return on investment time: 2-3 years  
Novelty of the technology: Very high

### Solution 4 – Roof solar power generation and water heating

Roof solar panels generate sustainable power for a building. At the same time, they reduce the “heat island” effect and the need for air-conditioning. The energy obtained through solar radiation can also be used directly for water-heating inside a building.

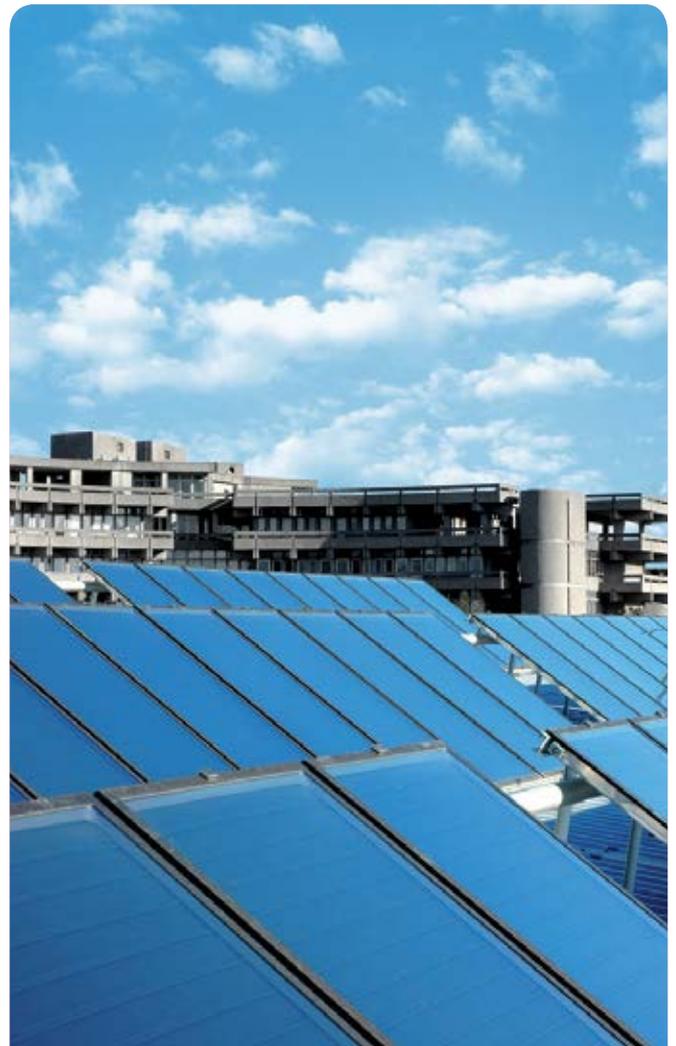
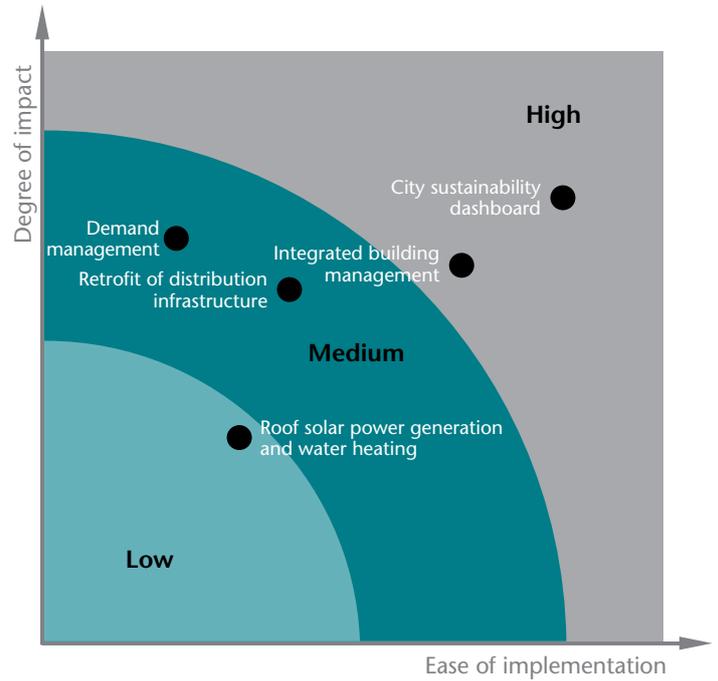
Typical return on investment time: 4-5 years  
Novelty of the technology: Medium

### Solution 5 – Retrofit of power distribution infrastructure

The power distribution network is the backbone of a building’s energy use. Low-voltage power distribution, low-voltage final circuit distribution, power quality correction devices and a power monitoring system are essential building blocks in order to improve energy efficiency in buildings.

Typical return on investment time: 3-5 years  
Novelty of the technology: Medium

Figure 10: Impact vs. ease of implementation of building sector solutions



## Citizen engagement plan

Achieving the highest levels of energy efficiency is not only a technological challenge. The behaviors of the individuals and organizations are crucial to achieving technological potential.

The UII therefore recommends actions to stimulate interest, understanding and action around energy efficiency in buildings and to make citizens part of the “smart Yixing” process.

