



Sustainable urbanization: The role of ICT in city development

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Executive summary

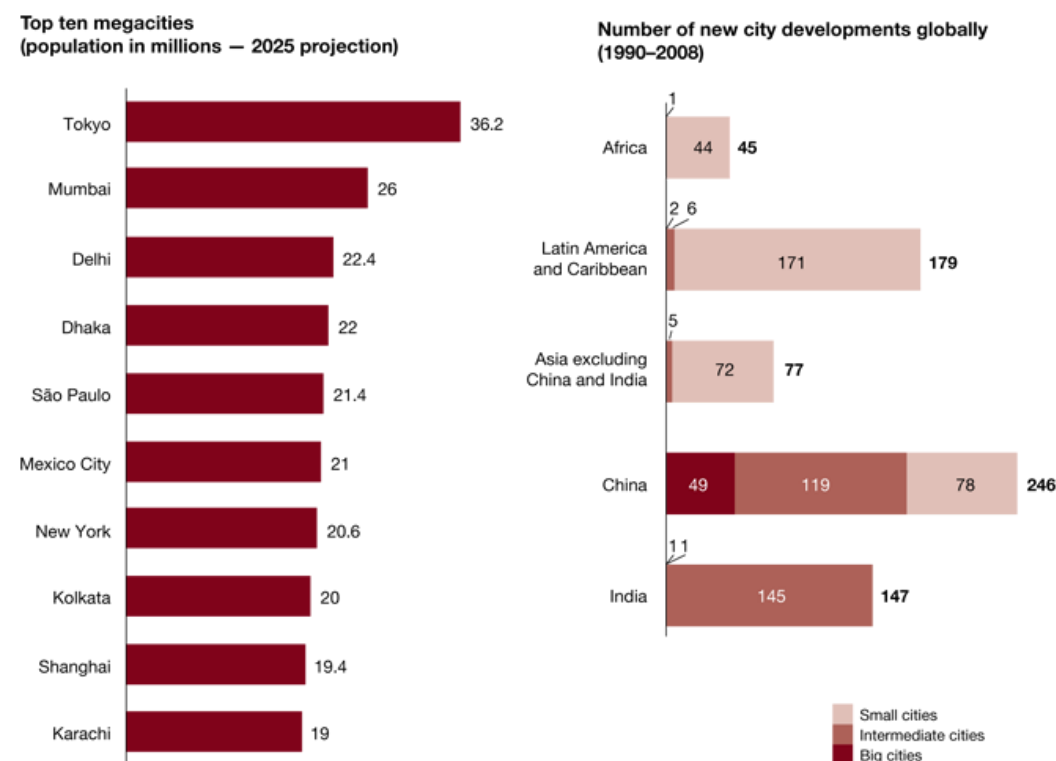
Increasing urbanization and awareness of sustainability issues are setting off a wave of investments in revitalization of existing cities and development of new ones. However, given the scale of the challenge, simply throwing more money at the problem is not a solution — the world needs a new operating paradigm that provides for the needs of urban residents in an economically viable, socially inclusive, and environmentally sustainable way. Businesses and governments are starting to recognize the role of technology in meeting these objectives. City investments that include a large ICT (information and communications technology) component can enable the designing of smarter cities that offer a better quality of life for their residents while being more sustainable and cost efficient. It is not only the residents that stand to benefit from this trend; governments can meet their objectives faster and more cheaply, while ICT players find themselves at the cusp of a whole new market. If these stakeholders hope to play and win in this uncharted territory, they will need to adopt a new operating paradigm.

The urban century

This is the urban century — more people worldwide are living in urban areas than rural for the first time in recorded history. The urbanization trend picked up pace in the 20th century and has accelerated since. Whereas in 1950 only about 30 percent of the world's population lived in cities, today the figure is more than 50 percent. By 2030, the United Nations expects more than 60 percent of the world's population to live in cities. With the urban populations of Asia and Africa set to double between 2000 and 2030, going forward, this trend is expected to be dominated by developing economies.

Urbanization manifests itself in two ways: expansion of existing cities and creation of new ones (see *Exhibit 1*).

