A global perspective:

Power Solutions that can drive sustainability in smart cities

Presented by Hubertus von Grünberg, Chairman of ABB's Board of Directors
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1. Introduction
Cities today are home to 50% of the world’s population and account for 60% of global GDP. By 2050, an additional 2.9 billion people will be living in cities, and urban dwellers will represent 70% of the world’s population. About 90% of this growth will be in developing economies as people are drawn to urban areas by the perceived economic advantages. Consequently, cities will need new infrastructure to meet the needs of their citizens and businesses.\(^1\)

Urbanization has become a major driving force in China's economic development. However, it is also generating some of China’s biggest challenges, especially the increasing appetite for energy and the sustainable development of cities.

An effective way to improve quality of life and drive sustainability and economic growth is by making cities “smart”. Smart cities monitor, optimize and control key systems and infrastructure, such as buildings, energy, water, waste and transport, and they are designed and run with the involvement of their citizens and stakeholders.

In all cities, reliable provision of energy is essential for powering infrastructure and transportation, economic growth and quality of life. This paper analyzes how existing smart solutions are already helping cities become more sustainable through improvements in efficiency, use of clean energy and reductions in emissions, while maintaining reliability of energy as part of their journey towards becoming a smart city. It aims to provide ideas for policy makers who are designing China’s urbanization strategies.

2. Urbanization: a global challenge
To prosper in today's urbanizing world, cities must accommodate growth arising from increased population and business activity. At the same time, they must create more sustainable environments that reduce local air and water pollution, meet carbon reduction targets and respect limited resources. Finally, they must remain competitive by creating the right environment for businesses to invest and citizens to enjoy a decent standard of living.

The sustainability issue is increasingly important for cities in many parts of the world. Cities occupy only 3% of the world’s land mass, but consume over two-thirds of the world’s energy and account for 60-80% of global greenhouse gas emissions.\(^3\) Moreover, the number of consumers and their levels of consumption rise as a consequence of urbanization, increasing levels of emissions.\(^4\)

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\(^2\) C40Cities, http://www.c40cities.org/

\(^3\) UNEP: Global Initiative for Resource Efficient Cities, 2012

\(^4\) http://eau.sagepub.com/content/21/2/545
According to the China Academy of Social Sciences, China is the world’s most rapidly urbanizing country and, for the first time in its long history, more Chinese are now living in cities than in rural areas. In 2011, city dwellers made up 51.3% of the population. The scale of China’s urbanization is also unprecedented. By 2025, China’s cities will have added 350 million people, more than the entire population of the United States today. By then, China will have approximately 220 cities with over one million inhabitants, and the urban economy will be generating over 90% of the country’s GDP.

Although urbanization will boost consumer purchasing power and investment and continue to drive economic growth, it will at the same time pose severe challenges for the country’s sustainable development, both in social and economic terms.

China faces major challenges in meeting its energy needs. It possesses limited natural resources and these are spread thinly over a vast population; China’s per-capita energy consumption is one-fourth that of the US. As urban populations grow, energy consumption will increase and China will need to find ways to expand its energy supply. The country already suffers from shortages; in 2010, 8.6% of China’s energy needs were met by imports. Insufficient domestic resources will continue to exacerbate the gap between China’s energy supply and demand, supporting expectations of rising energy imports.

In addition to energy security issues, China must confront significant environmental degradation caused by heavy reliance on coal to generate power. Over half of China’s electricity is produced by burning coal. According to statistics published by the U.S. Energy Information Administration in 2010, China’s coal usage accounts for approximately one-fifth of the world’s total CO₂ emissions. Moreover, China is the world’s largest emitter of CO₂ emissions. Increasing urbanization will compel China to seek solutions for maintaining a reliable energy supply in an environmentally sustainable manner.

Rising incomes associated with urbanization are also contributing to harmful emissions from vehicles because more people are buying cars. Growth in car ownership is forecast to rise by 36% annually and an estimated 20 million new cars are expected to be added to China’s roads in 2013. As China expands its energy supplies and consumes more energy, it will need to contend with the growing associated environmental consequences.