### Organize a communication campaign around “smart Yixing”

When it comes to building energy efficiency, a lot of the potential savings are linked to user behavior. The UII recommends a program to communicate potential actions and benefits with Yixing citizens to make Yixing a smarter city:

- Develop a visual identity and messages to be shared around the city about actions taken by the city for energy efficiency and behavior that citizens could adopt to participate in this effort and help to save energy;
- Build a “sustainability museum” where citizens can understand technologies and learn about potential actions for energy efficiency action;
- Create energy-saving citizen leaders (5,000 green leader adults, 10,000 energy guardian angel students) would attend training about energy efficiency that they could share with their family, friends and community.

### Foster good company practices through information sharing

Although energy savings usually lead to high efficiency and cost savings, these measures are often not implemented due to a lack of awareness. In order to persuade companies to adopt best practices, it is important to make their behavior transparent to governments, other companies and the general public.

The UII recommends:

- All companies above a designated size in Yixing should be required to report their sustainability performance;
- The city should publish a ranking to compare their performance and highlight the leaders and laggards;
- The best-performing companies should be invited to join a “sustainable company club” giving them an opportunity to share best practices and gain additional exposure to local leaders and foreign experts.

These recommendations can create pressure for action as companies see awards as a competitive advantage and aim to outdo their peers.

Such recognition programs are extremely cost-effective and can be used together with energy performance agreements between companies and government.

### Encourage green business and entrepreneurship in Yixing

Beyond the implementation of state-of-the art technologies to achieve outstanding performance in energy efficiency, Yixing also aims to be a center for sustainability innovation. This can only be achieved with policies that foster local green entrepreneurship:

- Fund a green incubator to increase access to capital for young sustainability companies in Yixing;
- Establish a fund investing in green start-ups with very favorable conditions in order to attract worldwide talent to the city.

# Industry and building high-level execution plan

## Pilot projects

The most straightforward way to implement the solutions described in this report is to directly apply them to pilot projects (either from volunteering companies, nominated companies, or government-owned companies or buildings). This enables confirmation that the approach is successful and sets an example which can later be followed and replicated by the rest of the market.

## Industry

As outlined in the previous sections, Yixing could achieve maximum impact by focusing on the three “less energy efficient” sectors: production and supply of electricity and heat, non-metallic mineral products industry, chemical materials and chemical products manufacturing.

A step-by-step roll-out would maximize opportunities for success, starting with 1-2 projects in the focus industries during 2013. If successful, this approach could then be replicated to a growing number of companies and industries.

## Buildings

Although public, commercial and residential sectors represent similar shares of Yixing electricity consumption, the implementation of energy efficiency solutions in each of these three sectors presents very different challenges.

Public buildings are the most straightforward target for this new set of solutions. They represent a sizeable share of total building consumption and are directly under government jurisdiction. They should therefore be the main focus in the short term as pilot and demonstration projects.

Commercial buildings are not under direct government jurisdiction but have very good incentives to implement energy efficiency. They directly benefit from the savings generated and therefore can improve user comfort while cutting costs.

The residential building sector is the most difficult to tackle. There is usually an alignment problem between the landlord or developer who is investing in energy efficiency and the customer who is paying the energy bill. Households are also reluctant to engage in large investments in order to generate long-term savings. The best policies for residential buildings would be mandatory standards for new buildings followed by an efficient communication plan to improve users’ behavior.

The first step in the roll-out of the solutions for buildings would therefore be to apply them to government and commercial buildings. Once again, a step-by-step implementation is to be preferred, starting with 1-2 commercial buildings in 2013, with a quick replication to both government and commercial buildings once successful results are confirmed.



# Industry, buildings and citizen engagement action plan

Figure 11: Short, mid and long-term action plan

	Industry	Buildings	Citizen engagement
2020 Long term	<ul style="list-style-type: none"> <li>Full deployment in target industries and partial deployment in other sectors</li> </ul>	<ul style="list-style-type: none"> <li>Scale-up to all government buildings and approximately 30-40% commercial buildings</li> </ul>	<ul style="list-style-type: none"> <li>Set up a fund for green-entrepreneurship in Yixing to attract global talent</li> </ul>
2017 Medium term	<ul style="list-style-type: none"> <li>Total of about 30 projects in the three target industries</li> </ul>	<ul style="list-style-type: none"> <li>Extend pilot to approximately 30 government buildings and approximately 10 commercial buildings</li> </ul>	<ul style="list-style-type: none"> <li>Extend sustainability reporting requirement to all companies in Yixing</li> </ul>
2014 Short term	<ul style="list-style-type: none"> <li>Launch 3 pilot projects in each of the target industries</li> </ul>	<ul style="list-style-type: none"> <li>Launch a pilot project with approximately 10 government buildings and approximately 3 commercial buildings</li> </ul>	<ul style="list-style-type: none"> <li>Launch 'Smart Yixing' communication campaign</li> <li>Build a sustainability museum</li> <li>Push biggest companies in Yixing to report their sustainability performance</li> </ul>
6 months Quick wins	<ul style="list-style-type: none"> <li>Launch 1-2 trial projects in some of the target industries</li> </ul>	<ul style="list-style-type: none"> <li>Launch 1-2 pilot projects in government buildings</li> </ul>	<ul style="list-style-type: none"> <li>Set and publish clear standards for company sustainability reporting</li> <li>Request all major companies to carry out detailed energy audit</li> </ul>