Exhibit 1: Expansion of cities due to urbanization



Source: U.N.-Habitat "State of the World's Cities 2008/2009"
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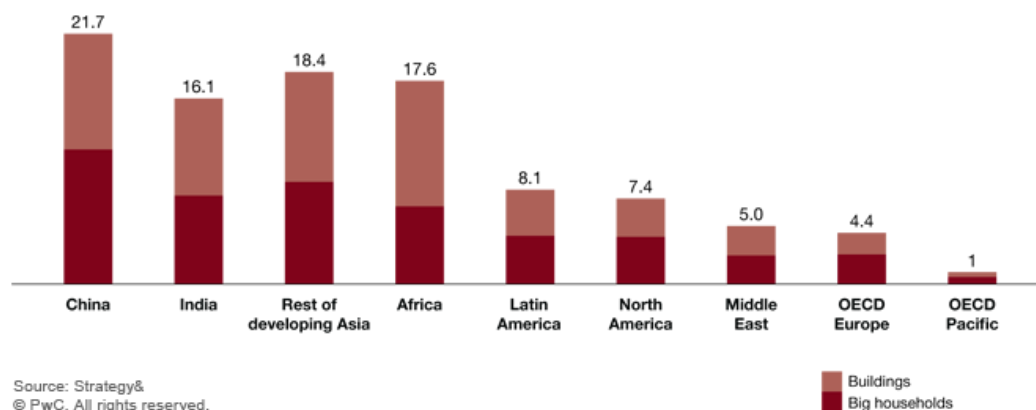
For example, in 1950, only two cities had populations of more than 10 million: New York and Tokyo. By 1975, Shanghai and Mexico City joined the club. But by 2004, the number of such megacities had rocketed to 22, and together, these cities now account for 9 percent of the world's urban population. By 2050, at least 100 new millionplus cities are expected to appear. As existing cities continue to expand, new ones are being developed. Between 1990 and 2000, urbanization in developing regions was characterized by the emergence of new cities that did not exist prior to 1990. These 694 new cities started out as rural towns and became urban areas by virtue of changes in their administrative status, natural growth, or migration. These changes assumed significance in Asia, where more than 295 settlements transformed into small cities during this period.

Implications of urbanization

Urban populations are growing at a faster rate than their cities can support. Cities are stretched to the limit, struggling to provide basic urban services at unprecedented scales. The drought of 2006 in London, the worst in a century, will be remembered for the dirty little secret it exposed. Hundreds of thousands of liters of water — enough to fill 10 million bathtubs — was leaking every day from the city's old and rotting pipes, some of which dated back to the Victorian era. All over the world, major cities — Cairo, Los Angeles, Beijing, Paris, Moscow, Mumbai, Tokyo, Washington, São Paulo — have stories to tell of electricity, transportation, or water systems in crisis. Traffic congestion and pollution continue to increase as overcrowding has become endemic. Urban poverty, associated with unemployment and inadequate housing and services, is a serious socioeconomic challenge. Although the exact circumstances vary from one city to the next, all urban areas have one thing in common — critical infrastructure is technologically outdated, woefully inadequate, increasingly fragile, and incapable of meeting even the current needs of all its residents.

Estimates differ, but it is clear that significant investments are required to meet urbanization demands. Global spending on city development and building infrastructure is expected to flow into trillions of dollars over the next 30 years, largely concentrated in developing nations (*see Exhibit 2*).

Exhibit 2: Cumulative building construction spend (2005–2035, in US\$ trillions)



These investments have multiplier effects as they trigger opportunities to grow secondary sectors and services while injecting liquidity into the market, ultimately serving to create a more sustainable socioeconomic environment.

Take India, for example. Indian cities need to prepare for an influx of tens of millions of people in the coming decades. The 170-million-plus slum dwellers in India ^[1] surpass the total populations of all but five countries in the world. Mumbai, which originally planned to accommodate 7 million residents, ^[2] is now home to 18 million. ^[3]

The resulting urban sprawl and lack of affordable housing have brought to Mumbai the dubious distinction of fostering the single largest urban slum settlement in Asia: Dharavi.

By 2025, there are expected to be 13 urban agglomerations in India with more than 10 million inhabitants. Providing for these numbers of people is no mean feat. Given the pace and magnitude of urbanization, the solution does not lie in simply throwing more money into the usual tactics for addressing the problem. Building more roads can serve only as a temporary reprieve from congestion and can do little to reduce pollution in a rapidly urbanizing environment. Generating more electricity or developing new sources for water cannot purge the system of such embedded inefficiencies as distribution losses, leakage, and pilferage.

Merely enhancing infrastructure also poses socioeconomic and environmental challenges. Cities are already the source of close to 80 percent of global CO₂ emissions, ^[4] and will account for an ever-higher percentage in the coming years, as more and more people reside in and move to cities in search of prosperity. If we continue with the same solutions that have been used to address urban development needs in the past, the resulting urban ecological footprint will not be sustainable — humanity will need the equivalent of

two planets to maintain those lifestyles by the 2030s.^[5] At the heart of the matter, we face a challenge of meeting demands of urbanization in an economically viable, socially inclusive, and environmentally sustainable fashion.