6 http://www.friends-of-europe.org/ContentNavigation/Library/Libraryoverview/tabid/1186/articleType/ArticleView/articleId/3184/Greening-China’s-cities-of-tomorrow.aspx
11 http://www.eri.org.cn/uploadfile/Executive_Summary.pdf p.25
12 http://www.eia.gov/countries/data.cfm
13 http://www.eia.gov/countries/data.cfm
15 http://www.businessweek.com/articles/2013-02-04/energy-imports-china-energy-imports
It is encouraging to see that the Chinese government has plans to tackle these challenges. Both the 12th Five-Year-Plan and the most recent Energy White Paper have laid out solid targets to reduce carbon emissions, enhance energy efficiency, and develop renewable energies. In addition to serving as the guidelines for China’s future development, these targets are becoming a key measurement of government officials’ performance at many levels as China focuses more on qualitative rather than quantitative improvements. With the government’s endorsement and commitment, it is to be expected that the country’s development will shift to a more sustainable approach.

As China continues to modernize, electricity will become an increasingly important type of energy. China’s electricity consumption is set to double over the period 2010-2020, and China is expected to account for 34% of the increase in world electricity demand from 2010-2035. Bolstered by ABB’s core technologies and business strengths, this paper will focus on how existing power solutions can help cities become “smarter”.

3. Smart cities as a mechanism for meeting city goals

An effective way to improve quality of life and to encourage sustainability and economic growth is by making cities “smart”. Smart cities monitor, optimize and control key urban systems, such as buildings, energy, water, waste and transport, and are designed and run with the buy-in and commitment of citizens and other stakeholders. The concept is based on the introduction of next-generation power supply control systems, which incorporate IT technologies into grid management to maximize efficiency, resilience and system security.

Many infrastructure solutions can already be made “smart” in their own right, such as solutions for buildings, water, energy, communications, transport and waste. This sort of bottom-up innovation, led by the different service providers, has been successfully executed for years and it will continue to play a significant role in meeting city needs. But when orchestrated in a top-down manner by local governments, these solutions can be coordinated to help address a broader city vision. There are several examples of this, which we will come to in due course.

Smart cities usually include such elements as energy management systems (EMS), automated buildings and homes, a distributed power generation system, and infrastructure for electric vehicles. The engagement of citizens and business is also vital because many changes require the education and buy in of consumers, and sometimes their support, if the benefits are to be realized.

China attaches great importance to the construction of smart cities and the market is believed to have the potential to boost the development of a chain of industries. Over 150 cities have proposals

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16 The following policy documents are released by Chinese government:
http://www.gov.cn/zwgk/2012-08/21/content_2207867.htm
http://www.gov.cn/jrzg/2012-10/24/content_2250377.htm
18 http://www.worldenergyoutlook.org/publications/weo-2012/#d.en.26099
19 http://www04.abb.com/global/seitp/seitp202.nsf/0/7ddd81f4bb44dd0dc12577340019ac0c/$file/10_21_finlandsmartgrid.pdf
to build smart cities, according to the China Communications Industry Association, the leading organization in promoting the idea and application of smart cities in China.  

However, the concept of smart cities is still so new that it will take time for people to change their traditional energy management methods. In China, the development of smart cities is likely to be complicated further by the lack of a holistic designer to integrate resources efficiently, the lack of an open platform for all key stakeholders to get involved and share data and resources, and the lack of assurances of policy continuity.

4. Case studies

As in other countries, China's urbanization process will inevitably lead to the growth of new cities and the upgrading of infrastructure in old ones. Urban planners should incorporate the expertise of all key stakeholders, such as industry insiders, academics, investors, service providers and consumers. By engaging stakeholders from the outset, cities can ensure they form cohesive policies which address the needs of its interest groups. Not only will this enable urban planners to understand more of the potential long-term demands and issues, it will also help them integrate technologies across sectors to achieve city goals.

Globally, countries are already pioneering smart city technologies to address the challenges of urbanization. The examples below demonstrate how existing power solutions have helped cities to maximize resources and contribute to environmentally sustainable urban areas. These examples may be illustrative for China as it looks to develop its own smart city solutions.