## Possible financial mechanisms

Investments for more energy efficient industry and buildings are usually very demanding in terms of capital expenditure. This is often difficult for municipalities to finance, and innovative business models can be required to reduce initial capital expenditures:

- **Performance contracting:** A type of project finance where third-party financing is used to pay the up-front cost for a project leading to annual guaranteed cost savings, and the debt is paid down out of the future cost savings.
- **Outsourcing:** The city government outsources management of systems or infrastructure to third parties.
- **Software-as-a-service (SaaS) model:** A company provides software and operates it, and charges a monthly or yearly fee. This model enables the user to significantly reduce up-front capital expenses.
- **Information and payment services:** A third-party can provide information or payment services to city residents and businesses in exchange for a fee.
- **Concessionaire model:** A third party operates systems under agreement with the city, creating additional revenue for the city.

Some of these business models are better adapted to some specific technology solutions. The following table provides examples of a good fit between business models and solutions.

Figure 12: Link between solutions and financing business models

<b>Performance contracting</b>	<ul style="list-style-type: none"> <li>• Retrofit of building for energy efficiency</li> </ul>
<b>Outsourcing</b>	<ul style="list-style-type: none"> <li>• Monitoring and maintenance of buildings</li> <li>• Monitoring and management of transportation system</li> </ul>
<b>SaaS model</b>	<ul style="list-style-type: none"> <li>• Building management system</li> <li>• Sustainability dashboard</li> <li>• Intelligent traffic management systems</li> </ul>
<b>Information &amp; payment services</b>	<ul style="list-style-type: none"> <li>• Payment services for transport</li> <li>• Traveler information about traffic and parking</li> </ul>
<b>Concessionaire model</b>	<ul style="list-style-type: none"> <li>• Tolling</li> <li>• Traffic enforcement, congestion charging, traffic fare collection</li> </ul>

### Box 8: Case study - Performance contracting for a 5-star hotel in Beijing

#### Solution implemented

A full energy retrofit solution was provided to the hotel, starting with a complete energy audit and advisory services. The solution includes a building energy management platform and HVAC optimization. Most importantly, the project was carried out using an innovative performance contracting model: the hotel did not have to invest any capital and the company made a profit out of the project within the five-year payback time.

#### Customer benefit

The retrofit enables the company to guarantee 25% energy savings, resulting in a reduction of 1.6 million units of electricity consumption and 1,700 tonnes of CO<sub>2</sub> emissions per year.

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## Endnotes

1. The World Bank (2012). *Sustainable Low-Carbon City Development in China*. Directions in Development series – Countries and Regions. Baeumler, A, E. Ijjasz-Vasquez, and S. Mehndiratta, Eds.
2. The World Bank (2012).
3. The World Bank (2012).
4. The ecological footprint of the city will provide critical indicators of where Yixing needs to invest its efforts to become more sustainable, especially in meeting the 12th Five-year Plan target of reducing carbon intensity by 17% by 2015.
5. Organisation for Economic Co-operation and Development (OECD) (2012b). *Compact City Policies – A Comparative Assessment*. Paris: OECD.
6. According to the Mayor of Yixing.
7. The World Bank (2012).
8. The City of Lijiang provides excellent examples of pedestrian-friendly streets dedicated to retail boutique shopping, eateries and tourist attractions. The City of Guangzhou has also successfully restored an inner-city canal with pedestrian-only walkways on both banks of the canal that together link parks, gardens, an artificial lake, restored buildings of historic significance and small eateries, boutiques and curio shops.
9. Yixing should plan its light rail and/or metro routes and stations now to guide future development. To ensure effective transit-oriented development, Yixing should also build light rail/metro routes just before allowing developers to build new districts. This would not only avoid the pitfalls of implementing mass transit after new districts are built, it would also boost the value of the land when it comes to selling development rights.
10. The World Bank (2012).
11. Dashboards were installed in close to 1,000 schools in Ontario, Canada. The results revealed carbon emissions variations and their corresponding running cost implications of more than 5:1 between the best and worst performing schools. This compelled students, parents, teachers and superintendents to look at the causes and to take measures to improve their performance.

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The World Business Council for Sustainable Development is a CEO-led organization of forward-thinking companies that galvanizes the global business community to create a sustainable future for business, society and the environment. Together with its members, the Council applies its respected thought leadership and effective advocacy to generate constructive solutions and take shared action. Leveraging its strong relationships with stakeholders as the leading advocate for business, the Council helps drive debate and policy change in favor of sustainable development solutions.

The WBCSD provides a forum for its 200 member companies – which represent all business sectors, all continents and combined revenue of more than US\$ 7 trillion – to share best practices on sustainable development issues and to develop innovative tools that change the status quo. The Council also benefits from a network of 60 national and regional business councils and partner organizations, a majority of which are based in developing countries.

[www.wbcsd.org](http://www.wbcsd.org)

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