An alternative vision for cities of the future

Urbanization is an inevitable progression. It can go well, it can happen badly, but progress it will. To make urbanization a positive and productive transformation that will deliver long-term gains to citizens, three goals need to be achieved — social equitability, economic viability, and environmental sustainability. Social equitability is based on the principle of inclusion; there is no discrimination in access to benefits across population segments. Economically viable solutions are those that are financially self-sustaining. Environmental sustainability ensures the preservation of the environment for future generations.

Businesses and governments are starting to recognize the role of technology in meeting the goals of urban infrastructure provisioning both today and in the long term. Previous centuries saw industrial infrastructure such as railways, roads, and telephone lines preparing the way for new cities and new connections. This century's urbanization is based on the integrated management of the economic, social, and infrastructure aspects of urbanization via the use of networked information. An intelligent solution ensures more equitable access to services — an aspect in which several one-off urban development projects today are found wanting.

Governments of many countries are taking the lead in developing the next generation of cities driven by technological solutions. For example, South Korea is building a new city with state-of-the-art schools, hospitals, apartments, office buildings, and high-end cultural amenities (*see sidebar on Songdo*).

Songdo: South Korea leads the way in building next-generation cities

Songdo International City in Incheon, South Korea, is the world's newest city. Built on 1,500 acres of land reclaimed from the Yellow Sea off Incheon, it was created to establish a new standard of smart urban development.

Government authorities in South Korea have partnered with property developer Gale International and Cisco to develop an interconnected communications network system and a suite of solutions for the residents of Songdo. The city will deploy video networking technology and energy management software tools citywide to link municipal systems, education institutions, healthcare facilities, transportation systems, and hospitality organizations into a common network.

Songdo IBD (International Business District) will encourage sustainable design practices by incorporating the latest design standards and technologies that reduce energy consumption, increase energy efficiency, utilize recycled and natural materials, and generate clean or renewable electricity. Songdo buildings will be built embedded with advanced energy management solutions. Greywater and rain will be collected for irrigation and use in cooling towers. A network of underground pneumatic pipes will move solid waste, reducing the need for garbage trucks.

Songdo is also a petri dish for green transportation schemes. The city's main car depot has been buried in a sunken courtyard to keep heat and emissions down. A new public transport system will include underground trains linked to Seoul and a network of electric water taxis in the city's saltwater canals to reduce Songdo's carbon footprint.

More than 40 percent of the city is designated for open spaces, with parks accessible from all corners of the district. A 100-acre "central park" will be built over the multi-level underground parking in the city center.

The future of cities is evident now in Songdo, a city that seems to have found a harmonious connection between nature and technology, innovation and innovative urban design, and superior quality of life.

Masdar City, the world's first carbon-neutral, zero-waste city, is an initiative of the government of Abu Dhabi intended to position the country as a leader in renewable energy and sustainable technology (*see sidebar on Masdar*).

Masdar: A renewable oasis^[6]

Amid the oil fields and beachfronts of Abu Dhabi, in the United Arab Emirates (UAE), a city powered entirely by renewable energy is rapidly taking shape. Masdar City^[7] is a planned urban environment of about 2.5 square miles (6 square kilometers) that is expected to house 40,000 residents after its completion over the next decade.

To be entirely self-sufficient, Masdar City will use energy technologies to reduce its waste to nearly nothing, and to leave a negligible footprint of carbon and other industrial emissions. Engineers are exploring solutions such as "personal rapid transportation (PRT) units," which are, essentially, shared solar-powered vehicles that hold six people at a time and can be directed to any of the 200 or so stations beneath the city. The city aims to recycle most of its water. Parks and plazas, filled with greenery and modeled after traditional Arab gardens, will foster a sense of community and encourage walking. Narrow alleys between buildings will offer shade and reduce the need for air conditioning.

Masdar sees implementation of the relevant IT solutions as critical to meeting its goals. ICT solutions such as smart home/smart office and city management applications have been identified to add tangible value through enabling more efficient deployment of services (for example, enhanced monitoring of facilities to reduce consumption, demand-managed scheduling of PRT). Sustainability management solutions add intangible value, keeping citizens informed about the environmental progress agenda, and smart home and electronic wallet solutions enhance entertainment and improve quality of life.