4.1 Improving energy efficiency in buildings with smart technology

<table>
<thead>
<tr>
<th>Situation</th>
<th>Buildings in China account for approximately one-third of total energy consumption, and this figure is expected to rise sharply in the coming years. At the same time, heating efficiency in China’s buildings is only one-third of that of industrialized countries.²¹</th>
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<td>According to China’s 12th Five-Year Plan of Energy Saving and Emission Reduction, savings on electricity consumption should ideally reach 800 gigawatts. Moreover, the Chinese authorities intend to expand the application of renewable energy sources in buildings. As of 2012, renewables account for 2% of building energy usage in China.²²</td>
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<tr>
<td>Solution</td>
<td>Adding automation and intelligent technologies can make core processes more efficient, reduce energy consumption in parts of the building that are not in use, and pre-heat or pre-cool the structure at times when energy is cheaper.</td>
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<tr>
<td>Benefits</td>
<td>“Intelligent” buildings conserve significant amounts of energy by powering off</td>
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²⁰ http://www.chinadaily.com.cn/bizchina/2012-11/15/content_15931273.htm
²¹ http://discovery.163.com/12/1124/12/8H2UD3JC000125LI.html
parts of the building that are not in use.

Large-scale application of intelligent building technology could help China’s cities achieve efficiency targets and save significant amounts of energy.

Such technologies can also give building owners and occupants a higher degree of control over the building environment. Lighting control systems are estimated to deliver power savings of up to 50%.

**Landmark buildings in Singapore**

Intelligent building technology has helped to cut energy consumption in several award-winning buildings in Singapore. For example, the National Library of Singapore was fitted with intelligent building technology such as presence-controlled lighting sensors that automatically switch off lights after a certain period of inactivity, and ultra-light-sensitive sensors that brighten or dim lights according to the amount of natural light entering the building. It won the ASEAN Energy Efficient Building Best Practices Award in 2007.

Figures from 2006 and 2007 show that thanks to automation technology, Singapore’s national library consumes 102.59 kilowatts (kW) per m² annually. That is 21% less than its target of 124.47 kW, and less than half the national average of 220 kW.23

### 4.2 Reducing sea-port emissions and pollution through shore-to-ship power solutions

**Situation**

Every year, more than 100,000 vessels dock at 4,500 ports around the world. Ships typically use diesel generators to produce electricity while in port, which generates high levels of emissions and noise. Globally, ships produce around 900 million metric tons of CO₂, equivalent to emissions produced by 220 coal-fired power plants.

China has seven of the world’s ten largest ports in terms of volume of freight24. As China’s marine trade grows, local ports will face ever-increasing pressure to reduce emissions. According to the 12th Five-Year Plan, domestic ports need to reduce CO₂ emissions by more than 10% by 2015, while ships need to reduce emissions by at least 16%.

**Solution**

Shore-to-ship power solutions enable ships to plug into an onshore power source instead of using diesel fuel. After synchronizing with the local grid, ships’ on-board auxiliary generators are automatically switched off.

**Benefits**

It is estimated that shore-to-ship power technology can eliminate 98% of

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23 [http://www.abb.com/cawp/seitp202/a215861bfb299d56c12574b4004a6b17.aspx](http://www.abb.com/cawp/seitp202/a215861bfb299d56c12574b4004a6b17.aspx)

emissions, as well as all the noise and vibrations associated with diesel generators, making it possible to have ports in the middle of cities and people living right on the water’s edge. From ship-owners’ perspective, it reduces maintenance and operating costs.

Ystad, Sweden
With around 3,500 vessels served per year, Ystad is the fifth-largest port in Sweden. The vessels in port generate high levels of noise and emissions because of the on-board diesel generators used to provide electricity for basic amenities.

Ystad chose shore-to-ship power connections to mitigate the damaging effects mentioned above. This system enables docked ships to shut down their diesel engines and plug into an onshore power source, thus cutting both emissions and noise.

Thanks to an ambitious investment program, Ystad has enjoyed double-digit growth in tonnage over the past three years and is one of the few ports to have experienced growth in the current economic climate. According to preliminary estimates, the electrified port will cut emissions by 97.5%.

4.3 Reducing emissions from transportation with electric vehicles (EVs)

Situation
China is the world’s largest automobile market. Total vehicles sales are expected to hit 20 million in 2013 and 30 million in 2015, accounting for over 30% of the world total.25

Rising emissions from vehicles impede the development of sustainable, livable cities.