The underlying technology

The vision of a modern smart city is that of an urban center that is safe, green, and efficient because all structures — whether used for power, water, waste management, or transportation — are designed, constructed, and maintained with the use of advanced, integrated materials, sensors, electronics, and integrated networks. This vision is made possible by a host of underlying technology components (see Exhibit 3).

Exhibit 3: Examples of ICT-based city solutions

Energy/utilities/water	Healthcare	Transport
<ul style="list-style-type: none"> – “Smart metering” systems <ul style="list-style-type: none"> · Real-time usage metering savings — 10–15% energy – “Smart distribution” systems <ul style="list-style-type: none"> · Intelligent networked transmission/distribution · Real-time network condition monitoring 	<ul style="list-style-type: none"> – Remote systems for diagnostics and treatment <ul style="list-style-type: none"> · Enhance patient experience and penetration of direct care · Improve emergency responses 	<ul style="list-style-type: none"> – Intelligent transport systems <ul style="list-style-type: none"> · Direct traffic flow based on real-time information – Automatic systems for reducing congestion <ul style="list-style-type: none"> · Dynamic demand handling · Systems like carsharing, multi-modal transport scheduling, etc.
Education	Housing	Public safety and security
<ul style="list-style-type: none"> – Systems for interactive two-way content delivery to students and teachers <ul style="list-style-type: none"> · Monitoring systems · Remote access · Access to quality content 	<ul style="list-style-type: none"> – Intelligent real estate solutions that manage building energy efficiency, security, utility supply, etc. <ul style="list-style-type: none"> · Reduce total cost of ownership over building life cycle · Provide environmentally sustainable properties 	<ul style="list-style-type: none"> – Intelligent systems <ul style="list-style-type: none"> · Citywide monitoring, sensor tracking, alerting, controls – Dynamic resource management systems <ul style="list-style-type: none"> · Quick emergency response

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The use of smart grids/meters for water and power transmission provides a technology-enabled solution to reduce leakage and waste and increase transparency and reliability. Smart grids deliver electricity from suppliers to consumers using two-way digital technology and can integrate alternative sources of electricity such as solar and wind energy. A study by the United States Department of Energy calculated that internal modernization of U.S. grids with smart grid capabilities would save between US\$46 billion and \$117 billion over the next 20 years. ⁸

Tele-health services, which connect hospitals to remote facilities for consultation, diagnosis, and sometimes training, are increasingly finding acceptance as a means of increasing accessibility and reducing cost of delivery. In Chongqing, southwest China, two hospitals in the Shapingba district, South Western and Xinqiao, have implemented tele-medicine solutions, connecting with other participating hospitals.

Intelligent transportation solutions help in improving efficiency and resource utilization across air, road, rail, and sea. The cities of Stockholm and London have implemented intelligent traffic management and congestion charging solutions. The city of Ahmedabad in Gujarat, India, has deployed a GPS-enabled Bus Rapid Transit System (BRTS) solution to meet its transportation needs in a sustainable fashion (see sidebar on Ahmedabad). Ahmedabad BRTS is modeled on the hugely successful Transmilenio of Bogota and the BRTS of Curitiba, Brazil. These solutions aim not only to reduce congestion, but also to improve public transport and minimize environmental impact.

Sustainable transportation in Ahmedabad, India

The Ahmedabad government developed BRTS to provide reliable and secure public transport with the primary objective of reducing travel time. The system was planned in collaboration with the Centre for Environmental Planning and Technology, keeping sustainability at the core of the planning process. Approximately 155 kilometers of road were created within BRTS after planners determined the service utilization by considering socioeconomic characteristics, travel demand patterns, road network characteristics, the proposed metro plan, and the existing Ahmedabad Municipal Transport Service (AMTS) route network. The

BRTS has state-of-the-art bus stations equipped with ramps for the disabled, CCTVs, and comfortable seating arrangements for commuters. The scheduling and tracking of buses on all routes is performed from a central location in the city.

Key design elements include GPS-enabled buses, an integrated control center for traffic management, and use of driver assist and automation technologies with vehicle prioritization and passenger information systems for operational efficiency. Procurement and operation of buses is undertaken by private operators via a public-private partnership (PPP) model.

BRTS was awarded the 2010 Sustainable Transport Award, beating four other prominent cities worldwide.

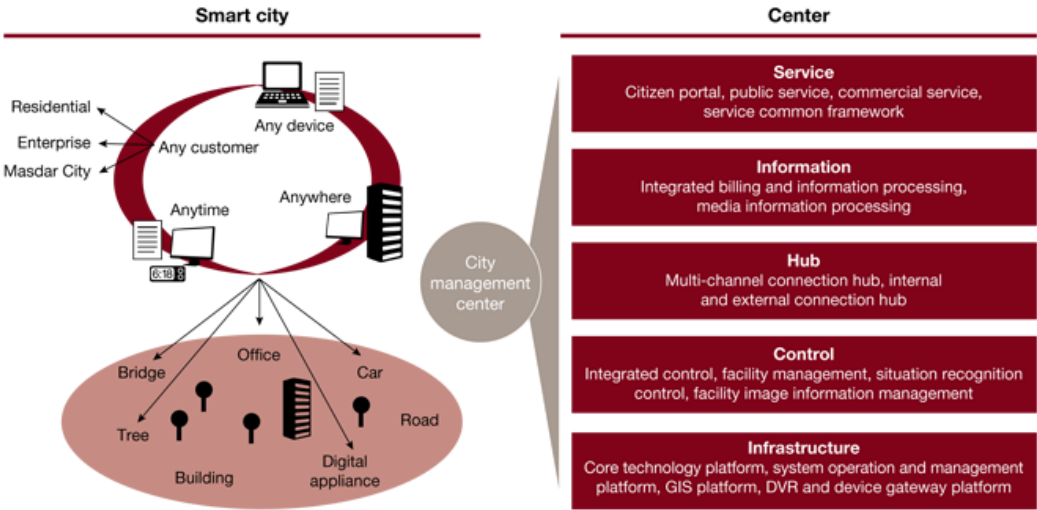
ICT can play an important enabling role in the avoidance of high-emissions infrastructures. It supports the construction of smart/green buildings with features such as leverage sensors and controls designed to improve efficiency and tailor energy use to demand. Public safety and security solutions help prevent, detect, and respond to security requirements. Real Time Crime Centers (RTCCs) and integrated emergency response solutions are technology-enabled solutions that have been used successfully worldwide to increase efficiency and reduce response time. The New York Police Department RTCC has reduced the crime rate by 27 percent; the police use analytics and visualization tools to decipher crime patterns as they are forming. Cities like Songdo are building public safety and security solutions based on citywide surveillance systems that are centrally monitored and integrated with emergency response capabilities.

These technology solutions not only make urban service delivery economically viable, but also ensure environmental sustainability and social inclusiveness.

Modern cities integrate these various technology components to deliver a higher quality of life to their residents. ICT strategies of leading “smart cities” are typically based on three key tenets. First, the ICT infrastructure should enable interaction and interconnectivity between and across homes, office buildings, transportation systems, and smart utilities to ease the chore of urban living for the citizenry. Second, services should be universally accessible to all city residents. Third, services should be centered on the individual consumer and focused on a superior consumer experience. In order to deliver against these tenets, a host of public and private services focused on citizens need to be powered by a common underlying network that provides connectivity across the city (see Exhibit 4).

Technology solutions not only make urban service delivery economically viable, but also ensure environmental sustainability and social inclusiveness.

Exhibit 4: Concept of a smart city



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Benefits of smart cities

Smart cities offer the promise of a better, more sustainable lifestyle to their constituents in the following ways:

Efficient usage: Technology solutions across the fields of energy, transport, and waste lead to direct economic and environmental benefits. Examples include customized energy consumption through smart metering, micro-grids, and dynamic pricing.

Connected and transparent public services: Efficiency in public and citizen services was driven by siloed e-governance initiatives in the early days. Over time, the focus has shifted to connected delivery of government services, which allows for a better citizen experience. An example is one-stop updating of location records that feed seamlessly to post offices, police records, banks, schools, and taxation databases. Integrated record management also allows for holistic health services across locations. Ready access to services and those services' performance standards for all individuals serves the cause of transparency and equity in city governance.

Increased safety and security: Smart cities tend to deploy integrated public safety and security solutions (remote monitoring, smart cameras, pattern recognition, and red flagging through heuristic platforms), resulting in safe and secure settings for their citizens.

A better lifestyle: These next-generation cities combine and broaden their objectives to create stronger links between government, education, and industry by leveraging ICT. In order to attract and retain talent, these cities also provide worldclass amenities in terms of schools, housing, landscaping, and retail and entertainment outlets.