Despite favorable policies in place to stimulate the use of electric vehicles (EVs), customer buy-in fell short of expectations due to the lack of a convenient EV-charging system that enables users to recharge cars in urban areas. High prices, slow charging times, short battery service life and the newness of relevant technologies have also deterred consumers.26

Solution
An EV-charging infrastructure with various charging options to suit the differing needs of drivers and providers is an effective way to reduce vehicle emissions. Various types of charging allow drivers to recharge in minutes, hours or overnight.

References

25 http://www.chinaeconomicreview.com/node/63511
26 http://www.reuters.com/article/2012/04/25/china-ev-idUSL3E8FO14620120425
http://www.nydailynews.com/autos/electric-vehicle-market-struggles-slow-sales-article-1.1178155
Online management systems also enable operators to see the status of their chargers and control them accordingly. Network consulting, installation, commissioning and maintenance services are required to ensure effective administration.

<table>
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<tr>
<th>Benefits</th>
<th>EVs are often a more environmentally friendly option when compared with traditional cars. Studies have shown that in many countries, such as the United States and Britain, electric cars have been proven to produce lower CO₂ emissions compared to traditional gasoline-powered cars, even after factoring in emissions from electricity generation.</th>
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Strategically deploying an electric-charging infrastructure encourages the purchase of EVs. Moreover, setting up supporting monitoring systems for charging infrastructure provides the basis for incorporating renewable energy, further contributing to sustainability.

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<tr>
<th>Case Study</th>
<th>EVs in Estonia</th>
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<td>The Estonian government has provided fast-charging networks in all urban areas with more than 5,000 inhabitants. It has also installed chargers every 50 km on major roads, creating the highest concentration of DC chargers in Europe. These investments in electric mobility are part of the national government's plan to reduce carbon emissions.</td>
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<td></td>
<td>To meet this goal, the Estonian government ordered 165 DC chargers from ABB to create the world’s first nationwide fast-charging network for EVs.</td>
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### 4.4 Empowering citizens to use greener energy through information and automation

<table>
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<th>Situation</th>
<th>Consumers frequently don’t know when energy might be greener or cheaper, and even those that do often lack the ability to easily manage their energy consumption.</th>
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<tbody>
<tr>
<td>Solution</td>
<td>Smart homes and buildings is a concept where customers receive information updates on when renewable energy is plentiful and are given the information and equipment to enable them to adjust their behavior accordingly. For example, washing machines could be run when the building energy management system is informed that renewable energy is available, or the price is low. Consumers and building operators can see current conditions through in-home energy displays, or through web-based applications.</td>
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27 US research:  
UK research:  
Benefits

This type of solution has been shown to deliver savings for consumers.

Case Study

Stockholm Royal Seaport

The Swedish capital Stockholm is building the Stockholm Royal Seaport, a new commercial and residential district that integrates multiple smart solutions to promote sustainable energy consumption habits.

One goal of the new district is to cover 30% of its electricity needs locally using renewables or surplus energy. Residents can produce their own electricity from solar panels and either store it or feed it back into the grid.

The Stockholm Royal Seaport also aims to eliminate the use of fossil fuels by 2030, pointing to the importance of implementing large-scale smart grid systems to support the district’s energy needs.

5. Conclusion

Cities face a number of challenges around managing growth, becoming more sustainable and remaining competitive. This is especially true of China, given its growing need for energy to support its rapid urbanization process.

Smart cities can provide multi-faceted solutions to meet these challenges. When it comes to energy, the need for a coordinated approach is paramount because energy efficiency and conservation extends right through the urban environment, from integration of renewables, to the reduction of vehicle emissions, to management of power.

Planning, developing and implementing appropriate solutions require close coordination at the city level and across multiple sectors. By selectively implementing improved supervision, optimization and control through smart city technology, cities can deliver significant improvements in quality of life and drive sustainability and economic growth.

The involvement of all key stakeholders is crucially important in the implementation of a reliable plan for a smart city. The government should play the leading role by setting policy and providing financial support. Companies, such as investors, service providers, infrastructure and automation providers and information and communications technology providers, should be motivated to contribute industrial experience and advanced technological know-how. Finally, end users should be educated to understand the benefits of smart city living.

Urbanization is a global trend. China can nurture the sustainable growth of its cities by drawing on global experience and knowledge. As a world leader in smart city technologies, ABB would be honored to assist the Chinese government in finding sustainable solutions to the challenges of urbanization.

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