Implications for stakeholders

A wide range of decision makers and influencers are involved in building a city, including a master developer (usually a government agency), multiple property developers, design consultants, ICT players, and tenants. Governments have the opportunity to embrace the underlying technology and solutions to develop better cities, cheaper and faster. The prospects for property developers are immense if they can make timely moves to ride the crest and stay ahead of competition. ICT players, for their part, can leverage this incredible business opportunity to reap rich rewards if they can use this narrow window to establish themselves as leaders in this space — but participating requires a different operating paradigm.

We outline the implications for these key stakeholders:

Governments

Consider the role of ICT up front in city development: Governments embarking on new city development can significantly stretch their investments by planning appropriate use of technology. The key to this approach lies in developing an ICT master plan that is both parallel to and a component of the city's master plan.

Engage in public-private partnerships (PPPs): Governments operating on razor-thin budgets may not be in a position to make the necessary investments to develop high-caliber infrastructure. Public-sector agencies may also lack an understanding of the true extent of ICT deployment required to create smart cities. Consequently, many government organizations are tapping the private sector for capital, technology, and expertise to finance, develop, and manage public-sector infrastructure projects. However, what a PPP must involve is not always clear. A variety of options exist to engage the private sector, such as leases, contracts, and joint ventures, with varying levels of risk sharing and investment. The key lies in matching the right commercial construct with the right requirements to create a symbiotic relationship for both parties.

Developers

Understand the role of technology: Sustainability concerns are on the rise. Technology continues to become more ubiquitous. Modern-day properties incorporate holistic energy management and security solutions that not only generate longer-term savings but also increase the value of the assets. Property developers need to be aware of the latest technology advancements in this space; early adopters will gain an edge in this changing landscape.

Engage with ICT providers: Developers need to engage with ICT providers right from the start — first in an advisory capacity, then with the ongoing operations of selecting, developing, deploying, and operating the technology solutions.

Profit from participatory rights: Developers considering technology solution deployment control access rights to a lucrative opportunity for ICT players. They need to understand the value of these rights to ICT players and appropriately profit from providing a "right to play."

ICT providers

Think "solutions" as opposed to "products": ICT players will need to develop capabilities to provide end-to-end solutions. Select global players such as IBM and Cisco have realized this opportunity as the next frontier in growing their businesses and have launched massive capability-development activities. Some regional players, thanks to their proximity to the market, have already completed pilot programs and are now rolling out city services.

Build managed service capabilities: As mentioned before, governments and developers demand turnkey solutions and are increasingly exploring innovative business models that allow them to transfer the capital expenditure investments and risk to vendors. Consequently, ICT providers with managed service/managed capacity capabilities will have an edge.

Construct partnerships: Across the wide range of decision makers and influencers involved in building a city, ICT players need to create appropriate partnerships, both on the supply side to develop capabilities and on the demand side to gain (sometimes buy) access and the right to play.

Adopt a different operating paradigm: ICT providers are used to short turnaround times for product sales or service provisioning with immediate realization of revenues. Money flows in a city build-out, however, are significantly different from those in the traditional sales model to which ICT players are accustomed. These require a long sales cycle that involves significant lobbying of governments to influence up-front design of the city's ICT master plan. Furthermore, "build, own, and transfer" (BOT)-type contracts requiring advance investment in exchange for operating rights are commonplace. These arrangements come with a delayed break-even point and much higher exposure to risk.

Conclusion

The world is urbanizing rapidly, and significant investments will be required to fulfill basic demands. The unprecedented urban growth that is expected, especially in countries such as India and China, demands a radical and proactive response. This will require a wide range of policies and practices to be conceptualized around new socially inclusive and environmentally friendly paradigms. Technology has a role to play, and the global community is waking up to it. The current situation holds tremendous potential for governments to build cities of the future that can serve as engines of growth by attracting talent and investment in the global competitive landscape. Property developers and ICT players that embrace these trends have an opportunity to cash in on the benefits.

Endnotes

1. [U.N.–Habitat](#).
2. Fourth Five-Year Plan, Planning Commission, Government of India.
3. [U.N.–Habitat](#).
4. "Reinventing the City: Three Prerequisites for Greening Urban Infrastructures," WWF and Strategy&, 2010.
5. "Reinventing the City: Three Prerequisites for Greening Urban Infrastructures," WWF and Strategy&, 2010.
6. "A Renewable Oasis," Melissa Master Cavanaugh, *strategy+business*, Spring 2010.
7. *Masdar* is the Arabic word for source.
8. ["GridWise: The Benefits of a Transformed Energy System,"](#) Pacific Northwest National Laboratory under contract with the United States Department of Energy. Retrieved 5 December 2008.

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